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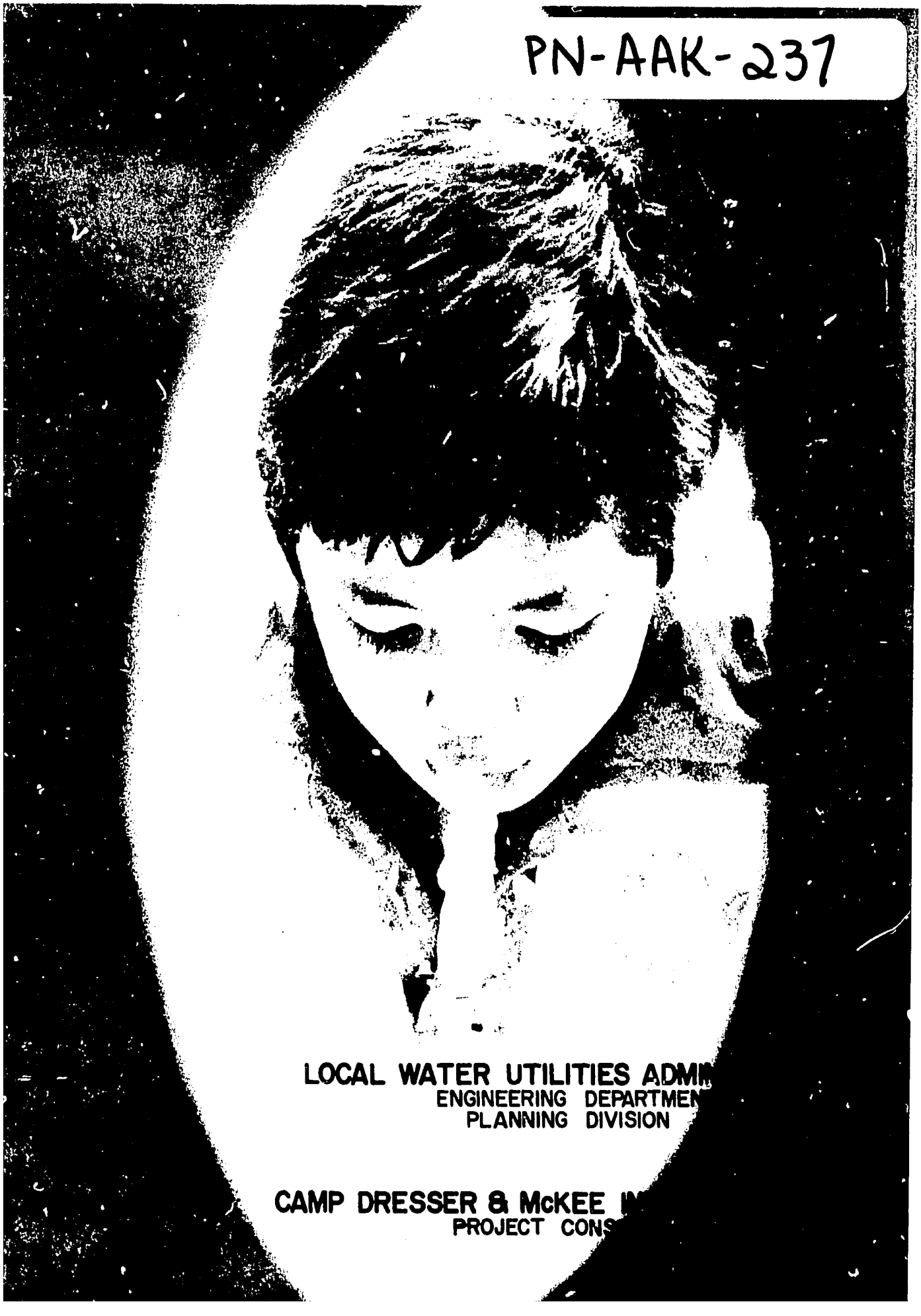

COTABATO CITY WATER DISTRICT

LOCAL WATER UTILITIES ADMI
ENGINEERING DEPARTMEN
PLANNING DIVISION

CAMP DRESSER & McKEE I
PROJECT CONS

APRIL
1978

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CHAPTER IX DESCRIPTION AND COST OF THE RECOMMENDED PLAN

A. GENERAL

This chapter describes the immediate improvement program, and the first and second stages of the long-term construction program. In addition, the capital, operation and maintenance costs of the recommended program, concepts concerning sewerage and drainage, comments regarding the management of water resources and a statement regarding the environmental impact of this project are included. Appendices F, G, N and O, Volume II contain discussions of Design Criteria, Basis of Cost Estimates, Construction Methods and Materials and Outline Specifications, respectively. The recommended construction program consists of the following implementation steps:

1. Immediate Improvement Program (1978-79)
2. Stage I Phase A of the Long-Term Construction Program (1980-85)
3. Stage I Phase B of the Long-Term Construction Program (1986-90)
4. Stage II Phase A of the Long-Term Construction Program (1991-95)
5. Stage II Phase B of the Long-Term Construction Program (1996-2000)

In some cases, facilities included in the last phases of construction are only designed for a short term to the year 2000. These facilities are included in the cost analysis of this study to determine their economic impact on the overall program. However, from a technical point of view, they may not be the most practical or economical facilities to construct. During the design of the last phases of the construction program, the design engineers should study alternatives beyond the year 2000 and design facilities accordingly.

Source

The present sources of water supply utilized by COT-WD are four wells located within Barrio Rosary Heights and the Dimapatoy River in Barrio Dimapatoy, Dinaig (municipality southwest of Cotabato City). As discussed in Chapter IV, the present capacity of the existing source facilities is approximately 6,080 cumd (2,390 cumd from Dimapatoy and 3,690 cumd from the four wells combined). The 6,080 cumd capacity is adequate to meet the projected 1981 maximum-day demand of COT-WD. However, the Dimapatoy River source will be abandoned because of its turbid water whenever it rains upstream and the absence of treatment facilities.

Four alternative sources were considered for the long-term water supply of COT-WD in Chapter VIII. Tanuel Spring supplemented by induced infiltration wells along the Simuay River is the most economical source. During the immediate improvement program, Tanuel Spring will be developed as a new source in addition to the existing city wells. Total capacity of Tanuel Spring will supply the projected water demand of COT-WD up to year 1988. From then on, induced infiltration wells along the Simuay River will be developed to meet the projected water demand of COT-WD to the year 2000.

The COT-WD should apply with the National Water Resources Council for water rights on Tanuel Spring and on the Simuay River area.

Transmission System

The existing 250 mm CCI transmission main from Dimapatoy River to Barrio Tamontaca will be abandoned as the Dimapatoy River source will be abandoned during the immediate improvement program. A new 200 mm transmission pipeline, about 7 km long, will be constructed from Tanuel Spring to Barrio Tamontaca as part of the immediate improvement program. The new line will be connected to the existing 250 mm pipeline from Barrio Tamontaca to the reservoir. An additional 350 mm transmission pipeline will be constructed parallel to the 200 mm pipeline during Phase I-A (1980-85) of the long-range program.

With the development of the Simuay River induced infiltration wells in the later part of Phase I-B (1988), a new 250 mm pipeline will be constructed from the Simuay River source to the poblacion and will be connected to the distribution system.

The second phase of the long-range program will involve the construction of a 250 mm pipeline during Phase II-A (1991-95) and another 250 mm pipeline during Phase II-B (1996-2000) from the Simuay River well field to the distribution system.

Distribution Storage

Cotabato City currently has a ground storage tank, with a capacity of 750 cum, located in the core city on top of Colina (PC) Hill. The existing tank is a reinforced concrete structure constructed in 1939. Based on the alternative studies conducted for COT-WD and presented in Chapter VIII, the least costly alternative is the maximization of storage capacity and a supply rate equal to maximum-day demand. The storage requirement of COT-WD in the year 2000 is approximately 13.3 percent of the maximum-day demand or a total storage requirement of 3,450 cum. The staged construction of the storage will be discussed in the succeeding sections. The existing tank will be used through the year 2000.

Distribution System

The existing distribution system will be expanded to serve the additional service area of the poblacion and the barrios of Rosary Heights, Bagua and Tamontaca by the year 1990. Barrio Kalanganan will be served by the year 2000.

A total length of about 29.3 km of 100 to 350 mm pipelines will be installed by 1990. This includes pipe replacements for those undersized pipelines in the existing system. By the year 2000, an additional length of about 13 km of 150 to 250 mm pipelines will be added to the system to serve the additional outlying service areas. The above lengths of pipelines do not include the new internal network pipelines that will be installed during the construction program. The distribution facilities proposed for the long-term development of the COT-WD are shown in Figure IX-1 (appended).

Administrative and Other Service Facilities

In addition to the source transmission and distribution facilities required for the production and transportation of water to consumers, it will be necessary to provide other facilities to improve administrative operation, maintenance and quality control capabilities within the water district. An administration building will be constructed and plumbing tools and meter repair facilities will be purchased during the immediate improvement program. A plumbing shop will be constructed and water quality laboratory facilities will be provided in Phase I-A (1980).

Design Considerations

The recommended program of pipeline construction reflects the results of successive computer analyses of the COT-WD distribution system. The general design criteria and methods of analysis are discussed in Appendix K of Volume II and Chapter XII of the Methodology Manual.

The method of selecting pipeline sizes consists of analyzing each pipe for the anticipated worst set of hydraulic conditions. Since each computer analysis is critical to a different series of pipes, there is no single program result that can be included herein as "design run."

The computer printouts for the peak-hour and minimum flow conditions are included in Annex IX-C as representative of the worst conditions for pipe design. The peak-hour condition can, in general, be considered as the "design run" for the majority of pipes. However, certain variations in operational modes, especially in systems with well supplies, can be more critical for some pipelines.

During the design of the recommended facilities, it is imperative that the design engineer re-run the computer program to determine the critical conditions for each pipeline to be designed. It is also important to revise the program during each design phase to take into account the actual system conditions. It is recommended that a new series of hydraulic studies of the distribution system be conducted after some improvements have been completed and the system operates with adequate pressures for 24 hours a day. The results of these studies can be incorporated into future designs. Additional considerations concerning the updating of this report are discussed in Appendix Q, Volume II.

B. IMMEDIATE IMPROVEMENT PROGRAM

While the findings and recommendations of this report are being reviewed, pending their approval by the COT-WD, LNUA and financial agencies, certain steps may be taken to facilitate immediate improvements in the COT-WD water supply system. The proposed "high impact" improvements will upgrade the service to existing consumers and will provide service to a limited number of new consumers before implementation of the initial phase of the long-term construction program.

As discussed in Chapter IV, the existing system has many deficiencies. Some corrective measures are recommended in the immediate

The immediate improvement program will improve and expand water supply service primarily by the addition of source and distribution facilities. The program will consist of the following:

1. The construction of a new spring intake structure and provision of pumping equipment.
2. The installation of about 7.0 km of 200 mm transmission pipelines.
3. The installation of about 2.2 km of 100 to 250 mm distribution pipelines as shown in Figure IX-2 and listed in Table IX-1.
4. The initiation of intensive leakage detection survey and repair program.
5. The addition of reliable disinfection equipment to provide full-time chlorination of the distribution system.
6. The metering of 1,655 existing flat-rate service connections as well as the provision of 1,018 new connections and repair of approximately 20 percent (348) of the existing connections.
7. The construction of a new administrative building and purchase of appurtenances such as shop tools, vehicles, office equipment and furniture to upgrade the operational capabilities of the water district.

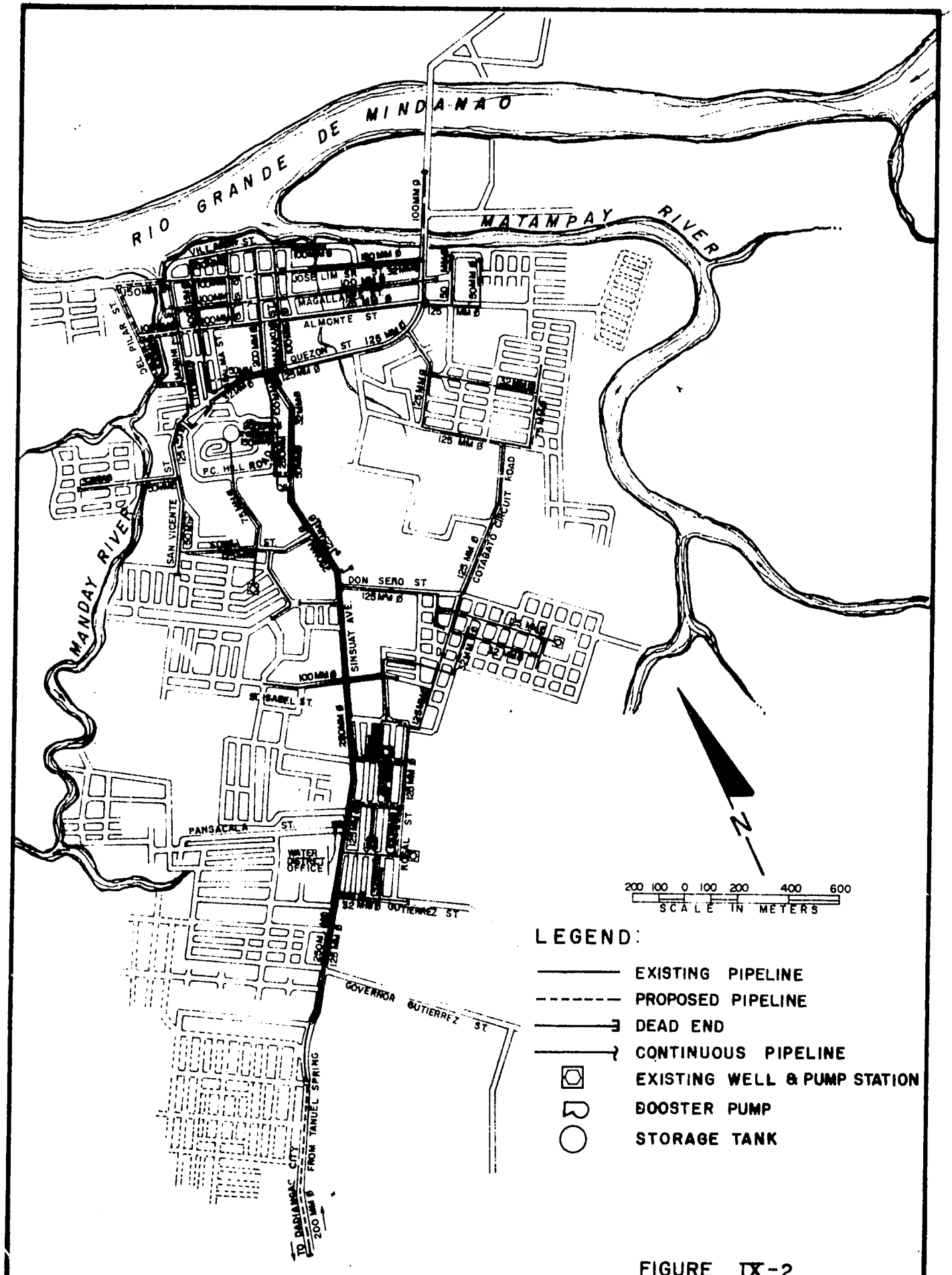


FIGURE IX-2
IMMEDIATE IMPROVEMENTS
COTABATO CITY WATER DISTRICT

FEASIBILITY STUDY FOR WATER SUPPLY OF SECOND TEN URBAN AREAS **LWUA-CDM**

TABLE IX-1

DISTRIBUTION PIPELINES
IMMEDIATE IMPROVEMENT PROGRAM
(1978-1979)

Pipe Number	Description/Location	Pipe Size (mm)	Pipe Length (m)
438	Along Santos St.	100	100
250	Along Jose Rosales Subdivision Road	100	120
251	Along Del Pilar St.	100	220
252	Along Del Pilar St.	100	200
253	Along Almonte St. near Eusebio Tanghal Subdivision	100	160
279*	Connecting line of pipes at corner of Almonte St. and Quezon Ave.	100	5
			805
423	Along Jose Lim Sr. St.	150	160
424	Along Jose Lim Sr. St.	150	260
459**	Pipe replacement on Ilang-Ilang well line	150	5
462**	Pipe replacement on Ortuoste well line	150	5
223	Along Rosal St.	150	180
254	Along Jose Lim Sr. St. near Manday	150	200
262	Connecting ine of ipes near Cotabato Light and Power Station	150	20
267	Along Rosales St.	150	200
269	Connecting lines of Pipes along Martinez St.	150	20
			1,050
	Tanuel Spring to Tamontaca	200	7,000
211	Along PC Hill Road	250	190
214	Storage tank line	250	200
			390
		Total	9,245

*Not shown in map, only a connecting pipe.
**Not shown in map, only a replacement in pump line.

The new 200 mm transmission pipeline from Tanuel spring will provide a better quality of water to the COT-WD consumers. The provision of additional 100 mm pipelines in the poblacion and Barrios Rosary Heights and Bagua will provide additional loops for better pressure and flow distribution and the installation of 250 mm pipeline along the storage tank line will lessen the pressure head loss. Existing city well pump discharge lines, 75 mm and 125 mm in diameter, will be replaced by 150 mm pipes to reduce loss in head to the system.

The provision of better pressure distribution throughout the COT-WD distribution system on a 24-hour basis will tend to aggravate the current level of system leakage and wastage. It is therefore essential that an intensive program of leakage and wastage surveys and associated system repairs be undertaken during the immediate improvement program.

Water meters will be provided for the existing 1,655 flat-rate connections. About 348 of the total present connections (1,742) will require major piping repair or replacement. Approximately 1,018 new connections will be installed, increasing the 1980 served population to 40 percent of the total 1980 service area population.

Disinfection equipment consisting of structures, chlorinators, booster pumps and scales will be installed at the existing four wells and at the Tanuel Spring pump station. This will provide adequate disinfection of water supplied to consumers.

The operational capabilities of the COT-WD will be significantly enhanced by the acquisition of land and the construction of a new administrative building, complete with office space for administration, billing and record keeping, as well as a small library. This new building will be furnished with desks, filing cabinets, typewriters, addressograph and validating machines. In addition, plumbing tools and meter repair facilities will be provided for installation and repair of water meters, service connections and pipes in the distribution system.

Table IX-2 presents the breakdown of costs (at 1978 price levels) for the immediate improvement program. The total project cost of ₱6.35 million consists of ₱3.20 million in foreign exchange and ₱3.15 million in local currency.

TABLE IX-2

COST SUMMARY[1]
IMMEDIATE IMPROVEMENT PROGRAM

Item	Cost (₱) Local	Foreign[2]	Total
Source Facilities[3]			
(Spring Intake Structure)			
Materials and Equipment	3,600	20,500	
Civil and Structural	31,400	-	
(Booster Pumping Station)			
Materials and Equipment	44,100	109,900	
Civil and Structural	103,000	-	
(Disinfection Facilities)			
Materials and Equipment	12,000	86,500	
Civil and Structural	24,000	-	
	218,100	216,900	435,000
Transmission and Distribution Facilities[3]			
(250 mm x 390 m)			
Materials and Equipment	22,600	85,800	
Civil and Structural	47,200	-	
(200 mm x 7,000 m)			
Materials and Equipment	217,000	882,000	
Civil and Structural	595,000	-	
(150 mm x 1,050 m)			
Materials and Equipment	23,100	91,400	
Civil and Structural	76,700	-	
(100 mm x 805 m)			
Materials and Equipment	3,200	32,200	
Civil and Structural	42,700	-	
(Valves)			
Materials and Equipment	7,000	21,700	
Civil and Structural	7,300	-	
(Fire Hydrants)			
Materials and Equipment	3,000	8,000	
Civil and Structural	2,700	-	
(Leakage Survey and Repair)			
Materials and Equipment	9,600	32,700	
Civil and Structural	86,500	55,000	
	1,143,600	1,208,800	2,352,400

1/ July 1978 prices.
2/ Exchange rate @ US $1.00 = ₱7.00
3/ Contingencies and engineering are 15 and 10 percent, respectively, for these items.

TABLE IX-2 (Continued)

Item	Cost (₱) Total	Foreign	Total
Administrative and Miscellaneous Facilities 4/			
(Administrative Building)			
Materials and Equipment	37,600	55,800	
Civil and Structural	363,000	-	
(Plumbing and Meter Repair Facilities)			
Materials and Equipment	4,500	93,300	
Civil and Structural	-	-	
	405,100	149,100	554,200
Sub-total 4/			
Materials and Equipment	387,300	1,519,800	1,907,100
Civil and Structural	1,379,500	55,000	1,434,500
	1,766,800	1,574,800	3,341,600
Service Connections 5/			
(1,018 new service connections, 1,655 for conversion, 348 for replacement)			
Materials and Equipment	32,900	914,600	
Civil and Structural	493,700	-	
	526,600	914,600	1,441,200
Vehicles 5/			
(2 van or pick-up)			
Materials and Equipment	60,000	60,000	
Civil and Structural	-	-	
(Miscellaneous Items)			
Materials and Equipment	5,000	8,000	
Civil and Structural	-	-	
	65,000	68,000	133,000
Sub-total 5/			
Materials and Equipment	97,900	982,600	1,080,500
Civil and Structural	493,700	-	493,700
	591,600	982,600	1,574,200
Total Construction Cost			
Materials and Equipment	485,200	2,502,400	2,987,600
Civil and Structural	1,873,200	55,000	1,928,200
Sub-total	2,358,400	2,557,400	4,915,800

4/ Contingencies and engineering are 15 and 10 percent, respectively for these items.

5/ Contingencies and engineering are 10 and 5 percent, respectively for these items.

TABLE IX-2 (Continued)

Item	Cost (₱) Local	Foreign	Total
Contingencies			
@ 15 percent	265,000	236,200	501,200
@ 10 percent	59,200	98,300	151,500
	324,200	334,500	658,700
Engineering			
@ 10 percent	134,500	249,800	384,300
@ 5 percent	30,300	56,300	86,600
	164,800	306,100	470,900
Land	300,000	-	300,000
TOTAL PROJECT COST	3,147,400	3,198,000	6,345,400

C. FIRST STAGE OF THE RECOMMENDED LONG-TERM CONSTRUCTION PROGRAM (1980-1990)

As a result of the alternative studies discussed in Chapter VIII, the COT-WD will develop Tanuel Spring and induced infiltration wells along the Simuay River as its future sources of water supply.

The first stage of the recommended construction program, including source development, treatment, transmission, distribution and storage facilities, will be implemented in two construction phases. The first construction phase will be implemented between 1980 and 1985, and the second, between 1986 and 1990.

Existing facilities will be incorporated into the recommended scheme to the maximum extent possible. Most of the existing distribution facilities constructed in 1939 will be replaced during the first stage of the construction program. The existing 250-mm distribution main line along Sinsuat Avenue and the 125- to 200-mm pipelines will be retained and incorporated into the proposed system.

As previously discussed, COT-WD will meet projected peak hour demands with supply coming from the source and the storage tanks. The existing storage tank located in Colina Hill will be retained and incorporated in the long-range program. The tank has an overflow elevation of 53 meters above MSL, which is sufficient to maintain the required pressures within the service area.

CONSTRUCTION PHASE I-A (1980-1985)

Source Development

During Phase I-A, the pumping station at Tanuel Spring constructed during the immediate improvement program will be expanded. Additional pumpsets will be installed and equipped with necessary valves and pipings. Production meters will be provided to measure total water production and will be adequately sized to be used to the year 2000. The addition of new pumpsets will increase source capacity from 2,400 cumd to 12,700 cumd. This will satisfy the projected water demands of the system under maximum-day conditions to the 1988 (See Figure IX-3). Existing city wells will then be used only as stand-by units.

The chlorination structure at Tanuel Spring will also be expanded. Additional equipment such as chlorinators, booster, pumps, scales and appurtenances will be installed.

Storage Facilities

The analysis of distribution storage in Chapter VIII indicates that a total storage capacity equivalent to 13.3 percent of maximum-day demand (3,450 cum) should be provided by the year 2000; the required

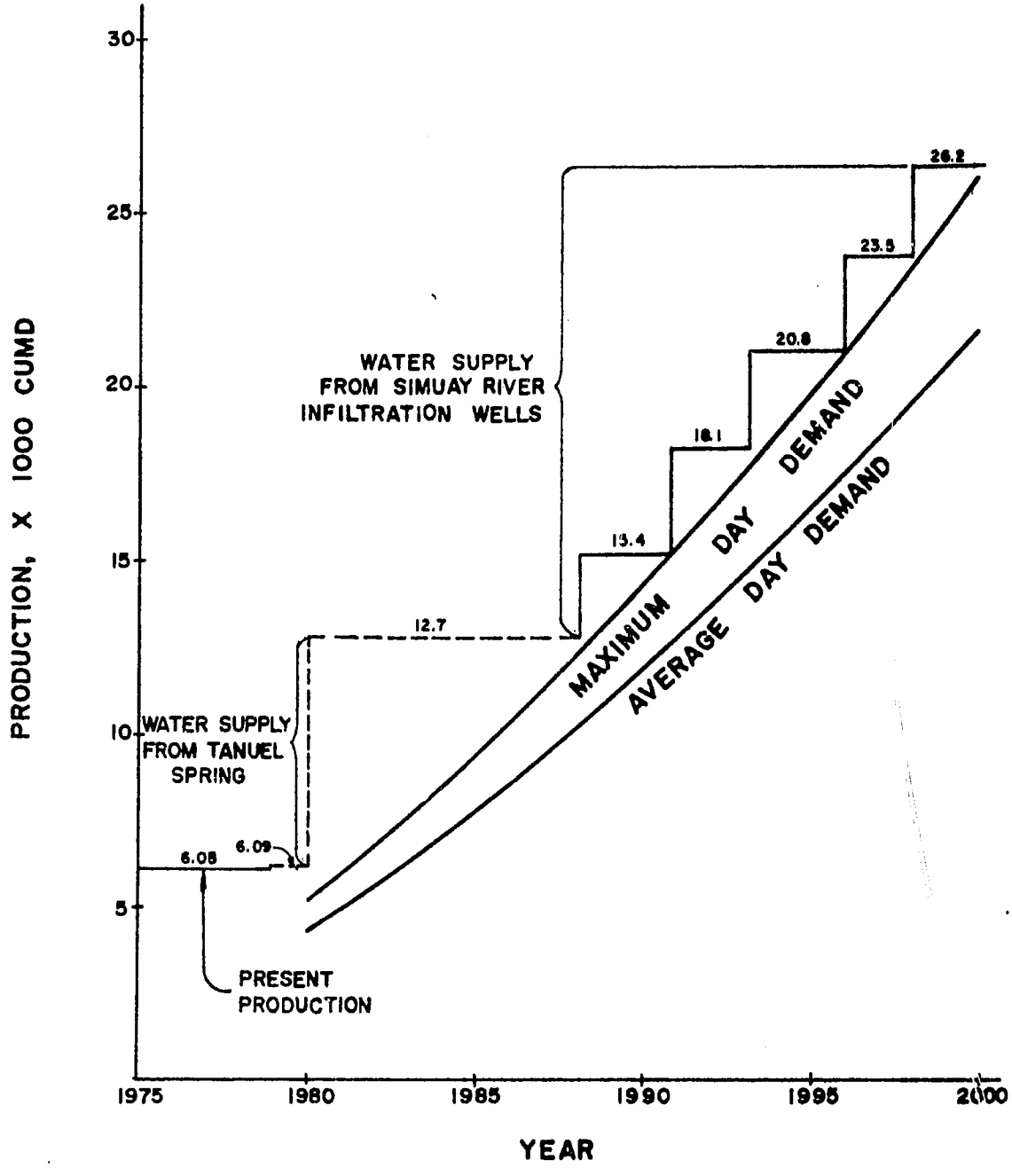


FIGURE IX-3

WATER SUPPLY/DEMAND CHART

COTABATO CITY WATER DISTRICT

FEASIBILITY STUDY FOR WATER SUPPLY OF SECOND TEN URBAN AREAS LWUA-CDM

volume has been staged in four construction phases. During Phase I-A, a 675-cum storage tank will be constructed to supplement the existing 750-cum storage tank and will be installed at the same site as the existing tank at Colina Hill, with an overflow elevation of 53 meters above MSL. The total storage volume of 1,425 cum would be adequate to meet the peak-hour demand fluctuations to the year 1986.

Transmission Facilities

During Phase I-A, a 6,570-meter transmission pipeline, 350 mm in diameter, will be installed parallel to the 200-mm pipeline from Tanuel Spring to Barrio Tamontaca and will be connected to the 350-mm distribution main extending up to the proposed storage tank. The resulting parallel system of 200-mm and 350-mm pipelines will be adequate to transmit 12,700 cumd, the full capacity of the spring.

Distribution System Facilities

Improvements to the distribution system for Phase I-A will involve replacement of existing 100-mm distribution pipelines which have poor hydraulic capacity and installation of pipeline in new service areas, thereby increasing served population.

A total length of 16,440 meters of 100- to 350-mm distribution pipelines will be installed. All pipelines recommended for Phase-I-A construction will provide hydraulic capacity for projected peak-hour flows.

Some of the recommended pipe sizes would be adequate up to year 2000; some would need reinforcement, as they are incorporated into the proposed system in succeeding construction phases. Pipelines along the existing storage tank line and Quezon Avenue will be phased out for technical reasons. Pipes recommended for Phase I-A would extend water supply to additional consumers, while reinforcement to existing pipes in succeeding construction phases would enhance hydraulic capacity as the Simuay induced infiltration wells are developed.

All necessary valves and appurtenances have been included in the cost estimates of the distribution pipelines.

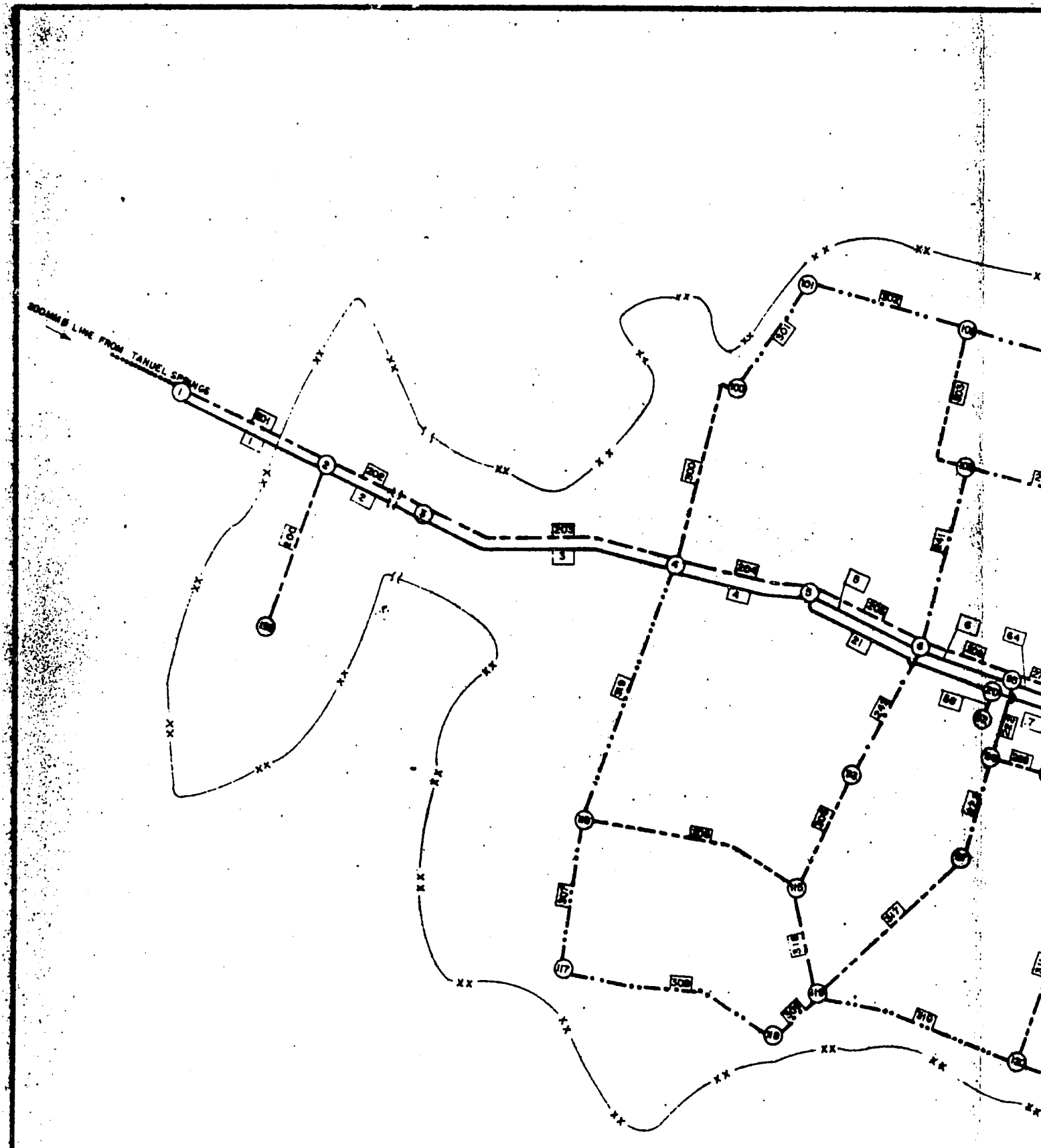
Details of pipelines for construction during Phase I-A are reflected in Table IX-3 and shown in Figures IX-1 (appended) and IX-4.

The final computer printouts for the year 2000 peak-hour conditions and for minimum flow conditions are shown in Annex IX-C.

TABLE IX-3

DISTRIBUTION PIPELINES - PHASE I-A (1980-85)

Pipe Number	Description/Location	Pipe Size (mm)	Pipe Length (m)
405	Along Bonifacio Street	100	120
406	Along Bonifacio Street	100	90
407	Along Bonifacio Street	100	110
408	Along Bonifacio Street	100	70
409	Along Quezon Avenue	100	60
413	Along Sinsuat Avenue	100	90
414	Along Villaeron Street	100	130
415	Along Villaeron Street	100	120
416	Along Villaeron Street	100	70
417	Along Villaeron Street	100	160
425	Along Magallanes Street	100	80
426	Along Magallanes Street	100	130
427	Along Magallanes Street	100	60
428	Along Magallanes Street	100	300
429	Along Magallanes Street	100	260
430	Along Magallanes Street	100	120
431	Along Almonte Street	100	80
432	Along Almonte Street	100	130
433	Along Almonte Street	100	120
434	Along Almonte Street	100	60
435	Along Almonte Street	100	60
439	Along Santos Street	100	100
445	Along Figueroa Street	100	90
446	Along Figueroa Street	100	100
447	Along Figueroa Street	100	90
282	Near Notre Dame Girls Dept. Road	100	280
283	Near Notre Dame Girls Dept. Road	100	180
255	Along Mabini and Villaeron Streets	100	140
257	Along Bonifacio Street	100	160
258	Along Aguinaldo Street	100	80
260	Along Magallanes Street	100	70
261	Along Magallanes Street	100	60
263	Along Villaeron Street	100	220
264	Along Supermarket Road	100	100
265	Along Supermarket Road	100	210
266	Along Supermarket Road	100	200
			4,500
400	Along Mabini Street	150	100
401	Along Mabini Street	150	80
402	Along Mabini Street	150	120
403	Along Mabini Street	150	90



FEASIBILITY STUDY FOR WATER SUPPLY OF SECOND TEN URBAN AREAS LWUA-CDM

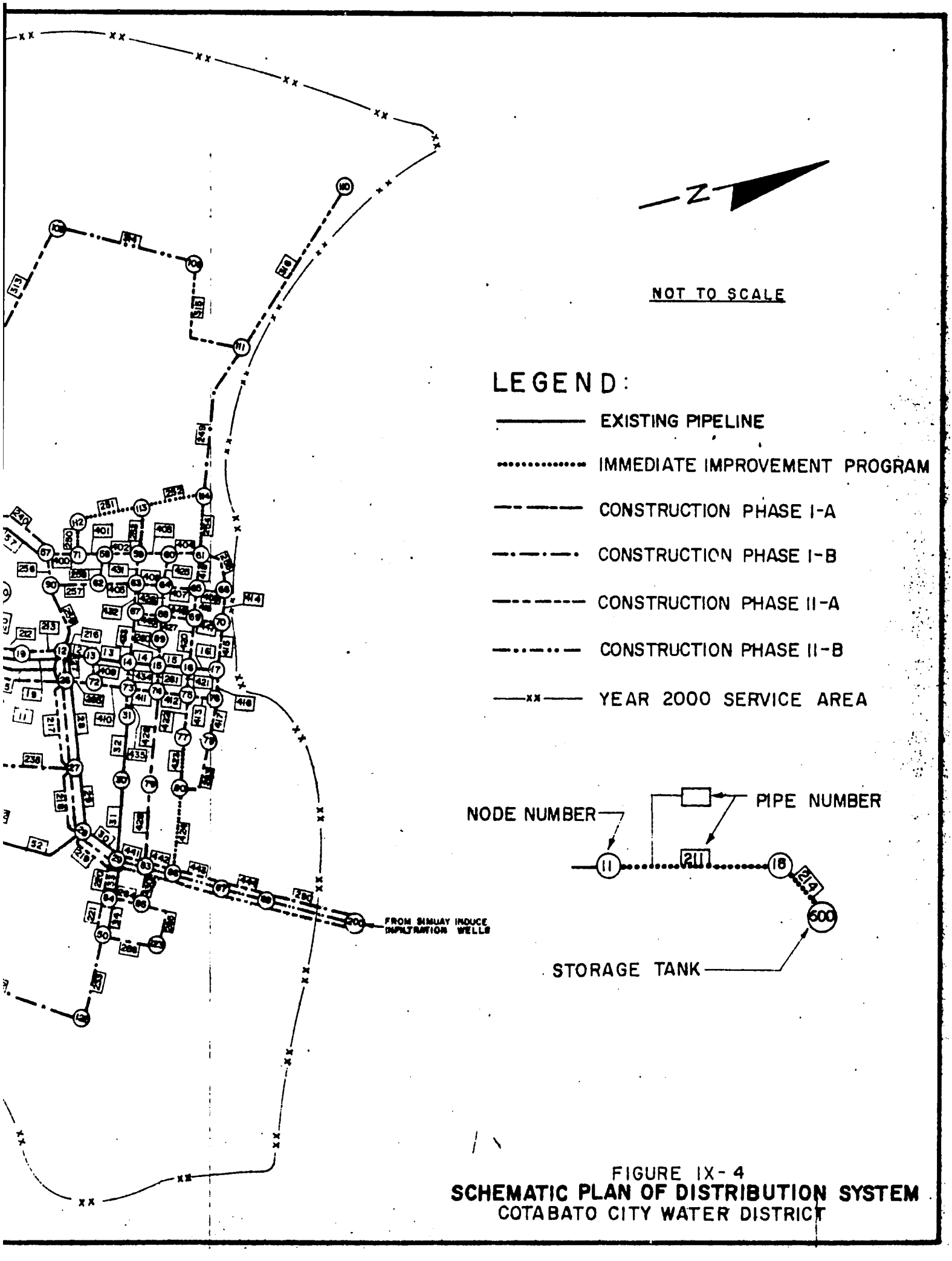


FIGURE IX-4
SCHEMATIC PLAN OF DISTRIBUTION SYSTEM
COTABATO CITY WATER DISTRICT

Table IX-3 (Continued)

Pipe Number	Description/Location	Pipe Size (mm)	Pipe Length (m)
404	Along Mabini Street	150	110
410	Along Makakua Street	150	190
411	Along Makakua Street	150	90
412	Along Makakua Street	150	110
418	Along Jose Lim Sr. Street	150	90
419	Along Jose Lim Sr. Street	150	130
420	Along Jose Lim Sr. Street	150	120
421	Along Jose Lim Sr. Street	150	60
422	Along Jose Lim Sr. Street	150	150
200	Distribution Pipeline to Bo. Tamontaca	150	500
215	Along Sinsuat Avenue near Cathedral	150	420
222	Sinsuat Avenue - Gutierrez St. to Gutierrez - Rosal Streets	150	220
224	Rosales - Rosal Streets to Rosal-Santos Streets	150	170
225	Sinsuat Avenue-Cotabato Circuit Road to Provincial Motor Pool	150	340
226	Along Cotabato Circuit Road from Provincial Motor Pool to Don Cero Street	150	230
227	Along Cotabato Circuit Road from Provincial Motor Pool to Don Cero Street	150	70
228	Along Cotabato Circuit Road from Provincial Motor Pool to Don Cero Street	150	70
239	San Vicente-Sousa Streets to San Vicente - Tulingan Streets	150	280
240	San Vicente-Tulingan Streets to San Vicente - Mabini Streets	150	320
268	Gutierrez-Rosal Streets to Rosal-Ortouste Sts.	150	180
274	Santos-Rosal Streets to Rosal-Martinez Streets	150	150
275	Martinez-Rosal Streets to Cotabato Road Junction	150	180
285	Along Makakua Street	150	10
			4,580
441	Quezon Avenue-Almonte Street to Quezon Avenue-Magallanes Street	200	90
442	Quezon Avenue-Magallanes Street to Quezon Avenue-Jose Lim Sr. Street	200	100
443	Quezon Avenue-Jose Lim Sr. Street to Quezon Avenue - Suan Street	200	180
444	Quezon Avenue - Suan Street to Quezon Avenue - Datu Siang Street	200	140
212	Along PC Hill Road	200	100
213	Along PC Hill Road	200	160
216	Along Quezon Avenue near Cathedral	200	20
217	Along Quezon Avenue near Cathedral	200	340
218	Along Quezon Avenue to Quezon Avenue - Notre Dame Avenue	200	200

Table IX-3 (Continued)

Pipe Number	Description/Location	Pipe Size (mm)	Pipe Length (m)
219	Notre Dame-Quezon Avenue to Quezon Avenue - Almonte Street	200	140
220	Quezon Avenue - Almonte Street to Supermarket Road	200	120
221	Along Almonte Street near Supermarket	200	100
256	Mabini Street to Palma Street along Quezon Avenue	200	90
259	Palma Street to Sinsuat Avenue along Quezon Avenue	200	240
			2,020
201	Along Cotabato Allah Makar National Road near Bo. Tamontaca	350	400
202	Along Cotabato Allah Makar National Road near Bo. Tamontaca	350	700
203	Along Cotabato Allah Makar National Road near Alfredo Ortouste Subdivision	350	1,460
204	Along Sinsuat Avenue near Notre Dame Hospital	350	400
205	Along Sinsuat Avenue from Notre Dame Hospital to Gov. Gutierrez Street	350	380
206	Gov. Gutierrez St. to Gutierrez Street along Sinsuat Avenue	350	280
207	Ortouste Street to Pansacala Street along Sinsuat Avenue	350	80
208	Rosales Street to Cotabato Circuit Road along Sinsuat Avenue	350	480
209	Cotabato Circuit Road to Don Sero Street along Sinsuat Avenue	350	350
210	Sousa Street to Cotabato Light and Power Plant along Sinsuat Avenue	350	290
276	Gutierrez Street to Ortouste Street along Sinsuat Avenue	350	180
			5,000
277	Pansacala Street to Rosales Street along Sinsuat Avenue	350	110
278	Don Sero Street to Sousa Street along Sinsuat Avenue	350	230
			5,340
	Total		16,440

Internal Network

The existing distribution system and internal piping network, together with the pipelines installed during the immediate improvement program, will serve approximately 202 hectares of the COT-WD area by 1980. The remaining service area will be provided with the internal piping network by 1985.

During Phase I-A, an additional area of approximately 202 hectares will be served by internal network system. This will bring the total area served by equivalent internal network system to 417 hectares by 1985. This consists of 202 hectares served by the existing system and immediate improvements; 13 hectares covered by distribution pipelines installed during Phase I-A; and the 202 hectares of internal network installed during Phase I-A. A description of internal network systems is presented in Appendix K, Volume II and details of internal network system piping installation for the COT-WD are presented in Annex IX-C.

Service Connections

During Phase I-A, approximately 2,164 service connections will be installed in Cotabato Poblacion and the barrios of Rosary Heights, Bagua and Tamontaca. The total number of connections installed by 1985 will be about 4,924 broken down into 1,742 existing connections and the 1,018 connections installed during the immediate improvement program. The rate of installation of service connections during this phase will be approximately 433 connections per year.

In addition to the new service connections proposed for this phase, 80 percent (1,394) of the existing connections will be repaired or replaced because of their age and poor installation and materials.

Details of service connection installation are presented in Annex IX-C.

Fire Protection

Fire protection will be provided for Cotabato Poblacion, barrios Rosary Heights, Bagua and Tamontaca. During Phase I-A, a total of 417 hectares, or about 37 percent of the total area to be served by 2000, will receive fire protection service by fire hydrant installation. Of this total, 172 hectares will be provided with higher level of fire protection. Portions of the Poblacion and barrios Rosary Heights, and Bagua will be provided with higher level of hydrant service because of the high-value property associated with commercial areas. Normal residential-type service will be provided for the rest of the area.

Cost Summary - Phase I-A

The cost summary for proposed construction during Phase I-A is presented in Table IX-4. Based on 1978 price levels, the total project cost for this phase is ₱21.83 million with a foreign exchange component (FEC) of ₱11.69 million, which includes direct and indirect import items. Table IX-4 also presents a cost breakdown based on materials and equipment procurement and required civil and structural work. Materials and equipment considered in this breakdown include pipes, valves, pumping equipment, water meters, hydrants, chlorinators and laboratory facilities.

CONSTRUCTION PHASE I-B (1986-1990)

Source Facilities

As discussed in Chapter VIII, the Tanuel Spring source will be supplemented with induced infiltration wells to be drilled in the Simuay River area. For the construction of these wells, the following parameters have been assumed based on limited existing well data available: (1) minimum well spacing of 500 meters, (2) well depth, 45 meters, (3) size of casing, 250 mm and (4) capacity of 2,700 cumd.

The construction of one induced infiltration well in 1988 will increase the source capacity from 12,700 cumd to 15,400 cumd, sufficient to meet the maximum-day demand until 1991.

Chlorination facilities will be installed adjacent to the well to disinfect the water supply as it is pumped into the transmission main. These facilities include a chlorinator, booster pump, scale, piping and metering equipment.

Storage Facilities

During Phase I-B, additional storage capacity of 675 cumd will be constructed to increase the storage capacity available in Phase I-A. The total storage capacity of 2,100 cum will be adequate to meet the storage requirement up to year 1991.

Transmission Facilities

The development of induced infiltration wells in the Simuay River area during Phase I-B, will require construction of a new 5,830 m, 250 mm transmission pipeline from Simuay source to Quirino Bridge in the poblacion. These will be connected to the main distribution pipeline along Quezon Avenue. The 250 mm transmission pipeline will be adequate to carry the required additional supply up to year 1993.

Distribution System

In Phase I-B, an additional length of approximately 10.6 km of 100 to 150 mm pipelines will be installed to extend service to previously unserved areas, to provide loops for better pressure distribution in some areas and to reinforce existing pipes.

