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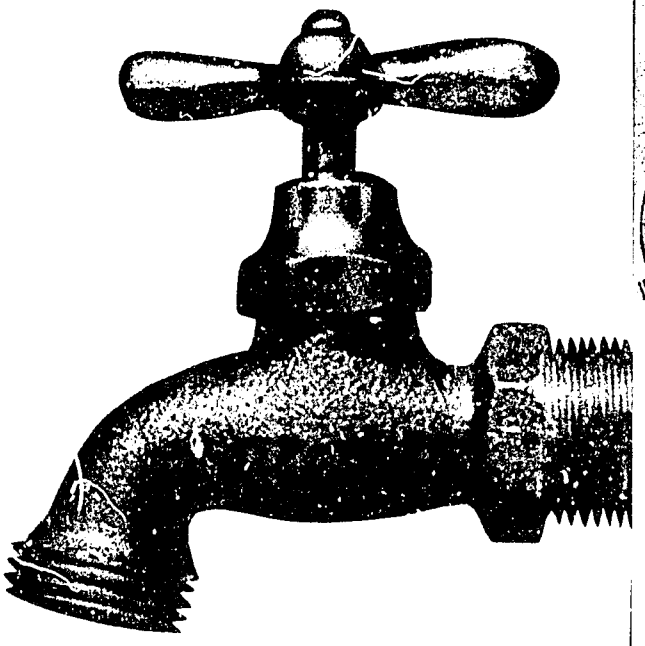

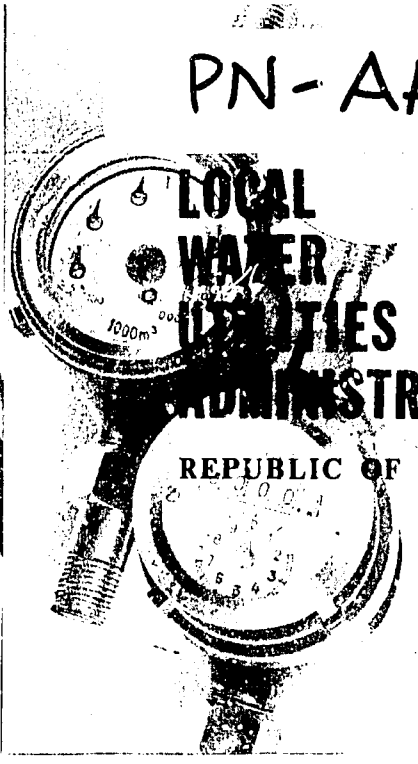

LOCAL WATER UTILITIES ADMINISTRATION

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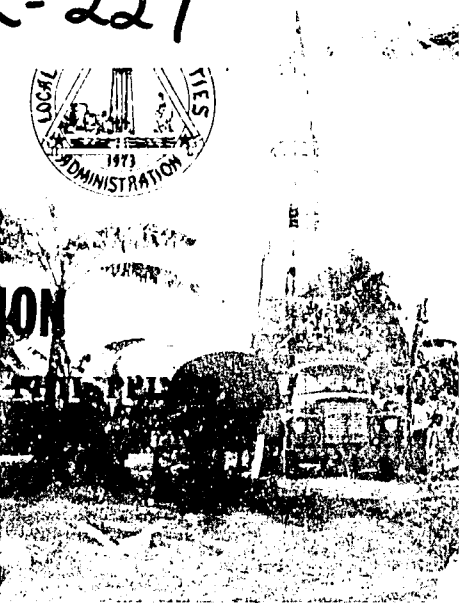

APPENDICES
VOLUME II

WATER TUBIG

FINAL REPORT
FEASIBILITY STUDY
WATER SUPPLY

SECOND TEN-PROGRAM AREAS

SEPTEMBER 1977

CAMP DRESSER & McKEE INTERNATIONAL INC.

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22 December 1976

Mr. Carlos C. Leaño, Jr.
General Manager
Local Water Utilities Administration
7th Floor, NIA Building
E. de los Santos Avenue
Quezon City

Subject: Volume II - Appendices of the Feasibility Studies for the Second Ten Urban Areas

Dear Mr. Leaño:

In accordance with the contract between Local Water Utilities Administration (LWUA) and Camp Dresser & McKee International, Inc. (CDM) dated 14 October 1974 and amended 10 August 1976, we take pleasure in submitting this report volume.

Volume II contains the appendices common to all technical reports associated with the feasibility studies for the Second Ten Urban Areas.

The main text (Volume I) for each of the Second Ten Urban Areas will be submitted separately.

We wish to extend our thanks to the LWUA Board, all members of our counterpart LWUA staff and the various officials of the Water Districts and agencies of the Government of the Philippines, who so generously assisted us during the course of our study.

Very truly yours,

CAMP DRESSER & McKEE INTERNATIONAL, INC.

LEONARDO V. GUTIERREZ, JR.
Project Manager

PAUL W. PRENDIVILLE
Principal-In-Charge

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APPENDIX A

TERMS OF REFERENCE

FEASIBILITY STUDIES FOR TEN ADDITIONAL PROVINCIAL AREAS

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APPENDIX A

TERMS OF REFERENCE

FEASIBILITY STUDIES FOR TEN ADDITIONAL PROVINCIAL AREAS

General

The project consists of three parts: (1) training of counterpart engineers through on-the-job assignments of the various aspects of relevant water supply feasibility studies, (2) preparing water supply feasibility studies for five provincial urban areas (referred to herein as the third five areas), using counterpart LWUA and local consultant personnel for conducting such studies, (3) preparing additional five water supply feasibility studies for urban areas (referred to herein as the fourth five areas), with the counterpart personnel taking a dominant role in the conduct of such studies.

Training

The Contractor will be assigned full-time LWUA couterparts who will receive continuous on-the-job training. The Contractor shall design the training program, along with actual field work and problem-solving sessions, for eventual counterpart self-sufficiency. In order to obtain maximum benefit from the training program, LWUA will make every reasonable effort to assign qualified personnel on a continuous basis for the full duration of the project. For the training program to be effective, the Contractor will have supervisory control over all assigned counterparts to the project. It is expected that, upon completion of this project, the full-time personnel assigned for training will be technically competent to plan and execute future feasibility studies without the assistance of foreign consultants.

Third Five Feasibility Studies

The Contractor shall prepare technical, economic and financial feasibility studies for each of five selected areas of water districts. The feasibility studies shall be adequate to determine the scope, magnitude, essential plans and features, benefits and costs of the project, including alternate solutions thereto.

The quality and depth of the feasibility reports shall be adequate to serve as the basis for negotiation of loans from international lending agencies to finance design and construction of feasible provincial water systems.

More specifically, the work to be performed shall include, but not necessarily be limited to the following:

a. Evaluate all available data such as maps, geological, climatological, and hydrological reports, census statistics, water production and demand, availability of power, etc. Develop such other data and information as needed to support the project analysis and recommendations.

b. Make hydrogeological and hydrological studies to determine the available water resources and the least-cost method of developing these resources to meet present and future demands. These studies shall include test well programs where necessary. Data developed shall be sufficient to establish feasibility and to assist in detailed design of source facilities for either ground or surface water.

c. Make field surveys and studies pertaining to: population, socio-economics, water production and consumption, existing water and sewage disposal facilities, power requirements, location of existing water facilities, availability of local construction materials and equipment and effects of the proposed project on the environment.

d. Develop alternative plans for the supply, treatment, transmission and distribution of water. Select a master plan, based on least present worth cost, taking into account the capital cost streams and operational cost streams in the foreseeable future. Provide a detailed description of the existing water systems, including an evaluation of integrating the existing system of portions thereof with the proposed future development of the expanded system.

e. Prepare preliminary plans, drawings, outline specifications, design criteria and analysis, equipment and constructing standards, all in sufficient detail to define the projects, and the phasing of such project master plans to the year 2000. A list of emergency/early action works shall be prepared to provide immediate relief and high impact solutions to present water supply problems.

f. Prepare reasonably firm estimates of costs for the engineering, construction, operation and maintenance of the projects recommended for implementation. The estimates shall be based on the assumption that offshore procurement will be obtained from Free World sources. These estimates shall be sufficiently detailed to indicate the costs of the components of the

project and shall be defined in terms of local costs and foreign exchange. Consideration shall be given to the effects of the energy crisis and shortages of supply of vital commodities.

g. Design water rate schedules that are within the citizens' ability-to-pay of each area and at the same time result in a self-supporting system. On this basis, carry out a financial analysis and present the results in the form of both a statement of profit and loss and a statement of source and application of funds. The analysis should include a year-by-year estimate of debt coverage and a financial feasibility analysis on a time adjusted basis, taking into account inflationary trends.

h. Develop an economic analysis which considers all quantifiable economic costs and economic benefits. Non-quantifiable elements should be explained and appraised to the extent possible. The reports shall clearly state and justify all assumptions made. They shall show the bases and results of internal rate or return calculations (utilizing discounted cost flow methodology) on alternative investment possibilities considered and include sensitivity testing of crucial variables. The results shall be compared to the opportunity costs of capital and appropriate conclusions drawn.

Draft final reports for the third five cities shall be completed after the eleventh month of the official start date of this contract amendment.

The names of the third five urban areas to be covered by the studies shall be made known by LWUA to the Contractor at least a week prior to the effective start date.

Fourth Five Feasibility Studies

The conduct of these studies shall be such that the counterpart LWUA and local consultant personnel would take a dominant role in the study development of the fourth five cities. The requirements for the feasibility studies will be the same as the above except that the draft final report shall be completed after the seventeenth month of the official start date of this contract amendment.

The names of the fourth five urban areas to be covered by the studies shall be made known by LWUA to the Contractor no later than sixty (60) days after the effective start date.

Reports and Printed Matters

The Contractor shall prepare and submit technical reports and documents to LWUA, as follows:

1. Draft final reports of the water supply feasibility studies of the third five water districts in seven (7) copies in the English language no later than the end of the tenth month. LWUA will provide the review and comments within four (4) weeks of receipt of the draft report. Relevant corrections, addenda and errata will be provided within two (2) weeks of receipt of LWUA's review of the draft.

2. Draft final reports of the water supply feasibility studies of the fourth five water districts in seven (7) copies in the English language no later than the end of the seventeenth month. Within four (4) weeks of the receipt of the draft report, LWUA will provide their review and comments. Relevant corrections, addenda, errata will be provided within two (2) weeks of receipt of LWUA's review of the draft.

APPENDIX B

SUMMARY - FIRST TEN-AREA FEASIBILITY STUDIES

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APPENDIX B

SUMMARY - FIRST-TEN AREA FEASIBILITY STUDIES

A. GENERAL

Findings

1. Field tests show that most water distribution systems have old and inadequately sized pipes with considerably reduced capacities, resulting in low pressures and marginal fire-fighting capabilities.

2. Water sources, both ground and surface water, are available, and in most cases, plentiful; but water handling facilities such as impoundments, reservoirs, intake structures, transmission mains, treatment plants, storage facilities, and distribution piping have to be planned, engineered, and constructed to convey the water to the demand centers.

3. Water demand will increase exponentially as urban population grows, accompanied by increases in the standard of living/ opportunity.

4. Implementation of well planned and properly engineered water supply systems is feasible, from the technical and the economic/ financial viewpoints.

5. Quantifiable economic benefits exceed the known costs of the water supply projects. The non-quantifiable benefits are also significant. Therefore, economic analysis of the implementation of improved and adequate water supply systems is substantially more favorable than financial analysis would indicate.

6. The recommended plan may be implemented through well defined series of construction stages. These staged programs are considered financially viable, provided water rates are set on the basis of the consumers' ability-to-pay. In certain cases, the water rate structure may be designed to provide some form of subsidy to lower income groups.

7. The local capability to plan, design, construct, manage and operate efficiently improved water supply systems will have to be strengthened to keep up with the increasing demand for such expertise.

Recommendations - Technical

1. The logical and economical development of waterworks facilities must be based on a comprehensive long-range planning process. The planning process must take into account alternative studies, economic optimization of the selected plan, and the citizen's ability-to-pay.

2. Approximately two-thirds of the water produced in existing water supply system is not sold or billed against water consumers. Such unaccounted-for-water is due mostly to leakage and wastage in the transmission and distribution systems. A comprehensive leakage and wastage survey must be conducted in preparation to a corrective leakage/wastage program.

3. All existing flat-rate connections must be metered as early as possible. Meters should be installed first on unmetered large-demand connections, where pressures are high and eventually, where demand and pressures are low. An effective meter repair and preventive maintenance program should be initiated as soon as possible.

4. A routine water measurement and sampling program at the sites of proposed and existing water sources and within the existing distribution system must be initiated. Bacteriological, chemical and physical testing of these water samples should be performed so that corrective measures can be made to safeguard public health of the water consumers.

5. A continuous disinfection program must be enforced to safeguard the entire water distribution system on a 24-hour daily basis.

6. A physical inventory and survey of all existing water supply and drainage/sewerage systems and all connections to private premises must be conducted. An inventory of all private wells, septic tanks and private drainage systems to complete as-built drawings will be included in this task.

7. A flexible and enforceable plumbing code must be adopted to complement proposed water supply facility improvements; to eliminate water supply/drainage cross-connections; and to minimize potential (future) wastewater/drainage problems.

8. A hydrological and meteorological data collection and monitoring program must be initiated by establishing stream, spring, rainfall and evaporation gaging stations and by measuring water levels and volumetric discharges at existing and proposed well fields.

Recommendations -- Institutional

1. The legal basis for the development of existing and new water sources must be established. Guidelines for the implementation and enforcement of policies such as water allocation should be established.

2. Water rates have traditionally been so low that, in most cases, even operational costs are not even covered by collected revenues. Water rates must be increased to realistic levels to cover amortization of capital expenses and operational cost. Associated with this water rate increase is the need to socialize the pricing structure, e.g., a stepped-up rate structure. Low-income water users should be billed according to their ability-to-pay, with high-income consumers, industries and commercial establishments subsidizing the low-income groups.

3. There is a serious need to upgrade and train personnel involved in the planning, design, construction, management and operation of water supply systems. Therefore, improvements to the engineering, management and maintenance procedures should be implemented in anticipation of future requirements that will be imposed by funding agencies and the water district's demands.

4. After the physical inventory is completed (Item 6, Technical Recommendations) a water audit task force should be organized within the water district to monitor/inspect premises and to detect/minimize leakage wastage and meter tampering. Such task force should be granted police powers in protecting the water resources of the community.

5. - To encourage early provision of water service and to help low-income households, a revolving fund for service connections should be established within the water district.

Scope of Project

The first 10 feasibility studies were financed from proceeds of a loan to the Government of the Republic of the Philippines from the United States of America through the Agency for International Development. The studies covered over eight percent of people living in provincial urban areas of the Philippines.

The project consisted of 4 parts:

1. Preparing water supply master plans and feasibility studies for 10 provincial urban areas of the Philippines, initially: Cebu, Zamboanga, Butuan, Ozamis, and Dast (see Appendix Figure B-1);

2. Developing a methodology of conducting these studies through weekly training seminars of LWUA engineers;

3. Applying this training methodology, using LWUA trainees, in the preparation of master plans and feasibility studies for the second 5 areas, namely: Tarlac, Cabanatuan, San Fernando-La Union, Lucena and Lipa; and

4. Assisting LWUA in long-range planning by developing selection criteria, applying these criteria to 100 cities and conducting pre-feasibility surveys and data collection on these cities/municipalities. (Refer to Appendix C.)

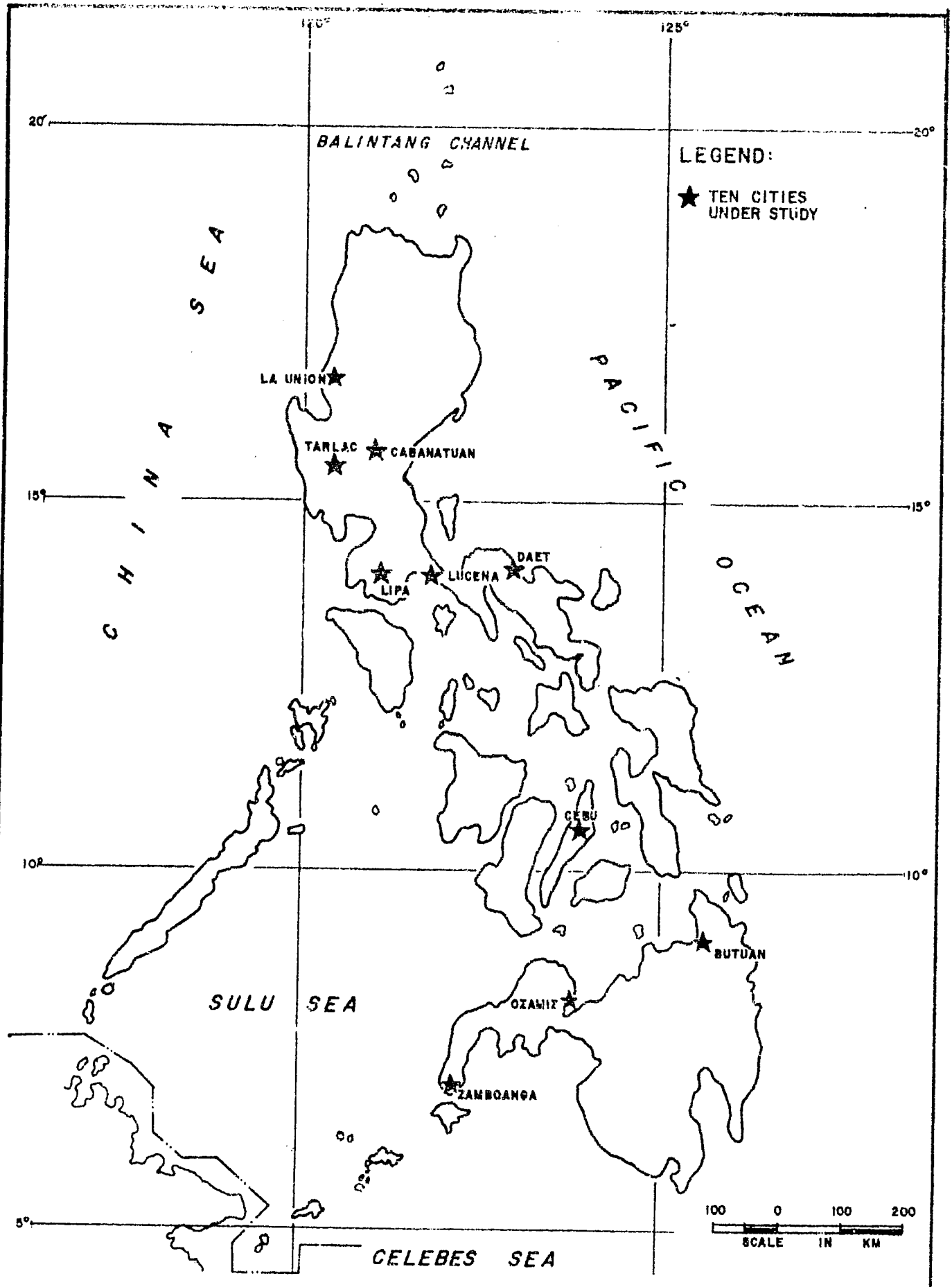
The training of counterpart LWUA and local consulting (DCCD Engineering Corporation) personnel was an important element in the conduct of such studies.

Existing Data/Facilities

Hydrologic and hydrogeologic information is scarce and insufficient to make accurate assessment of the future potential surface and ground water resources. Therefore, the safe yield studies of streams and underground aquifers have been based on short-term field work supplemented by broad estimates and tempered largely by engineering judgment.

The existing waterworks facilities of the urban areas are inadequately designed and improperly operated. There is evidence of widespread wastage of the water through leakage from old, corroded pipe mains, and careless use by the average householder. Wastage is associated with and encouraged by unmetered (flat-rate) water connections. Water rates have traditionally been so low that, in most cases, operational costs are not even covered by collected revenues.

Deficiencies. Most deficiencies in the 10 water districts studied are similar: water shortage, system age, water unaccountability, insufficient disinfection, and inadequate service.



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

FIGURE B-1
LOCATION MAP

The water shortage affects the system pressures, fire-fighting potential, and consumption patterns. Because water must be rationed, pressures fluctuate over a wide range and often become negative. The negative pressures increase the possibility of contaminated water entering the distribution system. Areas receiving no water are extremely vulnerable to fires. Many water district customers have modified their consumption patterns because of water rationing. Some get water only during night-time hours, and others, only during day-time hours. Such service strains any goodwill developed between consumers and the water district. Unserved households are, in the best of circumstances, sub-users obtaining their water from dwellings connected to the distribution system. These unserved households must pay water vendors rates (up to 5-7 times) greater than water district rates.

More than two-thirds of the water produced is neither sold nor billed against the water consumers. Leakage and wastage comprise more than half of the water produced. House connections without meters or with non-functioning meters are billed on a flat-rate basis - a situation which encourages the wasting of water. (See Table B-1.)

The water supply system generally includes numerous opportunities for cross-connections with polluted water from drains/sewers.

APPENDIX TABLE B-1

WATER ACCOUNTABILITY
(As a Percentage of Water Production)

	Accounted-For-Water			Unaccounted-For-Water				
Area	Metered Billing	Flat-Rate Billing	Total	Underestimated Flat-Rate Use	Wastage	Leakage	Other	Tota
Ozamiz	33	4	37	9	13	35	6	63
Daet	3	25	28	5	31	30	6	72
Butuan	7	26	33	5	31	23	8	67
Zamboanga	20	20	40	9	29	15	7	60
Cebu	17	14	31	11	26	25	7	69
Lucena	0	17	17	17	33	26	7	83
Lipa	0	21	21	7	29	36	7	79
Tarlac	5	41	46	0	35	10	9	54
Cabanatuan	16	31	47	7	30	10	6	53
San Fernando	17	4	21	3	7	62	7	79

Planning Criteria

The following criteria were used as guidelines for the feasibility studies:

1. Regional Approach: Planning of facilities was made on a regional basis, taking into account the short-term district boundaries and the logical long-term service areas beyond present or political boundaries.

2. Source of Water: Groundwater and surface water were given equal emphasis as potential sources of water.

3. Self-Sufficiency: The recommended plan was based on a system which would provide the highest quality of water service within the ability-to-pay of the customers.

4. Conservation: Selection of alternative plans considered water, power, chemicals, and foreign exchange as a valuable resource which must be conserved to the best extent possible.

5. Stage Development: The long-range implementation program for source, transmission and treatment facilities was based on several construction stages/phases to satisfy projected requirements for a specific design year:

Stage/Phase	Implementation/Construction Period	Target Design Year
Early Action	1976-78	
Stage I	1977-90	1990
Phase I-A	1977-82	
Phase I-B	1982-86	
Phase I-C	1986-90	
Stage II	1990-2000	2000
Phase II-A	1990-95	
Phase II-B	1995-2000	

6. Alternative Plan Screening and Selection: From an array of identified plan alternatives, an interim plan was selected on the basis of least (present worth) cost and other non-economic parameters. The selected (interim) plan was tested for economic/financial feasibility.

7. Skilled Manpower Shortage: The recommended plan recognizes, in the short term, the apparent shortage in skilled, technical and managerial expertise. Emphasis was given on the need for district personnel training and certification.

8. Water Quality: The feasibility study identifies present and future water quality problems and includes recommendations towards providing water supply that is safe, healthful and wholesome. It develops conceptually long-range water quality management plans to conserve the integrity of this valuable resource.

Design Criteria

Average per capita domestic water consumption for each of the 10 water districts was estimated with the use of field data and available records of past and present water use. Per capita domestic use was increased annually to account for projected economic growth within the community (see Appendix Table B-2).

Commercial and institutional water demands were estimated as a percentage of the domestic demand. Where no reliable records were available, a unit demand of 5 cumd/ha (gross) was used.

There are currently few or almost no heavy and/or "wet" industries in the provincial areas studied. Projection of future industrial water demand was based on land zoning plans, where available.

Maximum-day and peak-hour demands were estimated from field data and available records. From an evaluation of variations in water use observed in one of the water districts, the following ratios were adopted for this study:

Relationship of Flow	Ratio
Maximum-Day to Average-Day Demand	1.20:1.00
Peak-Hour to Average-Day Demand	1.50:1.00 - 1.75:1.00

APPENDIX TABLE B-2

AVERAGE DAILY WATER
DEMAND AND SUPPLY REQUIREMENT (contd)

Category of Water Use	Ozamiz			Dasi			Butuan			Zamboanga			Cebu		
Year	1980	1990	2000	1980	1990	2000	1980	1990	2000	1980	1990	2000	1985	1990	2000
Domestic	3,230	7,050	13,900	5,760	12,640	25,500	4,000	11,080	22,800	8,800	16,600	27,600	68,200	94,000	168,000
Commercial/Institutional	390*	850*	1,700*	690*	1,520*	3,060*	400	1,100	2,300	2,200	2,600	3,000	6,800	9,400	17,000
Industrial							100	560	2,100	500	1,100	2,000	3,600	7,600	12,000
Accounted-for-Water	3,620	7,900	15,600	6,450	14,160	28,560	4,500	12,700	27,200	11,500	20,300	32,600	78,600	111,000	197,000
(Equivalent, lpcd)	(134)	(149)	(168)	(134)	(149)	(168)	(135)	(153)	(179)	(158)	(163)	(177)	(170)	(183)	(205)
Unaccounted-for-Water	2,380	3,400	3,900	4,300	6,070	7,140	1,900	4,200	6,800	7,700	8,700	8,200	33,700	37,000	49,000
(Equivalent, lpcd)	(89)	(64)	(42)	(89)	(64)	(42)	(58)	(50)	(45)	(105)	(70)	(45)	(73)	(61)	(51)
Grand Total	6,000	11,300	19,500	10,800	20,200	35,700	6,400	16,900	34,000	19,200	29,000	40,800	112,300	148,000	246,000

	Cabanatuan			La Union			Iloena			Lipa			Tarlac		
Year	1985	1990	2000	1985	1990	2000	1985	1990	2000	1985	1990	2000	1985	1990	2000
Domestic	9,300	13,200	22,600	4,260	8,000	19,600	9,800	15,400	26,900	3,900	7,200	12,900	8,300	12,300	21,300
Commercial/Institutional	1,900*	2,400*	3,600*	900	1,320	2,400	1,500	2,000	2,700	600*	1,100*	2,000*	1,700*	2,200*	3,400*
Industrial				660	950	1,400	650	1,000	1,700						
Air Base										1,750	1,800	1,850			
Accounted-for-Water	11,200	15,600	26,200	5,820	10,270	23,400	11,950	18,400	31,300	6,250	10,100	16,750	10,000	14,500	24,700
(Equivalent, lpcd)	(160)	(165)	(180)	(188)	(184)	(188)	(166)	(174)	(186)	(202)	(189)	(188)	(159)	(165)	(180)
Unaccounted-for-Water	3,700	4,400	6,600	1,930	2,830	5,900	5,150	5,000	7,800	1,500	2,400	3,700	3,300	4,100	6,200
(Equivalent, lpcd)	(53)	(47)	(45)	(62)	(51)	(48)	(71)	(47)	(46)	(48)	(47)	(42)	(53)	(47)	(45)
Grand Total	14,900	20,000	32,800	7,750	13,100	29,300	17,100	23,400	39,100	7,750	12,500	20,450	13,300	18,600	30,900

*Industrial demand is included.

A review of the available records and consumption patterns indicated that the present unaccounted-for-water is high, amounting to 50-80 percent of the water production. For preliminary design purposes, it has been assumed that unaccounted-for-water would be reduced gradually as positive improvements are added to the water system. By the year 2000, unaccounted-for-water would be about 20 percent or even less.

Cost and Economic Criteria

The opportunity cost of capital or discount rate used in this feasibility study is 12 percent. The discount rate was utilized for economic screening of the technically viably alternatives.

Projections indicate a general price escalation rate of 10-12 percent for the period 1976 through 1980; 8-10 percent for the period 1981-85; and 6-8 percent for the period 1986-90.

For the purpose of cost estimating, a construction cost index (CCI) for water supply projects has been developed, with 1965 as the base year (CCI=100). Unit costs for the water supply feasibility studies have been projected to July 1976 price levels (CCI=384). Construction cost curves have been developed for in-place costs of pipelines, deep wells, water treatment plants, pump stations, and storage reservoirs and used for estimating the relative cost magnitudes of alternative water supply plans.

Ability-to-Pay Issue

Presidential Decree No. 198 stipulates that water district must be financially self-sufficient. In the past, most water systems have not been able to generate sufficient revenues to cover even just the operation and maintenance expenses due to various factors including poor pricing schemes, defective collection system and inadequate consumer promotion. The major reason that has been pointed out, however, is that the consumers being served by the water district have such low incomes and hence, they 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 target population to be served must first be ascertained.

Since water districts are not expected to be extended government subsidy, this has significantly simplified the analysis of the factors affecting ability-to-pay. The factors that affect ability-to-pay are the annual income of families covered by the water district; percentage of their income allocated to water supply; average per capita water use; and the cost of water per unit volume.

In March 1975, an informal survey was conducted among Water District General Managers to help gather data needed in 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 ten of the water districts were revenue-producing prior to the change in management of the water district, thirteen 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 to 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 levels of their families are similar to the national income levels; and (c) they are near Manila, only about two hours away by bus.

The survey covered 556 families, classified into 4 income groups. Twenty-eight (28) percent came from the low-income class; 55 percent from the middle income; 12 percent from the upper middle income; and 5 percent from the highest income group.

The following table presents the highlights and pertinent findings of the survey:

ESTIMATED ABILITY-TO-PAY BY INCOME GROUPING

	Low	Middle	Upper Middle	High
Income Group % Distribution	28%	55%	12%	5%
Probable Ability-to-Pay on Basis of Improved Service	₱13.50	₱24.50	₱37.00	₱67.50
Estimated Monthly Average Income	₱300	₱700	₱1,000	₱2,700
Ability-to-Pay Divided by Average Income	4.5%	3.5%	3.7%	2.5%

The foregoing table indicates that the low-income group may be able to pay a maximum of ₱13.50 a month for water (about 4.5 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 (about 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 for a socialized price structure.

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

Alternative Studies

Several alternatives on water sources, source development, water treatment, transmission and distribution of treated water were identified for each of the 10 provincial urban areas. These alternatives were evaluated and screened, using economic and non-economic techniques.

Alternative analysis of the water source(s) for the long-range program is primarily based on the least present worth cost alternative, tempered by non-economic parameters such as socio-political, environmental and other considerations.

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

The water quality tests performed on samples taken from spring and well sources indicate, in general, that most of the physical and chemical quality parameters are within "permissible" and/or excessive" limits as defined in the Philippine Drinking Water Standards.

For ground water sources, disinfection will be the only treatment needed. Disinfection ensures safety of the water delivered to the consumers. Various disinfecting chemicals (chlorine, iodine, bromine, oxidizing agents) and processes (ozonation, ultra-violet radiation) were examined in this study. Chlorination, which has a long history of successful application, has been determined to be the most practicable disinfection process. In 3 cases (where surface water is the primary source), complete treatment is recommended. The treatment process consists of chemical flocculation, coagulation, sedimentation, multi-media rapid sand filtration and chlorination.

Major distribution alternatives for the areas are concerned with pressure zones, feeder mains, storage facilities and internal distribution network (service mains).

Important considerations with respect to distribution storage are location, and staging of required volume. The alternatives for feeder mains include the location or routes, sizes, spacing in the network, and construction staging. The alignments for future feeder mains have been chosen along existing and planned road and street rights-of-way. As much as possible, the feeder mains have been looped to avoid dead-end service areas; to minimize the number of customers affected by line shut-off; and to provide adequate pressure during maximum demand periods as the water can be supplied from more than one direction. Two-hundred (200) mm has been taken as the minimum diameter of feeder mains and 1,000 meters, as the maximum spacing. The timing of construction of the feeder mains took into account the attainable level of growth in the distribution system, with priority given to areas having higher densities of potential customers.

Alternative studies on the internal network systems considered service both with and without fire protection. Other considerations included minimum pressures in the system; minimum pipe sizes, valve location and spacing; and type, location, and spacing of fire hydrants.

Alternatives available to counteract present and future water shortages include: (1) reuse of wastewater, (2) desalting, (3) precipitation augmentation, (4) land management, and (5) dual plumbing system. Except for land management, the above alternatives would have little or no applicability in the project area in the immediate future, in view of economic and other factors unique to the study area.

Recommended Plan(s)

The recommended plans for the 10 provincial urban areas include:

(1) Maximum use of existing facilities.

(2) Interim improvements that may be implemented by the district (with or without LWUA financing).

(3) Reinforcement and expansion of the transmission and distribution facilities, including pipelines, valves, pressure control chambers, chlorination stations and storage tanks (with LWUA financing).

(4) Expansion of internal distribution piping, and installation of new metered service connections (with LWUA financing).

For the long-range (2000) plan, the principal water sources will be:

Principal Water Source	Number of Areas	Name of Urban Areas
Springs	3	Ozamiz, Daet, Lucena
Wells	5	Butuan, Lipa, Tarlac, Cabanatuan, San Fernando
Surface Water	2	Zamboanga, Cebu

The long-range plan has been divided into 5 construction stages, with the following data (see Table B-3):

	Total/Average for 10 Urban Areas
Total Project Costs (₱ x 10^6)	2,282.1
Project Costs for Phase I-A (₱ x 10^6)	806.3
Total Served Population (Year 2000)	2.222 million
Total Served Population (1986)	1.078 million
Average Cost per Year 2000 Resident (₱)	1,027
Average Cost per Year 1986 Resident (₱)	748

APPENDIX TABLE B-3

SUMMARY SHEET
TEN-AREA FEASIBILITY STUDY

	OZAMIZ	DAET	BUTUAN	ZAMBOANGA	CEBU	LUCENA	LIPA	TARLAC	CABANATUAN	SAN FERNANDO	TOTAL
Area (ha) Served											
Present	170	380	60	1,020	1,060	360	190	275	390	215	4,120
Future (Year 2000)	750	1,580	1,325	2,100	2,660	1,470	860	1,140	1,130	1,155	14,170
Population (1000)											
1980	85.5	143.0	124.8	132.0	635.1	129.5	72.6	115.5	108.2	98.0	[illegible],644.2
1990	118.4	188.0	166.3	178.0	865.4	171.2	96.0	149.9	149.4	134.9	2,217.5
2000	154.0	248.0	209.6	230.0	1,129.3	222.6	121.8	190.8	190.1	179.1	2,875.3
Served Population (1000)											
1980	26.9	48.0	33.2	73.0	[illegible]	[illegible]	20.4	23.0	34.5	10.2	682.7
1990	53.0	95.0	83.3	125.0	605.0	105.9	53.4	87.5	94.3	55.6	1,358.0
2000	93.0	170.0	151.5	184.0	960.0	167.8	88.7	137.1	148.0	124.2	2,222.3
Maximum-Day Demand (cum)											
1980	7,200	13,000	7,700	23,000	135,000	16,400	6,200	7,400	12,300	5,000	233,200
1990	13,600	24,200	20,300	34,800	178,000	28,100	15,000	22,300	24,000	15,800	376,100
2000	23,400	42,800	40,800	49,000	295,000	46,900	24,500	37,100	39,400	35,200	634,100
Existing Facilities											
Source	Springs	Springs	Wells	Surface water	Mostly wells, some surface water	Springs some surface water	Springs groundwater wells	Groundwater wells	Groundwater wells	Surface water	
Treatment	None	None	Intermittent	Partial	Partial	Intermittent	Intermittent, partial	None	None	Partial	
Water Quality											
Wells	Good	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Good	Good	
Springs	Good	Good	n/a	n/a	Fair	Good	Fair	n/a	n/a	Good	
Surface Water	Needs treatment	Needs treatment	Needs treatment	Needs treatment	Needs treatment	Needs treatment	Needs treatment	Needs treatment	Needs treatment	Needs treatment	
Long-Range Plan											
Source	Highland springs	Highland springs	Wells	Surface water	Impounded surface water	Highland springs	Groundwater wells, springs	Groundwater wells	Groundwater wells	Infiltration wells	
Treatment	Disinfection	Disinfection	Disinfection	Complete	Complete	Disinfection	Disinfection	Disinfection	Disinfection	Disinfection	
Project Cost (P x 10^6)											
Overall	79.7	192.7	163.0	156.3	1,238.8	110.5	54.6	80.5	93.3	112.8	2,282.[illegible]
Phase I-A	23.0	48.6	33.9	43.5	520.1	37.5	14.0	25.2	29.2	31.3	806.[illegible]
1986 Served Population	42,560	76,200	63,260	104,200	500,000	78,900	35,500	67,300	74,900	35,900	1,078,720
Per Capita Cost	P 540	P 637	P 535	P 417	1,040	P 475	P 394	P 374	P 390	P 872	
Economic Benefit/ Cost Ratio	1.16:1	1.16:1	1.27:1	1.64:1	1.25:1	1.86:1	1.88:1	1.55:1	1.48:1	1.25:1	
Internal Economic Rate of Return[2/]						24%	22%	20%	21%	16%	
Resulting Water Rates(P)	1.00/cum	1.10/cum	1.60/cum	1.20/cum	1.60/cum	0.80/cum	1.00/cum	1.00/cum	0.75/cum	1.25/cum	
Initial Borrowing Required (P x 10^6)	31.1	67.7	45.5	56.5	797.5	56.5	22.0	37.8	46.9	44.5	

[2/] This additional method of calculating the relationship between economic benefits and costs was applied only to the second 5 urban areas.

The per capita project costs of upgrading the existing systems to provide at least 1986 needs range from ₱334 to ₱1,045. Based on the assumption that the water district has to be financially self-sufficient, water rates for the initial 3-year period (1978-80) would be ₱0.75 - ₱1.60/cum. With social pricing, the resulting water rates correspond to 3 to 5 percent of the income of the low-income groups; and 2½ to 5½ percent of that of the average-income groups, without social pricing (see Appendix Table B-4).

Details of the recommended plan(s) are shown in pages B-19 to B-48.

Prior to the implementation of the Phase I-A Program, early action works will be performed for each urban area. The early action program includes easily implementable steps in planning and administration; land acquisition and data collection; and operational improvements. Of importance are:

(1) strengthening the legal basis for development of water sources;

(2) initiating improvements to the management, engineering and maintenance procedures;

(3) land and right-of-way acquisition for proposed improvements;

(4) routine collection of hydrologic and meteorological data;

(5) conversion of all service connections to metered services;[3/]

(6) leakage survey and appropriate repairs to pipelines and valves;

(7) acquisition of selected office and system equipment;

(8) cleaning and lining encrusted pipes;

(9) provision of disinfection facilities (chlorination); and

(10) installation of water analysis and testing facilities.

[3/] Economic analysis shows a benefit/cost ratio which justifies total metering of service connections.

APPENDIX TABLE B-4

FINANCIAL ANALYSIS

		Misamis	Daet	Butuan	Zamboanga	Cebu	Lucena	Lipa	Tarlac	Cabanatuan	La Union	Lipa Survey
Without Social Pricing	Average Water Rate (₱/cum)	1.00	1.10	1.60	1.20	1.60	0.80	1.00	1.00	0.75	1.25	
	Monthly Cost/Average Household[4] (₱/month)	24.00	26.40	38.40	28.80	38.40	19.20	24.00	24.00	18.00	30.00	25.00
	Percentage of Income[5] (%)	3.40	3.80	5.50	4.10	5.50	2.70	3.40	3.40	2.57	4.28	3.7
With Social Pricing	Socialized: 0-15 cum	0.75	0.80	0.80	0.80	0.80	0.60	0.75	0.75	0.50	0.80	
	Water : 16-30 "	1.35	1.50	2.75	1.65	2.75	1.10	1.35	1.35	1.10	1.85	
	Rate : 31-40 "	1.95	2.30	4.60	3.50	4.60	1.50	1.95	1.95	1.70	3.10	
	(₱/cum) : Above 40 cum	2.55	2.95	6.35	4.50	6.35	1.90	2.55	2.55	2.30	4.70	
	Monthly Cost/ Below Average Household[6] (₱/month)	12.60	13.50	14.75	13.65	14.75	10.10	12.60	12.60	8.60	13.85	13.50
	Percentage of Income[7] (%)	4.2	4.5	4.9	4.6	4.9	3.4	4.2	4.2	2.9	4.6	4.5

4/ Based on water use 24 cum/month.

5/ Based on average income ₱700/month (1976 levels).

6/ Based on water use 16 cum/month.

7/ Based on household income ₱300/month (1976 levels).

Financial Feasibility

The financial feasibility analysis made for the study establishes a detailed set of guidelines that the water district management may use in making crucial decisions during the initial years. A plan was developed to indicate the manner and the time funds would be used to operate and maintain the system; implement the program; establish reserve funds; and retire the indebtedness. Water rates have been developed on the basis that the system will be financially self-supporting. These water rates appear to be within the ability-to-pay of the average householder in the district (see Appendix Table B-4).

Funds from revenues derived from the operations of the water district can be devoted to financing developmental costs to the extent that the revenues exceed annual cash requirements for all purposes. Funds may be borrowed by the water district for development. From the district's point of view, LWUA is the primary, if not the only, realistic source of funds. LWUA borrows both local and foreign currencies at varying terms and lends them to water districts.

Funds required to cover development costs have been determined in the financial study. Also included in the financial analyses are (1) water district assets and depreciation forecasts, (2) annual depreciation expenses, (3) revolving fund for service connections, (4) debt service requirements, (5) revenue unit forecasts, (6) water rates determination, (7) revenue forecasts, (8) feasibility of charges, (9) external borrowing required, (10) projections of financial statements, (11) cash flow statements, and (12) other financial statements.

Economic Feasibility

The recommended improvements of the water supply system will bring about numerous economic benefits to the water district. Economic feasibility studies show that the benefits exceed the economic costs associated with the development and operation of the water supply system. The economic benefits that will be derived from an improved, upgraded, and expanded water system can be classified into quantifiable and non-quantifiable. Quantifiable benefits are those which can be expressed in monetary terms while non-quantifiable benefits are intangible but real, and are extremely difficult to express in monetary terms. The quantifiable benefits that have been identified and for which monetary values have been determined are increase in land values, health improvement, reduction in fire insurance cost, reduction in fire damage and incremental revenue. Significant non-quantifiable benefits are improved standard of living and economic linkages.

The economic cost of the proposed water supply system is the sum of all expenditures required to realize project objectives and benefits. Costs include (1) capital expenditure costs, and (2) annual costs.

One method of determining the economic feasibility of a water supply project is by comparing the present value of the benefits likely to be derived and the present value of the costs. The results can be expressed as a ratio called the benefit-cost-ratio. The project is considered feasible if the ratio is equal to or greater than one to one. Another method utilizes the internal economic rate of return (IERR). The IERR is the discount rate at which the present value of the benefit stream equals the present value of the cost stream. If the calculated IERR exceeds the adopted or national discount rate (12 percent in this particular study), then the project is considered economical. Both methods were used in the economic analysis.

Sewerage/Drainage Concepts

Except the Zamboanga City Water District, none of the 10 urban areas have central sanitary sewage (wastewater) collection and disposal systems. Generally, septic tanks are used in larger houses and establishments. The effluents from the septic tanks are piped to leaching pits, or overflow into the nearest drainage ditches. The latter practice results in grossly polluted open drains and gives rise to offensive and unaesthetic conditions.

As the water supply problem is resolved, wastewater quantities will increase. Consequently, related public health and aesthetic problems will also increase. Therefore, as soon as the first phase of the water supply program is underway, appropriate steps should be taken by the water district towards the satisfactory solution of the anticipated wastewater problem.

The initial effort should be directed to developing a comprehensive sewerage/drainage feasibility sutdy. This study must address the issue of whether a combined or a separate system should be provided. This should also include various alternative studies relating to ultimate disposal of wastewater such as primary treatment and river disposal, wastewater reclamation, etc.

In the meantime, an inventory of existing facilities and collection of pertinent data and information should be connected in preparation for the sewerage/drainage feasibility study. These activities will include a house-to-house survey of wastewater and toilet facilities and compilation of available and as-built drawings of the storm drains and canals.

Monitoring of Water Quality and Flows

To provide accurate and reliable data for operation and planning/ detailed design of future facilities, it is imperative that water quality and flow of the proposed water sources such as springs be monitored. Flow data from the springs may be taken monthly, except during the dry months when flow data should be done on a bi-weekly basis. Monitoring activities should be coordinated and the water district or its consultants should update and review the monitoring program as the goals and the needs of the study area change.

Updating the Water Supply Master Plan

After the water supply master plan has been adopted and initially implemented, it will be necessary to undertake a program of continuously updating and keeping the plan current. Plan updating should take place at least once every 5 years, or sooner if significant changes occur. Updating is required to assess the effectiveness of the current plan, the benefits gained, the actual costs, and the problems encountered; and to provide overall review, refinement, and direction for the future.

B. RECOMMENDED PLANS

1. Misamis Occidental Water District (MOWD)

Source

The long-term supply of the Ozamiz-Clarin service area of the MOWD will be derived from the present Talibaksan and Cocok Spring sources, and from the Regina, Bitoon and Lower Dalingap Springs.

The Cocok, Regina and Bitoon Springs will be developed during the first construction phase (1977-82). Certain improvements to the Talibaksan Spring facilities will also be made during this phase. These sources will provide a minimum combined yield of approximately 10,400 cumd which will be adequate to meet the projected demand of the water district until 1986. Subsequent source development, which must be completed by 1986, will tap the Lower Dalingap Spring to provide additional capacity to meet the water demand at least until the year 2000.

Transmission

Transmission lines for the long-term improvement plan will total 47 km ranging in size from 100 to 350 mm. These will connect the spring sources, storage tanks, and the distribution systems of Ozamiz and Clarin. During the first construction phase, 15.2 km of 150 to 250 mm pipes will be installed.

Treatment

The only treatment that will be required for the Ozamiz-Clarin water supply is disinfection by chlorination and it is recommended that this be provided in the early action program. Chlorination facilities will be installed at 2 points, one to serve the Cocok and Regina Springs and the other to treat the flow from the Talibaksan, Bitoon and Lower Dalingap Springs.

Storage

Three (3) storage tanks will be provided in 3 construction phases. The first tank will be a 1,900 cum ground storage tank to be built during the first construction phase in Barrio Segatic at a ground elevation of about 67 meters. It will receive the flow from the Talibaksan and Bitoon Springs and will serve Ozamiz and Clarin. The second tank will be a 700-cum ground storage facility on the Ozamiz City distribution system. This tank, to be built in Barrio Kalabayan at a ground elevation of 63 meters, will provide additional supply during peak-demand periods and will help maintain uniform pressures in the fringe areas of the distribution system near Ozamiz City. The third tank is a 900-cum storage tank. It will be located at the site of the first storage tank in Barrio Segatic, unless future demand conditions indicate that another site in Ozamiz or Clarin is preferable.

Distribution

A total of 41 km of distribution mains ranging in size from 150 to 200 mm will be constructed in the long-term plan. Pipes 5.2 km long and 150 and 200 mm in diameter, and 18 valves will be installed during the first construction phase. Of the total pipe length for the first phase, 1.2 km of 150 mm pipes will be installed in Clarin and the rest in Ozamiz City. The distribution systems of Clarin and Ozamiz City will be connected during the second construction phase by a 6 km long, 150-mm line along the National Road. Distribution mains to reinforce earlier mains will be installed during later construction phases.

Internal Network

Internal network piping (service mains) will be installed to reinforce the existing distribution system and to extend the water service to new areas. It is projected that by the year 2000, some 750 hectares will be served by the water system. Of this area, 190 hectares will be served directly from transmission and distribution mains and 560 hectares from the internal network system.

During the first construction phase, internal network piping will reinforce the network in 30 hectares of the present service area and will include installing 17 fire hydrants in the same area. Additional 100 hectares will receive internal network piping, 85 hectares in and around the Ozamiz City poblacion and 15 hectares in the Clarin poblacion. A total 8.9 km of 100-mm pipes and 3.2 km of 150-mm pipes will be installed.

Service Connections

The long-term program involves a total of 12,550 service connections by the year 2000. Some 1,500 new connections and replacements for 200 existing connections are scheduled to be installed during the first construction phase. Metering all service connections is a goal of the water district.

Other Facilities

The existing offices and facilities for the administration and operation of the MOWD are housed in rented and overcrowded premises. In addition, the district does not have facilities for the testing and repair of customer water meters, and for water sampling and analyses. To provide for the necessary facilities/space, a new administration building will be built in the first construction phase. The water analysis laboratory will be expanded in a later construction phase.

Capital Cost Summary[8]

Construction Stage/Phase	Construction Period	Construction Cost (₱)	Total Project Cost (₱)	Foreign Exchange Component (US$)
Early Action	1976-78	₱ 594,000	₱ 683,000	$ 44,000
I-A	1977-82	16,232,000	23,006,000	774,000
I-B	1982-86	4,785,000	6,522,000	180,000
I-C	1986-90	7,572,000	10,591,000	416,000
II-A	1984-95[9]	15,143,000	21,401,000	773,000
II-B	1992-2000	12,412,000	17,464,000	548,000
TOTAL		₱56,738,000	₱79,667,000	$2,735,000

2. Camarines Norte Water District (CNWD)

Source Development

Future sources of supply of the CNWD will be the existing Boro Boro, Magana and Lugui Spring sources to be improved during the initial construction phase, and later on the Malubay, Banban, Balane, Alinao, Vargas and Bungcay Springs. Boro Boro, Magana and Lugui Springs have an estimated combined capacity of 13,900 which can meet the system water demands until 1981, the year when the Malubay Spring must be fully developed. The Malubay Spring will provide an additional capacity of 6,900 cumd, thereby increasing total source capacity to 21,000 cumd. This total capacity will be adequate until 1988.

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[8] All costs are based on July 1976 prices and an exchange rate of ₱7.00 to $1.00.

[9] Each construction phase is generally 4 to 5 years. However, a major exception to this is Stage II which begins in 1984 and ends in 1995 since the development of the Lower Dalingap Spring must be implemented in 1984-86. Because this additional source will provide water supply to satisfy demands in Ozamiz and Clarin until year 2000, the cost of the development of this source has been included in the Stage II program.

The Banban and Balane Springs, scheduled to be developed in 1987-88, will increase the total supply to approximately 30,000 cumd, sufficient until 1994. The additional flow required from 1994 to 2000 will be obtained from the Alinao, Vargas and Bungcay Springs. These springs will provide an additional capacity of 11,700 cumd, bringing total source capacity to 41,900 cumd.

Storage

Six (6) storage facilities are planned to be constructed in the long-term improvement program. Two (2) tanks will be initially built, one to serve the Labo service area and the other to serve the other municipalities. The Labo tank will be a 400-cum ground tank constructed between Barrio Tulay na Lupa and Labo, 3 km from Labo, and at a ground elevation of 37-40 meters. Water from the Boro Boro-Magana-Lugui-Malubay systems will discharge into this facility before delivery to Labo. The second tank, referred to as San Vicente Source Storage Tank No. 1, is a 1,100-cum storage tank to be built 2 km west of San Vicente, also at ground elevation 37-40 meters. This tank will also receive flow from the Boro Boro-Magana-Lugui-Malubay spring supplies.

During the third construction phase, a third source storage tank (San Vicente Source Storage Tank No. 2) will be constructed near San Vicente, also at elevation 37-40 meters. This tank will have a capacity of 1,700 cum and will be designed to receive the flow from 5 or more springs proposed to be tapped in the future.

Other tanks to be constructed are distribution storage facilities. One tank will be designed to serve the Labo service area and will be located north of Labo. It will have a volume of 400 cum and a maximum water level elevation of 40 meters. The other 2 tanks, to be built in separate construction phases, will be located in Barrio Padaguit and will have maximum water level elevations of 40 meters. The first tank will have an operational volume of 1,800 cum; the second, 1,000 cum.

Water Treatment

Disinfection by chlorination will be the only treatment required for the water from the existing and proposed sources. Three (3) chlorination stations will be established near the Labo Source Storage Tank and the San Vicente Source Storage Tanks No. 1 and 2. Each chlorination station will be equipped with 2 chlorinators, one serving as stand-by.

Transmission and Distribution Mains

A total of 132.5 km of transmission and distribution mains ranging in size from 100 to 600 mm is required for the long-term improvement plan. During the first construction phase, 32 km of pipeline ranging in diameter from 200 to 600 mm will be installed. Of this total pipe length, 9.4 km will be 200-350 mm transmission lines from the proposed spring sources to the source storage tanks.

Internal Network

Internal network piping will be installed to reinforce existing distribution systems and to extend water service to new areas. It is projected that by the year 2000, 1,580 hectares will be served by the water district. Two-hundred forty (240) hectares of this area will be served directly from transmission and distribution mains, and 1,340 hectares, from the internal network systems.

