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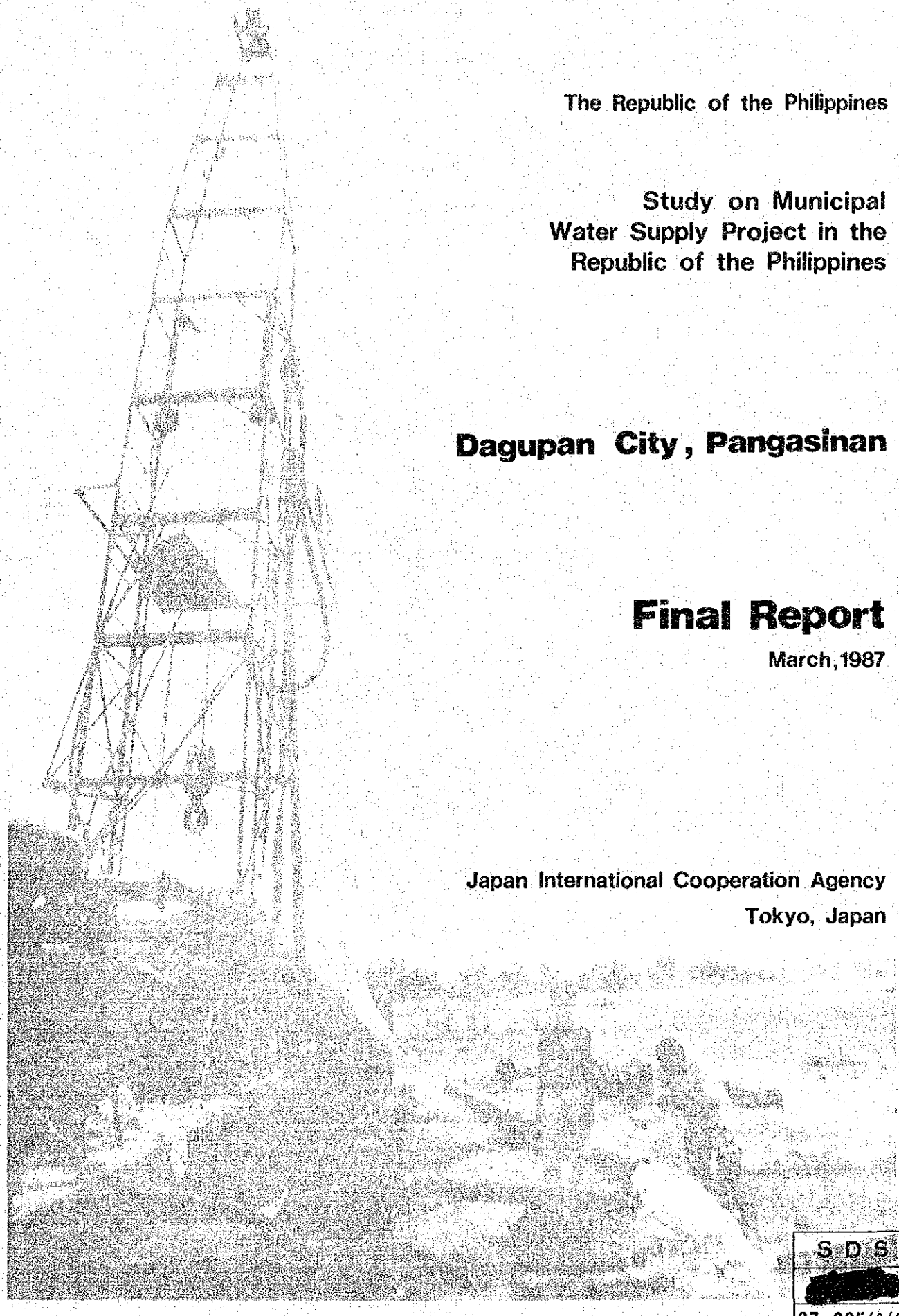