TABLE IX-4

CONSTRUCTION COST SUMMARY[1]
PHASE I-A

Item	Cost (₱) Total	Foreign[2]	Total
Source Facilities[3]			
Expansion of Booster Pump Station and Chlorination Facilities at Tanuel			
Materials and Equipment	137,300	364,300	
Civil and Structural	316,000	-	
	453,300	364,300	817,600
Pipelines[3] (Transmission and Distribution)			
(11,910 m x 350 mm)			
Materials and Equipment	662,900	4,669,200	
Civil and Structural	2,449,800	-	
(2,020 m x 200 mm)			
Materials and Equipment	63,500	254,200	
Civil and Structural	171,100		
(4,580 m x 150 mm)			
Materials and Equipment	99,800	399,000	
Civil and Structural	332,500	-	
(4,500 m x 100 mm)			
Materials and Equipment	16,300	179,700	
Civil and Structural	239,600	-	
Valves[3]			
Materials and Equipment	41,100	164,400	
Civil and Structural	51,400	-	
	4,128,000	5,666,500	9,794,500
Storage Facilities[3]			
Materials and Equipment	283,400	20,200	
Civil and Structural	121,400	81,000	
	404,800	101,200	506,000

1/ 1978 Prices
2/ Exchange rate @ US $1.00 = ₱7.00
3/ Contingencies and engineering are 15 and 10 percent, respectively, for these items.

TABLE IX-4 (Continued)

Item	Cost (₱) Local	Foreign	Total
Internal Network[4]			
Materials and Equipment	112,000	876,800	
Civil and Structural	1,106,400	-	
	1,218,400	876,800	2,095,200
Fire Hydrants[4]			
Materials and Equipment	152,500	520,800	
Civil and Structural	224,200	-	
	376,700	520,800	897,500
Plumbing Shop and Laboratory Facilities[4]			
Materials and Equipment	21,000	189,000	
Civil and Structural	409,200	-	
	430,200	189,000	619,200
Sub-total[4]			
Materials and Equipment	1,589,700	7,637,600	9,227,300
Civil and Structural	5,421,700	81,000	5,502,700
	7,011,400	7,718,600	14,730,000
Service Connections[5]			
Materials and Equipment	86,100	1,469,000	
Civil and Structural	1,040,300	-	
	1,126,400	1,469,000	2,595,400
Sub-total[5]			
Materials and Equipment	86,100	1,469,000	1,555,100
Civil and Structural	1,040,300	-	1,040,300
	1,126,400	1,469,000	2,595,400
Total Construction Cost			
Materials and Equipment	1,675,800	9,106,600	10,782,400
Civil and Structural	6,462,000	81,000	6,543,000
	8,137,800	9,187,600	17,325,400

[4] Contingencies and engineering are 15 and 10 percent, respectively, for these items.

[5] Engineering and contingencies are 5 and 10 percent, respectively, for these items.

TABLE IX-4 (Continued)

Item	Cost (₱) Local	Foreign	Total
Contingencies			
@ 15 percent	1,051,700	1,157,800	2,209,500
@ 10 percent	112,600	146,900	259,500
	1,164,300	1,304,700	2,469,000
Sub-total	9,302,100	10,492,300	19,794,400
Engineering			
@ 10 percent	592,900	1,101,100	1,694,000
@ 5 percent	49,900	92,800	142,700
	642,800	1,193,900	1,836,700
Sub-total	9,944,900	11,686,200	21,631,100
Land	200,000		200,000
TOTAL PROJECT COST	10,144,900	11,686,200	21,831,100

Details of these proposed pipelines are listed in Table IX-5 and shown in Figures IX-4 and IX-1 (appended).

Internal Network

New internal network for approximately 159 hectares within the 1990 service area will be provided during Phase I-B. The total internal network area of 656 hectares served by 1990 consists of 417 hectares served in Phase I-A; 80 hectares for area served by distribution pipelines constructed in Phase I-B; and 159 hectares for area served by internal network constructed during Phase I-B. Details of internal network systems are presented in Annex IX-C.

Service Connections

During Phase I-B, a additional 3,860 service connections will be installed within the 1990 service area. The total number of service connections within the service area of COT-WD by the year 1990 will be about 8,784. The rate of service connection installation during this phase will be 772 per year (see Annex IX-C).

Fire Protection

An additional area of 239 hectares covering the poblacion and barrios of Rosary Heights, Bagua and Tamontaca will be provided with fire protection service by the installation of fire hydrants. This will provide approximately 58 percent coverage of the total areas to be covered by the year 2000 for COT-WD. Approximately 75 hectares of the 170 hectares to be provided with fire protection for Barrio Rosary Heights will receive a higher level of fire hydrant service. Normal residential-type service will be provided for the rest of the area, totalling approximately 164 hectares (see Annex IX-C for details of hydrant installation).

Cost Summary - Phase I-B

The cost summary for proposed construction during Phase I-B is presented in Table IX-6. Based on 1978 price levels, the total project cost for this phase is ₱16.54 million, with foreign exchange component of ₱7.39 million.

TABLE IX-5

DISTRIBUTION PIPELINES - PHASE I-B (1986-1990)

Pipe Number	Location/Description	Pipe Size (mm)	Pipe Length (m)
272	Along Notre Dame Avenue	150	60
229	Don Sero St., Cotabato Circuit Road to Radio Station along Don Sero St.	150	370
230	Along Don Sero St. near Sero Elementary School Extension	150	300
231	Along Cotabato Circuit Road near Notre Dame University Campus	150	620
232	Along Cotabato Circuit Road near Jose Vilo Subdivision	150	660
234	Along Notre Dame Avenue near Uy Kala Moreno Subdivision	150	220
236	Along Sousa St.	150	170
237	Along Sousa St.	150	160
238	Along Sousa St.	150	200
241	Along Cipriano Yap Subdivision Road	150	540
243	Along Julian Pascual Subdivision Road	150	260
244	Along Pansacala St.	150	690
245	Along San Vicente St. near Casimiro Bañas Subdivision	150	640
246	Cotabato Circuit Road, San Vicente to Cotabato Circuit Road, Sinsuat Avenue	150	700
247	Cotabato Circuit Road, San Vicente St. to San Vicente-Sousa St.	150	500
249	Along National Road near Kwong Cheong Fat Subdivision	150	500
270	Along Rosales St. near Luis Sero Subdivision	150	300
271	Along Notre Dame Avenue	150	320
273	Along Gutierrez St.	150	300
280	Along Don Sero St.	150	100
281	Sinsuat Avenue to Cotabato Circuit Road along Don Sero St.	150	380
286	Along Sergrotooao - Cipriano Yap Subdivision Road	150	500
			8,490
211	Reinforcement along PC Hill Road	200	190
214	Reinforcement on Storage Tank Line	200	200
233	Along Almonte St. near Marquez Subdivision	200	280
235	Along Uy Kala Moreno Subdivision Road	200	280
242	Along Governor Gutierrez Road	200	400
248	Along Tulingan St.	200	460
			1,810
290	Datu Siang St., Quezon Avenue to Quirino Bridge	250	300
		Total	10,600

TABLE IX-6

CONSTRUCTION COST SUMMARY[1]
PHASE I-B

Item	Cost (₱) Local	Foreign[2]	Total
Source Facilities[3] (1-well, pump station, Production meter and chlorination facilities)			
Materials and Equipment	99,400	193,300	
Civil and Structural	170,800	3,000	
	270,200	196,300	466,500
River Crossing and Access Road[3]			
Materials and Equipment	840,000	60,000	
Civil and Structural	760,000	240,000	
	1,600,000	300,000	1,900,000
Transmission and Distribution Facilities[3]			
(250 mm x 6,130 m)			
Materials and Equipment	355,000	1,350,000	
Civil and Structural	741,700	-	
(200 mm x 1,810 m)			
Materials and Equipment	56,900	227,800	
Civil and Structural	153,300		
(150 mm x 8,490 m)			
Materials and Equipment	184,900	739,600	
Civil and Structural	616,400	-	
(Valves)			
Materials and Equipment	24,300	77,300	
Civil and Structural	25,400	-	
	2,157,900	2,394,700	4,552,600
Internal Network (159 ha)			
Materials and Equipment	86,400	675,800	
Civil and Structural	853,000	-	
	939,400	675,800	1,615,200
Storage Facilities[3]			
Materials and Equipment	283,400	20,200	
Civil and Structural	121,400	81,000	
	404,800	101,200	506,000

1/ 1978 Prices
2/ Exchange rate @ US $1.00 = ₱7.00
3/ Contingencies and engineering are 15 and 10 percent, respectively, for these items.

TABLE IX-6 (Continued)

Item	Cost (₱) Local	Foreign	Total
Fire Hydrants[4]			
Materials and Equipment	75,000	256,100	
Civil and Structural	110,300	-	
	185,300	256,100	441,400
Sub-total[4]			
Materials and Equipment	2,005,300	3,600,100	5,605,400
Civil and Structural	3,552,300	324,000	3,876,300
	5,557,600	3,924,100	9,481,700
Service Connections[5] (3,860 new connections)			
Materials and Equipment	93,400	1,868,200	
Civil and Structural	1,261,100	-	
	1,354,500	1,868,200	3,222,700
Total Construction Cost			
Materials and Equipment	2,098,700	5,468,300	7,567,000
Civil and Structural	4,813,400	324,000	5,137,400
	6,912,100	5,792,300	12,704,400
Contingencies			
@ 15 percent	833,600	588,600	1,422,200
@ 10 percent	135,500	186,800	322,300
	969,100	775,400	1,744,500
Engineering			
@ 10 percent	381,600	708,800	1,090,400
@ 5 percent	62,100	115,200	177,300
	443,700	824,000	1,267,700
Land	820,000	-	820,000
TOTAL PROJECT COST	9,144,900	7,391,700	16,536,600

4/ Contingencies and engineering are 15 and 10 percent, respectively, for these items.

5/ Contingencies and engineering are 10 and 5 percent, respectively, for these items.

D. SECOND STAGE OF THE RECOMMENDED LONG-TERM CONSTRUCTION PROGRAM

The second stage of the recommended program includes provision of additional source, storage, transmission and distribution facilities and expansion of internal network system, service connection and fire protection facilities. These works will be implemented in two construction phases. The first phase of the second stage program will be implemented from 1991 to 1995 and the second phase, from 1996 to 2000.

CONSTRUCTION PHASE II-A (1991-1995)

Source Facilities

As previously stated, wells installed during Phase I-B will provide sufficient volume of water to meet the maximum-day water demand until 1991. To provide adequate source capacity to meet 1995 maximum-day demand, two wells will be constructed during Phase II-A. These wells will each produce an estimated 2,700 cumd, and will be constructed in 1991 and 1993, respectively. The additional 5,400 cumd source capacity provided during this construction phase will increase the total capacity to 20,800 cumd for COT-WD which will be sufficient to meet maximum-day demand until 1996 (see Figure IX-3).

Storage Facilities

An additional storage tank with a capacity of 675 cum will be constructed during Phase II-A. This will supplement the existing capacity of COT-WD. The new storage tank will be located at the existing site and will be interconnected to the tanks constructed in the first stage. The total storage capacity of 2,775 cum is enough to meet storage requirement up to year 1996.

Transmission Facilities

A second 6,830 meter transmission pipeline 250 mm in diameter, extending from induced infiltration wells in the Simuay River area to the Quirino bridge in the poblacion will be constructed during Phase II-A. From the Quirino bridge, the new pipeline will be interconnected to the main distribution pipeline along Quezon Avenue. This pipeline will provide sufficient hydraulic capacity to the year 1998.

Distribution System

The distribution system improvements recommended for COT-WD during Phase II-A will consist of the construction of additional pipelines to provide additional service to Barrio Kalanganan and to

the outlying areas previously unserved and to reinforce existing pipelines for better flow and pressure distribution. Table IX-7 is a list of the improvements recommended for construction during Phase II-A and Figures IX-4 and IX-1 (appended) show the pipelines included in Phase II-A.

Internal Network

An additional area of 203 hectares of internal network system and an equivalent area served by distribution pipelines of 50 hectares will be provided during Phase II-A. This will provide service to 53 percent of the additional area to be served between 1990 and 2000, resulting in service to about 80 percent of the served area in 2000.

Service Connections

An additional 3,821 service connections will be installed during Phase II-A, at an annual rate of approximately 764 connections per year. By the year 1995, the COT-WD will have a total of 12,605 service connections.

Fire Protection

A total of 253 hectares will be provided with fire protection service by the installation of fire hydrants during Phase II-A. This area will include the barrio of Kalanganan. By year 1995, 80 percent of the year 2000 served area will have fire protection service. Normal residential-type hydrant service will be provided for all areas during this phase.

Cost Summary - Phase II-A

A cost summary for construction during Phase II-A is presented in Table IX-8, based 1978 price levels. The total project cost for Phase II-A is ₱14.50 million, with a foreign exchange component of ₱7.46 million.

TABLE IX-7

DISTRIBUTION PIPELINES - PHASE II-A (1991-1995)

Pipe Number	Location/Description	Pipe Size (mm)	Pipe Length (m)
300	Near Ortouste Subdivision	150	560
303	Along Laureano Sebastian Subdivision Road	150	470
306	Governor Gutierrez - Maria Gutierrez St . to Maria Gutierrez - Durian St .	150	660
311	Along Lius Sero Subdivision Road	150	500
313	From Tulingan St. to Salik Panda Subdivision	150	530
315	Along the road to Lugay-Lugay Elementary School	150	400
316	Distribution pipeline to Barrio Kalanganan	150	600
317	Along Gutierrez St. near Proposed City Hall Site	150	560
318	Near Proposed City Hall Site	150	300
			4,580
441	Pipe Reinforcement from Quezon Avenue - Almonte St. to Quezon Avenue - Magallanes St.	200	90
442	Pipe Reinforcement from Quezon Avenue - Magallanes St. to Quezon Avenue - Jose Lim Sr. St.	200	100
305	Along Governor Gutierrez St.	200	360
			550
443	Pipe Reinforcement from Quezon Avenue - Jose Lim Sr. St. to Quezon Avenue - Suan St.	250	180
444	Pipe Reinforcement from Quezon Avenue - Suan St. to Quezon Avenue - Datu Siang St.	250	140
211	Pipe Reinforcement along PC Hill Road	250	190
212	Pipe Reinforcement along PC Hill Road	250	100
213	Pipe Reinforcement along PC Hill Road	250	160
214	Storage tank line reinforcement	250	200
216	Pipe Reinforcement along Quezon Avenue near cathedral	250	20
217	Pipe Reinforcement along Quezon Avenue near cathedral	250	340
218	Pipe Reinforcement along Quezon Avenue to Quezon - Notre Dame Avenue	250	200

TABLE IX-7 (Continued)

Pipe Number	Location/Description	Pipe Size (mm)	Pipe Length (m)
219	Pipe Reinforcement from Notre - Dame - Quezon Avenue to Quezon Avenue - Almonte St.	250	140
290	Pipe Reinforcement from Datu Siang St. - Quezon Avenue to Quirino Bridge	250	300
			1,970
		Total	7,100

TABLE IX-8

CONSTRUCTION COST SUMMARY[1]
PHASE II-A

Item	Cost (₱) Local	Foreign[2]	Total
Source Facilities[3]			
(2-wells, pump stations, production meters and disinfection equipment)			
Materials and Equipment	195,900	344,800	
Civil and Structural	336,800	6,000	
	532,700	350,800	883,500
Transmission and Distribution Facilities[3]			
(250 mm x 8,800 m)			
Materials and Equipment	511,100	1,937,900	
Civil and Structural	1,064,800		
(200 mm x 1,050 m)			
Materials and Equipment	33,000	132,100	
Civil and Structural	88,900	-	
(150 mm x 4,580 m)			
Materials and Equipment	99,800	399,000	
Civil and Structural	332,500		
(Valves)			
Materials and Equipment	15,100	50,100	
Civil and Structural	16,400	-	
	2,161,600	2,519,100	4,680,700
Fire Hydrants[3]			
(253 ha)			
Materials and Equipment	55,600	189,800	
Civil and Structural	81,700	-	
	137,500	189,800	327,300
Internal Network[3]			
(203 ha)			
Materials and Equipment	112,100	877,300	
Civil and Structural	1,107,200	-	
	1,219,300	877,300	2,096,600

[1] 1978 Prices
[2] Exchange rate @ US $1.00 = ₱7.00
[3] Contingencies and engineering are 15 and 10 percent, respectively, for these items.

TABLE IX-8 (Continued)

	Cost (₱)		
	Local	Foreign	Total
Storage[4] (675 cum)			
Materials and Equipment	283,400	20,200	
Civil and Structural	121,400	81,000	
	404,800	101,200	506,000
Sub-total[4]			
Materials and Equipment	1,306,000	3,951,200	5,257,200
Civil and Structural	3,149,700	87,000	3,236,700
	4,455,700	4,038,200	8,493,900
Service Connections[5] (3,821 new service connections)			
Materials and Equipment	92,500	1,849,300	
Civil and Structural	1,248,300	-	
	1,340,800	1,849,300	3,190,100
Vehicle[5] (1 vehicle)			
Materials and Equipment	30,000	30,000	
Civil and Structural	-	-	
	30,000	30,000	60,000
Sub-total[5]			
Materials and Equipment	122,500	1,879,300	2,001,800
Civil and Structural	1,248,300	-	1,248,300
	1,370,800	1,879,300	3,250,100
Total Construction Cost			
Materials and Equipment	1,428,500	5,830,500	7,259,000
Civil and Structural	4,398,000	87,000	4,485,000
	5,826,500	5,917,500	11,744,000
Contingencies			
@ 15 percent	668,400	605,700	1,274,100
@ 10 percent	137,100	187,900	325,000
	805,500	793,600	1,599,100
Engineering			
@ 10 percent	341,900,	634,900	976,800
@ 5 percent	62,600	116,200	178,800
	404,500	751,100	1,155,600
TOTAL PROJECT COST	7,036,500	7,462,200	14,498,700

4/ Contingencies and engineering are 15 and 10 percent, respectively, for these items.

5/ Contingencies and engineering are 10 and 5 percent, respectively, for these items.

CONSTRUCTION PHASE II-B (1996-2000)

Source Facilities

During this final phase of the recommended construction program, two additional wells will be required in 1996 and 1998, respectively. Each of the wells will have a capacity of 2,700 cumd, and will be provided with structures, pumping, metering, piping and disinfection facilities as required. The additional 5,400 cumd capacity provided during Phase II-B will increase the total source capacity to 26,200 cumd sufficient to satisfy system demand until the year 2000.

Storage Facilities

To meet the storage requirement for year 2000, an additional 675 cum storagecapacity will be constructed during Phase II-B. By then, a total of 2,700 cum of storage capacity will have been constructed, in addition to the existing storage tank capacity. The total volume of 3,540 cum is adequate to meet the storage requirement of COT-WD to year 2000.

Transmission Facilities

With the development of additional source capacity in the induced infiltration wells in the Simuay River area, a new 7,830-meters long, 250 mm transmission pipeline will be constructed, reinforcing the transmission pipelines installed in PhasesI-B and II-A. This parallel transmission network will provide adequate pipe capacity to the year 2000.

Distribution Facilities

During Phase II-B, an additional length of approximately 6,070 meters of 150-250 mm distribution pipelines will be installed to extend service to the (additional) outlying unserved areas, to provide loops for better pressure distribution in the system and to reinforce pipelines to increase their carrying capacity.

Table IX-9 and Figures IX-4 and IX-1 (appended) show the pipelines installed during Phase II-B.

Internal Network

During Phase II-B, an additional area of 172 hectares of internal network and an equivalent area served by distribution pipelines of 53 hectares will be provided. This will provide service to 100 percent of the year 2000 served area by the end of the construction period in 2000.

TABLE IX-9

DISTRIBUTION PIPELINES - PHASE II-B (1996-2000)

Pipe Number	Description/Location	Pipe Size (mm)	Pipe Length (m)
301	Located in Laureano Sebastian Subdivision	150	360
302	Located in Laureano Sebastian Subdivision	150	480
304	Located in Sergio Tocao Subdivision	150	520
307	Along Durian Street	150	440
308	Located in Sanguan Kamal Subdivision	150	660
309	Located in Sanguan Kamal Subdivision	150	200
310	Along Kakar Creek	150	600
312	Along Kakar Creek	150	780
314	Near Lugay-Lugay Elementary School	150	460
319	From Sinsuat Avenue to Maria Gutierrez - Durian Streets	150	760
			5,260
441	Pipe Reinforcement from Quezon Avenue - Almonte St. to Quezon Avenue - Magallanes Streets	250	90
442	Pipe Reinforcement from Quezon Avenue - Magallanes Strett to Quezon Avenue - Jose Lim Sr., Street	250	100
443	Pipe Reinforcement from Quezon Avenue - Jose Lim Sr., Street to Quezon Avenue - Suan Street	250	180
444	Pipe Reinforcement from Quezon Avenue - Suan Street, to Quezon Avenue - Datu Siang Street	250	140
290	Pipe Reinforcement from Datu Siang Street Quezon Avenue to Quirino Bridge	250	300
			810
		Total	6,070

Service Connections

Service connections will be installed at an annual rate of 1,096 connections per year during Phase II-B, to provide a total of 5,482 new connections during the period 1996-2000. By 2000, the total number of service connections within the area served by COT-WD will be 18,087.

Fire Protection

During Phase II-B, an additional area of 225 hectares will be provided with fire protection service within the COT-WD. This will provide complete coverage of the total area to be covered by the year 2000. See Annex IX-C for details of hydrant installation.

Cost Summary - Phase II-B

The cost summary for construction during Phase II-B is presented in Table IX-10. Based on 1978 price levels, the total project cost of this phase is ₱15.85 million, with a foreign exchange component of ₱8.31 million.

E. CAPITAL COST SUMMARY

The capital costs for each phase of the recommended construction program, including the immediate improvement program, are summarized in Table IX-11. The total project costs presented in this table include engineering, contingencies and land costs. All construction cost estimates are based on 1978 price levels. The foreign exchange component of the total project cost includes the cost of direct and indirect import items.

F. ANNUAL OPERATION AND MAINTENANCE COSTS

Annual operation and maintenance costs include personnel, power, fuel, chemicals, maintenance, office supplies and other miscellaneous expenses which are necessary to maintain the overall water supply system. The total annual operation and maintenance cost of the existing system was ₱583,310 in 1976. Following implementation of the immediate improvement program and the long-term construction program, the annual cost will increase due to the additional costs for personnel, chemicals, fuel and maintenance.

The annual operating and maintenance costs are estimated to be ₱0.57 million, ₱1.26 million, ₱2.37 million in 1980, 1990 and 2000 respectively. The breakdown of these costs is presented in Table IX-12. All costs shown are based on projected 1978 price levels.

TABLE IX-10

CONSTRUCTION COST SUMMARY[1]
PHASE II-B

Item	Cost in (₱) Local	FEC[2]	Total
Source Facilities (2-wells, pump stations, production meter and disinfection facilities)			
Materials and Equipment	195,900	344,800	
Civil and Structural	336,800	6,000	
	532,700	350,800	883,500
Transmission and Distribution Facilities			
(150 mm x 8,640 m)			
Materials and Equipment	501,800	1,902,500	
Civil and Structural	1,045,400	-	
(200 mm x 500 m)			
Materials and Equipment	15,700	62,900	
Civil and Structural	42,400	-	
(150 mm x 5,260 m)			
Materials and Equipment	114,600	458,300	
Civil and Structural	381,900	-	
(Valves)			
Materials and Equipment	15,800	51,700	
Civil and Structural	16,900	-	
	2,134,500	2,475,400	4,609,900
Storage[3] (675 cum)			
Materials and Equipment	283,400	20,200	
Civil and Structural	121,400	81,000	
	404,800	101,200	506,000
Internal Network[3] (172 ha)			
Materials and Equipment	95,500	747,300	
Civil and Structural	943,100	-	
	1,038,600	747,300	1,785,900

1/1978 prices.
2/Exchange rate @ U.S. $1.00 = ₱7.00
3/Contingencies and engineering are 15 and 10 percent, respectively, for these items.

TABLE IX-10 (Continued)

Items	Cost in (₱) Local	Foreign	Total
Fire Hydrants[4/]			
Materials and Equipment	50,000	170,800	
Civil and Structural	73,500	-	
	123,500	170,800	294,300
Sub-Total[4/]			
Materials and Equipment	1,272,700	3,758,500	5,031,200
Civil and Structural	2,961,400	87,000	3,048,400
	4,234,100	3,845,500	8,079,600
Service Connections[5/] (5,482 new service connections)			
Materials and Equipment	141,400	2,827,500	2,968,900
Civil and Structural	1,908,600	-	1,908,600
	2,050,000	2,827,500	4,877,500
Total Construction Cost			
Materials and Equipment	1,414,100	6,586,000	8,000,100
Civil and Structural	4,870,000	87,000	4,957,000
	6,284,100	6,673,000	12,957,100
Contingencies			
@ 15 Percent	635,100	576,800	1,211,900
@ 10 Percent	205,000	282,800	487,800
	840,100	859,600	1,699,700
Engineering			
@ 10 percent	325,200	603,900	929,100
@ 5 percent	93,900	174,400	268,300
	419,100	778,300	1,197.400
TOTAL PROJECT COST	7,543,300	8,310,900	15,854,200

4/ Contingencies and engineering are 15 and 10 percent, respectively, for these items.

5/ Contingencies and engineering are 10 and 5 percent, respectively, for these items.

TABLE IX-11

CAPITAL COST SUMMARY

Construction Phase	Construction Year	Construction Cost (₱)	Project Cost (₱) Local	FEC	Total
Immediate Improvement Program	1978-1980	4,915,800	3,147,500	3,198,000	6,345,400
I-A	1981-1985	17,325,400	10,144,900	11,686,200	21,831,100
I-B	1986-1990	12,704,400	9,144,900	7,391,700	16,536,600
II-A	1991-1995	11,744,000	7,036,500	7,462,200	14,498,700
II-B	1996-2000	12,957,100	7,543,300	8,310,900	15,854,200
		59,646,700	37,017,000	38,049,000	75,066,000

TABLE IX-12

OPERATION AND MAINTENANCE COST[1] SUMMARY

Year	Administrative and Personnel	Power[2] and Fuel	Chemicals[3]	Maintenance[4]	Miscellaneous[5]	Total
1976	130,740	420,310	-	6,330	25,930	583,310
1980	267,540	182,170	36,900	46,420	37,960	570,990
1985	290,940	298,480	57,560	161,980	61,140	870,100
1990	345,020	455,430	96,650	260,580	98,470	1,256,150
1995	411,840	621,750	126,870	371,650	158,580	1,690,690
2000	580,320	880,620	167,680	485,200	255,400	2,369,220

1/ 1978 prices.

2/ It is assumed that by 1980 and for years to come, the National Power Corporation will supply power to Cotabato City at the rate of ₱.25/kwhr. At present, power supply for Cotabato City is provided by Cotabato Light Power Corporation from a diesel-operated plant at a rate of ₱0.70/kwhr.

3/ Includes chlorine costs at ₱10.00/kg and laboratory chemicals.

4/ Includes mechanical equipment at 2% per annum and other items at ½% per annum.

5/ Based on 1976 budget, increased at 10% per annum.

G. SEWERAGE/DRAINAGE CONCEPTS

Existing Drainage System

The existing drainage facilities of Cotabato City consist mainly of a system of open canals and concrete pipes. Open canals are earth and lined varying in width from 0.3 to 1.0 meter and from 0.3 to 1.2 meter deep. Concrete pipes along some of city streets (Almonte, Makakua and parts of Mabini and Jose Lim Streets) have diameters ranging from 0.30 to 1.0 meter (see Figure IX-5). Most of these street drains are interconnected at street intersections by 0.3 meter diameter drainage culverts.

The existing facilities transport storm water runoff to Manday Creek on the west, Rio Grande de Mindanao on the north, Mindanao creek in the poblacion and to depressed swampy areas in some parts of the city. In spite of the presence of natural channels for discharge of stormwater runoff, some open canals and small ditches overflow during rainy seasons. These overflows occur at road intersection drainage culverts that are not maintained and are therefore clogged during storms.

Field observations of the drainage system in Cotabato City are as follows:

1. The main disposal areas for storm water runoff are Manday River which runs on the western side of the city and Rio Grande de Mindanao which runs along the northern side of the city. Some storm water is disposed of into depressed areas between Sinsuat Avenue and Cotabato Circuit Road and in Don Sero Subdivision.

2. Domestic wastewater is discharged directly into ditches. Some roof drainage is transported to these facilities, causing occasional flooding during rainy seasons. Although direct discharge of domestic wastewater to storm water facilities is uncommon, it is likely that an appreciable amount of domestic wastewater travels overland during rainy periods.

3. Maintenance of drainage facilities is very poor.

4. Clogging of drainage conduits is caused by disposal of solid wastes into drainage channels.

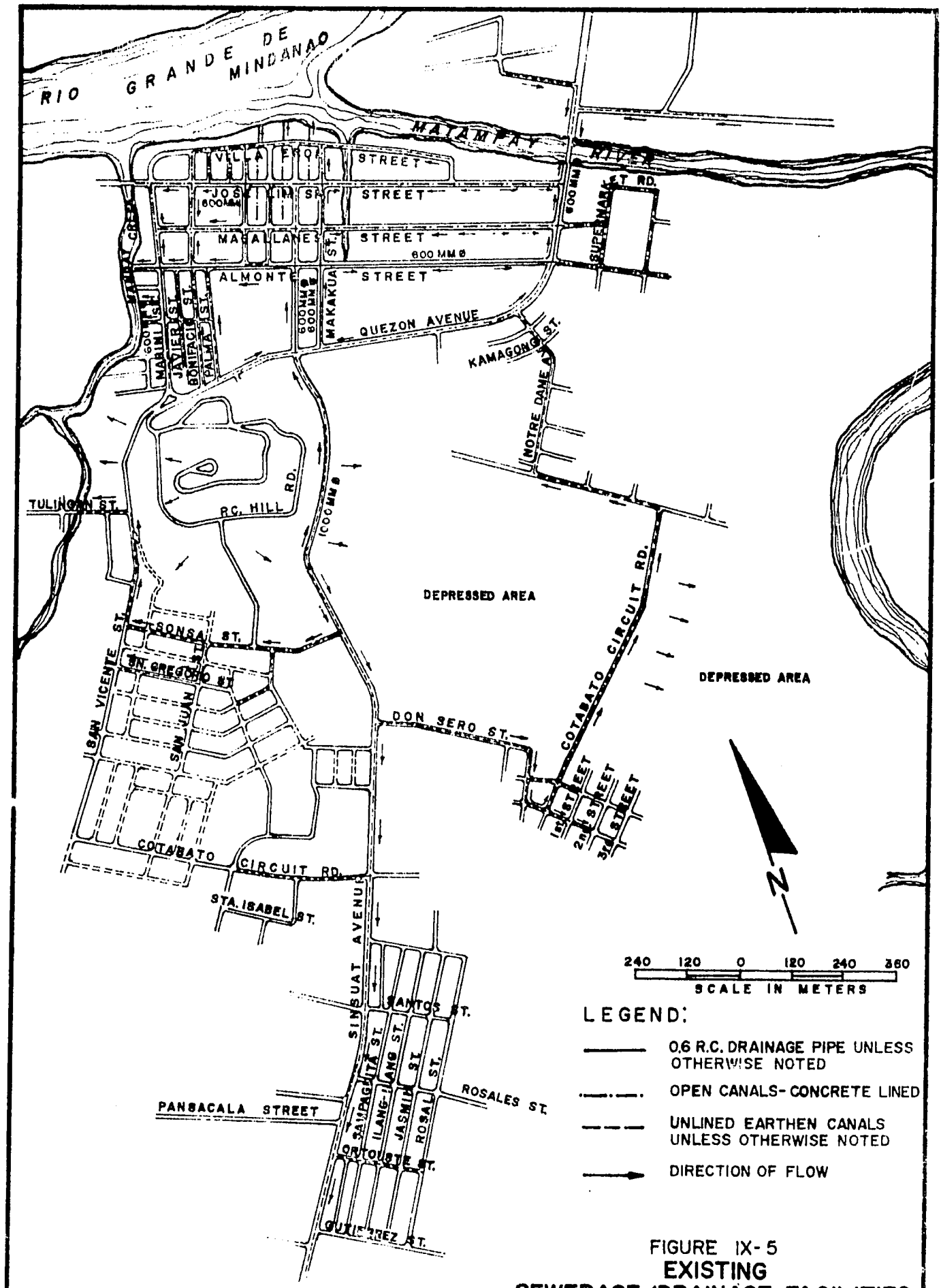


FIGURE IX-5
EXISTING SEWERAGE/DRAINAGE FACILITIES
SCHEMATIC
COTABATO CITY WATER DISTRICT

FEASIBILITY STUDY FOR WATER SUPPLY OF SECOND TEN URBAN AREAS LWUA-CDM

Relationship with Infrastructure and Other Engineering and Economic Factors

The provision of sewerage and drainage facilities within the COT-WD has a significant impact on water supply and other infrastructure components. Economics (public's ability-to-pay) and the status of public health also affect directly the feasibility of providing sewerage and drainage facilities.

In view of the current relatively minor storm water drainage problems being experienced in the COT-WD area, it appears that drainage facilities do not warrant high priority in Cotabato's list of infrastructure components. Before decisions can be made concerning the implementation of sewerage and/or drainage programs, additional technical and economic data must be collected and evaluated.

Information from the Department of Health indicates that in 1975, 37 percent of Cotabato City households had water-sealed toilet facilities; 33 percent had closed-pit type toilets; and 30 percent had no toilet facilities. Although statistics indicate that the general level of occurrence of satisfactory toilet facilities is higher in Cotabato City than in most other comparable urban communities in the Philippines, it is unlikely that such a low percentage of "modern" facilities can economically justify a near-future sewerage program.

The rationale for the provision of wastewater facilities has traditionally been based on aesthetics and public health benefits. At present, there is an obvious water supply problem in the COT-WD. As the water supply problem is resolved, wastewater volumes will increase. Related aesthetic and public health standards will improve in time, increasing the urgency for solution of the wastewater problem.

Projected Wastewater Volumes

Wastewater flows in COT-WD have been projected for the years 1990, 2000, 2005 and 2025. These estimates are shown in Table IX-13.

The service area considered for the wastewater projections is the core area to receive water supply by 1980. This area is the most densely populated area in the water district, and is the area where public health and nuisance problems associated with wastewater will be greatest. Although it is projected that the entire water service area would receive sewer service, only the poblacion and Barrio Rosary Heights will receive sewer service by the year 2025. This decision was based on high annual sewer connection rate required to sewer the poblacion, Rosary Heights, Bagua and Tamontaca.

The wastewater volume which could be collected was determined by estimating the percentage of water supply connections (domestic and commercial/industrial/institutional) receiving sewer connections during the design period from 1990 to 2025. It was assumed that all water supply connections would have sewer connections by 2025, and that in 1990, 30 percent of domestic and 50 percent of commercial/industrial/institutional water supply connections would have sewer connections. It was assumed that no unusually large water-consuming connections would occur during the design period and that 90 percent of water consumed would therefore be returned to the sewers. An allowance was made for groundwater infiltration into the sewers, based on projected percentage of physical area with sewers and an infiltration rate of 0.15 lps/hectare. The resultant number of sewer connections required during the design period was then checked to ensure that the annual rate of sewer connections was realistically within the physical capabilities of the water district.

Alternatives Available

The cost of sewerage/drainage facilities for the COT-WD area is expected to be significant.

The provision of a financially self-sufficient sewerage/drainage system is seldom achieved even in developed countries. It is likely that the COT-WD is no exception to this rule.

Feasible alternatives for sewerage in the COT-WD area appear to be as follows:

1. individual (septic tanks) or unified public collection system;

2. combined or separate sewerage/drainage systems;

3. various degrees of centralized community sewage treatment;

4. disposal system (river or land disposal) for treated sewage.

The question of whether the COT-WD should construct a combined or a separate sewerage/drainage system depends on economic circumstances.

An alternative to the combined system which must be investigated in detail during the sewerage feasibility study is the provision of open canals (peripheral drains).

Alternative treatment and disposal methods for intercepted wastewater may consist of:

1. Screening of gross solids, high-rate lagoons and effluent discharge into Rio Grande de Mindanao.

TABLE IX-13

AVERAGE DAILY WASTEWATER FLOWS
COTABATO CITY WATER DISTRICT

Served Area	Design Year	Wastewater Flows (cumd) Domestic	Commercial/ Industrial/ Institutional	Infiltration Allowance	Total
Poblacion	1990	1,240	330	640	2,210
	2000	3,400	860	830	5,090
	2005	5,060	1,440	910	7,410
	2025	18,340	4,580	1,270	24,190
Rosary Heights	1990	0	0	0	0
	2000	2,240	670	990	3,900
	2005	3,240	1,020	1,100	5,360
	2025	10,060	3,770	1,530	15,360
Total	1990	1,240	330	640	2,210
	2000	5,640	1,530	1,820	8,990
	2005	8,300	2,460	2,010	12,770
	2025	28,400	8,380	2,800	39,580

2. Some form of treatment such as conventional primary or high-rate secondary treatment may be applied. Treated wastes may potentially be used for agricultural irrigation.

Recommendations

As soon as the first phase of the water supply program is underway, a comprehensive sewerage/drainage feasibility study should be undertaken. This study must address the issue of combined versus separate sewers. It should also update the population and water demand projections of this water supply study.

Once the decision has been made to use either the combined or separate system, the water district must embark as promptly as possible on a street sewering and house connection program.

A plumbing code should be developed by the COT-WD to coordinate plumbing requirements for water, wastewater and surface runoff facilities. This code becomes very important and meaningful particularly if a separate system of sewers is adopted.

In the meantime, a house-to-house survey should be conducted to inventory existing wastewater and toilet facilities. As-built drawings of storm drains and peripheral canals must be compiled and accurately recorded in preparation for the sewerage/drainage feasibility study.

For residences and establishments that currently lack waste disposal facilities and are financially unable to provide the modern flush toilet with septic tank, the Department of Health (Division of Environmental Sanitation) has developed an inexpensive water-seal toilet.

Permanent rights-of-way should be acquired for the main routes that will be used for drainage/sewerage conduits.

The current practice of dumping solid wastes into waterways, canals and manholes, should be strictly prohibited. Solid wastes not only pollute the water, but are also very unsightly and serve as habitats for flies, rodents and parasites. The proper handling of solid wastes should be studied and planned carefully.

H. MANAGEMENT OF WATER RESOURCES

In order to make the best use of water resources available for present and future use of COT-WD, certain technical and management steps must be considered. These considerations are primarily related

to the collection of data concerning the chemical quality and amount of water produced by the district, and a data storage and retrieval system which would provide easy access to those organizations dealing with the subject. These are discussed further in Appendix P, Volume II of this report.

I. UPDATING THE WATER SUPPLY MASTER PLAN

To be a meaningful working document, this water supply master plan must be periodically updated. Changes related to technological developments, social goals, land use concepts, unforeseen population growth or movement, etc., must be reviewed for possible long-range impact on the programs recommended in this report. An outline of the steps required for such periodic updating is presented in Appendix Q, Volume II.

J. ENVIRONMENTAL CONSIDERATIONS

Appendix R, Volume II discusses some of the ways the recommended program may affect the environment of the study area. Some of the natural resources affected by the program are irreplaceable, requiring due consideration before actual construction.

ANNEX IX-C

DISTRIBUTION SYSTEM GROWTH

ANNEX IX-C

DISTRIBUTION SYSTEM GROWTH

General

It is necessary to project the growth of the distribution system in order to estimate the required expenditures for the internal network piping, service connections, and fire hydrant requirements. The projection of distribution system growth is based on (1) an apportionment of the served population among individual sections within the service area, (2) the projected number of people served by each connection, and (3) the anticipated total area of individual served sections within the service area. The details of these items are discussed below.

Served Population

The projections of served population presented in Chapter VI are presented in Annex Table IX-C-1 according to individual community served and respective service areas in 1976, 1980, 1990 and 2000.

Number of Persons Per Connection

Based on the pilot area study carried out within the present (1976) service area, the present number of persons served by a single service connection is approximately 8.0 It is estimated that the overall served population per service connection within the water district service area is slightly less. It has been assumed that the effects of future increased living standards and family planning will be offset by the effects of future inward migration, and that the resultant per-connection population will be approximately 7 persons for the 1990 study period and 6 persons for the 2000 study period.

Total Served Area for Individual Communities

The total served areas of the individual served communities have been projected on the basis of field studies and locations with potential consumers of the COT-WD water supply. These projections are presented in Annex Table IX-C-2.

Area Served by Internal Network Systems

In order to project the net area to be served by internal network piping, the gross served areas presented in Annex Table IX-C-2 were reduced in proportion to the expected percentage of population

served (as shown in Annex Table IX-C-1). Served populations in 1980, 1990 and 2000 are expected to be approximately 40, 70 and 80 percent, respectively, of the total population within the corresponding service areas. It has therefore been assumed that 81 and 86 percent of the total service area will actually receive water service by the years 1990 and 2000, respectively. For the 1980 service area, about 55 percent of the total area (367 ha) or 202 hectares will receive water service by 1980. The remainder of the 1980 service area will be served fully by the year 1985.

ANNEX TABLE IX-C-1

SERVED POPULATION PROJECTIONS
COTABATO CITY WATER DISTRICT

Community per Community Served	1976 Service Area	1980 Service Area	1990 Service Area	2000 Service Area
Poblacion	6,192	10,200	27,440	44,640
Rosary Heights	6,232	9,592	27,650	49,010
Bagua	1,200	1,792	4,480	9,656
Tamontaca	312	496	1,920	4,240
Kalanganan	-	-	-	974
Total Served Population	13,936	22,080	61,490	108,520
Total Service Area Population	50,300	55,170	87,840	135,650
Percent Served	28	40	70	80

ANNEX TABLE IX-C-2

TOTAL SERVICE AREA (ha)
COTABATO CITY WATER DISTRICT

Community Served	1976 Service Area	1980 Service Area	1990 Service Area	2000 Service Area
Poblacion	98	98	174	217
Rosary Heights	236	236	507	782
Bagua	13.5	13.5	42	143
Tamontaca	19.5	19.5	90	145
Kalanganan	-	-	-	32
Total Service Area	367	367	813	1,319

The resultant areas to receive internal network system are given in Annex Table IX-C-3, according to service area, and Annex Table IX-C-4, according to construction phase. It has also been assumed that distribution system pipelines passing through the service area will provide service to the areas within 50 meters on each side of the pipelines. The corresponding areas served by the distribution system pipelines are listed in Annex Table IX-C-5, according to construction phase. The net areas served by internal network system are shown in Annex Table IX-C-6.

ANNEX TABLE IX-C-3

TOTAL AREA SERVED BY INTERNAL NETWORK SYSTEM, BY SERVICE AREA (ha)

Community Served		1980 Service Area 1/	1990 Service Area	2000 Service Area
Poblacion	(90)	98	148	206
Rosary Heights	(95)	236	406	665
Bagua	(7)	13.5	34	115
Tamontaca	(10)	19.5	68	123
Kalanganan		-	-	25
Total	(202) 2/	367	656	1,134

ANNEX TABLE IX-C-4

TOTAL AREA SERVED BY INTERNAL NETWORK SYSTEM BY CONSTRUCTION PHASE (ha)

Community Served		Phase I-A (1981-85)	Phase I-B (1986-90)	Phase II-A (1991-95)	Phase II-B (1996-2000)
Poblacion	(90)	33	25	29	29
Rosary Heights	(95)	141	170	130	129
Bagua	(7)	7	20	41	40
Tamontaca	(10)	34	24	28	27
Kalanganan		-	-	25	-
Total	(202) 3/	215	239	253	225
Cumulative Total		417	656	909	1,134

1/ Remainder of the 1980 service area not served by 1980 will be served by 1985.

2/ Area served by 1980, including the immediate improvement program pipelines.

3/ Area served by 1980.

ANNEX TABLE IX-C-5

INTERNAL NETWORK ALLOWANCE FOR DISTRIBUTION PIPES (ha)

Community Served	Phase I-A (1981-85)	Phase I-B (1986-90)	Phase II-A (1991-95)	Phase II-B (1996-2000)	Total
Poblacion	-	15	-	-	15
Rosary Heights	8	55	34	48	145
Bagua	-	10	10	5	25
Tamontaca	5	-	-	-	5
Kalanganan	-	-	6	-	6
Total	13	80	50	53	196

ANNEX TABLE IX-C-6

AREA SERVED BY INTERNAL NETWORK SYSTEM (ha)

Community Served	1980[1]	Phase I-A (1981-85)	Phase I-B (1986-90)	Phase II-A (1991-95)	Phase II-B (1996-2000)
Poblacion	90	33	10	29	29
Rosary Heights	95	133	115	96	81
Bagua	7	7	10	31	35
Tamontaca	10	29	24	28	27
Kalanganan	-	-	-	19	-
Total	202	202	159	203	172
Area Served by Distribution Pipelines (ha)		13	80	50	53
Cumulative Total Equivalent Internal Network (ha)		417	656	909	1,134

Number of Service Connections

The number of service connections to be installed is obtained by dividing the served population (see Annex Table IX-C-1) by the average number of persons per connection. The estimated number of service connections for each community within the service area is presented in Annex Table IX-C-7 by service area and Annex Table IX-C-8 by construction phase.

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[1] Includes area served by distribution pipeline.

ANNEX TABLE IX-C-7

SCHEDULE FOR SERVICE CONNECTION INSTALLATION

	1976 Service Area	1980 Service Area	1990 Service Area	2000 Service Area
Poblacion	(774)*	501	2,645	3,520
Rosary Heights	(779)*	420	2,751	4,220
Bagua	(150)*	74	416	970
Tamontaca	(39)*	23	212	433
Kalanganan	-	-	-	160
Total	(1742)*	1,018	6,024	9,303
Cumulative Total	1,742	2,760	8,784	18,087

ANNEX TABLE IX-C-8

SCHEDULE OF SERVICE CONNECTION INSTALLATION
BY CONSTRUCTION PHASE

Community Served	Immediate Improvement Program	Phase I-A (1981-85)	Phase I-B (1986-90)	Phase II-A (1991-95)	Phase II-B (1996-2000)
Poblacion	501	952	1,693	1,452	2,068
Rosary Heights	420	974	1,777	1,719	2,501
Bagua	74	151	265	382	588
Tamontaca	23	87	125	191	242
Kalanganan	-	-	-	77	83
	1,018	2,164	3.860	3,821	5,482
Cumulative Total (including existing 1,742 connections)	2,760	4,924	8,784	12,605	18,087
Rate per Year	509	433	772	764	1,090

*Existing service connections

During the leakage survey to be conducted during the immediate improvement program, it is expected that some existing service connections will be identified as major sources of leakage. It has therefore been anticipated that 20 percent of existing service connections will require major repair or replacement by 1980, and that the remaining 80 percent will be repaired or replaced during Phase I-A.

Areas Receiving Fire Protection

The total area to receive water supply by 2000 will also receive fire protection by the same year. A high level of fire protection will be provided for areas where high property values or high population densities are expected. Hence, 44 percent of the poblacion and 23 percent of Barrio Rosary Heights served areas will receive high-level fire protection. The rest of the communities served will be provided with normal residential-type of fire hydrant service. The schedule of fire hydrant installation is presented in Annex Table IX-C-9.