During the first construction phase, the existing internal network in 80 hectares of the Daet service area will be reinforced and provided with fire protection service. The internal networks in the other municipalities do not require immediate reinforcement. Also, water service will be extended to 160 hectares in Daet and Mercedes. One-hundred (100) hectares in the fringe area of Daet and 60 hectares in Mercedes will be served. The area in Mercedes will also be provided with fire protection.

Service Connections

The long-term program involves a total of 28,000 service connections by the year 2000. It is estimated that the district will have 4,000 connections by 1978. Some 2,400 new connections are planned to be installed during the period 1978-82, bringing the total number of services to 6,400 by the end of this period.

Capital Cost Summary[10]

Construction Stage/Phase	Construction Period	Construction Cost (₱)	Total Project Cost (₱)	Foreign Exchange Component (US$)
Early Action Works	1976-78	₱ 1,426,000	₱ 1,640,000	$ 161,300
I-A	1977-82	31,446,000	48,574,000	2,284,600
I-B	1982-86	15,432,000	23,840,000	685,600
I-C	1985-90	28,343,000	41,055,000	1,691,300
II-A	1990-95	39,691,000	58,333,000	2,389,800
II-B	1995-2000	12,430,000	19,221,000	579,500
TOTAL		₱128,768,000	₱192,663,000	$7,792,100

3. Zamboanga City Water District (ZCWD)

Interim Improvements

A total 3,600 meters of 150-mm pipes are recommended to be cleaned and lined. The significant portion of these pipes are within the core city area.

Source Development

The future source of supply of the ZCWD will be the Tumaga River, the existing source. The expected yield of this river is sufficient to meet projected maximum daily demands until the year 2000, without construction of a major dam. However, it is recommended that a permanent diversion dam be constructed to replace the existing dam of loosely packed cobblestones. Analyses have indicated that the best site for this new dam is approximately 300 meters upstream of the existing dam. The proposed dam, 27 meters lo 2.3 meters high, and of reinforced concrete, will be constructed during the first construction period (1977-1982). Additional source facilities include a new intake structure and fine screen/grit removal chamber.

[10] All costs are based on July 1976 prices.

Raw Water Transmission Lines

Transmission facilities for conveying raw water from the Tumaga River diversion to treatment works at Pasonanca Park will consist of 2 pipelines. The first pipeline, to be constructed during the first construction period, is 600 mm in diameter and 4 km long. It will be laid along the east side of the Tumaga River. This transmission main will have a capacity of 29,800 cumd, adequate until 1986. Operation of the first transmission main will permit dewatering and inspection of the existing 750-mm transmission main. The second transmission main will be 500 mm in diameter and 3 km long, and will provide additional capacity for the projected year 2000 maximum daily demand. It is planned to thread this pipeline into the existing water transmission line. The second pipeline must be operational by 1986.

Water Treatment

Complete water treatment, consisting of chemical coagulation, sedimentation, filtration and chlorination, will be provided for the Zamboanga City supply as required for water obtained from surface sources. Alterations and additions will be made, during the first construction phase, to the existing treatment plant in Pasonanca Park. The plant will be converted to a conventional complete treatment plant. The plant will have a capacity of 32,700 cumd, which is adequate to meet maximum daily demands until 1988. Plant expansion which should be completed by 1988, will bring the total treatment capacity to 49,000 cumd, the year 2000 projected maximum daily demand.

Storage

Storage facilities are planned to be constructed at 2 sites: (1) the treatment plant site in Pasonanca Park and (2) Barrio Cabatangan. A total of 7,400 cum storage will be provided, divided equally between the 2 sites. Initial construction, which will be during the third phase (1986-90), will provide 1,850 cum storage at each site. Both storage tanks will be built at elevation 45-52 meters.

Treated Water Transmission Facilities

Treated water transmission lines will deliver water from the treatment plant to the distribution system or storage tanks. A total of 16.2 km of new transmission mains ranging in size from 250 to 600 mm is required for the long-term improvement plan. Only 3.2 km of 300-mm pipe will be installed during the first construction phase.

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Other Facilities

The existing ZCWD office building, which currently houses the entire administrative staff, meter repair shop and other facilities, is very crowded. It is recommended that this existing building be designated for use only by the General Manager and Customer Service staff; and a new building for the water meter testing and repair shop, a new water analysis laboratory, and for general storage be constructed in the first construction phase. The meter testing/repair shop and water analysis laboratory will be expanded in 1990-1995.

Capital Cost Summary[11]

Construction Stage/Phase	Construction Period	Construction Cost (₱)	Total Project Cost (₱)	Foreign Exchange Component (US$)
Early Action	1976-78	₱ 646,000	₱ 743,000	$ 52,000
Interim Improvements	1977-79	311,000	358,000	8,000
I-A	1978-82	30,671,000	43,532,000	2,186,000
I-B	1982-86	14,983,000	20,779,000	829,000
I-C	1986-90	30,486,000	43,182,000	1,626,000
II-A	1990-95	17,271,000	24,023,000	938,000
II-B	1995-2000	17,051,000	23,667,000	731,000
TOTAL		₱111,419,000	₱156,284,000	$6,370,000

[11] All costs are based on July 1976 prices.

4. Butuan City Water District (BCWD)

Interim Improvements

The main interim improvement which must be completed by 1977 is the overhaul or replacement of the existing pumpset in the Bonbon deep well. This will provide a groundwater supply of 1,000 cumd or more to the existing transmission line at an operating pressure such that the line will carry the well and reservoir water simultaneously. An additional deep well should be drilled in the same vicinity as a stand-by or supplementary source and as an eventual replacement because the production rate of the existing well appears to be declining gradually.

Source Development

A long-term groundwater supply by induced infiltration wells, tapping the surface gravels of the Taguibo River Valley to the northeast of the City Proper, has been found to be the most economical and practical for the study area. A total of 20 wells will be constructed in Taguibo for the long-term improvement plan. Based on preliminary field observations, it has been assumed that the wells will have 250-mm casing, depth of approximately 50 meters, and spaced approximately 400 meters apart. Each well will be equipped with a diesel engine-driven well pump capable of delivering 2,200 cumd at a total head of 80 meters. Six (6) wells (5 production wells plus 1 stand-by) will be constructed duri the initial construction phase. Six (6) wells and 8 wells will be added during 2 subsequent construction phases.

Transmission Facilities

Transmission lines to be constructed for the long-term improvement plan will total 53.0 km ranging in size from 300 to 450 mm. These lines will connect the well sources and storage tanks to the distribution system. Mains, 11.3 km long and 300 to 400 mm in diameter, will be installed during the first construction phase to transmit the flows from the Taguibo wells.

Water Treatment

The only treatment that will be required for the Taguibo deep well water supply is disinfection by chlorination. Chlorination facilities will be installed at 5 points. Two (2) stations will serve the first 6 wells and the other three will treat the flow from the latter additional wells. Chlorination is also recommended for the surface water and well sources at Bonbon. The chlorination stations for the Bonbon supply are recommended to be constructed in the Early Action and Interim Improvement Programs.

Storage

Two (2) storage tanks will be provided in 2 construction phases. The first tank will be a 2,500-cum ground storage tank to be constructed during the second construction phase (1982-86) near Bonbon at a ground elevation of 28-35 meters. It will be connected by a 300-mm line to the transmission line from the Taguibo wells. The second tank will also be a 2,500-cum ground storage facility. It will be built at the same location as the first tank and will likewise be connected to a later-stage transmission line from Taguibo.

Distribution Mains

A total of 58.1 km of distribution mains and 107 valves ranging in size from 150 to 300 mm will be installed. Pipes, 10 km long and 150 to 250-mm in diameter, and 19 valves will be installed during the first phase of construction (1977-82). The initial improvements will be concentrated in the core city and densely populated areas of Butuan City.

Internal Network

Internal network piping (service mains) will be installed to reinforce the existing distribution system and to extend the water service to new areas. It is projected that by the year 2000, 1,325 hectares in and around the Butuan City poblacion will be served by the water system. Of this area, 300 hectares will be served directly from transmission and distribution mains and 1,025 hectares, from the internal network system. All areas with internal network piping will have fire protection service.

During the first construction phase, internal network piping will reinforce the existing network, including installation of fire hydrants, in 40 hectares of the present service area. Additional 160 hectares within the core city will also receive internal network piping but without fire protection service. Installation of fire hydrants in new service areas is deferred until succeeding or later construction phases.

Service Connections

The long-term construction program involves a total of 22,500 service connections by the year 2000. Some 3,000 new connections are scheduled to be installed during the first construction phase, bringing the total number of services to about 3,500 by the end of this construction period. All services will be metered.

Other Facilities

The existing offices and facilities for the administration and operation of the BCWD are housed in rented and overcrowded premises. In addition, the district does not have facilities for the testing and repair of water meters, and for water sampling and analyses.

Capital Cost Summary[12/]

Construction Stage/Phase	Construction Period	Construction Cost (₱)	Total Project Cost (₱)	Foreign Exchange Component (US$)
Early Action		₱ 569,000	₱ 654,000	$ 55,000
Interim Improvements		248,000	285,000	19,000
I-A	1977-82	22,986,000	33,868,000	1,586,000
I-B	1982-86	28,230,000	41,855,000	1,881,000
I-C	1986-90	12,152,000	15,521,000	511,000
I[illegible] A	1990-95	34,069,000	51,551,000	2,455,000
II-B	1995-2000	12,127,000	19,216,000	589,000
TOTAL		₱110,381,000	₱162,950,000	$7,096,000

5. Metropolitan Cebu Water District (MCWD)

Source Development

The long-term supply of the MCWD will be derived from the Balamban and Mananga Rivers. During the first construction period, Balamban River will be developed.

An 82-meter high dam, located near Barrio Lusaran, will be constructed to regulate the Balamban River flows to an estimated potential safe yield of 138,000 cumd, which is expected to be adequate until 1993. Additional supply to meet projected year 2000 water demands will be derived from the Mananga River which is scheduled to be developed in the fourth construction period.

12/ All costs are based on July 1976 prices.

The selected dam site on the Balamban River appears to be suitable for construction of either a rockfill or a concrete dam. The project will also include upstream and downstream cofferdams, a diversion tunnel, a chute-type spillway, access roads, and raw water system consisting of a reinforced concrete intake tower and transmission line to the Talamban water treatment plant.

The Mananga River source development facilities will include a 96-meter high dam located 1.5 km north of Barrio Jaclupan to regulate the Mananga River flows to provide an estimated potential safe yield of 83,400 cumd. Other facilities will be similar to those recommended for the Balamban River development.

Raw Water Transmission Line

Raw water transmission lines will deliver raw water from the surface sources to their respective treatment plants. A total of 29.1 km of transmission line ranging in size from 600 to 2,500 mm will be needed.

The initial transmission line will consist of a 7.6 km long, 2,500-mm diameter concrete-lined tunnel and a 7.7 km long, 1,000-mm pipeline. However, the transmission pipeline will be adequate only until 1988; thus a 7.7 km long, 600-mm pipeline will be constructed during third construction period to reinforce the line.

For the Mananga River system, the raw water transmission line will consist of a 6.1 km long, 1,000-mm pipeline.

Water Treatment Plants

Complete treatment will be required for both the Balamban and Mananga River waters. The proposed treatment plants are conventional-type and will employ coagulation, flocculation, sedimentation, filtration and disinfection.

The treatment plant for the Balamban River supply will be located near Barrio Talamban and will have an ultimate design plant capacity of 166,000 cumd. The initial facilities for a 120,000-cumd capacity will be installed during the first construction period and will include a chemical building and an administrative building. These building facilities will be designed and constructed to be adequate for the full capacity of the treatment plant. Expansion will be implemented during the fourth construction period.

The treatment plant and facilities for the Mananga River supply will be similar in design concept to those recommended for the Balamban system. Design capacity of the plant is 100,000 cumd.

Treated Water Transmission Facilities

Treated water transmission lines will convey water from treatment plants to the distribution system or storage facilities. A total of 85 km of transmission mains ranging in size from 200 to 1,400 mm will be needed in the long-term improvement program. Thirty-three (33) km of 250 to 1,400-mm pipes will be installed during the first construction period. These facilities will include the line from the Talamban treatment plant to Cebu and the Tisa storage tank, the line from the plant to Mandaue and Lapu-Lapu, and the line to Consolacion, Liloan and Mandaue.

Storage Facilities

Six (6) new storage facilities with a total volume of 60,600 cum will be provided in 4 construction phases at the 2 treatment plants and Tisa. Five (5) of these tanks will have operational ranges varying from 3 to 7 meters and overflow elevations at 70 meters. Initially, a 20,000-cum ground storage tank with a 7-meter operational range will be located between elevations 63-70 meters at Tisa.

The sixth storage tank will be installed during the last construction period. This will have a capacity of 600 cum and an overflow elevation at 100 meters to serve the high area in Talamban. The existing Betania storage tank will also be improved.

Booster Pumping Facilities

Two booster pumping stations are needed in the long-term plan for the MCWD system. One pumping station will serve the Guadalupe-Lahug area; the other, the high area at Talamban.

The Guadalupe-Lahug booster zone will encompass the area in Barrios Guadalupe and Lahug between ground elevations 40 and 90 meters. The pump station for this zone will be installed during the second construction period and will have a capacity of 4,000 cumd. It will be connected to the existing Betania storage tank through a network of 150-200 mm distribution mains. A reinforced concrete cover will be provided for the Betania storage tank to protect the water from contamination. The capacity of the pumping station will be increased to 5,000 cumd in the fourth period, with the installation of additional pumping units.

The pumping station for the Talamban booster zone will have a 4,000-cumd capacity and will be constructed in the last construction period.

Distribution Mains

A total of 153 km of distribution mains ranging in size from 150 to 450 mm will be installed. Initial improvements to the feeder system, consisting of 29 km of 150-400 mm pipes, will be concentrated in the central area of Cebu City, the core city areas of Mandaue and Lapu-Lapu and in Consolacion, Liloan and Compostela.

Internal Network

Internal network piping will be installed to reinforce existing internal networks and to extend the water service to new areas. It is projected that by the year 2000, 5,050 hectares will be served by the water system. Of this area, 1,330 hectares will be served directly from transmission and distribution mains and 3,720 hectares, from the internal network systems.

During the initial construction period, 630 hectares of of existing internal networks in the cities of Cebu and Mandaue will be reinforced. This will cover the entire network serving Mandaue and an area in the older portion of Cebu City and its high-value commercial and institutional district bounded by distribution mains to be installed during the same period. New areas to be provided with internal network include 100 hectares in Cebu City and 40 hectares each in the central parts of Lapu-Lapu City and Consolacion, a total of 180 hectares. About 60 km of 100 and 150-mm pipes and 251 commercial-type fire hydrants will be installed. The ares to be covered by fire protection will be limited to 300 hectares in the core city of Cebu, 100 hectares in Mandaue, 30 hectares in Lapu-Lapu and 10 hectares in Consolacion.

Service Connections

The long-term program involves the installation of 119,700 new service connections in MCWD. Of this number, 7,700 connections will be installed during the early action and interim improvement programs. Some 17,000 new connections are to be installed and about 2,000 existing service connections will be replaced during the first construction period. All services will be metered.

Other Facilities

The building being rented for the administration of the MCWD will rapidly become inadequate for the expanded water system and increasing number of customers. A new administrative building at the Talamban Water Treatment Plant is included in the first construction period and will house a proposed water analysis laboratory, new and appropriate meter testing and repair equipment, and general shop and storage facilities. The existing water analysis laboratory will be transferred to the new administrative building. The water analysis laboratory and meter testing/repair shop will be expanded during the fourth construction period.

Capital Cost Summary[13]

Construction Phase	Construction Period	Construction Cost (₱ x 1,000)	Project Cost (₱ x 1,000) Local Component	Foreign Exchange Component	Total
Early Action Works	1976	5,060	3,555	2,264	5,819
Interim Improvements	1976-78	16,360	9,557	11,138	20,695
I-A	1978-82	399,175	330,360	189,746	520,106
I-B	1982-87	38,795	24,055	26,492	50,547
I-C	1986-89	69,553	46,199	44,426	90,625
II-A	1989-94	379,627	312,830	181,805	494,635
II-B	1995-2000	43,272	26,566	29,815	56,381
TOTAL		951,842	753,122	485,686	1,238,808

[13] All costs are based on July 1976 prices.

6. Lipa City Water District (LCWD)

Source

The long-term water supply for the LCWD will be derived primarily from groundwater wells. The service area will have 3 pressure zones served by a total of 21 wells of which 9, 5 and 4 operational wells are planned to serve Pressure Zones 1, 2 and 3, respectively. Each pressure zone will be provided with a stand-by well. Interconnections among the 3 pressure zones will be kept normally closed and will be opened only during emergency situations.

Construction of the new wells will be done in 3 stages and will follow as closely as possible the growth and expansion of the service area. The following criteria have been established, based on the available limited well data, for the well construction: (1) well spacing, 2 km in each aquifer; (2) well depth, 100 meters in the upper aquifer and 200 meters in the lower aquifer; (3) size of casing, 200 mm; (4) average yield from one well, 1,300 cumd; (5) pumping water level, 45 meters for the upper aquifer and 135 meters for the lower aquifer.

Transmission/Distribution

The transmission/distribution facilities for the long-term improvement program of LCWD will include 47.3 km of pipelines ranging in size from 100 to 250 mm. These will serve to connect the well sources (and existing ones) with the proposed storage tanks and the internal network of the LCWD. During the first construction period, 15.6 km of pipelines ranging in size from 100 to 200 mm will be installed.

Treatment

The only treatment proposed for the water supplied to the LCWD system is disinfection by chlorination. Chlorination facilities will be provided for every additional wells.

Storage

The ultimate storage requirement in Lipa is 2,800 cum, with 1,400 cum to be provided in the first construction stage and additional 1,400 cum to be provided in the second construction stage. The existing storage tank in the poblacion is recommended to be kept as emergency storage and the Fernando Air Base storage facilities should be restored and kept in service. In the first construction phase, the storage tank in the poblacion will be utilized and the storage tank at the Fernando

Air Base will be renovated. During the second construction period, the required 1,400-cum storage will be provided through a 1,000-cum storage tank, located in Barrio Balintawak at an elevation range of 335-340 meters, and through another 400-cum storage tank in Barrio Tibig at elevation range of 362-365 meters.

Internal Network

Internal network piping will be installed to reinforce the existing distribution system and to extend water service to new areas. Existing internal network systems for 140 hectares will be reinforced by 1990. New service areas will be provided with internal network covering 40 hectares, 70 hectares and 125 hectares by 1982, 1986 and 1990, respectively, in the first stage of the long-term construction program. Hence, it is projected that by the year 2000, 680 hectares of service area will be covered by internal network piping.

Service Connections

The long-term construction program involves a total of 14,600 additional service connections through the year 2000. During the first construction phase 2,050 new connections are scheduled to be installed. Metering all service connections is a goal of the water district.

Other Facilities

At present, the LCWD occupies a small office space within the compound of the Lipa City Engineering Department. The existing office is not adequate for proper operation and management of the district. A new administration building will be built in the first construction phase. This office complex will include an administrative area and functional space for laboratory, meter shop, storage, garage and parking which are, in general, needed for the efficient operation of a water district.

Capital Cost Summary[14]

Construction Phase	Construction Period	Construction Cost (₱ x 1,000)	Project Cost (₱ x 1,000) Local	FEC	Total
Early Action Works	1977-78	983	461	726	1,187
I-A	1978-82	10,774	7,340	6,700	14,040
I-B	1982-86	8,365	5,762	5,210	10,972
I-C	1986-90	5,262	3,344	3,512	6,856
II-A	1990-1995	10,517	7,355	6,427	13,782
II-B	1995-2000	5,927	3,877	3,846	7,723
TOTAL		41,828	28,139	26,421	54,560

7. Lucena-Pagbilao-Tayabas Water District (LPTWD)

Source

The long-term water supply for the LPTWD will be derived primarily from the May-it Spring. Expansion of the existing collection facilities at May-it Spring includes miscellaneous site works, construction of an additional collection chamber, construction of a valve/metering chamber and construction of a 1.5 km gravel-surfaced access road. These facilities will be constructed during the first construction phase and will not require expansion during the study period. These facilities will provide the projected demands in Lucena and Pagbilao until the year 2000.

The existing Ibia, Lalo Grande, Lalo Pequeño and Dapdap "A" and "B" spring facilities will supply water to Tayabas, and will not require additional works except for the construction of a 2-km access road. These springs will provide sufficient flows to meet system demands in Tayabas until 1995, at which time the Dapdap "C", "D" and "E" Springs will be developed to provide the additional 1,650 cumd required to meet projected year 2000 demands.

[14] All costs are based on July 1976 prices.

Transmission

The transmission facilities for the long-term improvement program in the LPTWD will include 21.6 km of pipelines ranging in size from 200 to 700 mm. They will serve to connect the spring sources with the proposed storage tanks and distribution systems of Lucena, Pagbilao and Tayabas. During the first phase of construction, 17.7 km of pipelines (with all required appurtenances) ranging in size from 200 to 700 mm, will be constructed.

Treatment

The only treatment proposed for the water supplied to the LPTWD system is disinfection by chlorination. All chlorination facilities required for projected year 2000 flows will be provided during the Early Action Program, except those for the May-it Spring supply which will be augmented with larger-capacity facilities during the first construction phase.

Storage

The ultimate storage requirement in Pagbilao is 900 cum, with 500 cum to be provided in the first construction phase and 400 cum to be provided by 1992. Both storage tanks will be constructed at an elevation of 70 meters, approximately 1.5 km from Pagbilao along the Pagbilao-Tayabas Road.

The year 2000 storage requirement for Tayabas will be provided in 2 stages, 700 cum to be provided in the first construction phase and 500 cum to be provided by 1992. These storage tanks will be located at an elevation of 230 meters, about 1.0 km from Tayabas along the road to the northwest of Tayabas.

The storage requirement for Lucena will be located at 2 sites - Isabang and Tongko. Economic comparison of various alternatives indicates that 70 percent of the Lucena storage requirement will be provided at the Tongko site. The first-phase construction will consist only of providing covers for the existing tanks. The entire projected year 2000 storage requirement at Tongko (3,500 cum) will be included in the new tank to be constructed in 1992. The balance of the Lucena storage requirement will be located at Isabang, at an elevation of 70 meters.

Distribution

The total construction program for the study period includes 60 km of pipelines ranging in size from 150 to 250 mm. The first phase of construction includes 13.4 km of pipelines of sizes 150 to 250 mm.

Internal Network

Internal network piping will be installed to reinforce the existing distribution system and to extend water service to new areas. Existing internal network systems for about 300 hectares will be reinforced by 1985. New service areas will be provided with internal network covering 205, 460 and 855 hectares by 1985, 1990 and 2000, respectively. Hence, it is projected that by the year 2000, 1,155 hectares of service area will be covered by internal network piping. Additional 315 hectares served directly from transmission and distribution mains will increase the year 2000 service area to 1,470 hectares.

Service Connection

The long-term construction program involves a total of 24,900 additional service connections by the year 2000. During the first construction phase, 3,050 new connections are scheduled to be installed. Metering all service connections is a goal of the water district.

Other Facilities

The LPTWD maintains an office in Lucena, which it (LPTWD) owns but is located on land owned by the Provincial Government. LPTWD does not have facilities for the testing and repair of customer water meters, and for water sampling and analyses. To provide for the necessary facilities and space, a new administration building will be built in the first construction phase. Additional revenue offices for Tayabas and Pagbilao may be constructed at a later stage.

Capital Cost Summary[15]

Construction Period	Construction Cost (₱1,000)	Project Cost (₱ x 1,000) Local	FEC	Total
Early Action Program (1976-78)	1,692.0	821.0	1,222.0	2,043.0
Phase I-A (1978-82)	28,772.4	17,311.7	20,177.3	37,489.0
Phase I-B (1982-86)	11,273.1	7,047.8	7,640.5	14,688.3
Phase I-C (1986-90)	12,618.7	7,858.4	8,583.2	16,441.6
Phase II-A (1990-95)	21,068.9	13,369.8	14,081.8	27,451.6
Phase II-B (1995-2000)	9,487.6	5,980.3	6,381.6	12,361.9
TOTAL	84,912.7	52,389.0	58,086.4	110,475.4

8. Tarlac Water District (TWD)

Source

The long-term water supply for the TWD will be derived mainly from deep well sources. The service area will have 2 pressure zones served by a total of 11 new wells, of which eight (8) are planned to serve Pressure Zone 1. Interconnections between the 2 pressure zones will be normally closed and will be opened only during emergency situations.

Construction of the new wells will be done in 3 stages and will follow as closely as possible the growth and expansion of the service area. The following criteria have been established based on the available limited well data, for the well construction: (1) well spacing, 2 km; (2) well depth, 200 meters; (3) diameter of casing, 300 mm; (4) average yield of one well, 3,800 cumd; (5) pumping water level, 65 meters. Four (4) new wells are to be constructed during the initial construction period.

Treatment

The only treatment proposed for the water supply of TWD is disinfection by chlorination. Each deep well will be equipped with chlorinating facilities to be installed adjacent to it.

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[15] All costs are based on July 1976 prices.

Storage

Five (5) reservoirs will be constructed, three for Pressure Zone 1 and two for Pressure Zone 2. All reservoirs will be located at the higher ground elevations southwest of the poblacion.

For Pressure Zone 1, the ultimate storage requirement is 3,300 cum. This volume will be provided at 2 sites in 3 constructed phases. Initially, a 6,300-cum standpipe (2,100 cum operational volume) will be built near the provincial hospital. In 2 separate subsequent construction phases, a 700-cum ground level tank and a 1,500-cum standpipe will be added. All storage tanks will have an operating range of 5 meters, overflow elevation of 70 meters above mean sea level, and an automatic or manual flow control device.

For Pressure Zone 2, with an ultimate storage requirement of 1,100 cum, a 2,400-cum (600 cum operational volume) standpipe will be constructed in 1978-80 at Barrio San Jose Urquico. A second standpipe with 2,000-cum total volume (500-cum operational volume) will be built at the same site in 1990-92. Both tanks will have a 5-meter operating range and overflow elevation of 90 meters.

Distribution Mains

The existing distribution mains of TWD will require reinforcement and expansion throughout the study period. The total construction program for the study period includes approximately 66 km of distribution mains ranging in size from 150 to 450 mm. The first construction phase requires 13 km of mains ranging in size from 200 to 450 mm.

Internal Network

Internal network piping will be installed to replace existing pipes that are undersized or badly corroded to reinforce the distribution system and to extend water service to new areas. The existing internal network systems in 230 hectares will be completely reinforced by 1990. New areas that will be provided with internal network will cover 120 hectares in the first construction period and will total 415 hectares in 1990 and 610 hectares by the year 2000. Additional 300 hectares will be served directly from distribution mains, increasing the year 2000 area served to 1,140 hectares.

Service Connections

The long-term construction program includes a total of 23,200 additional service connections through the year 2000. During the first construction phase 4,900 new connections are scheduled to be installed and 200 existing connections will be replaced. Metering all service connections is a goal of the water district.

Other Facilities

The existing administrative and operations facilities of the TWD consist of a rented central office in a local commercial building, an improvised field located beneath the elevated storage tank and a small wooden shop. The district does not have facilities for testing and repair of water meters and for water sampling and analysis. To provide for the necessary facilities/space, a new administrative building will be provided in the first construction phase.

Because of the similar needs of the Cabanatuan City and Tarlac water districts, the relatively short distance between them, the relatively high capital cost of laboratory facilities and the relative scarcity of experienced laboratory personnel, only one laboratory will be constructed to serve both water districts. This laboratory will be built in Tarlac.

Capital Cost Summary[16]

Construction Phase	Construction Period	Construction Cost (₱1,000)	Project Cost (₱ x 1,000) Local	FEC	Total
Early Action Works	1977-1978	1,305	690	886	1,576
Phase I-A	1978-1982	19,353	13,928	11,289	25,217
Phase I-B	1982-1986	12,027	7,951	7,727	15,678
Phase I-C	1986-1990	5,779	3,603	3,927	7,530
Phase II-A	1990-1995	14,513	9,763	9,155	18,918
Phase II-B	1995-2000	8,894	5,727	5,862	11,589
TOTAL		61,871	41,662	38,846	80,508

[16] All costs are based on July 1976 prices.

9. Cabanatuan City Water District (CCWD)

Source

The long-term water supply for the CCWD will be derived mainly from deep well sources. The service area will have 2 pressure zones served by a total of 16 new wells, of which fourteen (14) will serve Pressure Zone 1. Because of the recommended well spacing of 1 to 2 km, 2 wells will be needed in Pressure Zone 2, although the water demand in this pressure zone is very small. Excess water from Pressure Zone 2 will be transferred to Pressure Zone 1 through a pressure-regulating valve.

Construction of the new wells will be done in 5 stages and will follow as closely as possible the growth and expansion of the service area. The following criteria have been established based on the available limited well data, for the well construction: (1) minimum well spacing, 1 to 2 km; (2) well depth, 300 meters; (3) diameter of casing, 300 mm; (4) average yield of one well, 2,600 cumd; (5) pumping water level, 30 meters. Six (6) new wells will be constructed during the first construction phase.

Treatment

The only treatment proposed for the water supply of CCWD is disinfection by chlorination. Each deep well will be equipped with chlorinating facilities to be installed adjacent to it.

Storage

For Pressure Zone 1, the ultimate storage requirement is 4,800 cum. This volume will be provided at 3 sites in 2 construction phases. Two (2) storage facilities will be provided during the first construction phase. In 1978-80 a 4,600-cum standpipe (1,200 cum operational volume) will be built in Barrio Bantug Bulalo. The second facility will also be a standpipe with 5,300-cum volume (1,200 cum operational volume), to be built in 1980-82 in the poblacion. Both storage tanks will have an operating range of 5 meters, overflow elevation of 70 meters above mean sea level, and will be equipped with double-acting altitude valves for flow control.

For Pressure Zone 2, with an ultimate storage requirement of only 100 cum, a 400-cum (100 cum operational volume) standpipe will be constructed in 1995-97 in Barrio Bangad. The tank will have an overflow elevation of 60 meters and will be equipped with a double-acting altitude valve.

Distribution Mains

The existing distribution system of CCWD will require reinforcement and expansion throughout the study period. The total construction program for the study period includes 54.4 km of distribution mains ranging in size from 150 to 250 mm. The first construction phase requires 13.2 km of mains ranging in size from 150 to 250 mm.

Internal Network

Internal network piping will be installed to replace existing pipes that are undersized or badly corroded, to reinforce the distribution system and to extend water service to new areas. Initially, the internal network over a 200-hectare portion of the existing service area between the Cagayan Valley Road and Nabao Creek and in Barrio Aduas will be reinforced. The existing internal network systems in 340 hectares will be completely reinforced by 1990. New areas that will be provided with internal network will cover 100 hectares in the first construction phase and will total 350 hectares in 1990 and 570 hectares by the year 2000. Additional 220 hectares will be served directly from distribution mains, increasing the year 2000 area served to 1,130 hectares.

Service Connections

The long-term construction program involves a total of 22,950 additional service connections through the year 2000. During the first construction phase 4,550 new connections will be installed and 600 existing connections will be replaced. Metering all service connections is a goal of the water district.

Other Facilities

The existing administrative and operations facilities of the CCWD are housed in a rented central office in a local commercial building. CCWD does not have facilities for testing and repair of water meters and for water sampling and analyses. To provide for the necessary space and facilities, a new administration building will be built in the first construction phase. However, a regional laboratory to be located in Tarlac will take care of the water analyses for the CCWD and other water districts in the area.

Capital Cost Summary[17]

Construction Period	Construction Cost (₱1,000)	Project Cost (₱ x 1,000) Local	FEC	Total
Early Action Program (1977-78)	1,077	437	863	1,300
Phase I-A (1978-82)	21,960	18,046	11,184	29,230
Phase I-B (1982-86)	13,225	10,078	7,477	17,555
Phase I-C (1986-90)	9,416	6,482	5,797	12,279
Phase II-A (1990-1995)	14,734	11,088	8,125	19,213
Phase II-B (1995-2000)	10,523	7,402	6,319	13,721
TOTAL	70,935	53,533	39,765	93,298

10. La Union Water District (LUWD)

Source

The long-term water supply for the LUWD will require a total of 25 infiltration wells, of which seventeen (17) will be in the Bauang system and eight (8) in the Baroro system. The infiltration wells for the Bauang system will be constructed in 4 stages, the first of which will involve 5 wells. The following criteria have been established based on limited available data, for construction of the Bauang infiltration wells: (1) well spacing, 100-150 meters; (2) well depth, 50 meters; (3) diameter of casing, 250 mm; (4) average yield from one well, 2,000 cumd; and (5) pumping water level, 20 meters.

For the Baroro system, the infiltration wells will be constructed in 3 stages. Criteria established for construction of the Baroro wells are: (1) well spacing, 250-300 meters; (2) depth, 40 meters; (3) diameter of casing, 200 mm; (4) average yield from one well, 1,000 cumd; and (5) pumping water level, 20 meters. Three (3) wells, two operational and one standby, will be constructed during the first construction phase.

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[17] All costs are based on July 1976 prices.

Treatment

The only treatment recommended for the infiltration well water is disinfection by chlorination. Separate facilities will be provided for each system.

Transmission Facilities

The proposed transmission facilities for the long-term improvement plan in the LUWD will require 34.2 km pipes ranging in size from 200 to 500 mm for the Bauang system and 24.1 km of 200 and 300-mm pipes for the Baroro system. During the first construction phase, 21.6 km of 200 to 500-mm transmission pipelines will be constructed. Of this total length,15.2 km will be installed for the Bauang system and 6.4 km, for the Baroro system.

Distribution Mains

The total construction program for distribution mains includes 31.87 km of pipelines ranging in size from 150 to 250-mm in Bauang system and 11.80 km of 200 and 300-mm pipes for the Baroro system. Initially, 4.45 km of 200 and 250-mm distribution mains will be required for the Bauang system service area and 0.60 km of 150-mm pipe for the Baroro system.

Storage

Five (5) storage tanks will be constructed at 5 different sites in the recommended long-term LUWD water system. Three (3) tanks with a total storage capacity of 4,200 cum will be provided for the Bauang system. The remaining 2 tanks will be for the Baroro system and will have a total operational volume of 900 cum.

The existing 450-cum storage tank in San Fernando will be retained. The existing 150-cum storage facility in San Juan will be abandoned because its overflow elevation (66 meters) is significantly higher than the long-term HGL of 60 meters.

Booster Pumping Station

A 2,000-cum booster pumping station will be built during the last construction period, at the junction of the Bauang and Baroro systems. This station will be needed during the dry periods to tranfer water from the Bauang system to the Baroro system.

Internal Network

Internal network piping will be installed to reinforce the existing internal networks in 160-hectares area of San Fernando and and 25 hectares of San Juan and to extend water service to new areas. By the year 2000, a total of 805 hectares (including existing 185 hectares) will have internal network piping. Additional 350 hectares served directly from transmission and distribution mains will increase the year 2000 service area to 1,155 hectares.

Service Connections

The long-term construction program includes a total of 20,350 additional service connections through the year 2000. During the first construction phase, 1,500 new connections are scheduled to be installed and 200 existing connections will be replaced. Metering all service connections is a goal of the water district.

Other Facilities

At present, the LUWD occupies a small provincial government-owned office building which is not adequate for efficient operation and management of the district. It is recommended that a new office complex be constructed for the LUWD in San Fernando during the first construction phase. This office complex will include an administrative area and functional spaces for water analysis laboratory, meter repair and plumbing shops, storage, garage and parking.

Capital Cost Summary[18]

Construction Phase	Construction Period	Construction Cost (₱1,000)	Project Cost (₱ x 1,000)		
			Local	FEC	Total
Early Action Works	1977-78	943	624	515	1,139
I-A	1978-82	24,016	16,003	15,288	31,291
I-B	1982-86	7,670	5,324	4,671	9,995
I-C	1986-90	5,221	3,177	3,625	6,802
II-A	1990-95	35,046	22,189	23,576	45,765
II-B	1995-2000	13,696	8,975	8,875	17,850
TOTAL		86,592	56,292	56,550	112,842

18/ Based on July 1976 prices.

APPENDIX C

SUMMARY - PREFEASIBILITY STUDIES FOR 100 CITIES

APPENDIX C

SUMMARY - PREFEASIBILITY STUDIES FOR 100 CITIES

Prefeasibility surveys and data collection were conducted on 131 areas served by 110 water systems, for a period of 8 months. (These constitute about one-third of all cities/municipalities with existing waterworks and with a population of 30,000 or more in the Philippines.) Appendix Figure C-1 shows the location of the study areas.

Sixty-five (65) of the 110 water systems were found suitable as capital assistance projects for "complete" water supply improvements and 16 others as projects for "partial" improvement. Data on these water systems are summarized below:

	Complete Projects[1]	Partial Projects[2]
Number of Systems	65	16
Construction Cost[3] of Improvements	₱273,635,000	₱79,304,000
Foreign Exchange Component	$ 9,948,000	$ 3,979,000
Estimated Total Population Served by 1983	1,940,000	415,000
Average Population Served	30,000	26,000
Average Construction Cost Per Project	₱ 4,210,000	₱ 4,956,000
Average Foreign Exchange	$ 153,000	$ 249,000
Average Construction[4] Cost Per 1983 Resident	₱ 141	₱ 191

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[1] "Complete" projects are "feasible" from the technical and economic criteria and are recommended for capital assistance immediately.

[2] "Partial" projects are partially feasible based on certain criteria. Capital assistance may be provided on a selective basis.

[3] Does not include other costs such as land purchase, engineering services, legal and administrative costs, interest during construction and contingencies.

[4] Not "project" cost.

Forty-eight (48) of the 110 water systems would require special technical studies, most of which relate to groundwater investigations. Fifteen (15) of them are among the 65 systems recommended as capital assistance projects, and five, among the "partial" capital assistance projects.

Needed improvements which would cost relatively little but would greatly increase the water supply were classified as emergency works. Such works would be required in 58 water systems. Most works are in the category of broken pumps or engines which go out of order frequently, leaking transmission lines, etc.

Twenty-nine (29) waterworks were considered not suitable for capital assistance, based on available information.[5] Only in about six of the 110 systems are the people not seriously inconvenienced by lack of water. In the majority of the system, pressures are low (or non-existent) a large part of the day; much of the town area is not served; the available water is unevenly distributed; or there is just not enough water supply. Forty-three (43) systems were classified as having low pressures throughout the system ("low pressure" will not reach the second floor); forty-nine, as having both low and good pressures in part; and only thirteen, as having good pressure throughout. Forty-eight (48) systems have water pressures throughout the 24 hours; thirty-five, from 12 to 23 hours; fourteen, from 4 to 12 hours; four, from 2 to 4 hours daily; and five, less than 2 hours each day. Even these figures tend to make the situation look better than it is. In half a dozen instances, the 24-hour supply is available but inadequate. This is because a very inadequate spring or highland source feeds the system also 24 hours a day.

Other cities appear to have adequate or even excessive water, in each authorized connection. Here also, the figures are often misleading. In a number of towns, the unauthorized connections are numerous. In one town, they were estimated at 250 percent of the authorized connections. Leaks and other losses of water are generally excessive. Discussions with officials and consumers indicate that the consuming public needs more water. If the figures would show that the supply was nearly adequate for consumers, this may be untrue as usually there have been much loss and wasteful use.

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[5] For purposes of this study, a project is not suitable for capital assistance if (a) the source of required additional water is not apparent, and/or (b) the construction cost of initial (1983) requirements substantially exceeds ₱200/capita.

In the opinion of the surveyors, two findings do indicate the true situation. One is the overall per capita supply of 91 lpd (about 24 gallons), half a reasonable amount if there was little loss and waste and if the water was equitably distributed, which is generally not the case. The other is that only 25 percent of the households in the water service area have connections to the pipe system.

The quality of the water supplied definitely needs improvement in a number of water systems. At least four have muddy water systems in the pipes after a rain. Thirteen (13) sources in use are rather saline. Forty-four (44) water systems have water disinfected at source by chlorinating. In four of these systems, chlorination was judged to be somewhat effective most of the time; in the other forty, chlorination was judged generally ineffective.

Data on bacteriological quality are scarce; but apparently, the great majority of the supplies do not meet the bacteriological standards prescribed by the Philippine Government. Unfortunately, the bacteriological tests made do not distinguish between a real hazard which may cause an epidemic of typhoid fever or cholera and some incidental dust-borne contamination unlikely to have public health significance. Public health officers know that many water systems regularly fail the bacteriological tests. They also know that public health will be improved if more people drink piped water.

APPENDIX D

LOCAL WATER UTILITIES ADMINISTRATION

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LOCAL WATER UTILITIES ADMINISTRATION

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APPENDIX D

LOCAL WATER UTILITIES ADMINISTRATION

Historical Background

In response to the pressing need to provide adequate and well operated water supply systems in the Philippine provincial urban areas, the Local Water Utilities Administration (LWUA) was established through Presidential Decree (PD) 198 issued in May 1973. The decree seeks to establish, operate, maintain and develop reliable, adequate and economically viable water supply and wastewater disposal systems for provincial urban areas.

Prior to this development, a comprehensive study of selected water supply systems revealed the generally unsatisfactory condition of these systems. Waterworks facilities were mostly inadequate and provided frequently unsafe water; thus, immediate improvement was called for.

In September 1973, LWUA was formally organized. LWUA is to act as the national body that will coordinate efforts towards the development of water systems at the local level through the formation of water districts.

When PD 768 was promulgated on 15 August 1975, LWUA became a government corporation directly under the Office of the President. Through this new decree, the authorized capitalization of LWUA was increased from ₱200 million to ₱500 million to be provided over a 10-year period. The total amount of authorized loans from domestic sources was increased from ₱500 million to ₱1 billion, and from foreign sources, from $100 million to $500 million.

On 11 December 1975, LWUA was transferred from the Office of the President to the Department of Public Works, Transportation and Communication with the issuance of Letter of Instruction No. 31.

Goals and Functions

The primary objective of LWUA is to promote the development of water supply and wastewater disposal systems through the establishment of locally controlled water districts that are self-sufficient technically and financially. In line with these goals, LWUA's functions are to:

1. Prescribe and regulate the minimum acceptable standards of construction, materials and supplies, operation and maintenance, personnel training, accounting and fiscal policies;

2. Provide technical advice, managerial assistance, and financial assistance to water districts;
3. Monitor and evaluate water district performance;
4. Provide operational guidelines and review new water rates;
5. Effect systems integration, joint investment operations, district annexation and de-annexation whenever economically warranted.

Organizational Set-Up

Under Presidential Decree No. 198, LWUA is to be directed by a 5-man Board of Trustees. At present, however, the Board has 4 members, with the General Manager as the fourth member. The Board formulates policies for LWUA and the General Manager is responsible for implementing these policies.

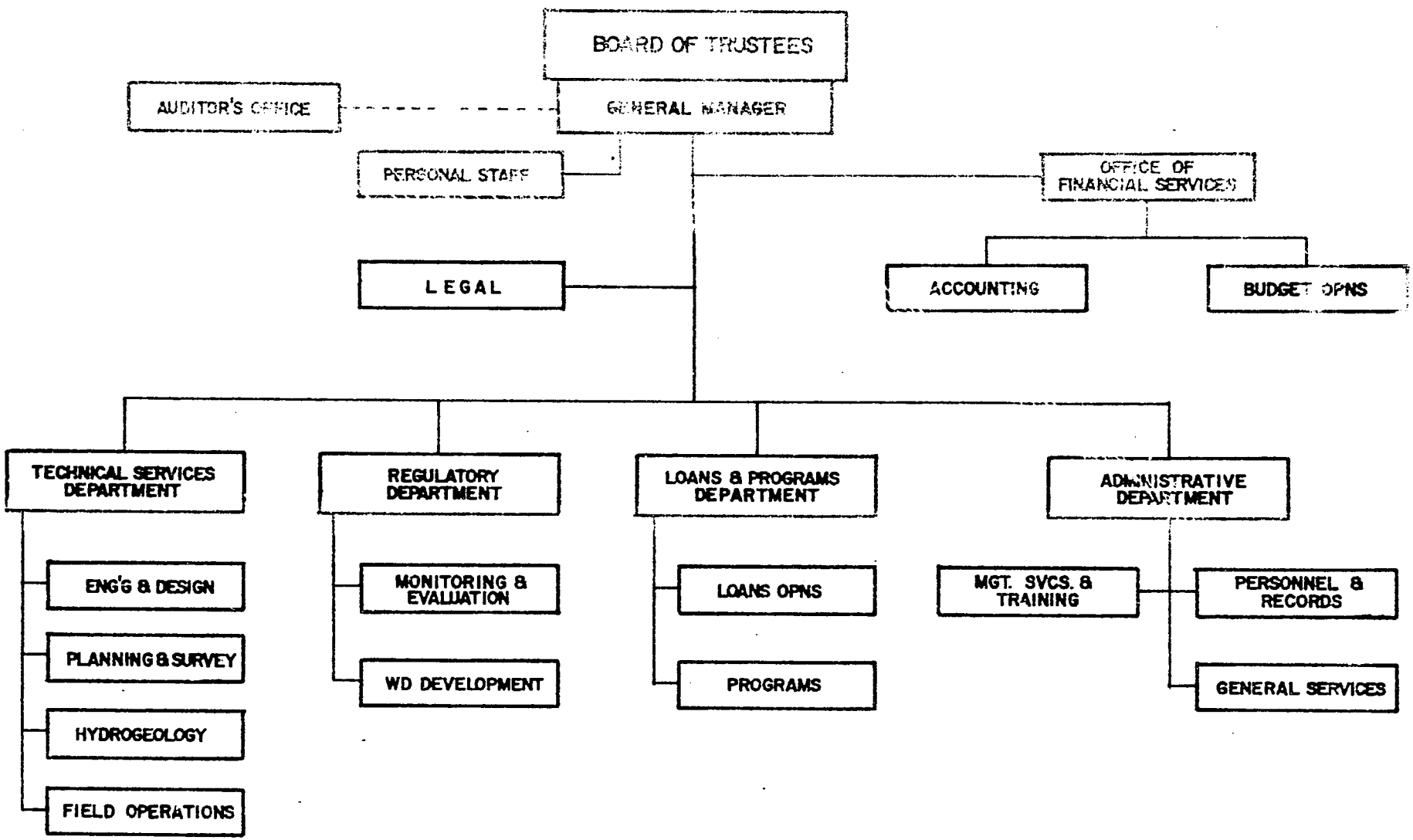
To carry out its functions, LWUA maintains 4 operating departments, each headed by a manager. (See Organizational Chart, Appendix Figure D-1.)

The Technical Services Department provides technical assistance to water districts and develops design, construction and operational standards.

The Loans and Programs Department administers and monitors LWUA's revolving fund and relending program. It develops application criteria and covenants and processes loan applications of duly constituted water districts. It also negotiates domestic and international loans.

The Regulatory Department monitors the performance and operations of water districts. It processes and administers LWUA's certification program for water districts. As a matter of policy, only duly organized water districts which have complied with certain minimum standards and procedures are issued a Conditional Certificate of Conformance (CCC) and are qualified for financial assistance from LWUA.

The Administrative Department provides the necessary staff support to LWUA in terms of personnel recruitment, records management, general services and related functions. The Management and Training Division under the Administrative Department organizes, develops and implements training programs for water district personnel in 4 areas - policy making, management, technical and operations. These may take the form of training courses, seminars and lectures aimed at strengthening the institutional structure of water districts. Likewise, training is provided to LWUA personnel to develop the necessary expertise that will be extended to the water districts for the efficient operation and management of their systems.



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

APPENDIX FIGURE D-1
LWUA ORGANIZATION CHART

Short-run and Long-range Programs

The short-run program of LWUA is geared towards the implementation of immediate measures to improve the operations and financial status of the water districts.

The long-range program, on the other hand, is directed towards the:

1. Establishment of a uniform standard for the administration and management of all water districts;
2. Development of minimum performance and quality standards for water districts and monitoring their conformance to said standards;
3. Creation of a water supply data bank by conducting extensive surveys of water supply systems;
4. Development of a priority schedule for the improvement and expansion of waterworks physical facilities;
5. Development of a relending program of water districts.

Ongoing Programs

As of 30 June 1976, 35 water districts have already been formed (twelve without a Conditional Certificate of Conformance or CCC); six are in the process of being formed; and twenty-five have expressed interest to district formation. A CCC is issued to a water district once it has significantly taken steps towards the improvement of public water supply, according to certain criteria prescribed by LWUA.

The following are the ongoing and recently completed projects of LWUA:

1. The 110 waterworks systems survey was conducted under a support contract with Camp Dresser & McKee International (CDM) and completed last March 1976. Data gathered form part of the data bank of LWUA.

   A loan of $20 million has been negotiated to finance the foreign exchange requirements of the project and to partially reimburse the local currency costs for 25-35 projects. As a continuation of this CDM study, LWUA is conducting an additional survey of the second 100 systems.

2. The feasibility studies for 10 provincial areas as reported in this paper were completed in August 1976. Funding for the design, supervision and construction of these systems has been negotiated with the Asian Development Bank and

the World Bank. Ongoing are the final engineering designs for Leyte Metro, Zamboanga, Ozamiz, Butuan, Camarines Norte, Metro Cebu.

3. The water resources evaluation program for Baguio City was completed in June 1976, and work on the interim improvements was concluded last March 1976.

4. Construction is currently underway for San Pablo, Bacolod, Cagayan de Oro, Batangas and Davao.

5. A program of seminar workshops for water district personnel is being conducted by LWUA. As of June 1976, 20 such seminars have been held. Concurrently, LWUA engineers and water district managers have been sent for training abroad. A cadetship program has also been launched wherein comprehensive apprenticeship training is given to new engineering graduates in preparation to permanent employment with LWUA.

Appendix Figure D-2 illustrates the provincial urban areas where improvements are currently being made.

LWUA Organizational Departments

Over a period of 3 years, LWUA has developed into an organization of almost 200 employees. It is continually expanding to meet the demands of its short-and long-range programs.

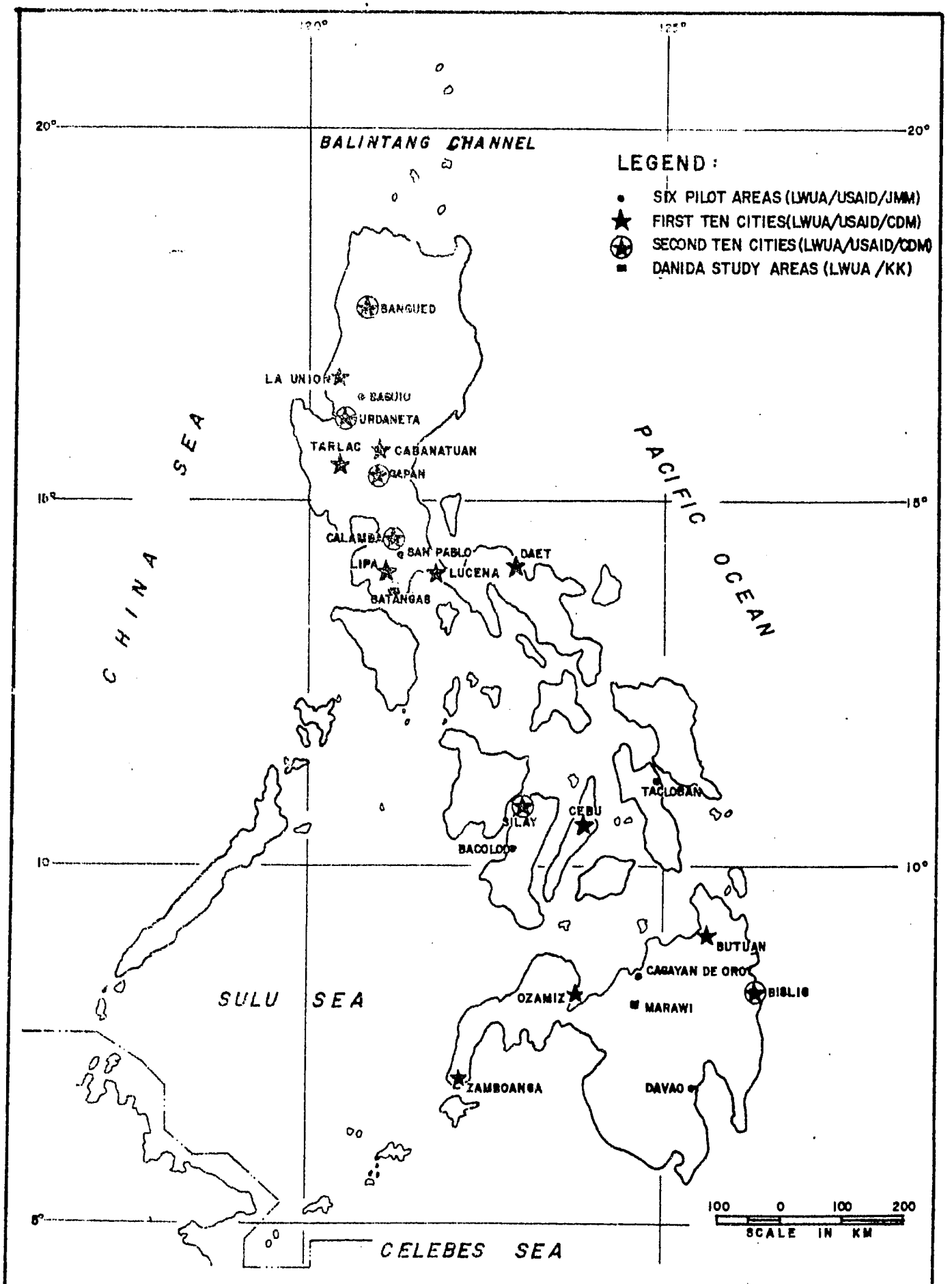
At present, LWUA is assisted by foreign consultants in developing its institutional capabilities. Advisory services are being provided particularly in operations and training; in the institutional development of water districts; and in the technical sector.