The Republic of the Philippines

Study on Municipal Water Supply Project in the Republic of the Philippines

Dagupan City, Pangasinan

Final Report

March, 1987

Japan International Cooperation Agency
Tokyo, Japan

THE REPUBLIC OF THE PHILIPPINES

STUDY
ON
MUNICIPAL WATER SUPPLY PROJECT
IN
THE REPUBLIC OF THE PHILIPPINES

DAGUPAN CITY, PANGASINAN

FINAL REPORT

MARCH, 1987

JAPAN INTERNATIONAL COOPERATION AGENCY
TOKYO, JAPAN

PREFACE

In response to the request of the Government of the Republic of the Philippines, the Japanese Government has decided to conduct a Master Plan and a Feasibility Study on Municipal Water Supply Project and entrusted the Study to the Japan International Cooperation Agency (JICA). JICA organized a study team headed by Mr. Toru Hayashi, Director, Nippon Jogesuido Sekkei Co., Ltd. to conduct the said study, from February 1986 to March 1987.

The team had discussions with the officials concerned of the Government of the Philippines and conducted a field survey in the Study Area and Metropolitan Manila. After the team returned to Japan, further studies were made and the present report has been prepared.

I hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries. I wish to express my deep appreciation to the officials concerned of the Government of the Philippines for their close cooperation extended to the team.