ANNEX TABLE IX-C-9

SCHEDULE FOR FIRE HYDRANT INSTALLATION BY CONSTRUCTION PHASE

	Areas Receiving Fire Protection					
Community Served	Phase I-A (1981-85)		Phase I-B (1986-90)	Phase II-A (1991-95)	Phase II-B (1996-2000)	Total
Poblacion	(90)	123	25	29	29	206
Rosary Heights	(75)	236	(75) 170	130	129	665
Bagua	(7)	14	20	41	40	115
Tamontaca		44	24	28	27	123
Kalanganan		-	-	25	-	25
	(171)	417*	(75) 239	253	225	1,134
Cumulative Total		417	656	909	1,134	

* Total area receiving fire protection includes both the high-value residential, commercial and industrial areas and the single-family residential areas. Figures in parentheses indicate areas to receive higher level of hydrant service.

Distribution System Computer Printouts

The computer printouts (Annex Tables IX-C-10, IX-C-11 and IX-C-12) indicate the estimated hydraulic conditions within the COT-WD distribution system in the year 2000. The peak-hour and minimum-flow conditions are included as representative of the design conditions at that time. The critical conditions for some pipelines may not have been the peak or minimum conditions, but the majority of proposed pipelines are carrying design flows during peak-hour conditions.

The format of Annex Tables IX-C-10, IX-C-11 and IX-C-12 is discussed in Chapter XII of the Methodology Manual. Pipeline numbers from 1 to 66 shown on the computer printouts are existing pipelines that were retained and incorporated in the long-range program. Existing pipelines that are to be replaced immediately are those numbered from 400 to 447 as shown on the printouts. The "200" series pipelines are pipes to be installed to satisfy 1990 conditions. The "300" series pipelines are to satisfy the 2000 design conditions.

Some of the pipelines in the recommended construction program may appear to be in a construction phase not indicated by appropriate pipe numbers. This may result from other conditions governing the staging of recommended facilities.

COMPUTER PRINTOUT (CONT'D)
YEAR 2000 PEAK HOUR

COROZAL CITY WATER DISTRICT YEAR 2000 PEAK HOUR CONDITION

INPUT AND OUTPUT IN	LPS
NO OF NODES	125
NO OF PIPES	213
MAX NO OF ITERATIONS	20
PEAKING FACTOR	1.75000
ALLOW P-DROP FR/STATIC - PCT	30.0
STATIC HGL FOR P-DROP CALC	53.0
MAX UNBAL - LPS	0.05000
MAX ALLOW VEL -MPS	3.000
MIN ALLOW VEL - MPS	0.400
MAX ALLOW HL - M/1000 M	10.00
MIN ALLOW HL - M/1000 M	0.30
MAX ALLOW PRESS - ATM	7.000
MIN ALLOW PRESS - ATM	0.700
NO OF HEADS TO BE READ	1
NO OF UNKNOWN CONSUMPTIONS	1
SUM OF FIXED DEMANDS	137.67
BANDWIDTH	18

ITER 1	UNBAL	79.38 LPS
ITER 2	UNBAL	39.86 LPS
ITER 3	UNBAL	26.25 LPS
ITER 4	UNBAL	12.02 LPS
ITER 5	UNBAL	5.08 LPS
ITER 6	UNBAL	2.26 LPS
ITER 7	UNBAL	0.82 LPS
ITER 8	UNBAL	0.16 LPS
ITER 9	UNBAL	0.02 LPS

SOLUTION NO. 1 REACHED IN 9 ITERATIONS
0.0208 LPS UNBALANCE

ANNEX TABLE IX-C-10 (continued)

	FROM	TO	MM									
1	1	2	250	400.	90	0.242E-02	34.75	0.71		1.72	4.31	
[illegible]	2	3	250	700.	90	0.423E-02	31.76	0.65		2.55	3.65	
[illegible]	3	4	250	1460.	[illegible]	[illegible]	30.69	[illegible]		[illegible]	[illegible]	
4	4	5	250	400.	90	0.242E-02	22.98	0.47		0.80	2.00	
5	5	6	250	380.	90	0.230E-02	21.07	0.43		0.65	1.71	
[illegible]	6	95	250	280.	90	0.169E-02	12.51	0.25	LO	0.18	0.65	
[illegible]	7	8	250	80.	90	0.483E-03	7.45	0.15	LO	0.02	0.25	LO
[illegible]	9	21	250	480.	90	0.290E-02	0.39	0.01	LO	0.00	0.00	LO
[illegible]	24	9	250	350.	90	0.211E-02	6.50	0.13	LO	0.07	0.19	LO
[illegible]	11	10	250	290.	90	0.175E-02	16.49	0.34	LO	0.31	1.08	
11	11	12	250	420.	90	0.254E-02	5.10	0.10	LO	0.05	0.12	LO
12	12	13	250	20.	90	0.121E-03	19.11	0.39	LO	0.33	1.42	
13	13	14	200	200.	90	0.358E-02	16.32	0.52		0.63	3.15	
14	14	15	200	90.	90	0.161E-02	11.75	0.37	LO	0.15	1.71	
15	15	16	200	100.	90	0.179E-02	8.86	0.28	LO	0.10	1.02	
16	16	17	200	100.	90	0.179E-02	3.00	0.10	LO	0.01	0.14	LO
17	16	11	150	190.	60	0.293E-01	4.42	0.25	LO	0.46	2.42	
18	18	19	150	100.	60	0.154E-01	4.00	0.23	LO	0.20	2.01	
19	19	12	150	160.	60	0.246E-01	3.93	0.22	LO	0.31	1.94	
20	500	18	150	200.	60	0.308E-01	7.04	0.40	LO	1.14	5.71	
21	5	20	125	660.	60	0.247E 00	1.95	0.16	LO	0.85	1.29	
22	20	21	125	360.	60	0.135E 00	0.73	0.06	LO	0.07	0.21	LO
23	21	22	125	170.	60	0.636E-01	4.17	0.34	LO	0.89	5.26	
24	22	23	125	310.	60	0.116E 00	1.36	0.11	LO	0.20	0.66	
25	24	23	125	350.	60	0.131E 00	3.26	0.27	LO	1.17	3.33	
26	25	24	125	520.	60	0.195E 00	1.52	0.12	LO	0.42	0.81	
27	12	26	125	20.	60	0.749E-02	0.07	0.01	LO	0.00	0.00	LO
28	27	26	125	340.	60	0.127E 00	0.46	0.04	LO	0.03	0.09	LO
29	28	27	125	200.	60	0.749E-01	1.88	0.15	LO	0.24	1.20	
30	29	28	125	140.	60	0.524E-01	2.49	0.20	LO	0.28	2.02	
31	29	30	125	260.	60	0.973E-01	3.83	0.31	LO	1.17	4.50	
32	30	31	125	240.	60	0.898E-01	0.77	0.06	LO	0.05	0.23	LO
33	29	84	125	120.	60	0.449E-01	5.21	0.42		0.95	7.95	
34	84	50	125	100.	60	0.374E-01	4.87	0.40	LO	0.70	7.02	
35	7	33	125	110.	60	0.412E-01	5.69	0.46		1.03	9.35	
36	35	34	125	100.	60	0.374E-01	0.24	0.02	LO	0.00	0.03	LO
37	35	36	125	170.	60	0.636E-01	1.02	0.08	LO	0.07	0.39	
38	36	38	125	150.	60	0.561E-01	1.08	0.09	LO	0.06	0.43	
39	40	39	150	60.	100	0.359E-02	1.83	0.10	LO	0.01	0.18	LO
40	41	40	150	170.	100	0.102E-01	2.57	0.15	LO	0.06	0.34	
41	23	41	150	150.	100	0.857E-02	3.30	0.19	LO	0.08	0.55	
42	38	42	125	180.	60	0.674E-01	0.91	0.07	LO	0.06	0.31	
43	42	43	125	230.	60	0.861E-01	2.81	0.23	LO	0.58	2.54	
44	43	44	125	70.	60	0.262E-01	2.28	0.19	LO	0.12	1.72	
45	47	44	125	150.	60	0.561E-01	2.70	0.22	LO	0.35	2.36	
46	24	47	125	380.	60	0.142E 00	3.85	0.31	LO	1.73	4.54	
47	44	45	125	370.	60	0.138E 00	1.96	0.16	LO	0.48	1.30	
48	45	46	125	70.	60	0.262E-01	0.98	0.08	LO	0.03	0.36	
49	44	91	125	70.	60	0.262E-01	2.22	0.18	LO	0.11	1.63	
50	91	99	125	620.	60	0.232E 00	2.27	0.18	LO	1.06	1.71	

ANNEX TABLE IX-C-10 (continued)

[illegible]	FROM-TO	[illegible] MM	MTRS	[illegible] C	[illegible]	FLOW MPS--CK	[illegible]	[illegible] MT	[illegible] MT/1000	[illegible] CK
[illegible]	49	48 125	320.	60	0.120E 00	2.32	0.19 LO	0.57	1.78	
[illegible]	28	49 125	360.	60	0.135E 00	6.01	0.49	3.73	10.36	HI
[illegible]	10	51 125	170.	60	0.636E-01	5.00	0.41	1.25	7.37	
[illegible]4	51	54 125	160.	60	0.599E-01	4.47	0.36 LO	0.96	5.99	
[illegible]	54	55 125	200.	60	0.749E-01	3.41	0.28 LO	0.72	3.62	
[illegible]	55	56 125	280.	60	0.105E 00	2.82	0.23 LO	0.72	2.56	
[illegible]7	57	56 125	360.	60	0.135E 00	4.08	0.33 LO	1.32	5.37	
[illegible]8	20	32 125	100.	60	0.374E-01	0.49	0.04 LO	0.01	0.10	LO
[illegible]3	99	48 125	60.	60	0.225E-01	4.68	0.38 LO	0.39	6.52	
[illegible]	95	7 250	180.	90	0.109E-02	9.52	0.19 LO	0.07	0.39	
[illegible]	8	21 250	110.	90	0.664E-03	3.32	0.07 LO	0.01	0.06	LO
[illegible]6	10	24 250	230.	90	0.139E-02	11.30	0.23 LO	0.12	0.54	
[illegible]0	57	71 150	100.	100	0.598E-02	7.06	0.40 LO	0.22	2.23	
[illegible]1	71	58 150	80.	100	0.478E-02	2.41	0.14 LO	0.02	0.31	
[illegible]02	58	59 150	120.	100	0.719E-02	3.34	0.19 LO	0.07	0.56	
[illegible]03	59	60 150	90.	100	0.538E-02	0.73	0.04 LO	0.00	0.03	LO
[illegible]04	60	61 150	110.	100	0.658E-02	2.79	0.16 LO	0.04	0.40	
[illegible]05	63	62 100	120.	100	0.517E-01	0.36	0.05 LO	0.01	0.06	LO
[illegible]06	64	63 100	90.	100	0.388E-01	0.50	0.06 LO	0.01	0.12	LO
[illegible]07	65	64 100	110.	100	0.474E-01	0.67	0.09 LO	0.02	0.21	LO
[illegible]08	66	65 100	70.	100	0.302E-01	0.27	0.03 LO	0.00	0.04	LO
[illegible]09	13	72 100	60.	100	0.259E-01	0.62	0.08 LO	0.01	0.18	LO
[illegible]10	72	73 150	190.	100	0.114E-01	8.39	0.47	0.58	3.07	
[illegible]11	73	74 150	90.	100	0.538E-02	5.08	0.29 LO	0.11	1.21	
[illegible]12	74	75 150	110.	100	0.658E-02	3.37	0.19 LO	0.06	0.57	
[illegible]13	75	76 100	90.	100	0.388E-01	1.13	0.14 LO	0.05	0.54	
[illegible]14	70	66 100	130.	100	0.560E-01	3.50	0.45	0.57	4.39	
[illegible]15	17	70 100	120.	100	0.517E-01	3.92	0.50	0.65	5.40	
[illegible]16	76	17 100	70.	100	0.302E-01	1.76	0.22 LO	0.09	1.23	
[illegible]7	78	76 100	160.	100	0.689E-01	1.38	0.18 LO	0.13	0.79	
[illegible]18	65	61 150	90.	100	0.538E-02	8.77	0.50	0.30	3.34	
[illegible]9	69	65 150	130.	100	0.777E-02	10.22	0.58	0.58	4.43	
[illegible]0	16	69 150	120.	100	0.718E-02	11.49	0.65	0.66	5.50	
[illegible]1	75	16 150	60.	100	0.359E-02	6.67	0.38 LO	0.12	2.01	
[illegible]	77	75 150	150.	100	0.897E-02	5.47	0.31 LO	0.21	1.39	
[illegible]4	86	80 150	260.	100	0.155E-01	11.52	0.65	1.44	5.53	
23	80	77 150	160.	100	0.957E-02	6.89	0.39 LO	0.34	2.13	
25	64	60 100	80.	100	0.345E-01	2.81	0.36 LO	0.23	2.92	
26	68	64 100	130.	100	0.560E-01	3.59	0.46	0.60	4.59	
[illegible]7	89	68 100	60.	100	0.259E-01	3.90	0.50	0.32	5.35	
[illegible]28	79	74 100	300.	100	0.129E 00	1.66	0.21 LO	0.33	1.11	
29	83	79 100	260.	100	0.112E 00	3.64	0.46	1.23	4.72	
[illegible]30	83	85 100	120.	100	0.517E-01	5.49	0.70	1.21	10.09	HI
31	63	59 100	80.	100	0.345E-01	2.72	0.35 LO	0.22	2.75	
[illegible]32	67	63 100	130.	100	0.560E-01	3.63	0.46	0.61	4.69	
[illegible]33	14	67 100	120.	100	0.517E-01	4.72	0.60	0.91	7.62	
[illegible]4	73	14 100	60.	100	0.259E-01	1.19	0.15 LO	0.04	0.60	
35	73	31 100	60.	100	0.259E-01	1.37	0.17 LO	0.05	0.77	
[illegible]8	37	36 100	100.	100	0.431E-01	1.67	0.21 LO	0.11	1.12	
[illegible]9	22	37 100	100.	100	0.431E-01	2.16	0.28 LO	0.18	1.80	

ANNEX TABLE IX-C-10 (continued)

	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	85	29	350	90.	100	0.6335E-04	[illegible]	0.96		0.27	3.01	
	[illegible]	[illegible]	[illegible]	100.	120	[illegible]	102.91	[illegible]		[illegible]	[illegible]	
	87	86	[illegible]	130.	[illegible]	[illegible]	116.18	[illegible]		[illegible]	4.50	
	88	87	350	140.	120	0.9645E-04	115.05	1.40		0.55	6.07	
	67	68	100	90.	100	0.3685E-01	0.25	0.03	LO	0.09	0.38	LO
	[illegible]	68	130	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	LO	[illegible]	[illegible]	LO
	[illegible]	70	[illegible]	[illegible]	100	[illegible]	[illegible]	[illegible]	LO	[illegible]	[illegible]	[illegible]
	2	125	150	500.	100	0.2091E-01	8.12	0.46		1.45	2.69	
	1	2	350	400.	120	0.2791E-03	117.75	1.17		1.72	4.31	
	[illegible]	3	350	[illegible]	120	0.4827E-03	102.42	1.37		[illegible]	1.65	
	3	4	350	[illegible]	120	[illegible]	99.16	[illegible]		5.06	[illegible]	
	4	5	350	420.	120	[illegible]	74.24	0.77		0.80	[illegible]	
	5	6	350	380.	120	0.2521E-03	68.07	0.71		0.65	1.71	
	6	95	350	280.	120	0.1938E-03	40.40	0.42		0.18	0.65	
	7	8	350	60.	120	[illegible]	94.09	[illegible]	LO	0.07	[illegible]	LO
	9	21	350	460.	120	[illegible]	1.25	0.01	LO	0.06	0.03	LO
	24	9	350	350.	120	0.2415E-03	21.00	0.22	LO	0.07	0.19	LO
	11	10	350	390.	120	0.2005E-03	53.27	0.55		0.31	1.09	
	13	11	350	190.	120	0.1315E-03	87.12	0.87		0.46	2.42	
	18	19	300	190.	110	0.1717E-03	45.38	0.64		0.20	2.01	
	19	12	300	160.	110	[illegible]	44.57	0.63		0.31	1.44	
	600	18	350	200.	120	0.1285E-03	130.64	1.36		1.14	5.71	
	11	26	150	420.	100	0.2515E-01	1.45	0.08	LO	0.07	0.12	LO
	12	26	300	20.	110	[illegible]	1.15	0.12	LO	0.00	0.03	LO
	27	26	300	340.	110	0.5935E-03	8.50	0.12	LO	0.03	0.09	LO
	26	27	300	200.	110	0.3438E-03	34.45	0.49		0.24	1.20	
	29	28	300	140.	110	0.2415E-03	45.61	0.65		0.29	2.07	
	29	84	200	120.	110	0.1485E-02	32.86	1.05		0.95	7.99	
	84	50	200	100.	110	0.1235E-02	30.73	0.98		0.70	7.07	
	95	96	150	220.	100	0.1325E-01	10.92	0.62		1.10	5.30	
	33	35	150	180.	100	0.1085E-01	3.64	0.21	LO	0.13	0.51	
	35	36	150	170.	100	0.1025E-01	2.75	0.16	LO	0.07	0.39	
	9	42	150	340.	100	0.2035E-01	8.47	0.54		1.31	3.95	
	42	43	150	230.	100	0.1336E-01	7.57	0.43		0.58	2.94	
	43	44	150	70.	100	0.4195E-02	6.14	0.35	LO	0.12	1.73	
	44	91	150	70.	100	0.4195E-02	5.97	0.34	LO	0.11	1.63	
	91	92	150	370.	100	0.2215E-01	6.67	0.38	LO	0.74	2.01	
	92	121	150	300.	100	0.1795E-01	3.97	0.22	LO	0.23	0.77	
	91	99	150	620.	100	0.3715E-01	6.11	0.35	LO	1.06	1.71	
	122	99	150	660.	100	0.3955E-01	4.66	0.26	LO	0.69	1.03	
	50	122	200	280.	110	0.3465E-02	29.79	0.95		1.36	6.63	
	124	98	150	220.	100	0.1325E-01	15.98	0.90		2.23	10.32	HI
	27	124	200	280.	110	0.3465E-02	23.59	0.75		1.20	4.30	
	10	51	150	170.	100	0.1025E-01	13.46	0.76		1.25	7.37	
	51	54	150	160.	100	0.9575E-02	12.03	0.68		0.96	5.99	
	54	55	150	200.	100	0.1205E-01	9.17	0.52		0.72	[illegible]	
	55	56	150	280.	100	0.1675E-01	7.60	0.43		0.72	2.56	
	57	56	150	320.	100	0.1915E-01	11.72	0.66		1.22	5.73	
	6	103	150	540.	100	0.3235E-01	10.22	0.58		2.39	4.42	
	6	93	200	400.	110	0.6945E-02	21.85	0.75		1.48	3.73	

BEST AVAILABLE DOCUMENT

ANNEX TABLE IX-C-10 (continued)

NO.	TEST FROM	TO	DIA MM.	L MIPS	H-W C	S-VALUE	FLOW	-MPI- MPS	CK	MT	MT/1000	CK
243	105	104	150	260.	100	0.155E-01	1.99	0.11	LO	0.06	0.21	LO
244	8	105	150	640.	100	0.413E-01	8.76	0.50		2.30	3.33	
245	105	106	150	640.	100	0.383E-01	2.08	0.12	LO	0.15	0.23	LO
246	9	106	150	700.	100	0.419E-01	8.99	0.51		2.44	3.49	
247	106	55	150	500.	100	0.299E-01	3.49	0.20	LO	0.30	0.61	
248	56	107	200	460.	110	0.568E-02	22.30	0.71		1.78	3.98	
249	114	111	150	500.	100	0.299E-01	12.92	0.71		3.22	6.45	
250	71	112	100	120.	100	0.517E-01	3.84	0.49		0.62	5.20	
251	112	113	100	220.	100	0.948E-01	2.19	0.28	LO	0.41	1.84	
252	113	114	100	200.	100	0.862E-01	2.45	0.31	LO	0.45	2.27	
[illegible]	59	113	100	160.	100	0.689E-01	4.09	0.52		0.94	5.86	
[illegible]	61	114	150	200.	100	0.120E-01	12.81	0.73		1.35	6.73	
[illegible]	56	61	100	140.	100	0.603E-01	2.39	0.30	LO	0.30	2.16	
[illegible]	90	57	200	90.	110	0.111E-02	25.40	0.81		0.44	4.93	
[illegible]	90	62	100	160.	100	0.689E-01	3.06	0.39	LO	0.55	3.41	
[illegible]	62	58	100	80.	100	0.345E-01	2.17	0.28	LO	0.15	1.81	
[illegible]	12	90	200	240.	110	0.296E-02	30.34	0.97		1.65	6.86	
[illegible]	15	89	100	70.	100	0.302E-01	4.26	0.54		0.44	6.32	
[illegible]	74	15	100	60.	100	0.259E-01	1.85	0.24	LO	0.08	1.35	
[illegible]	11	25	150	20.	100	0.120E-02	4.13	0.23	LO	0.02	0.83	
[illegible]	80	78	100	220.	100	0.948E-01	2.38	0.30	LO	0.47	2.15	
[illegible]	85	84	100	100.	100	0.431E-01	0.54	0.07	LO	0.01	0.14	LO
[illegible]	85	123	100	210.	100	0.905E-01	3.06	0.39	LO	0.72	3.42	
[illegible]	50	123	100	200.	100	0.862E-01	0.14	0.02	LO	0.00	0.01	LO
[illegible]	21	35	150	200.	100	0.120E-01	11.61	0.66		1.12	5.60	
[illegible]	33	96	150	180.	100	0.108E-01	0.33	0.02	LO	0.00	0.01	LO
[illegible]	39	38	150	20.	100	0.120E-02	1.10	0.06	LO	0.00	0.07	LO
[illegible]	35	94	150	300.	100	0.179E-01	9.52	0.54		1.16	3.88	
[illegible]	98	99	150	320.	100	0.191E-01	3.90	0.22	LO	0.24	0.74	
[illegible]	98	49	150	60.	100	0.259E-01	1.56	0.20	LO	0.06	0.98	
[illegible]	96	97	150	300.	100	0.179E-01	9.29	0.53		1.11	3.71	
[illegible]	36	38	150	150.	100	0.897E-02	2.90	0.16	LO	0.06	0.43	
[illegible]	38	42	150	180.	100	0.108E-01	2.45	0.14	LO	0.06	0.31	
276	95	7	350	180.	120	0.124E-03	30.75	0.32	LO	0.07	0.39	
277	8	21	350	110.	120	0.757E-04	10.73	0.11	LO	0.01	0.06	LO
278	10	24	350	230.	120	0.158E-03	36.51	0.38	LO	0.12	0.54	
280	47	91	150	100.	100	0.599E-02	10.53	0.60		0.47	4.68	
281	24	47	150	380.	100	0.227E-01	10.37	0.59		1.73	4.54	
282	52	53	100	280.	100	0.121E 00	0.49	0.06	LO	0.03	0.11	LO
283	51	52	100	180.	100	0.776E-01	1.22	0.16	LO	0.11	0.63	
285	26	72	150	10.	100	0.598E-03	9.57	0.54		0.04	3.92	
286	103	105	150	500.	100	0.299E-01	2.64	0.15	LO	0.18	0.36	
290	200	88	400	300.	120	0.108E-03	153.00	1.22		1.20	3.99	
300	4	100	150	560.	100	0.335E-01	11.22	0.64		2.95	5.27	
301	100	101	150	360.	100	0.215E-01	6.10	0.35	LO	0.61	1.70	
302	101	102	150	480.	100	0.287E-01	3.89	0.22	LO	0.36	0.74	
303	103	102	150	470.	100	0.281E-01	1.71	0.10	LO	0.08	0.16	LO
304	102	104	150	520.	100	0.311E-01	2.42	0.14	LO	0.16	0.31	
305	93	115	200	360.	110	0.445E-02	17.95	0.57		0.93	2.59	
306	115	116	150	660.	100	0.395E-01	3.46	0.20	LO	0.39	0.60	

ANNEX TABLE IX-C-10 (continued)

NO	FROM-TO		NM	MTRS	H-W C	K-VALUE	FLOW	--VEL-- MPS	--CK	--HEADLOSS-- MT	MT/1000	CK
307	116	117	150	440.	100	0.263E-01	5.30	0.30	LO	0.58	1.31	
308	118	117	150	660.	100	0.395E-01	1.56	0.09	LO	0.09	0.14	LO
309	119	118	150	200.	100	0.120E-01	5.48	0.31	LO	0.28	1.39	
310	119	120	150	600.	100	0.359E-01	2.17	0.12	LO	0.15	0.25	LO
311	94	120	150	500.	100	0.299E-01	5.13	0.29	LO	0.62	1.23	
312	120	121	150	780.	110	0.391E-01	2.40	0.14	LO	0.20	0.25	LO
313	107	108	150	530.	100	0.317E-01	9.48	0.54		2.04	3.85	
314	109	108	150	460.	100	0.275E-01	2.20	0.12	LO	0.12	0.26	LO
315	111	109	150	400.	100	0.239E-01	5.70	0.32	LO	0.60	1.50	
316	111	110	150	600.	100	0.359E-01	4.02	0.23	LO	0.47	0.79	
317	97	119	150	560.	100	0.335E-01	4.90	0.28	LO	0.63	1.13	
318	115	119	150	300.	100	0.179E-01	6.67	0.38	LO	0.60	2.01	
319	4	116	150	760.	100	0.455E-01	11.63	0.66		4.27	5.62	

ANNEX TABLE IX-C-10 (continued)

NODE	CURRENT ELEV	FLOW	HGL ELEV	HEAD FTRS	PRESSURE ATM---CK	PRESSURE PCT DROP---CK
1	10.0	147.00	59.90U	49.90	4.83	-16.05
2	2.0	-4.51	58.18U	56.18	5.44	-10.15
3	2.0	-4.51	55.62U	53.62	5.19	-5.14
4	2.0	-9.78	50.62U	48.62	4.71	4.66
5	10.0	-6.13	49.82U	39.82	3.85	7.40
6	10.0	-4.16	49.17U	39.17	3.79	8.90
7	10.0	-3.04	48.92U	38.92	3.77	9.49
8	10.0	-8.71	48.90U	38.90	3.77	9.54
9	15.0	-7.40	48.89U	33.89	3.28	10.81
10	12.0	-3.48	49.08U	37.08	3.59	9.55
11	15.0	-6.09	49.40U	34.40	3.33	9.48
12	5.0	-2.92	49.35U	44.35	4.29	7.61
13	3.0	-2.17	49.32U	46.32	4.48	7.36
14	3.0	-1.05	48.69U	45.69	4.42	8.62
15	3.0	-0.47	48.53U	45.53	4.41	8.93
16	3.0	-1.05	48.43U	45.43	4.40	9.14
17	3.0	-0.84	48.42U	45.42	4.40	9.16
18	20.0	-1.75	49.86U	29.86	2.89	9.52
19	20.0	-0.88	49.66U	29.66	2.87	10.13
20	10.0	-0.73	48.97U	38.97	3.77	9.38
21	10.0	-0.65	48.89U	38.89	3.77	9.55
22	10.0	-0.65	48.00U	38.00	3.68	11.63
23	15.0	-1.31	47.79U	32.79	3.17	13.70
24	12.0	-4.36	48.96U	36.96	3.58	9.85
25	15.0	-2.61	49.38U	34.38	3.33	9.52
26	5.0	-2.08	49.35U	44.35	4.29	7.61
27	3.0	-3.78	49.38U	46.38	4.49	7.24
28	3.0	-5.76	49.62U	46.62	4.51	6.76
29	3.0	-2.45	49.90U	46.90	4.54	6.20
30	3.0	-3.06	48.73U	45.73	4.43	8.53
31	3.0	-2.13	48.68U	45.68	4.42	8.64
32	10.0	-0.49	48.96U	38.96	3.77	9.40
33	10.0	-1.71	47.89U	37.89	3.67	11.88
34	10.0	-0.24	47.77U	37.77	3.66	12.16
35	10.0	-1.71	47.77U	37.77	3.66	12.16
36	10.0	-1.47	47.71U	37.71	3.65	12.31
37	10.0	-0.49	47.82U	37.82	3.66	12.05
38	12.0	-1.71	47.64U	35.64	3.45	13.07
39	12.0	-0.73	47.64U	35.64	3.45	13.07
40	13.0	-0.73	47.65U	34.65	3.35	13.37
41	13.0	-0.73	47.71U	34.71	3.36	13.22
42	10.0	-2.45	47.59U	37.59	3.64	12.59
43	10.0	-1.96	47.00U	37.00	3.58	13.95
44	10.0	-0.98	46.88U	36.88	3.57	14.23
45	10.0	-0.98	46.40U	36.40	3.52	15.35
46	10.0	-0.98	46.37U	36.37	3.52	15.41
47	10.0	-0.98	47.23U	37.23	3.60	13.41
48	3.0	-7.00	45.32U	42.32	4.10	15.36
49	3.0	-5.25	45.89U	42.89	4.15	14.22
50	3.0	-5.67	48.25U	45.25	4.38	9.51

ANNEX TABLE IX-C-10 (continued)

[illegible]	[illegible] ELEV	FLOW	[illegible] ELEV	MEAN [illegible]	PRESSURE ATM---CK	PRESSURE PCT DROP---CK
53	10.0	-0.73	47.83U	37.83	3.66	12.02
54	6.0	-0.73	47.72U	41.72	4.04	11.24
53	6.0	-0.49	47.69U	41.69	4.04	11.31
54	5.0	-3.92	46.87U	41.87	4.05	12.76
55	5.0	-5.65	46.15U	41.15	3.98	14.27
56	8.0	-3.92	45.43U	37.43	3.62	16.82
57	10.0	-2.54	47.26U	37.26	3.61	13.35
58	4.0	-1.24	47.01U	43.01	4.16	12.22
59	3.0	-1.24	46.94U	43.94	4.25	12.11
60	3.0	-0.75	46.94U	43.94	4.25	12.12
61	3.0	-1.14	46.90U	43.90	4.25	12.21
62	4.0	-1.24	47.16U	43.16	4.18	11.93
63	3.0	-1.05	47.16U	44.16	4.28	11.67
64	3.0	-0.94	47.17U	44.17	4.28	11.65
65	3.0	-1.05	47.20U	44.20	4.28	11.61
66	3.0	-0.84	47.20U	44.20	4.28	11.60
67	3.0	-0.84	47.77U	44.77	4.33	10.45
68	3.0	-0.75	47.77U	44.77	4.33	10.46
69	3.0	-0.84	47.77U	44.77	4.33	10.45
70	3.0	-0.65	47.77U	44.77	4.33	10.46
71	6.0	-0.80	47.04U	41.04	3.97	12.69
72	5.0	-1.80	49.31U	44.31	4.29	7.69
73	3.0	-0.75	48.72U	45.72	4.43	8.55
74	3.0	-1.52	48.61U	45.61	4.42	8.77
75	3.0	-1.03	48.55U	45.55	4.41	8.89
76	3.0	-0.75	48.50U	45.50	4.41	8.99
77	3.0	-1.42	48.76U	45.76	4.43	8.48
78	3.0	-1.00	48.63U	45.63	4.42	8.74
79	3.0	-1.98	48.95U	45.95	4.45	8.11
80	3.0	-2.26	49.10U	46.10	4.46	7.80
83	3.0	-1.33	50.17U	47.17	4.57	5.65
84	3.0	-3.01	48.95U	45.95	4.45	8.10
85	3.0	-1.89	48.96U	45.96	4.45	8.08
86	3.0	-1.73	50.54U	47.54	4.60	4.92
87	3.0	-18.88	51.37U	48.37	4.68	3.27
88	3.0	-17.95	52.22U	49.22	4.76	1.57
89	3.0	-0.37	48.09U	45.09	4.37	9.82
90	8.0	-1.89	47.70U	39.70	3.84	11.77
91	10.0	-3.67	46.77U	36.77	3.56	14.50
92	10.0	-2.69	46.02U	36.02	3.49	16.22
93	10.0	-3.90	47.68U	37.68	3.65	12.38
94	10.0	-4.39	46.61U	36.61	3.54	14.87
95	10.0	-1.71	48.99U	38.99	3.77	9.33
96	10.0	-1.96	47.89U	37.89	3.67	11.89
97	10.0	-4.39	46.78U	36.78	3.56	14.48
98	3.0	-10.52	45.95U	42.95	4.16	14.11
99	3.0	-12.25	45.71U	42.71	4.13	14.58
100	4.0	-5.13	47.67U	43.67	4.23	10.87
101	3.0	-2.20	47.06U	44.06	4.27	11.88
102	3.0	-3.18	46.71U	43.71	4.23	12.59

ANNEX TABLE IX-C-10 (continued)

Node	Shaft ELEV	Flow	Hdr ELEV	Head MTRS	ATM---CK		PCT DROP---CK
102	5.0	-5.86	46.78U	41.78	4.04		12.96
104	3.0	-4.41	46.55U	43.55	4.22		12.[illegible]
105	3.0	-7.33	46.60U	43.60	4.22		12.80
106	3.0	-7.58	46.45U	43.45	4.21		13.10
107	3.0	-12.83	43.65U	40.65	3.94		18.70
108	3.0	-11.67	41.61U	38.61	3.74		22.78
109	3.0	-3.51	41.73U	38.73	3.75		22.54
110	2.0	-4.02	41.85U	39.85	3.86		21.85
111	3.0	-2.30	42.33U	39.33	3.81		21.35
112	3.0	-1.64	46.41U	43.41	4.20		13.18
113	3.0	-3.83	46.01U	43.01	4.16		13.99
114	3.0	-2.75	45.55U	42.55	4.12		14.90
115	10.0	-7.82	46.74U	36.74	3.56		14.55
116	3.0	-9.78	46.35U	43.35	4.20		13.30
117	3.0	-6.86	45.77U	42.77	4.14		14.45
118	5.0	-3.92	45.86U	40.86	3.96		14.87
119	8.0	-3.92	46.14U	38.14	3.69		15.24
120	3.0	-4.90	45.99U	42.99	4.16		14.02
121	10.0	-6.37	45.79U	35.79	3.46		16.76
122	3.0	-25.13	46.39U	43.39	4.20		13.22
123	3.0	-3.20	48.24U	45.24	4.38		9.51
124	3.0	-7.61	48.17U	45.17	4.37		9.65
125	3.0	-8.12	56.73U	53.73	5.20		-7.46
200	8.0	153.00	53.41U	45.41	4.40		-0.92
300	46.0	137.67U	51.00	5.00	0.48	LO	28.57

ANNEX TABLE IX-C-11

COMPUTER PRINTOUT (001-49)
YEAR 2000 MINIMUM FLOW
(TANUEL SPRING AS MAIN SOURCE)

COLOMBO CITY WATER DISTRICT YEAR 2000 MINIMUM FLOW CONDITION

INPUT AND OUTPUT IN	LPS
NO OF NODES	125
NO OF PIPES	213
MAX NO OF ITERATIONS	20
PEAKING FACTOR	0.30000
ALLOW H-DROP FR/STATIC - PCT	30.0
STATIC HGL FOR H-DROP CALC	53.0
MAX UNBA - LPS	0.05000
MAX ALLOW VEL -MPS	3.000
MIN ALLOW VEL - MPS	0.400
MAX ALLOW HL - M/1000 M	10.00
MIN ALLOW HL - M/1000 M	0.30
MAX ALLOW PRESS - ATM	7.000
MIN ALLOW PRESS - ATM	0.700
NO OF HEADS TO BE READ	1
NO OF UNKNOWN CONSUMPTIONS	1
SUM OF FIXED DEMANDS	-117.97
BANDWIDTH	18

ITER 1 UNBAL 79.39 LPS
ITER 2 UNBAL 35.69 LPS
ITER 3 UNBAL 38.11 LPS
ITER 4 UNBAL 8.04 LPS
ITER 5 UNBAL 3.11 LPS
ITER 6 UNBAL 1.10 LPS
ITER 7 UNBAL 0.19 LPS
ITER 8 UNBAL 0.01 LPS

SOLUTION NO. 1 REACHED IN 8 ITERATIONS
0.0069 LPS UNBALANCE

ANNEX TABLE IX-C-11 (continued)

PIPE NO	NOTE2 FROM-TO	DIA MM	L MTRS	T C	K-VALUE	FLOW	VEL MPS	CK	HEADLOSS MT	MT/1000	CK
1	1	2 250	400.	90	0.242E-02	34.75	0.71		1.72	4.31	
2	2	3 250	700.	90	0.423E-02	34.24	0.70		2.94	4.19	
3	3	4 250	1400.	90	0.832E-02	34.05	0.69		6.06	4.15	
4	4	5 250	400.	90	0.242E-02	29.83	0.61		1.30	3.25	
5	5	6 250	380.	90	0.230E-02	28.88	0.59		1.16	3.06	
6	6	95 250	250.	90	0.169E-02	26.18	0.53		0.71	2.55	
7	7	8 250	80.	90	0.483E-03	24.46	0.50		0.18	2.25	
8	21	9 250	420.	90	0.290E-02	23.51	0.48		1.00	2.09	
9	9	24 250	390.	90	0.211E-02	22.59	0.46		0.68	1.94	
10	10	11 250	290.	90	0.175E-02	22.26	0.45		0.55	1.89	
11	11	12 250	420.	90	0.254E-02	9.17	0.19	LO	0.15	0.37	
12	13	12 250	20.	90	0.121E-03	1.17	0.02	LO	0.00	0.01	LO
13	14	13 200	200.	90	0.358E-02	0.89	0.03	LO	0.00	0.01	LO
14	15	14 200	90.	90	0.161E-02	0.86	0.03	LO	0.00	0.01	LO
15	16	15 200	100.	90	0.179E-02	0.71	0.02	LO	0.00	0.01	LO
16	17	15 200	100.	90	0.179E-02	0.07	0.00	LO	0.00	0.00	LO
17	11	18 150	190.	60	0.293E-01	4.26	0.24	LO	0.43	2.26	
18	19	18 150	170.	60	0.154E-01	2.82	0.16	LO	0.11	1.05	
19	12	19 150	160.	60	0.246E-01	2.84	0.16	LO	0.17	1.06	
20	19	500 150	200.	60	0.306E-01	6.03	0.34	LO	0.86	4.29	
21	5	20 125	660.	60	0.247E 00	2.96	0.24	LO	1.84	2.80	
22	20	21 125	360.	60	0.135E 00	2.75	0.22	LO	0.88	2.44	
23	21	22 125	170.	60	0.636E-01	2.73	0.22	LO	0.41	2.40	
24	22	23 125	310.	60	0.116E 00	1.93	0.16	LO	0.39	1.26	
25	23	24 125	330.	60	0.131E 00	2.80	0.23	LO	0.88	2.53	
26	24	25 125	520.	60	0.195E 00	2.43	0.20	LO	1.01	1.94	
27	26	12 125	20.	60	0.744E-02	1.29	0.10	LO	0.01	0.60	
28	27	26 125	340.	60	0.127E 00	1.19	0.10	LO	0.18	0.52	
29	28	27 125	200.	60	0.749E-01	1.21	0.10	LO	0.11	0.53	
30	29	28 125	140.	60	0.524E-01	1.30	0.11	LO	0.09	0.61	
31	29	30 125	260.	60	0.973E-01	1.63	0.13	LO	0.24	0.92	
32	30	31 125	240.	60	0.898E-01	1.10	0.09	LO	0.11	0.45	
33	29	34 125	120.	60	0.449E-01	0.64	0.05	LO	0.02	0.16	LO
34	34	60 125	100.	60	0.374E-01	0.61	0.05	LO	0.01	0.15	LO
35	7	33 125	110.	60	0.412E-01	1.07	0.14	LO	0.11	0.96	
36	35	34 125	100.	60	0.374E-01	0.04	0.00	LO	0.00	0.00	LO
37	35	36 125	170.	60	0.636E-01	2.46	0.20	LO	0.34	1.98	
38	36	38 125	150.	60	0.561E-01	2.55	0.21	LO	0.32	2.13	
39	39	40 150	60.	100	0.359E-02	1.35	0.08	LO	0.01	0.10	LO
40	40	41 150	170.	100	0.102E-01	1.23	0.07	LO	0.01	0.09	LO
41	41	23 150	160.	100	0.897E-02	1.10	0.06	LO	0.01	0.07	LO
42	38	42 125	150.	60	0.674E-01	2.07	0.17	LO	0.26	1.45	
43	42	43 125	230.	60	0.861E-01	2.24	0.18	LO	0.38	1.67	
44	43	44 125	70.	60	0.262E-01	2.15	0.18	LO	0.11	1.54	
45	44	47 125	150.	60	0.561E-01	1.24	0.10	LO	0.08	0.56	
46	47	24 125	330.	60	0.142E 00	0.75	0.06	LO	0.08	0.22	LO
47	44	45 125	370.	60	0.138E 00	0.34	0.03	LO	0.02	0.05	LO
48	45	46 125	70.	60	0.262E-01	0.17	0.01	LO	0.00	0.01	LO
49	44	91 125	70.	60	0.262E-01	1.68	0.14	LO	0.07	0.97	
50	91	99 125	620.	60	0.232E 00	2.10	0.17	LO	0.92	1.48	

ANNEX TABLE IX-C-11 (continued)

PIPE NO	COUPLS FROM-TO	DIA MM	L MTRS	T-W C	K-VALUE	[illegible]	--VEL-- MPS	--CK	--HEADLOSS-- MT	MT/1000	CK
51	48	49 125	320.	60	0.1[illegible]E 00	0.66	0.05	LO	0.06	0.17	LO
52	28	49 125	360.	60	0.1[illegible]E 00	0.71	0.06	LO	0.07	0.20	LO
53	10	51 125	170.	60	0.5[illegible]E-01	0.86	0.07	LO	0.05	0.29	LO
54	51	54 125	150.	60	0.599E-01	0.77	0.05	LO	0.04	0.23	LO
55	54	55 125	200.	60	0.749E-01	0.59	0.05	LO	0.03	0.14	LO
56	55	56 125	280.	60	0.1[illegible]E 00	2.28	0.19	LO	0.48	1.73	
57	56	57 125	360.	60	0.1[illegible]E 00	0.86	0.07	LO	0.10	0.28	LO
58	30	32 125	100.	60	0.374E-01	0.08	0.01	LO	0.00	0.00	LO
63	09	48 125	60.	60	0.225E-01	1.86	0.15	LO	0.07	1.18	
64	95	7 250	150.	90	0.109E-02	24.96	0.51		0.42	2.34	
65	8	21 250	110.	90	0.664E-03	24.32	0.50		0.24	2.23	
66	24	10 250	230.	90	0.139E-02	23.16	0.47		0.47	2.03	
400	57	71 150	100.	100	0.598E-02	1.74	0.10	LO	0.02	0.17	LO
401	71	55 150	80.	100	0.478E-02	0.97	0.05	LO	0.00	0.06	LO
402	59	59 150	120.	100	0.718E-02	0.96	0.05	LO	0.01	0.05	LO
403	59	60 150	90.	100	0.538E-02	0.36	0.02	LO	0.00	0.01	LO
404	60	61 150	110.	100	0.658E-02	0.54	0.03	LO	0.00	0.02	LO
405	62	63 100	120.	100	0.517E-01	0.18	0.02	LO	0.00	0.02	LO
406	63	64 100	90.	100	0.388E-01	0.10	0.01	LO	0.00	0.01	LO
407	64	65 100	110.	100	0.474E-01	0.03	0.00	LO	0.00	0.00	LO
408	65	66 100	70.	100	0.302E-01	0.01	0.00	LO	0.00	0.00	LO
409	72	13 100	60.	100	0.259E-01	0.65	0.08	LO	0.01	0.19	LO
410	73	72 150	190.	100	0.114E-01	0.63	0.04	LO	0.00	0.03	LO
411	74	73 150	90.	100	0.538E-02	0.73	0.04	LO	0.00	0.03	LO
412	75	74 150	110.	100	0.658E-02	0.81	0.03	LO	0.00	0.02	LO
413	76	75 100	90.	100	0.388E-01	0.02	0.00	LO	0.00	0.00	LO
414	70	56 100	130.	100	0.560E-01	0.43	0.05	LO	0.01	0.09	LO
415	17	70 100	120.	100	0.517E-01	0.52	0.07	LO	0.02	0.13	LO
416	76	17 100	70.	100	0.302E-01	0.74	0.09	LO	0.02	0.25	LO
417	78	76 100	160.	100	0.689E-01	0.89	0.11	LO	0.06	0.35	
418	65	61 150	90.	100	0.538E-02	1.07	0.06	LO	0.01	0.07	LO
419	69	65 150	130.	100	0.777E-02	1.24	0.07	LO	0.01	0.09	LO
420	15	69 150	120.	100	0.718E-02	1.51	0.09	LO	0.02	0.13	LO
421	75	16 150	60.	100	0.359E-02	2.33	0.13	LO	0.02	0.29	LO
422	77	75 150	150.	100	0.897E-02	3.09	0.17	LO	0.07	0.46	
423	86	80 150	260.	100	0.159E-01	4.78	0.27	LO	0.28	1.08	
424	80	77 150	160.	100	0.957E-02	3.33	0.19	LO	0.09	0.56	
425	64	60 100	80.	100	0.345E-01	0.31	0.04	LO	0.00	0.05	LO
426	53	54 100	130.	100	0.560E-01	0.41	0.05	LO	0.01	0.08	LO
427	89	68 100	60.	100	0.259E-01	0.46	0.06	LO	0.01	0.10	LO
428	79	74 100	300.	100	0.129E 00	1.14	0.15	LO	0.17	0.55	
429	83	79 100	260.	100	0.112E 00	1.48	0.19	LO	0.23	0.89	
430	83	85 100	120.	100	0.517E-01	1.02	0.13	LO	0.05	0.45	
431	63	59 100	80.	100	0.345E-01	0.30	0.04	LO	0.00	0.05	LO
432	67	63 100	130.	100	0.560E-01	0.39	0.05	LO	0.01	0.08	LO
433	14	67 100	120.	100	0.517E-01	0.50	0.06	LO	0.01	0.12	LO
434	73	14 100	60.	100	0.259E-01	0.71	0.09	LO	0.01	0.23	LO
435	31	73 100	60.	100	0.259E-01	0.74	0.09	LO	0.01	0.25	LO
436	37	36 100	100.	100	0.431E-01	0.60	0.08	LO	0.02	0.17	LO
437	23	37 100	100.	100	0.431E-01	0.69	0.09	LO	0.02	0.22	LO

ANNEX TABLE IX-C-11 (continued)