Within each of the 4 departments, the following improvements in LWUA capabilities have been made:

1. Loans and Programs Department

The development of the capabilities within this department is essential since improvements in the local water systems are largely dependent on the financial support LWUA extends to the water districts.

A long-range program has been developed to determine the future capitalization needs of LWUA to carry out its improvement programs and secure commitments from foreign and domestic lending institutions for needed loans.



APPENDIX FIGURE D-2
LOCATION MAP

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

Loans have been negotiated with United States Agency for International Development, Danish International Development Agency and Asian Development Bank. Loan conditions have been satisfactorily met.

The procedures for the relending program with water districts for both short-and long-term loans have been established. These include standard loan covenants, relending interest rates and repayment procedures.

Before LWUA grants any loan to a water district, it performs a thorough examination and analysis of its repayment capability. As a prerequisite to any loan application, a 10-year cash flow projection of the water district is submitted for review. This projection serves as a measure of future financial performance.

Financial monitoring is done every month. Financial statements of loan recipients are analyzed to facilitate early detection of financial problems so that necessary remedial measures are applied on a timely basis.

2. Technical Department

a. Engineering and Design Section

In line with LWUA's objective of standardizing methods and procedures, the section developed a Technical Standards Manual. This is the current basis for LWUA's review of design work submitted by engineering firms.

The staff has also developed the capability to prequalify construction firms and administer construction contracts. Construction firms are evaluated in terms of technical capabilities; available equipment, financial resources and previous projects undertaken.

b. Planning and Survey Section

Extensive participation of LWUA counterpart personnel in the preparation of comprehensive feasibility studies continues under the amended CDM contract for additional 10 cities. At the end of this assignment, the LWUA personnel involved shall have acquired the proficiency to undertake similar studies.

As part of LWUA's long-range planning, the 110 water systems survey was performed; and based on the findings of this survey, the Interim Demonstration Program was launched. LWUA engineers, with advisory support from consultants, will take a dominant role in undertaking interim improvements for some 25 to 35 high-impact projects.

c. Hydrogeology

At present, there is very limited local expertise in the field of hydrogeology. Consequently, a number of LWUA engineers in this section have been sent to foreign institutions for specialized training.

To supplement theoretical knowledge, vast field experience is required. The field studies for Baguio and those of the CDM Second Ten Cities are a source of field experience in hydrogeology.

d. Field Operations

The field operations team assists the water districts in their technical and operational problems. For now, assistance is centered on the construction phase of the system. A Construction/Inspection Manual contains LWUA's policy on construction. The manual includes procurement procedures and documents for use of the districts in their purchase of equipment and materials.

3. Regulatory Department

The formation and development of water districts comprise the main function of the Regulatory Department. It administers the certification program in which CCC's are issued only to water districts that meet certain minimum standards set by LWUA and have given firm commitments for specific levels of development. Audit teams are sent out annually to evaluate progress in the water districts and extend assistance in cases of perceived difficulties.

With regard to water district development, the Regulatory Department checks the compliance of the water districts to the various standards and operating guidelines set by LWUA. For instance, methods for water rate structuring were established for use of the water districts. Prior to implementation, rate increases by water districts are reviewed by LWUA.

The Commercial Practices Manual for billing and collection has been implemented in several water districts. LWUA staffmembers trained by a consulting firm are now undertaking the task on their own.

Some staffmembers are currently working with foreign consultants as part of the management advisory teams. These groups have been created to provide managerial assistance to the districts.

4. Administrative Department

The Training Division under the Administrative Department organizes, develops and implements training programs for water district personnel and for LWUA's in-house staff. These programs may take the form of lectures, seminars or forums. Training grants abroad are also offered to supplement technical expertise.

Modern screening methods are applied in the recruitment of the in-house staff. A performance evaluation scheme has been prepared to gauge the inclinations and development of each employee. Moreover, a cadetship program wherein young engineers undergo rigid training before permanent employment has been initiated.

Training programs for water district personnel are provided in 4 areas - policy making, management, technical, and operations. These programs are designed to upgrade the quality of water district personnel and consequently improve their operations.

As part of the water district institutional development, the Training Division has devised recruitment procedures, personnel rules and regulations, and personnel evaluation schemes. Advisory and consultative services are also provided in matters related to personnel development.

Water District Institutional Development

Earlier studies of the country's water supply systems showed that their development is mainly dependent on 3 factors, namely: establishment of a national agency to provide technical, financial, and management assistance; weaning these systems from political influence; and, operating these systems in a business-like manner.

The water district concept was introduced to promote the development of self-sufficient and politically independent water systems. By definition, a water district is a geographical subdivision composed of one or more cities/municipalities serviced by one water utility. It is a non-profit, quasi-public corporation run by a 5-man Board of Directors through a General Manager and is independent from the local government. The organizational structure of the water districts allows the elimination of political intervention so they are left to manage their affairs independently.

The Local Water Utilities Administration functions as the national agency empowered to extend technical, financial and management assistance to the water districts. It implements improvement programs to help the water districts attain higher levels of growth.

A basic factor in the development of the water district is the capabilities of its Board of Directos and key staff. LWUA's Training Division, in coordination with other departments, attends to the training needs of the water districts. Training activities are organized periodically for different levels of water district personnel to provide them with better insights on management and individual performance. Reports indicate a marked improvement in a number of water districts that have adopted the prescribed approach to personnel management. In general, the level of competence and management is improving.

As regards financial management, the Commercial Practices Manual is proving to be a very effective method of increasing revenues and reducing costs in the water district. LWUA has carried out the installation of this manual after which the water district is left on its own to implement the procedures introduced.

The Commercial Practices Manual has been installed in 5 pilot projects. All five have increased revenues, three have accumulated sufficient surplus to meet their obligations to LWUA. With these encouraging results, the manual may very well be the instrument to build up financially self-sufficient systems.

The Challenge Ahead

The differences in the degree of development of the water districts are largely attributed to the varying reactions to the guidelines issued by LWUA.

One particular problem of the districts is increasing water rates to realistic levels. Some districts would rather postpone any rate increases until service has improved. The hesitation has,

in many cases, resulted in the failure of revenues to match operational costs. In general, loan recipients are required to increase their water rates to prove their willingness and ability to meet their obligations. Other districts desiring physical improvements to their systems have increased their rates. A probable cause is the district's concern for public antagonism. A similar attitude has been observed in the implementation of most major changes advocated by LWUA.

LWUA has intensified its public relations activities, emphasizing the importance of the LWUA guidelines in attaining self-sufficiency. Teams are sent out to help water districts in their public relations efforts. To be meaningful, all these efforts will require the full cooperation of the water districts.

APPENDIX E

NATIONAL ECONOMY

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NATIONAL ECONOMY

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APPENDIX E

NATIONAL ECONOMY*

The Philippine economy is basically dependent upon agriculture. For many decades, agriculture has accounted for about one-third of the gross national product (GNP). The services industry comes second with about one-fourth share of the GNP, followed by the manufacturing sector with about one-fifth.

Post-War Period (1946-1972)

The principal strategy adopted by the government during post World War II period was import-substitution. Although this system provided the country with certain commodities, it resulted into a somewhat unbalanced development. The bias favoring capital intensive large-scale industries proved undesirable in a labor-surplus economy. Consequently, during the 1960's , the country experienced a slowdown in industrial growth. It became increasingly difficult to finance the growing import requirements of the industrial sector with receipts from agricultural exports. By that time, low productivity and vulnerability to world price fluctuations had become the major problems of the principal agricultural export products. It became apparent then that the import-substitution policy had outlived its role as the primary instrument of economic growth.

To redirect the manufacturing sector from its dependence on import-substitution towards an export strategy, the government opted for decontrol and devaluation. These measures which were completed in 1962, however, failed to inject vigor to the industrial sector. A second devaluation was effected in 1970 by "floating" the peso i.e. allowing the peso to seek its own level in the foreign exchange market. This resulted in a drop in the value of the peso by about 42 percent in relation to the US dollar from 1970 to mid-1973. Although a minor export boom was experienced, it triggered off severe inflation.

Economy Under the New Society (1972-present)

In late 1972 with the advent of the New Society, sweeping reforms were instituted to transform the country's socio-economic structure. The main objective was to accelerate economic development and at the same time make the results socially meaningful. The declaration of martial law was met by a brief period of hesitation in industrial activity. By the end of 1973, however, all economic indicators of the country went up to unprecedented levels. For instance, real GNP increased by 9.9 percent and the surplus in

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*This was written in September 1976.

the balance of payments (BOP) was $671 million, both the highest recorded in Philippine history. This was achieved despite the devastating floods in July and August 1972 which ravaged the entire Central Luzon, the lakeshore towns of Laguna de Bay and Metropolitan Manila.

In 1974, vigorous inflationary and recessionary pressures triggered by the oil price hike gripped most parts of the world, particularly the Philippines. The growth rate of real GNP declined to 5.8 percent. Inflation rate went up to a critical level of 39.8 percent during the year. A noteworthy accomplishment, however, was the surplus in the balance of payments registered for 1974 amounting to $110 million (₱777 million)*. The sectors which showed healthy growth rates were agricultural grains, heavy manufactured products and tourism-related services.

In 1975, the national economy posted a relatively creditable performance despite continued recessionary trends abroad. Real GNP went up from ₱41.0 billion to ₱43.4 billion or an increase of 5.9 percent. This increase was brought about by encouraging developments in rice production, nickel mining and construction. A most remarkable accomplishment for the year was the drastic deceleration of the inflation rate to only 7.4 percent. However, a deficit of $521 million was registered in the country's BOP. This resulted from both a reduction in prices of and demand for the country's export products, aggravated by a considerably higher import bill. Total imports of the country for the year soared to $3.2 billion while exports amounted to only $2.2 billion, or a merchandise trade deficit of $1 billion.

Inflation is a recent local problem, having started only in 1970. Before 1970, the country enjoyed a remarkable degree of price stability for two decades. From 1950 to 1960, for instance, consumer prices in Manila rose by an average of only 0.6 percent per year. From 1961-1970, consumer prices in the country increased at an average rate of 5.6 percent per year. From 1970-71, the rate of increase jumped up to 21.8 percent but tapered off to 8.2 percent the following year.

In 1975, the Philippine labor force was estimated to be 14.7 million or about 35 percent of the population. Every year, the labor market must be able to absorb about 800,000 people who become

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*The prevailing exchange rate by the end of 1974 was ₱7.07 to $1.00.

available for employment. This new increment to the labor force creates significant pressure on the economy, despite the fact that about 300,000 withdraw from the labor force every year.

The Philippine population is relatively young. More than half of the estimated 41.8-million population in 1975 are less than 20 years of age. Moreover, only 3.4 percent are above 65 years of age. In 1970, the population growth rate was 3.01 percent but this went down to 2.66 percent in 1975 as a result of a massive government campaign on family planning. The average Filipino family size is 5.9. More than two-thirds of households are located outside the urban centers.

For many years, sugar has been the major export product of the country. In 1975, it accounted for 25 percent of total export earnings. Other principal export products and their percentage shares in export receipts in 1975 are coconut oil (10 percent), copper concentrates (9.2 percent), logs and lumber (8.5 percent) and copra (7.5 percent).

On imports, mineral fuels, lubricants and related materials comprise a major portion of the foreign exchange outflow. In 1975, for instance, they constituted 22.3 percent of the total import bill. Machinery and parts other than electric took up 18.9 percent; transport equipment, 8.7 percent; base metals, 6.2 percent; and cereals and cereal preparations, 5.1 percent.

In the past decade, Japan and the United States have been the country's major trading partners. In 1975, Japan accounted for 31.8 percent of the total trade (includes both exports and imports) while the United States' share was 24.7 percent. Saudi Arabia came third with 6.5 percent. Other major trading partners are Netherlands, United Kingdom, Federal Republic of Germany, Australia and Kuwait.

The country has a stable and well-developed banking system. It consists of 36 commercial banks, 33 development banks, 11 savings banks and 739 rural banks. At the end of 1975, total assets of commercial banks stood at ₱50.0 billion which was almost 20 percent higher than the previous year. Total resources of the development banks amounted to ₱7.0 billion in 1974 while those of the savings banks amounted to ₱1.2 billion. The rural banks, which have been established in major cities and municipalities all over the country, had total assets of ₱2.1 billion in 1974. In addition to these banks, there are 13 investment houses with aggregate resources of ₱3.8 billion in 1975.

For 1976, it is likely that the country will experience similar difficulties in its balance of payments position, though to a lesser degree. On the whole, prospects for 1976 appear encouraging especially because the industrialized nations have shown clear signs of economic recovery. Recent studies on the projected inflation rates for 1976 to 1977 indicate that the country's major trading partners (with the exception of Australia) would be able to keep their inflation rate at a maximum level of 10 percent. Based on these studies and the volume of trade between the Philippines and its major partners, it is projected that the inflation rate of imported items for 1976-1977 would come up to about 9.8 percent.

APPENDIX F

DESIGN CRITERIA

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APPENDIX F

DESIGN CRITERIA

General

The following may be considered as design criteria for the long-range facilities for water supply purposes. However, in view of scarcity of funds and financial feasibility, the criteria for the initial and emergency stage may be of somewhat lower quality.

Service Area

Present and future water service areas will be determined for the water district. General topography, natural barriers, municipal boundaries, zoning plans will be taken into account in the determination of the future service area limits.

Population Projections

The total service area population would be projected on the basis of separate projections for the core city or poblacion and for the barrios within the present and future service areas. Transient population such as students, tourists, refugees, will be included in these estimates.

A percentage of population served will be estimated for the present and future systems. This estimation of percentage population currently served in the study area will be based on number of piped water connections and average number of persons per urban household as obtained from the official census books. In the estimation of future population served, cost and availability of the water from sources other than the water district will be considered.

Land Use Projections

Residential, institutional, industrial, commercial and public areas within the water service area will be designated either from the existing master development or zoning plans of the community or from data on other cities with similar characteristics. A projection of the land use pattern for the study area will be shown on a map and summarized in a table.

Pressure Zones

Depending on general topography of the water service area there may be one or more service pressure zones in the water distribution system. The maximum difference in ground levels in any pressure zone will not be more than 50 meters.

Separate supply lines from the source will be provided for each zone where economically feasible.

Unit Water Demands

a. Domestic: Average per capita domestic water consumption will be estimated for the service area. Past water district records and records from similar cities will be used for early estimates. When using the water district records, the actual metered customers and borrowers will be considered separately. For borrowers, an average unit consumption of 20 lpcd will be assumed. However, the final estimates will be based on actual field measurements. Field measurement will be done by direct meter reading by isolating certain service area sections that will represent different economic classes of customers. This measurement will be conducted in areas with adequate supply.

Unit domestic consumption will be increased by 1 to 2 percent each year to account for economic growth within the community.

b. Institutional and Commercial: Institutional and commercial water demands will be estimated as a percentage of domestic demand based on available past records of the water districts or similar cities. If no records are available a unit flow of 5 cumd per gross hectare will be used in the estimates.

c. Industrial: At present, there is no heavy industry in the study areas. However, available zoning plans designate areas for future heavy industrial development.

Past records on the water consumption of existing light industrial establishments will be studied to establish unit flows required per unit area. If no records are available, a unit flow of 10 cumd/ha (gross) will be used in the estimates.

d. Parks, golf courses: Water demands for the public parks and golf courses will be estimated from past records.

Unaccountable Water

A tentative percentage of the total supply requirement will be established for unaccountable water from available water district records and consumption patterns. The final estimate of unaccountable

water will be based on actual field measurements. Unaccountable water may include waste and unrecorded usage. It is assumed that the amount of unaccounted-for-water will be reduced gradually with the implementation of staged improvements to the system.

Total Supply

The total of various water demands and unaccounted-for-water will be the total water supply requirement for the study area. If there is more than one pressure zone in the service area, the required supply in each pressure zone will be estimated.

Demand Variation

Maximum-day and peak-hour demands in each service area will be estimated from the available records for areas with adequate supply. If no data are available the demand factors would be obtained from other similar areas. To check assumed values an attempt will be made in the field to record hourly fluctuations for a minimum period of 24 hours.

For preliminary studies, a maximum-day to average-day ratio of 1.2:1 and a peak-hour to average-day ratio of 1.5:1 - 2.0:1 will be used.

The present and future projected water demands will be tabulated.

Population and Demand Distribution

The service area will be divided into several sub-areas representing different population densities and demand patterns. Locations of the existing large demand customers (e.g., industry, military base, university campus, airport, etc.) and their water usages will be obtained through water district records or field measurements. With these data, a demand load distribution will be made for the existing and future water distribution systems.

Existing Water System Analysis

After gathering all pertinent data, the existing system will be analyzed through a computer program. All the pipelines, 100 mm and larger, will be included in this study. Regular and large demands will be distributed at relevant nodes of the system skeleton. Average-day demands will be included in computer input data. Demand factors will be applied for maximum-day and peak-hour flow conditions. About 5 percent of unaccountable water will be allocated to transmission

line and the remaining unaccountable water will be evenly distributed in the distribution system. The primary system (pipeline 4 inches and larger) will be checked for only peak-hour demand condition to find out about areas with capacity shortage and low pressures. Any high-level area which is being served by a booster station would be studied separately after establishing its hydraulic grade line (HGL).

If there is a storage tank floating in the system, the water level in the tank will be assumed to be at the middle of the operational storage portion, during peak-hour demand condition. In the computer application of the system, either the input flow or HGL at the source will be fixed. The following "C" values will be used for pipe friction losses.

a) Asbestos Cement Pipe

Size (mm)	100-150	200-300	350-500
"C" value	100	110	120

b) Cast Iron Pipe

Size (mm)	100-150	200-300	350-500
Age: new	100	110	120
10 years	90	100	110[1]
20 years	80	90	105[1]
30 years or more	70	80	100[1]

The internal distribution system will be checked for fire flow plus maximum-day demand. After computing the node pressures in the primary system for the maximum-day demand, a typical commercial residential area will be checked for fire protection. A fire flow demand of 15 lps will be applied at each of 2 adjacent hydrants.

Computer Studies for Future System

The proposed system will be studied for the design year 2000 first and the economy of construction staging for 1990 will be checked specially for supply, treatment and transmission facilities.

A system skeleton will be prepared for each pressure zone. Future pipelines will follow existing roads or proposed roads as much as possible. The maximum spacing between feeder main lines will not exceed 1,000 meters. For strengthening the system hydraulically all the pipelines will be looped as much as practical and economically feasible. The primary system which will be checked

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[1] Subject to field verification.

hydraulically first will include 200 mm and larger pipelines. The projected average-day demand loads will be distributed at nodes. For computer input, the pipe data will include a pipe number, connecting node numbers, diameter, length and "C" value; the node data will include a node number, ground elevation, and average-day demand for the design year.

The maximum hydrostatic pressure in the system will not exceed 70 meters. If the existing water supply facilities were to be used, the pre-established HGL elevation would be evaluated carefully for deciding whether to continue to use them or to phase them out.

If a feasible storage tank site can be located in the system, a system input at a rate of maximum-day demand will be required. If no storage tank site is available, then the system input will be at a rate of peak-hour demand. (In the case of well supply, this means the total safe yield from the wells has to meet peak-hour demands.)

In the proposed system, asbestos cement, cement lined cast or ductile iron, cement lined steel or prestressed concrete pipe will be used. The following "C" values will be applied throughout the studies:

Pipe Size (mm)	"C" Value
200-300	110
350-500	120
600-larger	130

A field cleaning and lining of existing large-size mains will be considered as part of the improvement program. An operational storage volume of 15-20 percent of maximum-day demand at the design year will be provided. The maximum operational level fluctuation in the tank will be 7 meters. If there is more than one storage in the system, the operational volume required at each site will be determined through computer analysis.

Well pump capacities will be based on an evaluation of the pumping test of the well for yield and drawdown. In determining pump head characteristics, the estimated minimum water level in the well, head losses through suction pipe assembly and the head required in the system would be investigated.

Booster pumps will be selected either to meet peak-hour demands if there is no distribution storage or to meet maximum-day demands if there is an adequate storage. Each booster zone will be studied

separately. The primary system (pipes 200 mm and larger) will be checked for:

a) Peak-hour demand condition by applying a demand factor of 1.5-2.0. (For this condition it will be assumed that the system storage tank level is 2-3 meters below the overflow elevation. The selected pipe sizes will be adequate for not creating a pressure less than 14 meters at any point of the primary system).

b) Minimum flow plus tank filling if the storage tank site is located too far from the demand center. (The minimum flow is 30 percent of the average daily demand.)

The internal distribution network will be checked for fire flow plus maximum-day demand, at least at 2 typical areas: (1) a high-value commercial area (for a fire flow of 20 lps from each of 2 adjacent hydrants); (2) a residential area (for a fire flow of 10 lps from each of 2 adjacent hydrants).

Computer runs will be repeated with revised pipe sizes until the system meets the design criteria.

Special effort will be made to utilize all or portion of the existing facilities as much as feasible. Data on the existing facilities required for this purpose are as follows:

Supply facilities	:	HGL elevation and variation flow input capacity
Pipelines	:	sizes, locations, "C" values
Pump Stations	:	pump curves, rated head and discharge values, HGL elevations on the suction and discharge sides, pump age, condition
Storage Tanks	:	overflow elevation, side water depth, operational depth, type, condition
Wells	:	safe yield, water level
Hydrants	:	inlet-outlet characteristics, locations
Valves	:	check valves, closed or throttled valves

Pipes

In evaluating and selecting the pipe material for the proposed improvement program of the service area waterworks system, careful consideration should be given to the following:

a. The pipe strength to resist both internal and external pressures;

b. Service life of the pipe material (resistance to corrosion, erosion and disintegration);

c. Pipe laying and jointing (simplicity, reliability);

d. Operation and maintenance problems; and

e. Economic consideration

Pressure class requirement for major transmission lines will be investigated on a pipeline profile. Working pressures will include additional allowances for surges and water hammer. Minimum pressure class of pipe will not be less than 7 kg/sqcm.

Generally, concrete pipe and cement-lined pipe have a better average coefficient of friction than unlined cast iron, ductile iron or steel pipe.

Because of the brittleness of the material, the use of cast iron pipe and asbestos cement pipe is generally limited to the smaller sizes. In addition to the inability to take large bending loads with brittle pipe, sudden failures and discharge large volumes of water that not only cause extensive damage but may also put the water system out of operation for a long period, can occur.

A high sulfate content of the soil will limit the use of concrete or asbestos cement pipe or require special protective coating. When the sulfate concentration in the soil exceeds 0.5 percent (or 300 mg/l), unprotected concrete pipe should not be used. Many types of soil can be corrosive to ferrous metal pipe. A corrosion survey along the pipeline routes is necessary to locate extremely corrosive areas so that suitable types of pipe material and protective systems can be selected.

A minimum trench width of 0.60 meter would be specified for new pipelines. Trench width will increase with the pipe size as shown in the following formula:

$$\text{Trench Width} = 0.50 + D \text{ (m)}$$

The minimum cover on a pipe shall be 0.60 meter. If there is a traffic load, the minimum cover shall be increased to 0.90 meter. If this cannot be accomplished, the pipe will be encased in concrete.

Recommended Pipe Materials

A final pipe selection can be based on economic cost comparison of the recommended pipe materials for the required service and capacity as shown in the following table:

Pipe Material	Diameter (mm)				Service	
	10-100	150-400	450-600	700-1200	Distribution	Transmission
Prestressed Concrete	-[2]	-	-	x	-	x
Steel	x			x	-	x
Cast Iron	-	x	x	-	x	x
Ductile Iron	-	x	x	x	x	x
Asbestos Cement	-	x	x	-	x	-
Polyvinyl Chloride or Polyethylene Pipe[3]	x	-	-	-		

Pipe class should be in accordance with the required operational pressures in the system.

Pipe Cleaning and Lining in Place

It is possible to increase capacity of old transmission and distribution pipelines by 20 to 50 percent with cleaning and lining process. This is specially true where extensive internal scaling has occurred in the pipeline. Experience shows that cleaning and cement lining in place of 150-mm diameter and larger water mains are more economical than installing new mains to obtain the same capacity increase. Therefore, cleaning and cement lining in place will be included in the improvement program, where extensive capacity losses in the water mains are observed.

Valves

To isolate and drain pipeline sections for test, inspection, cleaning and repair, a number of valves are generally installed in the line. The most commonly used valves are gate and butterfly valves, followed by check, cone valves, blow-off and air release valves. Despite the wide range of designs, all valves have only one purpose: to slow down or stop the flow of water. In a dis-

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[2] Galvanized steel pipe.
[3] Service connections only.

tribution system, a large number of shut-off valves (gate and butterfly) are utilized. Gate valves are more applicable to pipe sizes up to 300 mm. For larger-size pipelines butterfly valves will be used.

Valves in a distribution system will normally be located at street intersections. The valve spacing in high consumption areas will be closer than low consumption areas. A maximum valve spacing of 300 to 500 meters will be considered in preliminary layouts. However, the final value spacing will depend on judgment of conditions in a particular system.

Valves shall be equipped with handlever, handwheels, chains or hand, phematic or electric operations.

The minimum working pressure of valve will be in accordance with the service requirements. Valve design and manufacture will conform to the current AWWA or ASTM specifications.

Fire Hydrants

Fire hydrants will be located at street intersections as much as possible. Spacing and sizes will be as follows:

(a) High-value residential, commercial and industrial areas:

Spacing	:	150 m, maximum
Connecting pipe size	:	100 mm, minimum in looped systems 150 mm, minimum in dead-end systems
Hose outlet	:	1 x 60 mm (2½ in)
Pumper outlet	:	1 x 100 mm (4 in)

(b) Normal single family residential areas:

Spacing	:	250 m, maximum
Connecting pipe size	:	100 mm (4 in)
Hose-Pumper outlet	:	1-100 mm (4 in)

The exterior surface of fire hydrant will be painted for protection and easy location.

Flow Meters

A. Differential Head Meters

The flow of fluid through a constriction in a pressure conduct results in lowering of pressure at constriction. The drop in piezometric head between the undisturbed flow and the

constriction is a function of the flow rate. The venturimeter, flow nozzle and orifice meter are constriction meters which make use of this principle. The head loss through a venturimeter is considerably less than for the other two types of meters. Pitot tubes and pitotmeters may also be typed as differential head meters.

B. Mechanical Meters

Mechanical meters are widely used in water distribution systems. Two types of mechanical meters in common are positive displacement and propeller meters. The positive displacement-type meters are more accurate in measuring small flows. This type of meter is not recommended, however, for water having fine particles as it is likely to become inoperative due to clogging.

Plumbing Code

The Philippine National Plumbing Code shall be applicable.

Distribution Storage Tanks

Distribution storage tanks are used to provide storage volume to meet fluctuations in water use, to provide fire storage, and to stabilize pressures in the distribution system. The tank in relation to the service area, should be located as much as possible on the opposite site from the source; on the other hand, the tank location should not be too far away from the demand center. A storage tank is normally located at a sufficiently high point so that water level in the tank can control the hydraulic grade line and fluctuate with the variation of system demand. A tank refills when the demand is low and feeds into the system when the demand is high. With an adequately sized storaged tank, it is possible to have supply and transmission facilities operating, more or less, at a steady rate which is normally about maximum-day demand for the design year.

The total effective storage volume required in a service zone should be at least equal to the required operational storage. Fire and emergency storage may be provided if economically justified. As mentioned previously, the equalizing or operational volume is to be equal to 15 to 20 percent of the maximum-day demand in any design year. A maximum side water depth (or level fluctuation) of 7 meters will be assumed for the operational storage.

The maximum hydrostatic pressure in any pressure zone in the distribution system should not exceed 70 meters. The tank overflow elevation, therefore, will be set at a level which will be a maximum

of 70 meters higher than the lowest ground level in the service area. A storage tank can be ground-type, elevated or a stand-pipe, all covered. A tank shape can be rectangular or circular. Roof slab of a tank will be supported on interior columns. The tanks are normally constructed from reinforced concrete or steel. Reinforced concrete tanks have less maintenance costs and will not require foreign exchange.

Piping in a tank will consist of incoming flow pipe, overflow and drain pipe, and outgoing flow pipes. All these pipes, except overflow pipe, are valved.

For large cities within a same pressure zone, more than one tank site may be needed. In this case, volume distribution at each site can be determined through computer analysis. The land for the tank site should be sufficient to accommodate short-term as well as future storage units for the service area.

Booster Pump Stations

A pump station structure and related piping will be designed for a period of 25 years. On the other hand, the equipment, including pumps and motors, will be designed for about 15 years.

Selection of pumps will be based on system-discharge curve. With development of composite pump curve for the number of existing and proposed pumps at a station and application of this curve on the systems, the head-discharge curve indicates rated flow and head for the pumps. Where pump is pumping directly into distribution system, the system curve will be studied through computer analysis.

To prevent excessive pressures in the pumped supply system (specially during minimum demand periods), pumps will be selected with a shut-off head which will not be greater than the rated head by more than 10 percent.

If the water has to be pumped through a long transmission line before it reaches the distribution system, an economical study may be necessary before deciding on pumping head versus transmission pipe size. In this study, pressure limitation in a distribution system has to be considered. If there is an adequate storage in the system, the pump station can be designed for the maximum-day demands estimated for a particular design year. If there is no feasible site available for a storage tank, pump stations will have to be designed for peak-hour demands.

The total design head of a pump should include static head and dynamic head which consists of friction and turbulence losses in suction and discharge piping.

Pump drive will be either an electrical motor or a diesel engine. Economy and practicality of electric or diesel power will have to be studied for the study area.

Electricity is 480 volts, three-phased with 60 cycles. Local needs for additional power transmission line and a substation will have to be investigated.

In addition to manual start-stop, each pump station shall be equipped with high-pressure sensing device to automatically stop the pump on a high discharge or low suction pressure. For proper operation, maintenance and safety of a pump, the following are generally provided on the discharge line: shut-off valve, check valve, surge relief valve, pressure gage, flow meter and air and anti-vacuum valve.

Each pump station should have a superstructure constructed from locally available material to help provide security from theft and vandalism and to minimize the noise problem in residential areas.

Sufficient land should be taken for a pump station to accommodate short-term as well as future facilities.

Pumps are to be constant-speed single-stage, horizontal or vertical centrifugal type. The minimum number of pumps in any station will not be less than two. Pump ratings, make and model in the system will preferably be the same to simplify operation and maintenance. A stand-by capacity equal to that of largest pump in a pump battery is desirable to assure the firm capacity of the station even when one pump is out of service. When electricity is not reliable, one of the larger pump motors can be close-coupled with a diesel-or gas-driven engine. By this, at least part of station capacity will be available in the event of power failure.

Water Quality Criteria

The water provided by a public water supply system should be free from substances harmful to human health and should be of the highest quality through a treatment process that is economically feasible. An acceptable water should have the following general qualities:

1. Water should be free from pathogenic organisms, and at all times, free from suspicion of being a means of conveying disease;

2. Toxic substances in the water should be below the concentration that would be injurious to health.

3. The water should be free from encrusting or corrosive properties and should be clear, colorless, tasteless and odorless.

Maximum acceptable concentrations of some of the most significant constituents of water, as established by the Philippine National Committee on Drinking Water Standards and by the World Health Organization (WHO) are to be used as guideline.

Surface Water Sources

The treatment of water from a surface source must be economically feasible and should meet the current requirements of the Philippine Drinking Water Standards with respect to bacteriological, physical, chemical and radiological qualities.

The quantity of water at the source(s) should be adequate to supply or supplement the water demand of the service area at least until the year 2000.

Hydrological Studies

Daily or monthly stream flow records, if available, should be used in the safe yield estimates. If stream flow records are not available, correlations with similar basins with longer period of records, based on drainage areas, should be made. Recommendation should be made for the establishment of stream gaging stations for use in design. To extend stream flow records for a longer period, rainfall-runoff correlations can be used. The minimum recorded flow minus riparian rights would give the minimum amount of water available from a particular source for the service area. This minimum flow rate will be compared with the estimated total gross water demand in the service area to decide whether any impoundment is needed and when needed. Without a need for impoundment reservoir, a water diversion and intake structure would be required for the supply. If an impoundment is necessary to meet the demand, an investigation will have to be carried out on possible dam sites. Dam sites can be located, first, on 1:50,000 topo-maps. As a result of a preliminary field investigation covering area geology, accessibility and major relocation due to reservoir impoundment, some of the sites can be

eliminated. For the selected sites, mass inflow curves will be plotted covering at least one significant dry period. Mass inflow curve should be adjusted for evaporation and riparian rights. Demand lines drawn tangent to the high points of the mass curve represent rate of withdrawal from the reservoir. Assuming the reservoir to be full wherever a demand line intersects the mass curve, the maximum departure between the demand line and the mass curve represents the net reservoir capacity required to satisfy the demand. Usually some volume in the reservoir, which may also be called dead volume, is allocated for siltation.

To determine the basic dam height, area-volume curves are drawn up for each feasible dam site. From these curves, a dam height can be selected which would create enough volume of reservoir to satisfy the demand and dead volume requirements. Estimated reservoir volume will be increased by 25 percent for supply safety. In some cases, one stream may not yield sufficient quantity of water. Then it will be necessary to look into other river basins or ground water for supplementary supply.

In other cases, the same stream may be considered for multipurpose basin development including power, irrigation and navigation. This will require close cooperation with the other authorities to make sure that adequate amount of water will be available for municipal usage. In accordance with the governmental requirements in the Philippines, any proposed dam 60 meters or higher must be communicated to the National Power Corporation (Napocor).

Raw Water Pump Stations

Location, arrangement, type of equipment and structure are important aspects of a pump station to be investigated in the design. Before deciding on a raw water pump station, an economical cost comparison will be made for gravity flow through a tunnel if area topography is suitable. A raw water pump station usually requires an approach channel, intake structure which will be equipped with stop logs, bar screen and control gates, and pump wet well.

The station will be designed for the maximum-day demand in the design year. Pumps will be capable of delivering the design flow at the maximum head which is the sum of differential static head, suction lift (if any), and suction and discharge head losses. Selection of pumps in the station will be based on the application of pump curves on system head-capacity curve.

Electric motor or diesel engine-driven, vertical turbine pumps will be used for the raw water pumpage.

Staging of Source Development

During source development studies, a demand versus supply chart will be prepared to show a timely staging of facility construction. A demand-supply chart will include the supply from the existing sources which, in some cases, may be phased out if economically justified, following the development of new sources.

The staging of construction will be in accordance with the following demand conditions:

Facility	Demand
Dams	Average-day
Water Treatment Plant	Maximum-day
Diversion and Intake	Maximum-day
Transmission Lines	a) Peak-hour if no distribution storage b) Maximum-day if there is an adequate storage

Sufficient time shall be allowed for planning, design and construction of future facilities.

Surveys

Water quality surveys are important as they would indicate cost of treating the proposed source of water. Water samples will be taken from all the sources and laboratory analysis will be made. Topographical surveys at 1:2,000 scale will be required at dam sites for facility layouts.

Groundwater-Springs

Springs can be developed for gravity or pumped supply. In both cases, sufficient period of flow measurements will be needed for determining the minimum yield. The yield of some springs may be increased by direct pumpage; however, before this is done, a careful evaluation of aquifer and recharge area should be made to avoid possible damage to the spring. The major works needed for spring development would be the construction of a collection chamber with necessary piping arrangement. Water quality must be checked to see if any treatment would be required, the most likely quality problem with spring water being either excessive hardness, iron or manganese. The spring recharge area must be protected from pollution.

In the construction staging of spring development, the measured minimum yield should meet the maximum-day demand of the service area, if adequate storage is provided for peak-hour demands. With no storage in the distribution system, construction staging should correspond with peak-hour demands.

Groundwater-Wells

All the available data pertinent to existing wells in the study area will be collected and evaluated to determine well and aquifer parameters including water table elevations, well yields and drawdowns, well geometries, interference between wells, and water quality. In addition, geologic, hydrologic and meteorologic data will be evaluated with information on current withdrawals to estimate recharge to aquifers and the overall safe yield of the source.

In many cases, test wells may be constructed to obtain the necessary data. Test well sites and depths will be chosen to provide data on unexplored important sections of the aquifer. For each test well, a minimum number of 2 observation wells would be desirable.

Based on available information and test well results, the aquifer coefficients will be estimated. With this and the hydrogeological appraisal of the area, practical design yield, well size, depth and spacing can be planned. Water quality analysis will indicate treatment requirements of the source.

Construction staging of wells should follow the same criteria as explained for spring development.

Water, in general, has to be pumped from a groundwater well, with the exception of flowing artesian wells with adequate yield. Pumps normally used for this purpose are either multi-stage vertical turbine pumps which are shaft-driven by motors or engines located on top of well, or submersible pumps in which the pumps and electric motors are combined in one unit placed below the water surface of the well. The pump bowls may be set at approximately 5-10 meters below the lowest anticipated pumping level. The lowering of the water table in a given aquifer and the specific capacity of the well must be considered when calculating the anticipated ultimate pumping level.

Where the source of electric power is not reliable, diesel engines will be considered for pump drive units. Pumping head will be determined by pumping level in the well and minimum

pressure requirements in the distribution system during peak-hour demands or by tank-filling operation during minimum-hour demands.

Water Treatment Works

Objectives of Water Treatment. In the design of water treatment plants, the provision of safe water is the prime goal. The treated water must be clear and colorless and pleasant to the taste. Water quality obtained at the plant should be preserved in the distribution system. The control point for the determination of water quality is the consumer's tap and not the outlet of the treatment plant. Another basic objective is that water treatment be accomplished, using facilities with reasonable capital and operating costs. In plant design, the various alternatives, including plant performance and cost studies, will be investigated.

General Design Considerations. Where previous experience with treatment of the same or similar source is lacking, special studies would be necessary for design purposes. These special studies may include tests conducted in the laboratory, in existing plants or in pilot plants. The rated or nominal design capacity of the treatment plant will be the maximum-day water demand of the system for the design year. Using water demand projections, a logical program for development of treatment facilities may be established. Decision will have to be made about which units to be built initially for ultimate needs or to provide for development in stages. The following are factors which have a bearing on the period of design of treatment facilities: (1) the useful life of facilities, (2) the ease of extension, (3) the rate of growth of the service area, (4) the rate of interest on the loan, (5) the change of purchasing power during the debt period, and (6) the performance of facilities during the early years.

Pumping station and chemical building structures are to be constructed for ultimate capacity; pretreatment and filter facilities are to be built in stages as the need develops.

For operational safety, even in the initial stage of construction, none of the important units such as flocculation, settling and filter basins are to be less than two. Stand-by units will be provided especially when the plant treats a water that is highly contaminated.

Available sites will be evaluated to determine the most favorable location for the plant. An accurate estimate of the area required for the ultimate development of the site is important.

In plant sizing and layout, the following points will be considered:

(1) Frequency of basin cleaning, length of filter runs and effluent quality will be carefully evaluated.

(2) An economic but durable construction: outdoor type filters can be adopted in the Philippines. Construction items will be selected for a minimum service period of 50 years.

(3) The smallest feasible number of units will be chosen, but the number will be sufficient to provide stand-by capability.

(4) Operation of filters, flocculators and chemical feeding equipment requires the most attention of operators. It is therefore desirable to arrange the plant so that these functions are close together, rather than widely separated.

(5) Chemical feed lines are to be as short and direct as reasonably possible. For this reason, it may be necessary to place the rapid mix basin in the chemical building.

(6) Chemical handling and feeding system will be simplified.

(7) Unessential instrumentation will be avoided.

Types of Water Treatment Plants

The quality of raw water varies greatly from source to source. Accordingly, the type of treatment to produce a safe and palatable water will vary. The World Health Organization has established treatment requirements in relation to the coliform bacterial content of raw water.

Application of treatment methods in relation to raw water characteristics is shown in Appendix Table F-1.

Classification of treatment plants according to raw water quality is a useful guide to the designer. However, such classification is not a substitute for engineering studies including, in some instances, experimental and pilot plant work as the basis for plant design.

APPENDIX TABLE F-1

APPLICATION OF TREATMENT METHODS[4]

Water Quality		Pretreatment				Treatment					Special Treatment			
Constituents	Concentration	Screening	Prechlorination	Plain Settling	Aeration	Lime Softening	Coagulation and Sedimentation	Rapid Sand Filtration	Slow Sand Filtration	Postchlorination	Superchlorination[5] or Chloramonia-tion	Active Carbon	Special Chemical Treatment	Salt Water[6] Conversion
Coliform MPN per 100 ml (monthly average)	0–20									E				
	20–100			O			O	O	O	E				
	100–5,000		E				E	E	O	E				
	>5,000		E	O[7]			E	E		E	O			
Turbidity-units	0–100	O							O					
	10–200	O					E	E						
	> 200	O		O[8]			E	E						
Color-mg/l	20–70						O	O			O			
	> 70						E	E			O			
Tastes and odors	noticeable		O		O				O		O	E		
Calcium carbonate-mg/l	> 200					O	E	E	E				E	
Iron and manganese-mg/l	< 0.3		O	O				S						
	0.3–1.0				O		E	E	O					
	> 1.0		E		E		E	E	O				O	
Chloride-mg/l	0–250													
	250–500													O
	500[5]													E
Phenolic compounds-mg/l	0–0.005						O	O			O	O		
	> 0.005						E	E			O	E	O	
Toxic chemicals							E	E				E	O	
Less critical chemicals							O	O				O	O	

[4] E—essential; O—optional; S—special justification required

[5] Superchlorination shall be followed by dechlorination.

[6] As alternate, dilute with low-chloride water.

[7] Double settling shall be provided for coliform exceeding 20,000 M.B.N.

[8] For extreme muddy water, presedimentation by plain settling may be provided.

Source: Water Treatment Plant Design, ASCE, AWWA, CSSE, 1969 edition

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to time at given location, variable speed equipment is desirable for agitators. Power requirement is about 1.3 hp per 10,000-cumd flow. A recent trend in chemical mixing favors use of in-line blenders.

Coagulation and flocculation are greatly influenced by physical and chemical characteristics of water, including particle size and concentration, pH, water temperature, exchange capacity and electrolyte concentrations. The behaviour of water to be treated in a proposed plant can be best determined by: (1) laboratory testing using "jar test" technique, followed by laboratory filtration or (2) pilot plant.

The sequence of addition of chemicals for coagulation is often important and multiple points of application of the chemicals are therefore required. The chemicals ordinarily used are a pH-adjusting compound, such as lime or an acidic substance, the coagulant (normally aluminum sulfate or a ferric compound), and a coagulant or flocculation aid. Pre-chlorination treatment is commonly applied to water before or after a coagulant. Activated carbon for taste and odor control is usually applied at raw water intake to provide sufficient period of detention time.

Flocculation. Flocculation process follows chemical mixing. Detention time used for the design of flocculation basins will be 60 minutes. To increase floc strength, usage of chemical agents such as activated silica and polyelectrolytes may be considered. For the provincial areas in the Philippines, non-mechanical type of baffled flocculation basins may be economical. A distinct advantage of baffled flocculation basins is elimination of short circuiting of flow. However, the mixing intensity in this type of basin is dependent on flow rate.

The easiest way to manage flocculated water is to build the flocculation and sedimentation basins integrally, with a permeable baffle discharging the flocculated water into the sedimentation basin to assure uniform horizontal and vertical distribution of settling tank influent.

Sedimentation. This process usually finds application in 2 principal ways in water treatment: plain sedimentation and sedimentation following coagulation and flocculation. Plain sedimentation is usually used to reduce heavy sediment loads prior to complete treatment; therefore, it is often referred to as presedimentation.

Sedimentation following chemical coagulation and flocculation is used to remove color and turbidity by adding coagulants, and to remove hardness by adding lime and soda ash. This type of sedimentation follows presedimentation (if used) and aeration and precedes filtration.

In the design of sedimentation tanks, ideally, 4 zones are considered:

(a) an inlet zone to provide smooth transition from the influent flow to the uniform, steady flow desired in the settling zone. In general, the flocculation and settling basins are located in the same rectangular tank to eliminate the need for a channel inlet.

(b) a settling zone to provide tank volume for settling, free from the other 3 zones.

(c) a sludge zone to receive the settled material and prevent it from interfering with the sedimentation of particles in the settling zone.

(d) an outlet zone to provide smooth transition from the settling zone to the effluent flow. The water level in settling tanks is usually controlled at the outlet. Basin outlets are often of v-notch weir type, and these are quite often provided with means for vertical adjustment to aid in control of the overflow.

Most sedimentation tanks used in water purification today are of the horizontal flow type. The other types are known as upward-flow solids contact units and upward-flow sludge blanket type clarification basins. Because of simplicity in construction, operation and maintenance, the horizontal-flow type basins are expected to be applicable in the Philippines.

Horizontal-flow tanks may be either rectangular or circular in plan. Circular horizontal-flow tanks are usually center feed-type with radial flow. In a rectangular tank, the flow lines are parallel and all in one direction. The flow usually enters one end of the tank through a perforated or diffusion wall, travels the length of the tank, and then exits over some type of effluent weir. The choice of rectangular or circular horizontal-flow type is usually based on designer's preference and site limitations. Many sedimentation basins are equipped with mechanical equipment for the continuous removal of settled solids.

The standard approach in designing a sedimentation basin is to satisfy design criteria that have been arrived at through experience with full-scale plant operations and from pilot-plant research. Raw water quality varies from one source to another, therefore, only tentative design criteria can be established for preliminary design works.

The temperature of the water, the specific gravity of materials in suspension, and the size and shape of the suspended particles influence sedimentation process. Experience has shown that higher tank overflow rates can be used for warm water. A particle with higher specific gravity will settle faster. The time of retention in the sedimentation tank is important, because longer time permits more floc contacts and, hence, more floc growth.

The purpose of the settling tank is to hold the water for a period of time during which the velocity of flow through the tank has been greatly decreased to allow sedimentation to occur. The main characteristics of sedimentation tank involved include the tank surface area, which is dependent on the surface overflow rate; the tank depth, which is dependent on the detention time; the velocity of flow through the tanks, which is a function of the cross-sectional area of the tank, which in turn is a function of the length/width ratio of the tank, its surface area, and depth.

Preliminary design parameters of settling basins are shown in Appendix Table F-2.

APPENDIX TABLE F-2

DESIGN PARAMETERS OF SETTLING BASINS

Raw Water	Treatment	Overflow Rate (cumd/sqm)	Detention Time (hr)	Velocity through Basin (m/min)	Tank Depth (m)
Surface	Alum floc[2/]	25-50	2-4	0.15-0.50	3-4
	Ferrous floc[2/]	30-50	2-4	0.15-0.50	3-4
Surface or ground	Lime softening	40-60	1-3	0.20-0.60	3-4
	Without subsequent filtration	10-20	8-12	0.05-0.20	4-5
	Plain sedimentation	100	1-4	0.3 -1.00	3-5

Rectangular tanks can be constructed with practical lengths up to a maximum of about 80 meters. Generally, a length to width ratio between 3:1 to 5:1 is used. Rectangular tanks will have a

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[2/] With subsequent filtration.

minimum depth of about 2.5 meters and a recommended depth range from 2.5 to 5 meters. Where area is available, the shallower depths are preferable. In addition to the calculated settling basin, a provision for inlet, outlet and sludge collection zones, will be made.

The number of tanks to be provided is determined by the total flow, desired degree of flexibility of operation, and economy of design. A minimum of 2 basins must be provided. In larger plants, the number of units provided may be determined by the maximum practical size of a single tank.

The calculated width or diameter of a tank would later be adjusted to the next standard size of tank, for which mechanical collectors are available; for rectangular type, the length would be adjusted accordingly. Basins not provided with sludge removal equipment will be made deep enough to provide sufficient volume of sludge storage capacity. Typical basin outlet overflow rates are shown in Appendix Table F-3. In rectangular tanks, the overflow weir length required cannot usually be obtained with a single weir across the end of the tank. The required length is usually provided by a weir extension in the third outlet of the tank.

APPENDIX TABLE F-3

TYPICAL WEIR OVERFLOW RATES

Type of Treatment	Weir Overflow Rate cumd/m
Light alum floc (low turbidity water)	150
Heavier alum floc (higher turbidity water)	200
Heavy floc from lime softening	300

If gravity discharge of the sludge from the mechanically cleaned sedimentation tank is not feasible, sludge pumps of sufficient capacity must be installed.

Filtration. The goal of water treatment is to obtain the greatest clarity (or lowest turbidity) of the filter effluent. Water filtration is a physical and chemical process for separating suspended and colloidal impurities from water by passage through a porous medium, usually a bed of single or multi-layer granular material.

Filtration may be classified hydraulically as slow or rapid, depending upon the rate of flow per unit of surface area. Slow sand filters operate at a rate as high as 9 cumd/sqm, and rapid-- or high-rate filters operate as high as 20 cum/hr/sqm. One of the principal drawbacks to the use of slow sand filters is the large land area required. Another is the difficulty of getting good results under all raw water conditions. Slow sand filters are cleaned by scraping a surface layer of sand and washing the removed sand and returning it to the bed. Algae growth is another problem with slow sand filters specially in hot climates. As slow sand filters require minimum amount of mechanical equipment, it may be considered in the provincial areas of the Philippines where much land is available and when it is justified economically.

In the design of new plants, the gravity rapid filter with coarse-to-fine media (dual media) is the obvious choice for the great majority of installations. The best example of this is the coal-sand filter with a coarse coal layer of about 18 inches deep above a fine sand layer of about 8 inches thick. The filter media are supported by an underdrain system. The most important function of the filter underdrain is to provide uniform distribution of backwash water. It also serves to collect the filtered water. With many types of filter bottoms or underdrains, a supporting bed of gravel is used to keep the sand out of the underdrain and clearwell during filtration and to assist in uniform distribution of washwater during cleaning of beds. A gravel depth of 12 inches is usually adequate. The silica sand used in the filter media is specified to have an effective size of 0.35-0.50 mm and uniformity coefficient of about 1.7. Crushed anthracite coal has a specific gravity of 1.5, as compared to 2.65 for silica sand. Effective sizes of coal up to 0.7 mm are used in filters.

Efficiency of dual-media filters can be increased by the use of polyelectrolyte filter aid in small dose, usually 0.01-0.05 mg/l.

Warm water is easier to filter than cold water. Filtrability is the most important property of the applied water. Pilot plant studies are strongly recommended in preparation to filter plant design not only for filtrability of raw water and filter design but also for the measurement of wash rates and expansion required to fluidize the proposed bed.

The usual number of filter units is four, except in small plants where it may be two. The maximum size of individual filter units is governed principally by the rate at which washwater must be supplied and by problems in securing uniform distribution of washwater, that increase with larger areas. The largest filter unit normally employed is about 200 sqm. A unit of this size would be divided into 2 units of equal size, so that each half could be backwashed separately. For the preliminary design, a filtration rate of 10 cum/hr/sqm will be used.

Filters are usually laid out side by side in rows along one side or along both sides of a pipe gallery. One end of the row of filters should be kept unobstructed to permit future expansion. In proposed plants in the Philippines, the filter tops will be open as there will be no freezing problem. Clear-well storage will be located not underneath the pipe gallery but in an area adjacent to the filter basins.

Depth of water over the filter media for warm water may be about 1.5 meters. This much of adequate water depth above the media would reduce the possibility of air binding during loss of head operation.

Filter backwashing is done to remove from the bed all of the foreign material collected in the bed during the preceding filter run. In a warm climate, a maximum upward backwash flow of 50-60 cum/hr/sqm must be provided. Wastewater from backwash is collected in washwater troughs and conveyed into a waste drain.

Filters are equipped with a means of controlling the rate of flow through each bed.

Bacterial removal by filtration is never 100 percent, and the filtered water must be chlorinated for satisfactory disinfection. Provisions should be made to chlorinate filter influent and effluent.