[illegible] N	[illegible] FROM-TO	[illegible] MM	[illegible] MTRS	H-W C	K-VALUE	FLOW	--VEL-- MPS	--CK	--HEADLOSS--- MT	MT/100C	CK
[illegible]	[illegible]	[illegible]	[illegible]	120	[illegible]-04	31.87	1.33	LO	0.04	0.42	
[illegible]	[illegible]	[illegible]	[illegible]	120	[illegible]-04	34.61	1.36	LO	0.05	0.49	
[illegible]	[illegible]	[illegible]	[illegible]	120	[illegible]-03	39.98	0.41		0.11	0.63	
[illegible]	[illegible]	[illegible]	[illegible]	120	[illegible]-04	42.92	0.46		0.10	0.73	
[illegible]	[illegible]	67	[illegible]	[illegible]	0.398E-01	0.04	0.01	LO	0.00	0.00	LO
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.431E-01	0.12	0.01	LO	0.00	0.01	LO
[illegible]	[illegible]	70	[illegible]	[illegible]	[illegible]-01	0.02	0.00	LO	0.00	0.00	LO
[illegible]	2	125	[illegible]	[illegible]	0.209E-01	1.39	0.08	LO	0.06	0.11	LO
[illegible]	1	2	350	400.	120	0.275E-03	112.25	1.17	1.72	4.31	
[illegible]	2	3	350	700.	120	0.482E-03	110.60	1.15	2.94	4.19	
[illegible]	3	4	350	1400.	120	0.101E-02	110.01	1.14	6.06	4.15	
[illegible]	4	5	350	400.	120	0.275E-03	96.35	1.00	1.30	3.25	
[illegible]	5	6	350	350.	120	0.242E-03	93.29	0.97	1.16	3.06	
[illegible]	6	7	350	280.	120	0.195E-03	84.56	0.88	0.71	2.55	
[illegible]	7	8	350	80.	120	0.551E-04	79.03	0.82	0.18	2.25	
[illegible]	21	9	350	400.	120	0.231E-03	75.96	0.79	1.00	2.09	
[illegible]	[illegible]	24	350	350.	120	0.241E-03	72.99	0.76	0.68	1.94	
[illegible]	10	11	350	290.	120	0.200E-03	71.91	0.75	0.55	1.89	
[illegible]	11	13	350	140.	120	0.131E-03	79.14	0.82	0.43	2.26	
[illegible]	12	18	300	100.	110	0.171E-03	32.05	0.45	0.11	1.05	
[illegible]	12	19	300	160.	110	0.274E-03	32.18	0.46	0.17	1.06	
[illegible]	19	[illegible]	350	200.	120	0.138E-03	111.94	1.16	0.86	4.29	
[illegible]	11	26	150	420.	100	0.251E-01	2.55	0.14	LO	0.14	0.34
[illegible]	26	12	300	20.	110	0.343E-04	23.57	0.33	LO	0.01	0.60
[illegible]	27	26	300	340.	110	0.583E-03	21.81	0.31	LO	0.18	0.52
[illegible]	29	27	300	200.	110	0.343E-03	22.22	0.31	LO	0.11	0.53
[illegible]	29	28	300	140.	110	0.240E-03	23.83	0.34	LO	0.09	0.61
[illegible]	29	[illegible]	200	120.	110	0.148E-02	4.05	0.13	LO	0.02	0.16	LO
[illegible]	[illegible]	30	200	100.	110	0.123E-02	3.83	0.12	LO	0.01	0.15	LO
[illegible]	95	96	150	220.	100	0.132E-01	4.76	0.27	LO	0.24	1.07	
[illegible]	33	35	150	180.	100	0.108E-01	7.31	0.41		0.43	2.38	
[illegible]	35	36	150	170.	100	0.102E-01	6.62	0.37	LO	0.34	1.98	
[illegible]	9	42	150	340.	100	0.203E-01	1.03	0.06	LO	0.02	0.06	LO
[illegible]	42	43	150	230.	100	0.138E-01	6.03	0.34	LO	0.38	1.67	
[illegible]	43	44	150	70.	100	0.419E-02	5.79	0.33	LO	0.11	1.54	
[illegible]	44	91	150	70.	100	0.419E-02	4.51	0.26	LO	0.07	0.97	
[illegible]	92	91	150	370.	100	0.221E-01	3.88	0.22	LO	0.27	0.74	
[illegible]	121	92	150	300.	100	0.179E-01	4.34	0.25	LO	0.27	0.91	
[illegible]	91	99	150	620.	100	0.371E-01	5.66	0.32	LO	0.92	1.48	
[illegible]	99	122	150	660.	100	0.395E-01	0.96	0.05	LO	0.04	0.06	LO
[illegible]	50	122	200	290.	110	0.346E-02	3.35	0.11	LO	0.03	0.12	LO
[illegible]	95	124	150	220.	100	0.132E-01	1.52	0.09	LO	0.03	0.13	LO
[illegible]	124	27	200	290.	110	0.346E-02	0.21	0.01	LO	0.00	0.00	LO
[illegible]	10	51	150	170.	100	0.102E-01	2.33	0.13	LO	0.05	0.29	LO
[illegible]	51	54	150	160.	100	0.957E-02	2.08	0.12	LO	0.04	0.23	LO
[illegible]	54	55	150	210.	100	0.120E-01	1.59	0.09	LO	0.03	0.14	LO
[illegible]	55	56	150	280.	100	0.167E-01	6.15	0.35	LO	0.48	1.73	
[illegible]	55	57	150	320.	100	0.191E-01	2.46	0.14	LO	0.10	0.32	
[illegible]	6	103	150	540.	100	0.323E-01	5.00	0.28	LO	0.64	1.18	
[illegible]	5	23	200	400.	110	0.494E-02	5.72	0.18	LO	0.12	0.31	

ANNEX TABLE IX-C-11 (continued)

[illegible]	[illegible] CM-[illegible]	[illegible] MM	L MTS	[illegible]-W C	K-VALUE	FLOW	--VEL-- MPS	--CK	--HEADLOSS--- MT	MT/1000	CK
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3.78	[illegible].21	LE	0.13	0.70	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.05	[illegible].05	LE	0.03	0.05	LE
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6.93	0.39	LO	1.38	2.15	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.59	0.09	LO	0.10	0.14	LE
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	7.22	[illegible].41		1.15	2.33	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4.44	[illegible].14	LO	0.09	0.20	LO
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.53	0.09	LO	0.07	0.13	LE
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.54	0.08	LO	0.02	0.19	LO
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.35	[illegible].05	LO	0.01	0.06	LO
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.29	[illegible].04	LO	0.01	0.04	LO
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.59	0.03	LO	0.03	0.16	LO
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.71	[illegible].10	LO	0.03	0.16	LO
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.29	[illegible].04	LO	0.01	0.04	LO
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.15	0.04	LO	0.00	0.02	LO
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.50	[illegible].06	LO	0.02	0.12	LO
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.11	[illegible].01	LO	0.00	0.01	LO
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.32	0.01	LO	0.00	0.00	LO
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.52	[illegible].07	LO	0.01	0.13	LO
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.76	0.10	LO	0.02	0.26	LO
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.94	[illegible].11	LO	0.00	0.21	LO
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.06	0.14	LO	0.11	0.48	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.26	0.03	LO	0.00	0.04	LO
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.44	0.06	LO	0.02	0.09	LO
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.11	0.01	LO	0.00	0.01	LO
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3.30	0.19	LO	0.11	0.55	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5.93	0.34	LO	0.29	1.52	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.48	0.08	LO	0.00	0.12	LO
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.19	0.07	LO	0.02	0.08	LO
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2.85	0.16	LO	0.13	0.41	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.47	0.06	LO	0.01	0.11	LO
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.51	0.09	LO	0.04	0.13	LO
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6.38	0.39	LO	0.32	2.13	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5.59	0.32	LO	0.26	1.45	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	80.70	0.94		0.42	2.34	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	78.55	0.82		0.24	2.23	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	74.80	0.78		0.47	2.03	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.56	0.10	LO	0.02	0.16	LO
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2.01	0.11	LO	0.08	0.22	LO
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.08	0.01	LO	0.00	0.00	LO
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.21	0.03	LO	0.00	0.02	LO
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.33	0.02	LO	0.00	0.01	LO
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5.27	0.30	LO	0.65	1.30	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	45.00	0.37	LO	0.13	0.43	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	7.61	0.43		1.44	2.56	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6.73	0.38	LO	0.74	2.04	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6.35	0.36	LO	0.98	1.84	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.28	0.07	LO	0.04	0.09	LO
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4.53	0.26	LO	0.51	0.93	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5.05	0.16	LO	0.09	0.25	LO
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2.62	0.15	LO	0.23	0.36	

BEST AVAILABLE DOCUMENT

ANNEX TABLE IX-C-11 (continued)

PIPE NO	NODES FROM-TO		DIA MM	L MTRS	H-W C	K-VALUE	FLOW	--VEL-- MPS	--CK	--HEADLOSS--- MT	MT/100	CK
307	116	117	150	440.	100	0.263E-01	4.30	0.24	LO	0.39	0.89	
308	117	118	150	600.	100	0.395E-01	3.12	0.18	LO	0.32	0.49	
309	118	119	150	200.	100	0.120E-01	2.45	0.14	LO	0.06	0.31	
310	119	120	150	600.	100	0.359E-01	5.84	0.33	LO	0.94	1.57	
311	94	120	150	500.	100	0.299E-01	0.44	0.02	LO	0.01	0.01	LO
312	120	121	150	790.	100	0.391E-01	5.44	0.31	LO	0.90	1.15	
313	107	108	150	500.	100	0.317E-01	2.24	0.13	LO	0.14	0.27	LO
314	108	109	150	460.	100	0.275E-01	0.24	0.01	LO	0.00	0.00	LO
315	111	109	150	400.	100	0.239E-01	0.36	0.02	LO	0.00	0.01	LO
316	111	110	150	600.	100	0.359E-01	0.69	0.04	LO	0.02	0.03	LO
317	119	97	150	560.	100	0.335E-01	2.27	0.13	LO	0.15	0.27	LO
318	115	119	150	300.	100	0.179E-01	6.32	0.36	LO	0.55	1.82	
319	4	116	150	760.	100	0.455E-01	8.60	0.49		2.44	3.21	

ANNEX TABLE IX-C-11 (continued)

NUM	GROUND ELEV	FLOW	HOLE ELEV	HEAD MTRS	PRESSURE ATM---CK	PRESSURE PCT DROP---CK
1	10.0	147.[illegible]	[illegible].230U	58.23	5.64	-35.42
2	2.0	-[illegible].77	46.510U	64.51	6.24	-26.49
3	2.0	-[illegible].77	[illegible].570U	61.57	5.96	-20.73
4	2.0	-1.58	57.510U	55.51	5.37	-8.84
5	10.0	-1.05	56.210U	46.21	4.47	-7.46
6	10.0	-[illegible].71	55.050U	45.05	4.36	-4.76
7	10.0	-[illegible].52	53.910U	43.91	4.25	-2.12
8	10.0	-1.45	53.730U	43.73	4.23	-1.70
9	15.0	-1.27	52.480U	37.48	3.63	1.36
10	12.0	-[illegible].00	51.330U	39.33	3.81	4.06
11	15.0	-1.04	50.790U	35.79	3.46	5.83
12	5.0	-[illegible].50	50.630U	45.63	4.42	4.93
13	3.0	-[illegible].37	50.630U	47.63	4.61	4.73
14	3.0	-0.15	50.640U	47.64	4.61	4.73
15	3.0	-0.08	50.640U	47.64	4.61	4.73
16	3.0	-0.18	50.640U	47.64	4.61	4.72
17	3.0	-0.14	50.640U	47.64	4.61	4.72
18	20.0	-0.30	50.360U	30.36	2.94	8.01
19	20.0	-0.15	50.460U	30.46	2.95	7.69
20	10.0	-0.13	54.360U	44.36	4.29	-3.17
21	10.0	-0.11	53.490U	43.49	4.21	-1.13
22	10.0	-0.11	53.080U	43.08	4.17	-0.18
23	15.0	-0.22	52.690U	37.69	3.65	0.93
24	12.0	-0.75	51.800U	39.80	3.85	2.92
25	15.0	-0.45	50.790U	35.79	3.46	5.81
26	5.0	-0.36	50.640U	45.64	4.42	4.91
27	3.0	-0.65	50.820U	47.82	4.63	4.36
28	3.0	-0.79	50.930U	47.93	4.64	4.15
29	3.0	-0.42	51.010U	48.01	4.65	3.95
30	3.0	-0.52	50.770U	47.77	4.62	4.45
31	3.0	-0.37	50.660U	47.66	4.61	4.67
32	10.0	-0.09	54.360U	44.36	4.29	-3.17
33	10.0	-0.29	53.800U	43.80	4.24	-1.87
34	10.0	-0.04	53.380U	43.38	4.20	-0.87
35	10.0	-0.24	53.380U	43.38	4.20	-0.87
36	10.0	-0.25	53.040U	43.04	4.17	-0.04
37	10.0	-0.09	53.060U	43.06	4.17	-0.13
38	12.0	-0.29	52.720U	40.72	3.94	0.68
39	12.0	-0.13	52.720U	40.72	3.94	0.69
40	13.0	-0.13	52.710U	39.71	3.84	0.72
41	13.0	-0.13	52.700U	39.70	3.84	0.76
42	10.0	-0.42	52.460U	42.46	4.11	1.26
43	10.0	-0.34	52.080U	42.08	4.07	2.15
44	10.0	-0.17	51.970U	41.97	4.06	2.40
45	10.0	-0.17	51.950U	41.95	4.06	2.44
46	10.0	-0.17	51.950U	41.95	4.06	2.44
47	10.0	-0.17	51.880U	41.88	4.05	2.59
48	3.0	-1.20	50.910U	47.91	4.64	4.18
49	3.0	-0.90	50.860U	47.86	4.63	4.29
50	3.0	-0.97	50.980U	47.98	4.64	4.04

ANNEX TABLE IX-C-11 (continued)

NUMBER	[illegible] FLEV	FLEV	[illegible] FLEV	[illegible] MTS	---------PRESSURE--------- AIM---CK	PCT DROP---CK
[illegible]	10.0	-0.12	51.290	41.29	4.00	3.99
[illegible]	6.0	-0.13	51.290	45.29	4.38	3.66
[illegible]	6.0	-0.13	51.280	45.28	4.40	3.60
[illegible]	5.0	-0.67	51.250	46.25	4.43	3.65
[illegible]	5.0	-0.77	51.220	46.22	4.47	3.71
[illegible]	4.0	-0.47	50.740	42.74	4.14	5.03
57	10.0	-0.43	50.630	40.63	3.93	5.50
[illegible]	4.0	-0.21	50.610	46.61	4.61	4.87
[illegible]	3.0	-0.21	50.610	47.61	4.61	4.78
[illegible]	3.0	-0.13	50.610	47.61	4.61	4.79
61	3.0	-0.18	50.600	47.60	4.61	4.79
[illegible]	4.0	-0.21	50.610	46.61	4.61	4.87
[illegible]	3.0	-0.18	50.610	47.61	4.61	4.78
64	3.0	-0.16	50.610	47.61	4.61	4.78
[illegible]	3.0	-0.18	50.610	47.61	4.61	4.78
[illegible]	3.0	-0.14	50.610	47.61	4.61	4.78
[illegible]	3.0	-0.14	50.620	47.62	4.61	4.76
[illegible]	3.0	-0.13	50.620	47.62	4.61	4.76
[illegible]	3.0	-0.14	50.620	47.62	4.61	4.76
70	3.0	-0.11	50.620	47.62	4.61	4.76
71	5.0	-0.14	50.620	44.62	4.32	5.07
72	5.0	-0.31	50.640	45.64	4.42	4.91
73	3.0	-0.13	50.650	47.65	4.61	4.70
74	3.0	-0.26	50.650	47.65	4.61	4.70
75	3.0	-0.18	50.660	47.66	4.61	4.69
76	3.0	-0.13	50.660	47.66	4.61	4.69
77	3.0	-0.24	50.730	47.73	4.62	4.54
[illegible]	3.0	-0.17	50.710	47.71	4.62	4.58
79	3.0	-0.14	50.820	47.82	4.63	4.36
[illegible]	3.0	-0.30	50.820	47.82	4.63	4.37
83	3.0	-0.23	51.050	48.05	4.65	3.90
84	3.0	-0.32	50.990	47.99	4.65	4.02
[illegible]	3.0	-0.32	51.000	48.00	4.65	4.01
[illegible]	3.0	-0.30	51.100	48.10	4.66	3.80
[illegible]	3.0	-0.24	51.210	48.21	4.67	3.58
[illegible]	3.0	-0.08	51.310	48.31	4.68	3.37
[illegible]	3.0	-0.16	50.630	47.63	4.61	4.74
[illegible]	3.0	-0.32	50.630	42.63	4.13	5.26
91	10.0	-0.63	51.990	41.99	4.06	2.56
92	10.0	-0.46	52.170	42.17	4.08	1.92
93	10.0	-0.57	54.920	44.92	4.35	-4.47
[illegible]	10.0	-0.75	53.350	43.35	4.20	-0.82
[illegible]	10.0	-0.99	54.330	44.33	4.29	-3.10
[illegible]	10.0	-0.34	54.100	44.10	4.27	-2.55
[illegible]	10.0	-0.75	54.130	44.13	4.27	-2.64
[illegible]	3.0	-1.80	50.850	47.85	4.63	4.30
[illegible]	3.0	-2.10	50.980	47.98	4.64	4.04
100	4.0	-1.38	56.070	52.07	5.04	-0.27
101	3.0	-1.38	55.340	52.34	5.07	-4.67
102	3.0	-0.89	54.450	51.45	4.98	-2.91

ANNEX TABLE IX-C-11 (continued)

NODE	GROUND ELEV	FLOW	HGL ELEV	HEAD MTRS	PRESSURE ATM---CK		PRESSURE PCT DROP---CK	
103	5.0	-1.30	54.41U	49.41	4.78		-2.94	
104	3.0	-0.76	53.94U	50.94	4.93		-1.89	
105	3.0	-1.26	53.76U	50.76	4.91		-1.52	
106	3.0	-1.30	52.38U	49.38	4.76		1.23	
107	3.0	-2.20	50.65U	47.65	4.61		4.71	
108	3.0	-2.00	50.51U	47.51	4.60		4.99	
109	3.0	-0.60	50.50U	47.50	4.60		4.99	
110	2.0	-0.69	50.49U	48.49	4.69		4.92	
111	3.0	-0.48	50.51U	47.51	4.60		4.99	
112	3.0	-0.28	50.60U	47.60	4.61		4.91	
113	3.0	-0.56	50.58U	47.58	4.61		4.84	
114	3.0	-0.47	50.57U	47.57	4.61		4.85	
115	10.0	-1.34	54.83U	44.83	4.34		-4.26	
116	3.0	-1.48	55.07U	52.07	5.04		-4.13	
117	3.0	-1.18	54.67U	51.67	5.00		-3.35	
118	5.0	-0.67	54.35U	49.35	4.78		-2.51	
119	8.0	-0.57	54.29U	46.29	4.48		-2.86	
120	3.0	-0.94	53.34U	50.34	4.87		-0.69	
121	10.0	-1.09	52.45U	42.45	4.11		1.29	
122	3.0	-4.31	50.95U	47.95	4.64		4.11	
123	3.0	-3.55	50.98U	47.98	4.64		4.05	
124	3.0	-1.30	50.92U	47.92	4.63		4.36	
125	3.0	-1.39	66.45U	63.45	6.14		-26.90	
200	5.0	46.00	51.44U	43.44	4.21		3.46	
500	46.0	-117.97U	49.50	3.50	0.34	LO	50.00	HI

ANNEX TABLE IX-B-12

COMPUTER PRINTOUT (CONT-WD)
YEAR 2000 MINIMUM FLOW
(SINUAY INDUCED INFILTRATION WELLS AS MAIN SOURCE)

CUTABATO CITY WATER DISTRICT YEAR 2000 MINIMUM FLOW CONDITION

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INPUT AND OUTPUT IN                LPS
NO OF NODES                        125
NO OF PIPES                        213
MAX NO OF ITERATIONS                20
PEAKING FACTOR                 0.30000
ALLOW P DROP FR/STATIC     PCT 30.0
STATIC HGL FOR P-DROP CALC      53.0
MAX UNBAL - LPS                0.05000
MAX ALLOW VEL  MPS               3.000
MIN ALLOW VEL - MPS              0.400
MAX ALLOW HL     M/1000 M       10.00
MIN ALLOW HL     M/1000 M        0.30
MAX ALLOW PRESS - ATM            7.000
MIN ALLOW PRESS   ATM            0.700
NO OF HEADS TO BE READ               1
NO OF UNKNOWN CONSUMPTIONS           1
SUM OF FIXED DEMANDS           117.97
BANDWIDTH                           18
ITER   1 UNBAL    74.[illegible]2 LPS
ITER   2 UNBAL    34.1[illegible] LPS
ITER   3 UNBAL    22.[illegible] LPS
ITER   4 UNBAL     9.[illegible]2 LPS
ITER   5 UNBAL     2.0 LPS
ITER   6 UNBAL     0.[illegible] LPS
ITER   7 UNBAL     0.04 LPS

SOLUTION NO  1 REACHED IN   7 ITERATIONS
      0.0418 LPS UNBALANCE
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ANNEX TABLE IX-C-12 (continued)

PIPE NO	NODES FROM	NODES TO	DIA MM	L MTRS	H W C	K VALUE	FLOW	VEL MPS	CK	HEADLOSS MT	HEADLOSS MT/1000	CK
1	1	2	250	400.	90	0.242E-02	9.46	0.19	LO	0.15	0.39	
2	2	3	250	700.	90	0.423E-02	8.97	0.18	LO	0.24	0.35	
3	3	4	250	1460.	90	0.862E-02	8.76	0.18	LO	0.49	0.34	
4	4	5	250	400	90	0.242E-02	7.19	0.15	LO	0.09	0.23	LO
5	5	6	250	380.	90	0.230E-02	6.78	0.14	LO	0.08	0.21	LO
6	6	9	250	280.	90	0.169E-02	5.41	0.11	LO	0.04	0.14	LO
7	7	8	250	80.	90	0.483E-03	4.68	0.10	LO	0.01	0.11	LO
8	21	9	250	480.	90	0.290E-02	4.00	0.08	LO	0.04	0.08	LO
9	9	2	250	350.	90	0.211E-02	4.05	0.08	LO	0.03	0.08	LO
10	10	11	250	290.	90	0.175E-02	5.13	0.10	LO	0.04	0.12	LO
11	12	11	250	420.	90	0.254E-02	22.20	0.45		0.79	1.88	
12	13	12	250	20.	90	0.121E-03	11.09	0.23	LO	0.01	0.52	
13	14	13	200	200.	90	0.358E-02	9.24	0.29	LO	0.22	1.10	
14	15	1	200	90.	90	0.161E-02	7.51	0.24	LO	0.07	0.76	
15	16	15	200	100.	90	0.179E-02	5.87	0.19	LO	0.05	0.47	
16	17	16	200	100.	90	0.179E-02	1.29	0.04	LO	0.00	0.03	LO
17	11	18	150	190.	60	0.293E-01	2.55	0.14	LO	0.17	0.87	
18	19	18	150	100.	60	0.154E-01	5.54	0.31	LO	0.37	3.66	
19	12	19	150	160.	60	0.246E-01	5.55	0.31	LO	0.59	3.68	
20	18	100	150	200.	60	0.308E-01	6.03	0.34	LO	0.86	4.29	
21	5	20	125	660.	60	0.247E-00	0.68	0.06	LO	0.12	0.19	LO
22	20	21	125	360.	60	0.135E-00	0.47	0.04	LO	0.03	0.09	LO
23	21	22	125	170.	60	0.636E-01	0.26	0.02	LO	0.01	0.03	LO
24	22	23	125	310.	60	0.116E-00	0.25	0.02	LO	0.01	0.03	LO
25	23	24	125	350.	60	0.131E-00	0.61	0.05	LO	0.05	0.15	LO
26	24	25	125	520.	60	0.195E-00	0.54	0.04	LO	0.06	0.12	LO
27	26	12	125	20.	60	0.749E-02	4.44	0.36	LO	0.12	5.91	
28	27	26	125	340.	60	0.127E-00	4.64	0.38	LO	2.16	6.41	
29	28	27	125	200.	60	0.749E-01	4.98	0.41		1.47	7.33	
30	29	29	125	140.	60	0.524E-01	5.24	0.43		1.13	8.05	
31	25	30	125	260.	60	0.973E-01	5.48	0.45		2.27	8.74	
32	30	31	125	240.	60	0.899E-01	4.96	0.40		1.74	7.26	
33	29	34	125	120.	60	0.449E-01	1.76	0.14	LO	0.13	1.06	
34	84	50	125	100.	60	0.374E-01	1.90	0.15	LO	0.12	1.23	
35	7	33	125	110.	60	0.412E-01	0.59	0.05	LO	0.02	0.14	LO
36	35	34	125	100.	60	0.374E-01	0.04	0.00	LO	0.00	0.00	LO
37	36	35	125	170.	60	0.636E-01	0.02	0.00	LO	0.00	0.00	LO
38	38	36	125	150.	60	0.561E-01	0.14	0.01	LO	0.00	0.01	LO
39	39	40	150	60.	100	0.359E-02	0.84	0.05	LO	0.00	0.04	LO
40	40	41	150	170.	100	0.102E-01	0.71	0.04	LO	0.01	0.03	LO
41	41	23	150	150.	100	0.897E-02	0.59	0.03	LO	0.00	0.02	LO
42	42	38	125	180.	60	0.674E-01	0.48	0.04	LO	0.02	0.10	LO
43	43	42	125	230.	60	0.861E-01	1.05	0.09	LO	0.09	0.41	
44	44	43	125	70.	60	0.262E-01	1.14	0.09	LO	0.02	0.49	
45	44	43	125	150.	60	0.561E-01	0.60	0.05	LO	0.02	0.14	LO
46	47	24	125	380.	60	0.142E-00	1.16	0.09	LO	0.19	0.49	
47	44	45	125	370.	60	0.138E-00	0.34	0.03	LO	0.02	0.05	LO
48	45	46	125	70.	60	0.262E-01	0.17	0.01	LO	0.00	0.01	LO
49	91	47	125	70.	60	0.262E-01	1.44	0.12	LO	0.05	0.73	
50	99	91	125	620.	60	0.232E-00	3.31	0.27	LO	2.13	3.44	

ANNEX TABLE IX-C-12 (continued)

NO	NODES FROM	TO	DIA MM	L METRS	H-W C	K-VALUE	FLOW	-VEL MPS-	CK	HEADLOSS MT	MT/1000	CK
51	29	46	125	320.	60	0.120E 00	1.73	0.14	LO	0.33	1.03	
52	25	47	125	360.	60	0.135E 00	4.00	0.33	LO	1.76	4.88	
53	51	10	125	170.	60	0.636E-01	0.42	0.03	LO	0.01	0.07	LO
54	54	51	125	160.	60	0.599E 01	0.51	0.04	LO	0.02	0.11	LO
55	15	54	125	200.	60	0.749E-01	0.69	0.06	LO	0.04	0.19	LO
56	56	55	125	280.	60	0.105E 00	1.14	0.09	LO	0.13	0.48	
57	57	56	125	360.	60	0.135E 00	1.91	0.15	LO	0.45	1.25	
58	20	32	125	100.	60	0.374E-01	0.08	0.01	LO	0.00	0.00	LO
59	48	99	125	60.	60	0.225E-01	0.53	0.04	LO	0.01	0.12	LO
60	95	[illegible]	250	180.	90	0.109E-02	4.94	0.10	LO	0.02	0.12	LO
65	8	21	250	110.	90	0.664E-03	4.09	0.08	LO	0.01	0.08	LO
66	24	10	250	230.	90	0.139E-02	4.91	0.10	LO	0.03	0.11	LO
400	71	57	150	100.	100	0.593E-02	1.94	0.11	LO	0.02	0.20	LO
401	58	71	150	80.	100	0.478E-02	2.46	0.14	LO	0.03	0.32	
402	59	58	150	120.	100	0.718E 02	2.25	0.13	LO	0.03	0.27	LO
403	60	59	150	90.	100	0.538E-02	2.31	0.13	LO	0.03	0.28	LO
404	61	60	150	110.	100	0.658E-02	1.22	0.07	LO	0.01	0.09	LO
405	63	62	100	120.	100	0.517E-01	1.18	0.15	LO	0.07	0.58	
406	64	63	100	90.	100	0.388E-01	0.87	0.11	LO	0.03	0.33	
407	65	64	100	110.	100	0.474E-01	0.71	0.09	LO	0.03	0.23	LO
408	66	65	100	70.	100	0.302E-01	0.30	0.04	LO	0.00	0.05	LO
409	72	15	100	60.	100	0.259E-01	2.23	0.28	LO	0.11	1.90	
410	73	72	150	190.	100	0.114E-01	6.03	0.34	LO	0.32	1.56	
411	74	73	150	90.	100	0.538E-02	4.56	0.26	LO	0.09	1.04	
412	75	74	150	110.	100	0.658E-02	3.36	0.19	LO	0.06	0.56	
413	76	75	100	90.	100	0.388E-01	0.56	0.07	LO	0.01	0.15	LO
414	70	66	100	130.	100	0.560E-01	1.51	0.19	LO	0.12	0.93	
415	17	70	100	120.	100	0.517E-01	1.78	0.23	LO	0.15	1.25	
416	76	17	100	70.	100	0.302E-01	3.21	0.41		0.26	3.73	
417	78	75	100	160.	100	0.689E-01	3.90	0.50		0.86	5.35	
418	65	61	150	90.	100	0.538E-02	3.84	0.22	LO	0.06	0.72	
419	69	65	150	130.	100	0.777E-02	4.43	0.25	LO	0.12	0.94	
420	16	69	150	120.	100	0.718E-02	5.14	0.29	LO	0.15	1.24	
421	75	16	150	60.	100	0.359E-02	9.91	0.56		0.25	4.18	
422	77	75	150	150.	100	0.897E-02	12.88	0.73		1.02	6.80	
423	86	80	150	260.	100	0.155E-01	17.58	1.00		3.14	12.09	HI
424	80	77	150	160.	100	0.957E-02	13.13	0.74		1.13	7.04	
425	64	60	100	80.	100	0.345E-01	1.21	0.15	LO	0.05	0.61	
426	68	64	100	130.	100	0.560E-01	1.53	0.20	LO	0.12	0.95	
427	39	69	100	60.	100	0.259E-01	1.51	0.19	LO	0.06	0.93	
428	79	74	100	300.	100	0.129E 00	4.86	0.62		2.42	8.07	
429	83	79	100	250.	100	0.112E 00	5.20	0.66		2.38	9.14	
430	33	83	100	120.	100	0.517E-01	3.28	0.42		0.47	3.89	
431	53	59	100	80.	100	0.345E-01	1.15	0.15	LO	0.04	0.56	
432	57	63	100	130.	100	0.560E-01	1.64	0.21	LO	0.14	1.07	
433	14	67	100	120.	100	0.517E-01	1.20	0.15	LO	0.07	0.60	
434	73	14	100	60.	100	0.259E-01	3.10	0.39	LO	0.21	3.50	
435	31	73	100	60.	100	0.259E-01	4.59	0.58		0.43	7.25	
438	36	3	100	100.	100	0.431E-01	0.18	0.02	LO	0.00	0.02	LO
439	37	22	100	100.	100	0.431E-01	0.10	0.01	LO	0.00	0.01	LO

ANNEX TABLE IX-C-11 (continued)

NODE	GROUND ELEV	FLOW	POL ELEV	HEAD MTRS	PRESSURE ATM---CK	PRESSURE PCT DROP---CK
51	10.0	-0.13	51.290U	41.29	4.00	3.99
52	6.0	-0.13	51.280U	45.28	4.38	3.66
53	6.0	-0.18	51.280U	45.28	4.38	3.66
54	5.0	-0.67	51.250U	46.25	4.48	3.65
55	5.0	-0.47	51.220U	46.22	4.47	3.71
56	8.0	-0.67	50.740U	42.74	4.14	5.03
57	10.0	-0.43	50.630U	40.63	3.93	5.50
58	4.0	-0.21	50.610U	46.61	4.51	4.87
59	3.0	-0.21	50.610U	47.61	4.61	4.78
60	3.0	-0.13	50.610U	47.61	4.61	4.79
61	3.0	-0.19	50.600U	47.60	4.61	4.79
62	4.0	-0.21	50.610U	46.61	4.51	4.87
63	3.0	-0.18	50.610U	47.61	4.61	4.78
64	3.0	-0.16	50.610U	47.61	4.61	4.78
65	3.0	-0.18	50.610U	47.61	4.61	4.78
66	3.0	-0.14	50.610U	47.61	4.61	4.78
67	3.0	-0.14	50.620U	47.62	4.61	4.76
68	3.0	-0.13	50.620U	47.62	4.61	4.76
69	3.0	-0.14	50.620U	47.62	4.61	4.76
70	3.0	-0.11	50.620U	47.62	4.61	4.76
71	6.0	-0.14	50.620U	44.62	4.32	5.07
72	5.0	-0.31	50.640U	45.64	4.42	4.91
73	3.0	-0.13	50.650U	47.65	4.61	4.70
74	3.0	-0.26	50.650U	47.65	4.61	4.70
75	3.0	-0.18	50.660U	47.66	4.61	4.69
76	3.0	-0.13	50.660U	47.66	4.61	4.69
77	3.0	-0.24	50.730U	47.73	4.62	4.54
78	3.0	-0.17	50.710U	47.71	4.62	4.58
79	3.0	-0.34	50.820U	47.82	4.63	4.36
80	3.0	-0.39	50.820U	47.82	4.63	4.37
83	3.0	-0.23	51.050U	48.05	4.65	3.90
84	3.0	-0.32	50.990U	47.99	4.65	4.02
85	3.0	-0.32	51.000U	48.00	4.65	4.01
86	3.0	-0.30	51.100U	48.10	4.66	3.80
87	3.0	-0.24	51.210U	48.21	4.67	3.58
88	3.0	-0.08	51.310U	48.31	4.68	3.37
89	3.0	-0.06	50.630U	47.63	4.61	4.74
90	8.0	-0.32	50.630U	42.63	4.13	5.26
91	10.0	-0.63	51.900U	41.90	4.06	2.56
92	10.0	-0.46	52.170U	42.17	4.08	1.92
93	10.0	-0.67	54.920U	44.92	4.35	-4.47
94	10.0	-0.75	53.350U	43.35	4.20	-0.82
95	10.0	-0.79	54.330U	44.33	4.29	-3.10
96	10.0	-0.34	54.100U	44.10	4.27	-2.55
97	10.0	-0.75	54.130U	44.13	4.27	-2.64
98	3.0	-1.50	50.850U	47.85	4.63	4.30
99	3.0	-2.10	50.980U	47.98	4.64	4.04
100	4.0	-0.88	56.070U	52.07	5.04	-8.27
101	3.0	-0.58	55.340U	52.34	5.07	-4.67
102	3.0	-0.55	54.450U	51.45	4.98	-2.91

ANNEX TABLE IX-C-12 (continued)

PIPE NO	NODES FROM	NODES TO	DIA MM	L MTRS	H-W C	K-VALUE	FLOW	VEL MPS	CK	HEADLOSS MT	HEADLOSS MT/1000	CK
243	105	104	150	260.	100	0.155E-01	0.05	0.00	LO	0.00	0.00	LO
244	8	107	150	190.	100	0.413E-01	1.00	0.06	LO	0.04	0.05	LO
245	105	10	150	140.	100	0.383E-01	0.41	0.02	LO	0.01	0.01	LO
246	9	104	150	700.	100	0.419E-01	0.20	0.01	LO	0.00	0.00	LO
247	55	106	150	500.	100	0.299E-01	0.69	0.04	LO	0.01	0.03	LO
248	56	107	200	460.	110	0.568E-02	2.53	0.08	LO	0.03	0.07	LO
249	114	111	150	500.	100	0.299E-01	3.44	0.19	LO	0.30	0.59	
250	71	112	100	120.	100	0.517E-01	0.38	0.05	LO	0.01	0.07	LO
251	112	113	100	220.	100	0.948E-01	0.10	0.01	LO	0.00	0.01	LO
252	113	114	100	200.	100	0.862E-01	0.43	0.05	LO	0.02	0.09	LO
253	59	113	100	160.	100	0.689E-01	0.99	0.13	LO	0.07	0.42	
254	41	114	150	200.	100	0.120E-01	3.48	0.20	LO	0.12	0.60	
255	46	61	100	140.	100	0.603E-01	1.07	0.14	LO	0.07	0.49	
256	90	57	200	90.	110	0.111E-02	5.90	0.19	LO	0.03	0.33	
257	42	90	100	160.	100	0.689E-01	0.55	0.07	LO	0.02	0.14	LO
258	42	53	100	80.	100	0.345E-01	0.42	0.05	LO	0.01	0.09	LO
259	12	90	200	240.	110	0.296E-02	5.68	0.13	LO	0.07	0.31	
260	15	89	100	70.	100	0.302E-01	1.58	0.20	LO	0.07	1.00	
261	74	15	100	60.	100	0.259E-01	3.30	0.42		0.24	3.93	
262	25	11	150	20.	100	0.120E-02	0.09	0.01	LO	0.00	0.00	LO
263	80	78	100	220.	100	0.948E-01	4.07	0.52		1.28	5.80	
264	85	84	100	100.	100	0.431E-01	1.58	0.20	LO	0.10	1.01	
265	85	123	100	210.	100	0.905E-01	1.38	0.18	LO	0.15	0.73	
266	123	50	100	200.	100	0.862E-01	0.83	0.11	LO	0.06	0.30	
267	21	34	150	200.	100	0.120E-01	0.46	0.03	LO	0.00	0.01	LO
268	96	33	150	180.	100	0.108E-01	0.35	0.02	LO	0.00	0.01	LO
269	38	34	150	20.	100	0.120E-02	0.96	0.05	LO	0.00	0.06	LO
270	35	94	150	300.	100	0.179E-01	0.84	0.05	LO	0.01	0.04	LO
271	98	99	150	320.	100	0.191E-01	4.35	0.25	LO	0.29	0.91	
272	49	98	150	60.	100	0.259E-01	1.37	0.17	LO	0.05	0.77	
273	96	97	150	300.	100	0.179E-01	1.00	0.06	LO	0.02	0.05	LO
274	38	36	150	150.	100	0.897E-02	0.37	0.02	LO	0.00	0.01	LO
275	42	38	150	180.	100	0.108E-01	1.29	0.07	LO	0.02	0.10	LO
276	95	[illegible]	350	160.	120	0.124E-03	15.96	0.17	LO	0.02	0.12	LO
277	8	21	350	110.	120	0.757E-04	13.20	0.14	LO	0.01	0.08	LO
278	24	10	350	230.	120	0.158E-03	15.85	0.16	LO	0.03	0.11	LO
280	91	47	150	100.	100	0.598E-02	3.86	0.22	LO	0.07	0.73	
281	47	24	150	380.	100	0.227E-01	3.13	0.18	LO	0.19	0.49	
282	52	53	100	280.	100	0.121E 00	0.08	0.01	LO	0.00	0.00	LO
283	51	52	100	180.	100	0.776E-01	0.21	0.03	LO	0.00	0.02	LO
285	72	26	150	10.	100	0.598E-03	3.49	0.20	LO	0.01	0.60	
28	103	105	150	500.	100	0.299E-01	0.72	0.04	LO	0.02	0.03	LO
290	200	82	400	300.	120	0.108E-03	153.00	1.22		1.20	3.99	
300	4	100	150	560.	100	0.335E-01	2.45	0.14	LO	0.18	0.32	
301	100	101	150	350.	100	0.215E-01	1.57	0.09	LO	0.05	0.14	LO
302	101	102	150	480.	100	0.287E-01	1.20	0.07	LO	0.04	0.08	LO
303	103	102	150	470.	100	0.281E-01	0.05	0.00	LO	0.00	0.00	LO
304	102	104	150	520.	100	0.311E-01	0.70	0.04	LO	0.02	0.03	LO
305	53	115	200	360.	110	0.445E-02	2.65	0.08	LO	0.03	0.08	LO
306	115	116	150	660.	100	0.395E-01	0.21	0.01	LO	0.00	0.00	LO

ANNEX TABLE IX-C-12 (continued)

PIPE NO	NODES FROM	TO	DIA MM	L MTRS	H-W C	K-VALUE	FLOW	-VEL-- MPS--CK		- HEADLOSS-- MT	MT/1000	CK
307	116	117	150	440.	100	0.263E-01	1.04	0.06	LO	0.03	0.06	LO
308	118	117	150	760.	100	0.395E-01	0.14	0.01	LO	0.00	0.00	LO
309	119	118	150	200.	100	0.120E-01	0.81	0.05	LO	0.01	0.07	LO
310	120	119	150	400.	100	0.359E-01	0.14	0.01	LO	0.00	0.00	LO
311	124	120	150	900.	100	0.299E-01	0.09	0.00	LO	0.00	0.00	LO
312	121	120	150	780.	110	0.391E-01	0.89	0.05	LO	0.03	0.04	LO
313	107	106	150	530.	100	0.317E-01	0.33	0.02	LO	0.00	0.01	LO
314	109	108	150	460.	100	0.275E-01	1.67	0.09	LO	0.07	0.15	LO
315	111	109	150	400.	100	0.239E-01	2.27	0.13	LO	0.11	0.27	LO
316	111	110	150	600.	100	0.359E-01	0.69	0.04	LO	0.02	0.03	LO
317	97	119	150	560.	100	0.335E-01	0.25	0.01	LO	0.00	0.00	LO
318	115	109	150	300.	100	0.179E-01	1.10	0.06	LO	0.02	0.07	LO
319	4	117	150	760.	100	0.455E-01	2.50	0.14	LO	0.25	0.33	

ANNEX TABLE IX-C-12 (continued)

NO.	SECTION ELEV	FLOW	HGL ELEV	HEAD MTRS	PRESSURE ATM -CK	PRESSURE PCT DROP--CK
1	10.0	0.00	51.79U	41.79	4.09	2.81
2	2.0	0.77	51.64U	49.64	4.91	2.67
3	2.0	0.77	51.39U	49.39	4.[illegible]	3.15
4	2.0	1.63	50.90U	48.90	4.73	4.11
5	10.0	1.05	50.81U	40.81	3.95	5.10
6	10.0	0.71	50.73U	40.73	3.9[illegible]	5.28
7	10.0	0.52	50.67U	40.67	3.9[illegible]	5.42
8	10.0	1.49	50.66U	40.66	3.9[illegible]	5.44
9	15.0	1.27	50.61U	35.61	3.45	6.28
10	12.0	0.60	50.56U	38.56	3.73	5.95
11	15.0	1.04	50.52U	35.52	3.4[illegible]	6.52
12	5.0	0.50	51.31U	46.31	4.48	3.52
13	3.0	0.37	51.32U	48.32	4.68	3.35
14	3.0	0.19	51.54U	48.54	4.70	2.91
15	3.0	0.06	51.61U	48.61	4.71	2.78
16	3.0	0.18	51.66U	48.66	4.71	2.68
17	3.0	0.14	51.66U	48.66	4.71	2.68
18	20.0	0.30	50.36U	30.36	2.9[illegible]	8.01
19	20.0	0.15	50.72U	30.72	2.9	6.90
20	10.0	0.13	50.69U	40.69	3.9[illegible]	5.38
21	10.0	0.11	50.65U	40.65	3.9[illegible]	5.46
22	10.0	0.11	50.65U	40.65	3.93	5.47
23	15.0	0.22	50.64U	35.64	3.45	6.22
24	12.0	0.75	50.59U	38.59	3.74	5.89
25	15.0	0.45	50.52U	35.52	3.4[illegible]	6.52
26	5.0	0.36	51.43U	46.43	4.49	3.27
27	3.0	0.65	53.61U	50.61	4.90	1.22
28	3.0	0.99	55.08U	52.08	5.04	-4.15
29	3.0	0.42	56.20U	53.20	5.15	-6.40
30	3.0	0.52	53.93U	50.93	4.93	1.88
31	3.0	0.37	52.19U	49.19	4.76	1.62
32	10.0	0.08	50.69U	40.69	3.94	5.38
33	10.0	0.29	50.65U	40.65	3.94	5.46
34	10.0	0.04	50.65U	40.65	3.9[illegible]	5.47
35	10.0	0.29	50.65U	40.65	3.94	5.47
36	10.0	0.25	50.65U	40.65	3.94	5.47
37	10.0	0.08	50.65U	40.65	3.93	5.47
38	12.0	0.29	50.65U	38.65	3.74	5.73
39	12.0	0.13	50.65U	38.65	3.74	5.73
40	13.0	0.13	50.65U	37.65	3.64	5.88
41	13.0	0.13	50.64U	37.64	3.64	5.90
42	10.0	0.42	50.67U	40.67	3.94	5.42
43	10.0	0.34	50.76U	40.76	3.95	5.21
44	10.0	0.17	50.79U	40.79	3.95	5.13
45	10.0	0.17	50.78U	40.78	3.95	5.17
46	10.0	0.17	50.78U	40.78	3.95	5.17
47	10.0	0.17	50.77U	40.77	3.95	5.18
48	3.0	1.20	52.99U	49.99	4.84	0.02
49	3.0	0.90	53.32U	50.32	4.87	0.64
50	3.0	0.97	55.95U	52.95	5.13	-5.90

ANNEX TABLE IX-C-12 (continued)

NODE	GROUND ELEV	FLOW	HGL ELEV	HEAD MTRS	PRESSURE ATM	CK	PRESSURE PCT DROP	CK
51	10.0	0.13	50.57U	40.57	3.93		5.65	
52	6.0	0.13	50.57U	44.57	4.31		5.18	
53	6.0	0.05	50.57U	44.57	4.31		5.18	
54	5.0	0.57	50.59U	45.59	4.41		5.02	
55	5.0	0.97	50.63U	45.63	4.42		4.94	
56	8.0	0.67	50.76U	42.76	4.14		4.98	
57	10.0	0.43	51.21U	41.21	3.99		4.17	
58	4.0	0.21	51.25U	47.25	4.57		3.56	
59	3.0	0.21	51.29U	48.29	4.67		3.43	
60	3.0	0.13	51.31U	48.31	4.68		3.38	
61	3.0	0.19	51.32U	48.32	4.68		3.36	
62	4.0	0.21	51.26U	47.26	4.53		3.55	
63	3.0	0.18	51.33U	48.33	4.68		3.34	
64	3.0	0.16	51.36U	48.36	4.68		3.28	
65	3.0	0.13	51.39U	48.39	4.68		3.23	
66	3.0	0.14	51.39U	48.39	4.68		3.22	
67	3.0	0.14	51.47U	48.47	4.69		3.06	
68	3.0	0.13	51.48U	48.48	4.69		3.03	
69	3.0	0.14	51.51U	48.51	4.70		2.98	
70	3.0	0.11	51.51U	48.51	4.70		2.98	
71	6.0	0.14	51.23U	45.23	4.36		3.77	
72	5.0	0.31	51.44U	46.44	4.50		3.26	
73	3.0	0.13	51.75U	48.75	4.72		2.49	
74	3.0	0.26	51.85U	48.85	4.73		2.31	
75	3.0	0.13	51.91U	48.91	4.73		2.18	
76	3.0	0.13	51.92U	48.92	4.74		2.16	
77	3.0	0.24	52.93U	49.93	4.83		0.14	
78	3.0	0.17	52.78U	49.78	4.82		0.44	
79	3.0	0.34	54.27U	51.27	4.96		-2.53	
80	3.0	0.39	54.05U	51.05	4.94		-2.11	
83	3.0	0.23	56.64U	53.64	5.19		7.28	
84	3.0	0.52	56.07U	53.07	5.14		6.15	
85	3.0	0.32	56.18U	53.18	5.15		6.35	
86	3.0	0.30	57.20U	54.20	5.25		8.40	
87	3.0	3.24	58.47U	55.47	5.37		10.94	
88	3.0	3.08	59.50U	56.50	5.47		13.01	
89	3.0	0.06	51.54U	48.54	4.70		2.92	
90	5.0	0.32	51.24U	43.24	4.19		3.91	
91	10.0	0.63	50.85U	40.85	3.95		5.01	
92	10.0	0.45	50.73U	40.73	3.94		5.28	
93	10.0	0.67	50.68U	40.68	3.94		5.39	
94	10.0	0.75	50.64U	40.64	3.93		5.50	
95	10.0	0.29	50.69U	40.69	3.94		5.37	
96	10.0	0.34	50.66U	40.66	3.94		5.45	
97	10.0	0.75	50.64U	40.64	3.93		5.49	
98	3.0	1.80	53.27U	50.27	4.87		-0.54	
99	3.0	2.10	52.98U	49.98	4.84		0.04	
100	4.0	0.88	50.73U	46.73	4.52		4.64	
101	3.0	0.38	50.68U	47.68	4.62		4.65	
102	3.0	0.55	50.64U	47.64	4.61		4.73	

ANNEX TABLE IX-C-12 (continued)

NODE	GROUND ELEV	FLOW	HGL ELEV	HEAD MTRS	PRESSURE ATM	CK	PCT DROP	CK
103	5.0	1.00	50.64U	45.64	4.42		4.93	
104	3.0	0.75	50.62U	47.62	4.61		4.76	
105	3.0	1.25	50.62U	47.62	4.61		4.76	
106	3.0	1.30	50.61U	47.61	4.61		4.78	
107	3.0	2.20	50.73U	47.73	4.62		4.54	
108	3.0	2.00	50.72U	47.72	4.62		4.55	
109	3.0	0.60	50.80U	47.80	4.63		4.41	
110	2.0	0.69	50.99U	48.89	4.73		4.14	
111	3.0	0.48	50.91U	47.91	4.6[illegible]		4.19	
112	3.0	0.29	51.22U	48.22	4.67		3.56	
113	3.0	0.66	51.22U	48.22	4.67		3.56	
114	3.0	0.47	51.20U	48.20	4.67		3.60	
115	10.0	1.34	50.66U	40.66	3.94		5.45	
116	3.0	1.69	50.65U	47.65	4.61		4.69	
117	3.0	1.19	50.63U	47.63	4.61		4.75	
118	5.0	0.67	50.63U	45.63	4.42		4.94	
119	4.0	0.67	50.63U	42.63	4.13		5.26	
120	3.0	0.84	50.64U	47.64	4.61		4.73	
121	10.0	1.09	50.67U	40.67	3.94		5.43	
122	3.0	4.31	55.51U	52.51	5.08		-5.02	
123	3.0	0.55	56.01U	53.01	5.13		-6.02	
124	3.0	1.30	53.51U	50.51	4.89		-1.02	
125	3.0	1.39	51.58U	48.58	4.70		2.84	
200	8.0	183.00	60.70U	52.70	5.10		-17.11	
500	46.0	-117.97U	49.50	3.50	0.34	LC	50.00	HI

CHAPTER X FINANCIAL FEASIBILITY ANALYSIS

A. GENERAL

The financial feasibility analysis herein establishes a detailed set of guidelines that the water district management may use in making crucial decisions during the next years. The technical aspects and project cost of the recommended plan have been presented in Chapter IX. Its economic justification follows in Chapter XI. In this chapter, a plan is developed to indicate how and when funds will be used to operate and maintain the system, implement the program, establish reserve funds, and retire indebtedness.