Appendix Table F-4 shows the recommended velocities for water filtration units:

APPENDIX TABLE F-4

RECOMMENDED VELOCITIES FOR FILTRATION UNITS

Location	Velocity (m/sec)
Influent	1.0
Effluent	1.5
Backwash	3.5
Waste	2.0

Cost Estimates

The construction cost estimates of proposed improvements will be based on projected July 1978 unit prices. The estimates will show foreign and local cost components of the project cost. Con-

struction cost projections will be made for all items which will be included in a water supply project. When using a source information outside the Philippines necessary adjustment will be made to reflect the local labor cost. All estimates will be based on an exchange rate of ₱7 to $1. It will be assumed that customs duty will be charged on items imported for public water supply projects. Separate cost indices for local and foreign cost components will be developed. Cost tables will be prepared to show a breakdown of the estimated construction cost for major items.

The total project cost of any alternative scheme will be computed in the following manner:

1.	Construction Cost	A
2.	Physical Contingencies	0.15 A
	Sub Total	B
3.	Engineering	0.10 B
	Sub Total	C
4.	Land Cost	D
	Project Cost	E

(Cost contingency (inflation) and interest during construction are added later on.)

Economic Cost Comparison

In the determination of the least-cost water supply scheme, present worth cost comparison will be utilized. The present worth cost estimates will be based on the following criteria:

Base Year: 1978
Discount Rate: 12 percent
Service Life of Facilities:
a) Structures and Pipelines: 50 years
b) Mechanical Equipment: 15 years
c) Land: infinite

Total project cost will include construction cost, engineering and contingencies, land cost, administrative and legal fees and interest during construction. Present worth of capital costs will be calculated backward from completion time of construction.

Construction period will be estimated on the basis of similar type of facility construction in the Philippines.

Annual costs will include personnel, power, chemicals, and maintenance costs. These estimates will be carried out for the years 1978, 1990 and 2000. Present worth cost of annual expenditures will be based on gradient series at 12 percent interest rate.

Cost of any facility to be replaced during design period (1975-2000) will be included in the present worth cost analysis.

No escalation factor will be applied on July 1978 prices as all the schemes will be affected in the same rate.

Salavage value of a facility will be estimated by using linear depreciation for its value throughout its service life.

Economic comparison of alternative schemes and selection of the least-cost scheme will be based on present worth of net disbursements during the period of 1978-2000.

A P P E N D I X G

BASIS OF COST ESTIMATES/ACTUAL BIDS

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BASIS OF COST ESTIMATES/ACTUAL BIDS

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APPENDIX G

BASIS OF COST ESTIMATES/ACTUAL BIDS

Prologue

The original work in developing Appendix G was completed in December 1975. Since then several factors have developed and influenced the basis for cost estimates:

1. Recent construction bids on the initial construction phases of San Pablo Water District (October 1975), Bacoled Water District (December 1975), Cagayan de Oro Water District (January 1976), Davao Water District (April 1976) and Batangas Water District (April 1976). (Appendix Tables G-8 to G-13 at the latter part of Appendix G show actual bid prices that compare conservatively with CDM estimates.);

2. The decline of the Philippine inflationary rate, estimated by NEDA to have been 7.4 percent in 1975;

3. Worldwide optimism by knowledgeable economists that the near-term inflationary rates of the various countries bearing an influence in the Philippines will likewise decelerate to manageable levels.

As a result of these projections, the analysis used in these studies assumes the following escalation rates for the following periods:

	Annual Escalation Rate
1976 - 1980	10%
1981 - 1985	8%
1986 - 1990	6%

The resulting multipliers using July 1976 as Unity are as follows:

Year	Escalation Factor	
1976	1.000	(July 1976 unit prices)
1977	1.100	
1978	1.210	(Use for second 10 feasibility studies)
1979	1.331	
1980	1.464	
1981	1.581	
1982	1.707	
1983	1.844	
1984	1.991	
1985	2.151	
1986	2.280	
1987	2.417	
1988	2.562	
1989	2.716	
1990	2.879	

This report will use July 1978 cost figures as a basis for cost analysis and projections. Therefore, to convert the 1976 unit prices into July 1978 price levels, these should be multiplied by 1.21.

General

Cost data presented here refer basically to estimated construction costs which include all materials and labor together with some allowance for related miscellaneous work and contractor's overhead and profit. The cost data have been converted to unit prices in table or curve form for easy application during feasibility studies. In developing the estimates, data and information from various sources including local engineering consulting firms, materials and equipment manufacturers and suppliers and construction contractors have been utilized. In some cases, prices and cost estimates from the United States, modified and adjusted to suit local conditions, were also used. The cost figures have been projected to prices likely to prevail in July 1976.

Construction costs undergo short- and/or long-term changes reflecting fluctuation in the local (national) economy and world prices. In the United States, construction cost trends are printed weekly in the Engineering News Record (ENR) and used extensively as a guide for construction cost projections. Based on price movements of structural steel, portland cement, lumber and common labor, and beginning with base of 100 in 1913, this index has risen steadily and had a value of about 2,100 in mid-1974.

Cost analysis includes the development of construction cost indices (CCI) for local and foreign exchange component (FEC) of the cost. Price indices furnished by the Department of Economic Research, Central Bank of the Philippines (CBP) were applied to labor (skilled and unskilled), local materials, contractor's overhead, and profit. The CBP consumer price indices for all items were applied to the labor and profit components of construction work. For local materials, the retail price indices for construction materials were used. For imported mechanical and transportation equipment, the ENR cost indices were adopted. The resulting projections to July 1978 are shown in Appendix Figures G-1 and G-2.

The unit costs which are developed for this study are for construction costs only. The total project cost would include other items like surveys and engineering, contingencies, land and easement costs, administrative and legal costs, and interest during construction. A typical breakdown of the total project cost is shown in Appendix Table G-1.

APPENDIX TABLE G-1

TOTAL PROJECT COST

Item	Construction Period	Cost in Pesos		
		Local	FEC	Total
1. Source Development				
Material and Equipment		. . .	. . .	. . .
Civil and Structural Work		. . .	. . .	. . .
Construction Cost		. . .	. . .	. . .
15% Contingencies		. . .	. . .	. . .
Sub-Total		. . .	. . .	. . .
10% Engineering		(35%)	(65%)	. . .
Sub-Total		. . .	. . .	. . .
Land Costs		. . .	. . .	. . .
Total Project Cost[1]		. . .	. . .	. . .
2. Water Treatment Plant	. . .			
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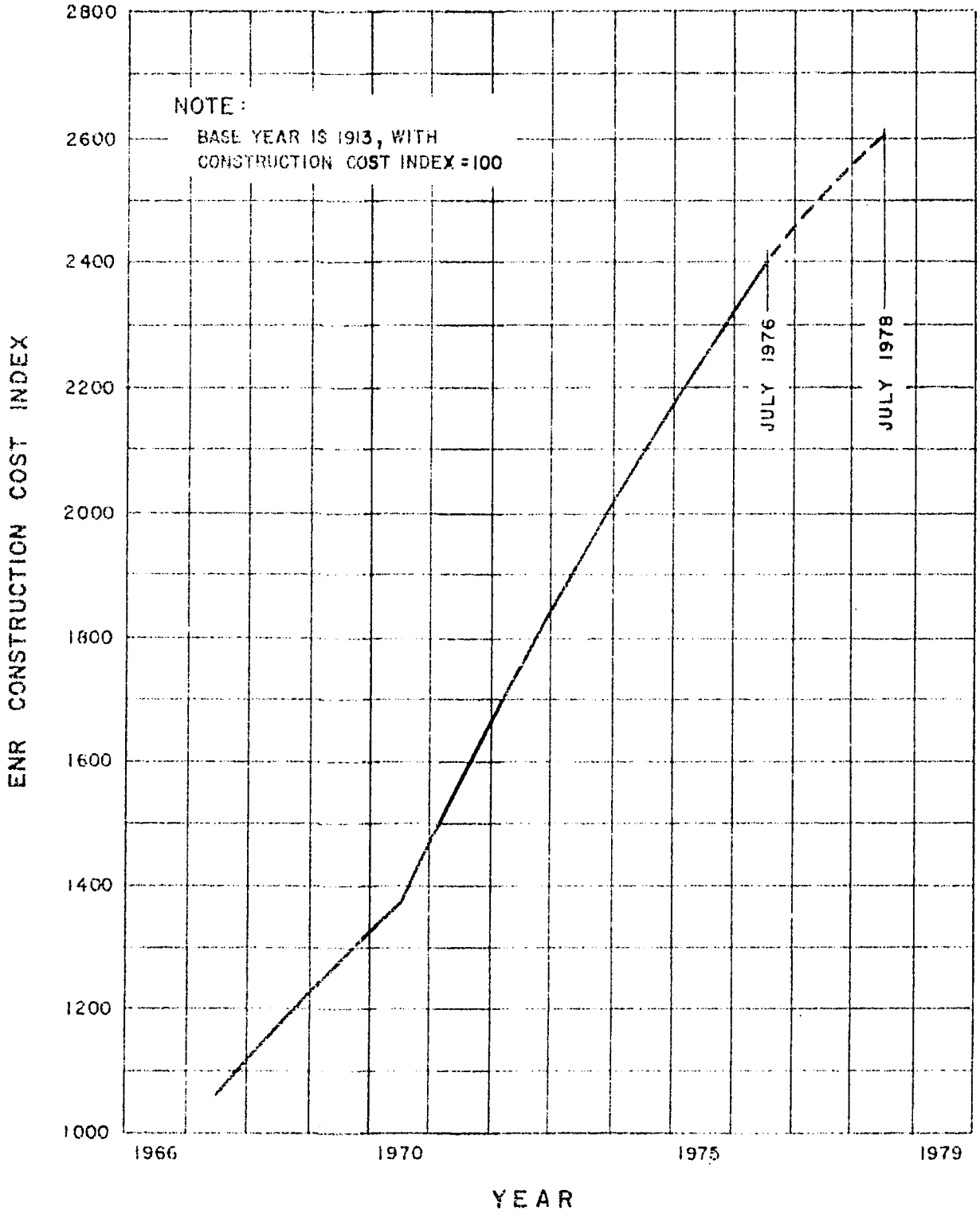
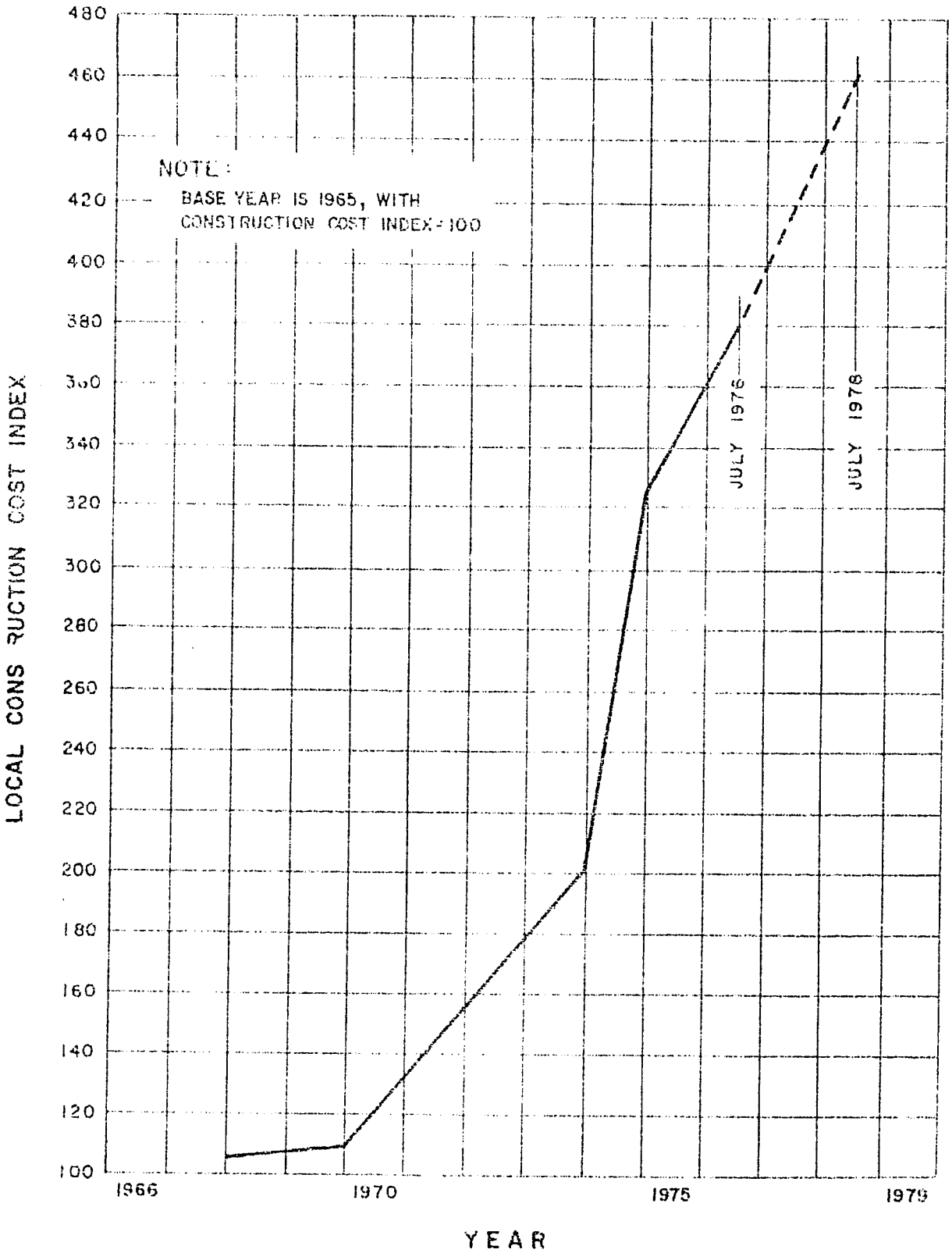
[1] Excluding interest during construction.



APPENDIX FIGURE G-1
ENGINEERING NEWS RECORD
CONSTRUCTION COST INDEX



APPENDIX FIGURE G-2
LOCAL CONSTRUCTION
COST INDEX

Dams and Appurtenances

Dams and appurtenances are special structures and as such, they must be treated individually in developing estimates for construction costs. Unit costs for items of work that normally enter into the construction of earthfill dams and appurtenances are listed in Appendix Table G-2. Application of the unit costs to estimated quantities for a given dam project will yield estimates of the construction cost for the project or components thereof.

Tunnels

The construction costs of tunnels are heavily dependent on a large number of variables including the types of rock or other material encountered; the physical or structural defects of the rocks; the extent to which water is present in the formations along the route of the proposed tunnel; length of tunnel to be driven; the size and shape of tunnel; the method of attacking the tunnel headings or faces; method of drilling (conventional vs. machine); ventilation and dust control requirements; the mucking operation employed; timbering; steel supports and rock bolt required; design and thickness of concrete lining; the skill and ability of workmen; and the knowledge and experience of their supervisors. Reasonably accurate construction costs of tunnels are difficult to estimate, more so in the absence of cost data on existing installations. Reliable estimates can be made only after thorough investigation of the tunnel route by borings, geological study and consultation with specialists in tunnel construction. The unit price approach, i.e., cost per unit length of tunnel, to tunnelling cost estimates is risky and can result in substantial errors.

For the purposes of this study, estimating prices developed for tunnels are those for component or appurtenant work for tunnelling rather than for the completed tunnel. The cost figures are presented in Appendix Table G-3. Construction cost for each tunnel project must be estimated individually.

Deep Wells

Cost data for deep well construction are presented in Appendix Figure G-3. The costs are based on actual construction costs, bid prices, and contract prices for deep wells.

APPENDIX TABLE G-2

UNIT COSTS FOR DAM AND APPURTENANCES[2/]

A. Dam Embankment

Item	Unit	Unit Cost (July 1976) (P)	Remarks
Clearing and grubbing	ha	1,500	Under water add 15%
Common excavation	cum	16	Under water add 15%
Hard pan excavation	cum	20	Under water add 15%
Rock excavation	cum	25	Under water add 15%
Rockfill for embankment			
quarry excavation	cum	65	
hauling and placement	cum/km	8	
Placement of coarse aggregate	cum	12	
Place of fine aggregate	cum	12	
Impervious earth core			
hauling	cum/km	8	
placement	cum	7	
Backfill			
dump	cum	8	
compacted	cum	60	
Crushed rock (material)	cum	50	
Riprap (placement)	sqm	30	
Steel sheet pile in place	ton	10,000	

B. Spillway

Excavation	(see unit costs given above)	
Concrete (plain)	cum	500
Reinforced concrete	cum	900

C. Mobilization and Demobilization: 5% of Total Construction Cost

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2/ Foreign exchange component of dams and appurtenances is 30 percent of total construction cost.

APPENDIX TABLE G-3

TUNNEL CONSTRUCTION COST[3] ESTIMATES
(July 1976 prices)

Item Number	Work Description	FEC (% of total)	Total Unit Cost (₱)
A.	Items with Unit Quantities		
1.	Open Excavation		
	a) Rock	45	25/cum
	b) Hard pan	45	20/cum
	c) Soil	40	16/cum
2.	Tunnel Excavation	50	200/cum
3.	Tunnel-Concrete Lining	35	1,000/cum
4.	Tunnel-Steel Supports	35	See Item B.4 below
5.	Rock Bolts	20	See Item B.5 below
6.	Grouting	45	See Item B.6 below
7.	Drainage	25	See Item B.7 below
8.	Miscellaneous	50	See Item B.8 below

B. Unit Prices Variable With Tunnel Inside Diameter
(All unit prices in pesos per meter of tunnel)

Item Number	Work Description	Tunnel Diameter (m) 2.5	3.0	4.0	5.0	7.0
4	Steel Supports[4]	800	900	1,100	1,300	1,550
5	Rock Bolts[4]	350	400	450	500	550
6	Grouting[4]	400	500	650	800	900
7	Drainage and Ventilation	500	550	600	650	650
8	Miscellaneous	500	600	750	900	1,000

[3] Does not include engineering and contingencies, land cost, administrative and legal fees.

[4] For required length only.

The estimating prices include materials and labor cost and are for non-gravel packed wells with perforated casing in lieu of a well screen. Costs of materials are based on the use of imported Schedule 40 black iron pipe casing. Labor costs include mobilization and demobilization charges, drilling, installation of casing, perforating, developing the well, test pumping, well disinfection, and grouting the upper 15 to 30 meters of the well.

Deep Well Pump and Pumphouses

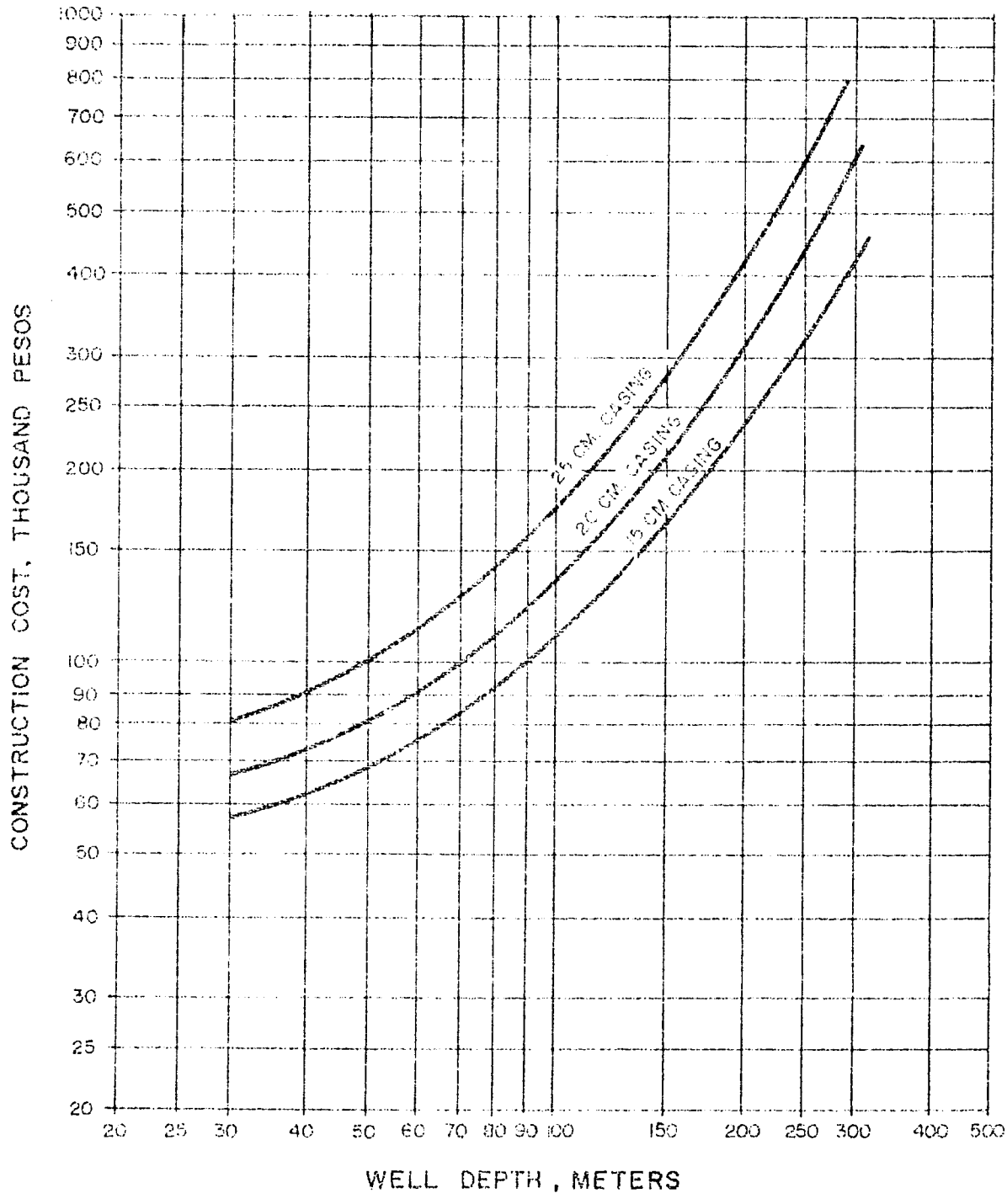
Construction cost estimates for deep well pumps and pumphouses are shown in Appendix Figure G-4. The estimates in Appendix Figure G-4 are based on the use of diesel engine driven deep well turbine pumps and include discharge piping and valves, controls, miscellaneous materials, and installation. The pumphouse is assumed to be constructed of masonry or cast-in-place reinforced concrete walls and roof of wooden members and corrugated galvanized iron roofing sheets. Alternatively, cast-in-place reinforced concrete flat slab roof may be employed. Costs do not include that of land and other site improvements.

Water Pump Stations

The cost curves which are shown in Appendix Figure G-5 are for a pump station adjacent to a river or lake. The cost of this type or pump station includes an approach channel, intake structure and a pump wet well. A superstructure for housing pump, motors and controls and necessary piping are also included. Cost of land, power transmission and substation, and access road must be added to the cost obtained from Appendix Figure G-5.

Water Treatment Plants

Numerous water treatment plants with various capacities have been built in the United States. Therefore, it was possible to develop cost curves for the treatment plants based on plant capacities used in the preliminary cost estimates. However, it was necessary to modify U.S. costs to reflect differing construction costs in the Philippines. The resulting construction costs are shown in Appendix Figure G-6. Costs related to land purchase, access road and power facilities will have to be added to the costs obtained from these curves.

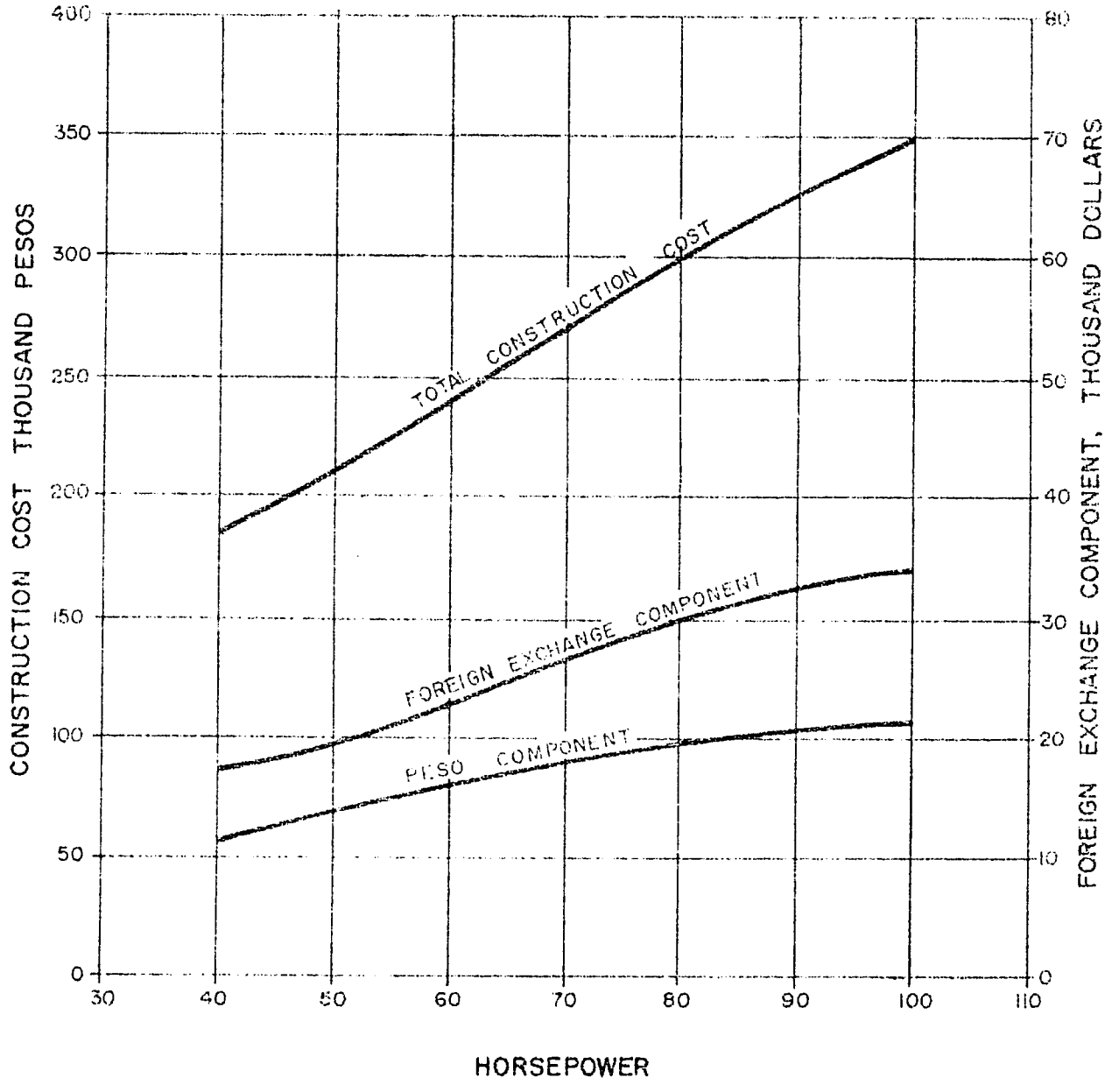


NOTES:

1. COST INCLUDES MOBILIZATION AND DEMOBILIZATION, DRILLING, CASING, SCREEN, DEVELOPING AND GROUTING.

2. FOREIGN EXCHANGE COMPONENT IS ABOUT 25 % OF TOTAL COST

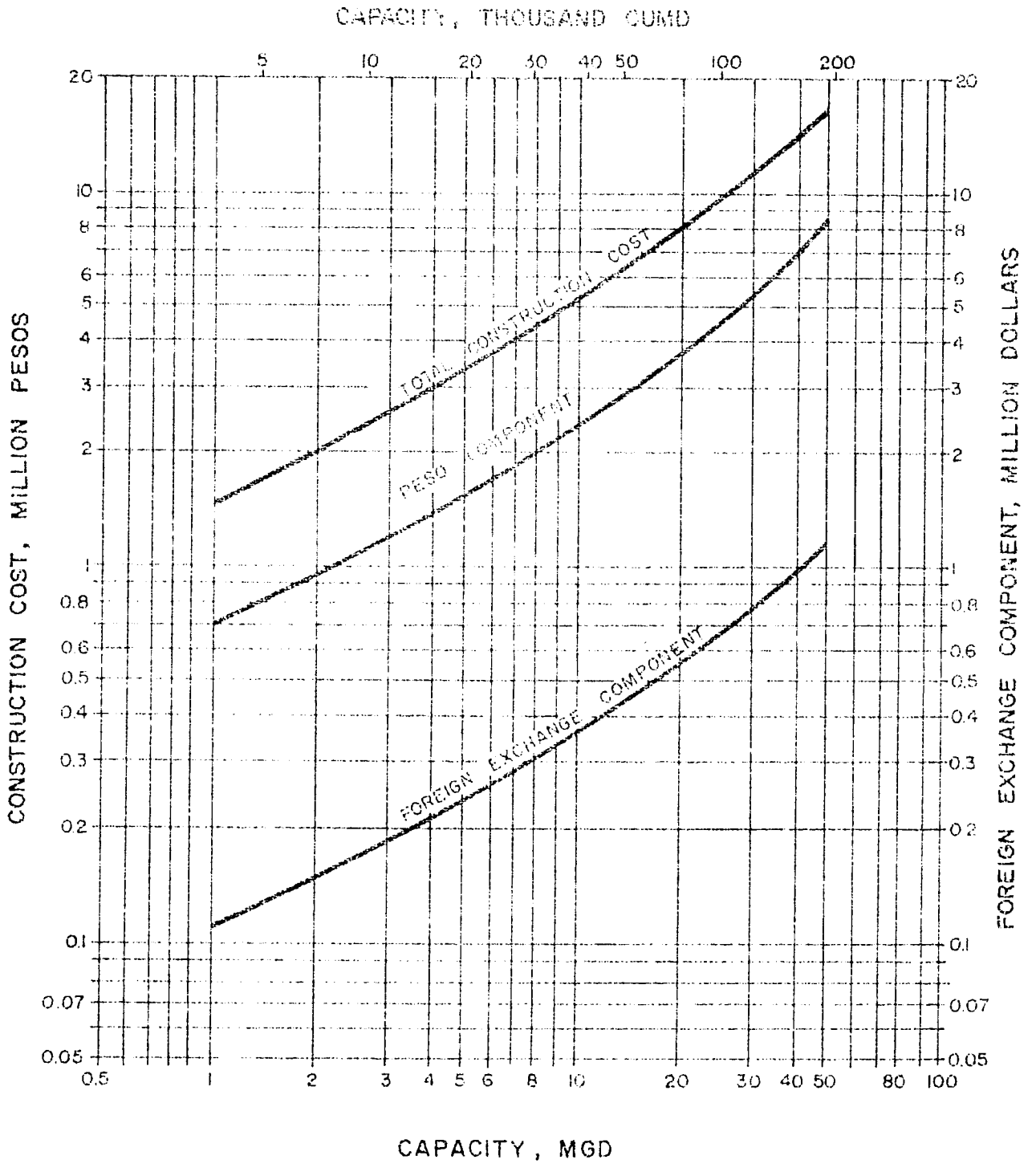
APPENDIX FIGURE G-3
DEEP WELL
CONSTRUCTION COSTS
(JULY 1976 PRICES)



NOTE:

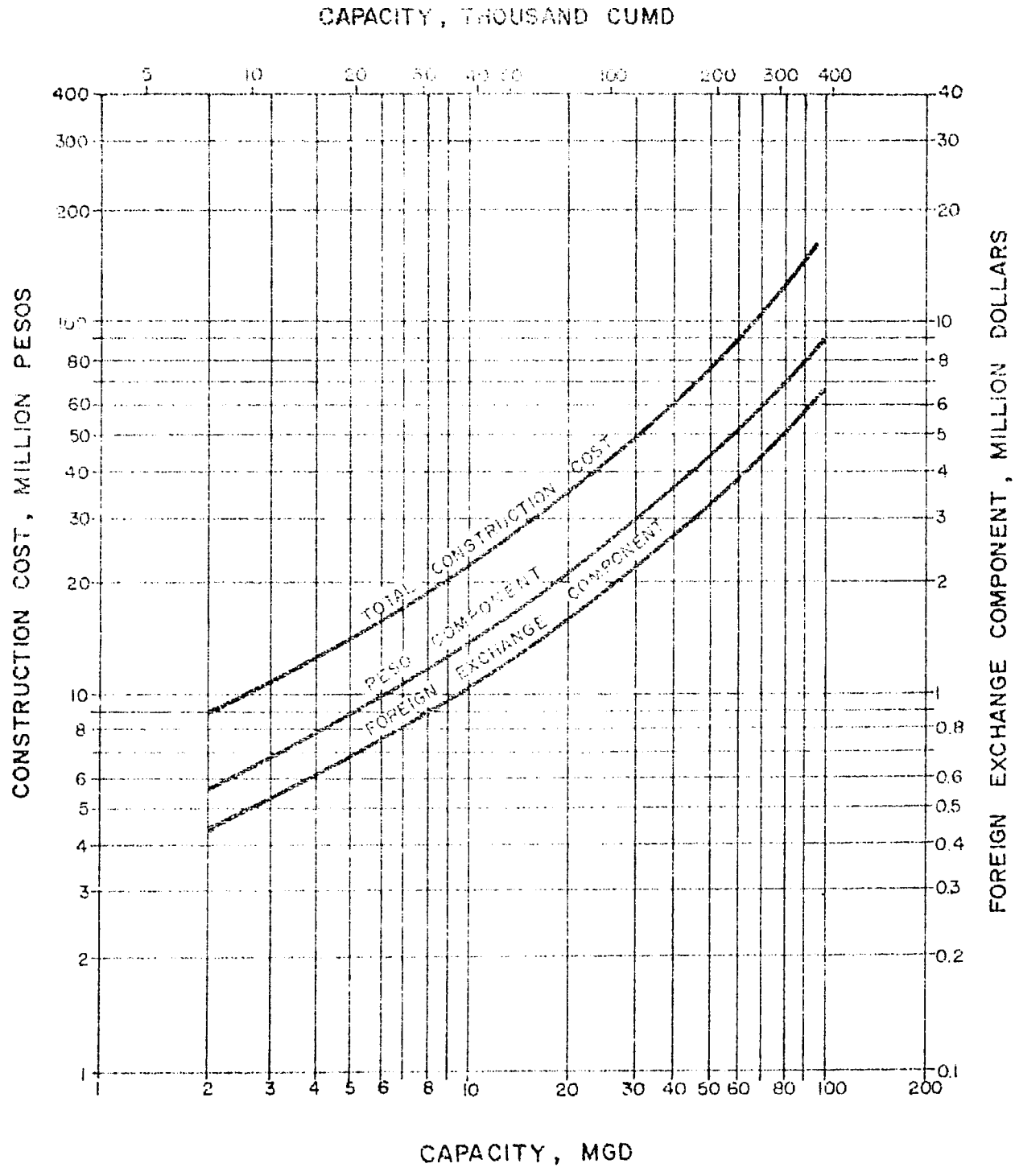
1. COST INCLUDES PUMP AND ENGINE DRIVE, CONTROLS, VALVES, FITTINGS, PUMP HOUSE, AND INSTALLATION.

APPENDIX FIGURE G-4
DEEP WELL PUMP STATION COSTS
(JULY 1976 PRICES)



APPENDIX FIGURE G-5
WATER PUMP STATION
CONSTRUCTION COSTS
(JULY 1976 PRICES)

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



NOTE:

1 COST INCLUDES CHEMICAL MIXING, FLOCCULATION, SETTLING BASINS; RAPID SAND FILTERS, CHLORINATION, SITE WORK, STRUCTURES AND EQUIPMENT.

APPENDIX FIGURE G-6
WATER TREATMENT PLANT
CONSTRUCTION COSTS
(JULY 1976 PRICES)

Water Mains

Cost studies have been made on pipe of various materials including cast iron, asbestos cement, steel, ductile iron and prestressed concrete. The unit costs of pipelines are based on the assumption that the least-cost pipe, whether locally manufactured or imported, will be utilized. The estimated unit in-place costs based on lower limit of cost envelope, are presented in Appendix Table G-4. The costs include pipe, fittings, jointing materials, excavation, pipe bedding, backfill, laying and jointing, concrete thrust blocks, pressure and leakage testing, disinfection and flushing, pavement replacement, clean up, transportation, contingencies, and contractor's overhead and profit. Cast iron pipe costs assume AWWA class 150 pipe with inside lining, outside tar coating, and bell and spigot lead caulked joints. Costs for asbestos cement pipe are for Class 25, ISO R160 specifications, with sleeve-type coupling joints. Costs for steel pipes are based on pipe with a wall thickness of 0.25 inch, with inside cement lining and outside double enamel coating.

Booster Pump Stations

Cost curves for booster pump station are shown in Appendix Figure G-7. Development of these curves is based on available local information and U.S. costs with some adjustment for the labor component. Booster pump station costs include pumps and motors, necessary controls, piping and a superstructure. Depending on location of the pump station, cost of access road, power transmission line and a substation, and land would have to be added to the costs obtained from this curve.

Ground Storage Reservoirs

Construction cost estimates of ground storage reservoirs are presented in Appendix Figure G-8, including steel, reinforced concrete and prestressed concrete tanks. The costs for steel and reinforced concrete tanks are based on updated costs of actual construction in the past in the Philippines and in other parts of the world.

For tanks constructed of prestressed concrete, the costs are based on prices of similar tanks constructed in the United States adjusted to reflect local prices of materials and labor and on the assumption that local expertise, equipment and facilities for such construction are available. At present, prestressed concrete tanks are not constructed in the Philippines.

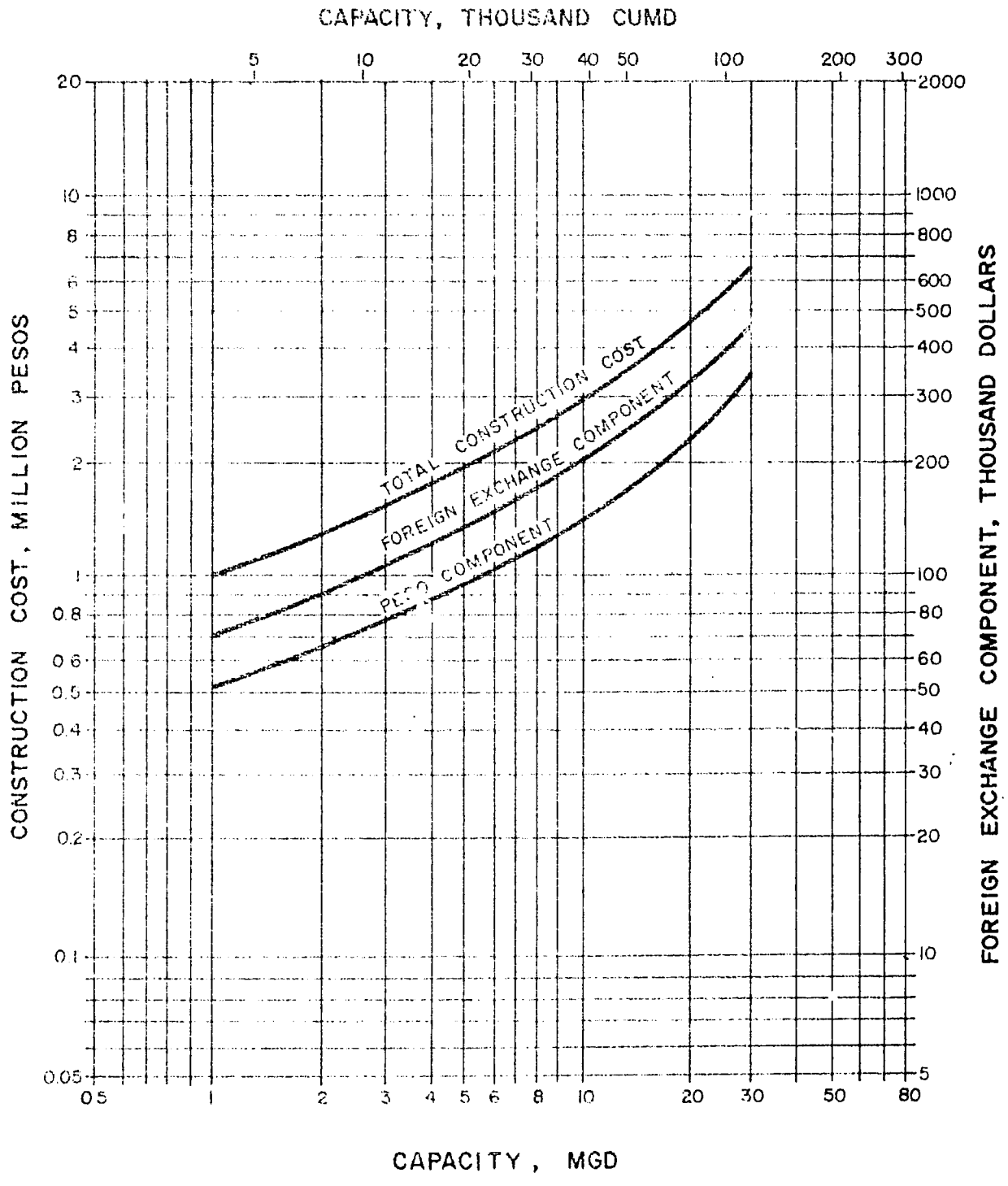
APPENDIX TABLE G-4

PIPELINE COSTS
(July 1976)

Size (mm)	Material	Unit Cost (₱/m) Local	FEC[5]	Total
100	AC, CI	47	33	80*
150	AC, CI	78	72	150
200	AC, CI, DI	96	104	200*
250	AC, CI, DI	148	182	330
300	AC, CI, DI	190	250	440*
350	AC, CI, DI	216	324	540*
400	AC, CI, DI	264	396	660*
450	AC, CI, DI	277	453	730*
500	AC, CI, DI	296	504	800*
600	AC, CI, DI	342	608	950*
700	PSCP, S, DI	448	672	1,120
800	PSCP, S, DI	520	780	1,300
900	PSCP, S, DI	588	882	1,470
1,000	PSCP, S, DI	672	1,008	1,680
1,100	PSCP, S, DI	780	1,170	1,950
1,200	PSCP, S, DI	912	1,368	2,280
1,300	PSCP, S, DI	1,000	1,500	2,500
1,400	PSCP, S	1,160	1,740	2,900
1,500	PSCP, S	1,260	1,890	3,150

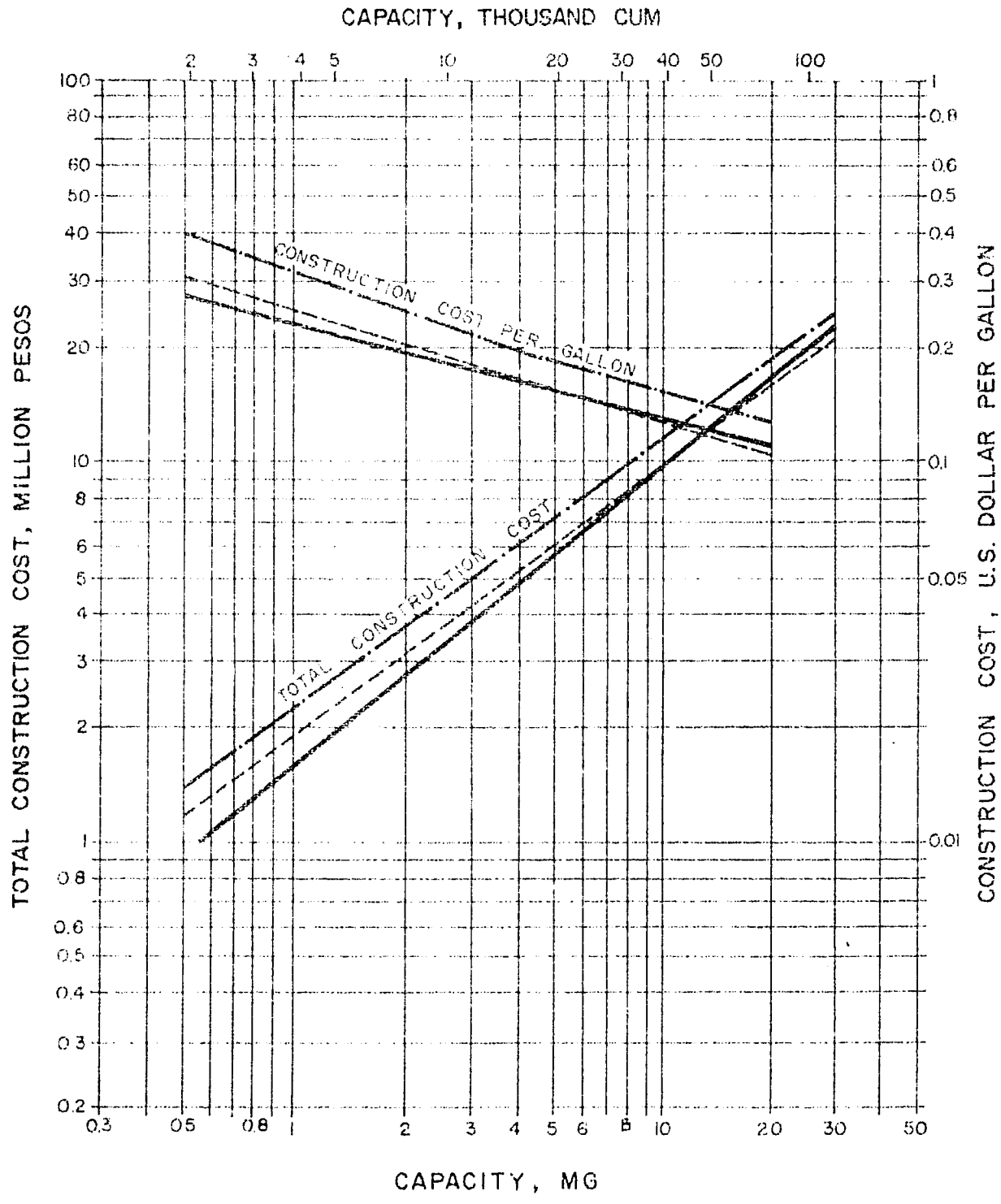
*Based on contractor's bid prices for San Pablo and Bacolod City water supply system improvements in November and December 1975.

[5] US $1 = ₱7.00



APPENDIX FIGURE G-7
BOOSTER PUMP STATION CONSTRUCTION COSTS
(JULY 1976 PRICES)

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



LEGEND:

STEEL

PRESTRESSED CONCRETE

REINFORCED CONCRETE

NOTE:

FEC OF STORAGE TANK COST IS ESTIMATED TO BE ABOUT 20 %.

APPENDIX FIGURE G-8
CONSTRUCTION COSTS FOR COVERED GROUND STORAGE TANKS
(JULY 1976 PRICES)

Tank costs include ordinary piping, valving, and tank accessories such as vent, access manhole, ladder rungs, etc. The costs do not include special valves and controls, land taking and access road.

Gate Valves

Gate valves up to 600 mm diameter can be manufactured in the Philippines. Unit costs for gate valves are based on the prices of locally manufactured valves. However, studies indicate that the prices of imported (U.S.) gate valves conforming to AWWA Standard 0500 are only slightly higher than those of the locally manufactured valves. The in-place estimating prices for gate valves up to 300 mm diameter are shown in Appendix Table G-5. The unit prices include a locally manufactured cast iron valve box and cover.

Butterfly Valves

Current local practice uses butterfly valves instead of gate valves for sizes 350 mm and larger. Butterfly valves are not manufactured in the Philippines and therefore cost data for this type of valve are based on the assumption that these valves will be imported. The unit in-place costs are given in Appendix Table G-5.

Fire Hydrants

The unit in-place costs for fire hydrants assume the use of dry barrel, compression type, traffic model hydrant with 2½-inch hose connection and one 4-inch pumper connection. The cost figures are shown in Appendix Table G-6 and include fire hydrant, gate valve, tee fitting, jointing materials, concrete thrust blocks, miscellaneous materials, and installation.

Service Connections

Cost data for service connections developed for this work are for 2 types of service lines. In the first type, the service line consists essentially of flexible polyethylene (PE) plastic pipe without a "gooseneck". The other type consists of a service line made up of GI pipe and employs a PE plastic pipe gooseneck.

The unit in-place estimating prices are for service connections from ½ to 2 inches as shown in Appendix Table G-7. The cost figures are based on the assumption that all materials and components of the service connection would be locally manufactured. The unit costs also assume connection to asbestos cement water distribution mains and include a service clamp in all cases.

APPENDIX TABLE G-5

IN-PLACE VALVE COSTS

A. Gate Valves

Size (mm)	In-Place Cost (P) Local	FEC	Total
100	630	770	1,400
150	760	1,140	1,900
200	990	1,610	2,600
250	1,300	2,400	3,700
300	1,580	3,220	4,800
350	3,040	6,460	9,500
400	3,900	9,100	13,000

B. Butterfly Valves

300	2,035	3,465	5,500
350	3,370	6,260	9,630
400	4,370	8,870	13,240
450	5,083	11,315	16,398
500	5,890	14,410	20,300
600	6,700	18,100	24,800
700	7,500	22,500	30,000
800	8,800	27,600	36,400
900	9,600	32,400	42,000
1,000	11,200	39,800	51,000
1,100	12,600	47,400	60,000
1,200	14,200	56,800	71,000
1,300	15,200	64,800	80,000
1,400	16,200	73,800	90,000
1,500	17,300	84,700	102,000

APPENDIX TABLE G-6

FIRE HYDRANTS[6]

Size (mm) (inlet connection)	In-Place Cost[7] (₱) Local	FEC[8]	Total
100	1,572	2,202	3,774
150	2,304	3,173	5,477

APPENDIX TABLE G-7

COST OF SERVICE CONNECTIONS
(July 1976)

Diameter (in)	In-Place Cost[9] (₱) Local	FEC[10]	Total
½	150	216	366
5/8 - 3/4	160	240	400
1	180	330	510
1½	360	840	1,200
2	450	1,350	1,800

6/ Hydrants are imported.

7/ Costs are for July 1976.

8/ Based on ₱7 to $1.

9/ The above estimated costs include all the material and work necessary for a service connection from water main to the meter (5 to 15 meters long) with the exception of pavement replacement and the meter.

10/ Foreign exchange component is based on contractor's bid prices for San Pablo and Bacolod City water supply system improvements in November and December, 1975. Exchange rate is US $1.00 to ₱7.00.

Not included in the unit costs are curb stops, curb boxes, and water meters. The in-place prices of these items should be added to the tabulated unit costs should it be desired to include them in the installation and estimating prices.

Actual Bid Prices

Appendix Tables G-8 to G-13 compare CDM estimates and unit prices taken from construction bids on the initial construction of the water supply systems of the following water districts: Bacolod, Batangas, Cagayan de Oro, Davao and San Pablo. Deepwell construction costs for these water districts are itemized in Appendix Tables G-14 to G-18.

APPENDIX TABLE G-8

UNIT PRICES OF PIPE-IN-PLACE
(₱/lineal meter)

Estimate by or Bid on	Date	Material	Cost/Meter	Remarks
		100 mm pipe		
CDM Estimate	July 1976	AC, CI	80.00	
Davao Water District	April 1976	AC	48.00	Low Bid
		"	48.56	
		"	50.00	
		"	53.42	
		"	59.00	
		"	66.12	
		"	70.68	
		"	87.80	
Bacolod Water District	Dec 1975	PVC	60.12	Low Bid
		"	62.60	
		"	88.10	
San Pablo Water District	Oct 1975	PVC	49.76	Low Bid
		"	73.83	
		"	125.00	
		150 mm pipe		
CDM Estimate	July 1976	AC, CI	150.00	
Cagayan de Oro Water District	Jan 1976	PVC	50.50*	Low Bid
		"	102.80*	
		"	113.38*	
Batangas Water District	April 1976	ACP	74.00	Low Bid
		"	80.90	
		"	105.00	

*LWUA furnished pipes.

APPENDIX TABLE 6-8 (Continued)

Estimate by or Bid on	Date	Material	Cost/Meter	Remarks
		200 mm pipe		
CDM Estimate	July 1976	AC, CI, DI	200.00	
Cagayan de Oro Water District	Jan 1976	Steel	193.25	Low Bid
		"	194.80	
		"	227.29	
		"	371.32	
Batangas Water District	April 1976	ACP	117.00	Low Bid
		"	130.70	
		"	155.00	
Davao Water District	April 1976	AC, Steel	123.11	Low Bid
		"	132.00	
		"	135.00	
		"	136.42	
		"	146.40	
		"	168.00	
		"	174.00	
		"	256.00	
Bacolod Water District	Dec 1975	PVC	138.62	Low Bid
		"	154.80	
		"	196.45	
San Pablo Water District	Oct 1975	PVC	126.29	Low Bid
		"	184.18	
		"	250.00	
		250 mm pipe		
CDM Estimate	July 1976	AC, CI, DI	330.00	
Batangas City Water District	April 1976	ACP	183.00	Low Bid
		"	223.65	
		"	250.00	

APPENDIX TABLE G-8 (Continued)

Estimate by or Bid on	Date	Material	Cost/Meter	Remarks
		300 mm pipe		
CDM Estimate	July 1976	AC, CI, DI	440.00	
Cagayan de Oro Water District	Jan 1976	Steel	339.70	Low Bid
		"	341.65	
		"	369.33	
		"	549.99	
Batangas Water District	April 1976	ACP	228.00	Low Bid
		"	255.65	
		"	285.00	
Bacolod Water District	Dec 1975	Steel	369.00	Low Bid
		"	377.08	
		"	382.90	
		350 mm pipe		
CDM Estimate	July 1976	AC, CI, DI	540.00	
Davao Water District	April 1976	Steel (LWUA	296.00	Low Bid
		" pipe)	340.00	
		"	347.83	
		"	376.39	
		"	399.00	
		"	406.00	
		"	532.00	
		"	700.00	
Bacolod Water District	Dec 1975	Steel	388.03	Low Bid
		"	400.00	
		"	428.65	
San Pablo Water District	Oct 1975	Steel	492.11	Low Bid
		"	560.00	
		"	587.55	

APPENDIX TABLE G-8 (Continued)

Estimate by or Bid on	Date	Material	Cost/meter	Remarks
		400 mm pipe		
CDM Estimate	July 1976	AC, CI, DI	660.00	
Cagayan de Oro Water District	Jan 1976	Steel	418.80	Low Bid
		"	471.35	
		"	476.00	
		"	633.67	
Batangas Water District	April 1976	Steel	321.00	Low Bid
		"	426.00	
		"	430.00	
Davao Water District	April 1976	Steel	338.00	Low Bid
		"	359.14	
		"	360.00	
		"	419.81	
		"	430.08	
		"	446.00	
		"	580.00	
		"	780.00	
Bacolod Water District	Dec 1975	Steel	456.06	Low Bid
		"	459.00	
		"	530.65	
San Pablo Water District	Oct 1975	Steel	588.22	Low Bid
		"	635.00	
		"	657.85	
		450 mm pipe		
CDM Estimate	July 1976	AC, CI, DI	730.00	
Davao Water District	April 1976	Steel	398.00	Low Bid
		"	474.35	
		"	475.00	
		"	581.00	
		"	651.00	
		"	808.00	
		"	1,030.00	
		"	1.078.06	

APPENDIX TABLE G-8 (Continued)

Estimate on or Bid on	Date	Material	Cost/meter	Remarks
		450 mm pipe (continued)		
Bacolod Water District	Dec 1975	Steel	555.64	Low Bid
		"	588.00	
		"	772.95	
San Pablo Water District	Oct 1975	Steel	695.17	Low Bid
		"	770.00	
		"	825.96	
		500 mm pipe		
CDM Estimate	July 1976	AC, CI, DI	800.00	
Cagayan de Oro Water District	Jan 1976	Steel	549.00	Low Bid
		"	605.00	
		"	613.00	
Batangas Water District	April 1976	Steel	372.00	Low Bid
		"	520.00	
		"	530.00	
Davao Water District	April 1976	Steel	447.00	Low Bid
		"	500.00	
		"	502.65	
		"	561.42	
		"	582.00	
		"	597.00	
		"	835.00	
		"	1,020.00	
Bacolod Water District	Dec 1975	Steel	609.00	Low Bid
		"	683.00	
			703.60	
		600 mm pipe		
CDM Estimate	July 1976	AC, CI, DI	950.00	
Cagayan de Oro Water District	Jan 1976	Steel	787.00	Low Bid
		"	847.00	
		"	900.00	
		"	1,044.34	

APPENDIX TABLE G-8 (Continued)

Estimate on or Bid on	Date	Material	Cost/meter	Remarks
		600 mm pipe (continued)		
Batangas Water District	April 1976	Steel	493.00	Low Bid
		"	552.00	
		"	700.00	
Davao Water District	April 1976	Steel	630.00	Low Bid
			645.87	
			692.00	
			723.00	
			730.00	
			751.91	
			909.00	
			1,240.00	
Bacolod Water District	Dec 1975	Steel	729.86	Low Bid
		"	748.00	
		"	836.00	
		900 mm pipe		
CDM Estimate	July 1976	PSCP, S, DI	1,470.00	
Davao Water District	April 1976	Steel	1,105.45	Low Bid
			1,115.00	
			1,140.00	
			1,221.00	
			1,342.00	
			1,361.22	
			1,665.00	
			2,070.00	

APPENDIX TABLE G-9

UNIT PRICES OF GATE VALVES
(Lump Sum, ₱/Item)

Estimate by or Bid On	Date	Local(₱)	FEC(₱)	Total(₱)	Remarks
		100 mm			
CDM Estimate	July 1976	630	770	1,400	
San Pablo Water District	Oct 1975	480	660	1,140	Low Bid
		1,877	-	1,877	
		1,600	629	2,229	
Cagayan de Oro Water District	Jan 1976	238	647	885	Low Bid
		502	616	1,118	
		50	1,114	1,164	
		533	703	1,236	
Bacolod Water District	Dec 1975	818	592	1,410	Low Bid
		914	621	1,535	
		1,061	615	1,676	
Davao Water District	April 1976	503	630	1,133	Low Bid
		600	622	1,222	
		700	568	1,268	
		743	600	1,343	
		657	716	1,373	
		664	730	1,394	
		971	568	1,539	
		865	675	1,540	
Batangas Water District	April 1976	861	-	861	Low Bid
		706	1,221	1,927	
		805	1,221	2,026	

APPENDIX TABLE G-9 (Continued)

Estimate by or Bid On	Date	Local(₱)	FEC(₱)	Total(₱)	Remarks
		150 mm			
CDM Estimate	July 1976	760	1,140	1,900	
San Pablo Water District	Oct 1975	600	900	1,500	Low Bid
		2,203	-	2,203	
		1,690	860	2,550	
Cagayan de Oro Water District	Jan 1976	67	1,531	1,598	Low Bid
		980	810	1,790	
		1,170	813	1,983	
		1,385	889	2,274	
Bacolod Water District	Dec 1975	940	855	1,795	Low Bid
		1,225	814	2,039	
		1,289	840	2,129	
Davao Water District	April 1976	600	900	1,500	Low Bid
		773	830	1,603	
		679	1,142	1,821	
		1,020	830	1,850	
		1,047	810	1,857	
		1,080	803	1,883	
		1,178	808	1,986	
		1,169	830	1,999	
Batangas Water District	April 1976	1,109	-	1,109	Low Bid
		760	2,326	3,086	
		1,025	2,326	3,351	
		200 mm			
CDM Estimate	July 1976	990	1,610	2,600	Low Bid
San Pablo Water District	Oct 1975	990	1,388	2,378	Low Bid
		2,190	1,349	3,539	
		3,926	-	3,926	

APPENDIX TABLE G-9 (Continued)

Estimate by or Bid On	Date	Local(₱)	FEC(₱)	Total(₱)	Remarks
		200 mm (Continued)			
Cagayan de Oro Water District	Jan 1976	1,186	1,277	2,463	Low Bid
		88	2,404	2,492	
		1,374	1,270	2,644	
		1,841	1,395	3,236	
Bacolod Water District	Dec 1975	1,510	1,320	2,830	Low Bid
		1,535	1,345	2,880	
		1,833	1,277	3,110	
Davao Water District	April 1976	700	1,388	2,088	Low Bid
		690	1,587	2,277	
		1,081	1,267	2,348	
		1,186	1,320	2,506	
		1,221	1,298	2,519	
		1,410	1,260	2,670	
		1,505	1,262	2,767	
		1,499	1,407	2,906	
Batangas Water District	April 1976	-	-	-	
		250 mm			
CDM Estimate	July 1976	1,300	2,400	3,700	
Batangas Water District	April 1976	2,383	-	2,383	Low Bid
		1,222	4,762	5,984	
		1,440	4,762	6,202	
		300 mm			
CDM Estimate	July 1976	1,580	3,220	4,800	
San Pablo Water District	Oct 1975	2,024	2,662	4,686	Low Bid
		3,160	2,607	5,767	
		7,021	-	7,021	

APPENDIX TABLE G-9 (Continued)

Estimate by or Bid On	Date	Local(₱)	FEC(₱)	Total(₱)	Remarks
		300 mm (Continued)			
Cagayan de Oro Water District	Jan 1976	1,890	2,436	4,326	Low Bid
		1,912	2,467	4,379	
		138	4,642	4,780	
		2,965	2,694	5,659	
Bacolod Water District	Dec 1975	1,821	2,615	4,436	Low Bid
		2,417	2,542	4,959	
		2,592	2,467	5,059	
Davao Water District	April 1976	750	2,700	3,450	Low Bid
		1,226	2,482	3,708	
		741	3,307	4,048	
		1,870	2,408	4,278	
		1,629	2,662	4,291	
		2,045	2,482	4,527	
		2,409	2,482	4,891	
		2,458	2,482	4,940	
Batangas Water District	April 1976	2,964	-	2,964	Low Bid
		1,338	6,698	8,036	
		1,570	6,698	8,268	

APPENDIX TABLE G-10

UNIT PRICES OF SERVICE CONNECTIONS
(Lump Sum, ₱/conn, 5-15 m long)

Estimate by or Bid On	Date	Local(₱)	FEC(₱)	Total(₱)	Remarks
	5/8" or 3/4" diameter				
CDM Estimate	July 1976	160	240	400	
San Pablo Water District	Oct 1975	125	287	412	Low Bid
		562	-	562	
		420	315	735	
Bacolod Water District	Dec 1975	93	187	280	Low Bid
		175	196	371	
		234	192	426	
Davao Water District	April 1976	104	123	227	Low Bid
		72	192	264	
		136	138	274	
		100	202	302	
		152	187	339	
		170	173	343	
		228	179	407	
		240	225	465	
Cagayan de Oro Water District	Jan 1976	64	180	244	Low Bid
		56	196	252	
		113	382	495	
		360	228	588	
	1" diameter				
CDM Estimate	July 1976	180	330	510	
San Pablo Water District	Oct 1975	161	399	560	Low Bid
		648	-	648	
		590	698	1,288	

APPENDIX TABLE G-10 (Continued)

Estimate by or Bid On	Date	Local(₱)	FEC(₱)	Total(₱)	Remarks
		1" diameter (Continued)			
Cagayan de Oro Water District	Jan 1976	74	244	318	Low Bid
		64	300	364	
		115	580	695	
		425	322	747	
Bacolod Water District	Dec 1975	153	202	355	Low Bid
		106	259	365	
		167	294	461	
		288	286	574	
Davao Water District	April 1976	106	189	295	Low Bid
		103	251	354	
		153	202	355	
		125	300	425	
		186	243	429	
		185	268	453	
		290	218	508	
		256	256	512	
		1 1/2" diameter			
CDM Estimate	July 1976	360	840	1,200	
San Pablo Water District	Oct 1975	978	-	978	Low Bid
		318	1,068	1,386	
		680	1,162	1,842	
Cagayan de Oro Water District	Jan 1976	86	574	660	Low Bid
		93	612	705	
		725	868	1,393	
		196	1,495	1,691	
Bacolod Water District	Dec 1975	144	660	804	Low Bid
		204	820	1,024	
		335	738	1,073	

APPENDIX TABLE G-10 (Continued)

Estimate by or Bid On	Date	Local(₱)	FEC(₱)	Total(₱)	Remarks
		1 1/2" diameter	(Continued)		
Davao Water District	April 1976	102	421	523	Low Bid
		352	222	574	
		213	480	693	
		175	600	775	
		130	656	786	
		230	669	899	
		470	450	920	
		395	607	1,002	
		2" diameter			
CDM Estimate	July 1976	450	1,350	1,800	
San Pablo Water District	Oct 1975	445	578	1,023	Low Bid
		1,467	-	1,467	
		850	1,560	2,410	
Cagayan de Oro Water District	Jan 1976	108	1,166	1,274	Low Bid
		112	1,447	1,559	
		1,024	1,285	2,309	
		171	2,193	2,364	
Bacolod Water District	Dec 1975	192	1,050	1,242	Low Bid
		410	1,120	1,530	
		215	1,325	1,540	
Davao Water District	April 1976	133	690	823	Low Bid
		220	725	945	
		106	969	1,075	
		690	638	1,328	
		496	848	1,344	
		225	1,125	1,350	
		487	893	1,380	
		245	1,167	1,412	

APPENDIX TABLE G-11

UNIT PRICES OF BUTTERFLY VALVES
(Lump Sum, ₱/Item)

Estimate by or Bid On	Date	Local(₱)	FEC(₱)	Total(₱)	Remarks
		350 mm			
CDM Estimate	July 1976	3,370	6,260	9,630	
San Pablo Water District	Oct 1975	3,400	4,388	7,788	Low Bid
		3,668	5,722	9,390	
		5,418	5,648	11,066	
Cagayan de Oro Water District	Jan 1976	-	-	-	
Bacolod Water District	Dec 1975	3,092	5,380	8,472	Low Bid
		3,254	5,640	8,894	
		3,157	5,820	8,977	
Davao Water District	April 1976	771	6,495	7,266	Low Bid
		850	6,750	7,600	
		2,923	4,972	7,895	
		3,788	5,138	8,926	
		2,874	6,356	9,230	
		3,330	6,420	9,750	
		3,595	8,715	12,310	
		5,370	8,415	13,785	
Batangas Water District	April 1976	-	-	-	
		400 mm			
CDM Estimate	July 1976	4,370	8,870	13,240	
San Pablo Water District	Oct 1975	5,035	5,888	10,923	Low Bid
		4,980	8,032	13,012	
		7,781	7,962	15,743	

APPENDIX TABLE G-11 (Continued)

Estimate by or Bid On	Date	Local(₱)	FEC(₱)	Total(₱)	Remarks
		400 mm (Continued)			
Cagayan de Oro Water District	Jan 1976	3,074	7,962	11,036	Low Bid
		3,588	7,762	11,350	
		4,670	8,697	13,367	
		205	14,984	15,188	
Bacolod Water District	Dec 1975	3,635	6,901	10,536	Low Bid
		3,775	8,205	11,980	
		4,829	7,658	12,487	
Davao Water District	April 1976	804	8,012	8,816	Low Bid
		1,000	8,250	9,250	
		3,430	7,279	10,709	
		4,642	6,360	11,002	
		4,480	7,350	11,830	
		4,735	7,421	12,156	
		4,240	8,468	12,708	
		5,690	8,468	14,158	
Batangas Water District	April 1976	1,766	6,416	8,182	Low Bid
		2,257	16,123	18,380	
		2,284	16,123	19,007	
		450 mm			
CDM Estimate	July 1976	5,083	11,315	16,398	
San Pablo Water District	Oct 1975	6,085	8,250	14,335	Low Bid
		5,829	10,125	15,954	
		9,582	10,010	19,592	
Cagayan de Oro Water District	Dec 1975	-	-	-	
Bacolod Water District	Dec 1975	4,678	8,422	13,100	Low Bid
		4,787	10,312	15,099	
		5,845	10,005	15,850	

APPENDIX TABLE G-11 (Continued)

Estimate by or Bid On	Date	Local(₱)	FEC(₱)	Total(₱)	Remarks
		450 mm (Continued)			
Davao Water District	April 1976	1,500	9,750	11,250	Low Bid
		856	11,385	12,241	
		3,950	9,750	13,700	
		4,251	9,465	13,716	
		4,727	9,465	14,192	
		6,700	8,902	15,602	
		5,700	10,455	16,155	
		7,017	9,465	16,482	
Batangas Water District	April 1976	-	-	-	
		500 mm			
CDM Estimate	July 1976	5,890	14,410	20,300	
San Pablo Water District	Oct 1975	-	-	-	
Cagayan de Oro Water District	Jan 1976	4,115	15,084	19,199	Low Bid
		5,372	14,228	19,600	
		7,602	16,482	24,084	
		238	28,395	28,633	
Bacolod Water District	Dec 1975	-	-	-	
Davao Water District	April 1976	1,700	12,750	14,450	Low Bid
		883	14,550	15,433	
		4,711	11,865	16,576	
		5,095	11,520	16,615	
		8,091	11,520	19,611	
		8,557	11,520	20,077	
		7,030	13,538	20,568	
Batangas Water District	April 1976	2,801	9,444	12,245	Low Bid
		3,285	21,178	24,463	
		4,591	21,178	25,769	

APPENDIX TABLE G-11 (Continued)

Estimate by or Bid On	Date	Local(₱)	FEC(₱)	Total(₱)	Remarks
		600 mm			
CDM Estimate	July 1976	6,700	18,100	24,800	
Bacolod Water District	Dec 1975	6,357	15,509	21,866	Low Bid
		6,210	18,998	25,208	
		7,185	19,568	26,753	
Davao Water District	April 1976	1,700	18,750	20,450	Low Bid
		928	21,839	22,767	
		6,324	16,882	23,206	
		5,959	17,670	23,629	
		7,760	17,850	25,610	
		11,631	17,160	28,791	
		11,846	17,160	29,006	
		900 mm			
CDM Estimate	July 1976	9,600	32,400	42,000	
Davao Water District	April 1976	2,300	45,000	47,300	Low Bid
		9,174	42,000	51,174	
		10,665	42,000	52,665	
		11,903	42,840	54,743	
		1,121	56,738	57,859	
		12,350	52,125	64,475	
		27,743	42,000	69,743	
		30,719	42,000	72,719	

APPENDIX TABLE G-12

UNIT PRICES OF FIRE HYDRANTS
(Lump Sum, ₱/Item)

Estimate by or Bid Op	Date	Local(₱)	FEC(₱)	Total(₱)	Remarks
	Commercial Type				
CDM Estimates	July 1976	2,304	3,173	5,477	
Batangas Water District	April 1976	-	-	-	
Cagayan de Oro Water District	Jan 1976	828	3,491	4,319	Low Bid
		2,772	2,760	5,532	
		3,570	2,432	6,002	
		792	5,927	6,714	
San Pablo Water District	Oct 1975	2,307	2,520	4,827	Low Bid
		2,800	3,712	6,512	
		7,987	1,619	9,606	
Bacolod Water District	Dec 1975	2,418	3,173	5,591	Low Bid
		2,642	3,148	5,790	
		4,398	3,225	7,623	
Davao Water District	April 1976	2,050	3,000	5,050	Low Bid
		2,442	2,868	5,310	
		2,681	2,985	5,666	
		3,363	2,790	6,153	
		3,565	2,859	6,424	
		3,828	2,812	6,640	
		4,560	2,828	7,388	
		2,126	5,649	7,775	

APPENDIX TABLE G-13

UNIT PRICES OF FIRE HYDRANTS
(Lump Sum, ₱/Item)

Estimate by or Bid On	Date	Local(₱)	FEC(₱)	Total(₱)	Remarks
		Residential Type			
CDM Estimate	July 1976	1,572	2,202	3,774	
Cagayan de Oro Water District	Jan 1976	620	542	1,162	Low Bid
		2,126	1,125	3,251	
		2,709	1,447	4,156	
		613	4,516	5,129	
San Pablo Water District	Oct 1975	1,818	1,500	3,318	Low Bid
		2,500	2,730	5,230	
		5,689	629	6,318	
Bacolod Water District	Dec 1975	2,068	1,847	3,915	Low Bid
		2,107	1,820	3,927	
		3,043	1,882	4,927	
Davao Water District	April 1976	1,926	1,078	3,003	Low Bid
		2,100	1,125	3,225	
		2,669	982	3,651	
		1,973	1,765	3,738	
		2,592	1,199	3,791	
		2,460	1,388	3,848	
		3,073	1,320	4,393	
		1,835	3,342	5,177	
Batangas Water District	April 1976	914	4,437	5,351	Low Bid
		1,130	4,437	5,567	
		1,445	4,437	5,882	

APPENDIX TABLE G-14

SAN PABLO CITY
DEEPWELL CONSTRUCTION

	Work Item	Unit	Unit Price (₱)	Total (₱)	Remarks
1.	Mobilization	1 well	4,500.00	4,000.00	
2.	Drilling				
	a) 254 mm	15 m	590.40	8,856.00	
	b) 152 mm	45 m	393.60	17,712.00	
3.	Install and Join Casing	60 m	131.20	7,872.00	
4.	Grouting (15 m)	10 bags	18.00	180.00	
5.	Develop Well	24 hr	140.00	3,360.00	
6.	Pump Test	48 hr	150.00	7,200.00	
7.	Well Completion	1 well	2,419.50	2,419.50	Includes RC Pedestal and Installation
8.	Furnish Casing				
	a) 152 mm	30 m	189.90	5,697.00	Blank
	b) 152 mm	30 m	268.45	8,053.50	perforated for Grouting
9.	Furnish Cement	10 bags	15.00	150.00	
	TOTAL BID PRICE			₱66,000.00	

* AS OF OCTOBER 1975

CON @ 15 cm casing at 60 m depth ₱75,000.00

APPENDIX TABLE G-15

CAGAYAN DE ORO CITY
DEEPWELL CONSTRUCTION

	Work Item	Unit	Unit Price (₱)	Total (₱)	Remarks
1.	Mobilization	1 well	5,000/well	5,000	
2.	Drilling				
	a) 571.5 mm (22½")	15.24 m	785/m	11,963.40	Hole to 15.24 m
	b) 406.44 mm (16")	106.76 m	525/m	56,049.00	from 15.24 to 122
	c) 279.4 mm (11")	98.00 m	330/m	82,340.00	from 122 to 221
3.	Install and Join Casing and Screen				
	a) 406.4 mm (16")	122 m	75/m	9,150.00	blank
	b) 279.4 mm (11")	8.3 m	65/m	5,395.00	blank
	c) 254 mm (10")	15.24 m	100/m	1,524.00	screen
4.	Grouting	50 bags	90/bag	4,500.00	above 15.24 m
5.	Develop Wells	24 hr	100/hr	2,400.00	
6.	Test Pump	48 hr	100/hr	4,800.00	
7.	Well Completion	1 well	2,500/well	2,500.00	Includes RC Pedestol B
8.	Furnish Casing				
	a) 406.4 mm (16")	106.76 m	450/m	48,042.00	
	b) 279.4 mm (11")	98.00 m	360/m	35,280.00	
9.	Furnish and Install well flange and blind flange, 406.4 mm (16")	1	190 ea	190.00	
10.	Furnish Screen (15.24 m)	50 ft	$ 67.63/ft	25,361.25	Johnson Stainless steel well screen
11.	Furnish Lead Pacren				
	a) 254 mm (10")	1	$ 88.20	661.50	
	b) 279 mm - 406 mm (11" - 16")	1	138.00	1,035.00	Lead Slip Pacren
12.	Freight for Items 10 and 11		$1,876.00	14,070.00	
	TOTAL BID PRICE			₱260,261.15	

NOTE:

Exchange Rate:

$1 = ₱7.50

* AS OF JANUARY 1976

CDW @ 27.9 cm casing at 220 m depth ₱512,000.00

APPENDIX TABLE G-16

MARAWI CITY
DEEPWELL CONSTRUCTION

	Work Item	Unit	Unit Price (₱)	Total (₱)	Remarks
1.	Demobilization and Demobilization	Lump Sum	36,500	36,500.00	
2.	Complete drilling of 356 mm hole				Includes temp. casing and sampling
	Drilling in Fractured Rock	30 m	6.30/m	189.00	
	Drilling in Other Materials	22 m	5.70/m	125.40	
3.	Electric Logging and Interpretation	Lump Sum	2,600/well	2,600.00	
4.	Permanent Casing 273 mm O.D.	30.5 m	1,000/m	30,500.00	Furnishing and Installation
5.	Installation of Screen (Incl. Transp)	Lump Sum	5,630/well	5,630.00	Assembling, Joint
6.	Sump 200 mm (8")	Lump Sum	400/well	400.00	With rotten cup installation
7.	Gravel Packing 78 mm	22 m	400/m	8,800.00	Around screen, sum
8.	Gravel Packing 42 mm	5 m	370/m	1,850.00	Around perm. casing
9.	Developing Well	48 hr	170/hr	8,160.00	Swabbing and bailing
10.	Developing Well	48 hr	170/hr	8,160.00	Air Compression and pump
11.	Test Pumping	48 hr	170/hr	8,160.00	65 lps
12.	Sealing 42 mm around Casing	19 m	100/m	1,900.00	With clay/bantonite
13.	Concrete Grouting 42 mm	5.25 m	100/m	525.00	Around Casing
14.	Disinfection, Completion of Well	Lump Sum	2.800/well	2,800.00	Includes Site Clean-Up
	TOTAL BID PRICE			₱116,299.40	

* AS OF NOVEMBER 1975

CDM @ 27.3 cm casing at 52 m depth ₱112,000.00

APPENDIX TABLE G-17

BATANGAS CITY
DEEPWELL CONSTRUCTION

	Work Item	Unit	Unit Price (₱)	Total (₱)	Remarks
1.	General Mobilization		2,500.00	2,500.00	
2.	Complete Drilling (500 mm)	150 m	721.60	108,240.00	
3.	Baiken Testing (2 hrs)	5 m	100.00	500.00	
4.	Electric Logging and Interpretation	Lump Sum	-	-	
5.	Casing (356 mm)	118.5 m	820.00	97,170.00	
6.	Bacteriological Test	4 m	100.00	400.00	Physical and Chemical
7.	Screen Installation	Lump Sum	3,000.00	3,000.00	30 m; 354 mm
8.	Sump Installation	Lump Sum	100.00	100.00	2 m; 324 mm
9.	Gravel Packing	52 m	180.00	9,360.00	
10.	Swabbing and Bailing	48 hr	60.00	2,880.00	
11.	Air Comp and Pumping	48 hr	100.00	4,800.00	
12.	Test Pumping	48 hr	100.00	4,800.00	1,025 gpm
13.	Cement Grouting	97.25 m	65.60	6,379.60	
14.	Disinfection and Site Clean-Up	Lump Sum	2,500.00	2,500.00	
	TOTAL BID PRICE			₱242,630.00	

* AS OF APRIL 1976

CDM @ 35 cm casing at 150 m depth ₱490,000.00

APPENDIX TABLE G-18

BACOLOD CITY
DEEPWELL CONSTRUCTION

	Work Item	Unit	Unit Price (₱)	Total (₱)	Remarks
1.	Mobilization	1 well	4,500.00/well	4,500.00	
2.	Drilling with Temp Casing				
	a) 600 mm (26")	15.24 m	943.80/m	14,383.51	Hole to 15.24 m
	b) 508 mm (20")	60.98 m	726.00/m	44,271.48	from 15.24 to 76.2
	c) 457 mm (18")	60.98 m	653.40/m	39,844.33	from 76.22 to 137.2
3.	Bailing Test	10 hrs	130.00/hr	1,300.00	
4.	Installing and Joining Casing and Screen				
	a) 508 mm (20")	15.24 m	40.00/m	609.60	Conduction pipe 15.2
	b) 406 mm (16")	60.98 m	32.00/m	1,951.36	Upper blank 60.9
	c) 254 mm (10")	60.98 m	20.00/m	1,219.60	Lower blank 60.9
	d) 254 mm (10")	15.24 m	40.00/m	609.60	Screen 15.24 m
	e) Settling and Joining upper to lower casing	1 well	500.00/well	500.00	
5.	Installing Centering devices	5 sets	400.00/set	2,000.00	every 164 m
6.	Gravel Packing, Labor	15 cm	135.00/cm	2,025.00	
7.	Grouting	100 bags	7.50/bag	750.00	
8.	Developing Well	48 hr	150.00/hr	7,200.00	for 48 hr
9.	Test Pumping	72 hr	160.00/hr	11,520.00	
10.	Well Completion Including RC Pedestal	1 well	2,969.00/well	2,969.00	and other appurtenances
11.	Demobilization	1 well	4,000.00/well	4,000.00	
12.	Supplying Casing Material				
	a) 15.24 m of 508 mm (20")	15.24 m	601.92/m	9,173.26	
	b) 60.98 m of 406.4mm (16")	60.98 m	481.55/m	29,364.92	
	c) 60.98 m of 254 mm (10")	60.98 m	323.53/m	19,729.86	
	d) 406.4 mm x 254 mm (16 in x 10 in)	1 pc	600.00/pc	600.00	Adapter
13.	Gravel for Packing	15 cm	100.00/cm	1,500.00	
14.	Cement for Grouting	100 bags	15.00/bag	1,500.00	
	TOTAL BID PRICE			₱201,520.52	

* AS OF DECEMBER 1975

CDM @ 25 cm casing at 137 m depth ₱240,000.00

APPENDIX H

NEDA/POPCOM POPULATION PROJECTIONS

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APPENDIX H

NEDA/POPCOM POPULATION PROJECTIONS

A. BACKGROUND

The population projections presented herein were taken from a research program conducted in 1973 by the National Census and Statistics Office with funding assistance from the United Nations Fund for Population Activities (UNFPA). The projections, approved by the National Economic and Development Authority (NEDA), constituted an attempt to outline a consistent set of population estimates which would serve as a uniform basis for Philippine national, sectoral and regional plans.

Appendix H was therefore taken from context from a 3-volume document printed in 1975 by NEDA. The population projections mentioned above formed an integral part of the following documents: Volume I, Conference Highlights and Planning Guidelines; Volume II, Population Projections for the Philippines by Province 1970-2000; and Volume III, Population Projections of Cities and Municipalities in the Philippines, 1970-2000.

B. POPULATION PROJECTION FOR THE ENTIRE PHILIPPINES (1970-2000)

Methodology

The national population to year 2000 was projected using the component or the cohort-survival method of projection. Age and sex of the population, age-specific fertility and mortality rates, age and sex distribution of migrants, and sex ratio at birth were the basic components used for this method of projection.

Data Sources

The basic data came primarily from the 1970 census final provincial counts; vital statistics particularly from the legal civil registration for 1960-70; and 1973 National Demographic Survey.

Procedures

1. The population data of 6 May 1970 were classified into 5-year age groups, such as 0-4, 5-9, etc., and by sex.

2. Data in the 0-4 and 5-9 groups were adjusted due to errors and bias in the reporting of ages, selective underenumeration, coding and punching errors.

3. The adjusted population by groups was projected to 1 July 1970 using the rate of population increase from 1960-1970, assuming that changes in the age distribution during the intervening period were negligible. (For males, multiply adjusted population as of 6 May 1970 by 1.004356 to get 1 July 1970 population. For females, use 1.00477.)

4. Life expectancy at birth for the period 1965-2000 was projected and life table values for the Philippines were estimated.

5. Future patterns of fertility rates were estimated, using birth rates reported in 1960-70.

   a) Low Assumption. Fertility will decline from the level established in 1965-1970 beginning in 1970, with an accelerated decline during 1975-1995. (6.31 in 1965-80 to 2.62 in 1995-2000)

   b) High Assumption. Fertility rates for the period 1970-75 will be the average of age-specific fertility rates* estimated in 1965-70 and those estimated for the period 1970-75 using low assumption. (5.83 for 1970-2000)

   c) Medium Assumption. Fertility will decline at a slower rate. The age-specific fertility rates in each 5-year period after 1970 are the arithmetic means of the estimated rates according to the high and low assumption. (6.31 in 1965-70, to 5.59 in 1970-75 to 4.22 in 1995-2000)

   d) Using the base population, sex ratio (106 males to 100 females), the calculated and assumed life table survival ratios, the age specific fertility rates, the population was projected up to the year 2000 by

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*Age-Specific Fertility Rate = $\frac{\text{Annual Birth to Average Women in a 5-Year Age Group}}{\text{No. of Average Women}} \times 1{,}000$

5-year intervals. The populations by age and sex for single calendar years for the period 1970-1980 were obtained by interpolation.

C. POPULATION PROJECTION FOR PROVINCES (1970-2000)

Methodology

The method used to project the population by age and sex for each of the 66 provinces and the city of Manila was the same as that used for the Philippines as a whole, except that additional assumptions on fertility and internal migration were introduced.

Assumptions

1. Probability of survival for each province is similar to the Philippine average for the duration of the projection.

2. Different sets of fertility rates were used for different planning regions.

3. The rates of net migration by age and sex for each province for the period 1970-80 will be the same as that observed during the 1960-70 period; for the period 1980-90 and 1990-2000 the rates will be one-half and one-fourth respectively of those observed for the period 1960-70.

4. During the 1970-80 period, the maximum outflow of people for any age group for a particular province will be 80 percent.

Procedure

1. The population by age and sex for each province was first projected to 1980, 1990 and 2000.

2. The figures for single calendar years were obtained by interpolation using the formula $P_t = P_o e^{rt}$

   Pt = population at time t

   Po = population at the base period

   r = rate of population growth

   t = time interval between time 0 and T

D. CITY/MUNICIPALITY POPULATION PROJECTION (1970-2000)

Methodology

Method used was the ratio method of projection which assumes that the ratio of the population in each city or municipality to the total population of the province will change according to a specified pattern at the same rate as it did in the past, with minor adjustments where necessary.

Data Used

The data included the total population of the cities/municipalities for the censal years 1939, 1948, 1960 and 1970; population projections for the provinces from 1970-2000; and past trend in the ratio of these smaller areas to that of the province.

Procedure

1. The ratio of population of each city/municipality to the total provincial population was computed for 1939, 1948, 1960 and 1970. On the basis of past trends, the city/municipality ratios were grouped into 4 types:

   Type I - consistent direction of change from 1939-70.

   Type II - same direction of change for 1960-70 and 1948-60 but different for 1939-48.

   Type III - direction of change in ratios is the same for 1939-48 and 1948-60 but different for 1960-70.

   Type IV - direction of change in ratios is different for 1948-60 from 1939-48 and from 1960-70.

2. The initial geometric rates of change of the ratios (r) were estimated based on the following assumptions:

   Type I - Change of r was the same as the average annual rate of change in the ratios for 1938-48, 1948-60, or 1960-70 whichever was closest to zero.

Type II – Change of r was the same as the average annual rate of change for 1948–60 or 1960–70, whichever was the less.

Type III – Change of r was ½ of the average annual rate of change for 1960–70.

Type IV – Same ratio as in the 1970 ratio.

3. Ratios were projected up to year 2000 assuming that the initial rate of change will become zero in 70 years.

$$\text{Ratio}_{k\ \text{year}} = \text{Ratio}_{1970} \left(1 + r - \frac{r}{70}\right) \left(1 + r - \frac{2r}{70}\right) - - - \left(1 + r - \frac{kr}{70}\right)$$

4. The calculated ratios for the city/municipality were then prorated to sum up to 1 for each province.

5. The ratios were then applied to the projected total population of the province to obtain the city/municipality projections.

Appendix Tables H-1 to H-11 show the population projections for 11 cities/municipalities, based on NEDA/Popcom projections.

APPENDIX TABLE H-1

NEDA/POPCOM PROJECTIONS
BANGUED, ABRA

	(1970)	1975	1980	1985	1990	1995	2000
	24,587						
High Assumption :		27,732	31,399	35,977	41,095	46,816	53,162
Growth Rate							
Ratio :		1.1279	1.1322	1.1458	1.1423	1.1392	1.1356
% :		2.436	2.514	2.759	2.697	2.641	2.576
Medium Assumption:		27,582	30,725	34,388	38,151	52,056	46,105
Growth Rate							
Ratio :		1.1218	1.1140	1.1192	1.1094	1.1023	1.0963
% :		2.325	2.183	2.278	2.098	1.967	1.856
Low Assumption :		27,435	30,052	32,806	35,210	37,328	39,211
Growth Rate							
Ratio :		1.1158	1.0954	1.0916	1.0733	1.0602	1.0504
% :		2.216	1.839	1.768	1.425	1.176	.988

APPENDIX TABLE H-2

NEDA/POPCOM PROJECTIONS
URDANETA, PANGASINAN

	(1970)	1975	1980	1985	1990	1995	2000
	58,690						
High Assumption :		66,831	75,709	87,586	100,504	116,369	133,700
Growth Rate							
Ratio :		1.1387	1.1328	1.1569	1.1475	1.1579	1.1489
% :		2.632	2.525	2.958	2.790	2.976	2.815
Medium Assumption:		66,422	73,960	83,511	93,058	104,235	115,614
Growth Rate							
Ratio :		1.1317	1.1135	1.1291	1.1143	1.1201	1.109
% :		2.505	2.173	2.458	2.188	2.294	2.09
Low Assumption :		66,015	72,211	79,443	85,620	92,203	97,985
Growth Rate							
Ratio :		1.1248	1.0939	1.1002	1.0778	1.0769	1.062
% :		2.380	1.811	1.928	1.509	1.493	1.229

APPENDIX TABLE H-3

NEDA/POPCOM PROJECTIONS
GAPAN, NUEVA ECIJA

	(1970)	1975	1980	1985	1990	1995	2000
	45,426						
High Assumption :		53,172	62,291	73,448	86,229	100,481	116,555
Growth Rate							
Ratio :		1.1705	1.1715	1.1791	1.1740	1.1652	1.1599
% :		3.199	3.216	3.35	3.26	3.10	3.01
Medium Assumption:		52,843	60,925	70,091	79,876	90,015	100,788
Growth Rate							
Ratio :		1.1632	1.1529	1.1504	1.1396	1.1269	1.1197
% :		3.07	2.88	2.84	2.65	2.42	2.29
Low Assumption :		52,516	59,559	66,746	73,528	79,628	85,388
Growth Rate							
Ratio :		1.1561	1.1341	1.12067	1.1016	1.083	1.0723
% :		2.94	2.55	2.30	1.95	1.61	1.41

APPENDIX TABLE H-4

NEDA/POPCOM PROJECTIONS
CALAMBA, LAGUNA

	(1970)	1975	1980	1985	1990	1995	2000
	82,714						
High Assumption :		99,196	119,590	142,995	170,759	198,927	231,355
Growth Rate							
Ratio :		1.1993	1.2056	1.1957	1.1942	1.1650	1.1630
% :		3.702	3.810	3.640	3.613	3.102	3.066
Medium Assumption:		98,649	117,110	136,756	158,598	178,916	201,138
Growth Rate							
Ratio :		1.1927	1.1871	1.1678	1.1597	1.1281	1.1242
% :		3.587	3.490	3.151	3.008	2.440	2.369
Low Assumption:		98,112	114,630	130,558	146,446	159,058	171,596
Growth Rate							
Ratio :		1.1862	1.1684	1.1390	1.1217	1.0861	1.0790
% :		3.474	3.162	2.637	2.323	1.666	1.532

APPENDIX TABLE H-5

NEDA/POPCOM PROJECTIONS
SILAY, NEGROS OCCIDENTAL

	(1970)	1975	1980	1985	1990	1995	2000
	69,200						
High Assumption:		72,257	75,733	84,058	92,783	105,210	118,695
Growth Rate							
Ratio:		1.0442	1.0481	1.1099	1.1038	1.1339	1.1282
%:		0.869	0.944	2.107	1.995	2.545	2.442
Medium Assumption:		71,733	73755	79,774	85,378	93,539	101,737
Growth Rate							
Ratio:		1.0366	1.0282	1.0816	1.0702	1.0956	1.0876
%:		0.722	0.558	1.581	1.366	1.843	1.694
Low Assumption:		71,206	71,777	75,479	77,980	81,942	85,210
Growth Rate							
Ratio:		1.0290	1.0080	1.0516	1.0331	1.0508	1.0399
%:		0.573	0.159	1.011	0.653	0.996	0.786

APPENDIX TABLE H-6

NEDA/POPCOM PROJECTIONS
BISLIG, SURIGAO DEL SUR

	(1970)	1975	1980	1985	1990	1995	2000
	40,405						
High Assumption:		48,637	58,481	70,675	84,787	102,149	122,232
Growth Rate							
Ratio:		1.2037	1.2024	1.2085	1.1997	1.2048	1.1966
%:		3.778	3.755	3.860	3.709	3.797	3.655
Medium Assumption:		48,346	56,878	66,828	77,516	89,865	103,217
Growth Rate							
Ratio:		1.1941	1.1789	1.1749	1.1599	1.1593	1.1486
%:		3.612	3.347	3.276	3.011	3.0	2.810
Low Assumption:		47,850	55,276	62,961	70,263	77,736	84,879
Growth Rate							
Ratio:		1.1843	1.1552	1.1390	1.1160	1.1064	1.0919
%:		3.441	2.928	2.637	2.219	2.043	1.774

APPENDIX TABLE H-7

NEDA/POPCOM PROJECTIONS
ROXAS CITY

	(1970)	1975	1980	1985	1990	1995	2000
	67,648						
High Assumption :		78,208	89,621	105,988	123,752	146,400	172,416
Growth Rate							
Ratio :		1.1561	1.1459	1.1826	1.1676	1.1830	1.1777
% :		2.944	2.761	3.411	3.148	3.418	3.325
Medium Assumption:		77,671	87,472	100,834	114,194	130,556	148,288
Growth Rate							
Ratio :		1.1482	1.1262	1.1528	1.1325	1.1433	1.1358
% :		2.802	2.405	2.885	2.520	2.715	2.579
Low Assumption :		77,133	85,324	95,678	104,647	114,818	124,731
Growth Rate							
Ratio :		1.1402	1.1062	1.1213	1.0937	1.0972	1.0863
% :		2.659	2.039	2.316	1.807	1.873	1.669

APPENDIX TABLE H-8

NEDA/POPCOM PROJECTIONS
OLONGAPO, ZAMBALES

	(1970)	1975	1980	1985	1990	1995	2000
	107,785						
High Assumption :		135,251	170,071	208,892	255,614	303,860	359,977
Growth Rate							
Ratio :		1.2548	1.2574	1.2283	1.2237	1.1887	1.1847
% :		4.644	4.687	4.20	4.120	3.518	3.448
Medium Assumption:		134,453	166,313	199,283	236,521	271,870	310,809
Growth Rate							
Ratio :		1.2474	1.237	1.1982	1.1869	1.1494	1.1432
% :		4.520	4.346	3.683	3.486	2.824	2.713
Low Assumption :		133,665	162,555	189,701	217,446	240,082	262,768
Growth Rate							
Ratio :		1.2401	1.2161	1.1670	1.1463	1.1041	1.0945
% :		4.398	3.991	3.137	2.768	2.0	1.822

APPENDIX TABLE H-9

NEDA/POPCOM PROJECTIONS
SAN FERNANDO, PAMPANGA

	(1970)	1975	1980	1985	1990	1995	2000
	84,362						
High Assumption	:	100,372	119,653	142,396	168,795	196,916	228,596
Growth Rate							
Ratio	:	1.190	1.1920	1.1901	1.1854	1.1666	1.1609
%	:	3.54	3.575	3.542	3.46	3.13	3.029
Medium Assumption	:	99,750	117,028	135,831	156,199	176,185	197,396
Growth Rate							
Ratio	:	1.1824	1.1732	1.1607	1.150	1.1280	1.1204
%	:	3.408	3.246	3.025	2.835	2.438	2.30
Low Assumption	:	99,134	114,402	129,284	143,614	155,594	166,909
Growth Rate							
Ratio	:	1.1751	1.1540	1.130	1.1108	1.0834	1.0727
%	:	3.280	2.91	2.474	2.124	1.615	1.413

APPENDIX TABLE H-10

NEDA/POPCOM PROJECTIONS
ILOILO CITY

	(1970)	1975	1980	1985	1990	1995	2000
	209,738						
High Assumption	:	249,508	291,981	347,562	409,056	485,636	570,388
Growth Rate							
Ratio	:	1.1896	1.1702	1.1904	1.1769	1.1872	1.1745
%	:	3.533	3.193	3.547	3.31	3.492	3.269
Medium Assumption	:	247,956	235,024	331,049	378,220	434,086	491,779
Growth Rate							
Ratio	:	1.1822	1.1495	1.1615	1.1425	1.1477	1.133
%	:	3.405	2.826	3.04	2.70	2.794	2.529
Low Assumption	:	246,394	278,015	314,547	347,365	382,885	415,043
Growth Rate							
Ratio	:	1.1748	1.1283	1.1314	1.1043	1.1023	1.084
%	:	3.274	2.444	2.500	2.005	1.967	1.626

APPENDIX TABLE H-11

NEDA/POPCOM PROJECTIONS
BAYBAY, LEYTE

		(1970)	1975	1980	1985	1990	1995	2000
		63,782						
High Assumption	:		67,289	71,070	78,713	86,690	98,436	111,172
Growth Rate								
Ratio	:		1.0550	1.0562	1.1075	1.1013	1.13549	1.1294
%	:		1.077	1.10	2.063	1.949	2.574	2.464
Medium Assumption	:		66,789	69,241	74,751	79,929	87,653	95,431
Growth Rate								
Ratio	:		1.0471	1.0367	1.0796	1.0693	1.0966	1.0887
%	:		0.925	0.723	1.544	1.349	1.861	1.714
Low Assumption	:		66,284	67,392	70,778	73,181	77,003	80,206
Growth Rate								
Ratio	:		1.0392	1.0167	0.0502	0.0340	1.0522	1.0416
%	:		0.772	0.332	0.984	0.671	1.023	0.818

APPENDIX TABLE H-12

COTABATO CITY

(1970)	1975	1980	1985	1990	1995	2000
61,184						
High Assumption :	78,919	100,703	126,954	158,378	195,306	238,749
Growth Rate						
Ratio :	1.29	1.28	1.26	1.25	1.23	1.22
% :	5.07	5.00	4.74	4.52	4.28	4.1
Medium Assumption :	78,297	98,036	120,097	144,795	171,750	201,497
Growth Rate						
Ratio :	1.28	1.25	1.22	1.21	1.19	1.17
% :	4.90	4.60	4.14	3.81	3.47	3.25
Low Assumption :	77,667	95,369	113,209	131,254	148,526	165,649
Growth Rate						
Ratio :	1.27	1.23	1.19	1.16	1.13	1.12
% :	4.74	4.19	3.49	3.00	2.50	2.21

APPENDIX I

SPECIFICATIONS FOR WATER TEST WELL CONSTRUCTION

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APPENDIX I

SPECIFICATIONS* FOR WATER TEST WELL CONSTRUCTION

A. GENERAL

Engineer

Camp Dresser & McKee International Inc. is herein referred to as the Engineer.

Scope of Work

a) All materials, labor, equipment, fuel, tools, transportation and services for the complete construction, development and testing of several test water wells shall be furnished by the Contractor.

b) The test wells shall be drilled by the cable tool (percussion) method with blank and perforated casings driven to follow the penetration of the bore hole or by the rotary method as directed by the Engineer. The exact depths and lengths will be determined by the Engineer from the log records of the bores. Payment for construction of the wells will be based on the unit prices bid for each item and no further payment will be made except for extra work under written authorization of the Engineer.

c) For test wells to be drilled by the rotary method, the work shall consist of the following:

   1) Drilling of a pilot hole to a depth as specified by the Engineer.

   2) Electric logging of the pilot hole.

   3) Reaming hole to diameter and depth as specified by the Engineer.

   4) Supply and installation of casing and slotted casing as specified by the Engineer.

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*These are simplified specifications. It is assumed that the Engineer will use much discretion (on the basis of experience) during the actual drilling and well testing.

5) Gravel packing annulus between casing and hole.

6) Installing cement grout sanitary seal and gravel fill pipe.

7) Developing the well.

8) Pump testing the well.

d) For test wells to be drilled by the cable tool (percussion) method, the work shall consist of the following:

1) Drilling bore holes to depth as directed by the Engineer, and casing of same with blank and perforated casing of diameter as prescribed by the Engineer.

2) Development of each well.

3) Pump testing of each well.

e) All materials, supplies, equipment and labor, except those services expressly stipulated to be furnished by the Engineer, shall be supplied by the Contractor. The Contractor shall leave the premises in a neat and orderly condition.

f) The test wells shall be located at various places in the Philippines. Exact locations are: (specify)

Permits, Certificates, Laws and Ordinances

The Contractor shall, at his own expense, procure all permits, certificates and license required by law for the execution of this work. He shall comply with all national or local laws, ordinances, decrees or rules and regulations relating to the performance of the work.

Local Conditions

The Contractor shall satisfy himself regarding all local conditions affecting his work by personal investigation and neither the information contained in this section nor those derived from maps or plans, or from the Engineer or his agents or employees shall act to relieve the Contractor from any responsibility hereunder or from fulfilling any and all of the terms and requirements of his Contract.

Extra Work or Reduced Work

The Engineer reserves the right to order additional work or to reduce the scope of the work if deemed necessary. Additional work will be paid for at the unit costs quoted in the proposal unless such unit costs are not directly applicable, in which case the costs will be negotiated. If the scope of the work is reduced only work actually performed will be paid for.

Drilling Water Supply and Motive Power Requirements

All drilling water, lighting and motive power, including necessary connections and installations, required for the proper execution of this Contract shall be to the account of the Contractor.

Boundaries of Work

The Engineer will provide land or right-of-way for the work specified in this Contract and make suitable provisions for the ingress and egress. Other Contractors and employees or agents of the Engineer may for all necessary purposes enter upon the work and premises used by the Contractor, and the Contractor shall conduct his work so as not to impede unnecessarily any work being done by others on or adjacent to the site.

Protection of Site and Security of Drilling Equipment

Excepting as otherwise provided herein, the Contractor shall protect all structures, walks, pipelines, trees, shrubbery, lawns, etc., during the progress of his work, shall remove from the site all cuttings, drillings, debris, and unused materials; and shall, upon the completion of the work restore the site as nearly as possible to its original condition, including the replacements, at the Contractor's sole expense, of any facility or landscaping which has been damaged beyond restoration of its original condition. Water pumped from the well shall be conducted to a place where it will be possible to dispose the water without damage to property or creation of a nuisance.

The Contractor shall be responsible for the security of his own tools and equipment at the jobsite.

Competent Workmen

The Contractor shall employ only competent workmen for the execution of his work and all such work shall be performed under the direct supervision of an experienced Well Driller satisfactory to the Engineer.

Completion of the Work

The Contractor shall begin work 20 calendar days after the contract agreement is signed. The contract shall be completed within 180 calendar days after initiation date.

B. MATERIALS

Well Casing

Casing, perforated casing and drive shoes shall be furnished by the Contractor and of diameter as required by the Engineer. Perforated casing shall be saw-slotted in a pattern approved by the Engineer. The lengths and positions of casing and perforated casing to be installed in each borehole shall be determined or approved by the Engineer. All casing shall be suitable for the intended work and is subject to the approval of the Engineer.

Cement

The Contractor shall provide all cement used for the bottom casing plug (percussion method) and sanitary seal (rotary method); and other miscellaneous requirements for the construction of water test wells.

C. CONSTRUCTION OF WATER TEST WELLS

Equipment

The work shall be performed with equipment which is adequate to complete all phases of well construction. If the Contractor's equipment is not capable of performing satisfactory work described in these specifications, the Contractor shall substitute at his own expense such equipment which is satisfactory to the Engineer.

Records

a) The Contractor shall keep an accurate record of the location of the top and bottom of each stratum penetrated and shall save and deliver to the Engineer a representative sample of one kilogram weight of materials taken from each 3-meter drilling and at every change of formation. All samples collected shall be dried, securely packaged, labelled to indicate depth and date, and stored in a location safe from disturbance and weather.

b) The Contractor shall submit a daily report describing the nature of material encountered, the work done during each day, including the items of work accomplished, such as depth drilled, casing set, etc., the water level in the well at the beginning and end of each shift and such other pertinent data as he is requested to make a record of.

c) A record shall be maintained daily indicating amounts of materials utilized, hours and equipment operations and any delays incurred in drilling activities.

d) Liquidated Damages: Failure on the part of the Contractor to obtain, preserve and deliver such samples or records to the Engineer shall be considered an actual damage to the Engineer and shall authorize the Engineer to retain from moneys due or to become due to the Contractor the sum of fifty pesos (₱50.00) as liquidated damages for each sample that the Contractor shall fail to obtain, preserve and deliver, or for each length of pipe not properly measured and recorded in the order in which it was placed in the well. In the event that, in the opinion of the Engineer, the failure of the Contractor to take and preserve the samples may affect the proper design of the screen, the Contractor may be required to perform such work as the Engineer deems necessary to remedy such failure.

e) Liquidated Damages for Delay: The Contractor shall pay to the Engineer as fixed, agreed and liquidated damages for each calendar day delay in the completion of all the work beyond the time agreed upon the amount of one hundred pesos (₱100.00) per day.

Rotary Method

a) Pilot Hole and Electric Logging

1) A pilot hole from 8 to 12 inches in diameter shall be drilled to a depth specified by the Engineer.

2) Stratigraphic samples shall be collected as specified in Section C-2a (Records-a, page I-4).

3) Self-potential and resistivity electric logs shall be run throughout the length of the pilot hole. The equipment and techniques used shall be such that

satisfactory logs suitable for selection of water-bearing strata are obtained. Prior to the commencement of the work, the electric logger shall be made available by the Contractor for inspection by the Engineer.

b) Final Diameter Bore Hole and Test Well Casing

1) Utilizing the stratigraphic samples and electric logs, the Contractor shall recommend the final cased depth and the intervals to be provided with perforated casing; however the Engineer shall make the final decision as to casing depth and pattern.