Water rates have been developed on the basis that the system will be financially self-supporting. Capital funds for the recommended plan will be obtained by borrowing from international lending agencies and LWUA. The water rates that have been developed appear to be within the ability-to-pay of the average householder in the water district.

The financial analysis includes only those revenues and disbursements for the proposed construction program from 1978 to 1990 (Immediate Improvements, Phase I-A and Phase I-B). All revenues and disbursements shown between 1990 and 2000 are those directly attributable to continued service and expenses occurring from facilities constructed between 1978 and 1990.

B. THE EXISTING SYSTEM

Personnel

As of October 1976, the water district was operated by 23 personnel. In order to meet the needs of an expanding organization, recent developments have been directed towards augmenting its present staff and the adoption of LWUA guidelines in the area of personnel management.

Water Rates

The present system has 1,655 flat-rate connections and 87 metered connections. As of December 1976, the water rates were as follows:

A. Metered Connections

1. Minimum charge for metered services consuming between 1 and 20 cubic meters per month:

a)	Domestic Service	₱15.00/month
b)	Commercial Service	20.00/month
c)	Industrial Service	25.00/month

2. For every cubic meter in excess of 20 cubic meters per month:

a)	Domestic Service	₱ 0.65/cum
b)	Commercial Service	0.70 cum
c)	Industrial Service	0.80 cum

B. Flat-Rate Connections

1. For the first faucet:

a)	Domestic Service	₱20.00/month
b)	Commercial Service	50.00/month
c)	Industrial Service	150.00/month

2. For additional faucet:

a)	Domestic Service	₱ 5.00/month
b)	Commercial Service	7.00/month
c)	Industrial Service	8.00/month

Financial Statements

Based on the Statement of Income and Expenses for the period January 1 to October 31, 1977, total revenue was ₱428,000 or an average of ₱42,800 a month. On the other hand, average monthly expenses amounted to ₱54,000. COT-WD, therefore, had an average monthly deficit of approximately ₱11,200. This deficit was reduced by the ₱15,000 monthly subsidy it received from the city government from January to April, 1977. However, the city government has not extended the subsidy from May 1977 due to its own financial problems. In order to meet its operational costs, the district is proposing an increase in its water rates.

The district is now in the process of installing the Commercial Practices Manual which prescribes detailed accounting procedures. However, historic financial records have not been based on organised basic accounting systems. Therefore, data on the past finances of the present system are inadequate to form a sound basis for future projections. It is, therefore, necessary to make certain assumptions. The financial feasibility of those assumptions will be tested as the project is implemented.

C. DEVELOPMENT COSTS

The cost estimates of the facilities needed to improve and expand water services of the water district over the developement planning period are presented in Chapter IX. Cost estimates of the facilities are based on the projected July 1978 prices.

Project Costs

Project costs of facilities recommended for implementation in Stage I are summarized on an annual basis in Annex Table X-C-1. Engineering services for design and construction supervision are broken down. It has been assumed that 70 percent of the engineering services applies to surveys and design and 30 percent to construction supervision. Design costs are shown in the year preceding construction. Contingencies (15/10 percent) are distributed uniformly during the construction period. Foreign exchange component of total project cost includes cost of direct and indirect import items, as well as portion of the engineering costs.

Escalation of Costs

To account for the effects of inflation, capital cost estimates are escalated. This has been done year by year on an item-by-item basis using escalation factors computed from assumed inflationary trends and applied to the basic current cost data as shown in Annex Table X-C-2. The escalation factors used are based on an average annual rate of inflation of 10 percent per year from 1978 through 1980, 8 percent from 1981 to 1985 and 6 percent per year thereafter. On the other hand, annual operation and maintenance costs and family income are escalated at a rate of 8 percent all throughout the 23-year study period. These escalation factors have been assumed to apply equally to the local and foreign exchange costs.

D. OPERATING AND MAINTENANCE COSTS

This cost category covers cash expenses required to keep the system operating and adequately maintained. It assures the continued maintenance of the water district's revenue-producing capacity and protection of its investment. Included in this cost category are: personnel, power, chemicals, maintenance, rental, and other miscellaneous expenses which are necessary to run the overall water system. Most items increase in accordance with the quantity of water produced; the number of customers served; and the extent to which the physical plant will be operated and maintained.

The operating costs of the existing and future systems are presented in Chapter IX.

E. FINANCING POLICIES COVERING LOCAL WATER DISTRICT DEVELOPMENT

The following are the major potential sources of funds which can be utilized by the COT-WD.

Operating Source

To the extent that revenues from the operations of the local water district exceed annual cash requirements for all other purposes, funds can be devoted to financing development costs. As a practical matter, it is highly desirable to finance a significant proportion of development costs in this manner in order to reduce the amount that must be borrowed and the associated debt service costs.

Non-Operating Sources

Non-operating sources of funds for development include 3 basic groups:

1. Loans - funds may be borrowed by the water district for development. One of LWUA's primary functions is lending funds for development to water districts. From the water district's point of view, LWUA is the primary, if not the only realistic, source of funds. LWUA borrows both foreign currencies and pesos at varying terms and relends needed funds to water districts according to the composite terms needed to support the blend of debt service terms LWUA itself must meet. At present, LWUA's terms include:

	Immediate Improvements Loan	Phase I-A and I-B Loan
Interest-	9 percent per annum to be computed at $\frac{3}{4}$ percent per month. Interest due on the local component is paid annually. Interest on foreign exchange is capitalized during construction. Total loan outstanding at the end of construction period earns another full year interest before repayment.	9 percent per annum to be computed monthly at $\frac{3}{4}$ percent per month from the year following the date of disbursement.

	Immediate Improvement Loan	Phase I-A and I-B Loan
Duration	30 year loan, disbursement assumed made at mid-year thus will earn interest for 6 months.	30-year loan from the date of initial disbursement.
Principal	amortized equally for 30 years to start one year after construction.	No principal payments due during construction periods (Construction periods of Stage I-Phases A and B are explained in Chapter IX). Principal repayment period is 30 years less the duration of the disbursement period.

2. Charges and Assessments - consist of payments made by new customers and benefiting property owners for the costs of specific portions of the facilities being developed. Typically, such charges are made for the costs of new construction and water meters and for all or a portion of the costs of new distribution system extensions. LWUA guidelines suggest that new customers may pay for connections and water meters, but currently do not include an assessment for distribution system costs. For purposes of the analysis new customers were assumed to be paying for the new connections and water meters on a revolving fund basis. These sources are referred to as "contributions in aid of construction" in accounting terminology and have the effect of reducing the amounts to be borrowed. Since many new customers will not be in a position to pay connection fees (or benefit assessment charges) in cash, it will be necessary to provide financing assistance. Present practice is to allow such payments to be made at a flat monthly rate of ₱5.00 over a period of 10 years.

3. Grants or Credits - LWUA has access to loan funds on concessionalry terms and is thus able to relend funds at rates that are below market rates. This in itself is a "credit" available to the local water district borrower. In some countries, the national government makes outright grants to local water districts in recognition of the overall national benefit of having safe and reliable water systems. Another approach is for the government to advance a portion of the funds needed during the early years of development at little or no interest to assist the local utility in building its financial capacity. This is another form of "credit" as referred to above. Later, as the revenue base expands and

development expenditures decline, the local utility refunds such advances as permitted by its cash position. At the present time, however, the local water district is expected to undertake its development programs with no equity participation by government or assistance other than the LWUA loans.

Reserve Requirements

Since reserve requirements are tied directly to obtaining development loans from LWUA, they are considered as funds required to support capital development. After total revenue requirements are determined, LWUA guidelines suggest that 10 percent be set aside for reserve funds. For purposes of this study, a lower percentage will be used, starting at 3 percent progressively increasing to 10 percent.

F. FUNDS FOR CAPITAL DEVELOPMENT

Once the basic data requirements are met and the financing policies outlined, funds required to cover development costs are then determined. The most important document in this regard is the breakdown of costs as escalated and shown in Annex Table X-C-2.

Depreciable Assets/Depreciation Expenses

Capital assets acquired each year become subject to depreciation in their first full year of service. Thus a pipeline completed in 1978 becomes "depreciable" in 1979. If it has a 50-year life, depreciation continues for 50 years and it is assumed to be retired in the 51st year. The cost of large facilities that require several years to construct is carried as "work-in-process" until completed.

Annex Table X-F-1 shows the water district's assets and depreciable value forecasts, the initial purpose of which is to show the appropriate "depreciable" values for use in calculating replacement costs and annual depreciation expenses. At the same time, year-end book values of assets are shown as well as the value of work-in-process.

Based on the schedule of assets, annual depreciation expenses were calculated and are shown in Annex Table X-F-2.

Revolving Fund for Connections

To assist new customers in financing service connections charges, it is necessary to provide working capital for a revolving fund. It is proposed that LWUA's present policy which provides for the costs to be payable at ₱5.00/month over a 10-year period be increased to ₱6.83 by 1978 to cover the increased unit price of meters. Net flow funds will be required over a period of 10 years to build sufficient income

to support the annual costs of connections. At some future point, income exceeds annual expenditures and the revolving fund can be used to refund the earlier advances of working capital.

Annex Table X-F-3 indicates the working capital requirements. In this table, the two key assumptions are:

a. The monthly installment payments are based on actual costs of constructing service connections and meters; thus, the monthly payments by customers connected to the system in 1981 would be greater than those who would be connected to the system in 1978 to account for the escalation of construction costs.

b. Sixty (60) percent of all new customers would utilize the installment method of financing connection charges.

Revenue Unit Forecast

The present LWUA rate policy incorporates the use of "revenue units" (RU) in determining the basic cost per cubic meter of water to domestic consumers. Commercial and industrial customers are charged twice the unit price for domestic use and wholesale water distributors are charged thrice the basic price. As defined, a "revenue unit" is an arbitrary unit of measure into which discharges from pipes of various sizes are reduced to a 3/8-inch connection by the use of conversion factors.

Thus, the discharge of a 3/8-inch connection (actually a ½-inch connection, but regulated by a water meter to give the discharge of a 3/8-inch connection) is multiplied by 1.0; that of a ½-inch by 2.5; that of a ¾-inch by 4; that of 1-inch by 8; and so forth, to get the total RUs delivered.

Two charges are levied on metered connections - the minimum charge and the commodity charge. The minimum charge is the fixed charge which covers the first 10 cum of water. It varies according to the size of the connection. The commodity charge is payment for water consumed after the first 10 cum. The unit price is uniform for every size and type of connection.

Annex Tables X-F-4a and X-F-4b give the revenue unit forecast.

G. ANALYSIS OF WATER RATES

Ability-To-Pay Issue

Presidential Decree No. 198 stipulates that water districts must be financially self-sufficient. In the past, most water systems have not been able to generate sufficient revenues to cover even the operation and maintenance expenses due to various factors including poor pricing schemes, defective collection system and inadequate consumer promotion. The major reason for insufficient revenues, however, is that certain comsumers being served by the water district have such low incomes and hence, are not in a financial position to pay the full costs of the system. Therefore, before a water system is improved and expanded, the ability-to-pay of the population targeted to be served, must be ascertained.

Since water districts are not expected to be extended government subsidy, the analysis of the factors affecting ability-to-pay has been significantly simplified. The factors that affect ability-to-pay are the annual income of families covered by the water district and the percentage of their income allocated to water supply.

In March 1975, an informal survey was conducted among Water District General Managers to help gather data needed for the ability-to-pay studies. Questionnaires were distributed to 15 water districts covering provincial areas that differed in size, location and economic conditions.

The answers given by the general managers of the 15 water districts are summarized as follows:

1) Though 10 of the water districts were revenue-producing prior to the change in management of the water district, 13 imposed increased water rates upon takeover.

2) Water consumers generally accepted the increase after some explanations justifying it. Only five received formal complaints about the increased rates while eight received formal complaints about the poor quality of water supply.

3) Ten had difficulty in the collection of water bills primarily due to dissatisfaction of consumers with the water service.

4) Assuming that capital and service improvements were made, the general managers indicated they could increase their rates by as low as 25 percent and as high as 447 percent for the average and below average households.

A formal survey was conducted in April and May, 1975 in the city of Lipa and the Municipality of Tanauan. These pilot areas were selected because (a) they are at present experiencing water supply problems, (b) the income level of their families is similar to that of the national income figure, and (c) they are near Manila, only about two hours away by bus.

The survey covered 556 families, classified into 4 income groups. Approximatley 28 percent came from the low-income class (below ₱220/month); 55 percent from the middle-income (₱221 - ₱750); 12 percent from the upper middle-income group (₱751-₱1,500); and 5 percent from the high-income group (above ₱1,500).

The table below presents the highlights and pertinent findings of the survey.

ESTIMATED ABILITY-TO-PAY BY INCOME GROUPING

					Weighted Average
Income Group	₱220	₱221-750	₱751-1,500	₱1,500	
% Distribution	28%	55%	12%	5%	
Probable Ability-to-Pay on Basis of Improved Service	₱13.50	₱24.50	₱37.00	₱67.50	₱25.00/mo
Estimated Average Income	₱220	₱660	₱1,000	₱2,700	₱680/household
Ability-to-Pay Divided by Average Income	6.1%	3.7%	3.7%	2.5%	3.7%

The foregoing table indicates that the low-income group may be able to pay a maximum of ₱13.50 a month for water (about 6.1 percent of their average income). In the extreme end, the high-income group may be able to pay a maximum of ₱67.50 a month for water (only 2.5 percent of their average income). This disparity in the percentage of income allocated to water by the 2 income groups may well be the best argument of those advocating a socialized price structure.

The probable maximum ability-to-pay of the pilot area average household is about ₱25.00 per month.[1]

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[1] This figure includes appropriate allowances for the respondents understating their income or willingness to pay and the increase in amount they are willing to pay as a result of improved services.

Family Income

In the Survey of Households Bulletin Series No. 34, published July 1973 by the NCSO, Manila, (page 3, Table 5), the following data are given:

	Total Families	Total Urban	Manila and Suburbs	Other Urban Areas	Rural
Median Family Annual Income, Pesos	₱2,454	₱3,972	₱5,202	₱3,650	₱1,954
Size of Sample, Families	6,347	1,913	525	1,388	4,434

The above data are for the 12-month period May 1970 to April 1971, more or less. The figure for "other urban areas", ₱3,650 median family annual income, may approximate, or may be a little less than the median family income in the areas served with piped water. As the figures cited above show, in general, people in urban areas tend to be financially better off than people in rural areas. The term "urban areas" includes all urban areas in the country. The inhabitants of the central urban area of a city or municipality are expected to be somewhat wealthier than the other areas of the city or municipality.

By July 1976, the annual income for "other urban areas" cited above, escalated at 10 percent per year, would be about ₱6,200/year.

The report, "The Filipino Family, Community, and Nation" by Emma Porio, Frank Lynch and Mary R. Hollensteiner published by the Institute of Philippine Culture of Ateneo de Manila University in April 1975, cites in Table A9, page 99 the results of a survey in April 1974. The families surveyed were distributed among 15 urban areas, and included 373 families in Metro Manila. Excluding the families in Metro Manila, mean monthly income of the remaining 1,599 families was ₱572, or ₱6,864 per year. Escalating this income at an annual rate of 10 percent, by 1 July 1976, it would be an income of about ₱8,510 per year. These 14 urban areas are among the more urbanized in the country. They included, for instance, only 3 municipalities, the other eleven being classified as cities. The median population of the 14 urban areas in the 1970 census was about 70,000.

Based on these data, the mean family income of the people residing in the water service areas of the communities whose water systems are proposed to be improved might be, by 1 July 1976, somewhere between the

₱6,200 per year (developed from the 1970/71 data of the NCSO) and the ₱8,510 per year (developed from the data of Porio, Lynch and Hollensteiner). For lack of other data, the average water-using family may have an income of about ₱7,900 during 1976 (or ₱660 per month, which is close to the Lipa household survey). This is equivalent to an annual income of $1,000 for a family of six or seven.

Initial Rate Determination

Several trials were made to come up with "revenue unit" (RU) prices that can be used for a period of several years. It is good practice for the water district to adjust prices every 3 years or so, instead of annually.

Based on the trials made, the water rates established at 3-year intervals are as follows:

Period	Water Rate (₱/RU)
1978-1980	₱0.75
1981-1983	1.20
1984-1986	1.50
1987-1989	1.70
1990-1992	2.00[2]
1993-1996	2.10
1997-2000	2.20

The first step of ₱0.75/RU was selected as an intermediate rate, in anticipation of the second step (₱1.20/RU) which is indicative of the required cost to make the system financially viable. The rate of ₱1.20/RU in 1982 cost levels is equivalent to ₱0.82 in 1978 prices (based on a 10 percent discount rate). Likewise ₱1.50/RU in 1985 is equivalent to ₱0.77 in 1978 prices.

Feasibility of Charges

The question of feasibility is a matter of analyzing whether or not the customers of the water district are able to pay the required charges both now and in the future in order to obtain safe and reliable water services. Inasmuch as the proposed water rates represent the "mean", determination has been made for that group of households whose income (₱700/mo) also represents the "mean". Probable use of water

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[2] This rate only covers expenses of debt service and operation and maintenance costs incurred for facilities constructed before 1990. Water rates from 1990-2000 would be higher if the COT-WD continued to construct additional facilities from 1990 to 2000.

by this group was calculated at 1[illegible] cum per month.[3/] For present purposes, the study covers consumers with ¾-inch connections inasmuch as they comprise the bulk of the domestic/government consumers. Working back, the 1979 rate of ₱0.75 per revenue unit will yield a montaly minimum charge of ₱18.75. The commodity charge for a 24-cum consumption is ₱10.50 (₱0.75 x 14). For newly connected customers who avail of the 10-year installment plan, monthly expenditure for water will increase by ₱6.83 to account for the service connection charge. Since both water and household incomes increase each year, the impact of the installment charge on the expenditure pattern of the household will decline over the 10-year period of payment. The estimated impact of the increased rates and connection charges on household patterns is shown below for the mid-point of each rate block.

	1979	1982	1985	1988	1991	1995	1999
Escalated income of household earning ₱700/mo in 1976 (8% per year)	880	1,110	1,400	1,760	2,220	3,020	4,110
Expenditure for 24-cum water consumption-minimum charge (first 10 cum)	18.75	30.00	37.50	42.50	50.00	52.50	55.00
Commodity charge (Rate/RU x 14 cum)	10.50	16.80	21.00	23.80	28.00	29.40	30.80
Income allocation to water for existing consumers (%)	3.3	4.2	4.2	3.8	3.5	2.7	2.1
Connection charge for new customers (₱6.83/mo in 1978)	7.51	9.63	12.13	14.45	17.20	21.71	27.40
Income allocation to water for new customers	4.2	5.1	5.0	4.6	4.3	3.4	2.8

[3/] Probable use of water by income groups:

Income Grouping	Below Average	Average	Upper Middle	High	Weighted Mean
Probable Water Use (cum/mo)	16	24	32	44	23.7

Since the mid-point of the period was selected for comparison, it should be noted that the proportions shown would be slightly higher in the year preceding the mid-point and lower in the succeeding year of each rate block.

In the example shown above, the proportions of the household income required for water services (except in 1982 and 1985 which are the crucial years) are considered within the upper range limit of the ability-to-pay studies done in Lipa City where willingness to pay fees for improved services were found to be about 3.7 percent of the household income.

In the final analysis, if any significant improvement is to be achieved in the scope and quality of public water service and if the requirement for commercially viable and financially self-supporting water districts is to be maintained, all groups of water customers will have to pay substantially higher charges for water services than they have paid in the past.

Socialized Water Rates

A policy guideline in the structuring of water rate charges is that they must be reasonable and realistic. Since water is a prime commodity both for the poor and the rich, the socialized rate may be determined such that a greater financial burden is carried by those who can afford it (but not to the point that it becomes oppressive to them).

In the preceding sections, specific rates established meet the cash requirements for an improved system, and at the same time, fall within the average consumer's ability-to-pay. Under this scheme, the cost for the first 10 cum consumed is ₱18.75 and the subsequent consumption, ₱0.75/cum. Thus, the monthly rates for the following water consumption will be:

Usage (cum/mo)	Cost/month (₱)[4]
16	23.25
18	24.75
20	26.25
22	27.75
24	29.25
30	33.75
32	35.25
44	44.25

[4] For ½-inch connection, domestic classification.

The estimated impact on the average income household (assumed to have a monthly 1976 income of ₱660) and the below average income household (assumed to have an adjusted monthly 1976 income of ₱300) is as follows:

Income Level	Projected 1979 Monthly Income	Monthly Usage of Water	Cost of Water/mo	Percent of Income Allocated to Water
Below Average	₱380	16 cum	₱23.25	6.1
Average	830	24 cum	29.25	3.5

The preceding table shows that the financial burden to the below average income group is heavy.

A socialized pricing alternative has been developed to relieve the low income groups of the high financial cost of water with the following rate structure:

first 16 cum/mo at	₱0.85/cum
from 17-24 cum/mo at	1.85/cum
25 or more cum/mo at	2.45/cum

The resulting monthly rates for the various water usages will be:

Usage (cum)	Cost/month (₱)
16	13.60
18	17.30
20	21.00
22	24.70
24	28.40
30	43.10
32	48.00
44	77.40

The corresponding impact on the various income levels is as follows:

Income Level	Projected 1979 Monthly Income	Monthly Usage of Water	Cost of Water/mo	Percent of Income Allocated to Water
Below Average	₱ 380	16 cum	₱13.60	3.6
Average	830	24 cum	28.40	3.4
Upper Middle	1,260	32 cum	48.00	3.8
High	2,910	44 cum	77.40	2.7

The preceding table shows that, across the income profile of the community, the monthly costs range from 2.7 - 3.8 percent of household income.

Revenue Forecasts

Estimated future levels of income from water sales are shown in Annex Table X-G-1.

H. FINANCIAL SUMMARY

Several trials have been conducted in developing the forecasts of financial statements of the COT-WD. These statements are based on the following major assumptions:

1. Reserve Fund: 3 percent of sales for 1978-1990; 6 percent for 1991-1995; and 10 percent for 1996-2000.

2. Uncollectibles: 2 percent of gross revenue requirements for the first year of a new rate application, and 1 percent for the second and third years.

3. Accounts Receivable: equivalent to 3 months of sales.

4. Accounts Payable: equivalent to 2 months of operating expenses.

External Borrowing Required

Annex Table X-H-1 shows a summary of the external borrowing required and the annual debt servicing of the loans. Two separate analyses were made for the immediate improvement loan and the Phase I-A and I-B loans to comply with prevailing LWUA terms.

Borrowing will start in 1978 and continue through 1990. The immediate improvement loan (1978-1980) will amount to ₱7.602 million. The Phase I-A loan will cover the 5-year period 1979-85 inclusive and will amount to ₱29.143 million. The Phase I-B loan will cover the 5-year period 1986-90 inclusive and will be about ₱29.026 million.

The immediate improvement loan of 7.602 million consists of ₱6.511 million in escalated capital expenditures (see Table X-C-2) and ₱1.067 million capitalized interest. The Stage I loans of ₱29.143 million in 1978 and ₱29.026 million in 1986 include escalated capital expenditures (see Table X-C-2) less revenues from the service connection revolving fund (see Table X-F-3).

Projections of Financial Statements

Annex Table X-H-2 shows the net income (loss) on a yearly basis. Net loss is forecasted in 1981 through 1986. Net income cumulative would show positive values in sixteen of the 23-year study period.

Other related data such as water production, water sales, unaccounted-for-water and rate of return based on net fixed assets in operation are also presented in table.

Cash Flow Statements

The cash flow statement provides an indication of the adequacy of working capital. It is not generally sufficient to cover cash outlays with revenues because of the tendency of cash receipts to lag behind cash outlays. In general, an expanding organization with an active capital development program and increasing level of activities will require similarly increasing quantities of working capital.

Annex Table X-H-3 presents the annual "Projected Sources and Applications of Funds." Potential net decreases are expected in 1978, 1982 and 1983. By 2000, positive net cumulative cash balance will be ₱34.953 million even if "cash at the beginning of 1978" has been assumed equal to zero.

Other Financial Statements

Appendix Table X-H-4 presents the "Projected Balance Sheet" which shows the projected fixed and current assets, liabilities and equity of the water district of the water district from 1978 to 2000.

Rate of Return

Discount rate of return on total investments (Annex Table X-H-5) measures the true efficiency of mobilizing investments on the project from a broader perspective. Taken from a different perspective, it measures the effective utilization of total investments employed in the project. It shows what the compounded growth of investment within the project cycle would be based on the interplay of cash outflows and the resulting inflows from such investment.

Net asset salvage value of ₱6.451 million is added to net cash inflow in the year 2000. This is done based on the assumption that the project will terminate in the last projection year. Hence, assets are to be liquidated and all liabilities are to be paid from the proceeds of the assets.

Several trials were made in finding the rate of interest that equated the present value of the cash inflows to the unrecovered investments. In the COT-WD, the rate of return, with assumptions made, is estimated to be 8.4 percent.

BEST AVAILABLE DOCUMENT

ANNEX X-C

DEVELOPMENT COSTS

ANNEX TABLE X-C-1

PROJECT COST OF RECOMMENDED PROGRAM
COTABATO CITY WATER DISTRICT
WITHOUT ESCALATION
(₱ x 1,000)

		1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	Total
Phases I-A and I-B															
Source Facilities	a) Equipment		40	297	298				18			265			[illegible]
	b) Wells								9			136			145
	c) Structures		25	187	188				10			152			[illegible]
Transmission and Distribution Facilities			788	5,801	5,801				366	527	527	1,305	1,316	[illegible]	[illegible]
Storage Facilities			41	599					41	599					[illegible]
Internal Network			169	413	413	413	414	414	544	383	383	383	382	382	[illegible]
Service Connections	a) Pipes		80	–	371	394	464	510	670	417	443	521	574	650	[illegible]
	b) Meters		20	–	110	98	110	121	173	159	168	198	218	248	[illegible]
Fire Hydrants			72	177	177	177	177	177	214	104	104	104	105	105	[illegible]
Plumbing Shop and Laboratory Facilities	a) Equipment		17	249											[illegible]
	b) Structure		33	485											[illegible]
River Crossing and Access Road									153		1,126	1,125			[illegible]
Immediate Improvements	a) Source Facilities 1) Equipment	319													319
	2) Structure	231													231
	b) Transmission and Distribution Facilities	2,976													2,976
	c) Administration Building 1) Equipment	118													118
	2) Structure	459													459
	d) Plumbing and Meter Repair Equipment	124													124
	e) Vehicles	139													139
	f) Miscellaneous Items	15													15
	g) Service Connections 1) Pipes	480	237	237											954
	2) Meters	531	90	90											711
Feasibility Studies 1/		63		384											[illegible]
Sub-total 2/		5,455	1,612	8,919	7,358	1,082	1,165	1,222	2,198	2,189	2,751	4,789	3,195	1,915	[illegible]
Land		300		200						820					[illegible]
Total Project Cost 3/		5,755	1,612	9,119	7,358	1,082	1,165	1,222	2,198	3,009	2,751	[illegible]	3,195	1,915	[illegible]

1/ Computed at approximately 1% of the total project cost.
2/ Includes design (first year of each major segment of development), supervision of construction and contingencies spread uniformly during the period of construction.
3/ Does not include interest during construction. For calculated interest see Table X-H-1.

ANNEX TABLE X-C-2

PROJECT COST OF RECOMMENDED PROGRAM
COTABATO CITY WATER DISTRICT
WITH ESCALATION
(P x 1,000)

			1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	Total
Phases I-A and I-B																
Escalation Factor			1.000	1.100	1.210	1.307	1.412	1.525	1.647	1.779	1.886	1.999	2.119	2.246	2.381	
Source Facilities	a) Equipment			44	359	389				32			552			1,386
	b) Wells			-						16			288			304
	c) Structures			28	226	246				18			322			840
Transmission and Distribution Facilities				867	7,019	7,582				551	994	1,053	4,037	4,281	1,257	27,741
Storage Facilities				45	725					73	1,130					1,973
Internal Network				186	500	540	583	631	681	968	722	766	812	858	910	8,157
Service Connections	a) Pipes			88		485	556	708	840	1,192	786	886	1,104	1,289	1,552	9,486
	b) Meters			22		124	138	168	193	308	300	336	420	490	590	3,115
Fire Hydrants				79	214	231	250	270	292	351	196	208	220	236	250	2,827
Plumbing Shop and Laboratory Facilities	a) Equipment			19	301											320
	b) Structure			35	587											623
River Crossing and Access Road										272		2,251	2,384			4,907
Immediate Improvements	a) Source Facilities	1) Equipment	319													319
		2) Structure	231													231
	b) Transmission and Distribution Facilities		2,976													2,976
	c) Administration Building	1) Equipment	118													118
		2) Structure	459													459
	d) Plumbing and Meter Repair Equipment		124													124
	e) Vehicles		139													139
	f) Miscellaneous Items		15													15
	g) Service Connections	1) Pipes	480	261	287											1,028
		2) Meters	531	99	109											739
Feasibility Studies			63		465											528
Sub-total			5,455	1,774	10,792	9,617	1,527	1,777	2,012	3,911	4,128	5,500	10,149	7,154	4,559	65,355
Land			300		242						1,547					2,089
Total Project Cost			5,755	1,774	11,034	9,617	1,527	1,777	2,012	3,911	5,675	5,500	10,149	7,154	4,559	70,444

ANNEX X-F

FUNDS FOR CAPITAL DEVELOPMENT

ANNEX TABLE X-F-1

ASSET AND DEPRECIABLE VALUE FORECAST
COTABATO CITY WATER DISTRICT
(P x 1,000)

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
I. WORK-IN-PROGRESS																							
Source Facilities a) Equipment		44	403	792				32	32	32	594												
b) Wells								16	16	16	304												
c) Structure		28	254	500				18	18	18	340												
Total Work-in-Progress		72	657	1292				66	66	66	1238												
II. ASSETS ADDED BY THE YEAR-END																							
Transmission and Distribution Facilities		867	1019	7582				651	994	1053	4037	4281	1257										
Storage Facilities		45	725					73	1130														
Internal Network		186	500	540	583	631	681	968	722	766	812	858	910										
Service Connections a) Pipes		88	-	485	556	708	840	1192	786	886	1104	1289	1552										
b) Meters		22	-	144	138	168	199	308	300	336	420	490	590										
Fire Hydrants		79	214	231	250	270	292	381	196	208	220	236	250										
Plumbing Shop and Laboratory Facilities a) Equipment		19	301																				
b) Structure		36	587																				
River Crossing and Access Road								272		2251	2384												
Immediate Improvements a) Source Facilities																							
1. Equipment	319																						
2. Structure	231																						
b) Transmission and Distribution Facilities	2976																						
c) Administrative Building																							
1. Equipment	118																						
2. Structure	459																						
d) Plumbing and Meter Repair Equipment	124																						
e) Vehicles	139																						
f) Miscellaneous Items	15																						
g) Service Connections																							
1. Pipes	480	261	287																				
2. Meters	531	99	109																				
Feasibility Studies	63		465																				
Replacements a) Source Facilities - Equipment																905		946	1006				
b) Service Connections - Meters																1509	271	287	371	351	417	287	593
c) Plumbing Shop and Laboratory Facilities— Equipment																		793					
d) Administration Building - Equipment																335							
e) Plumbing and Meter Repair - Equipment																352							
f) Vehicles								238							358							539	
g) Miscellaneous Items																43							
Total Assets by Year-End	5455	1782	10207	8562	1327	1777	2012	4083	4128	5500	8977	7154	4559		358	3144	271	2026	1377	351	417	1026	593
III. DEPRECIABLE VALUES																							
A. 50 Years Service Life																							
Existing Facilities	6851	6683	6683	6683	6548	6413	6278	6143	6008	6008	6008	6008	4024	4024	4024	4024	4024	4024	4024	4024	4024	4024	4024
Source Facilities - Structure	-	231	231	231	731	731	731	731	731	731	731	1071	1071	1071	1071	1071	1071	1071	1071	1071	1071	1071	1071
Transmission and Distribution Facilities	-	2976	3843	10862	18444	18444	18444	18444	19095	20089	21142	25179	29460	30717	30717	30717	30717	30717	30717	30717	30717	30717	30717

ANNEX TABLE X-F-1 (Continued)

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Storage Facilities	-	-	45	770	770	770	770	770	843	1973	1973	1973	1973	1973	1973	1973	1973	1973	1973	1973	1973	1973	1973
Internal Network	-	-	186	686	1226	1809	2440	3121	4089	4911	5577	6389	7247	8157	8157	8157	8157	8157	8157	8157	8157	8157	8157
Service Connection - Pipes	-	480	829	1116	1601	2157	2865	3705	4937	5683	6569	7673	8962	10514	10514	10514	10514	10514	10514	10514	10514	10514	10514
Fire Hydrants	-	-	79	293	524	774	1042	1336	1717	1913	2121	2341	2577	2827	2827	2827	2827	2827	2827	2827	2827	2827	2827
Plumbing Shop and Laboratory Facilities - Structure	-	-	36	523	623	623	623	623	623	623	623	623	623	623	623	623	623	623	623	623	623	623	623
River Crossing and Access Road	-	-							272	272	272	4907	4907	4907	4907	4907	4907	4907	4907	4907	4907	4907	4907
Administration Building - Structure	-	459	459	459	459	459	459	459	459	459	459	459	459	459	459	459	459	459	459	459	459	459	459
Total 50 Years Service Life	6851	10829	12391	81723	30926	32180	33654	35332	38734	42562	47726	56623	61303	65272	65272	65272	65272	65272	65272	65272	65272	65272	65272
B. 30 Years Service Life																							
Feasibility Studies		63	63	528	528	528	528	528	528	528	528	528	528	528	528	528	528	528	528	528	528	528	528
Total 30 Years Service Life	-	63	63	528	528	528	528	528	528	528	528	528	528	528	528	528	528	528	528	528	528	528	528
C. 25 Years Service Life																							
Existing Facilities																							
Source Facilities - Wells	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	-
												304	304	304	304	304	304	304	304	304	304	304	304
Total 25 Years Service Life	85	85	85	85	85	85	85	85	85	85	85	389	389	389	389	389	389	389	389	389	389	389	304
D. 15 Years Service Life																							
Existing Facilities	306	306	306	306	286	286	286	286	286	286	286	286	3	3	3	3	3	3	3	3	3	3	3
Source Facilities - Equipment	-	319	319	319	1111	1111	1111	1111	1111	1111	1111	1705	1705	1705	1705	1705	2291	2291	2878	3495	3495	3495	3495
Service Connections - Meters	-	531	652	761	905	1043	1211	1410	1718	2018	2354	2774	3264	3854	3854	3854	4832	5004	5182	5409	5622	5871	6159
Plumbing Shop and Laboratory Facilities - Equipment	-	-	19	320	320	320	320	320	320	320	320	320	320	320	320	320	320	320	793	793	793	793	793
Administration Building - Equipment	-	118	118	118	118	118	118	118	118	118	118	118	118	118	118	118	335	335	335	335	335	335	335
Plumbing Shop and Meter Repair Equipment	-	124	124	124	124	124	124	124	124	124	124	124	124	124	124	124	352	352	352	352	352	352	352
Miscellaneous Items	-	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	43	43	43	43	43	43	43
Total 15 Years Service Life	306	1413	1553	1963	2879	3017	3185	3384	3692	3992	4328	5342	5549	6139	6139	6139	8176	8348	9586	10430	10643	10850	11190
E. 7 Years Service Life																							
Vehicles	-	139	139	139	139	139	139	139	238	238	238	238	238	238	238	358	358	358	358	358	358	358	532
Total 7 Years Service Life	-	139	139	139	139	139	139	139	238	238	238	238	238	238	238	358	358	358	358	358	358	358	539
TOTAL DEPRECIABLE VALUES	7242	12529	14231	24438	34557	35949	37591	39468	43277	47405	52905	63120	68007	72566	72566	72686	74723	74895	76133	76977	77190	77439	77823
BOOK VALUE OF ASSETS OTHER THAN LAND	12697	14303	25095	34712	36084	37726	39603	43617	47471	52971	63120	70274	72566	72566	72924	75830	74994	76921	77510	77328	77607	78465	78416
LAND	300	300	542	542	542	542	542	542	2089	2089	2089	2089	2089	2089	2089	2089	2089	2089	2089	2089	2089	2089	2089
TOTAL BOOK VALUE OF ALL CAPITAL ASSETS	12997	14603	25637	35254	36626	38268	40245	44159	49560	55060	65209	72363	74655	74655	75073	77083	77083	79010	79599	79417	79696	80554	80505

ANNEX TABLE X-F-2

SCHEDULE OF DEPRECIATION EXPENSES
COTABATO CITY WATER DISTRICT
(₱ x 1000)

Year	50 Yr	30 Yr	25 Yr	15 Yr	7 Yr	Total Annual Depreciation Expenses	Accumulated Depreciation Prior Year	50 Yr	25 Yr	15 Yr	7 Yr	Total	Net Accumulated Depreciation Year End
1978	137	-	3	20	-	160	3,704					-	3,864
1979	217	2	3	94	20	336	3,864	168				168	4,032
1980	248	2	3	104	20	377	4,032						4,409
1981	434	18	3	131	20	606	4,409						5,015
1982	619	18	3	192	20	852	5,015	135		20		155	5,712
1983	644	18	3	201	20	886	5,712	135				135	6,463
1984	673	18	3	212	20	926	6,463	135				135	7,254
1985	707	18	3	226	20	974	7,254	135				135	8,093
1986	775	18	3	246	34	1,076	8,093	135			139	274	8,895
1987	851	18	3	266	34	1,172	8,895						10,067
1988	955	18	3	289	34	1,299	10,067						11,366
1989	1,132	18	16	356	34	1,556	11,366						12,922
1990	1,226	18	16	370	34	1,664	12,922	1,984		283		2,267	12,319
1991	1,304	18	16	409	34	1,782	12,319						14,101
1992	1,305	18	16	409	34	1,782	14,101						15,883
1993	1,305	18	16	409	51	1,799	15,883				237	238	17,444
1994	1,305	18	16	545	51	1,935	17,444			1,107		1,107	18,272
1995	1,305	18	16	557	51	1,947	18,272			99		99	20,120
1996	1,305	18	16	639	51	2,029	20,120			788		788	21,361
1997	1,305	18	16	695	51	2,085	21,361			533		533	22,913
1998	1,305	18	16	710	51	2,100	22,913			138		138	24,875
1999	1,305	18	16	726	51	2,116	24,875			168		168	26,823
2000	1,305	18	12	745	77	2,157	26,823		85	199	358	642	28,338

ANNEX TABLE X-P-3

WORKING CAPITAL REQUIREMENTS
FOR REVOLVING FUND FOR NEW CONNECTIONS
COTABATO CITY WATER DISTRICT

Year	Number of New Connections	Number of Installment Plan Added	Number of Installment Plan Paid	Total Paying Monthly Installment (Cumulative)	Monthly Installment Plan (Escalated)	₱ x 1,000							
						Increment Added[2]	Increment Deducted[2]	Cash Receipts: Lump Sum Payments[3] (Escalated)	Cash Receipts: Installment Payments (Cumulative)	Cash Receipts: Total Payments	Annual Construction Cost[4]	Working Capital Required	Cumulative Capital Requirements
1978	340	204	0	204	6.83	17		86	9	95	215	120	120
1979	339	203		407	7.51	18		94	26	120	236	116	236
1980	339	203		610	8.26	20		104	45	149	260	111	347
1981	339	203		813	8.92	22		112	66	178	280	102	449
1982	380	228		1,041	9.63	25		136	90	226	340	114	563
1983	427	256		1,297	10.40	32		165	119	284	412	128	691
1984	479	287		1,584	11.23	33		200	155	355	499	144	835
1985	539	323		1,907	12.13	47		243	198	441	607	166	1,001
1986	604	362		2,269	12.86	56		288	249	537	721	184	1,185
1987	679	407		2,676	13.63	57		344	311	655	859	204	1,389
1988	761	457	102	3,031	14.45	79	9	408	375	783	1,021	238	1,627
1989	856	514	204	3,341	15.31	94	18	487	443	930	1,217	287	1,914
1990	960	576	203	3,714	16.23	112	19	579	527	1,106	1,447	341	2,255
1991	0	0	203	3,511	17.20	0	21		562	562	0	(562)	1,693
1992			216	3,295	18.23		24		538	538		(538)	1,155
1993			242	3,053	19.32		29		509	509		(509)	646
1994			272	2,781	20.48		36		473	473		(473)	173
1995			305	2,476	21.71		43		430	430		(430)	(257)
1996			343	2,133	23.01		52		378	378		(378)	(635)
1997			385	1,748	24.39		62		316	316		(316)	(951)
1998			432	1,316	25.85		73		243	243		(243)	(1,194)
1999			485	831	27.40		87		156	156		(156)	(1,350)
2000	0	0	545	286	29.04	0	103		53	53	0	(53)	(1,403)

1/ Accumulated installment payments are calculated on the basis of 100 percent incremental additions during previous years and 50 percent of the last year.
2/ Based on the assumption that installment plan will be paid in ten years.
3/ Assumed to be 40 percent of construction cost.
4/ Amount to be shouldered by the customers which is: 2/3 of pipes + meters.

ANNEX TABLE X-F-4a

STRATIFICATION OF SERVICE CONNECTIONS
COTABATO CITY WATER DISTRICT

Year	Domestic/Government 1/2"	3/4"	1"	Sub-total	Commercial/Industrial 3/4"	1"	1½"	Sub-total	Total
1978	1,506	494	-	2,000	67	15	-	82	2,082
1980	1,723	662	265	2,650	77	22	11	110	2,760
1985	3,074	1,182	473	4,729	136	39	20	195	4,924
1990	5,483	2,109	844	8,436	244	69	35	348	8,784

ANNEX TABLE X-F-4b

REVENUE UNIT FORECAST[9]

Year	Domestic/Government 1/2" (2.5)	3/4" (4.0)	1" (8.0)	Sub-Total	Commercial/Industrial 3/4" (8.0)	1" (16.0)	1½" (40.0)	Sub-Total	Grand Total[9]	Minimum Charge (RUs)[10]	Estimated Consumption (cum/mo) Domestic	Commercial	Commodity Charge (RUs) Domestic[11]	Commercial[12]	Total Revenue Units
1978	3,765	1,976	-	5,741	536	240	-	776	6,517	782,040	720,145	95,995	480,145	172,310	1,434,495
1980	4,308	2,648	2,120	9,076	616	352	440	1,408	10,484	1,258,080	846,070	112,785	528,070	199,170	1,985,320
1985	7,685	4,728	3,784	16,197	1,088	624	800	2,512	18,709	2,245,080	1,519,860	215,350	932,390	383,200	3,561,350
1990	13,708	8,436	6,752	28,896	1,952	1,104	1,400	4,456	33,352	4,002,240	2,693,335	426,320	1,681,015	769,120	6,452,375

9/ Computation of revenue units based on LWUA Guidelines on structuring water rates.
10/ Grand total of number of connections multiplied by their respective conversion factors for computing revenue units (RUs).
11/ Multiply grand total by 120 (derived from 10 cum/month, the minimum amount covered by the minimum charge 12 months/year) in RUs.
12/ Domestic consumption = (120 x number of domestic connections) x use factor. Use factor for domestic/institutional classification is 1.
Commercial consumption = (120 x number of commercial connections) x use factor. Use factor for commercial classification is 2.