2) The pilot hole will be reamed to an enlarged diameter and to a depth sufficient to contain the total length of casing specified by the Engineer. During reaming, mud weight shall be maintained at the minimum necessary to support the borehole. The work shall proceed expeditiously and the borehole shall not be permitted to stand filled with drilling fluid for any longer than necessary.

3) The casing shall be placed plumb and centered in the borehole. Plumbness will be maintained to the degree necessary to accommodate the placement and operation of a vertical turbine test pump to a depth of at least 30 meters below the surface. In the event that the test pump cannot be operated as indicated, because of improper casing alignment, the well shall be repaired by the Contractor at no cost to the Engineer.

4) If, for any reason, the casing cannot be landed in the correct position or at a depth acceptable to the Engineer, the Contractor shall construct another well immediately adjacent to the original location and complete this well in accordance with specifications at no additional cost to the Engineer. The abandoned hole shall be sealed in accordance with directions from the Engineer.

5) The actual amount and location of perforated casing to be placed in each test well shall be determined by the Engineer.

6) Perforated casing shall be positioned in the center of the bore hole by centralizers fabricated by the Contractor to a pattern approved by the Engineer. The centralizers shall be spaced every 6 meters of perforated casing or as specified by the Engineer.

7) The bottom of the casing shall be closed by a welded steel plate.

8) In the event that the Contractor shall fail to sink the test well to the depth specified or to such lesser depth as ordered by the Engineer, or should he abandon the well because of loss of tools or for any other cause, if requested and as directed by the Engineer, he shall fill the abandoned hole with clay or clay and concrete and remove the casing.

c) Gravel Packing

1) Gravel pack material shall consist of clean, well-rounded grains of material that is mainly siliceous with no more than 5 percent that is calcareous.

2) The gravel pack material shall be of a grain size that is suited to both the formation grain size and the size of the slot openings. The gravel pack material shall have a uniformity coefficient at 2.5 or less. The gravel pack material shall be subject to the approval of the Engineer.

3) The method of placing gravel in the annulus between the casing and the bore shall be such as to avoid segregation of sizes of the gravel. The method of placement shall be subject to the approval of the Engineer.

4) Gravel shall be placed so as to fill the annulus without voids other than the normal intergranular spaces. The gravel fill shall extend from the bottom of the hole to a level of 15 meters below the ground surface.

i) Sanitary Seal and Gravel Fill Pipe

1) The annulus between the casing and the bore hole shall be filled with cement grout from the top of

the gravel pack 15 meters below the ground surface. Before placing the cement grout a 60-cm thick layer of puddled clay or other fine-texture material shall be placed on top of the gravel to minimize grout intrusion into the gravel.

2) Grout shall be proportioned of 22 to 26 liters of water to each 50-kg bag of cement. Only enough water shall be used to reach the proper consistency for placement of the grout slurry. To insure a good seal, the grout shall be allowed to set in an undisturbed well for a minimum of 48 hours. This period may be shortened to 24 hours if a suitable additive to accelerate setting time is used subject to the approval of the Engineer.

3) A 75-mm diameter pipe is to be installed in the annulus between the casing and the bore hole before grout is placed. This gravel-fill pipe is to extend from 1 meter below the top of the gravel pack to 35-cm above ground surface and is to be fitted with a pipe cap at the top.

<u>Percussion Method</u>

a) Placement of Test Well Casing

1) The casing shall be plumb and centered in the bore hole. Plumbness will be maintained to the degree necessary to accommodate the placement and operation of a vertical turbine test pump to a depth of at least 30 meters below the surface. In the event that nominal diameter pump cannot be operated as indicated, because of improper casing alignment, the well shall be repaired by the Contractor at no cost to the Engineer.

2) If, for any reason, the casing cannot be landed in the correct position or at a depth acceptable to the Engineer, The Contractor shall construct another well immediately adjacent to the original location and complete this well in accordance with specifications at no additional cost to the Engineer. The abandoned hole shall be sealed in accordance with directions from the Engineer.

3) When the final depth of the well has been reached by the bottom drive section, the open bottom of the casing shall be sealed with a plug consisting of 1/10 cubic meter of cement mixed into a slurry weighing 1,860 kg/cum.

The cement slurry shall be placed in the bottom of the well by the use of a dump bailer.

4) In the event that the Contractor shall fail to sink the test well to the depth specified or to such lesser depth as ordered by the Engineer, or should he abandon the well because of loss of tools or for any other cause, if requested and as directed by the Engineer, he shall fill the abandoned hole with clay or clay concrete and remove the casing.

b) Perforated Casing

Perforated casing is to be placed by the Contractor in each test well drilled under the percussion method as directed by the Engineer.

Repeat Work

a) All work required to be repeated, and all additional materials, labor, and equipment required shall be furnished at the expense of the Contractor. No claim for additional compensation shall be made or be allowed therefore, except as specifically provided herein.

D. DEVELOPMENT OF TEST WELLS

Time of Development

a) After each test well has been constructed in accordance with these specifications, the Contractor shall notify the Engineer and make necessary arrangements for conducting the well development. Minimum time for development shall be 24 hours of actual work, but development shall continue until the produced water is free of sediment and the specific capacity of the well is stabilized or as directed by the Engineer.

Equipment

a) The Contractor shall furnish all material, equipment and labor necessary to conduct development operations in accordance with these specifications.

Development Procedure

a) The Contractor, after completion of test well construction, shall bail the test well clean of all solid materials to the total depth of the well.

b) After bailing, the Contractor shall commence development of the well by the use of a surge block and a bailer suitable to the size of perforated casing in the well. After surging and bailing have stabilized the aquifer material and cleaned the well to the satisfaction of the Engineer, the test well shall be bailed clean to the total depth of the well.

c) The test pump shall be installed into the test well to a depth indicated by the Engineer. The test pump shall then be operated by running and stopping at production rates and for time period to be determined by the Engineer. Such development shall continue for a time period to be determined by the Engineer.

d) If the gravel level falls more than 35-cm below the bottom of the gravel-fill pipe at any time during development, gravel is to be added to fill the bore hole to the bottom of the gravel-fill pipe (applies only to rotary drilled wells).

e) Throughout the period of development the quantities of water produced, static water levels, and pumping water levels shall be recorded by the Contractor.

E. WELL TESTING

General

From information obtained during test well development, the Engineer shall determine a well test program to be followed.

Pumping

Test well production rates, as determined by the Engineer, shall be continuous for a minimum of 48 hours or more as specified by the Engineer.

Equipment

a) The Contractor shall provide all necessary devices to measure static water levels, pumping water levels, and quantities of water produced from the test wells.

b) Pumping equipment and pumps provided by the Contractor shall be capable of producing from 30-60 lps from a depth of at least 30 meters below the ground surface. Such equipment shall be capable of operating continuously for a period of 72 hours.

Records

Throughout the period of testing and during the period of recovery after testing until the measured water level has returned to original static level, the Contractor shall maintain a record indicating production rates, time, pumping levels and recovery levels in each test well. The Contractor will also assist the Engineer in the performance of all data collection procedures which may be required during the test program.

Water Disposal

Discharge water shall be disposed of at a sufficient distance from the well to avoid undesired recharge effects.

F. WELL COMPLETION

Well Cleaning

a) At the termination of well testing, the test pump shall be removed from each test well and each well shall be bailed clean to the total depth of the well.

b) A firmly attached cover plate or pipe cap shall be placed on each test and observation well to seal it.

Site Clean-Up

After completion of all construction and testing activities at each test well site, all equipment and residual materials shall be removed from each site. Each site shall then be restored to a condition as nearly as possible to that which existed before testing activities commenced. This work shall include, but not be limited to, restoration of fences and structures, removal of drill cuttings, levelling of disturbed ground surfaces and replacement or compensation for destroyed landscaping.

Salvaged material furnish by the Contractor shall remain his property. Payments shall then be based on the accepted test well.

G. SUBMISSION

At the end of the test well construction, and before final payment is made, the Contractor shall submit to the Engineer at least three (3) certified copies of the following:

a) Graphical log of well on 8-inch x 11-inch sheet showing, among others:

1) Total depth of well;

2) Description of strata encountered;

3) Sizes and lengths/specifications of casing installed; and

4) Dates of start and completion of construction of the test well.

b) Record of test for yield and drawdown, showing, among others:

1) Well capacity, dates and lengths of test;

2) Drawdown and recovery;

3) Method of measuring yield and drawdown; and

4) Specifications of test pump.

APPENDIX J

WATER TREATMENT ALTERNATIVES

APPENDIX J

WATER TREATMENT ALTERNATIVES

Disinfection of water supply may be accomplished through chemical application of chlorine, iodine, ozone, ultra-violet radiation and oxidizing agents.

Chlorination is a universal disinfection process used in most municipal water systems. Chlorine, a potent oxidizing agent, destroys bacteria, when mixed under certain time constraints and when applied in correct dosage.

Iodine has chemical properties that make it an effective agent against virus and certain bacterial cysts. However, research indicates that iodine treatment in excess of 3 weeks may have detrimental effects upon individuals afflicted with thyroid diseases.

Ozone, a blue gas and active form of oxygen, is rated to be a more vigorous oxidizing agent than chlorine. This versatile element not only disinfects but also sterilizes. It also helps in color reduction, iron and manganese oxidation, taste and odor control. Despite its impressive known qualities, ozone is yet to achieve universal acceptance.

Ultra-violet radiation is another method of disinfection applicable to small water systems. It involves high-cost equipment and requires considerable amount of power. Moreover, this type of treatment requires high-quality water, otherwise the ultra-violet rays may be absorbed by substances present in the water supply.

The use of metal ions with bactericidal properties, such as copper, silver and mercury, is limited by their cost, availability and potential adverse health effects if not properly dosed.

Bromine as a water disinfectant is costly and scarce. Liquid bromine produces irritating fumes and causes severe burns.

Oxidizing agents such as potassium permanganate and hydrogen peroxide have weak purifying qualities that require long contact time and high dosage.

The economics of disinfection serve as an important, if not sole, basis for the selection of a treatment method suitable to a particular water system. Selection is not necessarily based upon

the cheapest method available but on its dependability, effectiveness, suitability and reasonableness in cost. From this viewpoint, ozone and chlorine merit further consideration.

Ozone, as earlier indicated, lacks extensive practical application but its versatility makes it advantageous over chlorine under certain conditions. It can be more effective and economical when used for two or more stages of water purification. When taste and odor in water are organic, ozone may be as effective as chlorine. When disinfection only is required or water supply is clear, however, chlorine will be much more economical.

Plant-scale studies on ozonation show that it entails bigger capital investment than chlorination by the ratio of 3-4:1.

While ozone appears to be an efficient disinfectant, its practical application is supported with scarce data. This leaves chlorine, a proven disinfectant, as a more dependable method. Although considered a less rapid agent than ozone, chlorine fits well in large water supply systems.

Since the early 1990's, chlorine has been widely used in water treatment but recently in the United States, it has developed into a critical issue. Studies done by regulatory agencies revealed the presence of cancer-producing chlorine compounds in the drinking water of several cities in the eastern part of the United States, as a result of treating river waters contaminated by certain organic and chemical wastes. The studies indicated that through chlorination, the hazard levels of man-made chemicals and pesticides that pollute the river sources are increased.

However, the critical aspect of chlorination does not apply to the service area at this period of its development. Rivers are not generally contaminated by agro-industrial chemicals - a condition foreseen to remain for quite some time.

APPENDIX K

DISTRIBUTION SYSTEM ALTERNATIVES

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DISTRIBUTION SYSTEM ALTERNATIVES

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APPENDIX K

DISTRIBUTION SYSTEM ALTERNATIVES

General

The distribution system, in general, is composed of a network of distribution mains, internal distribution networks, storage facilities, booster pump stations, booster chlorination stations, and appurtenances such as valves, fire hydrants, meters, and service connections. The distribution mains are the larger pipelines which take the water from the transmission lines to the demand areas. The internal network system consists of the smaller street mains which distribute the water to consumers along smaller streets of the city and subdivisions. Booster pump stations are required to raise water from lower pressure zones to higher pressure zones where consumers are usually at higher ground elevations. The booster chlorination stations are required at the fringe areas of the water district to keep the chlorine residual at the desired concentration. The distribution storage facilities provide supplementary flows during the peak-demand periods. The transmission lines convey the water to and from the storage facility depending on whether it is filling or emptying.

The valves are placed throughout the distribution system to keep small service areas isolated by closing the valves at times when maintenance is required. The fire hydrants are connected to the distribution system at regular intervals depending upon the type of area served. The service connections convey the water from the internal distribution system to the consumer. Meters are placed on the service connection line to measure the amount of water consumed by the customer. The components of the distribution system described above are illustrated in Appendix Figure K-1.

The major alternatives for the components of the distribution system can be grouped into 2 categories:

(1) Size and Staging. For most components of the distribution system, it is possible either to install the capacity required for the design year or to stage the construction of the component by installing part of the required capacity in an early construction phase and the remaining capacity in a subsequent phase. Examples would be a 10,000 cum storage tank built in 1980 for the design year 2000; or a 6,000 cum storage tank built in 1980 and a 4,000 cum storage tank built in 1990. Installing a smaller-size component initially has the advantage of reducing capital cost in the initial construction period. Also, staging provides flexibility as more data will be available at a later date and

the assessment of population and economic growth may indicate a new location is preferable to that originally planned. In any case, studies should be made to determine the economic feasibility of staging.

(2) Location. Sometimes, more than one location exist for the construction of the distribution system component. In some cases, economic studies will aid in the selection of the most desirable site, and in other cases, practical consideration and engineering judgement will be of primary importance.

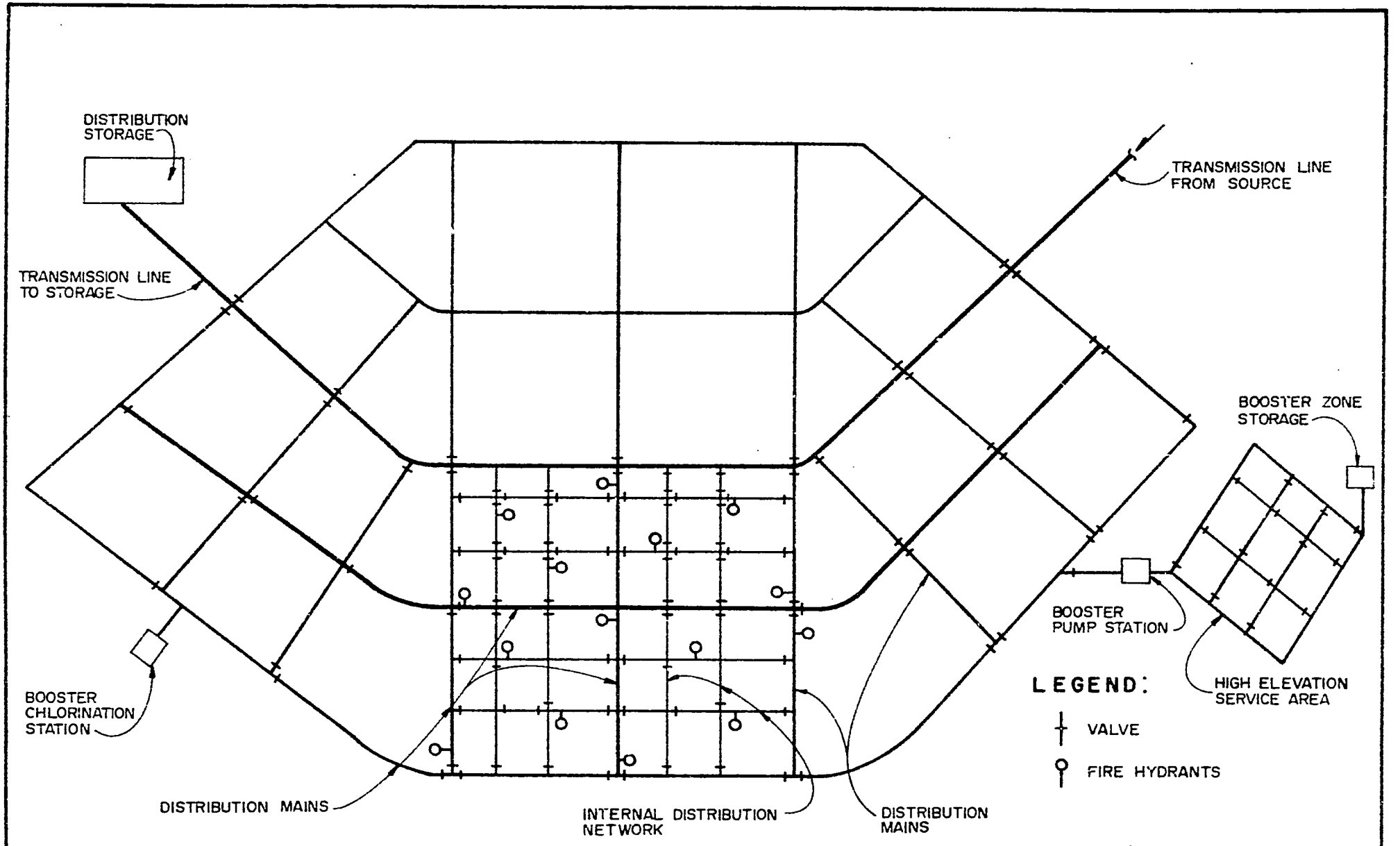
Each component of the distribution system and its respective alternatives are discussed in subsequent sections.

Distribution Mains

The alternatives for distribution mains are location, size, staging and the spacing in the network. To avoid land costs and also to place the mains as close to the demand center as possible, the alignments for future distribution mains should be chosen along existing and planned road and street rights-of-way. Where the service area will extend to areas without planned or existing roadways and streets, the location of the distribution mains is determined by topographic features. As much as possible, the distribution mains should be looped to avoid dead-end service areas; to minimize the number of concessionaires affected when valves are closed for maintenance; and to provide adequate pressure at times of maximum demand as the demand can be supplied from more than one direction.

The distribution main network system is designed to provide a minimum pressure of 14 meters during peak-hour conditions. The minimum size of distribution mains has been taken as 200 mm. In general, this size is large enough to provide adequate pressure during peak-hour and fire-flow conditions. In some residential areas, alternating 150 mm and 200 mm pipe sizes is adequate. Staging of distribution mains is economical at 10-year intervals in areas having wide streets and low population densities. However, in high-density areas having small streets, it is usually preferable to avoid 2-stage construction. There is limited space for utilities in these areas and considerable disruption occurs when the street is excavated for the new water main. It is better to install the pipe size required for ultimate design in these congested areas so that these problems can be avoided.

It is desirable to maintain the maximum spacing for distribution mains at 1,000 meters. This will provide uniform size and spacing for the internal mains as well as better pressure distribution through-



APPENDIX FIGURE K-1
COMPONENTS OF THE DISTRIBUTION SYSTEM
NOT TO SCALE

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

out the system. A wider spacing of the distribution mains would require larger pipe sizes in the internal distribution network to maintain sufficient pressures during fire-flow and peak-hour periods.

It is not recommended that the minimum distribution main sizes be staged. However, larger mains can be staged in some instances. A required pipe size of 250 mm for year 2000 demands can be conveniently staged with one 200 mm line in Stage I and another 200-mm parallel line in Stage II. However, in Stage II an extra cost of 15 percent may be included in the construction of the parallel line because of the problem encountered with interties to the Stage I line and safeguarding service connections and sometimes transferring the connections with the internal network. The economic evaluation of a 2-stage versus 1-stage construction of a 250-mm line is shown below:

EVALUATION OF DISTRIBUTION MAIN STAGING

						1976 Present Worth[2]			
Alternative	Construction Period	Pipe Size (mm)	Construction Cost[1] (₱/m)	Project Cost (₱/m)	Annual Cost (₱/m)	Capital Cost (₱/m)	Annual Cost (₱/m)	Salvage Value (₱/m)	Net Cost (₱/m)
Single-Stage	1980	250	475	648	3	412	14	19	407
							Total		407
Two-Stage	1980	200	360	491	2	312	9	14	307
	1990	200	414	565	2	116	2	19	99
							Total		406

Comparison of the 2 alternatives shows that constructing two parallel 200 mm lines in each stage costs almost the same as a single 250-mm line in Stage I. In this case, it would probably be better to install a 200 mm line initially because of the lower capital cost and added flexibility. Similar calculations for staging a 300-mm line with parallel 250-mm and 200-mm lines indicate only slight savings with 2-stage construction. Selection of distribution mains which should be staged must follow an analysis of the peak-

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1/ 1990 construction cost includes 15 percent penalty.
2/ Discount rate is 12 percent.

hour and fire-flow conditions to be sure that the smaller line constructed in Stage I will be hydraulically adequate until the second line is installed.

The timing of the construction of the distribution main systems should be such that an attainable level of growth in the distribution system is maintained. Areas having higher densities of potential customers should be connected in the early construction periods because the cost per connection will be lower and more revenues will be generated. Also, extension of service to large demand customers such as industries and commercial areas would be desirable when a reliable water supply is available. Service to this type of customer would have a positive impact on the economy of the study area.

Distribution Storage Tanks

Distribution storage tanks provide supplementary supply during peak-hour demand periods, during fire-flow demand periods and during emergency periods when source supply is reduced. The recommended distribution storage volume is 15-20 percent of maximum daily supply requirements. The storage facility is designed to empty during peak-hour demand periods and to fill overnight during minimum demand periods. The storage tanks should be located as close to the demand center as possible and on the opposite side of the service area from the source. By locating the storage in this manner, the peak-hour pressures will be higher as the supply can be provided from 2 directions.

It is recommended that storage facilities be constructed on-grade with an operational level fluctuation of 3 to 7 meters. The storage tanks should be of reinforced concrete and covered to prevent contamination. Initially, adequate land area should be purchased so that the ultimate storage capacity of the site can easily be accommodated. The storage facility is designed and constructed in increments so that the desired capacity is available when needed. It has been observed that staging at 10-year intervals is an economically appropriate time increment based on the discount rate used in this study.

For operational purposes the storage overflow elevation should be the same as the elevation of the HGL control at the source. Locating the storage at the same elevation as the source is sound engineering practice. The range of operating pressures within the distribution system is reduced. This keeps the pumping heads at booster stations and wells at more constant levels, simplifying operation of the pump station. No maintenance of double-acting altitude valves at the storage facility is required unlike when the storage is at a lower elevation than the source.

Tank filling will take place during the minimum demand periods. Amount and duration of minimum demand can be determined by 24-hour consumption records. Since these data are not available, it is assumed that the minimum demand is about 30 percent of the average demand for a period of 8 hours. Assuming a tank with 7-meter water depth, the differential head between the source HGL elevation and the storage tanks is a maximum of 7 meters when the tank is empty and 3.5 meters when the tank is half full. Because of this small head differential, care must be taken in choosing location and size of the supply lines.

Placing the storage HGL at an elevation lower than the source elevation is not recommended because this will mean that areas at the extreme ends of the distribution system will have insufficient pressures unless inordinately large distribution mains are provided. If locating the distribution storage tank at a lower elevation than the source is considered, a double-acting altitude valve (or continuous manual control) must be placed on the supply line to the tank. The valve closes when the water elevation in the tank reaches the overflow level and opens when the pressure drops in the distribution system, permitting water from the storage to enter. If the valve is not maintained at all times, it could fail to operate properly and cause lower pressures in the distribution system than required. Because the storage is at an elevation less than the source, it is difficult to obtain the required flow from the storage during peak flow demands as most of the supply will come from the direction of the source, the location of the highest HGL.

When suitable ground storage sites are not available, it is possible to utilize elevated storage tanks or standpipes. If possible, the overflow elevation should be the same as the HGL control on the source transmission line. The operational range of elevated storage may be reduced to 5 meters. In the case of standpipe storage, the volume lower than the top 7 meters should not be considered as part of the operational volume. Economic studies can aid in the selection of the best location. The present worth cost of the storage tank and the transmission line for several alternative sites should be evaluated to determine the least-cost alternative.

In some cases it is more economical to locate a portion of the distribution storage volume at the source HGL control. This reduces the pipe diameter required to fill the distribution storage tank located at the other end of the system. However, locating the storage at the source will mean that more supply must come from the source during peak-hour demand periods. Several alternative distribution and source storage schemes should be evaluated to determine the best apportionment of the required storage volume.

Internal Network System

The internal network system is the network of pipes within the 1,000-meter grid spacing of the distribution main network. The internal network consists of pipe sizes usually of 150 mm or smaller diameter, valves, fire hydrants and service connections. The alternatives in the internal distribution network are dependent on the level of water service provided. A system designed for fire flow demands may require larger internal distribution pipes than a system designed only for peak-hour demands. The fire-flow requirements are:

Type of Area	Fire-Flow Demand
Commercial, Industrial and High-Value Residential	20 lps at each of 2 adjacent fire hydrants
Single-Family Residential	10 lps at each of 2 adjacent fire hydrants

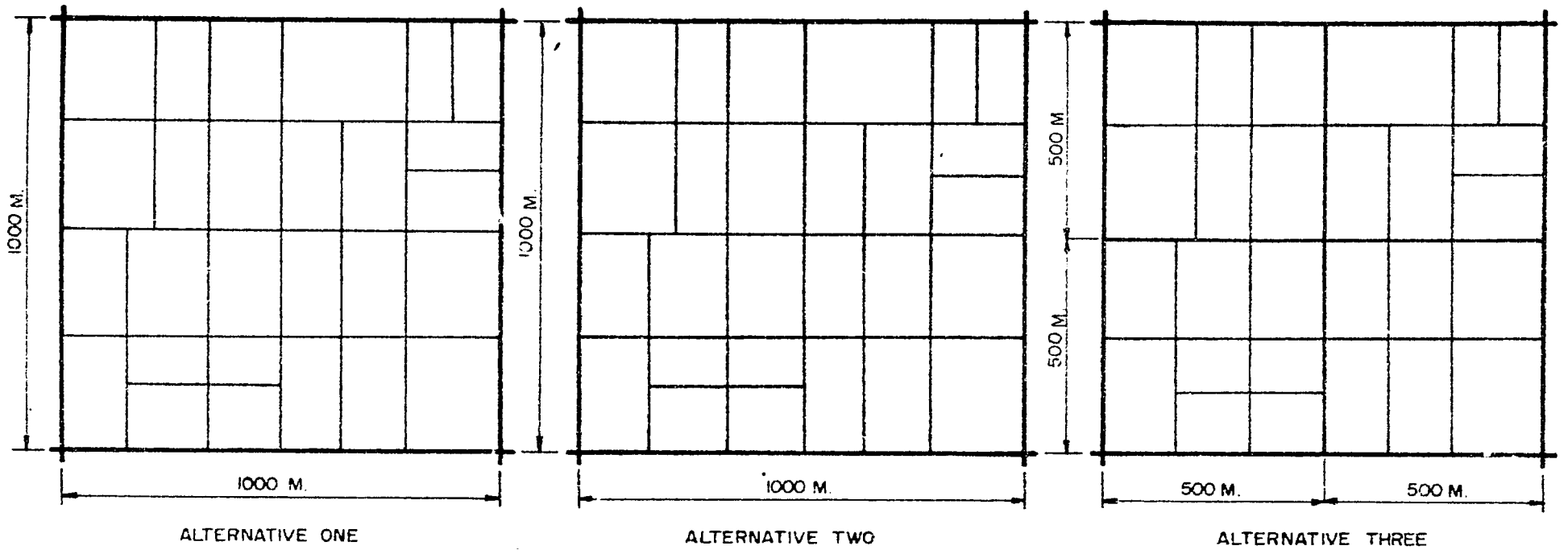
The internal network design is controlled by either of 2 conditions: peak-hour demands with minimum main pressure of 10 meters or fire-flow demand coincident with maximum-day demands with a minimum hydrant pressure of 7 meters.

In order to determine the response of the internal network to several flow conditions, a detailed study of the internal network was made. Commercial/residential areas in several cities in the Philippines were studied to determine a composite 100-hectare area. A typical 100-hectare area in the core city or fringe of the core city has 8-12 km of roads and streets. Since the internal network is installed along street rights-of-way, the total length of internal network pipe will also be 8-12 km for a 100-hectare area. An average of 8-12 km per 100-hectare area corresponds to 80-120 meters of pipe per hectare served. The 80 m/ha would be in less densely populated, high-value residential areas, and the 120 m/ha would be in densely populated, mixed residential and commercial areas. The 80 meters of pipe per hectare was used in the design study in order to evaluate the internal network under the most stressing conditions - less pipe per hectare will cause higher flows for the same areal demand. Three (3) alternative internal network designs were studied. The 3 alternatives are shown in Appendix Figure K-2 and listed below:

Alternative 1. All internal network pipe is 100 mm in diameter.

Alternative 2. All internal network pipe is 150 mm in diameter.

Alternative 3. The ratio of 100-mm pipe to 150-mm pipe is 3:1, i.e., 6,000 meters of 100-mm pipe and 2,000 meters of 150-mm pipe.



SIZE OF AREA = 100 HA
TOTAL LENGTH OF INTERNAL NET WORK PIPE = 80 M/HA.
DISTRIBUTION MAIN SPACING = 1000 M

INTERNAL NETWORK CHARACTERISTICS

	LENGTH OF 150 MM PIPE	LENGTH OF 100 MM PIPE
ALTERNATIVE ONE		8000 M.
ALTERNATIVE TWO	8000 M.	
ALTERNATIVE THREE	2000 M.	6000 M.

LEGEND:

- DISTRIBUTION MAIN
- 150 MM PIPE
- 100 MM PIPE

APPENDIX FIGURE K-2
ALTERNATIVE INTERNAL NETWORK SYSTEMS

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

The 3 alternative systems were evaluated by using the computer to solve for pressures and flows for varying population densities. The 100-hectare area was assumed to have a mixed residential and commercial land use. The domestic flow requirement was assumed to be 175 lpcd, and the commercial and institutional demand was assumed to be 10 percent of the domestic demand. The unaccounted-for-water was assumed to be 25 percent of the area's total demand. The demand was applied uniformly over the entire area. The alternative networks were analyzed under peak-hour condition (peaking factor of 2.0) and maximum-day plus fire-flow condition. The minimum pressure in the internal network is listed in Appendix Table K-1.

APPENDIX TABLE K-1

MINIMUM PRESSURE IN ALTERNATIVE INTERNAL NETWORK SYSTEM

Alternative System	Population Density	Minimum Pressure (m)[3]		
		Peak Hour	Commercial Fire Flow	Residential Fire Flow
1 - All	100/ha	11	7	11
100-mm Pipe	200/ha	10	6[4]	10
2[5] - All	300/ha	8[4]	4[4]	8
	100/ha	11	12	
150-mm Pipe	200/ha	11	11	
	300/ha	11	11	
3[5] - Ratio	100/ha	11	8	
of 100-mm to	200/ha	11	8	
150-mm Pipe is 3:1	300/ha	10	7	

[3] Average pressure in distribution mains is 14 meters.

[4] Less pressure than the criteria: Peak-hour minimum is 10 meters; fire-flow minimum is 7 meters.

[5] No residential fire test was analyzed because the minimum pressure criteria were satisfied in the commercial fire test.

The data indicate that Alternative 1 can meet minimum pressure requirements for all conditions for a population density of 100 per hectare. However, minimum criteria cannot be maintained for higher densities. Alternative 2 meets the pressure criteria for all population densities studied. Alternative 3 also satisfies the minimum criteria for all population densities studied.

The only difference between Alternatives 1 and 3 is the two 150-mm lines which are placed in the middle of the 100-hectare area. The two 150-mm lines add considerable carrying capacity to the internal network as indicated by the data in Appendix Table K-1. Alternative 3 can meet minimum pressures during commercial fire-flow test. Even though a 150-mm fire hydrant might be connected to a 100-mm pipe, it is possible to support the commercial fire-flow because water can be supplied from at least 2 directions and the larger, supporting 150-mm main or distribution main is no more than 250 meters away.

Other computer studies were carried out on Alternatives 1 and 3 by increasing the total length of internal network pipe to 120 m/ha. The peak-hour pressures were increased approximately by 2 meters as the peak-hour flow was spread among more pipes. However, the fire-flow pressures increased only slightly as the fireflow was applied to a much smaller area of the system.

The construction costs for installing the internal network piping for each alternative, and several sub-alternatives of the total internal network piping are listed below:

Alternative	Length of Pipe (m/ha)	Ratio of 100 mm : 150 mm	Construction Cost (₱/ha)[6]
1 - All	80	80:0	6,400
100-mm Pipe	100	100:0	8,000
	120	120:0	9,600
2 - All	80	0:0	12,000
150-mm Pipe	100	0:100	15,000
	120	0:120	18,000
3 - Mixed	80	60:20	7,800
100-150 mm Pipe	100	80:20	9,400
	120	100:20	11,000

[6] Costs do not include valves or fire hydrants.

Alternative 3 is 15-22 percent more than Alternative 1 and 35-39 percent less than Alternative 2. Though Alternative 1 provides sufficient service for residential areas up to 200 people per hectare, Alternative 3 is the recommended internal network system. Alternative 3 can meet minimum pressure requirements for higher density, levels and during commercial fire-flow conditions. This alternative can serve an area which is initially residential but gradually becomes commercial without requiring reinforcement. Also, further tests indicate that Alternative 3 can meet minimum pressures up to 400 people per hectare when 120 m/ha of internal network pipe is required.

The minimum recommended pipe size in the internal network is 100 mm. Smaller pipe would reduce peak-hour pressures and would severely limit fire-fighting potential. Though pipes less than 100 mm are cheaper, the installation costs are not significantly less than that for 100-mm pipe. Also, the capacity of smaller pipe is considerably less. The installation price per unit of capacity is shown in Appendix Figure K-3 for pipe sizes ranging from 50 to 350 mm. The curve turns upward very sharply for pipes smaller than 100 mm. On a capacity basis, the 75-mm pipe costs 80 percent more than the 100-mm pipe and is therefore not recommended for internal network pipe.

Staging of internal network pipes is not usually economical or practical. Streets and utilities should be provided in accordance with development and zoning plans. The internal network should be designed with the ultimate plan of the area, fixing the required demands and fire flows. Thus, the period for staging to be economical would have to be 10 years or more.

The valves in the distribution main network and the internal distribution system should be spaced so that interruption in service due to maintenance would affect as few customers as possible. Each internal network connection to a distribution main should have a valve so that repair to an internal main would not require closing of valves on distribution mains. High-demand areas should have more frequent valve spacing than low-demand areas. Valves should normally be placed at street intersections with a minimum spacing of 300 to 500 meters depending on the character of the area.

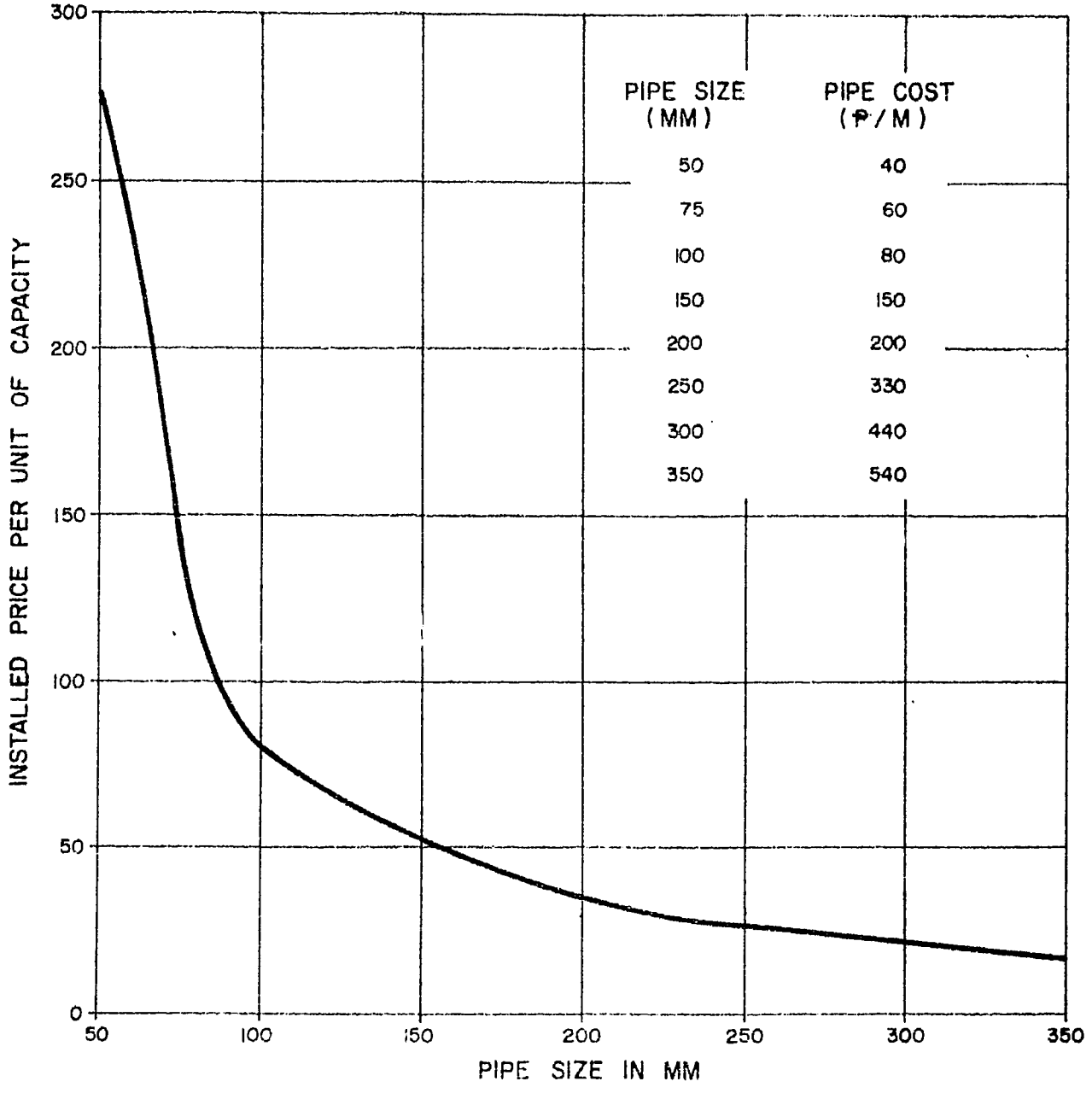
Fire hydrants will be placed at street intersections to permit quick location and enable fire-fighting in several directions. In high-value areas, hydrants will be spaced a maximum of 150 meters apart with 2 outlets - 1 x 60 mm hose outlet and a 1 x 100 mm pump outlet. The hydrant will be connected to a main with a minimum diameter of 100 mm. In single-family residential areas, hydrants will be connected to 100-mm mains and spaced a maximum of 250 meters apart. The outlet will be connected to a 1 x 100 mm pump or hose.

Customer service connections consist of a connection to the internal network main and a service line to the customer. The service line will be provided with a "gooseneck" for connection to the main and a service meter will be provided for continuous measurement of water provided to the customer. A valve should be inserted in the service ahead of the meter to enable the water district to terminate service when it becomes necessary.

Booster Zone

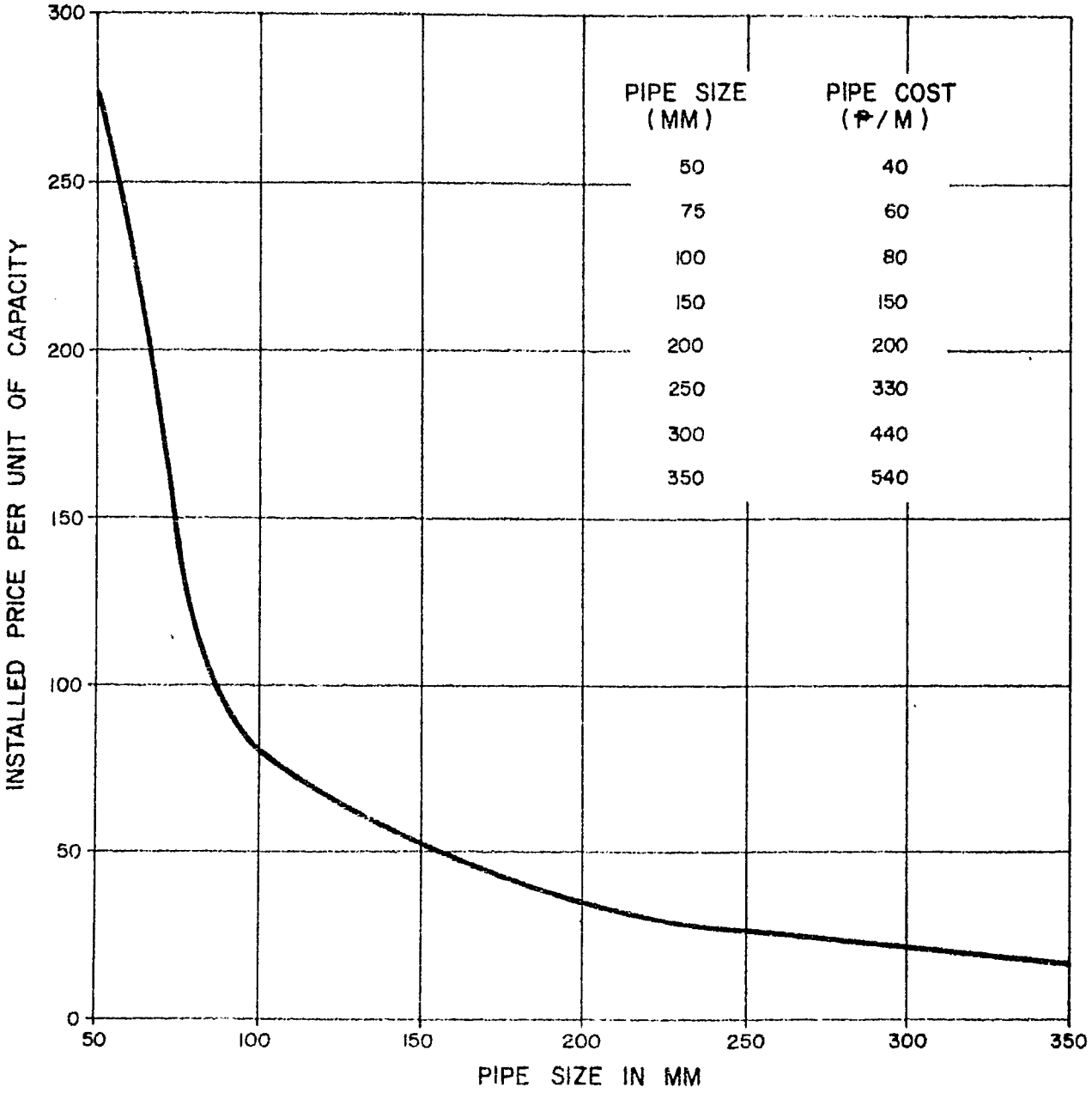
Portions of the service area at elevations which are too high to be served from the same HGL control as the service area at lower elevations, must be served by booster pumpage. The booster pump station raises the HGL to sufficient levels to serve the concessionaires in the booster zone. A storage tank should be located in the booster zone to supply peak-hour demand. The storage tank should be located on the opposite side of the booster zone from the booster pump station. The booster zone storage should have an overflow elevation not more than 70 meters above the lowest ground elevation in the booster zone. The booster pump station should be designed to pump maximum-day supply requirements.

Booster pump station should have at least 2 pumps to permit maintenance without interrupting service. One (1) of the units should be diesel or gas-powered to permit a minimum level of service interruption during power shortages.



NOTE:
CAPACITY OF 100 MM PIPE TAKEN AS UNITY. CAPACITY CALCULATED USING SAME HEADLOSS FOR ALL PIPE SIZES.

APPENDIX FIGURE K – 3
INSTALLED PIPE COSTS PER UNIT OF CAPACITY



NOTE:
CAPACITY OF 100 MM PIPE TAKEN AS UNITY CAPACITY CALCULATED USING SAME HEADLOSS FOR ALL PIPE SIZES.

APPENDIX FIGURE K – 3
INSTALLED PIPE COSTS PER UNIT OF CAPACITY

APPENDIX L

HAND PUMP WELL

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APPENDIX L

HAND PUMP WELL

An alternative to a piped water system in urban areas is hand pump wells (HPW). Under existing conditions in the Philippines, HPW will probably provide at the pump drinking water not significantly less safe than a piped water system. Water from the HPW may be contaminated while carried from the pump to the point of use. Similarly, safety of the piped water is not guaranteed, if also carried.

Benefits from personal and domestic hygiene occur from any water system in proportion to the amount used. This amount depends primarily upon the convenience with which water is provided. A HPW in the yard immediately adjacent to or in the house, will ordinarily be found reasonably convenient to use.

Water from a HPW is ordinarily not used in adequate quantity to support a sanitary sewer system and would not otherwise be very helpful to public or neighborhood cleanliness. HPW is, in this respect, inferior to a piped water system. This specific advantage of a piped water system over HPW is less important if there is no sanitary sewer system, or if the urban area in question does not have the funds to provide private water-borne waste system as substitute for the public sanitary sewer system.

Similarly, water from a good piped water system is ordinarily much more convenient and useful for non-essential uses than water from a HPW. A HPW is much inferior to a good piped water system for fire prevention.

In summary, water supply from HPW does not have the advantages of a piped system installed in the house. Water from a convenient HPW (which means a HPW adjacent to the house) is usually preferable to water from a piped system located away from the house. A piped water supply not available continually during at least the day-time hours or available only at a distance from the house is generally inferior to a HPW located in the premises.

Therefore, the HPW may provide a valid alternative to the piped water system in certain urban areas if funds are not sufficient for a modern upgraded piped water service.

Types and Costs of HPW

Hand pump wells may be classified in 2 categories:

1. Water level high enough for suction pump use (within 6 to 8 meters below ground surface);
2. Water level too deep for suction pump use (below 8 meters).

The depth of well required to reach a good aquifer at any particular site is a critical factor which influences costs.

High Water Level HPW. A high water level HPW includes the following components:

1. A simple pitcher pump, which should be brass-lined and connected to a 32-mm pipe. It may have a piston diameter between 60 to 100 mm ($2\frac{1}{2}$ to 4 inches) and a stroke of 25 to 125 mm (3 to 5 inches). Whatever the stroke and piston diameter, replacement cup leathers must be readily available to the people using the pump. A PVC lining is acceptable, instead of the brass lining.

2. A well screen, commonly called a "well point" when used with a hand pump, as it commonly has a point on the end.

3. Galvanized steel pipe, of 32 mm ($1\frac{1}{4}$ inches) nominal diameter to connect the well screen in the aquifer to the pump.

A concrete or masonry platform may be provided around the pipe at the ground surface. It is not essential for sanitary purposes if the connecting pipe is 10 meters long or more. When not essential, platforms are commonly left to the pump user to provide, and are therefore not an expense to the public program. If a platform is provided, a short drain is also usually provided to carry wastewater away from the immediate vicinity of the well.

The cost of a HPW is the sum of the costs of the materials at site, labor of installation, and supervision. The average cost of such HPW will vary from ₱1,000 (at 20-meter depth) to ₱3,000 (at 75-meter depth).

Deep Water Level HPW. A deep water level HPW should have the pumping element, the pump piston, installed below the pumping water level. If the pumping water level is at 15 meters, for instance, the pump piston must be 15 meters or more under ground.

The essential materials of such a well would include:

1. A pump, or more properly, a pump cylinder, which should be brass-lined steel, of 57 mm ($2\frac{1}{4}$ inches) or 54 mm (2 3/16 inches) diameter. The cylinder should include the piston of the 3-cup type, and the bottom valve assembly. The cylinder should connect on the top to a 62 mm ($2\frac{1}{2}$ inches) diameter pipe and on the bottom to a 62 mm ($2\frac{1}{2}$ inches) diameter pipe.

2. The well screen, which will be the same as that of the other wells described here.

3. Galvanized steel pipe of 62 mm ($2\frac{1}{2}$ inches) nominal diameter to connect the well screen to the pump cylinder and serve as casing.

4. Galvanized steel pipe of 62 mm ($2\frac{1}{2}$ inches) nominal diameter to connect the top of the pump cylinder to the discharge head.

5. A pump rod to connect the pump piston through the discharge head to the pump handle. If the rod is not more than 12 meters long, it may be of 11 mm (7/16 inches) steel. If more than 12 meters long, the pump rod should be of wood.

The average cost of such HPW will vary from ₱2,500 (at 20-meter depth) to ₱8,000 (at 75-meter depth).

Potential Application

In the first 10-area project, there are certain fringe areas[1] that could potentially adopt the HPW as an interim measure for water supply until such time that the permanent conventional system extends toward those areas. The following table shows these areas and the probable per capita costs if a HPW were provided for each home:

Water District	Community	Pumping Level (m)	Well Depth (m)	HPW Cost	Per Capita Cost[2]
MOWD	Clarin	near surface	40-50	₱2,000	₱290
CNWD	Basud	3-6	20-60	₱1,800	₱260
MCWD	Liloan	8-15	20-30	₱3,000	₱430
MCWD	Compostela	15	30-50	₱4,400	₱630

The HPW has a per capita cost which is 50-100 percent of the per capita cost of a piped water system. Because of the better level of service and fire-fighting potential of the piped water

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[1] Where groundwater conditions are favorable for HPW.
[2] Based on 7 persons per house.

system, the HPW alternative is not recommended in areas where a piped water system is a viable alternative. Hence, areas within the water district which have a population density of 100 per hectare should be served by a piped water supply.

APPENDIX M

WATER RESOURCES CONSERVATION MEASURES

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APPENDIX M

WATER RESOURCES CONSERVATION MEASURES

Alternatives available to counteract future (and present) water shortages include the following: reuse of wastewater, desalting, precipitation augmentation, land management, and dual plumbing system. These alternatives are discussed below.

Wastewater Reuse

One of the potential alternatives in meeting future water demand is the reuse or recycling of wastewater (sewage). In Singapore, reclaimed wastewater is used in the cooling process in industries. A full-scale municipal reuse facility in Windhoek in Southwest Africa built in 1969 provides a major source of potable water.

Reuse of wastewater can be accomplished in 2 ways: by natural self-purification which makes reuse possible for irrigation and recharging of ground and surface waters, and by technological process. The technology of reuse involves treatment of wastewater from the community for domestic, industrial, irrigation and other purposes.

Complex treatment processes are necessary to remove the objectionable characteristics of wastewater and make it suitable for a particular use. There are 3 basic phases of treatment - primary, secondary and tertiary. One of these or all may be applied, depending on the types of use and pollutants present in the wastewater.

Studies on wastewater reclamation deal with enhancing its economic feasibility for large-scale use and technological expansion. Achieving these objectives will depend on several factors.

It is technologically possible to produce water of any desired quality from any source. However, the controlling factor is economics. For instance, because of its lesser solids content, wastewater reclamation is simpler than seawater desalting as an alternative source of supply.

The feasibility of wastewater reclamation as a source of water supply will be limited in the service area since wastewater volumes are currently minimal, and future increases in sewerage are expected to be slow.

Desalting

Desalting is the process of converting seawater into fresh water. It involves removing substantial amounts of the ocean's salts and minerals.

There are three basic methods of desalting: distillation, freezing and electrodialysis, each with several variations.

Over 90 percent of the present application of desalting is done by distillation. In this process, seawater is evaporated and the vapor is condensed. Salt deposits form on the surfaces of the evaporating equipment and the desalinated water is the resulting distillate. The least costly distillation unit uses solar energy as heat source.

Electrodialysis obtains fresh water by using an electric current to separate the ions of the contaminating salts.

In the process of freezing, ice is formed from a saline solution and is melted to produce fresh water. However, the melted ice sometimes has a salty taste.

In 1970, 33 small desalting plants were put into operation throughout the world, with a combined capacity of 226,000 cumd. Kuwait has the largest plant with a 113,600 cumd capacity which is sufficient to supply a population of 150,000. Other plants are found in the Netherlands, the United States, Venezuela and Aruba.

For the most part, desalting is still experimental. At present it is not technically and economically feasible to convert meaningful amounts of seawater into fresh water. All the processes have inherent defects for general use, including the problem of disposing about 50 percent of removed salts and minerals of the total treated seawater.

These processes are also costly because they involve significant quantities of energy. Whereas treatment of ordinary water supply (before the energy crisis) cost about five cents per 1,000 gallons of fresh water, desalting cost about $1.00 per gallon of desalted water. This cost covered only the plant itself and excluded necessary transmission facilities.

Precipitation Augmentation

Rain can be artificially induced to increase water supply. The most common method of stimulating rainfall is cloud seeding. The theory behind cloud seeding is that under certain conditions,

air containing much moisture will not yield precipitation because of the absence of particles of dust, crystal or chemical droplets. In cloud seeding, such particles are artifically implanted in supersaturated clouds to stimulate rainfall. The particles used in the method are usually silver iodide crystals.