ANNEX X-G

ANALYSIS OF WATER RATES

ANNEX TABLE X-G-1

REVENUE FORECASTS
COTABATO CITY WATER DISTRICT

Year	Rate/RU ₱	Estimated Number of RUs (Yearly in 000s)	₱ x 1,000 Income from Sales	(Bad Debt)	Other Income 13/	Total Net Income
1978	0.75	1,434	1,076	22	22	1,076
1979	0.75	1,710	1,283	13	26	1,296
1980	0.75	1,985	1,489	15	30	1,504
1981	1.20	2,237	2,684	54	54	2,684
1982	1.20	2,505	3,006	30	60	3,036
1983	1.20	2,820	3,384	34	68	3,418
1984	1.50	3,167	4,751	95	95	4,751
1985	1.50	3,561	5,342	53	107	5,396
1986	1.50	4,024	6,036	60	121	6,097
1987	1.70	4,515	7,676	154	154	7,676
1988	1.70	5,093	8,658	87	173	8,744
1989	1.70	5,729	9,739	97	195	9,837
1990	2.00	6,452	12,904	258	258	12,904
1991	2.00	↓	12,904	129	258	13,033
1992	2.00		12,904	129	258	13,033
1993	2.10		13,549	271	271	13,549
1994	2.10		13,549	135	271	13,685
1995	2.10		13,549	135	271	13,685
1996	2.10		13,549	135	271	13,685
1997	2.20		14,194	284	284	14,194
1998	2.20		14,194	142	284	14,336
1999	2.20		14,194	142	284	14,336
2000	2.20	6,452	14,194	142	284	14,336

13/ Other income (derived from meter replacement charges, contingency fees of new connections, service fees, etc) is about 2% of sales.

ANNEX X-H

FINANCIAL SUMMARY

ANNEX TABLE X-H-1

DEBT SERVICE SCHEDULE OF TOTAL PROJECT LOAN
COTABATO CITY WATER DISTRICT
(₱ x 1,000)

Year	Immediate Improvement	Phase I-A and I-B	Total	Immediate Improvement	Phase I-A and I-B	Total	Immediate Improvement	Phase I-A and I-B	Total	Total Debt Service
1978	5,883	-	5,883	-		-	131	-	131	131
1979	6,521	1,294	7,815	-		-	268	-	268	268
1980	7,240	11,783	19,023	-		-	282	116	398	398
1981	7,602	21,222	28,824	-		-	290	1,060	1,350	1,350
1982	7,546	22,523	30,069	56		56	684	1,910	2,594	2,650
1983	7,485	24,016	31,501	61		61	679	2,027	2,706	2,767
1984	7,419	25,673	33,092	66		66	674	2,161	2,835	2,901
1985	7,347	29,143	36,490	72		72	668	2,311	2,979	3,051
1986	7,268	34,062	41,330	79	219	298	661	2,623	3,284	3,582
1987	7,182	38,688	45,870	86	219	305	654	3,066	3,720	4,025
1988	7,088	47,835	54,923	94	219	313	646	3,482	4,128	4,441
1989	6,986	53,731	60,717	102	328	430	638	4,305	4,943	5,373
1990	6,875	56,856	63,731	111	328	439	629	4,836	5,465	5,904
1991	6,754	56,310	63,064	121	546	667	619	5,117	5,736	6,403
1992	6,622	55,545	62,167	132	765	897	608	5,068	5,676	6,573
1993	6,478	54,780	61,258	144	765	909	596	4,999	5,595	6,504
1994	6,321	53,688	60,009	157	1,092	1,249	583	4,930	5,513	6,762
1995	6,150	52,596	58,746	171	1,092	1,263	569	4,832	5,401	6,664
1996	5,964	51,287	57,251	186	1,309	1,495	554	4,734	5,288	6,783
1997	5,761	49,759	55,520	203	1,528	1,731	537	4,616	5,153	6,884
1998	5,539	48,231	53,770	222	1,528	1,750	518	4,478	4,996	6,746
1999	5,298	46,485	51,783	241	1,746	1,987	499	4,341	4,840	6,827
2000	5,035	44,520	49,555	263	1,965	2,228	477	4,184	4,661	6,889

[illegible]

[illegible]

COTABATO CITY WATER DISTRICT
(P x 1,000)

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
[illegible] (1,000 cum)	135[illegible]	135[illegible]	1336	1596	1596	1596	1596	2623	2623	2623	2623	2623	4332	4332	4332	4332	4332	4332	4332	4332	4332	[illegible]
[illegible] (1,000 cum)	[illegible]	[illegible]	[illegible]	359	[illegible]	359	[illegible]	1735	1735	1735	1735	1735	3120	3120	3120	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible] (%)	20	20	20	20	20	20	20	34	34	34	34	34	28	28	28	[illegible]	[illegible]	28	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	2692	2692	2760	2760	2760	2760	2760	4724	4924	4924	4924	4924	[illegible]	[illegible]	[illegible]	[illegible]	4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible] (lpcd)	[illegible]	105	105	105	105	105	105	113	113	113	113	113	127	120	120	120	120	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible] Revenue																						
Water Sales	1076	1283	1469	2684	3006	3384	4751	5342	6036	7676	8638	9739	12904	12904	12904	13549	13549	13549	13549	14194	14194	[illegible]
Less: Uncollectibles	22	13	15	54	30	34	95	53	60	154	87	97	258	129	129	271	135	135	135	284	142	142
Other Revenue	22	26	30	54	60	68	95	107	121	154	173	195	258	258	258	271	271	271	271	284	284	284
Total Revenue	1076	1296	1504	2684	3036	3418	4751	5396	6097	7676	8744	9837	12904	13033	13033	13549	13685	13685	13685	14194	14336	14336
Operating Expenses																						
Administration and Personnel	228	265	313	360	388	420	463	498	538	639	690	804	869	938	1012	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Power and Fuel	238	327	213	251	297	352	[illegible]	510	587	697	828	948	1148	1238	1339	1444	1562	1685	1822	1967	2122	[illegible]
Chemicals	31	54	43	51	60	71	[illegible]	98	117	130	164	194	244	263	282	306	332	359	387	415	450	[illegible]
Maintenance	28	42	54	156	185	228	249	277	342	404	474	597	657	709	766	826	894	964	1041	1126	1214	1311
Miscellaneous	31	38	44	53	62	74	88	105	124	148	176	209	245	263	290	312	335	364	394	425	459	495
Depreciation	160	310	377	606	852	[illegible]	926	974	1076	1172	1339	1556	1664	1782	1782	1782	1935	1947	2029	2035	2100	2116
Total Operating Expenses	778	1065	1044	1477	1844	2031	2028	2462	2764	3198	3631	4308	4830	5198	5475	5761	6244	6536	7054	7511	7563	7434
Operating Income	298	231	460	1207	1192	[illegible]	2523	[illegible]	3333	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Plus: Interest on Reserves	2	7	13	22	34	47	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Net Income before Interest	300	238	473	1229	1226	1434	2567	3019	3422	4616	5265	5740	6333	6175	6506	[illegible]	[illegible]	[illegible]	[illegible]	7712	[illegible]	[illegible]
Interest on Debt	131	268	398	1350	2594	2706	2835	2979	3294	3720	4129	4243	5465	5736	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Net Income (Loss)	169	(30)	75	(121)	(1368)	(1272)	(268)	40	128	896	1157	797	[illegible]	2439	2330	2732	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cumulative Net Income (Loss)	169	139	214	93	(1275)	(2547)	(2735)	(2753)	(2617)	(1721)	(564)	233	3101	5540	7870	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Appropriation to Reserves	32	38	45	81	90	102	163	168	181	230	260	292	337	774	774	[illegible]	[illegible]	713	[illegible]	[illegible]	[illegible]	[illegible]
Average Net Fixed Assets in Operation	6400	10070	16027	25640	30998	32427	33415	35513	39367	43030	49833	57090	61[illegible]	62512	60920	60870	[illegible]	[illegible]	59611	[illegible]	[illegible]	[illegible]
Rate of Return (%)	4.7	2.3	2.9	4.7	3.8	4.3	7.6	8.3	8.4	10.2	10.3	9.7	13.0	12.3	12.4	[illegible]	[illegible]	11.8	11.1	11.4	[illegible]	[illegible]

ANNEX TABLE A-B-3

PROJECTED SOURCES AND APPLICATIONS OF FUNDS
COLORADO CITY WATER DISTRICT
($ x 1,000)

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
SOURCES OF FUNDS																							
Net Income Before Interest	300	238	473	1220	1226	1434	2587	3019	3422	4616	5285	5740	8333	8175	8006	8327	8114	7477	7570	7816	7715	7850	7074
Add: Depreciation	160	336	377	615	852	886	926	974	1076	1172	1299	1556	1664	1782	1782	1795	1835	1927	2029	2054	2100	2116	2137
Total Internal Cash Generation	460	574	850	1835	2078	2320	3513	3993	4496	5.53	6584	7296	9997	9957	9788	10122	10049	9404	9599	9870	9815	9966	9211
Long-Term Borrowing	5883	1932	11208	9801	1301	1 3	1657	3470	5138	4845	9366	6224	3453										
Capital Contributions	35	120	149	178	326	[illegible]	355	441	537	655	783	930	1106	562	538	509	473	430	378	316	223	150	53
Total External Cash Generation	5978	2052	11357	9979	1527	1777	2012	3911	5675	5500	10149	7154	4559										
Total Sources of Funds	6438	2626	12207	11814	3605	4097	5525	7904	10173	11288	16733	14450	14556	10519	10326	10635	10522	10254	9977	10217	10058	9.65	9284
APPLICATIONS OF FUNDS																							
Capital Expenditures	5755	1774	11034	9617	1527	1777	2012	3911	5675	5500	10149	7154	4559										
Capitalized Interest	128	278	343	362																			
Debt Service: Interest	131	262	338	1350	2594	2706	2835	2979	3284	3720	4128	4943	5465	5736	5670	5595	5513	5401	5288	5153	4996	4840	4661
Principal	-	-	-	-	56	61	66	72	298	305	313	430	439	667	837	909	[illegible]	1263	1495	1731	1750	[illegible]	2224
Sub total	131	268	338	1350	2650	2767	2901	3051	3582	4025	4441	5373	5904	6403	6573	6504	6762	6664	6783	6884	6746	6817	6885
Replacements								238							358	3144	[illegible]	3026	1377	351	417	1026	593
Increase in Working Capital	508	(174)	70	336	100	123	359	286	2	386	321	203	819	(716)	(40)	557	(424)	(43)	(35)	42	(1)	(40)	(32)
Total Applications of Funds	6522	2146	11825	11665	4277	4667	5272	7486	9259	9911	14911	12820	11282	5687	6891	10235	6809	9647	8135	7297	7163	7811	7447
INCREASE (DECREASE) IN CASH BALANCE	(84)	480	382	149	(672)	(570)	253	418	914	1377	1822	1630	3274	4832	3435	400	3913	1607	1842	920	2949	1564	1839
CASH BALANCE BEGINNING OF YEAR	-	(84)	396	778	927	255	(315)	(62)	356	1270	2647	4469	6099	9373	14205	17640	18040	21953	23560	25402	26322	29271	30835
CASH BALANCE END OF YEAR	(84)	396	778	927	255	(3[illegible])	(62)	356	1270	2647	4469	6099	9373	14205	17640	18040	21953	23560	25402	26322	29271	30835	[illegible]
DEBT SERVICE RATIO (TIMES)	3.51	2.14	2.14	1.36	0.76	0.84	1.21	1.31	1.26	1.44	1.48	1.36	1.69	1.56	1.49	1.56	1.49	1.47	1.22	1.44	1.47	1.41	1.32
RATIO OF INTERNALLY GENERATED CASH USED TOWARD SERVICE TO CAPITAL EXPENDITURE (%)	5.59	12.91	3.99	4.86	-	-	30.42	24.09	16.14	32.05	21.12	26.88	39.78										

ANNEX TABLE X-H-4

PROJECTED BALANCE SHEET
COTABATO CITY WATER DISTRICT
(P x 1,000)

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
ASSETS																							
Fixed Assets:																							
Gross Value of Fixed Assets	13125	14937	25709	35053	37717	33359	41236	45184	50[illegible]	56085	65[illegible]	73434	75726	75746	76104	7[illegible]010	78174	80101	80[illegible]0	90[illegible]8	85[illegible]97	81645	[illegible]
Less: Accumulated Depreciation	3864	4032	4409	5015	5712	6461	7254	8033	8[illegible]	10[illegible]	11[illegible]	12[illegible]	13313	13101	15[illegible]	17[illegible]	17272	20130	21301	22313	24[illegible]5	26[illegible]	28[illegible]
Net Value of Fixed Assets	9261	10905	21300	30038	32005	32898	33982	37091	41630	46018	53[illegible]	60932	63427	61645	60221	61[illegible]	59902	59971	59329	57535	55[illegible]	54[illegible]	[illegible]
Work in Progress	–	72	657	1292				66	[illegible]	66	1[illegible]												
Total Fixed Assets	9261	10977	21957	31330	32005	32896	33982	37157	41756	46084	54934	60932	63427	61645	60221	61566	59902	59971	59329	57535	55[illegible]	54[illegible]	[illegible]
Current Assets:																							
Cash	(84)	396	778	987	455	(315)	(62)	356	1270	2647	4469	6099	9373	14205	17650	18040	21353	23566	25[illegible]	28322	31[illegible]	33114	[illegible]
Accounts Receivable	269	321	372	671	752	846	1189	1336	1[illegible]09	1919	2165	2435	3226	3226	3226	3387	3387	3387	3387	3549	3549	3[illegible]	3[illegible]
Less: Bad Debts	6	3	4	13	8	8	21	13	15	38	22	24	65	32	32	68	34	34	34	34	[illegible]	[illegible]	35
Inventories	348	138	147	227	261	316	376	533	[illegible]01	553	261	658	735	88	95	605	201	215	233	256	290	[illegible]	173
Total Current Assets	527	852	1293	1812	1260	839	1477	2212	3165	4281	7175	9168	13329	17497	20939	21964	25505	27128	29[illegible]	32056	[illegible]	36[illegible]	39[illegible]
Total Assets	9788	11829	23250	33142	33265	33735	35459	39369	44921	51065	62109	69700	76756	79132	81150	83530	85409	87109	88337	89651	[illegible]	91774	[illegible]
EQUITY AND LIABILITIES																							
Current Liabilities:																							
Accounts Payable	103	122	111	145	185	191	217	248	185	338	379	459	527	569	616	664	719	775	839	904	976	1053	1139
Current Maturities of Long-Term Debt	–	–	–	56	61	66	72	223	95	313	439	439	667	877	909	1249	1263	1495	1711	1750	1[illegible]7	2228	2464
Total Current Liabilities	103	122	111	201	246	257	289	546	530	651	819	898	1194	1466	1525	1913	1971	2270	2569	2654	[illegible]	3281	3607
Long-Term Debt (Less: Current Maturities)	5803	7815	19023	28768	30008	31435	33020	36192	41025	45551	54493	60278	63064	62167	61258	60009	58746	57251	55520	53770	51[illegible]	49[illegible]	47207
Equity:																							
Government Contribution	3538	3538	3538	3538	3538	3538	3538	3538	3538	3538	3538	3535	3538	3538	3538	3538	3536	3538	3538	3538	3538	3538	3538
Capital Contribution	95	215	364	542	768	1052	1407	1848	7385	3040	3823	4753	5659	6421	6959	7465	7941	8171	8742	9065	[illegible]	9466	9517
Reserves	32	70	115	196	286	388	531	697	872	1102	1362	1652	2041	2815	3589	4402	5215	6028	7383	8802	10[illegible]21	11649	13059
Unappropriated Retained Earnings	137	69	99	(103)	(1561)	(2935)	(3326)	(4446)	(3489)	(2823)	(1306)	(1421)	1060	2725	4281	6200	7988	9651	10[illegible]78	11822	13[illegible]22	14[illegible]	15[illegible]
Total Equity	3802	3892	4116	4173	3031	2043	2150	2631	3306	4857	6797	8524	12498	15499	18367	21608	24682	27588	30248	33227	36189	38[illegible]	41404
Total Equity and Liabilities	9788	11829	23250	33142	33265	33735	35459	39369	44921	51065	62109	69700	76756	79132	81150	83530	85409	87109	88337	89651	90[illegible]35	91774	[illegible]

ANNEX TABLE X-H-5

RATE OF RETURN ON TOTAL INVESTMENT
(DISCOUNTED CASH FLOW METHOD)
COTABATO CITY WATER DISTRICT
(₱ x 1000)

Year	Debt Service	Net Increase In Cash	Total Cash Inflow	Investments	Net Cash Inflow	1st Trial Present Value: 8% Factor	Value	2nd Trial Present Value: 10% Factor	Value
1978	131	(84)	47	5,883	(5,836)	1.000	(5,836)	1.000	(5,836)
1979	268	480	748	2,052	(1,304)	.926	(1,208)	.909	(1,185)
1980	398	382	780	11,357	(10,577)	.857	(9,064)	.826	(8,737)
1981	1,350	149	1,499	9,979	(8,480)	.794	(6,733)	.751	(6,368)
1982	2,650	(672)	1,978	1,527	451	.735	331	.683	308
1983	2,767	(570)	2,197	1,777	420	.681	286	.621	261
1984	2,901	253	3,154	2,012	1,142	.630	719	.564	644
1985	3,051	418	3,469	4,149	(680)	.583	(396)	.513	(349)
1986	3,582	914	4,496	5,675	(1,179)	.540	(637	.467	(551)
1987	4,025	1,377	5,402	5,500	(98)	.500	(49)	.424	(42)
1988	4,441	1,822	6,263	10,149	(3,886)	.463	(1,799)	.386	(1,500)
1989	5,373	1,630	7,003	7,154	(151)	.429	(65)	.350	(53)
1990	5,904	3,274	9,178	4,559	4,619	.397	(1,834	.319	1,473
1991	6,403	4,832	11,235	-	11,235	.368	4,134	.290	3,258
1992	6,573	3,435	10,008	358	9,650	.340	3,281	.263	2,538
1993	6,504	400	6,904	3,144	3,760	.315	1,184	.239	899
1994	6,762	3,913	10,675	271	10,404	.292	3,038	.218	2,268
1995	6,664	1,607	8,271	2,026	6,245	.270	1,686	.198	1,237
1996	6,783	1,842	8,625	1,377	7,248	.250	1,812	.180	1,305
1997	6,884	2,920	9,804	351	9,453	.232	1,193	.164	1,550
1998	6,746	2,898	9,644	417	9,227	.215	1,984	.149	1,375
1999	6,827	1,894	8,721	1,026	7,695	.199	1,531	.135	1,039
2000	6,889	1,839	8,728	593	14,586[14]	.184	2,684	.123	1,794
							+1,008		-4,672

RATE OF RETURN = 8.4%

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[14] Includes net asset value of ₱6,451

Total assets	₱ 92,098
Total Liabilities	(50,694)
Cash	(34,953)
Net Asset Value	₱ 6,451

CHAPTER XI ECONOMIC FEASIBILITY ANALYSIS

A. WATER AND THE ECONOMY

Introduction

Water is a basic requirement in any country's economic development and no economic activity can take place without it. However, this basic function diminishes in relative importance as a higher level of economic development is attained by a country. In most instances, the availability of water alone will not spur economic growth for there are other significant factors that influence development, such as peace and order, political stability, rate of taxation and availability of infrastructure facilities. Hence, a water supply project must be considered as only one part of a regional development program. It must be viewed within the context of the overall government program.

Considering that the Philippines is still a developing country, water supply plays a fairly important role in the national or regional economy. Traditionally, water has been made available to the consuming public at very nominal rates. There is a tendency for the consumers to use water wastefully. As a consequence, the regard given to it is far below its true importance.

To the water consumer, the value of water is measured by its contribution to the satisfaction of the family group which uses the water. His perspective includes himself and his household and all the health, well-being and productivity aspects of family life. To the businessman, water is valued for all it does to improve business. From the national viewpoint, the benefits to the water user, both householder and businessman, are only a part of the total.

Major User of Water Supply

Domestic. Water for domestic use is usually given top priority because water is essential to life and, up to a point, essential to general well-being. Estimation of the beneficial value of water for domestic purposes is best viewed in terms of average willingness to pay for water rather than do without it. It will be noted that the willingness to pay is higher than the price charged insofar as most users are concerned.

Industrial Use. Water is used by industry primarily as a factor of production. In some instances, it goes into the production process as an input. This is the case for the soft drinks industry. One

method of determining the value of water to industry is to analyze the cost of alternative industrial processes which produce the same product but use less water. This is not, however, always possible and may be unduly laborious.

Other Uses. Crop irrigation is one of the major uses of water. The value of water used for irrigation purposes can be estimated by an elaborate calculation of "with" and "without" project conditions. All other costs are assumed to be paid and water becomes the residual claimant under "with" and "without" project conditions. Detailed analysis of the area to be irrigated is required.

Another important use is hydropower generation. Water used for this purpose may be valued by comparison with the lowest-cost alternative of providing electric power. Lastly, bodies of water serve a basic role in many recreational activities. Ordinarily, water quality is not adversely affected by recreational use. Water value in this case depends on a number of factors such as accessibility, setting, beauty and quality.

In the Philippines, the National Water Resources Council establishes the water priorities, in pursuance of the policies laid down by its charter, Presidential Decree No. 424. In general, the system of priorities for the development, conservation and utilization of the country's water resources reflects the current usage of water and is responsive to the changing demand for water. Another presidential decree (Presidential Decree No. 198) has declared that the creation, operation, maintenance and expansion of water supply and wastewater disposal systems are a national policy of high priority.

B. METHODOLOGY

Recommended and Next-Best System

One approach in determining the economic feasibility of a water supply project involves a comparison of the benefits and costs of the recommended system and those of the next best system. In this method, the capital expenditure costs and the operating and maintenace costs for both alternative systems are transformed to an equivalent annual cost basis during the projection period. The comparison will show which of the alternative systems will generate the same level of benefits at less cost.

Benefit-Cost Ratio

A second approach in determining the economic feasibility of water supply project involves the following steps:

1. The identification of the economic benefits and costs that can be attributed to the establishment, operation and maintenance of an improved water supply system;

2. The determination of the possible bases for quantifying these benefits and costs; and

3. The comparison of the present value of the benefits likely to be generated and the present value of the costs.

The results of the economic analysis are then expressed as a single ratio called the benefit-cost ratio. The project is considered feasible if the ratio is equal to or greater than 1:1.

Internal Rate of Return

Another method involves the calculation of the internal economic rate of return of the proposed project. The total amount of the benefits as well as of the costs is determined throughout the projection period. By trial and error, the interest rate at which the present worth of the benefits is equal to the present worth of the costs is then calculated. The project is considered desirable if its internal economic rate of return is higher than the minimum rate generally acceptable in such projects, which is usually the opportunity cost of capital.

Method(s) Adopted

Both the second and third methods were employed in determining this project's economic feasibility. These two were considered more appropriate than the first method because, in this case, the recommended plan has already been selected from several alternatives on the basis of present worth cost comparisons (as discussed in Chapters VIII and IX).

Calculation of Benefit and Cost Streams

The economic studies cover only Stage I of the proposed water supply program, which extends from 1978 to 1990. Benefits, however, were projected up to 2000 except for land values which end at 1990. This is because the benefits (except for land values) from the facilities to be constructed up to 1990 would continue to accrue beyond their construction period.

The construction costs included in the analysis are those which will be incurred up to 1990, except replacement costs and the operation and maintenance costs which were projected up to 2000. This is due to the fact that proper maintenance of the facilities will have to be undertaken regularly for as long as benefits are desired to be realized from the system.

Estimates of benefits and costs were based on 1978 prices. In recognition of inflationary pressures, all benefits were escalated by 10 percent from 1978 to 1980, by 8 percent from 1981 to 1985 and by 6 percent from 1986 to 1990. All project costs were also escalated in the same manner, with the exception of operation and maintenance costs which were escalated uniformly by 8 percent all throughout the study period. In both cases, however, the escalation factor for 1990 was held constant up to 2000. This is because only Stage I of the proposed project is being considered in the economic analysis; hence, only partial inflation has been adopted.

C. QUANTIFIABLE BENEFITS

The economic benefits that will be derived from the proposed water supply improvement program for the water district may be classified into quantifiable and non-quantifiable. Quantifiable benefits are those which can be expressed in monetary terms. On the other hand, non-quantifiable benefits are intangible but real, and are extremely difficult to express in monetary terms.

Benefits resulting from the proposed project were evaluated on an incremental basis, i.e., on a "with" or "without" principle. Hence, the benefit figures reflect only those that will accrue to the service area as a result of the improvement of the water supply system. They exclude the benefits arising from the present system.

The quantifiable benefits that are discussed in the following sections are: increase in land values, improved health conditions, reduction in fire damage, and beneficial value of water.

Increase in Land Values

The implementation of the water supply project will result in an increase in the land values of the service area. However, it must be pointed out that the increase in land values cannot be attributed solely to the water supply project. Any difference between the acquisition cost and the present market value of a piece of land evolves from a series of market and public forces which exist whether or not the water supply project is undertaken. Such forces include the general pace of industrialization, construction activity, inflation,

land speculation, taxation, public land acquisition and selling. More particularly, such a difference could be the result of a general estimation of productivity due to infrastructure investments which include a water supply project.

The portion of land values attributable to the provision of an improved public water supply system was estimated in the household survey in Lipa City (May 1975) to be about 22.6 percent of the market value of a piece of land. It is reasonable to assume that this figure represents the incremental value of a piece of land, given access to water supply. In a specific instance, a residential lot about 400 sqm has the following market values:

Without Water	400 sqm x ₱50	=	₱ 20,000
With Water	400 sqm x ₱65	=	₱ 26,000
	Ratio	=	1.3 or 30% increase

In this particular case, the incremental cost of ₱6,000 closely represents the market value of a private well (complete with pump, electric controls, etc.) to serve the premises.

On the basis of this information, it may be conservative to assume that 20 percent of the value of land served by the water distribution system could be attributed to the water supply project.

Assumptions made for this analysis are explained in Annex XI-C. Annex Table XI-C-1 shows the computations of this benefit, which amounts to a present worth of ₱42.59 million.

Health Benefits

The establishment of a water supply system in a community will necessarily bring about health benefits to the population. Undoubtedly, the provision of safe, potable water to the population is a prerequisite for the maintenance of minimum health standards. These health benefits are ordinarily manifested in the following:

1. A significant reduction in the incidence of water-borne diseases such as cholera, dysentery, gastro-enteritis, and typhoid/paratyphoid. As a result, there will be a decrease in the amount of time lost by income earners who are afflicted with such diseases.

2. A subsequent reduction in premature deaths due to the lower incidence of water-borne diseases.

3. A corresponding reduction in medical expenses for the same reason.

Calculations for the health benefits and associated assumptions used are presented in Annex XI-C. Annex Table XI-C-2 shows the health benefits on a yearly basis, with a total present worth of ₱1.59 million.

Reduction in Fire Damage

With the installation of suitable fire hydrants especially in the high-value as well as the residential districts in the service area as part of the proposed project, savings due to reduced fire damages will result from the availability of an adequate amount of water and increased water pressure for fire-fighting purposes. Calculations relative to this benefit are explained in Annex XI-C and shown in detail in Annex Table XI-C-3. The present value of this benefit amounts to ₱8.72 million.

No attempt was made to quantify the inconvenience to the people rendered homeless and the value of human lives lost due to fire.

Beneficial Value of Water

This benefit (sometimes called "consumer satisfaction") is quantified by the additional revenue generated by the water district as a result of an improved water supply project. In the case of a community which previously did not have any piped water system, the "consumer satisfaction" benefit may be measured by the full amount of the economic value of the accounted-for-water.

For a community where the proposed project involves merely the expansion and improvement of the existing system, this benefit may be measured by the economic value of the incremental water production directly resulting from the improvement of the system.

For this benefit, the concept of consumers'surplus was adopted. This concept takes into account not only what households and commercial establishments are actually paying for water but also how much more the consumers are willing to pay for this essential commodity. Calculations for the beneficial value of water are shown in Annex XI-C and Annex Table XI-C-4. The present value of this benefit amounts to ₱22.35 million.

D. NON-QUANTIFIABLE BENEFITS

The non-quantifiable benefits arising from a water supply project are generally as important as the quantifiable benefits. However, they do not easily lend themselves to valuation. The approach taken herein is to acknowledge their existence and importance. No

attempt has been made to quantify or include them in the benefit-cost calculations.

The proposed water supply project will set off a chain of events beyond its construction period. Those activities include among others the inducement to industry to establish plants in the service area due to availability of a dependable water supply. Without such supply, new industrial and commercial establishments would be forced to develop their own supply system or relocate elsewhere. The overall cost of providing separate water systems is normally large and represents a deterrent to invest in the area and consequently to industrial development.

Because of the employment generated by the project, hired laborers are able to spend their wages for purchasing goods at the local stores. Hence, each peso they spend is generated back into the income stream of the local economy. In the operation and maintenance of the project, the water district would find it advantageous to purchase required supplies locally and engage local service.

E. ECONOMIC COSTS

General

The total cost of the proposed water supply system is the sum of all expenditures required to realize project objectives and benefits.

Costs have been divided into the following:

1. Project costs

2. Replacement costs

3. Operating and maintenance costs

In general, economic costs are easier to identify and quantify than benefits. This is because most of the costs are incurred in real, monetary terms to pay for either goods or services while benefits are usually intangible.

Project Costs

Project costs include the construction cost of the proposed facilities such as pipes, meters and equipment, as well as, engineering services and contingencies and land cost. The cost of the feasibility studies has also been included.

Annex Table XI-E-1 shows the construction costs of the proposed water supply project for the water district. They are listed by component as to type of expenditure in 1978 prices. They are further broken down into foreign and domestic components.

The cost of unskilled labor is shown separately from the domestic component of the project. From the balance of the domestic cost, 5 percent was assumed to be in the form of hidden taxes.

Adjustment of Project Costs

In the determination of the project costs, adjustments were made for those items which are not properly valued by the price mechanism. A price other than the market price (called the shadow price) was imputed to these items. In this way, most of the effects of price discrepancies which could be identified, whether primary or secondary, were incorporated directly into the project analysis and imputed as direct costs to project investment. The 'shadow prices' used in this analysis are those employed by international lending institutions and the Infrastructure Computer Center of the Department of Public Works, Transportation and Communication.

One of the items where 'shadow pricing' was applied is the price of unskilled labor (otherwise known as common labor). In a perfectly competitive market, the price of labor is determined by the marginal value of its product. In this case, therefore, the price of labor is equal to the value of the output which an extra laborer hired would produce. However, this is not applicable in an economy such as that of the Philippines where there is a surplus of labor. Since there is widespread disguised unemployment in such an economy, unskilled labor is normally valued below the actual wage rate likely to be paid. In this study, the opportunity cost of unskilled labor or its potential in other employment was valued at one half of its estimated cost in the project. The net effect is to reduce the cost of unskilled labor by 50 percent, thereby reducing the summation of project costs.

Skilled labor, on the other hand, was valued at its going rate. It was assumed that if skilled labor were not employed in the service area, it would probably migrate elsewhere to obtain employment or a better wage.

Adjustments were also made with respect to cost of project facilities which use up limited foreign exchange reserves. Foreign exchange used to import project components was valued at 1.2 times their actual peso cost. This effectively increased foreign exchange cost by 20 percent, thereby affecting project cost in a similar manner. This was done to reflect the opportunity cost or alternative value of foreign exchange. Domestic components, on the other hand, were priced at their actual cost.

Interest was not included since this is considered a financial instead of an economic cost.

Annex Table XI-E-1 shows the conversion of financial costs to economic costs through shadow pricing and other adjustments. The present value (see Table XI-E-4) of total economic project cost for COT-WD amounts to ₱39.91 million.

Replacement Costs

Based on the criteria used in the financial studies, vehicles have a life expectancy of 7 years while meters are expected to be replaced every 15 years. Other items which have a service life of 15 years are the equipment of the source facilities, the plumbing shop and laboratory, the equipment of administrative shop building, miscellaneous items, and plumbing and meter repair items included in the immediate improvement program. The feasibility studies are assumed to apply for 30 years, while the well is expected to last for 25 years. All other facilities in the system have a life expectancy of 50 years.

Therefore, vehicles, meters, equipment, and the miscellaneous items with a service life of 15 years will have to be replaced during the 23-year period from 1978 to 2000. Annex Table XI-E-2 shows the replacement schedule and costs of vehicles, meters, equipment, and miscellaneous items. The present value of total replacement costs (see Table XI-E-4) for Cotabato City amounts to ₱1.13 million.

Salvage Value

Annex Table XI-E-3 shows the salvage value in 2001 of all the capital equipment to be used in the project. The percentage of salvage value was based on the remaining service life of the facilities in 2001. For COT-WD, the present worth of the salvage value (see Table XI-E-4) is ₱4.39 million.

Operating and Maintenance Cost

Operating and maintenance costs refer to the costs associated with the maintenance, operation and management of the project. Otherwise known as annual costs, they include personnel, power, chemicals, and other miscellaneous maintenance expenses such as fuel and lubrication, repairs, communication needs and office rental. Only the operating and maintenance costs of the proposed project (i.e., excluding those of the present system) were considered in this study.

Annex Table XI-E-4 presents the incremental annual recurring costs associated with running and operating the water district up to 2000. The present value of these costs amounts to ₱5.12 million.

Calculation for Economic Costs

The economic cost may be expressed as the adjusted (shadow priced) project cost plus replacement cost plus operating/maintenance cost less salvage value. Annex Table XI-E-4 shows the computation of total economic costs for COT-WD, amounting to ₱41.76 million.

F. BENEFIT-COST ANALYSIS

The summary of the quantifiable economic benefits and economic costs for COT-WD is shown below. They are expressed in their present values (discounted at 12 percent) after the 1978 prices have been escalated.

SUMMARY OF BENEFITS AND COSTS
($₱ \times 10^6$)

Benefits		Costs	
Increase in Land Values	₱42.593	Project Cost	₱39.911
Health	1.587	(+)	
Reduction in Fire Damage	8.720	Replacement Cost	1.126
Beneficial Value	22.350	(+)	
		Operating and Maintenance Cost	5.116
	₱75.250	Sub-total	₱46.153
		(-)	
		Salvage Value	4.393
			₱41.760

Benefit Cost Ratio - 1.80 : 1

The preceding table shows that the quantifiable benefits exceed the economic costs associated with the improvement of the water supply system in COT-WD. Under the principle of benefit-cost ratio, the project is, therefore, considered economically feasible.

The actual benefits of the proposed project may really be greater than what the benefit-cost ratio represents because the non-quantifiable benefits have not been incorporated into the analysis.

G. INTERNAL ECONOMIC RATE OF RETURN

The internal economic rate of return (IERR) is the rate at which the present value of the quantifiable benefits is equal to the present value of the economic costs of the proposed project. It is generally held that for a project to be feasible and desirable, its IERR should be higher than the prevailing opportunity cost of capital. In this particular study, the opportunity cost of capital is 12 percent.

For COT-WD, the IERR is 56.08 percent as shown in Annex Table XI-G-1. On the basis of the above stated principle of IERR, the proposed project appears to be economically feasible and justified.

ANNEX XI-C

QUANTIFIABLE BENEFITS

ANNEX XI-C

QUANTIFIABLE BENEFITS

Portion of Land Values Attributable to Water Supply Project

Annex Table XI-C-1 shows the present value of the portion of land values attributable to the proposed water supply project, based on the following assumptions:

1. In accordance with the staging program of the construction of facilities, the 1980 service area of 367 hectares was projected to increase in the following manner: by 30 hectares from 1980 to 1981; by 23 hectares from 1981 to 1982; by 36 hectares from 1982 to 1983; by 38 hectares from 1983 to 1984; by 42 hectares from 1984 to 1985; by 45 hectares from 1985 to 1986; by 49 hectares from 1986 to 1987; by 53 hectares from 1987 to 1988; by 58 hectares from 1988 to 1989; and by 62 hectares from 1989 to 1990.

2. Land use was assumed to be 87 percent residential and 13 percent commercial/institutional/industrial throughout the projection period. This classification was based on the water demand projections in 1980 by consumer category, as shown in Chapter VI.

3. The 1977 costs of land based on estimated market values in Cotabato are:

Residential	: ₱30 per sqm
Industrial/Commercial/Institutional	: ₱40 per sqm

These costs were assumed to be constant over the projection period.

4. The portion of the total cost of land specifically attributable to the provision of water supply was assumed to be 20 percent of the cost of land. This land value benefit was escalated by 8 percent from 1980 to 1985, and by 6 percent from 1985 to 1990.

5. A discount factor of 12 percent was used to obtain the present values of the benefits. This is believed to be the opportunity cost of capital and is commonly used for public investment projects like water supply development.

For COT-WD, the land value benefit in its present worth amounts to ₱42.59 million.

ANNEX TABLE XI-C-1

PORTION OF LAND VALUES ATTRIBUTABLE TO PROJECT
COTABATO WATER DISTRICT

Year	Land Use (sqm)		Cost of Land (₱ x 1000)		Total Cost of Land (₱ x 1000)	20 Percent Benefit Due to Project (₱ x 1000)	Escalation Factor	Escalated Benefit (₱ x 1000)	Discount Factor at 12%	Present Value of Benefit (₱ x 1000)
	Residential	Commercial/ Institutional/ Industrial	Residential	Commercial/ Institutional/ Industrial						
1980	3,192,900	477,100	₱ 85,787.0	₱ 19,084.0	₱ 114,871.0	₱ 22,974.2	1.210	₱ 27,798.8	.797	₱ 22,155.[illegible]
1981	261,000	39,000	7,830.0	1,560.0	9,390.0	1,878.0	1.307	2,454.5	.712	1,747.[illegible]
1982	200,200	29,900	6,003.0	1,196.0	7,199.0	1,439.8	1.412	2,033.0	.63[illegible]	1,293.[illegible]
1983	313,200	46,800	9,396.0	1,872.0	11,268.0	2,253.6	1.525	3,436.7	.56[illegible]	1,948.[illegible]
19[illegible]	33[illegible],600	49,400	9,918.0	1,976.0	11,894.0	2,378.8	1.647	3,917.9	.507	1,986.4
19[illegible]	365,400	54,600	10,962.0	2,184.0	13,146.0	2,629.2	1.779	4,677.3	.452	2,114.[illegible]
1986	391,500	58,500	11,745.0	2,340.0	14,085.0	2,817.0	1.886	5,312.9	.404	2,144.4
1987	426,300	63,700	12,789.0	2,548.0	15,337.0	3,067.4	1.999	6,131.7	.361	2,213.[illegible]
1988	461,100	68,900	13,833.0	2,756.0	16,589.0	3,317.8	2.119	7,030.4	.322	2,26[illegible]
1989	504,600	75,400	15,138.0	3,016.0	18,154.0	3,630.8	2.246	8,154.8	.288	2,34[illegible]
1990	539,400	80,600	16,182.0	3,224.0	19,406.0	3,881.2	2.381	9,241.1	.257	2,37[illegible]
								₱ 8[illegible]		₱ 42,5[illegible]

Health Benefits

To determine the amount of benefit arising from the reduction of income lost of those afflicted with water-borne diseases, pertinent statistics on morbidity rate were gathered from the Department of Health. From 1964 to 1974, an average of 1,305.6 out of every 100,000 population in the province of Cotabato were afflicted with primary water-borne diseases every year, regardless of age, sex, and income class. The same rate was assumed for the City of Cotabato in the absence of specific data. The morbidity rate in the service area was assumed to remain constant during the 21-year projection period.

Since not all of those afflicted with said diseases are wage-earners, an adjustment was made accordingly. Based on the 1970 Census on Population and Housing of the National Census and Statistics Office, 68 percent of the municipality's population was economically active.[1] It was assumed, therefore, that only 68 percent of 1,305.6 per 100,000 who were afflicted with primary water-borne diseases were economically active. Hence, this is the only segment of the population who would suffer a reduction in income due to said diseases. Furthermore, these afflicted wage-earners were assumed to be earning ₱8 a day and unable to work for 15 days on the average because of their illness. The final figure corresponding to the economic cost of time lost due to water-borne diseases was thereby arrived at by multiplying the number of people afflicted with water-borne diseases by 68 percent, by ₱8 a day and then by 15 days.

Another health benefit that could be associated with the establishment of a safe public water supply system is the reduction of the economic cost of the premature death of those afflicted with water-borne diseases in the service area. Obviously, the reduction of the life span of the population caused by said diseases is an economic loss to the community.

This economic loss due to premature death was determined by multiplying the number of people who die because of water-borne diseases (assuming that a water supply improvement program were not undertaken) by 68 percent and then by ₱11,629. The projected number of such deaths was based on the average of the 10-year mortality rate for primary water-borne diseases in the province of Cotabato, as gathered from the Department of Health. These figures indicated that 61.5 persons died of the 1,305.6 per 100,000 who were afflicted with water-borne diseases. This mortality rate was assumed to be constant over the projection period. The 68 percent corresponds to the income-earning portion of the service area population. The ₱11,629 represents the monetary value of each death.

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[1] Economically active population includes those who are 10 years old and over, whether employed or unemployed, excluding retired persons, students and housewives.

This was derived from the estimated income to be earned by the average wage-earner over a period of five years discounted at 12 percent plus 20 percent associated economic costs (summation of ₱200 a month x 12 months x discount factor + 20 percent associated costs).

The third health benefit that can be derived from the improvement of the water supply in the service area is the reduction of the medical expenses of persons afflicted with water-borne disease. According to the Lipa City pilot survey on "Ability-to-Pay",[2/] an afflicted person spends ₱113.00 annually on the average for medical expenses, which include hospitalization, medicine and doctor's fee. Based on this finding, the total medical expenses incurred due to water-borne diseases were arrived at by multiplying ₱113.00 by the number of people afflicted with such diseases in the service area.

The sum of all three economic costs related to health benefits had to undergo three final adjustments to arrive at more meaningful figures. First, 40 percent of the total economic loss due to water-borne diseases was taken as the health benefit directly resulting from the water supply improvement program. This reduction was made to account for the fact that not all water-borne diseases are caused by a poor water system and may also be due to less than ideal personal hygiene or lack of sewerage facilities. Second, the 40 percent health benefit was escalated by 8 percent from 1980 to 1985, by 6 percent from 1985 to 1990, after which the escalation factor was held constant up to 2000. Third, the escalated health benefit was discounted to its present worth at 12 percent. Annex Table XI-C-2 shows the calculations associated with the health benefits for COT-WD. The total present value of said benefits after the adjustments amounts to ₱1.59 million.

Reduction in Fire Damage

The proposed water supply improvement program will result in increased water pressure and reliable supply for domestic as well as for fire-fighting purposes. At present, 67 percent of the fire hydrants in Cotabato are effectively operating. With the implementation of the program which will involve the installation of new fire hydrants, the fire protection coverage will be provided to the service area. Hence, a reduction in fire damage is expected in the service area.

2/ Refer to Methodology Manuel, Chapter 20 for "Ability to Pay" studies.

ANNEX TABLE XI-C-2

HEALTH BENEFITS
COTABATO CITY WATER DISTRICT

Year	Served Population	Cost of Time Lost Due to Illness (1)	Economic Loss Due to Premature Death (2)	Cost of Medical Expenses (3)	Total Economic Losses Due to Illness	40 Percent Reduction Due to Project (Benefits)	Escalation Factor	Escalated Reduction Due to Project	Discount Factor at 12 Percent	Present Value of Benefit
1980	22,080	23,523	107,381	32,575	163,479	65,392	1.210	79,124	.797	63,062
1981	24,460	26,059	118,955	36,087	181,101	72,440	1.307	94,679	.712	67,412
1982	27,100	28,872	131,794	39,981	200,647	80,259	1.412	113,326	.636	72,075
1983	30,020	31,982	145,995	44,289	222,266	88,906	1.525	135,582	.567	76,875
1984	33,260	35,434	161,752	49,069	246,255	98,502	1.547	152,233	.507	82,252
1985	36,850	39,259	179,211	54,366	272,836	109,134	1.779	194,149	.452	87,735
1986	40,820	43,488	198,518	60,223	302,229	120,892	1.886	228,002	.404	92,113
1987	45,223	48,179	219,931	66,719	334,829	133,932	1.999	267,730	.361	96,651
1988	50,100	53,375	243,649	73,914	370,938	148,375	2.119	314,407	.322	101,239
1989	55,500	59,128	269,910	81,881	410,919	164,368	2.246	369,170	.288	106,321
1990	61,490	65,510	299,041	90,718	455,269	182,106	2.381	433,594	.257	111,434
1991	↓	↓	↓	↓	↓	↓	↓	↓	.229	99,233
1992									.205	88,187
1993									.183	79,348
1994									.163	70,576
1995									.146	63,305
1996									.130	56,367
1997									.116	50,297
1998									.104	45,094
1999									.093	40,324
2000	61,490	65,510	299,041	90,718	455,269	182,106	2.381	433,594	.083	35,988
								6,727,936		1,586,768

Total Population: 61,184
Economically Active: 41,864
or 68%

Morbidity Rate: 1,305.6/100,000
Mortality Rate: 61.5/100,000

1) $68\% \times \frac{1305.6}{100,000} \times S.P. \times ₱8 \times 15$

2) $68\% \times \frac{61.5}{100,000} \times S.P. \times ₱11,629$

3) $\frac{1,305.6}{100,000} \times S.P. \times ₱113$

This reduction was assumed to be 0.75 percent of the combined assessed values of all structures in the service area. For Cotabato, the average assessed value of each structure was assumed to be ₱18,800[3]. The number of structures was derived from the projected population to be served by the system, assuming that each household has an average of 6.3 members.[4]

The fire protection benefit was based on the assumed overall reduction in fire damage, but correlated with the schedule of fire hydrant installation in the service area. Percentage of fire protection starts at 55 percent in 1981, gradually increasing to 81 percent in 1990 in accordance with the extent of the service area to be covered by the fire hydrants.

The net reduction in fire damage was escalated by 8 percent from 1980 to 1985, by 6 percent from 1985 to 1990, after which the escalation factor was held constant up to 2000. It was then discounted at 12 percent. The present value of the fire protection benefit, as shown in Annex Table XI-C-3 amounts to ₱8.72 million.

Beneficial Value of Water

Since water is essential to human life, all members of the served population in the service area presumably would be willing to obtain it in sufficient quantities at some given price. With the proposed improvement of the system's facilities, the volume of water production is expected to increase considerably to serve the needs of the growing population. This will bring about additional revenues to the water district, especially since a price increase of water may be justified in view of the improved service.

In general, water rates charged by the water district do not reflect the true value of water. Moreover, it is recognized that households and commercial users are really willing to pay more than what they are actually being charged for water consumed. From the economic viewpoint, therefore, there is a consumers' surplus. This consumers' surplus refers to the additional amount consumers are willing to pay over and above what they are paying for water. For purposes of this study, this additional value has been estimated to be 50 percent higher than domestic water rates and 25 percent higher than the commercial/industrial/institutional water rates[5].

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[3] In the absence of assessed value records on Cotabato, the figure on the municipality of Gapan in Nueva Ecija was used.

[4] Based on the 1970 Census on Housing in Cotabato Province.

[5] Refer to Revised Procedures for the Economic and Financial Analysis of Water Projects, LWUA, May 1977.

ANNEX TABLE XI-C-3

REDUCTION IN FIRE DAMAGE
COTABATO CITY WATER DISTRICT

Year	Number of Structures 6/	Total Value at P18,000 each 7/ (P x 1000)	Overall Reduction in Fire Damage (.0075)P x 1000	Percentage of Fire Protection	Net Reduction in Fire Damage (Benefit) (P x 1000)	Escalation Factor 8/	Escalated Value of Net Reduction (P x 1000)	Discount Factor at 12 Percent	Present Value of Net Benefit P x 1000
1980	3,505	65,894.0	494.2	–	–	1.210	–	.797	–
1981	3,883	73,000.4	547.5	55%	301.1	1.307	393.5	.712	280.2
1982	4,302	80,877.6	606.6	59	357.9	1.412	505.4	.636	321.4
1983	4,765	89,582.0	671.9	63	423.3	1.525	645.5	.567	366.0
1984	5,279	99,245.2	744.3	67	498.7	1.647	821.4	.507	416.4
1985	5,849	109,961.2	824.7	72	593.8	1.779	1,056.4	.452	477.5
1986	6,479	121,805.2	913.5	76	694.2	1.886	1,309.3	.404	529.0
1987	7,178	134,946.4	1,012.1	77	779.3	1.999	1,557.8	.361	562.3
1988	7,952	149,497.6	1,121.1	78	874.5	2.119	1,853.1	.322	596.7
1989	8,810	165,628.0	1,242.2	79	981.3	2.246	2,204.0	.288	634.9
1990	9,760	183,488.0	1,376.2	81	1,114.7	2.381	2,654.1	.257	682.1
1991	↓	↓	↓	↓	↓	↓	↓	.229	607.8
1992								.205	544.1
1993								.183	485.7
1994								.163	432.6
1995								.146	387.5
1996								.130	345.0
1997								.116	307.9
1998								.104	276.3
1999								.093	246.8
2000	9,760	183,488.0	1,376.2	81	1,114.7	2.381	2,654.1	.083	220.3
							39,541.5		5,720.1

6/ Derived from the served population projections in Chapter VI.

7/ Based on the assessed value records in Gapan, in the absence of similar data in Cotabato.

8/ Escalated annually by 10 percent from 1978 to 1980, by 8 percent from 1980 to 1985, and by 6 percent from 1985 to 1990, after which the escalation factor was held constant up to 2000.

In the determination of this benefit, the following steps were taken:

1. Only the incremental volume of accounted-for-water was considered; hence, the 1977 accounted-for-water amounting to 598,980 cum was deducted from total accounted-for-water projections in Chapter VI. The water demand projections in Chapter VI, expressed in liters per capita per day, were converted to cubic meters per year.

2. Classification of accounted-for-water into domestic and others (commercial/institutional/industrial) was based likewise on Chapter VI.

3. The price per cubic meter of water was obtained from the unescalated rate per revenue unit in Chapter X, Annex Table X-C-1. The rates were, however, adjusted upwards to reflect consumers' surplus: 50 percent higher for domestic water and 25 percent higher for others.

4. The total economic revenues were then escalated by 10 percent from 1978 to 1980, by 8 percent from 1980 to 1985, by 6 percent from 1985 to 1990, after which the escalation values were discounted at 12 percent to obtain their present values.

For COT-WD, the beneficial value of water amounts to a present value of ₱22.35 million, as shown in Annex Table XI-C-4.

ANNEX TABLE XI-C-4

BENEFICIAL VALUE OF WATER
COTABATO WATER DISTRICT

Year	Incremental Accounted-for-Water[9] (cum/year)	Domestic (cum/year)	Others (cum/year)	Price per cum[10] Domestic	Price per cum[10] Others	Economic Value[11] per cum Domestic	Economic Value[11] per cum Others	Economic Water Revenues (P x 100) Domestic	Economic Water Revenues (P x 100) Others	Total Economic Revenues	Escalation Factor[12]	Escalated Economic Revenues	Discount Factor at 12%	PV of Economic Revenues
1977	596,960													
1978	101,700	88,528	13,228	0.75	1.50	1.13	1.88	100	24.9	124.9	1.000	124.9	1.000	124.9
1979	220,799	192,095	28,704	0.69	1.38	1.03	1.73	197.9	49.7	247.6	1.100	272.4	.893	243.2
1980	360,065	313,257	46,808	0.64	1.28	0.96	1.60	300.7	74.9	375.6	1.210	454.5	.797	362.2
1981	480,131	417,714	62,417	0.95	1.90	1.43	2.38	597.3	148.6	745.9	1.307	974.9	.712	694.4
1982	615,229	535,249	79,980	0.88	1.76	1.32	2.20	705.5	176.0	881.5	1.412	1,244.1	.636	792.5
1983	767,241	667,500	99,741	0.82	1.64	1.23	2.05	821.0	204.5	1,025.5	1.525	1,563.3	.567	886.7
1984	938,283	816,306	121,977	0.94	1.88	1.41	2.35	1,151.0	286.6	1,437.6	1.647	2,367.7	.507	1,200.4
1985	1,130,739	983,743	146,996	0.88	1.76	1.32	2.20	1,298.5	323.4	1,621.9	1.779	2,885.4	.452	1,304.[illegible]
1986	1,347,289	1,172,141	175,148	0.81	1.62	1.22	2.03	1,430.0	355.6	1,785.6	1.886	3,367.6	.404	1,360.[illegible]
1987	1,590,950	1,384,127	206,823	0.85	1.70	1.28	2.13	1,771.7	440.5	2,212.2	1.999	4,422.2	.361	1,596.4
1988	1,865,115	1,622,650	242,465	0.79	1.58	1.19	1.98	1,931.0	480.1	2,411.1	2.119	5,109.1	.322	1,645.[illegible]
1989	2,173,604	1,891,035	282,569	0.73	1.46	1.10	1.83	2,080.1	517.1	2,597.2	2.381	5,833.3	.288	1,6[illegible].0
1990	2,520,715	2,193,022	327,693	0.79	1.58	1.19	1.98	2,609.7	648.8	3,258.5	2.381	7,758.5	.257	1,993.9
1991	↓	↓	↓	0.74	1.48	1.11	1.85	2,434.3	606.2	3,040.5	2.381	7,239.4	.229	1,657.[illegible]
1992				0.68	1.36	1.02	1.70	2,230.9	557.1	2,794.0	2.381	6,652.5	.205	1,363.[illegible]
1993				0.66	1.32	0.99	1.65	2,171.1	540.7	2,711.8	2.381	6,456.8	.183	1,1[illegible]
1994				0.61	1.22	0.92	1.53	2,017.6	501.4	2,519.0	2.381	5,995.7	.163	[illegible]
1995				0.57	1.14	0.86	1.43	1,886.0	468.6	2,354.6	2.381	5,606.3	.145	[illegible]
1996				0.53	1.06	0.80	1.33	1,754.4	435.8	2,190.2	2.381	5,214.5	.130	6[illegible]
1997				0.51	1.02	0.77	1.28	1,688.6	419.4	2,108.0	2.381	5,019.1	.116	5[illegible]
1998				0.47	0.94	0.71	1.18	1,557.0	386.7	1,943.7	2.381	4,627.9	.103	4[illegible]
1999				0.44	0.88	0.66	1.10	1,447.4	360.5	1,807.9	2.381	4,304.6	.093	4[illegible]
2000	2,520,715	2,193,022	327,693	0.40	0.80	0.60	1.00	1,315.8	327.7	1,643.5	2.381	3,913.2	.083	324.[illegible]
												91,[illegible]		[illegible]

9/ The 1977 volume of 596,960 cum per year of accounted-for-water was deducted from the water demand projections throughout the study period to obtain the incremental volume.

10/ The rate per cum of water for domestic use was derived by de-escalating the rate per revenue unit of water in Table X-[illegible]-1, Chapter X; the rate of water for other uses (commercial, institutional and industrial) was assumed to be twice that for domestic use.

11/ Assumed to be 30 percent higher than domestic rates and [illegible] percent higher than rate for "others".

12/ Escalation assumed to be [illegible] percent from 1977 to 1980, by 5 percent from 1981 to 1985, by 6 percent from 1985 to 1990, after which the escalation factor was held constant up to 2000.

ANNEX XI-E

ECONOMIC COSTS

ANNEX TABLE XI-E-1

CONVERSION OF FINANCIAL COST TO ECONOMIC COST
COTABATO CITY WATER DISTRICT

	Financial Project Cost	Foreign Exchange Component	Domestic Component	Unskilled Labor	Balance Domestic Component 13/	Taxes 14/ 5%	Others 95%	Foreign Exchange Component x 1.2	Unskilled Labor x .5	Others x 1.0	Economic Project Cost 15/	Economic Construction Cost 16/
Source Facilities												
Equipment	918,000	695,457	222,543	47,500	175,043	8,752	166,291	834,548	23,750	166,291	1,024,589	809,392
Well	145,000	12,046	132,954	17,300	115,654	5,783	109,871	14,455	8,650	109,871	132,9[illegible]	105,119
Structure	562,000	-	562,000	49,500	512,500	25,675	487,825	-	24,750	487,825	512,575	404,862
Raw Water Pump & Appurtenances	2,204,000	287,025	1,916,975	570,000	1,346,975	67,349	1,279,626	[illegible],230	285,000	[illegible],526	2,143,096	1,694,858
Transmission & Distribution	16,149,000	10,342,826	7,806,174	1,147,700	6,658,474	332,924	6,325,550	12,411,391	573,850	6,325,550	19,310,791	15,256,447
Storage Facilities	1,280,000	308,408	971,592	121,200	850,392	42,510	807,882	370,090	[illegible]	[illegible]	[illegible]	[illegible]
Internal Network	4,693,000	2,062,842	2,630,158	433,000	2,197,158	109,858	2,087,300	2,475,410	216,500	2,087,300	4,779,210	3,778,032
Fire Hydrants	1,893,000	393,518	699,482	159,200	540,282	27,014	513,268	1,192,222	79,600	513,268	1,785,090	1,411,138
Pumping Shop & Laboratory												
Equipment	266,000	233,048	32,952	14,000	18,952	948	18,004	279,658	7,000	18,004	304,662	240,840
Structure	490,000	-	490,000	61,400	428,600	22,830	433,770	-	30,700	433,770	464,470	367,170
Service Connect.												
a) Pipes	5,096,000	2,524,298	2,571,702	576,600	1,995,102	99,756	1,895,346	3,029,158	288,300	1,895,346	5,212,804	4,513,250
b) Meters	1,[illegible]	1,334,620	268,380	159,200	109,180	5,459	103,721	1,625,544	79,600	103,721	1,8[illegible]	1,[illegible],117
Feasibility Studies	447,000	245,850	201,150	-	201,150	10,058	191,092	295,020	-	191,092	486,112	384,112
Immediate Improvement												
Source Facilities												
Equipment	319,000	244,734	74,266	12,700	61,566	3,078	58,488	293,681	6,350	58,488	358,519	283,414
Structure	231,000	37,217	193,783	24,300	169,483	8,474	161,009	44,660	12,150	161,009	217,819	172,189
Trans. & Dist. Facilities	2,976,000	1,565,962	1,410,038	304,000	1,106,038	55,302	1,050,736	1,879,154	152,000	1,050,736	3,081,890	2,436,277
Fire Hydrants	-	-										
Service Connections												
a) Pipes	[illegible]	465,254	488,746	100,100	358,646	19,432	369,214	558,305	50,050	369,214	977,563	826,380
b) Meters	[illegible]	[illegible],439	118,561	102,400	16,161	808	15,353	710,927	51,200	15,353	777,480	[illegible]
Adm. Bldg. & Equipment												
Equipment	118,000	71,152	46,848	6,300	40,548	2,027	38,521	85,382	3,150	38,521	127,053	100,437
Structure	459,000	-	459,000	54,500	404,500	20,225	384,275	-	27,250	384,275	411,525	325,316
Pumping Water Repair	124,000	114,606	9,394	6,500	2,894	145	2,749	137,527	3,250	2,749	143,256	113,246
Vehicles	139,000	70,290	68,710	-	65,710	3,436	65,274	84,348	-	65,274	149,622	129,541
Other Miscellaneous Items	15,000	9,265	5,735	-	5,735	287	5,448	11,115	-	5,448	16,563	14,143
Sub-Total	43,840,000	22,430,857	21,409,143	3,966,600	17,442,543	872,130	16,570,413	26,917,028	1,983,300	16,570,413	45,470,741	36,720,154
Land	1,320,000	-	1,320,000	-	1,320,000	66,000	1,254,000	-	-	1,254,000	1,254,000	1,254,000
Total	45,160,000	22,430,857	22,729,143	3,966,600	18,762,543	938,130	17,824,413	26,917,028	1,983,300	17,824,413	46,724,741	37,974,154

13/ Domestic cost component less unskilled labor cost.

14/ Computed at 5 percent of domestic cost component after unskilled labor cost was deducted from it.

15/ Obtained by adding foreign exchange cost, unskilled labor cost and cost of 'others' after they have been adjusted through shadow pricing.

16/ Derived by subtracting contingencies and engineering services from the economic project cost.

ANNEX TABLE XI-E-2

REPLACEMENT COST
COTABATO CITY WATER DISTRICT
1978 PRICES
₱ x 1000

	7-Year Items	15-Year Items				
Year	Vehicles	Meters	Equipment	Misc. Items	Plumbing/ Meter Repair	Total
1978						
1979						
1980						
1981						
1982						
1983						
1984						
1985	129.5					12[illegible]
1986						
1987						
1988						
1989						
1990						
1991						
1992	129.5					129.[illegible]
1993		502.7	383.8	14.3	113.3	1,01[illegible].1
1994		10[illegible].0	51.0			1[illegible]
1995		8[illegible].2	487.0			572.[illegible]
1996		10[illegible].5	263.3			369.[illegible]
1997		9[illegible].0				9[illegible]
1998		10[illegible].9				10[illegible]
1999	129.5	11[illegible].4				24[illegible]
2000		167.[illegible]	1[illegible].4			[illegible]
TOTAL	388.5	1,282.[illegible]	1,200.[illegible]	14.3	113.3	2,[illegible]

ANNEX TABLE XI-E-3

SALVAGE VALUE IN 2001
COTABATO CITY WATER DISTRICT
(P x 1000)

	50 Years			30 Years			25 Years			15 Years			7 Years			Infinite			
	Economic Value	Remaining Service Life in 2001 (In Percent)	Salvage Value	Economic Value	Remaining Service Life in 2001 (In Percent)	Salvage Value	Economic Value	Remaining Service Life in 2001 (In Percent)	Salvage Value	Economic Value	Remaining Service Life in 2001 (In Percent)	Salvage Value	Economic Value	Remaining Service Life in 2001 (In Percent)	Salvage Value	Economic Value	Remaining Service Life in 2001 (In Percent)	Salvage Value	Total Salvage Value[17]
1978	3,359.8	56%	1,881.5	68.5	27%	18.5										284.7	100%	284.7	2,184.7
1979	1,206.7	58	699.9																699.9
1980	6,512.4	60	3,907.4	417.6	33%	137.8										190.6	100	190.6	4,235.8
1981	5,830.7	62	3,615.0																3,615.0
1982	828.1	64	530.0																530.0
1983	891.4	66	588.3																588.3
1984	932.0	68	633.8																633.8
1985	1,659.8	70	1,161.9				6.5	40%	2.6										1,164.5
1986	1,666.8	72	1,200.1							153.5	7%	10.7				778.7	100	778.7	1,989.5
1987	2,026.4	74	1,499.5							162.9	13	21.1							1,520.7
1988	3,363.6	76	2,556.3				98.6	52	51.3	425.2	20	85.0							2,692.6
1989	2,506.4	78	1,955.0							209.8	27	56.7							2,011.7
1990	1,413.9	80	1,131.1							239.6	33	79.1							1,210.2
1991																			
1992																			
1993										1,014.1	53	537.5							537.5
1994										155.0	60	93.0							93.0
1995										572.2	67	383.4							383.4
1996										369.8	73	270.0							270.0
1997										94.0	80	75.2							75.2
1998										104.9	87	91.3							91.3
1999										117.4	93	109.2	129.5	86%	111.4				220.6
2000										183.0	100	183.0							183.0
	32,198.0		21,359.8	486.1		156.3	105.1		53.9	3,501.4		1,999.3	129.5		111.4	1,252.0			24,930.7

17/ Salvage values for each year represent the salvage value of the item in year 2001.

ANNEX TABLE XI-E-4

SUMMARY OF ECONOMIC COSTS
COTABATO CITY WATER DISTRICT
₱ x 1,000

Year	Project Costs	Replacement Costs	O and M Costs	Total Costs	Escalation Factor for Other Costs[19]	Escalation Factor for O and M Costs[20]	Escalated Project Cost	Escalated Replacement Costs	Escalated O and M Costs	Escalated Total Costs	Discount Factor at 12 Percent	Present Value of Project Costs	Present Value of Replacement Costs	Present Value of O and M Costs	Present Value of Total Costs
[illegible]	[illegible]		35.0	5,967.1	1.000	1.000	5,932.1		35.0	5,967.1	1.000	5,932.1		35.0	5,967.1
[illegible]	[illegible]		91.3	1,771.6	1.100	1.020	1,848.3		98.6	1,946.9	[illegible]	[illegible]		[illegible]	[illegible]
[illegible]	[illegible]		(12.3)	9,585.6	1.210	1.166	11,520.9		(14.3)	11,526.6	[illegible]	[illegible]		(11.4)	[illegible]
[illegible]	[illegible]		107.7	7,903.3	1.307	1.260	10,[illegible]		135.7	7,324.5	[illegible]	7,254.4		[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	1.412	1.360	1,573.5		159.6	1,775.1	[illegible]	[illegible]		[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	1.525	1.469	1,835.5		287.2	2,122.7	[illegible]	[illegible]		[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		373.9	2,437.4	[illegible]	[illegible]		[illegible]	[illegible]
1985	2,[illegible]	129.5	286.9	2,672.1	1.779	1.714	4,013.1	230.4	491.6	4,735.1	.452	1,813.9	104.1	222.2	2,110.2
1986	3,[illegible]		340.1	3,361.0	1.886	1.851	5,703.1		629.5	6,332.6	.404	2,304.1		254.3	2,5[illegible]
[illegible]	[illegible]		430.2	3,138.4	1.999	1.999	5,413.7		860.0	6,273.7	.361	1,954.1		310.5	[illegible]
[illegible]	4,[illegible]		496.0	5,341.8	2.119	2.159	10,268.3		1,070.9	11,339.2	[illegible]	3,306.4		[illegible]	3,65[illegible]
1989	3,356.8		597.6	3,954.4	2.246	2.332	7,5[illegible].4		1,393.6	8,933.0	[illegible]	2,171.3		401.4	2,572.7
1990	2,001.8		672.9	2,674.7	2.381	2.5[illegible]	4,7[illegible].3		1,694.5	6,4[illegible]	.257	1,224.9		435.5	[illegible]
1991	0			672.9			0			1,694.5	.229	0		388.0	338.0
1992		129.5		802.4				308.3		2,002.8	.205		63.2	347.4	410.6
[illegible]		1,014.1		1,687.0				2,414.6		4,109.1	.183		441.9	310.1	752.0
[illegible]		155.0		827.9				369.1		2,063.6	.163		60.2	276.2	336.4
1995		572.2		[illegible]				1,362.4		3,056.9	.146		198.9	247.4	446.3
1996		369.6		1,042.7				580.5		2,575.0	.130		113.5	220.3	334.8
1997		94.0		766.9				223.8		1,918.3	.116		26.0	196.6	222.6
1998		164.9		777.3				249.8		1,564.3	.104		26.0	176.2	202.2
1999		246.9		919.8				587.9		2,282.4	.093		54.7	157.5	212.3
2000	0	183.0	672.9	855.9	2.381	2.518	0	435.7	1,694.5	2,130.2	.083	0	36.2	140.6	176.8
	26,724.7	2,938.9	10,352.2	60,075.8			72,711.5	7,062.5	22,200.8	103,974.8		39,910.7	1,[illegible]	3,[illegible]	22,[illegible]
Salvage Value in 2001[18]				- 24,930.7	2.381					- 59,360.0	.074				[illegible]
				35,145.1						44,614.8					21,[illegible]

[18] The annual salvage values were not escalated individually since they represent values for 2001; hence, only their sum was escalated by the factor used for project and replacement costs.

[19] Project cost and replacement cost were escalated annually by 10 percent from 1978 to 1980, by 8 percent from 1980 to 1985, by 6 percent from 1985 to 1990, after which the escalation factor was held constant up to 2000.

[20] Operating and maintenance costs were escalated annually by 8 percent from 1978 to 1990, after which the escalation factor was held constant up to 2000.

ANNEX XI-G

INTERNAL ECONOMIC RATE OF RETURN

ANNEX TABLE XI-G-1

INTERNAL RATE OF RETURN
COTABATO CITY WATER DISTRICT
(₱ x 1000)

Year	Escalated Values Benefits	Escalated Values Costs	Discount Factor at 55 Percent	Present Values Benefits	Present Values Costs	Discount Factor at 60 Percent	Present Values Benefits	Present Values Costs
1978	124.9	5,967.1	1.000	124.9	5,967.1	1.000	124.9	5,967.1
1979	272.4	1,946.9	.645	175.7	1,255.8	.625	170.3	1,216.8
1980	28,332.4	11,526.6	.416	11,786.3	4,795.1	.391	11,078.0	4,506.9
1981	3,917.6	10,324.5	.269	1,053.8	2,777.3	.244	955.9	2,519.2
1982	3,897.8	1,778.1	.173	674.3	307.6	.153	596.4	272.0
1983	5,781.7	2,122.7	.112	647.6	237.7	.095	549.3	201.7
1984	7,269.2	2,457.4	.072	523.4	176.9	.060	436.2	147.4
1985	8,813.2	4,735.1	.047	414.2	222.6	.037	326.1	175.2
1986	10,217.8	6,332.6	.030	306.5	190.0	.023	235.0	145.6
1987	12,379.4	6,273.7	.019	235.2	119.2	.015	185.7	94.1
1988	14,307.0	11,339.2	.012	171.7	136.1	.009	128.8	102.1
1989	16,561.3	8,933.0	.008	132.5	71.5	.006	99.4	153.6
1990	20,087.3	6,460.8	.005	100.4	32.3	.004	80.3	25.8
1991	10,327.1	1,694.5	.003	131.0	5.1	.002	20.7	3.4
1992	9,740.2	2,002.8	.002	19.5	4.0	.001	9.7	2.0
1993	9,544.5	4,109.1	.001	9.5	4.1	.001	9.5	4.1
1994	9,085.4	2,063.6	.001	9.1	2.1	.001	9.1	2.1
1995	8,694.0	3.056.9	.001	8.7	3.1	-	-	-
1996	8,302.6	2,575.0	-	-	-	-	-	-
1997	8,106.8	1,918.3	-	-	-	-	-	-
1998	7,715.6	1,944.3	-	-	-	-	-	-
1999	7,392.3	2,282.4	-	-	-	-	-	-
2000	7,000.9	2,130.2	-	-	-	-	-	-
	217,871.4			16,424.3			15,015.3	
		103,974.8			16,307.6			15,439.1
Salvage Value		24,930.7			0.0			0.0
		79,044.7			16,307.6			15,439.1
	2.76			1.00				

Present Value at 55% = 116.7
Present Value at 60% = $\frac{423.8}{540.5}$

$$IERR = .55 + \frac{.05(116.7)}{540.5}$$

$$= .55 + .0108$$

$$= 56.08\%$$

M E T H O D O L O G Y

M E M O R A N D A

Methodology Memorandum No. 1

To : L. V. Gutierrez, Jr.

From : A. de Vera

Date : 4 January 1977

Subject: Pilot Area Survey

A. Need

In estimating water accountability, data on the ratio of borrowers to primary users, average persons per household, and per capita consumption are necessary. Information on capacity and willingness-to-pay would greatly aid financial analysis. In all cases, these data are not readily available in the Philippines. The only way to get these data would be to actually perform a house-to-house survey within the served areas of the water district (WD). Considering time and financial constraints, a pilot area survey would be the best approach. This is merely surveying a representative area within the WD and projecting the data obtained for the entire served area of the WD.

B. Methodology

1. Choose a pilot area within the WD. Desirable requirements for the area are as follows:

   a. adequate line pressures, preferably with 24-hour service;
   b. metered connections;
   c. presence of domestic as well as commercial connections. Ratio of commercial to domestic connections for the area must not exceed that for the entire WD;
   d. representative income levels of the concessionaires.

2. Devise a one-page questionnaire so that it:

   a. is easily understood by WD personnel (who will serve as interviewers);
   b. provides relevant information;
   c. provides a means of cross-checking some answers given by respondents;
   d. would make tabular analysis easy.

   A sample questionnaire is attached.

3. Get assistance from the WD personnel in the house-to-house survey. It is suggested that they do the actual interview because of their familiarity with local customs and dialects. However, before allowing the WD enumerators to proceed on their own, it is necessary that:

   a. the enumerators be given a thorough briefing on the importance of the survey, as well as the purpose of each item in the questionnaire.
   b. the enumerators be accompanied to the first few houses, and given additional pointers or feedback before they proceed on their own.

4. Conduct a house-to-house survey of all households within the pilot area. A map at this point indicating the existing houses (with their code numbers) would be necessary. The following would be helpful during the survey:

   a. brief the respondents about the purpose of the survey before asking questions. It is very important that they be receptive to the interviewers. Otherwise data given could be misleading.
   b. in asking for estimates of consumption, avoid using technical terms, i.e., liters, gallons, etc. Use local containers like pails, drums or whatever they use. Note the capacity of the container in the questionnaire.

C. <u>Data</u>

The following data may be obtained from the survey:

1. Pilot area density
2. Average persons/household
3. Borrowers from connected households and percentage of households dependent on the WD
4. Potential concessionaires
5. Consumption estimates
6. Income levels and the respective rates showing willingness to pay for improved service
7. Water accountability

_____ WATER DISTRICT
PILOT AREA QUESTIONNAIRE

DATE _____
TIME _____

INTERVIEWEE _____ ADDRESS _____

TYPE OF DWELLING _____ CONSTRUCTION MATERIAL _____

WD CONCESSIONAIRE

1. NO. OF OCCUPANTS: _____

2. CLASSIFICATION:
   - ☐ Domestic
   - ☐ Commercial
   - ☐ Institutional
   - ☐ Industrial
   - ☐ _____

3. SIZE OF CONNECTION:
   ☐ ½" ☐ 1" ☐ 2"
   ☐ ¾" ☐ 1½" ☐ _____

4. TYPE OF CONNECTION:
   - ☐ metered: meter functioning
   - ☐ metered: meter damaged
   - ☐ flat rate (unmetered)

5. APPURTENANCES (Connected to System)
   - ☐ with hand pump
   - ☐ with electric motor pump
     HRS used/day _____
     Pump rated HP _____
     GPM _____

6. OTHER SOURCE ASIDE FROM WD:

Own	Other HH
☐ wells	☐ wells
☐ springs	☐ springs
☐ rainwater	☐ rainwater
☐ _____	☐ _____

NON-WD CONCESSIONAIRE

1. NO. OF OCCUPANTS: _____

2. SOURCE OF SUPPLY:
   - ☐ own private well
   - ☐ rainwater
   - ☐ spring
   - ☐ public faucet
   - ☐ WD concessionaire
     HH Code No. _____
   - ☐ public well
   - ☐ others' private well
   - ☐ _____

3. CONSUMPTION:
   - ☐ free
   - ☐ paying
     volume used per day _____
     Paying ₱ _____
     for _____.

REMARKS:

FOR ALL HOUSEHOLDS

1. WD-WATER AVAILABLE:
   No. of hours _____
   Time _____

2. FAUCETS:
   ☐ 1 ☐ 3 ☐ 5
   ☐ 2 ☐ 4 ☐ ___

3. SHOWERS:
   ☐ 1 ☐ 2 ☐ 3 ☐ ___

4. FLUSH WATER CLOSET:
   ☐ 1 ☐ 2 ☐ 3 ☐ ___

5. MANUAL WATER CLOSET:
   ☐ 1 ☐ 2 ☐ 3 ☐ ___

6. ☐ w/septic tank ☐ w/o septic tank

7. AVERAGE MONTHLY:

	Consumption	Billing/PYMT
WD:	_____	_____
wells:	_____	_____
others:	_____	_____

8. USER:
   - ☐ w/ borrowers
   - ☐ w/o borrowers

   Total no. of HH borrowers _____
   Total no. of HH borrowers' occupants _____

9. How much would you be willing to pay if water service were improved?
   _____/month.

(TO BE FILLED UP AT THE WD OFFICE)

1. HOUSEHOLD CODE NO. _____

2. INCOME:
   - ☐ below average (₱220 below)
   - ☐ average (₱221 – 750)
   - ☐ upper middle (₱751 – 1,500)
   - ☐ high (₱1,500 above)

3. WD CONCESSIONAIRE:
   - ☐ registered
   - ☐ unregistered

4. PAYMENTS:
   - ☐ up-to-date
   - ☐ delinquent

_____
ENUMERATOR

_____
POSITION

Methodology Memorandum No. 2

To : L. V. Gutierrez, Jr.

From : A. de Vera

Date : 31 January 1977

Subject: Estimating Water Accountability

A. Need

To be able to determine future water demand per capita, need for leak detection and survey program, and the level of development possible for reducing wastage and leakage, the following information must first be available.

1. Ratio of accounted-for and unaccounted-for-water.

2. Ratio of wastage and leakage in relation to total production.

3. Domestic consumption per capita.

Although there are various methods for estimating water accountability, the selection of a method depends on the purpose for which it is to be used and the level of accuracy desired. Accounted-for-water as used herein refers to the revenue-producing water for the water district. It is the sum of the billed metered consumption and inferred water consumption at flat-rate connections.

B. Methodology

1. Pilot Area Survey

a. Objective - To be able to estimate total accounted-for and unaccounted-for-water. Accuracy will depend on the reliability of the consumption figures as obtained in the pilot area survey.[1]

b. Data Necessary - Monthly production; number of metered and unmetered connections; water rate schedule; pilot area data; and total monthly metered consumption.

---

[1] Refer to Methodology Memorandum No. 1.

c. Steps

1) Obtain total number of households dependent on water system. To do this, first obtain ratio of households dependent on the system to total households in the pilot area and apply ratio to the whole service area. Compute for number of primary and secondary users.

2) Compute for inferred flat-rate use per month.

3) Compute total accounted-for-water by adding average monthly metered consumption and total inferred flat-rate use per month.

4) Unaccounted-for-water is total production less accounted-for-water. It is also the total of potentially billable water plus wastage, leakage and other uses.

5) Potentially billable water is the sum of:

   - Usage of borrowers from flat-rate primary users;
   - Unbilled flat-rate use
   - Wastage of flat-rate users

2. Weighted Average of First 10-City Survey

a. Objective - In a water system with all functions billed as flat-rate, computing for water accountability is impossible without resorting to detailed surveys. However, this method implies that the figures obtained during the first 10-area survey (CDM - 1975) approximate those of other water districts. Accuracy, however, is not determined.

b. Data Necessary - Total monthly production and figures obtained during the First 10-Area Survey of CDM.

c. Steps

Multiply monthly production by:

.31 to get accounted-for-water
.11 to get underestimated flat-rate use
.26 to get wastage
.25 to get leakage
.07 for others

3. Field Study Method

a. Objective - To be able to determine within ± 5 percent accuracy water accountability figures. This method, however, is time-consuming and very expensive.

b. Data Necessary - All data received shall be generated in the field. The number of concessionaires and the water rate schedule are basic requirements.

c. Steps

1) For each section of transmission and distribution line in the water system, appropriate measuring devices shall be installed in order to determine the amount of water flowing in and out, water used by the concessionaires, and water leakage.

2) Desk-top analysis is then necessary to determine water accountability.

METHODOLOGY MEMORANDUM NO. 3

To : L. V. Gutierrez, Jr.

From : P. del Rosario

Date : 8 February 1977

Subject: Classification of Water Districts According to Future Water Requirements

A. Introduction

The purpose of this methodology manual is to classify water districts (WD) so that future water requirements may be estimated. The factors to be considered in classifying WD's are economic and social development in the district's boundaries, probable sources of additional water supply and the people's ability-to-pay for improved water service.

The group with the probable highest per capita consumption is labelled Group I; and the group with the probable lowest water consumption, Group V. Affluent and highly urbanized water districts may fall under Group I, while less developed and small water districts, under Group V.

B. Methodology

The initial service area of the WD will most likely include the central urban area or core city (poblacion). To classify it according to future water demands, the WD and its central urban area are judged according to 5 grouping criteria - 1975 urban income, 1975 standard of living, 1975 business index, 1980 cost of water, and served population in 1980. For each criterion, a number of points, from 0 to 20, are allotted to each water district. The total number of points under the 5 criteria determines the classification of the WD.

Table MM 3-1 lists the 5 criteria by which the WD can be classified, and the points allotted to rankings in each criterion.

The grouping of the WD's based on the range of total points under the 5 criteria is as follows:

TABLE NX 3-1

WATER DISTRICT GROUPING CRITERIA

1975 Urban Income: Income Taxes Paid by Urban Residents ($)	Points 20	1975 Standard of Living: % of Households with Refrigerators in Urban Area	Points 10	% of Households with Flush Toilets in Urban Area	Points 10	1975 Business Index: % of Commercial Establishments in Urban Area	Points 20	1980 Cost of Water: Source of Additional Water Supply	Points 20	1980 Served Population: Population Served in Urban Area	Points 20
more than 30,000,000	20	more than 30	10	more than 60	10	more than 6.6	[illegible]	Spring, gravity type	20	more than 150,000	20
10,000,001-30,000,000	18	25.1 - 30	9	50.1 - 60	9	4.6 - 6.6	16			100,001 - 150,000	18
5,000,001-10,000,000	16	20.1 - 25	8	40.1 - 50	8	3.1 - 4.5	11	Spring with booster pump	17	80,001 - 100,000	16
1,000,001- 5,000,000	14	15.1 - 20	7	30.1 - 40	7	1.7 - 3.0	7	Infiltration with short transmission line/ well points	14	65,001 - 80,000	14
500,001- 1,000,000	12	10.1 - 15	6	20.1 - 30	6	1.0 - 1.6	4			52,001 - 65,000	12
100,001- 500,000	10	5 - 10	5	10 - 20	5	less than 1	2	Infiltration with long transmission line/ wells	11	41,001 - 52,000	10
50,001- 100,000	8	less than 5	4	less than 10	4					31,001 - 41,000	9
20,001- 50,000	6							Surface water without reservoir	7	22,001 - 31,000	8
8,001- 20,000	4							Surface water with reservoir	5	15,001 - 22,000	7
4,001- 8,000	2									10,001 - 15,000	6
4,000 or less	1									less than 10,000	5

Group	Total Points
I	70 and above
II	60 - 69
III	50 - 59
IV	40 - 49
V	39 and below

In allotting points under each criterion, readily available data are taken from the latest NCSO report (1970 or 1975 census). These data are: total population in the city or municipality; total households; number of urban households; number of commercial establishments; number of industrial establishments; number of households with refrigerators; and number of households using flush water-sealed toilets. The data on total income taxes paid in the city/municipality in 1975 were obtained from the BIR office. Data on the probable sources of additional water supply were taken from the recent preliminary hydro-survey conducted by LWUA and the WD.

The following is a procedure for assigning points to a WD on the basis of the 5 criteria.

1. 1975 Urban Income

Urban income is based on the total income taxes paid by individuals and business entities and the percentage of urban households with respect to total households in the city/municipality. If the 1975 data are not available, the percentage of urban households is projected to 1975 by applying an increase of 0.1 to 0.4 percent per year. In projecting the percentage of urban households, growth characteristics and urban development must be considered. The projected percentage is multiplied by 1975 total income. Table MM 3-1 shows the breakdown of the annual income with points ranging from 1 to 20.

2. 1975 Standard of Living

The standard of living is measured by the number of households in the urban area with refrigerators and those with flush water-sealed toilets.

The percentage of urban households with refrigerators with respect to total urban households is projected to 1975, if the 1975 census is not available. An increase

of 1 to 4 percent per annum is applied, depending upon the recent economic and social development in the city/municipality. The same procedure is applied to the percentage of urban households using flush water-sealed toilets. Table MM 3-1 shows the percentages of households with refrigerators and those with flush toilets with respect to total urban households, with points ranging from 4 to 10.

3. 1975 Business Index

The business index is measured by the percentage of commercial establishments with respect to total urban households in 1975. One industrial establishment (data from NCSO census) is assumed to be equivalent to 10 commercial establishments (except when the 1975 census is available). An increase of 1 to 20 establishments per year is applied, depending on the recent business activities and urban development in the city/municipality. The number of urban households in 1975 is obtained by multiplying the 1975 total households (total population + average of 7 persons/household) by the 1975 percentage of urban households as derived in the methodology for 1975 urban income. The 1975 sum of commercial establishments divided by the number of 1975 urban households is the business index of the city/municipality. Table MM 3-1 shows the various levels of business index, with corresponding points ranging from 2 to 20.

4. 1980 Cost of Water

The cost of water is inferred from the probable source of additional water supply by 1980. The probable source of additional water supply is weighted according to its apparent economic viability. A spring source that is located within the 1980 service area and can flow by gravity is considered the most economical. Surface water requiring complete water treatment with impounding reservoir is the most expensive. Infiltration galleries with short or long transmission lines, wells, or spring source requiring booster pump, are considered to have weights between the most and least expensive (see Table MM 3-1).

5. Served Population in 1980

The served population in 1980 is projected by delineating the future service areas of the WD and projecting the population of the city/municipality and of the service areas. The 1980 served population is determined as a portion of the service area population. In projecting the population served and the future service areas, economic growth and urban development, availability of water supply and capability of the water district to provide service must be considered.

C. Expected Water Demand By Class of WD

The experience of the LWUA-CDM staff, especially during the First Ten Urban Areas Project in the Philippines, has been used to assign values of expected water demand to the 5 classes of water districts. These expected water demands are shown in Table MM 3-2.

D. Example of Water District Classification

This method of classifying a water district is illustrated, with the Silay City Water District as an example. Available data for Silay City are taken from the NCSO and BIR reports, and from the preliminary hydro-survey by LWUA and the SIL-WD. The following data were obtained:

Total income taxes paid in the city - ₱20,049,139 (1974-1975)

Total population in the city - 103,493 (1975)

Total number of households in the city - 10,915 (1970)

Total number of households in the urban area - 3,693 (1970)

Total number of commercial establishments in the city - 36 (1970)

Total number of industrial establishments in the city - 1 (1970)

Total urban households with refrigerators - 266 (1970)

Total urban households using flush water-sealed toilets - 807 (1970)

Probable source of additional water supply - wells (1980)

Population in the service area - 21,280 (1980)

To determine the specific weights of the above data for each grouping criterion, the methodology developed is applied as follows:

TABLE MM 3-2

WATER DEMAND OF WATER DISTRICT GROUPINGS

Classification	Year 1980	1990	2000
Group I			
Domestic use, lpcd	140	155	175
Commercial/Industrial/Institutional			
% of domestic	17	21	25
Equivalent, lpcd	24	33	35
Accounted-for-water, lpcd	164	188	210
Unaccounted-for-water			
% of production	40	28	20
Equivalent, lpcd	109	73	52
Total production required, lpcd	273	261	262
Group II			
Domestic use, lpcd	120	135	150
Commercial/Industrial/Institutional			
% of domestic	15	17	20
Equivalent, lpcd	18	23	30
Accounted-for-water, lpcd	138	158	180
Unaccounted-for-water			
% of production	40	28	20
Equivalent, lpcd	92	62	45
Total production required, lpcd	230	220	225
Group III			
Domestic use, lpcd	105	120	135
Commercial/Industrial/Institutional			
% of domestic	13	16	18
Equivalent, lpcd	14	19	24
Accounted-for-water, lpcd	119	139	159
Unaccounted-for-water			
% of production	40	28	20
Equivalent, lpcd	79	54	40
Total production required, lpcd	198	193	199

TABLE MM 3-2 (Continued)

WATER DEMAND OF WATER DISTRICT GROUPINGS

Classification	Year 1980	1990	2000
Group IV			
Domestic use, lpcd	95	110	125
Commercial/Industrial/Institutional			
% of domestic	12	14	16
Equivalent, lpcd	12	15	20
Accounted-for-water, lpcd	107	125	145
Unaccounted-for-water			
% of production	40	28	20
Equivalent, lpcd	71	49	36
Total production required, lpcd	178	174	181
Group V			
Domestic use, lpcd	90	100	110
Commercial/Industrial/Institutional			
% of domestic	10	13	15
Equivalent, lpcd	9	13	17
Accounted-for-water, lpcd	99	113	127
Unaccounted-for-water			
% of production	40	28	20
Equivalent, lpcd	66	44	32
Total production required, lpcd	165	157	159

1. 1975 Urban Income

In 1970, the urban households accounted for 33.8 percent of the total households in the city. But due to recent developments in the local economy and subdivision housing projects in the urban sector of the city, the number of urban households was projected to increase to 3[illegible] percent in 1975. The product of the total 1974-1975 i[illegible]me taxes and the 1975 percentage of urban households represents the urban income taxes which amount to about ₱7.017 million. Table MM 3-1 gives this a weight of 16 points.

2. 1975 Standard of Living

This is measured by:

a. 1975 urban households using refrigerators

In 1970, 7.2 percent of the urban households had refrigerators. Due to economic and housing developments, the percentage was estimated to increase to about 12 percent in 1975. Table MM 3-1 gives this a weight of 6 points.

b. 1975 urban households using flush water-sealed toilet facilities

In 1970, the households with toilet facilities represented 21.9 percent of urban households. Due to the recent housing developments in the urban area, the households with toilet facilities were projected to be about 32 percent in 1975. Table MM 3-1 gives this a weight of 7 points.

3. 1975 Business Index

It is assumed that one industrial establishment is equivalent to 10 commercial establishments. Based on the 1970 census, the number of commercial establishments (equivalent industrial establishments included) was 46 (36 + 10). These establishments were expected to have increased to 96 (at 10 establishments per year) in 1975. Total urban households increased from 3,693 in 1970 to about 5,180 in 1975 (1975 population of 103,493 ÷ average 7 persons/household). Hence, the business index in 1975 was 1.9 percent (commercial establishments divided by the number of urban households in 1975). Table MM 3-1 gives this a weight of 7 points.

4. 1980 Cost of Water

Based on the hydro-survey of LWUA-CDM and SIL-WD, deepwells appear to be the most probable economical source of additional supply. Table MM 3-1 gives a weight of 11 points for this source.

5. 1980 Served Population

By 1980, the served population is expected to be about 15,630[1] as projected from the 1975 NCSO Census of Population and Housing. Table MM 3-1 gives this a weight of 7 points.

Therefore, the SIL-WD has a total of 54 points under the 5 criteria, indicating that it belongs to Group III. The water demands of this group from 1980 to year 2000 are listed in Table MM 3-2.

Table MM 3-3 classifies 16 water districts in the Philippines according to the 5 grouping criteria.

1/ See Chapter VI, Table VI-3, of the Silay City Feasibility Study Report.

TABLE MM 3-3

SUMMARY OF CITIES/MUNICIPALITIES SUBJECTED TO THE WATER DISTRICT GROUPING CRITERIA

City/Municipality	1975 Urban Income (Points)	1975 Standard of Living: Urban Households with Refrigerators (Points)	1975 Standard of Living: Urban Households with Flush Toilets (Points)	1975 Business Index (Points)	1980 Cost of Water Source of Supply (Points)	1980 Served Population (Points)	Total Points	Group
Bislig, Surigao del Sur	14	6	7	11	14	7	59	3
Urdaneta, Pangasinan	6	7	9	11	11	6	50	3
Calamba, Laguna	14	9	10	7	17	6	63	2
Gapan, Nueva Ecija	6	8	9	7	11	6	47	4
Silay City	16	6	7	7	11	7	54	3
Cebu City	20	10	10	7	5	20	72	1
Davao City	16	9	9	16	11	10	71	1
Bacolod City	20	9	9	7	11	18	74	1
Zamboanga City	14	7	9	7	7	16	62	2
Digos, Davao del Sur	12	6	9	7	11	5	50	3
Bacacay, Albay	1	5	9	11	20	5	51	3
Bangued, Abra	1	6	8	7	20	6	48	4
Dalaguete, Cebu	1	5	8	4	11	5	34	5
Baybay, Leyte	10	9	8	16	9	6	58	3
Roxas City	10	9	8	16	7	6	56	3
Cotabato City	12	9	8	11	11	7	58	3
Olongapo City	18	9	10	20	11			1
Subic	4	5	6	16	11	5	47	4
San Fernando (Pampanga)	14	6	7	20	11	7	65	2
Tarlac	12	8	8	16	11	8	63	2
Cabanatuan City	12	8	10	11	11	9	61	2
Lipa City	8	8	10	16	11	7	60	2
Lucena-Pagbilao-Tayabas	14	6	8	7	17	12	64	2
Daet	10	5	4	4	20	10	53	3

Methodology Memorandum No. 4

To : L. V. Gutierres, Jr.

From : E. Jacildo

Date : 20 January 1977

Subject: Probability Analysis of Stream Flows by Gumbel

A. Need

In evaluating the surface water sources for water supply purposes, the analyst has to focus his interest on statistical frequency of extreme low flows. Since the exact sequence of streamflow for future years can not be predicted, he also has to consider the probable variations in flows in order to develop a design on the basis of calculated risk.

In 1941, E. J. Gumbel devised a probability method by which recurring flows can be computed for design requirements. Under this method, the hydrologic data are analyzed as an "extreme value" distribution and the sets of hydrologic data are plotted as straight lines. Gumbel's method has been found advantageous to use.

B. Basic Data

The hydrologic data are found in Surface Water Supply Bulletins published by the Water Resources Division of the Bureau of Public Works (BPW). Data are presented in the following sequence:

1. Name of river basin
2. Name of stream
3. Location of gaging station in latitude and longitude
4. Drainage area in square kilometers
5. Records available: months and year
6. Gage elevation
7. Extremes; magnitude and dates of maximum and minimum flows
8. Remarks
9. Revisions
10. Presentation of daily discharge for one year

It should be noted that Surface Water Supply Bulletins after 1967 have not been published; they are on file at the BPW Water Resources Division.

C. Methodology

Below are the steps in Gumbel's probability analysis of streamflows.

Table MM4-1

1. Tabulate the monthly flows (mean, minimum or maximum, whatever is desired).
2. Take note of any changes in the yearly records as stated under "Remarks" or "Revisions" of the Bulletin. Write them under remarks in Table MM4-1.

Table MM4-2

1. Arrange all monthly flows in ascending order, i.e., from lowest to highest. Any flow that occurs more than once should be listed.
2. Rank the arranged flows under "m".
3. Take the logarithm of Q.
4. Solve for the probability flow by the formula

$$\frac{m}{n+1} \times 100$$

where, m is the rank of a particular flow
n is the total number of recorded flows.