The costs of cloud seeding in 1971 ranged from $0.81 to $1.86 per thousand cubic meters of additional run-off. This cost range, however, was derived from planning reports and as such, might not represent actual operations.

Cloud seeding does not always yield the desired effect of increased rainfall. Experiments show that the method also results in decreases in the amount of expected precipitation. This effect has not been sufficiently explained although a theory advanced is that the amount of rainfall depends on the types of cloud systems being needed.

Increases in precipitation do not necessarily produce proportional increases in usable water supply. The opportunities to increase precipitation depend on climatic conditions such that during the dry season, water supply increases are less frequent. Precipitation augmentation encourages the growth of vegetation that can reduce usable water yield.

Land Management

Land management can affect the amount and quality of water available for use. It is a method of both increasing and conserving water supply.

Two potential techniques of land management that apply to Philippine conditions are forest management and control of streambank vegetation. Forests impact upon water supply in a number of ways. They intercept rain on the surface of the leaves. They draw moisture from the soil and release it into the atmosphere by transpiration. Through the roots, leaves and other parts, forests facilitate the infiltration of precipitation into the soil. They also tend to shade the soil and slow down wind velocity, thus, reducing evaporation from the soil surface. Any alteration on the amount and type of vegetation, such as deforestration, will affect water supply.

Phreatophytes (or deep-rooted vegetation along the banks of canals and rivers) consume much water in their growth. Especially in cases where precipitation is low, phreatophytes may reduce the streamflow and the discharges of springs. Sometimes, they also

tend to increase flood stages when they invade stream channels and reduce channel capacity. Phreatophytes are mainly useful in the sense that they provide an important wildlife habitat. Based on their effects on the water supply, they have to be managed carefully as uprooting them is not necessarily the best answer to increasing water supply.

Dual Plumbing System

A relatively small increment of the total public water supply demands highly potable and clean water such as that required for drinking, cooling, bathing and washing clothes. It is possible, for instance, to use seawater for toilet flushing, washing streets, and fire-fighting. Where fresh potable water is in short supply, such as in Singapore and Hongkong, a dual system has demonstrated its effectiveness. For example, in Hongkong during the severe drought of the summer of 1963, water service was rationed into the various city sectors 4 hours every 4 days. Extraneous uses of water such as toilet flushing were therefore severely curtailed.' In some of the high-rise government housing in Hongkong, the dual plumbing system has been used, with sea water for toilet flushing.

There are two main objections that have been identified in the use of dual water supply system - cross-connections and associated cost. The dual system, where one system delivers potable water and the other system furnishes untreated water, can very well lead to water-borne disease outbreaks. Where proposed, the dual system should have the non-potable supply clearly indicated and separated from the potable supply. Proper plumbing codes and supervision of plumbing installation could minimize this health hazard.

If an existing system is to be replaced entirely by a dual system, the cost may well be unreasonable. However, if the existing water supply piping is retained as a potable (drinking) system and a new non-potable pipe network utilizing sea water is added, there is a possibility that the economics may prove the dual system to be worthwhile. Savings result where the non-potable system serves high-rise multi-family dwelling units wtih high population density. The increased cost resulting from the independent system may be offset by eliminating the need for developing new water resources and above all, retaining premium high-quality water for domestic consumption. Accordingly, the feasibility of the dual system has already been proven. Because the potable water system will not be used for fire protection, its distribution system need not be designed for high pressure otherwise required in a system with high fire demand.

APPENDIX N

CONSTRUCTION MATERIALS AND METHODS

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APPENDIX N

CONSTRUCTION MATERIALS AND METHODS

General

The construction of water supply system components such as source of supply facilities, transmission mains, treatment and distribution system works requires a wide range of construction procedures and specific materials designed for each purpose. Construction may vary from the laying of small underground pipelines to the construction of relatively large structures including the construction of buildings; installation of complicated mechanical and electrical equipment; excavation of all types; construction below ground level; pavement removal and replacement; and a host of other types of construction depending on the nature, magnitude and complexity of the waterworks project. This chapter describes certain materials and methods of importance in obtaining the class of construction needed to carry out the intent of preliminary design. Construction must be such that proper and economical operation is assured in order to protect the large investment that must be made to achieve the goal which is to make an adequate supply of safe and potable water available to the people.

Factors Affecting Construction

Factors affecting the facility and cost of construction of water system components include climate and weather conditions, availability of construction materials, availability of skilled and common labor, special construction equipment requirements, existing developments, and soil conditions.

The climate of the area will influence the construction methods to be used and the speed with which work can proceed. For example, protracted periods of intense rainfall will cause interruption and delay in construction work and may require shoring or bracing trenches for water mains to prevent their collapse and trench dewatering facilities. Adverse weather conditions will also affect the logistics of construction as the delivery and transportation of materials may be prevented or delayed.

A significant climatic factor in many parts of the Philippines is the frequency of tropical cyclones. An average of 19 tropical cyclones form in or enter the Philippine area of responsibility annually. Some areas in the Philippines are more susceptible to tropical cyclones than others. Aside from preventing prosecution of the work, tropical cyclones may also inflict significant damage on work already completed or in progress.

Other physical factors that could greatly affect the construction of water system facilities, particularly water distribution main construction procedures, are the width of streets; presence or absence of sidewalks, curbs, and gutters; traffic density; and other existing or proposed underground utilities.

Soil conditions are expected to vary for different areas and from place to place in any given area. Pertinent soil information for the construction of the various components of the water system improvements should be gathered and evaluated in order that any special construction problem or requirement can be properly determined and provided for. For example, soils with high sulfate content may eliminate consideration of asbestos cement pipe for water mains. In cases where transmission and distribution mains are to be laid in unstable soils, across streams, swamps, or marshlands, the soil conditions should be thoroughly checked that they can withstand the load; or the pipeline materials and joints should be selected and designed with provision for any excessive settlement that may occur.

There is a large reservoir of labor and skills in the Philippines to carry out the vast construction work involved in water supply system development or improvement. It may be necessary, however, to bring in to the project area certain technical personnel and specialists to supervise the work and installation, and to instruct in the maintenance and operation of complicated items of machinery and equipment.

In some large Philippine cities, there may be local construction contractors with the competence and resources to undertake all or portion of a waterworks project. In the event that local construction expertise and capability are not available or are deficient in some respects, several Metropolitan Manila-based construction firms can be utilized for any and almost all of the work needed for water supply projects.

Other types of work require the use of specialized equipment not only because it is virtually impossible or extremely difficult to accomplish the work with human power but also for faster, more efficient, more economical, and better quality of work. In general, however, the use of equipment-intensive construction procedures for waterworks improvements in the Philippines should be avoided, if possible. Common construction equipment such as trucks, cranes, etc., may be available in some project areas. Government-owned construction equipment for infrastructure projects assigned to highway regional or district offices may be available for use by private contractors on a rental basis.

Existing and proposed developments in a project area would normally create some problems with respect to the construction of water supply facilities. For economy and ease in construction, the implementation of waterworks projects must be planned with due consideration of other utilities and public works construction programs.

Construction Materials and Methods for Waterworks Projects

In any construction work, materials and procedures are two of the most important items needed for the successful prosecution and completion of the project. Many construction materials and procedures are common to several types of construction. Others are more specialized in nature and apply only to certain types of structure or work. In the following sections are discussed some of the materials and procedures that are normally needed and employed in the construction of water supply systems. Materials that go into concrete work, various pipe materials and valves, fire hydrants, service lines, pumps, and water meters are also given. With the expanding activities and programs in water supply development in the Philippines, the engineering and construction of large-capacity water supply works such as transmission tunnels, water mains, water treatment plants, pumping stations, and storage reservoirs, are expected to increase. Common practices in the construction of those facilities are discussed briefly.

Sand and Gravel

Sand and gravel may be needed in large quantities in a water supply development project area for uses like concrete aggregates, pipe bedding, road surfacing, etc. Unavailability of these materials in the amounts needed within reasonable hauling distance to a project area could add materially to the construction costs. In any water supply feasibility study and construction program, investigation should be carried out to locate sources of sand and gravel and to determine their suitability for the various works.

Cement

Cement is manufactured in large quantities in the Philippines and in recent years has been one of its export products. As of 1974, there were 18 operating cement plants in the Philippines, 11 located in Luzon, two in the Visayas, and five in Mindanao. The majority of the existing cement plants started original operation or underwent expansion within the last decade. In addition, 24 cement pro-

jects were registered with the Securities and Exchange Commission. The operating plants have a total capacity of 173.4 million bags of cement of 43 kg each. Total production in 1974 amounted to about 85 million bags, or 3.6 million metric tons, of which approximately 20 percent was exported.

No serious or special problem is likely to arise with respect to cement requirements of any water supply project in the Philippines.

Reinforcing Steel

For reinforced concrete construction, steel reinforcing bars are fabricated by 27 steel mills in the country. Reported production of reinforcing steel of the plants for 1974 amounted to 240,000 metric tons. Steel manufacturing normally conforms to ASTM standards. Reinforcing bars in sizes from 6 to 25 mm are readily available. For the larger sizes, bars are available in plain and deformed sections.

Concrete

From the foregoing, it can be concluded that all the principal materials needed for good quality concrete can be furnished from local (Philippine) sources. The quality of concrete needed for the various components of the development plan will have to be determined during the final design stage of the project.

Asbestos Cement Pipe

Asbestos cement pipe was first made in Europe in 1913, and was introduced in the United States in 1929. However, its extensive use for water system piping in the Philippines started only in the early sixties.

Asbestos cement pipe is manufactured from simple ingredients: asbestos fiber, silica sand, and cement. Asbestos fibers make up the smallest percentage of the total volume of pipe material ingredients but their high tensile properties add significantly to the overall pipe strength. The amount of each element used varies but is usually in the following ranges: asbestos, 15 to 20 percent, silica, 32 to 34 percent, and cement, 48 to 51 percent. Because of its methods of manufacture, asbestos cement pipe is smooth on the outside; due to the polished mandrel used in its formation, it normally has a very smooth interior bore. Therefore no coatings of any kind are used. Because of its chemical composition, asbestos cement pipe is not easily affected by corrosive waters; however, it requires a special outside coating for soils with high sulfate

content. With its smooth bore, it has a high C value at installation that can be expected to remain high throughout use. The low content of uncombined calcium hydroxide ensures that the leaching effects of soft waters will be at a minimum. Purchasers may specify a limit for uncombined calcium hydroxide. Disadvantages of this pipe include low strength, brittleness, disintegration, leakage, and low ductility.

Asbestos cement pipe which has been used for over a decade for water mains in the Philippines is widely accepted in this country and often has been the pipe material of choice for small sizes (80 to 300 mm) primarily because of its relative economy compared to ferrous pipes. The pipe is produced by two manufacturers with factories in Metropolitan Manila, and under the trade name Eternit and Italit, respectively. Pressure pipe is readily available in sizes from 80 to 600 mm for rated working pressures up to 130 mm. Pipes are generally manufactured according to ISO E-160 specifications and supplied in 4-meters lengths. A significant feature of asbestos cement pipe manufactured under the ISO specifications is that the required test pressure is only twice the rated working pressure.

Inquiries as to whether asbestos pipe conforming to AWWA standard C-400 can be manufactured by the local plants revealed that the pipes can be manufactured but at higher costs than ISO pipes because of the stringent requirements of the AWWA standard. For example, the AWWA standard requires a hydrostatic test pressure of $3\frac{1}{2}$ times the rated working pressure.

The AWWA standard covers 2 types of asbestos cement pipe: type I - for use where contact with aggresive waters and/or soils with sulfate content is not expected; and type II - for use where contact with aggressive waters and/or soils with sulfate content is expected to occur. The standard limits the uncombined calcium hydroxide (free lime) for type II pipe to 1 percent. To meet this requirement, the local manufacturers indicated that the cement would not prove suitable. For type I pipe, there is no prescribed limit for uncombined calcium hydroxide.

Locally produced asbestos cement pipes are normally joined with a coupling of the same composition and strength as the pipe and joints are sealed with double "O" rubb rings. Mechanical joints (Gibault joints) for joining asbestos cement pipes or asbestos cement-to-cast iron pipes are also produced locally.

In recent years, a question has been raised about the possible health hazard that may be associated with drinking water which has flowed through asbestos cement pipe. In an effort to determine the scope of the problem, the A/C Pipe Producers Association (U.S.) contracted with the American Water Works Association Research Foundation to study the problem of asbestos in water, specifically with relation to the use of asbestos cement pipe. One conclusion of the recently completed study is that though asbestos in water has become a potentially serious health hazard, the proper use of asbestos cement pipe for water does not pose a hazard to health by reason of ingestion of asbestos fibers. Highlights of the other findings and conclusions of the study are:

(1) Asbestos can pause granulomatous and fibrotic reactions in the lungs but there is no evidence that it does so in the gastro-intestinal tract.

(2) The general prevalence of asbestos in soil results in its presence in most waters of lake, river, and well origin, and in distribution systems whether fabricated of asbestos cement or other materials.

(3) Asbestos cement pipe systems have serviced large populations for 40 or more years in Europe and the United States with no apparent increase in peritomeal mesotheliomas among the public during this period, despite the fact that this tumor has been the focus of great interest among the pathologists for the past 10 years.

(4) No firm evidence shows that the proper use of asbestos cement pipe poses a hazard to health by reason of ingestion of asbestos fibers. Calculations comparing the probable ingestion exposure in occupational groups to that likely to occur as a result of ingestion of potable water from asbestos cement pipe systems suggest that the probability of risk to health from the use of such systems is small - approaching zero.

Based on the above, it is safe to assume that asbestos cement pipe is still an acceptable material for conveying and distributing public water supplies.

Cast Iron and Ductile Iron Pipe

General. There are 2 types of cast iron available for water systems: gray cast iron and ductile iron. Gray cast iron has a history of use that dates from over 300 years. Ductile iron was developed in 1948 and its use has been increasing since 1960.

Gray Cast Iron. Gray cast iron has characteristics of long life, toughness, imperviousness, and ease of tapping, that are provided by the chemical composition of the metal. Carrying capacity is ensured by proper lining.

The production of gray cast iron pipe consists of melting the metal in a furnace (cupola); the addition of such other materials as needed for the final desired composition; and the actual casting usually by a centrifugal process. As a molten iron is withdrawn from the cupola to a ladle, small amounts of graphite and ferrosilicon are added to adjust the carbon and silicon content; this is termed inoculation. The amounts of carbon, silicon, manganese, etc., although small, materially affect the structure of the iron. Each of the chemicals added is controlled in amounts to produce the desired qualities in the castings.

In gray cast iron, the major part of the carbon content occurs as free carbon or graphite in the form of flakes interspersed throughout the metal. An appreciable volume of graphite flakes makes gray cast iron more resistant to corrosion than the purer forms of iron because graphite does not corrode. Graphite in cast iron also affects the machinability of the pipe, that is, it makes the pipe more easily tapped and threaded for insertion of a corporation cock.

Cast iron pipe has been used for water supply systems in the Philippines for more than half a century. Prior to the introduction of asbestos cement pipe, cast iron dominated the market for water supply piping. Until locally manufactured in the 1950's, all cast iron pipes used were then imported.

At present, centrifrugally cast iron pipe is manufactured by the Filipino Pipe and Foundry Corporation and marketed under the trade name "Silva Pipes". This company's plant is located in Mandaluyong, Rizal and has an annual capacity of about 33,000 metric tons. Pipes are centrifugally cast in metal molds and are available in sizes from 150 to 600 mm, unlined or cement lined. The pipe is manufactured with bell and spigot ends for leadcaulked joints. Bell and spigot iron pipes are made in conformance with (U.S.) Federal Specifications or AWWA Standards. The Silva plant also manufactures cast iron fittings and Gibault joints for asbestos cement pipe to cast iron pipe.

Ductile Iron Pipe. Ductile iron pipe is stronger, tougher and more ductile than gray cast iron. Its characteristics are due to the configuration of the free carbon or graphite in the iron. Ductile iron is defined as cast iron with graphite in spheroidal (nodular) form. It is produced by adding an inoculant, usually magnesium, to molten iron.

Ductile iron is chemically akin to gray cast iron of low phosphorous and low sulfur content, the latter obtained by desulfurizing in the cupola. Magnesium can be added, after the removal of sulfur, in a post-inoculation treatment, with a silicon-base magnesium alloy.

Ductile iron pipe is centrifugally cast in the same manner as gray cast iron, but the melting and inoculation phase of the process is more complex; the casting phase is the same. At present, this type of pipe is not manufactured in the Philippines.

Steel Pipe

Early use of steel pipe for carrying water was in large, long, and exposed transmission lines in relatively dry areas where corrosion was not a problem. Other applications in other areas became more common as coal-tar coatings became available. Steel pipe is used in the Philippines in many distribution and transmission lines as well as in inplant systems. The American Water Works Association (AWWA) has prescribed standards for steel pipe for use in water systems. The Local Water Utilities Administration (LWUA) has adopted (U.S.) Federal Specifications SS-P385a dated 31 January 1964 and Amendment I dated 27 February 1968, with some modifications thereof, as its standards for steel pipe and specials.

As described by AWWA Standards, there are 2 types of steel water pipe: fabricated, electrically welded steel pipe, and mill-type steel pipe. Both types may be coated and lined.

Fabricated electrically welded pipe may be produced by automatic welding machines or by manual operations. AWWA Standard C201 gives detailed specifications for this type of pipe. Mill-type steel pipe may be furnace-welded (continuous butt-welded or furnace butt-welded), electrically welded, seamless. AWWA Standard C202 sets forth the specifications for mill-type steel pipes. An AWWA committee has been working to combine the 2 standards into a single standard.

Large- and small-diameter steel pipes are manufactured in the Philippines. The International Pipe Industries Corporation with plant in Pasig, Rizal manufactures spiral-welded pipe from 100 to 1,200 mm diameter. As of January 1975, this plant had a capacity of 15,000 metric tons per year but was undergoing expansion to double its present capacity. Pipe can be manufactured and cement-lined according to AWWA Standards C202 and C205, respectively.

Five (5) other plants produce small size pipe from 10 to 200 mm diameter. Both black and galvanized iron pipes can be produced accordingly to ISO or ASTM Standards. In 1974, the combined production of the plants amounted to 31,600 metric tons.

Prestressed Concrete Pressure Pipe

There are 4 usual types of concrete water pipe, classified according to the method of reinforcement. These types are: cylinder, not prestressed; steel cylinder, prestressed; non-cylinder, not prestressed; non-cylinder, prestressed.

AWWA has set forth design requirements for the first 3 types of pipes including minimum wall and lining thickness, reinforcing spacing, and core coat thickness specifications.

The steel cylinder, not prestressed concrete pipe, is covered under AWWA Standard C300.

The prestressed concrete embedded cylinder pipe consists of a water-tight steel cylinder, steel joint rings, a concrete core, high tensile wire reinforcing and a cement-mortar or concrete coating. Ranging in diameter from 16 to 144 inches, it is considered highly suitable for major water supply and transmission lines. This type of pipe is also recommended for unusually high pressure distribution lines. AWWA Standard C301 covers this type of pipe.

The fourth type of concrete pipe (prestressed, non-cylinder type) is not covered by AWWA Standards. This pipe consists of a concrete core manufactured by centrifugation, both longitudinally and circumferentially prestressed by high tensile wire, and protected by a dense coating of premixed cement-mortar.

Although prestressed concrete pipe is not yet manufactured and used in the Philippines, it is recommended that this type of pipe, where it is applicable, be considered in the final design of facilities. Unofficial information has revealed that 2 Philippine companies are planning to put up factories to manufacture prestressed concrete pressure pipes.

Plastic Pipe

Plastic pipe as a commercial product was first introduced in Germany in 1930 and in the United States in 1940. Polyvinyl chloride (PVC) was the first type produced. Later came cellulose acetate

butyrate (CAB) and polyvinyledine chloride (Saran). Volume production of plastic pipe began in 1948, when polyethylene (PE) was accepted for various water uses.

Early production of plastic pipe was in sizes below 50 mm, and most of the plastic pipes sold were for service lines and household plumbing systems. As developments in the plastics industry progressed, larger pipe sizes became available. Plastic pipe is today used for water distribution mains in many localities throughout the world, as well as for services and inplant piping systems.

There are about a dozen plastic materials that may be used in water systems. Only three, however, are in common use: PVC, PE, and ABS (acrylonitrile butadience strynene). ABS has been used primarily for drainage, waste, and vent (LWV) pipe and fittings for interior application. ABS has been popular a few years ago for water systems, but because it has only half the available hoop stress of PVC when subjected to internal pressure, the latter product is considered to be a better material for water lines.

Available U.S. standards for the manufacture of plastic pipe for use in water systems include ASTM, Department of Commerce, Commercial Standards, and USASI Standards.

PVC and PE pipes for use in water systems are manufactured in the Philippines. A PVC plant in Iligan City supplies most of the raw materials for PVC pipe to the local manufacturers. PVC pipe is available in sizes from 10 to 300 mm in 3 to 6-meter lengths and standard thermo-plastic pipe dimension ratio (SDR) from 9 to 32.5. The SDR is the ratio of pipe diameter to wall thickness. In the case of ABS and PVC pipe, the outside diameter is used; for PE, the inside pipe diameter is used. The SDR and hydrostatic design stress of the pipe affect its pressure rating which is defined : the estimated maximum operating internal pressure at which the pipe can function without failure.

Classes of PE pipe available include Medium Density, Schedule 40; and High Density, Schedule 40, 80, and 120. Pipe sizes are from 10 to 40 mm, 60-meter rolls for sizes 40 to 60 mm, and 25 to 30-meter length for pipe 75 to 300 mm in diameter.

To date, plastic pipe has not been used extensively in the Philippines for water mains. Limited experience with PVC pipe water mains used in a high pressure distribution system has not been satisfactory because of frequent failures and leakage particularly at the joints. One problem that has discouraged or deterred some engineers to specify PVC pipe is the non-standardization of fittings and connections among local plastic pipe manufacturers.

Thus, a project becomes a captive market for a particular brand of pipe once the project starts to use the particular brand.

Plastic pipe materials acceptable to LWUA are PVC, PE, and PB (polybutylene) and tentative standards therefore have been adopted by this organization. PB pipe, however, is not currently manufactured in the Philippines.

Valves and Fire Hydrants

Gate Valves. Gate valves for water systems are normally of the double-disc type, with parallel bronze-mounted seats, cast iron body, gate rings, wedges, and a non-rising stem with or without handwheel, or outside screw and yoke (OS & Y) type. Valves used for small lines (100 to 300 mm) in distribution systems are frequently furnished with an operating nut and installed with a valve box extending to the ground surface, providing accessibility to the operating nut. For valves, 400 mm or larger, which are in general power-operated, vaults with manhole access are generally provided to facilitate operation and maintenance. Also valves larger than 400 mm are often equipped with smaller by-pass valves, to reduce the pressure differentials and the power required during opening and closing operations. Gate valves for water service are covered by AWWA Standard C500. At present, most of the gate valves used in the Philippines are imported mostly from the U.S. or Japan. Valves up to 300 mm diameter conforming to AWWA requirements, however, can be manufactured in the Philippines.

Butterfly Valves. In recent years, butterfly valves have been increasingly used for water systems. Advantages of this type of valve are: driptight shut off, little maintenance, low head loss, small space requirement, reliability, and generally less expensive than gate valves particularly of the larger sizes. The AWWA has 2 standards for butterfly valves: AWWA Standard C504 which covers rubber-seated valves from 100 to 1,800 mm diameter for pressures up to 10 kg/sqcm, and AWWA Standard C505 which covers metal seated valves from 100 to 1,800 mm diameter for pressures up to 15 kg/sgcm.

Butterfly valves are not currently manufactured in the Philippines.

Air Valves. Air valves should be installed at high points in transmission lines, to permit the escape of air when the pipeline is being filled and to admit air when the pipeline is being emptied for maintenance or repair. It is usual to install air valves of the automatic type which open to release air accumulating during normal operation of the pipeline.

Blow-off Valves. Blow-off valves are generally installed at low points of transmission pipe lines and at low points and dead-ends in distribution systems to provide an outlet for removing sediments that may accumulate in those places. Ordinary gate valves may be used for this purpose, with provision for conveying the water and sediments "blow-off" to a suitable point of discharge.

Miscellaneous Valves. Miscellaneous and special valves for water systems include check valves to permit only one direction flow of the water; surge relief valves for surge and water hammer protection; altitude valves for controlling water levels in reservoirs and/or pump operations; and pressure reducing or regulating valves for dissipating excess pressures. None of these valves are manufactured in the Philippines.

Fire Hydrants. Fire hydrants that are in common use in Philippine towns and cities are of 2 types. One is a wet-barrel type consisting of a 60- or 75-mm riser pipe, usually GI pipe; a 60- or 75-mm GI tee or 90° elbow; and a 60-mm fire hose valve. A shut-off valve is generally installed between the hydrant and the water main to which it is connected. This type can be fabricated and assembled in the field or shop, ready for installation and connection to the water main.

The other type of hydrant is similar to that commonly used in European and North American communities. This hydrant is a dry-barrel type, with compression-type main valve, 100 or 150 mm inlet connection, and one or two 60-mm hose outlets and one 115-mm pumper connection.

The first type of hydrant has a disadvantage in that unless sufficient pressure in the main for the fire flow can be provided, it will not be effective for fire-fighting. For this reason the second type of hydrant appears to be advantageous.

Water Service Lines

Water services or service connections are pipes of usually small diameter that run from distribution mains or branch mains to customer premises. The water service connection is usually attached to the street main by means of a corporation stop which may be inserted while the main is in service and under pressure. Where the service connections are expected to be larger than 50 mm in diameter, tees, wyes, or special branches are installed, along with the water main construction. Ordinarily, water service to the customer's premises is turned on or off at a curb stop, accessible through a curb box. Various pipe materials have been and can be used for the service

lines. Non-flexible materials require a flexible "gooseneck" connection to the corporation cock. Gooseneck connections may be lead, copper, or flexible plastic.

At present, galvanised iron pipe is used in the Philippines for most water service connections. Galvanized iron pipe has a relatively short life because of its susceptibility to the corrosive action of soil on the outside and the water inside the pipe. The use of plastic pipe material for service connections may reduce this corrosion problem to a minimum.

Water Meters

Any modern water supply system should be equipped with the proper type of water meters so that the water produced and delivered can be accurately measured. Key locations in the system, at supply sources, treatment plants and pump stations should be provided with venturi tubes, orifice plates or other types of metering devices. Because such metering devices are not currently manufactured in the Philippines, these will have to be imported.

Every service connection to a distribution system should be equipped with a meter to reduce wastage and to obtain the proper billing. Small-size, turbine-type water meters are manufactured by the Liberty Manufacturing Corporation in the Philippines. Another local company, Domingo S. Jose, Inc., is in the process of putting up a factory to manufacture various sizes of meters under the trade name "Kimmon" under license by the Kimmon Manufacturing Company Ltd., a Japanese firm. Kimmon water meters of the turbine or rotary piston type are available in small sizes 10 to 50 mm. Propeller-type meters up to 400 mm are also manufactured by Kimmon plants in Japan.

In recent years, locally manufactured meters have been the most commonly used meters for service connections. Limited information indicates that these meters can be expected to function satisfactorily for only about a year after installation and have poor registration capability. Improvements in the characteristics and performance of these meters are obviously desirable.

Construction Methods For Water System Components

In the preceding sections, common construction materials for waterworks have been briefly discussed. The remainder of this report will be devoted to a general description of construction practices for deep wells, tunnels, water treatment plants, water mains, pumping stations, and storage reservoirs.

Deep Wells

Water wells have long been used in the Philippines as source of public and private water supplies and for small and large quantities of water. Wells that have been used for piped public water systems are generally of the drilled well type and capable of supplying several tons or hundred of gallons of water per minute. At present there are about half a dozen competent and experienced deep well drilling contractors in the Philippines. Present practice of deep well construction in the Philippines is normally by the percussion (or cable tool) or rotary method. Specifications usually call for the contractor to submit a well log. In unconsolidated formations, the well is usually cased with imported Schedule 40 black iron pipe. A telescoping casing employing 2 pipe sizes is commonly installed. As a rule, no well screen is used principally because of its high cost. Openings from the aquifer(s) to the well are provided by perforations in the casing. The perforation can be made in the field. Gravel packing around well screens or perforations is very rarely practiced.

After the installation of the well casing, the well is developed. Local well drilling contractors employ development methods such as pumping, surging and bailing, and development with compressed air.

Test pumping follows well development. The purpose of test pumping is to provide information on the yield and capacity of the well, which in turn helps in determining the capacity of pumping equipment. Water level measurements are taken during pumping (drawdown measurements) as well as after the pumping test is completed (well recovery). Common practice is to specify a 24-hour or 48-hour pumping test.

Water Main Construction Procedures

Water mains are generally installed to a definite alignment and grade. In the Philippines where freezing is not a problem, the depth of cover over the pipe specified usually depends on the surface load conditions. The minimum cover for the alignments which are subject to traffic loads is 90 cm. For the areas with no traffic loads, a minimum cover of 60 cm may be used. Trenches may be dug manually or with excavation machinery.

Trenches are excavated as shallow as possible but still provide enough depth for surface loading. Deep trenches are avoided since they usually require shoring and bracing; therefore, they are costly.

Trench Widths. Sufficient trench widths are provided to permit installation of the pipe, with room for the workmen to make up the joints and to tamp backfill under and around the pipe. Trench widths are governed by type of soil, pipe size, and excavating equipment. For asbestos cement and concrete pipes, unnecessarily wide trenches are avoided to minimize excessive backfill loads on the pipe. For asbestos cement pipe, the following widths are used:

Pipe Diameter (mm)	Trench Width (cm) Minimum	Maximum
100	45	70
150 or 200	50	80
250 or 300	60	90
350 or 400	75	100

For cast iron pipe 100 to 450 mm in diameter, the trench width is the diameter plus 40 cm; for the larger pipe up to 1,500 mm in diameter, the width is the pipe diameter plus 45 cm.

Wide trenches for small-diameter pipe are avoided, particularly in hard clay soils. Otherwise, the weight of backfill becomes out of proportion to the beam strength of a small pipe.

Where pipe is to be laid on a curve, it utilizes the available deflection characteristics of the joint. Many joints have an inherent ability to be deflected to some small degree, permitting pipe to be laid on a long-radius curve. For pipe laid on a curve, the trench width is somewhat wider than normal.

Excavation. Whether excavation is done manually or by machine, the excavated material is piled on one side of the trench at a distance away from the trench. The distance should be sufficient to prevent excavated material from rolling back into the trench and also to provide room for walking along the trench. In congested areas, it is usually necessary to haul and stockpile the excavated material temporarily at some other location and the excavated material suitable for backfill is transported back during backfill operations. Material unsuitable for backfill is disposed off the site.

Sheeting and Bracing. The need for sheeting and bracing to protect against cave-in depends on soil conditions and trench depths. They are installed where required not only to prevent delay in pipe laying but also to protect the workmen and the public.

Pipe Bedding. All types of pipe are bedded or supported properly at the trench bottom. Pipe is laid directly on the trench bottom if the bottom has been levelled properly. For greater load bearing ability of the pipe, the trench bottom is shaped to match the exterior circumference of the pipe. Care is taken to prevent voids or high spots under the pipe. High spots are shaved off, and voids filled with well tamped soil. For trenches in rock, unsuitable soil, or soft or wet soil, special bedding is provided. This is specially important for AC and CI pipes because of their lower tensible strength and brittleness.

For formations of rock or unsuitable soils, the trench is excavated to a depth of about 15 cm below the grade line of the pipe bottom, and the overexcavated material, replaced with sand or good soil free of clods, levelled and tamped to grade.

Joint Holes. Provision is made in the trench to permit proper jointing of the pipe with the type of joint employed. For asbestos-cement pipe laid directly on the trench bottom, a coupling hole about 8 cm deep and 15 cm longer than the coupling is dug at the joint location. For cast iron pipe joints of the bell and spigot type, which are made with lead caulking, the trench must be excavated wider and deeper at the joint location sufficient to provide room for the caulker to work.

Stringing, Laying and Jointing Pipe. To avoid unnecessary handling, pipes and fittings and other accessories are placed as near as possible to their final location in the line, with due regard to safety requirements. Pipes are placed as close to the trench line as possible and on the side opposite where the excavated material is to be piled. Asbestos cement pipe is usually not strung in advance of laying and jointing operations but is delivered from storage to trench as needed.

The procedure for laying pipe and making up pipe joints varies with the type of pipe material and type of joint. For asbestos cement pipe, general procedures are given in AWWA Standard C603 and are followed in the Philippines. The laying and jointing of cast iron and steel pipes conform with applicable portions of AWWA Standard C600, C603 and C205, Federal Specifications and in accordance with the recommendations and directions of the pipe manufacturers. As part of the final design, detailed specifications are included in the jointing procedures for all types of pipe to be installed. Furthermore, to have trouble-free service from a pipeline, the resident inspector insists on strict compliance with the specifications and construction drawings.

Leakage and Pressure Tests. All pipelines are subjected to leakage and hydrostatic tests. Such tests are usually done after the trench has been partially backfilled. Test procedures and requirements, allowable leakage, etc., vary with the type of pipe and joint. Procedures and requirements for asbestos cement pipelines and cast iron pipelines are specified in relevant AWWA standards.

Backfilling. Backfilling is an important part of proper pipeline installation and is given considerable attention. Backfilling is usually a 2-step procedure consisting of partial backfilling before leakage tests and completing the backfill after the tests. Select backfill material is placed at both sides of the trench uniformly for the full trench width up to the horizontal centerline of the pipe. The backfill material usually is tamped by hand under and on each side of the pipes to provide a void-free support.

Where visual inspection during leakage tests is not required, backfill is placed to the depth indicated above and then a cushion of backfill material, hand-placed and tamped, is added to cover the pipe to a depth of 30 cm.

Where visual inspection is required, joints are left exposed or covered only by a relatively shallow layer. After leakage tests are completed, the exposed joints or couplings are covered with hand placed material to a depth of 30 cm.

The remainder of the backfill material is deposited in the trench by hand or machine in layers, and tamped. This backfill should be good soil free from rocks, debris, clods and other unsuitable materials.

Disinfection. All newly installed or repaired water mains are cleaned and disinfected before they are accepted and placed into service. The main is first flushed clean of foreign matter at a scouring velocity of at least 0.75 m/sec. The flushing may be done after the pressure tests.

Suggested disinfection procedures are as described in AWWA Standard C601. The usual disinfectants are chlorine, calcium hypochlorite or sodium hypochlorite solution, or chlorinated lime solution. The disinfecting solution is applied at one extremity of a pipe section and drains at the opposite extremity of a properly segregated section. The rate of application gives a uniform dose of at least 25 mg/l at the end of the section being treated. The average contact period is 24 hours and should produce not less than 10 mg/l at the end of the line after the contact period. If shorter contact periods are used, the chlorine concentration is increased to 50 or 100 mg/l.

Water Service Connections. Components of a customer's service connection include a connection to the main (corporation cock), curb stop or turn-off valve and box, and the line itself. The service connection may be installed when the water mains are laid. Installation operations consist of trenching, main tapping, laying the line, installing the valves, and backfilling.

The trench may be dug by hand or by small backhoe. When dug by hand, the width must be sufficient to accommodate the digger. The trench bottom should be relatively flat and on the necessary grade. Special bedding is not required unless the soil is corrosive in nature and the pipe is not corrosion-resistant. Where the service line is made under a pavement, the pavement is removed and replaced after the installation is completed.

Methods for tapping service lines to mains vary, depending on the service line size and material. Where the size and the wall thickness of the main are sufficient to provide adequate full threads for the corporation cock, small-size service lines are connected to the main by direct drilling, tapping, or by other methods, and insertion of the corporation cock into the main. If the main is under pressure, the tapping, drilling, and insertion operations are done with a special tapping device. This operation is known as a wet tap.

If the pipe wall is too thin for direct tapping or will not provide the required number of full threads, service clamps are used. In such cases, drilling is done through a corporation cock that has been screwed into the service clamp. For connecting larger service lines, tees, wyes or special branch connections and larger drilling machines are used.

Laying the service line involves not only the laying of the pipe on the trench bottom but the installation and connection of the curb stop and box near the property line. It also involves the connection of the line to the corporation cock and sometimes to the shut-off valve or meter in the customer's premises. Where water meters are set outside the building, the operation is frequently done as a part of the service line installation operation. When the final connection is completed, the installation is tested under pressure.

Backfilling of trenches may be done manually or by machine. In either case, large stones or boulders are not placed directly on the line. Backfilling without tamping is usually done to some reasonable level above grade to allow for settlement. In areas to be paved or repaved, the backfill is tamped to at least 90 percent of the compaction value of the surrounding areas, then allowed to stand with temporary pavement for at least 3 months before permanent pavement is replaced.

Pipe Cleaning and Lining

General. Although pipe cleaning and lining per se may not be considered part of construction but rather of maintenance and rehabilitation of existing pipelines, many water system development projects in the Philippines will include such work as part of the initial water supply improvement program.

Pipe cleaning is the process of removing corrosion deposits and slimes from the inside of pipelines. The primary objective of pipe cleaning is to increase the carrying capacity of a pipeline which has diminished because of deterioration and, if possible, to restore the carrying capacity of the pipe close to its original capacity.

Lining refers to the process of placing a protective coating on the inside of a pipeline that has been cleaned. Lining of the pipe in-place after the line has been cleaned not only prevents recurrence of internal surface deterioration but also eliminates red water and stops leakage. Cleaning without lining is effective, but there can be no assurance that the pipe's carrying capacity will remain at its improved level for very long because cleaning does not remove the causes of pipeline deterioration. Cleaning alone is an expensive means of maintaining carrying capacity.

Cleaning. Three basic techniques are used for in-place pipe line cleaning. These are (1) drag, (2) hydraulic, and (3) mechanical. The choice of methods depends on the pipe diameter, water volume and pressure available, length of pipe to be cleaned, amount of encrustation or sediment, ease of access, distance between access points, provisions for disposal of wastewater from cleaning operations, and other local conditions.

1. Drag Cleaning. Drag cleaning is usually limited to pipe diameters of 100 to 600 mm. The cleaning equipment is pulled by a power winch through a line that has been removed from service. The method utilizes a spring-steel cleaning tool that is composed of a series of scrapers, followed by an assembly of tight-fitting squeegees. As the tool moves through the line, accumulated deposits are loosened by the scrapers, and then mechanically removed by the squeegees. The separate drag operations are repeated until the pipe wall is clean. Access openings are made in the pipeline at intervals of 90 to 150 meters depending on pipe size, line configuration, and condition of pipe.

2. Hydraulic Cleaning. The hydraulic method of pipe cleaning is most practical in long, comparatively straight runs of transmission or arterial mains. The method requires an adequate supply of water at a given pressure. The volume of water available and the required pressure depend on pipe size. The greater the volume of water available, the lower the pressure required.

The tool used in the hydraulic cleaning process consists of spring scrapers so arranged that part of the water pushing the tool is released through it to flush the scrapings and debris ahead of it. The tool usually travels at a rate of 10 to 30 meters per minute. The travel speed is controlled by regulating the rate of discharge of wastewater at the end of the pipe run being cleaned.

The operation begins by cutting out a section of the pipe, inserting the tool, replacing the removed section, and making up the joints. At the discharge end of the run, a cut is made into the pipe and a special line, attached to discharge the wastewater and debris above ground for ultimate disposal to sewers, storm drains, or acceptable runoff areas. If the tool cannot be discharged through the discharge line, it is stopped in the main and a cut is made in the pipe to remove it. Hydraulic cleaning is relatively rapid, effective, and economical.

3. Mechanical Cleaning. In pipelines greater than 660 mm in diameter, hydraulic cleaning becomes less practical, and mechanical cleaning is used. Mechanical cleaning is accomplished by an electrically driven and manually operated machine with rotating scraping blades which remove tuberculation, debris, and existing coatings by a honing action. These machines are driven by an operator who actually observes and controls the entire cleaning operation.

Lining. There are 3 methods of applying cement-mortar lining to pipelines in place: (1) centrifugal method, (2) reinforced centrifugal method, and (3) mandrel or tate process.

1. Centrifugal Process. After the pipe has been cleaned, access openings are cut every 150 to 200 meters (less in small pipes where bends occur). Bends cannot be negotiated in 100, 150 or 200 mm pipe sizes. After placement, the lining in these diameters may be troweled; for pipes above 200 mm diameter, troweling is always done to provide a smoother finish and the extra carrying capacity that results.

The field equipment for centrifugal lining includes a variable-speed winch for pulling the lining machine with its mortar hose and electric cable through the pipe; an electric generator to supply power to the winch and to the revolving head that dispenses the mortar; a specially-designed mortar mixer of the capacity needed to ensure ample mixing time; and a feeder to pump the mortar to the lining machine.

The lining material is usually a 1:2 portland cement-mortar, and the volume of mortar applied to the wall is controlled by the travel speed of the machine. A lining thickness of 5 to 20 mm is common on cast iron pipelines, but it may be as little as 3 mm. The thinner the lining, the smaller the reduction of the original cross-sectional areas of the pipe. Thin coatings may be sufficient in smaller pipelines. The thickness of lining for steel pipe lines depends on age, plate thickness, and condition of the metal.

In large mains that contain few service taps or lateral connections, all openings are plugged prior to lining and opened after lining by men working in the pipe. In lines below 400 mm diameter, where men cannot work, very little mortar is thrown into lateral openings, and any obstruction at the corporation cock is removed by blowing out the service line before the mortar sets completely.

Small mains tapped for service lines are usually by-passed by a temporary above-ground line to maintain customer service.

The cost of centrifugal in-place lining depends on a number of factors, principally: pipe diameter, pipe length, condition of the line, plan and profile of the line, bends, location and type of valves, length of section that can be removed from service during the operation, and by-pass traffic problems. The greater the length that can be lined at one time, the greater the production rate and the lower the cost.

Centrifugal in-place lining is applicable to pipe sizes up to 3,650 mm. One of its advantages is that the line can be placed in service 24 hours after the lining process. The process has also been used on newly installed steel pipelines.

2. Reinforced Lining. When pipelines of 600 mm or greater diameter are badly deteriorated, it may be desirable to reinforce the cement-mortar lining. This reinforcing process consists of 3 steps. First, a course of mortar one-half the final lining thickness is placed by centrifugal machine, without trowelling. Next, spirally wound reinforcing rod is placed. (The rod spacing depends on pipe size and strength requirements of the equivalent steel area. The size of the rod varies with the size of the pipe and the required reinforcing.) After the steel rod is placed, a second course of mortar is spun into place to the final desired thickness. The spiral rod has 2 advantages over prefabricated cage steel: it requires less steel, and it conforms to the inside contour of the line.

3. The Tate Process. The mandrel process, commonly known as the Tate process after its Australian inventor, cleans and scours out encrustation from the pipe, then lines the pipe with cement mortar. An advantage of the Tate process is that road opening is kept to a minimum. Only two major digging operations take place at both ends of a 90-meter section of main, and only small openings are required to disconnect and temporarily bypass service connections. The exact location of each service connection is obtained by electrifying the household system and sweeping the "live" area with a detector which tells the operator through headphones where the connection is located. Customers suffer only little inconvanience, with full service restorable in 24 hours.

The Tate process can be described briefly as follows: At both ends of a 90-meter section, a hole is dug and a 1-meter length of main is cut and removed. Flexible steel rods to which a wire rope is attached are pushed through the main from one end and drawn out from the other. An assembly of coil scrapers and steel brushes to scour the pipe, and rubber force cups to clean and dry it, is connected to the wire rope and this is pulled through about 90-meter section of main from 6 to 12 times, until it is completely clean. A special cement-mortar mixture of a relativel high initial water-cement ratio is then introduced into one end of the section and drawn by suction along the 90 meters length of main. A "cement gun" which spreads the mortar evenly over the walls of the cleaned pipe is then drawn through by winch. A smooth lining approximately 3 mm thick is left in the main, excess water escapes through the rear of the "gun", and the surplus mortar is removed and used to put a mat

ing 3 mm lining in the 1-meter length cut from the main at the start of the operation. This section is reconnected, the road surfaces at the opening are repaired, and the crew moves on to the next section to be cleaned and lined.

Pipe Cleaning in the Philippines

Until recently, pipe cleaning and lining in place have not been practiced in the Philippines. The Metropolitan Waterworks and Sewerage System (MWSS) has included these activities as part of its improvement program. A New Zealand-based company which can undertake these types of work is available locally. This firm employs the Tate process of in-place cleaning and lining.

Tunnel Construction Methods

Tunnels for water transmission lines may be constructed by conventional or machine tunnelling. Conventional tunnelling in rock formation involves the cyclical repetition of the following operations: drilling, blasting, loading, and removal of excavated materials; installation of primary supports where necessary; and the mixing, hauling, and placing of concrete to form the secondary lining. It is sometimes desirable to defer the installation of the secondary lining until driving operations have been completed or are remote from the lining operations.

In the machine tunnelling method, a tunnel excavating machine is employed at one tunnel face simultaneously with conventional tunnelling at the other face. There are many variations of mechanical rock excavators. Most adopt the same principle in which the machine bores a pilot hole into which an expanding "packer" is placed to form an anchor by which the machine pulls itself forward, enabling a larger rotating cutter head to bore the tunnel. The cutter head may be moved forward from 0.5 to 1.2 meters within the frame by hydraulic jacks. When the cutter has been advanced to its full distance, the cutter head is retracted and then the frame is pulled forward and locked in place, ready to begin the next advance. The cutter head is fitted with teeth or rollers which cut or spall the rock faces as the cutter head revolves. Cutters must be replaced frequently, depending on the hardness of the rock being excavated. Tunnel excavations are normally electrically powered. Excavated material is picked up by a series of revolving buckets, discharged into a belt conveyor and carried to rail haulage trucks. A tunnel driven by a mechanical excavator has a smooth bore as contrasted to a jagged, broken rock surface that results from conventional tunnelling methods.

The average rate of tunnelling by either conventional or machine tunnelling would depend on the nature of the materials and conditions encountered. Higher rates can be obtained with a high degree of mechanisation and a carefully organised and executed procedure. On the other hand, conventional tunnelling, although it may be slower, will require less foreign exchange costs.

Pumping Stations

General. Water supply pumping stations may be classified into deep well pumping stations, booster pumping stations and raw water pumping stations. The second type may be installed as part of a treatment plant or part of the water distribution system.

Centrifugal and turbine-type pumps are the most commonly used pumping units in waterworks applications. Prime-movers may be electric motor, diesel engine, gas engine, or other suitable energy source which can develop the required power. Because of their relatively low cost compared to other types of prime movers, electric motors are the favored type where electric power is available at reasonable costs. Dual-drive pumps can be used for operation by electric motor or by engine.

Pumping installations are usually housed in a structure that will provide protection from the elements and security from theft, tampering, etc. Each station is provided with the necessary suction and discharge piping and valving, controls, and a metering system with suitable indicating, totalising and recording facilities. Attention is also given to water hammer.

The structure which will house the pumps and appurtenant equipment is constructed from locally available masonry, wood and reinforced concrete materials. In some installations, deep well pumps equipped with weatherproof motors are not provided with pumphouses. The interior flanged pipes and valves are made from locally available valves and cement-lined steel or cast iron pipes, wherever possible.

Deep Well Pumps. Two types of deep well pumps in common use are the deep well turbine pump and the submersible (or submergible) deep well pump. The first type consists of impellers in series installed below the minimum expected water level during pumping. Each impeller is encased in a housing or bowl and is called a stage. The number of stages necessary for any given installation depends on the head that each stage can develop at a given pumping rate and on the total pumping head. Power is transmitted to the impellers through suitable shafting from a prime mover usually installed at the ground surface.

The submersible deep well pump is usually equipped with an electric motor drive. In this type the motor is installed in the well itself.

Booster Pumping Stations. The most widely used type of pump for booster pumping stations, whether in a treatment plant or in a distribution system, is the centrifugal pump. A centrifugal pump consists essentially of a rotating impeller which draws water into a center and a stationary casing which guides the water into the discharge outlet. Advantages of the centrifugal pump include ease of operation and repair, low starting torque, increased output with pressure drops or vice-versa, and smooth flow and uniform pressure.

In the Philippines, the manufacture of centrifugal pumps and motors is still in its infancy. For most waterworks projects, it is anticipated that pumping units will be imported items. If Philippine-manufactured equipment with the capability, efficiency, and quality desired become available in the future, local product should be considered in the final design and construction phases.

Raw Water Pumping Stations

Raw water pumping stations, as used herein, are intended to mean pump installations that draw water from a surface source such as a spring, river or lake. Such pumping stations are similar in many respects to booster pumping stations but may include some features and facilities not normally needed in booster stations such as intake screens, protection against flood waters, etc.

Water Storage Tanks

In the Philippines, water storage tanks, both elevated and ground tanks, are usually constructed of either cast-in-place reinforced concrete or steel. Prestressed concrete tanks, although gaining in use and popularity in other countries, have not been used in the Philippines. The relative economics between reinforced concrete and steel tanks depend somewhat on the tank size and tower height for elevated tanks. Generally, in the larger sizes, reinforced concrete tanks are more economical than steel tanks unless steel plates and other foreign-made components can be imported tax-free. In smaller sizes, the construction costs of steel tanks are comparable to that of reinforced concrete. However, maintenance costs of steel tanks are generally higher. This factor can make the total annual costs of steel tanks greater than those of reinforced concrete tanks.

Water Treatment Plants

Water that is to be used for drinking and public water supply purposes must satisfy certain minimum quality requirements with respect to safety, potability, etc. The water is subjected to treatment to upgrade its quality if it does not meet prescribed or desirable standards. As a general rule, all water from surface sources such as rivers, streams and lakes should as a minimum be given "complete" treatment to minimize the risk from water-borne diseases.

Modern complete water treatment plants employ the processes of flocculation, sedimentation, filtration, and disinfection. Other additional treatment may be given depending on the quality of the raw water and other factors.

The construction of a modern water treatment plant providing at least complete treatment or its equivalent will require the building of several components utilizing a multitude of tradesmen skilled in specific fields. The major construction fields which must be utilized to build the treatment plant include:

(1) General construction consisting of all earthwork, reinforced concrete work, civil works, and building construction.

(2) Mechanical work consisting of installing pumps, motors, treatment plant equipment such as mechanical feeders, sludge collectors, emergency generators, and other process mechanical equipment. Also, all large-size flanged pipes and valves required within the plant may be installed by the specialty.

(3) Electrical work consisting of general wiring of the entire plant for lighting and power. The furnishing and installation of simple controls, instrumentation and communications equipment may also be included as part of the electrical works contract. Where such equipment are complicated and extensive, it may be desirable for this work to be undertaken separately from the general electrical work.

(4) Pipeline and plumbing works including piping for the in-plant water system, sanitary sewers, storm drains, and building plumbing.

With good construction supervision, all this construction work can be done by qualified Philippine contractors. Special material and equipment for the plant will have to be imported.

A P P E N D I X O

OUTLINE SPECIFICATIONS

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OUTLINE SPECIFICATIONS

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APPENDIX O

OUTLINE SPECIFICATIONS

Spring Intake Structure

All spring intake structures shall be constructed of reinforced concrete. The intake structure shall be of a size sufficient to capture the maximum spring flow. The spring intake may be circular, rectangular or of other suitable shape. It shall be covered and provided with outlet pipe(s) and valve(s), overflow(s), vent(s), drain(s), covered access manhole(s) and other necessary appurtenances and site works. The intake facility shall also include a weir or other suitable device for flow measurements; security fencing; chlorination facilities (if necessary); general site improvement including drainage facilities for possible surface runoff; and an all-weather access road. Reinforced concrete construction, piping, fittings, valves, and all other materials and attendant work shall conform to LWUA Standards. (The water district shall acquire ownership of the intake structure site.)

Hydraulic Control Structure

Hydraulic pressure control structures on transmission lines for dissipating excess energy shall be of impact type in which pressure dissipation is accomplished by the impact of the incoming jet of water on a vertical baffle and by eddies or turbulence formed from the directional change of the jet after it strikes the baffle. The hydraulic control chamber shall be constructed of reinforced concrete and shall be covered. It shall be designed such that it can handle the design maximum flow. The chamber shall be provided with the necessary piping, overflows, and other protective devices. The work shall include general site improvement and security fencing, if necessary. (The water district shall acquire ownership of the land on which the control chamber will be built.)

Dams and Appurtenances

The construction of dams and appurtenances shall be performed by firms and personnel experienced in this line of work. The Contractor shall furnish plant and equipment which will be efficient, appropriate and large enough to secure a satisfactory quality of work and a rate of progress which will insure the completion of the work within the stipulated time.

The dam construction will include the main dam structure, upstream and downstream cofferdams, tunnels, diversion channels and spillway.

The zoned embankment dam will consist of a vertical core protected by filter and transition zones, and rolled rock-fill shells. The upstream face of the dam is protected by riprap against wave action.

Materials for the dams shall be as designed and specified and shall be obtained from designated borrow areas, excavations, or manufactured from rock obtained in required excavations.

The areas to be occupied by the required permanent construction and the surfaces of all borrow pits shall be cleared of all trees, stumps, exposed roots, brush, rubbish, and other objectionable matter. Excavation shall be made to the specified lines, grades, and dimensions. All necessary precautions shall be taken to preserve the material below and beyond the established lines of all excavation in the soundest possible condition. All excavations for embankment and structure foundations shall be made in the dry.

The diversion tunnel shall be concrete-lined. The portal structure will be provided with a slot for installation of stop logs for closure of the tunnel. The spillway will consist of an ungated overflow concrete structure and a concrete lined chute.

The raw water intake will be multi-ported and constructed of reinforced concrete.

Diversion Dams

The construction of the diversion dam shall be performed by firms and personnel experienced in this line of work. The Contractor shall exercise care to preserve the natural landscape and shall conduct his construction so as to prevent any unnecessary destruction, scarring, or defacing of the natural surroundings in the vicinity of work.

The Contractor shall construct and maintain all necessary coffordams, channels, flumes, drains, sumps, and/or other temporary diversion and protective works; shall furnish all materials required therefore; and shall furnish, install, maintain, and operate all necessary pumping and other equipment for removal of water from the various parts of the work free from water.

All concrete work shall be in accordance with LWUA standard specifications and supplementary specifications.

Access and Service Roads

The construction of access and service roads to water supply facilities shall include all necessary clearing and grubbing, excavation, fill and backfill, roadbed preparation, installation of

base course, surface finish or paving, bridges, and all drainage structures and facilities. The work will involve improvement and/or extension of existing roads and the construction of new access and service roads.

All roads shall be constructed in conformity with the specified lines, sections and grades. Materials and their installation shall be in accordance with the latest revision of the Bureau of Public Highways Standard Specifications for Highways and Bridges, local requirements, and supplementary specifications.

Water Transmission Pipelines

Raw and treated water transmission pipelines may be constructed of cast iron, ductile iron, asbestos cement, steel or prestressed concrete (with steel cylinder) pipe. Soil and corrosion studies shall be conducted prior to the final selection of pipe material. The transmission lines shall be equipped with all necessary valves and appurtenances such as shut-off and sectioning valves, air/vacuum and air release valves, blow-offs, inspection manhole, expansion joints, flexible couplings, anchorages, thrust blocking, and surge arresters.

Pipe, fittings, valves, other materials and installation, jointing, testing and disinfection shall be in accordance with LWUA Standard Specifications, where such specifications are applicable to the particular material or work. Available Standard Specifications of LWUA include those for cast iron, asbestos cement and steel pipes; gate and butterfly valves; blow-offs; air valves; and work relating to their installation.

Ductile iron pipe shall be manufactured in accordance with AWWA C151 "Ductile Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds." Fittings shall be either cast iron or ductile iron conforming to AWWA C110 "Gray Iron and Ductile Iron Fittings, 2 Inches through 48 Inches." All pipe and fittings shall have a cement mortar lining and bituminous seal coat on the inside in accordance with AWWA C104 "Cement Mortar Lining for Cast Iron and Ductile Iron Pipe and Fittings."

Prestressed concrete cylinder pipe shall conform to AWWA C301, "Reinforced Concrete Water Pipe-Steel Cylinder Type, Prestressed." Fittings shall conform to the specifications for cast iron, ductile iron, or steel pipe.

In general, all piping shall be designed for a minimum working pressure of 10.5 kg/sqcm (150 psi). The pressure class of fittings, couplings, special castings, and valves shall be at least equal to the pressure class of the pipe to be installed. Joints shall have the same or greater strength than the connecting pipe.

Shut-off and sectioning valves shall be either gate valves or butterfly valves, depending on the size and other factors. A sufficient number of air valves shall be provided to insure full protection of the pipeline.

All pipeline installation shall be in strict conformance with applicable AWWA and/or LWUA Standards and with the respective manufacturer's instruction and recommendations.

Water Treatment Plant

Water treatment plants designed to provide complete treatment would generally include facilities for chemical mixing, flocculation, sedimentation, rapid sand filtration, post chlorination, chemical storage, backwashing, treated water storage, and waste washwater and sludge disposal.

Chemical mixing chambers, flocculation and sedimentation tanks, filter boxes and treated water storage tanks shall be constructed of reinforced concrete.

Filter materials shall consist of filter sand and anthracite conforming with specified requirements with respect to composition and grading. For each filter, the necessary control valves, rate of flow controller, loss of head gage, flow meter and recorder shall be installed.

Instrumentation shall include suitable equipment to vary chemical feed rates in proportion to flow.

Concrete work, yard and in-plant piping, and painting work shall be in accordance with LWUA Standard Specifications and supplementary specifications.

Piling (if required), structural steel, architectural works, instrumentation and electrical works, mechanical equipment, and all other items not covered by LWUA Standards shall be constructed as specified.

Administration Building

The construction of administration buildings shall be of the materials and workmanship called for in the drawings and specifications. The administration building will generally consist mainly of offices but may include a water analysis laboratory, meter testing and repair shop, general work shop, and storage facilities.

Items of work shall include site preparation; foundations; concrete and masonry work; roofing and metal work; carpentry and joinery; plumbing, ventilation, and air-conditioning systems; lighting and power systems; architectural and other special finishes; painting work, landscaping and general site improvement work. Applicable LWUA Standard Specifications shall be employed in the construction work.

Well Construction

Deep well construction shall include the furnishing of all materials (except those that may be furnished by the Owner), equipment, tools, labor and all appurtenances and incidental work for construction of the deep wells. The work shall include drilling; installation of temporary casing, conductor pipe; well screen; developing and testing of the well; gravel packing; grouting, well completion and disinfection; and site work and clean-up.

The well shall be drilled using the cable tool (percussion) and/or rotary process, or other process acceptable to and approved by the Engineer. Well casing and/or conductor pipe shall be of the diameters, materials and class specified, or better.

For gravel-packed wells, only clean washed gravel composed of well rounded particles and of specified grading shall be used. The procedure to be employed shall be as approved by the Engineer.

The topmost 12 meters of the annular space between the conductor pipe and hole shall be filled with cement grout. The mixtures, method of mixing, and consistency of grout shall be as approved by the Engineer.

Developing of the well shall be done with care and by methods that will not cause damage to the well or cause adverse subsurface conditions that may destroy barriers to the vertical movement of water between aquifers. Upon completion of well development, test pumping shall be done in accordance with a test procedure that will be furnished to the Contractor by the Engineer. The pump shall be operated continuously for specified durations and pumping rates.

Immediately following satisfactory construction and development, samples of the well water shall be collected and analyzed in a laboratory acceptable to the Owner.

After completion of all construction, development, testing and related work at each well site, all equipment and residual materials shall be removed from the site. The site shall then be

restored to a condition as nearly as possible to that which existed before the well construction work, unless otherwise specified.

Flow Meters (Mainline Meters)

Flow meters for mainlines shall be differential pressure-type, propeller meters, or other suitable and acceptable devices. Differential pressure-type meters may be venturi tubes, Dall flow tubes, orifices or nozzles. The flow meter shall include suitable instrumentation for remote indicating, recording and totalling. Flow meter and accessories shall be products of reputable manufacturers that have manufactured such devices for fluid measurement for at least 5 years.

The venturi meter tube shall be of standard or long form design, the included angle of the outlet cone being approximately eight degrees. The tube shall have a body of high tensile gray iron or close grain, high tensile iron. Both inlet and throat shall have integrally cast annular pressure chambers with multiple, even spaced vents communicating with the interior of the meter tube.

Propeller-type meter shall have the same nominal inside diameter throughout its length to offer minimum obstruction to the flow. The meterhead shall be connected to the tube by means of a flanged connection, designed for easy removal from the tube for inspection and repair. The meter shall be furnished with a propeller of plastic or other suitable material mounted in the meter tube. The meter shall register within 2 percent of the true flow of water at all flows within the minimum and maximum ratings. The propeller-type meter shall conform to AWWA C704-70 "Standard for Cold Water Meters - Propeller Type for Main Line Applications."

The flow meter shall be designed for a minimum working pressure of 10.5 kg/sqcm (150 psi). Range of flow will be specified by the purchaser. Ends shall be flanged 250 lb American Standard unless otherwise specified.

Deep Well Turbine Pump

Deep well turbine pump shall be water-lubricated, line shaft vertical turbine pump, electric motor- or diesel engine-driven or both (dual drive), as required. Pump characteristics and operating conditions will be specified for each particular installation. Pump shall conform to ANSI B58.1 - 1971 (AWWA E101 - 71) "American National Standard for Deep Well Vertical Turbine Pumps - Line Shaft

and Submersible Types." Diesel engine and accessories shall conform to the specifications for diesel engine, except as modified herein.

For motor-driven pump, the motor shall be full voltage starting where the electric power system capacity and regulations permit; otherwise the motor shall be star-delta starting. The motor shall be vertical hollow-shaft squirrel cage induction type complying with ANSI C50.2. The motor shall be of ample size to drive the pump continuously over the specified range at the ambient temperature, without the load exceeding the service factor. Motor operating characteristics (voltage, phase, frequency, speed) and control and protective devices shall be as specified. A suitable base of high-grade cast iron or fabricated steel shall be provided for mounting the meter, and with discharge elbow having above-ground discharge outlet with companion flange.

With an engine drive, the power shall be applied to the pump shaft through a right angle gear set. The horizontal shaft shall be connected to the engine by a flexible-shaft coupling.

Pump bowls, impellers, pump shafts, line shafts, discharge column assembly, suction pipe and strainer shall conform to ANSI B58.1 - 1971.

A suitable air line of galvanized iron pipe or copper tubing of sufficient length to extend from the surface to the top of the bowl assembly shall be furnished with altitude gage reading in meters and connections for air pump.

The pump and prime movers shall be products of reputable manufacturers who have been regularly engaged in the manufacture of these equipment for the last 5 years. The manufacturer shall, if required, furnish a sworn statement that the equipment furnished and installed comply with the requirements of the applicable standards and the specifications. The equipment manufacturer/supplier shall furnish the services of competent personnel to supervise the installation and testing of the equipment. Spare parts, operation and maintenance manuals shall be provided. The pump equipment and controls shall be housed in a suitable permanent structure that provides protection from elements, damage, or vandalism.

Submersible Deep Well Pump

Submersible deep well pump shall conform to ANSI B58.1 - 1971 (AWWA E101 - 71) "American National Standard for Deep Well Vertical Turbine Pumps - Line Shaft and Submersible Types." Operating conditions and requirements will be specified for each particular installation.

The motor shall be of the squirrel cage induction type, suitable for across-the-line starting and shall be capable of reduced-voltage starting. It shall be capable of continuous operation under water at the specified conditions. Motor operating characteristics (voltage, phase, frequency, speed and control and protective devices) shall be as specified.

Submersible cable, surface plate, strainer, discharge pipe, pump bowls, impellers shall comply with the requirements of current ANSI B58.1.

The pump and accessories shall be products of reputable manufacturers who have been regularly engaged in the manufacture of these equipment for the last 5 years. The manufacturer shall, if required, furnish a sworn statement that the equipment furnished and installed comply with the requirements of the applicable standards and the specifications. The equipment manufacturer or supplier shall furnish the services of competent personnel to check the installation and testing of the equipment. Spare parts, as specified, and operation and maintenance manuals shall be furnished.

Diesel Engine

The engine shall be of the vertical in-line, or V-type multi-cylinder, full diesel, mechanical injection, heavy duty rating type. The engine may be either 2- or 4-stroke cycle and shall have specified rotative speed and piston speed. It shall be a model which has been in satisfactory operation in similar service at the same or higher rating and speed for at least 5 years. The engine's continuous duty rating, after deducting power consumed by all engine-driven auxiliaries, shall be not less than the horsepower required to operate the driven equipment at its specified full rated load. The engine rating shall be adjusted for operation at specified conditions of elevation and ambient temperature.

The unit shall be furnished for battery starting. Starting shall be accomplished by a 12- or 24-volt electric starter, as recommended by the manufacturer, which shall be capable of withstanding 5 minutes' continuous cranking.

The diesel engine shall be furnished with complete fuel system, lubrication system, governor, safety devices and controls, engine instrumentation, cooling system, exhaust system and accessories as will be specified. Accessories to be furnished include starting battery, automatic battery charger, manufacturer's standard spare parts, detailed operating and maintenance manuals and parts lists, complete set of gaskets and spare set of matched V-belts, and one spare set of fuel injectors.

Diesel Generator Unit

The diesel generator unit shall be complete with excitation system, controls, steel sub-bases, exhaust silencer, fuel system and all essential and desirable auxiliaries for a complete installation. The unit shall be arranged for manual pushbutton starting and stopping and manual transfer of load to the unit when it has attained rated frequency and voltage. The engine-generator set shall be a factory-assembled unit especially designed for operation on No. 2 diesel fuel oil.

The engine generator set shall be the standard product of a manufacturer regularly engaged in the production of this type of equipment. The diesel engine and accessories shall be as specified under Diesel Engine. The diesel engine shall be arranged for direct connection to the alternating current generator.

The generator shall be especially designed for direct connection to the diesel engine and shall be for the specified phase, frequency, and voltage. Tropical insulation with fungus protection shall be provided. Each unit shall be properly screened to prevent the entrance of rodents. The complete generator unit shall be free from critical speeds and torsional vibration that will endanger its satisfactory operation, or cause undue vibration in any part of the equipment, throughout its entire operating range of speed and load.

The generator control panel shall be either shock-proof and mounted on the generator unit or a free standing enclosed unit for floor mounting adjacent to the generator unit. It shall have at least the following instrumentation and equipment: AC voltmeter, AC ammeter, frequency meter, indicating KW meter, combination ammeter-voltmeter phase selector switch, 3 pole line circuit breakers of suitable amperage, and elapsed running time meter.

Chlorination System

Chlorine gas, in 150-lb cylinder or ton containers, whichever is most suitable for the particular installation, shall be employed in all chlorination stations. (Hypochlorite solutions are an acceptable substitute.) Chlorine solution shall be added to the water to be treated through chlorination equipment and accessories specifically designed and suited for the purpose.

Chlorinators shall be the vacuum-operated, solution feed type which meters the chlorine gas under vacuum and dissolves it in water, forming a concentrated solution that is then injected into the water. Direct feed chlorinators will not be permitted.

Chlorinators may be directly mounted on 150-lb cylinder or ton container, wall- or floor-mounted units. Models of a design that permit enlarging the capacity by replacement of a component such as the flow meter will be preferred to those with fixed maximum capacity. The chlorinators shall also be of a design that will permit either manual or automatic operation, the latter with the use of auxiliary equipment. At least 2 units shall be provided and installed, one serving as stand-by. The completed installation shall include all necessary piping, valves, controls and accessories including chlorine scales, gas masks, and gas leak detection and alarm systems.

Chlorinators and accessories shall be housed in a separate building or rooms specially designed for the equipment and their functions. (The site for the chlorination facilities shall be acquired by the district and necessary improvements and protective features shall be incorporated.)

Installation of Equipment - General

Special care shall be taken to ensure that all equipment are installed in proper alignment and level. This applies to, but is not limited to, pumps; drive units; gears; sluice gates; mechanical, electrical, instrumentation and communications equipment; and their appurtenances. Equipment contractors will be required to supply the necessary anchor bolts, drawings and templates of anchor bolts.

The general and equipment contractors shall be responsible for the equipment they supply. They shall use only competent personnel and appropriate equipment necessary to properly align, level and secure equipment in place.

The installation of the major equipment specified in the Contract shall be performed under the supervision of competent representatives of the manufacturers. The manufacturer's representative shall not only supervise the installation of the equipment, but shall also supervise the adjustments and testing of the equipment to insure that it will operate in a satisfactory manner as specified or intended. These representatives shall also instruct personnel and mechanics of the Owner in the operation, care and maintenance of the equipment. Complete sets of operating and maintenance instructions shall be furnished as required.

The Contractor shall submit a certificate from the manufacturer stating that the installation of the equipment is satisfactory, that the unit is ready for operation, and that the operating personnel has been sufficiently and thoroughly instructed in the proper operation, lubrication and care of the unit.

Installation of deep-well vertical turbine pumps is particularly critical if long service-free life is to be expected. Installation should only be done by experienced personnel following specifications of ANSI B58.1 - 1971 (AWWA E101 - 71) and paying particular attention to straightness of line shafts and proper alignment of all parts.

Booster Pump Stations

Booster pump stations shall be designed and constructed to comply with established criteria and standards of the LWUA as well as other requirements peculiar to each site. Booster pump facilities will generally consist of pumphouse, pump units, suction and discharge piping, control valves, gauges, flow meter and recorder, control and protective equipment, site works and security fencing.

Pump units shall be centrifugal, turbine, or submersible type. Centrifugal-and turbine-type pumps shall be either electric motor or diesel engine-driven. Submersible booster pumps shall be motor driven. Each pump shall have optimum efficiency at the specified duty point. Motors for electrically driven pumps shall be of adequate horsepower for the full operating range of the pump.

Storage Tanks

Elevated and ground storage tanks shall be generally constructed of reinforced concrete. For small capacity elevated tanks, steel tanks on steel towers may prove to be more economical and should be given consideration in the final design phase. Ground tanks may be circular, rectangular or other shape acceptable to and approved by the Owner. Tanks shall be designed in accordance with applicable national and local structural and sanitary codes. It shall be structurally sound with ample provisions for wind and/or seismic stresses. Concrete and reinforced concrete work including waterproofing, disinfection, painting, and all other incidental work shall be in strict compliance with LWUA Standard Specifications and Supplementary Specifications. All tanks intended for storing potable water shall be covered and watertight. For both elevated and ground tanks, available LWUA standard tanks shall be used to the fullest extent possible. Necessary piping, valves and accessories for operation, maintenance and safety shall be provided. Piping shall include inlet-outlet, overflow, drain, and vent. Shut-off valves, check valves, automatic flow control valves, water level indicators and instrumentation shall be provided as required.

Distribution System Piping and Components

General requirements with respect to materials, installation and other appurtenant work for water transmission pipelines are applicable to distribution system pipelines. Other distribution system components, including fire hydrants, service connections and customer water meters, shall be installed according to LWUA standard details and standard specifications.

Pipe Cleaning and Lining

Pipe cleaning and lining shall include all materials, labor, equipment and all incidental work necessary to clean and line the interior of pipelines in-situ and restore the pipelines in service. The work shall be performed by trained workmen under the supervision of personnel experienced and competent in this particular line of work.

Interior lining shall be cement mortar. The interior of pipes to be lined shall be thoroughly cleaned of all rust, encrustation, dirt, oil and grease and other foreign matter. Necessary repairs, including replacement, shall be made to pipe sections that are severely deteriorated and/or corroded. Any section of pipe that shall be cleaned and lined shall be restored to service in as short a time as possible, preferably within 24 hours.

All work shall be performed in accordance with AWWA Standard C602-67, except as may be modified in the specifications. The work shall include all excavation and backfill; installation and removal of temporary by-pass pipes, service connections, plugs, and closure pieces; making and closing required access openings; surface restoration; clean-up and disposal of debris and other waste materials.

APPENDIX P

MANAGEMENT OF GROUNDWATER RESOURCES

APPENDIX P

MANAGEMENT OF GROUNDWATER RESOURCES

The basic problem in water resource management is preserving the primary water sources for permanent use. Measures must be adopted to preserve their usefulness.

The flows of surface water sources should be continuously monitored under existing procedures of the Bureau of Public Works, Water Resources Survey Division, and in coordination with the National Water Resources Council (NWRC). Catchment areas should be regularly monitored to prevent excessive population settlement, deforestation and other activities which may be harmful to the quantity, quality or rate of flow or runoff from the area.

A continuous program of monitoring spring flows and rainfall records should be introduced. This will determine the variations in the spring performance and water quality, which may indicate the need for maintenance and other corrective measures. The analysis of the records will provide data on long-term groundwater resources that can guide future evaluation.

Management of wells should include monitoring program of flow rates, pumping time, pumping water levels, static water levels and water quality. These records should be maintained on a daily basis. Water quality analysis, consisting of parameters established by the Philippine Drinking Water Standards, should be performed at least once a month.

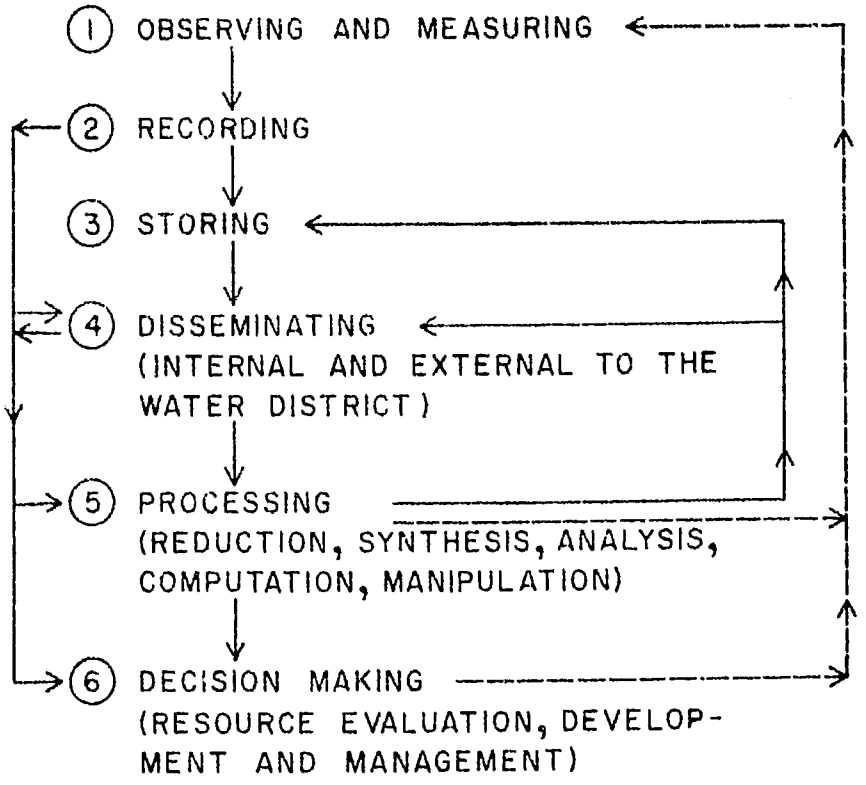
In the case of any springs used for municipal water supply, the water district must control the recharge area to prevent water diversion or other practices leading to lowered infiltration rates. It is also essential that pumping of well water be controlled to prevent lowering of the water table and consequent reduction in or complete loss of spring flow.

The node-path network shown in Appendix Figure P-1 illustrates the development and transmission of water quality monitoring and flow gaging data from the ground or surface water source to the level of management decisions.

Nodes 1 and 2 represent functions to be performed by the water district. These two functions involve the actual field sampling and laboratory analysis and the recording of data in field and laboratory notebooks and eventually computer input file forms. Node 3 represents the storage function. Data may be stored directly as field and laboratory notes, then published in monthly reports and copies sent to LWUA and NWRC. One of the future plans of NWRC is to computerize its data system.

The disseminating node, represented as 4, involves the retrieval from the NWRC computer file or copies of field and laboratory notes, annual, monthly, or other periodic reports and summaries. The processing node, 5, represents data summary by technical personnel and consultants for derivation of water quality/quantity relationships, for the definition of long-term trends, problem areas, and derivation of alternative solutions to water quality/quantity problems. This leads to the decision-making step, 6, wherein planning decisions are made and based on sound water quality/quantity knowledge.

Updating and review of the sampling program should be performed by the water district and their consultants as the goals and needs of the area change. These agencies should be responsible for maintaining communication among all the involved agencies. All data and information should be routed through LWUA and NWRC.



LEGEND:

——→ DATA FLOW

- - - → PLANNING AND PROGRAMING

APPENDIX FIGURE P-1
WATER DATA COLLECTION STORAGE AND RETRIEVAL

APPENDIX Q

UPDATING THE WATER SUPPLY MASTER PLAN

APPENDIX Q

UPDATING THE WATER SUPPLY MASTER PLAN

After the water supply master plan has been adopted and initially implemented, it is necessary to undertake a program for continuously updating and keeping the plan current. Plan updating should take place at least once every 5 years, or sooner if significant changes occur. Updating is required to assess the effectiveness of the current plan; the benefits gained; the actual costs; the problems encountered; and to provide overall review, refinement, and direction for the future.

In time, certain aspects of the plan may change. These aspects are directly or indirectly related to the following areas: technological changes, social goal changes, land use concept changes, and population projection changes.

One of the first steps in the updating procedure is to determine to what degree the previous plan has been implemented and the direction of implementation. This step has a dual purpose. First, it will reflect the basic suitability of the original plan and second, it will serve as the basis on which to update the plan. Technological changes in the water supply field may result in improved design criteria and contemporary construction methods, enough to alter the alternative systems analysis results. Social goals will undoubtedly change and there may be more or less emphasis on environmental and ecological control.

The use of land may change in some areas thereby altering population distribution and the need for previously unplanned-for-water services. Population projections may also be altered as refined information becomes available. Transportation networks and employment opportunities will be major determinants in the patterns of population distribution.

An updated report should contain sections or chapters similar to the current plan. The first chapter should be a summary of the updated findings, conclusions, and recommendations.

The second chapter should include the objectives of the updating exercise and the major events that lead into the need for updating. The third chapter should contain an updated description of the study area.

The fourth chapter should include the implemented facilities of the master plan, deviations thereof and reasons for the deviation from the master plan. It should include present updated water use and source flow data and should describe water quality problem areas.

Data concerning former water quality problem areas should be assessed to find what improvements have been made and to document any need for additional improvement. These data should have become available through the recommended monitoring and surveillance program.

The fifth chapter should present new planning and design criteria that may evolve after the master plan is adopted.

The sixth chapter should contain the projections and future conditions. In the areas of economic and demographic change, a review of all updated projections should be made to compare them with the previous plan. Where significant changes have occured, the data should be used for an updated alternative analysis.

The seventh and eighth chapters should contain a re-evaluation of water resources and alternative systems. Where significant changes in projections of future conditions have taken place, it will be necessary to re-evaluate the economic comparison of the alternatives.

The ninth chapter should explain in detail the updated plan. In the area of economic and financial feasibility analysis, re-evaluation of the internal rate of return as well as the rate structure should be made.

APPENDIX R

ENVIRONMENTAL ASSESSMENT

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APPENDIX R

ENVIRONMENTAL ASSESSMENT

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APPENDIX R

ENVIRONMENTAL ASSESSMENT

A. GENERAL

The consideration of certain environmental factors has been a necessary part of the decision-making process in analyzing a project. On a macroscale, the project is a means of controlling and providing one environmental asset - water - for the needs of people in a developing community.

To provide basic water supply, the project will involve the installation of deep and/or shallow wells; diversion or intake structure; treatment facilities; distribution system storage facilities; pumps, valves and other machinery; customer meters and fire hydrants; and a network of pipelines along streets, roads, highways and other rights-of-way (generally following normal routes of transport) specifically acquired for these purposes. Each component of the project, as it is constructed, will have a local environmental effect in terms of land use, construction activities, and final aesthetics. In the sense of a treatment plant's use of chemicals and power, and in the use of power for pumping water, there will be the wider environmental effect of depleting natural resources.

B. PROBABLE ENVIRONMENTAL EFFECTS

Soil Erosion

A short-term adverse impact will result from soil erosion and dust during construction of transmission and distribution pipelines.

Activities such as urban roadway and pipeline construction, and agricultural development increase the sediments carried into the streams. Agricultural development may increase erosion 4 to 9 times while urban construction may increase erosion 100 times. When surface water has excess quantities of sediment, the following adverse conditions are experienced:

(1) impairment of recreational values

(2) reduction in fish propagation

(3) increased cost of water treatment

(4) reduction of sunlight penetration

(5) clogging of stream channels

(6) loss of storage capacity in reservoirs

Increased attention has been given recently to the effects of urbanization and construction activities on soil erosion. Concern centers on the resulting sedimentation, i.e., the transport and deposition of soil sediment in receiving waters. Urbanization and construction activities increase sedimentation in 2 major ways. First, the general increase in peak storm runoff increases the erosion potential. Second, the clearing, levelling, and bulldozing of land for construction expose soil to erosive forces. Certain construction practices tend to increase erosion much more than necessary.

Good planning cannot eliminate all potential sedimentation problems and certain physical controls may be desirable. Permanent physical controls should be installed as quickly as possible in construction areas. These may include sodded diversion terraces, sod on steep cut or fill banks, and ponds that can be drained and cleaned as necessary during and after construction. Attention should be given to the limited ability of small ponds or detention basins to remove the clay-sized particles which increase turbidity. More effective methods may be necessary. Where permanent controls cannot be used because of heavy traffic, delays in installing utilities, etc., then mulch, temporary seeding, straw bales, and temporary detention dams, or some combination thereof, may be appropriate.

Dust problems during construction may be minimized by routine sprinkling of the construction area and returning the excavated area to its original state as soon as possible.

The erosion and dust problem can be minimized by the inclusion of strict erosion and dust control criteria in the contract specifications.

Noise

During the construction period, noise associated with heavy equipment and traffic will occur near the construction site. This temporary disruption will have only a moderate short-term impact. Wells with electric motors or engines and treatment plants will be moderately noisy. Such equipment must be housed within concrete (or block) structures so that noise transmitted is minimal.

Aesthetics

The transmission and distribution lines will be installed below ground level, the surfaces of which will then be returned to original condition. The treatment, storage, pumping, and other supporting facilities and equipment are relatively inconspicuous and will have little or no adverse effect on the existing environment. To minimize the adverse effect on the existing environment, the design of physical facilities must be done unobtrusively and in harmony with the surrounding areas.

Increase in Wastewater

A long-term adverse effect of the water supply project is the unavoidable increase in wastewater. As the available water supply increases, so will wastewater. Water-flush toilets are expected to increase in use as local economy progresses.

The additional volumes of wastewater that improved waterworks will generate are anticipated to be disposed of through the same means being used throughout the Philippines, i.e., septic tanks, cesspools, and surface drains in ditches or gutters. In terms of being burden to the existing surface drainage facilities or causing flooding, wastewater is insignificant, compared to run-off from even a minor rainstorm; however, minor revisions to surface drainage facilities may be necessary to prevent unsightly or desirable accumulations.

There are no current provisions for wastewater collection, treatment or disposal on a nationwide basis. While knowledgeable officials recognize this problem must be addressed in the future, there are no formal plans to meet the requirement at present. If left unattended and unresolved, unsatisfactory disposal of wastewater could present an additional hazard to public health, and could conceivably produce an adverse visual effect on the environment. The potable water system will not be in danger of contamination from the wastewater since, assuming proper installation and operation of the new improved distribution systems, the water

supply will be under sufficient constant pressure to prevent infiltration. In fact, the incidence of waterborne diseases should decline; many present water systems are subject to contamination by infiltration due to occasional negative pressures on distribution systems.

In the Philippines, wastewater has not been given the significance or priority it enjoys in more developed countries. In the contemplation and order of priorities, local decision-makers consider basic water supply and distribution to be far more important than sewage disposal. At this time, they are simply hesitant to consider investing an equal amount, and possibly more, of capital funds in sewerage as in waterworks improvements. In the highly urbanized coastal areas[1/] such as Metropolitan Manila, Cebu and Zamboanga, the order of priority appears to be water supply, drainage/flood control and then wastewater disposal.

Before planning the implementation of drainge and/or wastewater facilities, a policy decision must be made on whether the works should be designed on the basis of separate piping for surface run-off (storm) and (sanitary) wastewater, or of combined system. This can only be accomplished through a feasibility study. It is, therefore, essential that sewerage feasibility studies be conducted as early as possible after the initial implementation phase of the water supply plan is underway.

Environmental Effects of an Impoundment

The construction of a water supply impoundment will have positive and negative impacts on the environment. Evaluation of these impacts on the environment indicates a net environmental benefit.

[1/] In the Philippines, only Manila and Zamboanga have some form of wastewater disposal system. At present Manila is basically served by an antiquated sewage disposal system designed to served 220,000 (Metro Manila population is over 5 million today.) Practically all other liquid wastewater is transported to natural drainage systems through open ditches, gutters, canals, etc. Yet there is no evidence of intolerable or unacceptable public health conditions as a result. Zamboanga has a system which was built in 1913 and has had no significant improvements since then. It serves about 20 percent of the core city area.

Positive Impacts. A water supply impoundment will provide safe, adequate and economical water supply to an urban area. The alternative to this impoundment/transmission/treatment scheme is brackish water treatment of pumped groundwater in the specific case of Metropolitan Cebu. Besides being over four times more expensive, the brackish water treatment scheme involves very high energy use.

The lake or impoundment built behind the dam will provide a scenic and aesthetic asset to the community. This lake will attract tourists to view the waterscape which would have then replaced the currently denuded and eroding hillsides.

Reservoir storage, if properly operated, will also reduce the destructive effect of flash floods in areas downstream of the dam.

Negative Impacts. The impoundment will:

(1) increase the loss of water due to evaporation;
(2) change the habitat of any wildlife and other fauna;
(3) serve as a nutrient trap, holding nutrients which otherwise would have moved downstream;
(4) need to relocate people/homes from the watershed.

Loss of water from evaporation is a relatively minor impact since water in the uncontrolled rivers eventually gets lost to the seas.

While inundation means a loss of some non-aquatic species, the reservoir will provide a new habitat for waterfowl and other lake-oriented species.

Nutrients "trapped" in the impoundment may accelerate entrophication within the lake, stimulating the growth of algae and aquatic weeds.

With careful consideration during final design, these negative effects of the project can be significantly reduced.

Increase in Migration to Urban Areas

In the Philippines, migration from rural to urban areas is inescapable. Rural migrants seeking new economic opportunities usually have two distinct choices of destination: the Metropolitan Manila and the other urban areas. Being the most favored migration point, Metropolitan Manila, however, has reached a level when present government policies incline towards migration restraint. On the other hand, other urban areas of high growth potential await further development.

Metropolitan Manila is troubled with "people" congestion, "traffic" congestion, lack of housing, environmental problems (water and air pollution), unemployment, slums, poor quality of life, etc. For these reasons, plans for regional development in selective urban areas and growth centers such as Batangas, Dagupan, Baguio, Tuguegarao, Legaspi, Iloilo, Cebu, Butuan and Davao (in the order of distance from Metropolitan Manila) are currently being discussed.

The regional development plan offers an opportunity to minimize population density in already congested areas. It helps avoid overcrowding that has been detrimental to the health, safety and welfare of the residents. It intends to maintain a balance between quality of life and city living. Such development plan intends to intercept rural migration to Metro Manila and redirect this to the various regional development centers.

Infrastructure projects including water supply projects are strong stimuli to urban growth. It is usually admitted that a potable water supply is a necessary condition for economic growth and development of an urban area. Infrastructure projects such as public housing, roads, communications, markets, etc., become more beneficial when an adequate water supply project accompanies such investments.

Therefore, the provision of water supply projects in selected and dispersed urban areas in the Philippines will:

(1) assist in the current policy of discouraging migration to Metro Manila;

(2) enhance the growth of regional development centers throughout the Philippines.

C. IRREVERSIBLE COMMITMENT OF RESOURCES

The primary impact of the recommended plan on natural resources is the use of chlorine, power and fuel during the operating phase, and the use of materials, foreign exchange, etc., during the construction phase. The labor time for construction and operation is also a natural resource. However, in view of high unemployment in the study area, the use of this resource has a beneficial impact.

Secondary resource commitment occurs as a consequence of new development encouraged by the expansion of the water supply system. As the population continues to increase, areas of land will be irreversibly committed to residential, commercial, and industrial uses. Well developed and successful land use planning will minimize the loss of open space and related natural biota.

D. BENEFITS OF THE PROPOSED ACTION

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 waterborne 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 waterborne diseases.

3. A corresponding reduction in medical expenses due to lower incidence of waterborne diseases.

Other Benefits

The water supply project will generate other benefits as shown in the following table. This table indicates the implications of having (with) or not having (without) the water supply project.

E. EFFECTS OF DESALTING, WASTEWATER REUSE AND DUAL PLUMBING SYSTEM

Wastewater reuse and dual plumbing have significant health hazards. Recycled water might contain excessive elements, the treatment of which to make it potable is technologically expensive. In the dual plumbing system where one system carries untreated water, cross-connections can give rise to waterborne disease outbreaks.

Desalting may eliminate impoundments and long transmission lines, thereby, lessening the adverse effects such as erosion and noise, and on aesthetics. However, desalting will consume unusually large quantities of power and energy.

In all cases, wastewater will be generated and handling facilities will still be required (except for the wastewater reuse). Resources will still be committed such as land, power, fuel and human resources.

Hypothesis	"Without" Project	"With" Project
1. Water Adequacy	will continue to become in short supply; service will be intermittent and unreliable.	supply will be adequate at continuous pressure.
2. Water Quality	will continue to provide unsafe water and water-borne diseases will continuously be a threat.	supply will be safe, wholesome and healthful.
3. Personal Hygiene of Served Population	because of current water shortage, personal cleanliness is expected to range from marginal to lacking.	will enhance personal hygiene and overall appearance and cleanliness of the population.
4. Personal Satisfaction	will be minimal; significant time spent in fetching water.	release time for other productive activities; provides "modernization" benefits; enhances self-reliance.
5. Employment Benefits	no improvement.	will provide short-and long-term employment benefits.
6. Fire Protection and Fire Insurance	no improvement; area vulnerable to extensive fire damage because of water shortage; no reduction in insurance because the level of fire risks will remain essentially the same.	will improve the fire-fighting capabilities of the area; reduction in fire insurance cost since availability of water with adequate pressure will reduce fire risks.
7. Water-Using Industries in Area	no inducement to industries which use water as a primary or secondary input to locate in the area.	water-using industries will be encouraged to expand facilities, or relocate in the area.
8. Local Tourism	non-availability of piped potable water and poor sanitation facilities will be a deterrent to local tourism.	availability of water, if accompanied by sanitation program, will help boost local tourism.
9. Development of Areas Adjacent to Core City Area into Housing Subdivisions	no impetus to the development of areas adjacent to core city since not much economic activity can occur without adequate water supply.	will help spur the development of areas adjacent to core city into housing subdivisions because water supply availability somehow enhances standard of living.
10. Wastage of Water - a Valuable Natural Resource	wasteful consumption of water will continue because of the absence of safeguards to check its use.	undertaking of metering program and adoption of new realistic water rates will definitely minimize water wastage.
11. Land Values	market value of land will remain at present levels, except for effect of inflation.	will increase land values by at least 10 per cent since water availability is a major consideration in market values of land.

F. SUMMARY

The probable environmental effects are summarized in tabular form below:

PROBABLE ENVIRONMENTAL EFFECTS

Item	Term	Positive	Negative	Solution
Soil Erosion	short		✓	tight construction space
Dust	short		✓	"
Noise - Construction	short		✓	"
Noise - Operational	long		✓	proper design
Aesthetics	long	✓		"
Increase in Wastewater	long		unavoidable	solve sewage problem
Impoundment	long	✓✓	✓	careful design
Migration	long	✓	✓	careful planning
Resource Use	long/short		unavoidable	

1. Careful design and construction will minimize environmental disturbances while these will also create aesthetic and culturally pleasing conditions under which man can develop his most desirable potentialities.

2. The recommended plan will enhance public health, improve the quality of life in the community, and guide its long-term growth and productivity.

3. The peso costs and the short-term adverse effects are offset by the long-term benefits. When compared to the general benefits, particularly pertaining to health and social uplift, the amount of upset is relatively minor.

4. The commitment of resources is small, compared with the anticipated benefits. Resource use is necessary in the construction and operation of a water supply system, but the overall benefits show the overwhelming advantage of carrying on with the project.

APPENDIX 3

EXCERPTS - THE SOCIAL SOUNDNESS OF IMPROVING THE WATER SUPPLY SYSTEM IN FIVE PROVINCIAL CITIES

APPENDIX S

EXCERPTS - THE SOCIAL SOUNDNESS OF IMPROVING THE WATER SUPPLY SYSTEM IN FIVE PROVINCIAL CITIES*

"The range of problems and obstacles, on the one hand, and features conducive to the success of an improved water supply system in Bacolod, Cagayan de Oro, Davao, San Pablo, and Tacloban cities, on the other, is broad indeed. Specific factors have been noted for each city, yet all the points cited affect the other cities to some extent.

Among the important problems may be listed the following:

1. Concern over the increase in the cost of water under the new system pervades all the cities; the middle and lower class populations are especially apprehensive about this component. For some the worry is over the higher bills they will have to pay; for others, especially the poor, the difficulty is that they will have to pay for a service which was formerly free. Looking for other free sources will mean that new arrangements will have to be made by those in the bottom sector of the socioeconomic hierarchy, always a problem for them. Further, areas where water rates were only recently raised show some sensitivity to the prospect of another increase.

2. There seems to be little awareness of how cheaply people are currently getting the water available to them, given actual costs, and that they are in effect being subsidized.

3. Many city officials and local citizens show little concern over the inadequacy of the city water supply; once the LWUA comes into the picture they assume that it will take care of the problem and they therefore turn their attention elsewhere.

4. Local government officials in cities where existing waterworks bring income to the general fund, which in turn supports other services, are not pleased at the prospect of the new system's income being channelled to the Local Water District instead, outside their control or use.

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*Final Report submitted to LWUA by the Ateneo Institute of Philippine Culture on 6 April 1976

5. The all-private character of the board of directors represents a new and relatively untried mechanism for community public utility management; its separation from formal political authorities may result in delaying or other nonsupport characteristics from local officials. This will be especially so if the Local Water Works Board is captured by a sociopolitical faction seen as being in opposition to the existing local officials.

6. Residents who have their own supply of water from private wells, often the more affluent and influential members of the community, are less interested in the new system than those who rely on present antiquated piped systems or draw on public wells.

7. Residents of areas long plagued by water shortage and unkept politics' promises to remedy it show a great deal of skepticism as to whether the LWUA system will be any different.

8. Those with vested interest in the existing arrangement like large-scale and small-scale waterhaulers, well diggers, sellers of related equipment like filters or purifiers, and the like, are likely to oppose the establishment of a new system.

9. Those residents in areas where water for bathing or washing is obviously polluted, as in public streams, will more likely show an interest in a new water supply system.

The above problems suggest certain guidelines for overcoming them:

1. Pay special attention to schemes for lowering household water rates perhaps according to a graduated usage scale; also foster added earning schemes for the poor and marginally poor groups so that they would be more capable of subscribing to the water system.

2. Develop information programs that stress how much more economical in the long run, e.g., in terms of health and convenience, the higher cost water conversion will be, even for those who already have private wells operated by electric pumps.

3. Provide enough free communal faucets for residents of squatter areas, as well as private connections for those who can afford to subscribe.

4. Involve local community residents at all socioeconomic levels in the planning and participation of the project, especially as it affects their specific area.

5. Devise a communication system between the directors of the Local Water Board and local authorities so that appropriate liaison activities are enhanced;

6. Include the water supply program in local planning seminars for officials and citizens, stressing the city's need for greater coverage and for coordination between the officials and the local board.

7. Emphasize to local officials that the decline in general fund income from city-sponsored water services can be counterbalanced by the added taxes levied on new industries and commercial enterprises made possible by the new water system.

8. Insure that the selection process for the Board of Directors includes a wide range of the citizenry that spans socio-political factions.

9. Suggest or, for the poor, provide alternative sources of income for those currently involved in supplying water in terms of the old system.

10. Create a network or federation of local water boards which can meet as a whole at least annually to discuss mutual problems and learn from one another.

The social feasibility of improved water systems in the five project cities refers to the likelihood of their improving the lives of the resident populace, in particular the disadvantaged sectors represented by the poor and women. There is little doubt that health, the local economy, and the quality of life in general will improve with the advent of the system. In all the cities, people are looking forward to these improvements but are not aware as yet or willing in some cases to take the steps needed to help the project come about. Certainly some people will be benefited more than others—those upper-middle and lower class persons who can afford to pay for connections and higher rates, those who fall directly into the physical area covered, and in terms of prestige,

those chosen to serve on the local water board. Nonetheless, the poorer groups will also garner advantages in terms of the increased number of communal faucets available and the jobs created both by the installation process itself, and the industries and commercial entities that will evolve once sufficient water is available.

In the household, women especially will reap the advantages of an abundant water supply. Food preparation and cleaning procedures will be made easier by it. This in turn will give them some freedom to allocate the newfound time to supplementary income raising, child care, community activites, or sheer leisure, as she wishes. Improved health on the part of their children, husband, and other kin living in the household will relieve them of the considerable time and worry expended caring for the sick.

Ultimately, the validity of these predictions can be verified only by actual empirical research in each city on the real outcome of project implementation. Similarly, the spread effects will be definitely known after the fact not before it. The interplay of project and people requires careful monitoring to make the water scheme as closely compatible with and responsive to the needs, aspirations, and realistic situations of the mass populace."

APPENDIX T

LIST OF ABBREVIATIONS

CONVERSION TABLE

APPENDIX T

APPENDIX TABLE T-1

LIST OF ABBREVIATIONS

Organizations

ADB	Asian Development Bank
BAN-WD	Bangued Water District
BAY-WD	Baybay Water District
BIS-WD	Bislig Water District
BPW	Bureau of Public Works
CAL-WD	Calamba Water District
CDM	Camp Dresser & McKee International Inc.
COT-WD	Cotabato City Water District
DCCD	Design Consultation Construction and Development Engineering Corporation
EDF	Economic Development Foundation
GAP-WD	Gapan Water District
IBRD	International Bank for Reconstruction and Development
LWUA	Local Water Utilities Administration
MWSS	Metropolitan Waterworks and Sewerage System (formerly National Waterworks and Sewerage Authority or NWASA)
NCSO	National Census and Statistics Office
NEDA	National Economic Development Authority
NIA	National Irrigation Administration
NWRC	National Water Resources Council
PAGASA	Philippine Atmospheric, Geophysical and Astronomical Services Administration
ROX-WD	Roxas City Water District
SIL-WD	Silay City Water District
URD-WD	Urdaneta Water District
USAID	United States Agency for International Development

Units

AC	asbestos cement
CCI	centrifugally cast iron
CI	cast iron
cm	centimeter
cum	cubic meter
cumd	cubic meter per day
cumd/ha	cubic meter per day per hectare
cum/hr/sqkm	cubic meter per hour per square kilometer
cumd/m	cubic meter per day per meter

APPENDIX TABLE T-1 (Continued)

cum/mo	cubic meter per month
cum/sqkm/yr	cubic meter per square kilometer per year
FEC	foreign exchange component
GI	galvanized iron
GS	galvanized steel
ha	hectare
HGL	hydraulic grade line
hr	hour
kg	kilogram
km	kilometer
lpcd	liter per capita per day
lpd	liter per day
lps	liter per second
lps/m	liter per second per meter
m	meter
m/ha	meter per hectare
mg/l	milligram per liter
mm	millimeter
mm/yr	millimeter per year
mo	month
m/sec	meter per second
MSL	mean sea level
%	percent
₱	Philippine peso
pH	logarithm (base 10) of the reciprocal of the hydrogen ion concentration in water, moles per liter
PVC	polyvinyl chloride
RU	revenue unit
sqkm	square kilometer
sqmd	square meter per day
$	United States dollar
yr	year

APPENDIX TABLE T-2

CONVERSION TABLE

A. METRIC TO ENGLISH

MULTIPLY	BY	TO OBTAIN
Length		
meter (m)	3.281	feet (ft)
kilometer (km)	0.62137	mile (mi)
millimeter (mm)	0.03937	inch (in)
Area		
square meter (sqm)	10.764	square foot (sqft)
square kilometer (sqkm)	0.3861	square mile (sqmi)
square kilometer (sqkm)	100	hectare (ha)
hectare (ha)	2.471	acre (ac)
Volume		
cubic meter (cum)	35.31	cubic foot (cuft)
cubic meter (cum)	264.2	gallon (gal)
cubic meter (cum)	220	UK gallon (ImpGal)
cubic meter (cum)	0.00081	acre feet (acft)
cubic meter (cum)	1000	liter (l)
liter (l)	1000	cubic centimeter (cc)
Weight		
kilogram (kg)	2.2046	pound (lb)
ton (Mg)	1.1023	ton (2000 lb)
gram (g)	0.03527	ounce (oz)
Density		
kilogram/cubic meter (kg/cum)	0.06242	pound/cubic foot (lb/cuft)
Velocity		
meter/second (m/sec)	3.281	foot/second (ft/sec)
meter/second (m/sec)	2.232	mile/hour (mi/hr)
kilometer/hour (km/hr)	0.6215	mile/hour (mi/hr)

APPENDIX TABLE T-2 (Continued)

A. METRIC TO ENGLISH

MULTIPLY	BY	TO OBTAIN
Force		
newton (N)	0.224	pound force (lbf)
Pressure		
newton/square meter (N/sqm)	0.02089	pound force/square foot (psf)
newton/square meter (N/sqm)	0.145	pound force/square inch (psi)
newton/square meter (N/sqm)	0.3347	feet of water (ft)
meter of water (m)	1.42	pound force/square inch (psi)
meter of water (m)	0.010	bar
kilogram/square centimeter (kg/sqcm)	14.22	pound force/square inch (psi)
1 atmosphere	33.90	feet of water (ft)
1 atmosphere	14.7	pounds/square inch (lb/sqin)
1 atmosphere	1.058	tons/square foot (Mg/sqft)
1 atmosphere	10.33	meter of water (m)
1 atmosphere	0.02089	pound force/square foot (psf)
1 atmosphere	0.145	pound force/square inch (psi)
Flow		
cubic meter/second (cum/sec)	22.83	million gallons/day (mgd)
cubic meter/second (cum/sec)	35.31	cubic foot/second (cfs)
cubic meter/second (cum/sec)	15,852	gallon/minute (gpm)
cubic meter/second	86,400	cubic meter/day (cumd)
cubic meter/day/ square kilometer (cumd/sqkm)	0.143	cubic foot/day/acre (cfd/ac)

APPENDIX TABLE T-2 (Continued)

A. METRIC TO ENGLISH

MULTIPLY	BY	TO OBTAIN
Filtration Rate		
cubic meter/square meter/hour (cum/sqm/hr)	0.4098	gallon/minute/square foot (gpm/sqft)
cubic meter/square meter/day (cum/sqkm/d)	24.57	gallon/day/square foot (gpd/sqft)
Power		
watt (W)	3.413	British Thermal Unit/hour (BTU/hr)
kilowatt (kw)	1.339	horsepower (hp)

B. ENGLISH TO METRIC

Length		
feet (ft)	0.3048	meter (m)
mile (mi)	1.60934	kilometer (km)
inch (in)	25.4	millimeter (mm)
Area		
square feet (sqft)	0.0929	square meter (sqm)
square mile (sqmi)	2.590	square kilometer (sqkm)
acre (ac)	0.4947	hectare (ha)
hectare (ha)	0.01	square kilometer (sqkm)
Volume		
cubic feet (cuft)	0.028317	cubic meter (cum)
gallon (gal)	0.0037854	cubic meter (cum)
	3.785	liter (l)
acre foot (acft)	1235	cubic meter (cum)
Weight		
pound (lb)	0.45359	kilogram (kg)
ton (2000 lb)	0.90718	ton (Mg)
ounce (oz)	28.35	gram (g)
Density		
pound/cubic foot (lb/cuft)	16.02	kilogram/cubic meter (kg/cum)

APPENDIX TABLE T-2 (Continued)

B. ENGLISH TO METRIC

MULTIPLY	BY	TO OBTAIN
Velocity		
feet/second (ft/sec)	0.3048	meter/second (m/sec)
mile/hour (mi/hr)	0.448	meter/second (m/sec)
mile/hour (mi/hr)	1.609	kilometer/hour (km/hr)
Force		
pound force (lbf)	4.44822	newton (N)
Pressure		
pound force/square inch (psi)	0.705	meter of water (m)
pound force/square inch (psi)	0.0703	kilogram/square centimeter (kg/sqcm)
Flow		
million gallons/day (mgd)	0.04382	cubic meter/second (cum/sec)
million gallons/day (mgd)	43.82	liter/second (lps)
million gallons/day (mgd)	3790	cubic meter/day (cumd)
cubic foot/second (cuft/sec)	0.02832	cubic meter/second (cum/sec)
gallon/minute (gpm)	0.063	liter/second (lps)
Filtration Rate		
gallon per minute/square foot (gpm/sqft)	2.44	cubic meter/square meter/hour (cum/sqm/hr)
gallon per day/square foot (gpd/sqft)	0.0407	cubic meter/square meter/day (cum/sqmd)
Power		
British Thermal Unit/hour (BTU/hr)	0.293	Watt (W)
horsepower (hp)	0.747	kilowatt (kw)