5. Solve for the return period by the formula

$$\frac{n+1}{m}.$$

Figure MM4-1

1. Plot log Q as ordinate against probability as abscissa. Figure MM4-1 is Gumbel's special probability paper.
2. Draw a straight line (month line) passing through the points marked in step C-1. If not all the points fall on the line, adjust the line such that it passes on the average path of the points. Any return period which falls on the line is in month's term. The line may be extended in order to reach periods not covered by it.
3. Take the antilogarithms of the values of return periods in months as projected on the log Q scale (ordinate). The antilogs are the recurring flows in cubic meters per day.

TABLE MM4-1

MEAN-DAY DISCHARGE PER MONTH

Basin: Pampanga (San Vicente)

Station: Peñaranda River

Location: lat. 15°18'46"; long. 120°56'30"

Drainage Area: 575 sqkm

Gage Elevation: 11,050 m

Units: cumd x 1,000

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Minimum-Day Discharge/ Year	Remarks
1965	-	2,283	753	351	372	1,313	-	-	-	3,239	5,156	4,358		
1966	-	2,915	-	-	8,941	1,595	2,682	4,215	5,425	1,413	9,801	5,380		
1967	4,922	857	1,189	547	873	425	1,012	6,614	4,415	5,707	5,896	125		
1968	66	77	120	540	96	-	-	-	-	-	-	117		
1969	141	32	336	689	664	301	3,203	2,394	2,248	1,175	1,785	2,190		
1970	1,989	814	279	17	17	3,561	2,928	1,628	9,590	11,725	9,689	5,915		
1971	3,123	642	732	294	1,499	4,567	4,021	1,824	1,377	11,161	5,229	15,007		
1972	5,992	4,873	406	1,461	767	415	18,347	15,977	6,306	216	4,701	2,896		
1973	697	823	82	108	95	686	2,525	2,650	4,405	14,582	4,149	2,124		
1974	1,405	1,332	2,191	471	621	3,781	3,497	10,761	10,014	12,567	16,317	13,693		

TABLE MP4-2

MEANFLOW (PEÑARANDA RIVER, SAN VICENTE)
GAPAN WATER DISTRICT

m	Q cumd x 10^3	Log Q	Probability $(\frac{m}{n+1} \times 100)$	Return Period (Months) $(\frac{n+1}{m})$
1	17	4.230	0.93	108.00
2	17	4.230	1.85	54.00
3	32	4.505	2.78	36.00
4	66	4.820	3.70	27.00
5	77	4.886	4.63	21.60
6	82	4.914	5.56	18.00
7	95	4.978	6.48	15.43
8	96	4.982	7.41	13.50
9	108	5.033	8.33	12.00
10	117	5.068	9.26	10.80
11	120	5.079	10.18	9.82
12	125	5.097	11.11	9.00
13	141	5.149	12.04	8.31
14	216	5.334	12.96	7.71
15	279	5.446	13.89	7.20
16	294	5.468	14.82	6.75
17	301	5.478	15.74	6.35
18	336	5.526	16.67	6.00
19	351	5.545	17.59	5.68
20	372	5.570	18.52	5.40
21	406	5.608	19.44	5.14
22	415	5.618	20.37	4.91
23	425	5.628	21.30	4.70
24	471	5.673	22.22	4.50
25	540	5.732	23.15	4.32
26	547	5.738	24.07	4.15
27	621	5.793	25.00	4.00
28	642	5.808	25.93	3.86
29	664	5.822	26,85	3.72
30	686	5.836	27.78	3.60
31	689	5.838	28.70	3.48
32	697	5.843	29.63	3.38
33	732	5.864	30.56	3.27
34	753	5.877	31.48	3.18
35	767	5.885	32.41	3.08
36	814	5.911	33.33	3.00
37	823	5.915	34.26	2.92
38	857	5.933	35.18	2.84

TABLE MM4-2 (continued)

MEANFLOW (PEÑARANDA RIVER, SAN VICENTE)
GAPAN WATER DISTRICT

m	Q cumd x 10^3	Log Q	Probability $(\frac{m}{n+1} \times 100)$	Return Period (Months) $(\frac{n+1}{m})$
39	873	5.941	36.11	2.77
40	1,012	6.005	37.04	2.70
41	1,175	6.070	37.96	2.63
42	1,189	6.075	38.889	2.57
43	1,313	6.118	39.815	2.51
44	1,332	6.124	40.741	2.45
45	1,377	6.139	41.667	2.40
46	1,405	6.148	42.592	2.35
47	1,413	6.150	43.518	2.30
48	1,461	6.165	44.444	2.25
49	1,499	6.176	45.370	2.20
50	1,595	6.203	46.296	2.16
51	1,628	6.212	47.222	2.12
52	1,785	6.252	48.148	2.08
53	1,824	6.261	49.074	2.04
54	1,989	6.299	50.000	2.00
55	2,124	6.327	50.926	1.96
56	2,190	6.340	51.852	1.93
57	2,191	6.341	52.778	1.89
58	2,248	6.352	53.704	1.86
59	2,283	6.358	54.630	1.83
60	2,394	6.379	55.555	1.80
61	2,525	6.402	56.481	1.77
62	2,650	6.423	57.407	1.74
63	2,680	6.428	58.333	1.71
64	2,896	6.462	59.259	1.69
65	2,915	6.465	60.185	1.66
66	2,928	6.466	61.111	1.64
67	3,123	6.494	62.037	1.61
68	3,203	6.506	62.963	1.59
69	3,209	6.510	63.889	1.56
70	3,497	6.544	64.815	1.54
71	3,561	6.552	65.741	1.52
72	3,781	6.578	66.667	1.50
73	4,021	6.604	67.592	1.48
74	4,149	6.618	68.518	1.46
75	4,215	6.625	69.444	1.44
76	4,358	6.639	70.370	1.42

TABLE MM4-C (continued)

MEANFLOW (PEÑARANDA RIVER, SAN VICENTE)
GAPAN WATER DISTRICT

m	Q cumd x 10^3	Log Q	Probability ($\frac{m}{n+1}$ x 100)	Return Period (Months) ($\frac{n+1}{m}$)
77	4,405	6.644	71.296	1.40
78	4,415	6.645	72.222	1.38
79	4,567	6.660	73.148	1,37
80	4.701	6.672	74.074	1.35
81	4,873	6.688	75.000	1.33
82	4,922	6.697	75.926	1.32
83	5,156	6.712	76.852	1.30
84	5,229	6.718	77.778	1.28
85	5,380	6.731	78.704	1.27
86	5,425	6.734	79.630	1.26
87	5,707	6.756	80.556	1.24
88	5,896	6.770	81.481	1.23
89	5,992	6.778	82.407	1.21
90	6,306	6.800	83.333	1.20
91	6,614	6.820	84.259	1.19
92	6,915	6.840	85.185	1.17
93	8,941	6.951	86.111	1.16
94	9,590	6.982	87.037	1.15
95	9,689	6.986	87.963	1.14
96	9,801	6.991	88.889	1.12
97	10,014	7.001	89.815	1.11
98	10,761	7.032	90.741	1.10
99	11,161	7.048	91.667	1.09
100	11,726	7.069	92.592	1.08
101	12,567	7.099	93.518	1.07
102	13,693	7.136	94.444	1.06
103	14,582	7.164	95.370	1.05
104	15,007	7.176	96.296	1.04
105	15,977	7.203	97.222	1.03
106	16,317	7.213	98.148	1.02
107	18,347	7.264	99.074	1.01

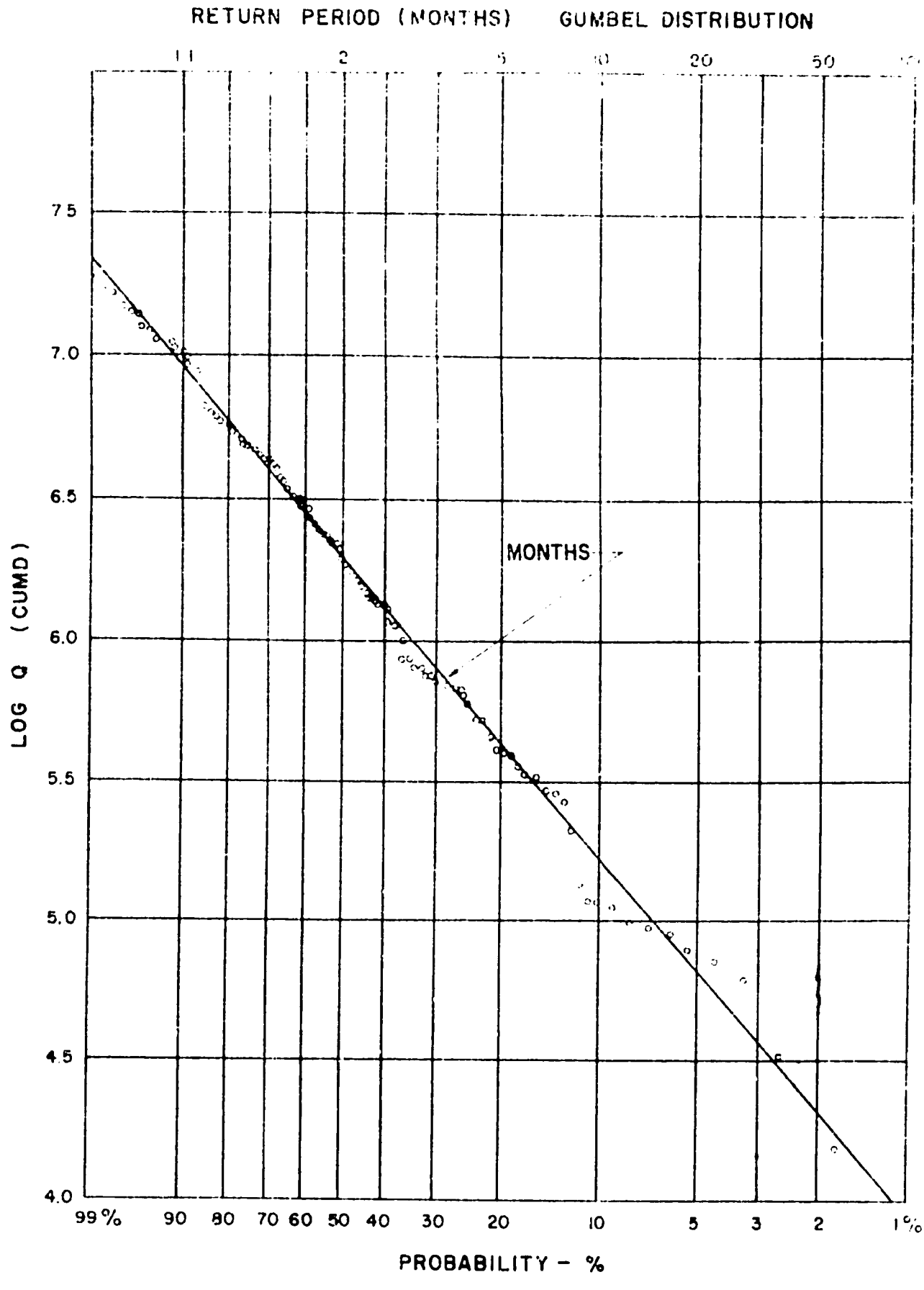


FIGURE MM4-1
MONTHLY MEANFLOW
(PENARANDA RIVER, SAN VICENTE)
GAPAN WATER DISTRICT

FEASIBILITY STUDY FOR WATER SUPPLY OF SECOND TEN URBAN AREAS LWUA-CDM

Methodology Memorandum No. 5

To : L. V. Gutierrez, Jr.

From : J. E. Arbuthnot/R. R. Conklin

Date : 16 May 1977

Subject: Quantity of Storage Versus Rate of Supply

A. General

The demand for water in a water system is not uniform, therefore, the system must be designed to supply water at varying rates of demand.

One common method of supplying water at varying rates is to provide a specific amount of source pumping capacity and supply the difference between demand and pumping capacity from a water storage facility.

The most economical amount of pumping capacity and storage volume is selected based on cost studies of alternative combinations of facilities that would meet a community's needs. Some of the factors that should be considered in these cost studies and some basic guidelines for selecting properly sized facilities are presented in this memorandum.

B. Discussion

The amount of water a community needs at any particular instant is primarily dependent on the following factors:

1. The number of people within the community
2. The number of water-consuming facilities within the average home (faucets, toilets, showers, automatic washing appliances, etc.)
3. The habits of people (what times people eat, shower, sleep, etc.)

In general, daily usage of water follows a pattern with two peak usage periods during the day and low usage late at night. Figure MM5-1 shows a typical variation measured in a section of the Cebu City distribution system.

The relationship of the peak usage on an average day can be determined statistically for a given community. The statistical peak is an average of each person's peak usage and has two important properties:

1. The statistical peak is a function of the number of people in the community. The fewer people, the higher the peak may be because each person's peak usage could more easily affect the total flow.

2. The statistical peak should be recognized as a mathematical average, and on some days the peak usage could be much higher or lower than the statistical peak.

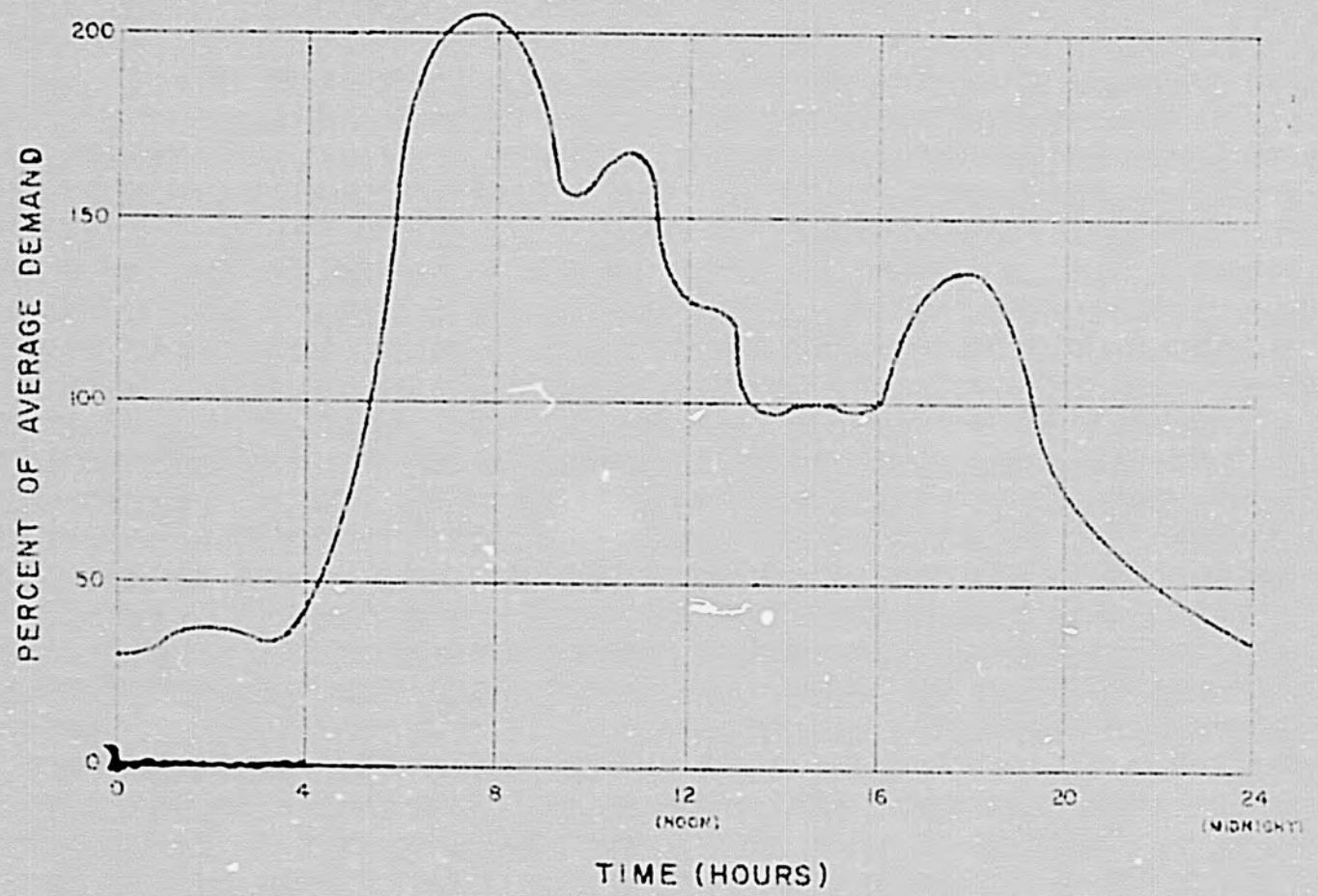
The common engineering practice for water systems is to supply water from a source at maximum-day rates either by pumping or gravity. Maximum-day demand is the maximum quantity of water used during an entire day in a single year. Water usage can be at or near maximum-day demand for a period of weeks during summer months. Source capacity must equal maximum-day demand because it would be impractical to store sufficient water to supply maximum-day demand rates for more than a few days.

The difference in demand between the peak-hour demands and the supply (which is equal to maximum-day demands) occurs during a period of short duration where demand exceeds supply. Stored water is used to meet this short period of excess demand and is called operational storage. It should be noted at this time that there are three categories of storage:

1. Operational storage - used to meet hourly fluctuations in demand.

2. Emergency storage - used to meet demands in case of breakdowns in source facilities; typically equal to a full day's demand.

3. Fire storage - used to meet the required volume of water used to extinguish the worst fire expected in the community.



LWUA-CDM

FIGURE MM5-1
DAILY USAGE PATTERN

Storage requirements for the last two categories have been largely neglected in these studies because of the excessive cost involved to provide the storage.

C. Methodology

The engineer must determine the amount of storage and source capacity to meet the demands in a specific community. A set of curves that relate the peak hourly usage to the number of people in a community has been developed by CDM and others.[1] Practice has shown that a volume of about 15 to 20 percent of the maximum-day usage is required as operational storage if source facilities can supply maximum-day demands. Combining the "peaking curves" with the operational storage requirement, a second set of curves relating the quantity of storage to the number of people, at different rates of source supply, has been developed (see Figure MM5-2).

Up to this point, the only option that has been discussed is to supply peak-hour demands from storage facilities. In many cases, the cost of storage facilities is so high that it may be more economical to provide additional source capacity and reduce the quantity of storage. This is especially true where storage is provided in elevated structures that are very costly, since they are built to withstand earthquakes. The curves in Figure MM5-2 have been used in this study to determine the requirements for storage at various supply rates in order to prepare cost comparisons of alternative supply and storage combinations.

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[1] ASCE Manual of Practice No. 37.

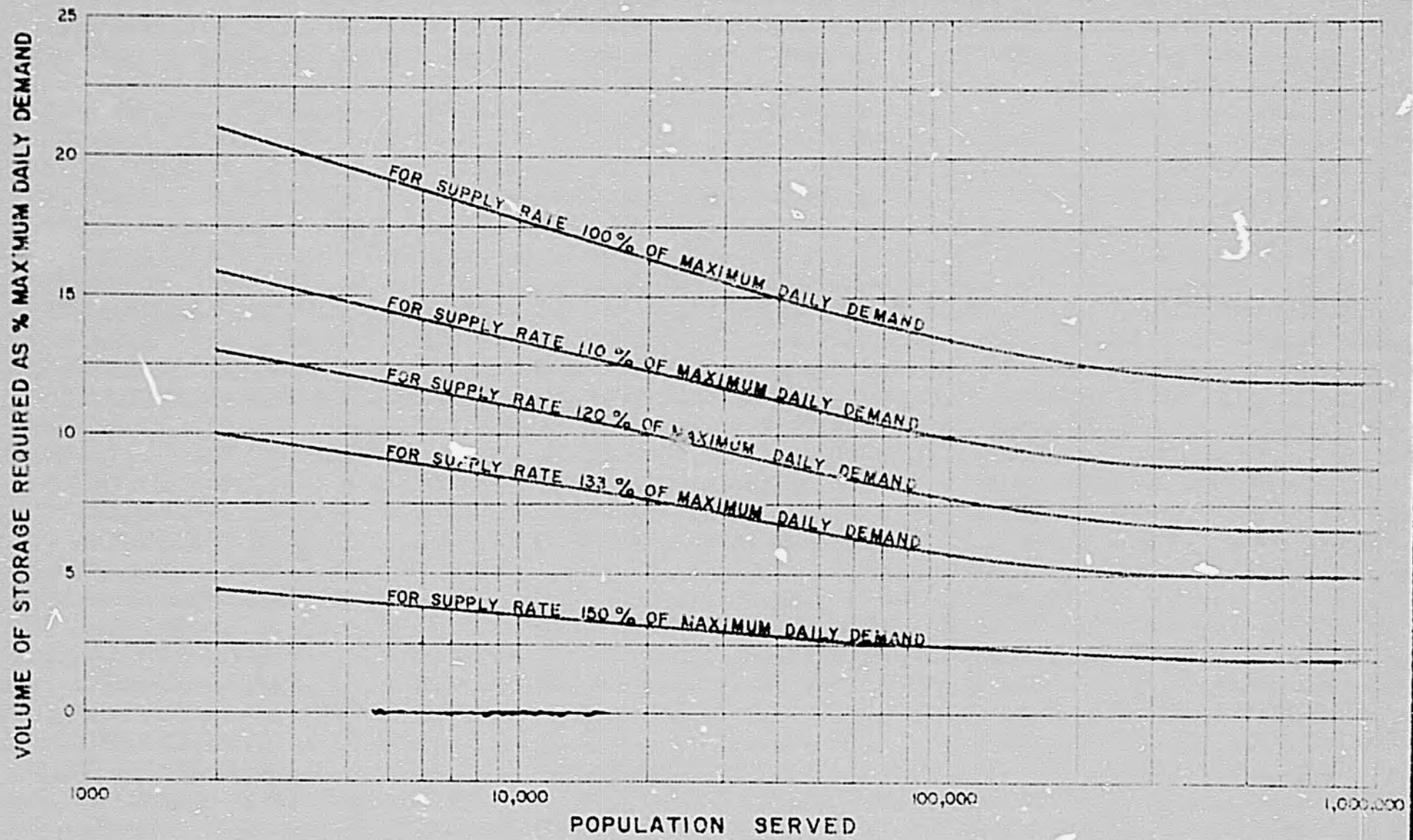


FIGURE MM 5-2
STORAGE REQUIRED
TO MEET
DAILY PEAK WATER DEMAND

FEASIBILITY STUDY FOR WATER SUPPLY OF SECOND TEN URBAN AREAS LWUA-CDM

Methodology Memorandum No. 6

To : L. V. Gutierres, Jr.

From : J. Arbuthnot; B. Conklin

Date : 22 March 1977

Subject: Economical Sizing of Pumped Waterlines

A. General

This memorandum develops an expression for the most economic size of a pipeline for pumped water systems based on two cost factors: cost of pipe-in-place and cost of pumping (energy). The larger the pipe the greater the cost of construction. Also, the larger the pipe the lesser the cost of energy required to pump water through the pipe. The most economic pipe sizes would be where the incremental cost of pumping is equal to the incremental cost of pipe construction.

In most situations, the above cost factors are the most important factors in determining the economical size of transmission mains. Even when these are not the only important factors, it is still advantageous to know what is the most economic size of pipe with regard to these two factors.

B. General Relationship

The total annual cost of a pipe line is equal to the sum of its construction cost (expressed on an amortized annual basis) plus its annual pumping cost.

$$C_t = C_c + C_p \text{ [1]}$$

To determine the most economic pipe diameter both the factors on the right hand side of the equation were expressed in terms of the diameter of the pipe. The equation was then differentiated with respect to the diameter, and solved for the diameter for which the resulting expression was equal to zero.[2]

---

[1] Total Annual Cost = Annual Construction Cost + Annual Pumping Cost.

[2] $\frac{d(C_t)}{dx} = \frac{d(C_c)}{dx} + \frac{d(C_p)}{dx} = 0$, where X = pipe diameter

C. Annual Construction Cost

The construction cost of the pipe was taken from Table G-4 of Appendix G, Basis of Cost Estimates, in Volume II of the final report. Costs were adjusted by adding a value for necessary valves and by escalating these by 10 percent per year for 2 years to obtain July 1978 construction costs. These costs were then increased by 15 percent for contingencies and then by 10 percent for engineering. The following equation was derived and represents the adjusted construction costs in Table G-4 in terms of the diameter.

$$C = 2845\ (\text{Dia.})^{1.292} \quad \text{---- Equation 1}$$

C is the installed cost of pipe in pesos per meter, and Dia, the diameter of the pipe in meters.

The amortized annual cost of construction is the cost of construction multiplied by the capital recovery factor (as influenced by the economic life of the pipe and discount factor). The general equation is:

$$\text{Annual Cost of Construction} = \text{CRF} \times 2845(\text{Dia.})^{1.292} \quad \text{---- Equation 2}$$

where CRF is the capital recovery factor; for n = 50 years, discount rate = 12%, CRF is equal to 0.12042.

D. Annual Pumping Cost

The annual cost of pumping energy may be expressed in terms of the amount of water pumped, the energy required to overcome the frictional loss in the pipe, the price of electrical energy and the efficiency of the pumping machinery. The general equation may be written as:

$$\text{Annual Cost of Pumping Energy} = \frac{\text{Mass/Year} \times g \times \text{Hf} \times \text{P/kwh}}{\text{efficiency} \times 3.6 \times 10^6} \quad \text{---- Equation 3}$$

where mass/Year is the amount of water pumped in kilograms; g, the gravitational constant; Hf, the energy lost by friction of flow in the pipe expressed in meters; P/kwh, the cost of energy in pesos per kilowatt hour; and 3.6×10^6, the number of newton-meters per kilowatt hour.

The friction loss of energy in the pipe may be expressed in terms of the diameter utilizing the Hazen-Williams (H&W) equation,

$$\text{Hf} = \frac{L \times \text{MLD}^{1.852}}{361.27\ C^{1.852}\ D^{4.87}} \quad \text{---- Equation 4}$$

where L is the length of pipe in meters; MLD, the flow of water in million liters per day; C, the Hazen & Williams roughness coefficient; and Dia, the diameter of the pipe in meters.

E. Minimum Cost Diameter

The expression for minimum cost diameter may be obtained by inserting the expression for HP in the equation for the cost of pumping energy, combining this with the expression for the annual cost of construction, differentiating, setting the resulting expression equal to zero and solving for the diameter:

$$\text{Minimum Cost Diameter} = \frac{MLD^{0.4628} \times (\text{pesos/kwh})^{0.1623}}{2.391\ (\text{efficiency})^{0.1623}\ C^{0.3005}\ (A/P,\ i\%,\ n)^{0.1623}}$$

using a C value of 120 and a capital recovery factor of 0.12042, the following equation is obtained:

$$\text{Minimum Cost Diameter} = \frac{MLD^{0.4628}(\text{pesos/kwh})^{0.1623}}{7.149\ (\text{efficiency})^{0.1623}} \quad \text{- - - - Equation 5}$$

The above equation is expressed graphically in Figure MN 6-1.

F. Limitations of the Analysis

How reliable is the preceding relationship (Equation 5), between water carried and economic pipe diameter? The derivation is rigorous but the relation is no more exact than are the simplifying assumptions upon which the derivation was based:

1. Construction Cost Relationship

The construction cost relation (Equation 1) has a standard deviation of just under 10 percent. This means that two-thirds of the time the formula will represent the adjusted costs tabulated, within 10 percent. The largest difference observed was 20 percent. Even so, economic conditions and the cost of pipe may change in time. Probably, a new table of pipe costs has to be made every 2 or 3 years, and the formulas, along with Figure MN 6-1, adjusted accordingly.

2. Other Assumptions

Other assumptions are:

C = 120 (Hazen & Williams coefficient)
i = 12% (Discount rate)
n = 50 years (Economical life of pipe)

The derivation also assumes that for the changes in pumping head, using various pipe sizes for a design flow, the total construction cost of the pumping station remains constant. This assumption is reasonable since the difference in cost

between one pump selection and another for different heads at the same flow would not alter the cost of the complete station by significant amount. Generally, the installed motor horsepower would also be the same since the motors come in standard sizes and one size may be used for a number of different pump selections at a given flow.

The relative rate of inflation for pipeline construction is assumed equal to that of power costs.

3. Flow Quantities are Based on Constant Flow

The derivation of the most economic pipe diameter is based on a constant rate of flow within the pipe. This is probably the most general and therefore the least accurate of any of the assumptions.

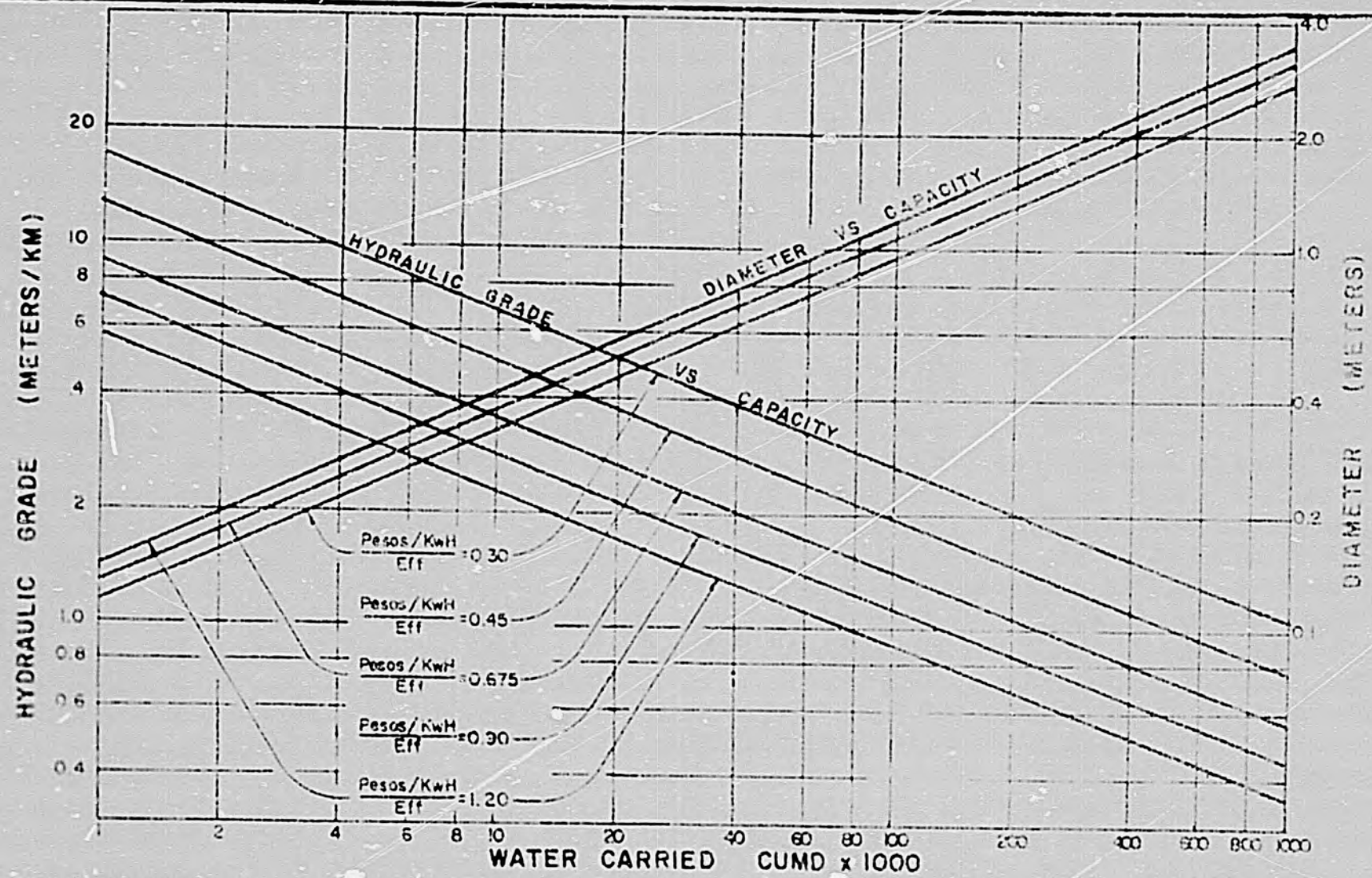
Normally a pipeline is designed for a specific flow condition; even under design conditions that flow may occur only part of the time. The flow in a transmission main could be expected to nearly equal the design flow for long period of time. However, in a distribution main, sized for peak-hour flows, the flow may not be equal to the design flow except for very short periods of time.

The variation in energy costs due to a fluctuating pumping rate through a pipeline can be calculated and applied to adjust the most economic pipe diameter determined from Figure MM 6-1. This so-called "energy variability factor" is discussed in the following section.

G. Energy Variability Factor

Figure MM 6-1 is based on selecting a pipeline where the flow will be constant throughout the year. In most cases, pipeline sizes are selected on a maximum expected rate of flow. If the flow through the pipeline is less than the design flow, the pumping head (which directly affects energy costs) would decrease according to the 2.852 power of the flow (Q). Conversely, if flow greater than design flow rate is pumped through a pipeline, the energy cost would be increased by the 2.852 power.

The overall difference in energy costs over the day or year can be calculated by comparing the costs of pumping at a constant flow rate with the cost of pumping at the expected flow variation. This value is the so-called "energy variability factor" (EVF). The design flow for the pipe is used as the base flow and the actual flow to the design flow over the day is expressed as a percent.



Note 1 CONSIDERS CONSTRUCTION AND PIPELINE FRICTION COSTS ONLY INCLUDING ENGINEERING AND CONTINGENCIES
2 AVERAGE C = 120 OVER 50 YEARS
3 ECONOMIC DISCOUNT RATE = 12 %
4 PIPE COST (MID 1978 PRICES) = $2845D^{1.29}$ PER METER, (D IN METERS)

FEASIBILITY STUDY FOR WATER SUPPLY OF SECOND TEN URBAN AREAS LWUA-CDM

FIGURE MM6-1
MOST ECONOMIC WATER TRANSMISSION

The method used is to raise the difference between actual flow and the base flow (expressed as a percentage) to the 2.852 power. The ratio of the sum for the day of the actual flow to the design flow each raised to the 2.852 power is equal to the EVF. Figure MM 6-2 and Table MM 6-1 present two possible flow variations and the calculated energy variability factor for each.

The two flow patterns selected for Figure MM 6-2 are not commonly used design curves. Pattern 1 was selected to show that if a higher rate of flow than the design flow is pumped through the pipeline during a portion of the day, the EVF is greater than 1.0. Pattern 2 shown that if the actual flow rate is nearly equal to the design flow, the EVF would be nearly equal to 1.0.

An EVF of less than 1.0 would be a more common occurrence since the majority of pipelines are designed for some maximum future flow. The suggested EVF in a following section is an example of an EVF less than 1.0.

I. Application of EVF

The EVF can be used with Figure MM 6-1 in calculating the minimum cost pipe diameter. The EVF is inserted into the annual energy cost equation (equation 3) and then included in the differentiation, resulting in a revised equation as follows:

$$\text{Minimum Cost Diameter} = EVF^{0.1623} \frac{MLD^{0.4628} \, (\text{Pesos/kwh})^{0.1623}}{7.149 \, (\text{efficiency})^{0.1623}} \quad \text{-- Equation 6}$$

The application of EVF requires 2 steps: first, design a minimum economic pipeline for some flow using Figure MM 6-1; and second, calculate the EVF for the actual flow variation and multiply the pipe size calculated in Step 1 by the EVF raised to the 0.1623 power.

J. Suggested EVF

The feasibility report on the Second Ten Provincial Urban Areas deals mainly with distribution pipelines; therefore, a suggested EVF that is applicable to distribution systems is presented herein.

The calculation of an EVF depends entirely on the flow data or assumed flow within a specific pipeline. The only accurate data produced during the feasibility studies are the diurnal flow variations measured in a portion of Cebu. The peak flow in the Cebu data was 2.06 which is greater than the design flows

TABLE XII 6-1

TABLE "EVF" FOR DIFFERENT FLOW PATTERNS

Hour	Flow Pattern No. 1		Flow Pattern No. 2	
	Percent of Average Day Demand	Energy Variation	Percent of Average Day Demand	Energy Variation
1	32	0.039	48	0.123
2	36	0.054	48	0.123
3	39	0.068	48	0.123
4	33	0.042	100	1.000
5	46	0.109	100	1.000
6	95	0.864	100	1.000
7	193	6.522	120	1.682
8	206	7.855	120	1.682
9	198	7.016	120	1.682
10	156	3.554	120	1.682
11	169	4.466	120	1.682
12	129	2.067	120	1.682
13	123	1.805	120	1.682
14	95	0.864	120	1.682
15	99	0.972	120	1.682
16	96	0.890	120	1.682
17	107	1.212	120	1.682
18	133	2.255	120	1.682
19	130	2.113	120	1.682
20	87	0.672	100	1.000
21	64	0.280	100	1.000
22	54	0.172	100	1.000
23	42	0.084	48	0.123
24	38	0.063	48	0.123
		44.038		28.481

$EVF_1 \frac{44.038}{24.000} = 1.83$

$EVF_2 \frac{28.481}{24.000} = 1.19$

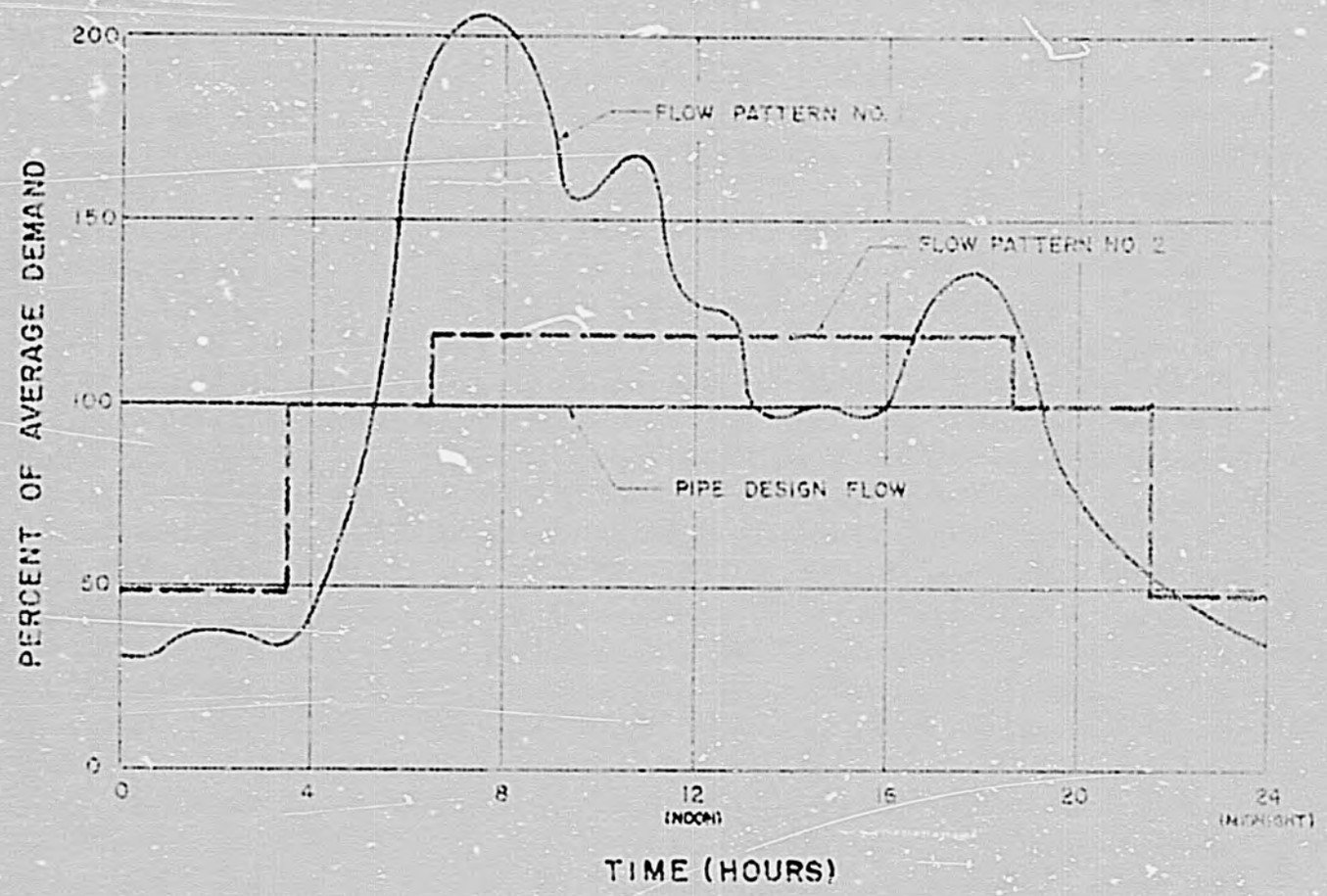


FIGURE MM6-2
SAMPLE FLOW PATTERNS

used for this study. Figure NM 6-3 presents an adjusted graph of diurnal flow using the shape of the Cebu curve but a maximum peak of 1.75. The EVF for this curve is equal to 0.32 (see Table NM 6-2) and when raised to the 0.1623 power, equals 0.83.

In practice, the EVF used for distribution systems in this study is only significant when the pipeline size is greater than 300 mm (significant means that EVF changes the recommended pipe size by a large incremental size).

K. Example

Problem: Select an economical distribution pipe size to convey a peak-hour flow of 20 MLD. The cost of power is 49 centavos per kilowatt hour, the pump efficiency is 81 percent, and the motor efficiency is equal to 90 percent.

Solution:

$$\frac{\text{Pesos/kwh}}{\text{Eff}} = \frac{.49}{.81 \times .90} = .672, \quad \text{say } .675$$

From Figure NM 6-1 using the flow of 20 MLD and Pesos/kwh/Eff = .675 select a pipe size of 500 mm.

For a flow variation in a distribution main, the EVF is equal to 0.32 and the EVF raised to the 0.1623 power is equal to 0.83. The most economical pipe size for the actual flow variation is equal to 0.83 x 500 m or 415 mm; so choose 400 mm pipe size.

TABLE MM 6-2

"EVF" FOR DISTRIBUTION SYSTEM

Hour	Percent of Average Day Demand	Percent of Design Flow[3]	Energy Variation[4]
1	35	20	0.010
2	40	23	0.015
3	39	22	0.013
4	37	21	0.012
5	73	42	0.084
6	134	77	0.475
7	164	94	0.838
8	175	100	1.000
9	174	99	0.972
10	163	93	0.813
11	162	93	0.813
12	134	77	0.475
13	118	67	0.317
14	94	54	0.172
15	94	54	0.172
16	94	54	0.172
17	105	60	0.233
18	129	74	0.424
19	123	70	0.362
20	96	55	0.182
21	72	41	0.079
22	58	33	0.042
73	47	27	0.024
24	40	23	0.015
			7.716

$$EVF = \frac{7.716}{24.000^{*}} = -.32 \qquad EVF^{0.1623} = 0.83$$

3/ Using 175 percent of average day as base flow for pipe design.
4/ Equals Percent Design Flow raised to the 2.852 power.
* Energy variation at constant flow

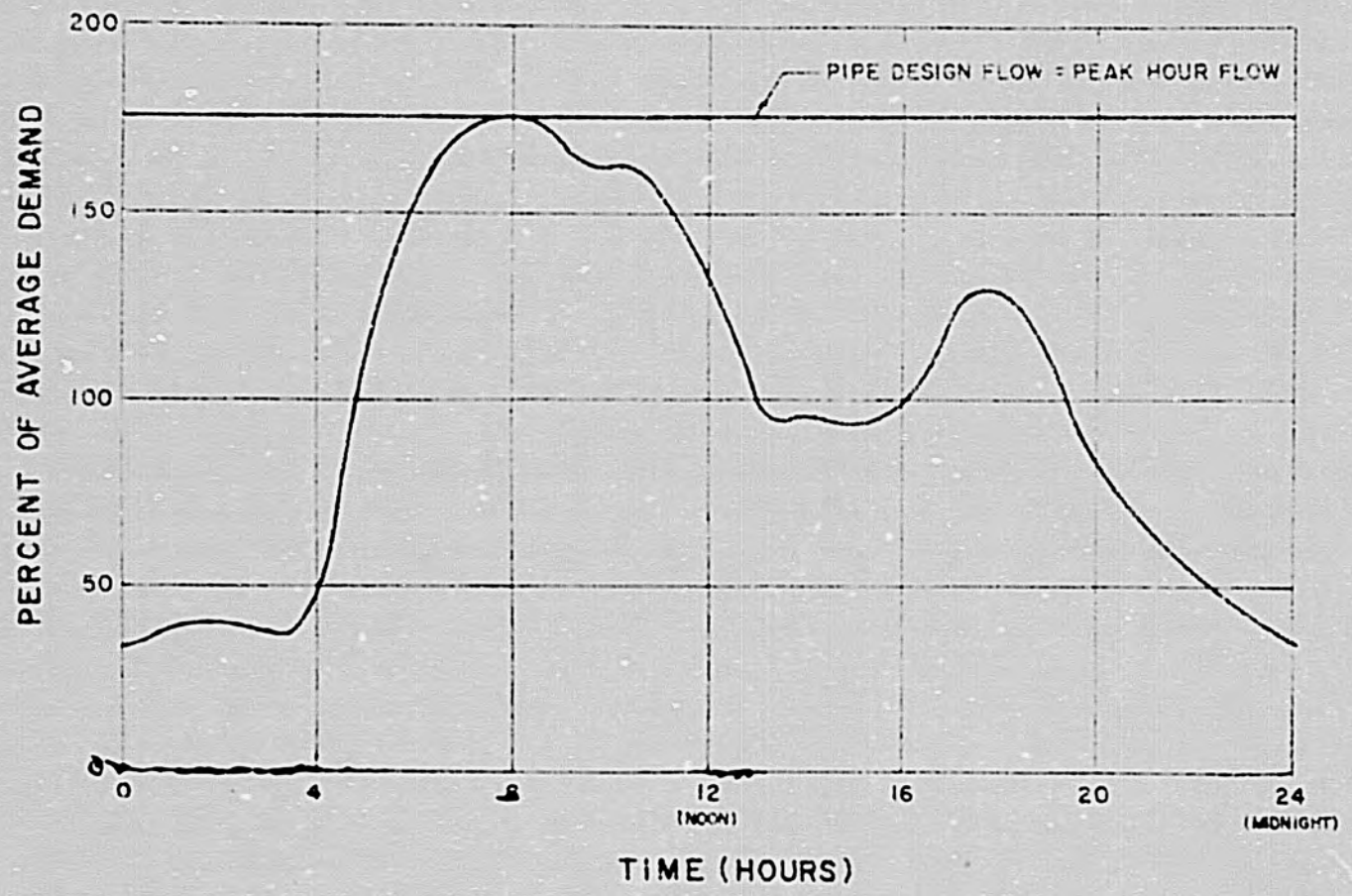


FIGURE MM6-3
TYPICAL FLOW VARIATION
FOR DISTRIBUTION MAINS