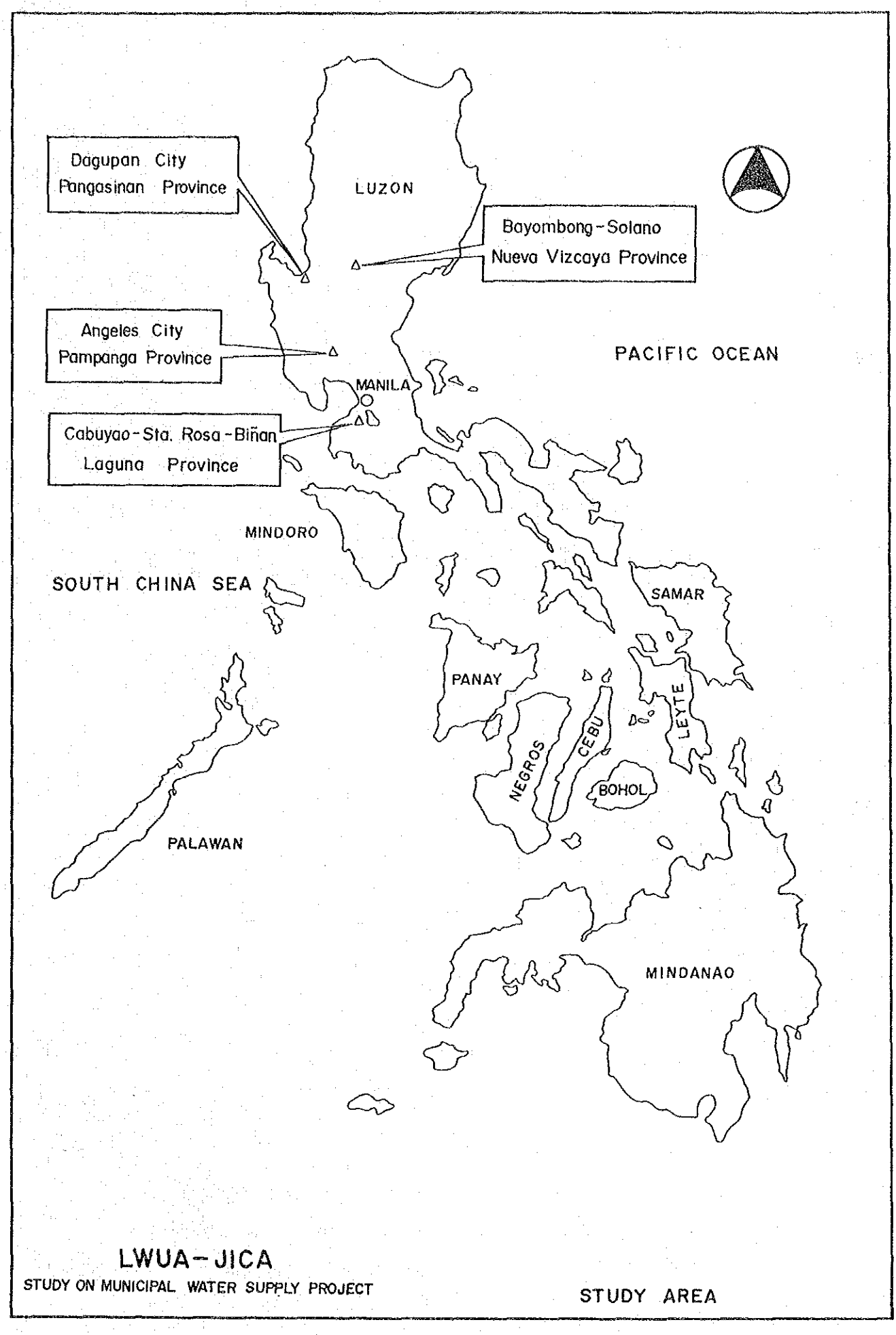
March, 1987

Keisuke Arita

Keisuke ARITA

President

Japan International Cooperation Agency



LWUA - JICA

STUDY ON MUNICIPAL WATER SUPPLY PROJECT

STUDY AREA

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LIST OF ACRONYMS AND ABBREVIATIONS

ACRONYMS

AC	-	Asbestos Cement
BPW	-	Bureau of Public Works (now MPWH)
BWP	-	Barangay Water Program
CI	-	Cast Iron
DAWASA	-	Dagupan City Waterworks System Administration
DECORP	-	Dagupan Electric Corporation
EIRR	-	Economic Internal Rate of Return
FIRR	-	Financial Internal Rate of Return
GI	-	Galvanized Iron
GIP	-	Galvanized Iron Pipe
GOJ	-	Government of Japan
GOP	-	Government of the Republic of the Philippines
HH	-	Household
JICA	-	Japan International Cooperation Agency
LWUA	-	Local Water Utilities Administration
MERALCO	-	Manila Electric Company
MPWH	-	Ministry of Public Works and Highways
NCSO	-	National Census and Statistics Office
NEDA	-	National Economic and Development Authority
NPC	-	National Power Corporation
PE	-	Polyethylene
PLDT	-	Philippine Long Distance Telephone Company
PT&T	-	Philippine Telegraph and Telephone Corporation
PVC	-	Polyvinyl Chloride
RCPI	-	Radio Communication of the Philippines, Incorporated
RWDC	-	Rural Waterworks Development Corporation

ABBREVIATIONS

Units

cm	-centimeter
cm/sec	-centimeter per second
cu.m	-cubic meter
cu.m/conn.day	-cubic meter per connection per day

Units

cu.m/day	-cubic meter per day
cu.m/day/km	-cubic meter per day per kilometer
cu.m/day/m	-cubic meter per day per meter
cu.m/hr	-cubic meter per hour
cu.m/month	-cubic meter per month
cu.m/sec	-cubic meter per second
FTU	-formazin turbidity unit
ha	-hectare
HP	-horse power
hr	-hour
kg/day	-kilogram per day
kg/sq.cm	-lilogram per square centimeter
km	-kilometer
KVA	-kilo volt ampere
kw	-kilo watt
KWH	-kilo watt hour
l/day	-liter per day
l/min	-liter per minute
l/min/m	-liter per minute per meter
l/sec	-liter per second
lpcd	-liter per capita per day
lps	-liter per second
lps/m	-liter per second per meter
mbgs	-meter below ground surface
mD	-meter in Depth
mH	-meter in Height
micro-S/cm or micro-Siemens/cm	-micro Siemens per centimeter
mm/day	-millimeter per day
m/km	-meter per kilometer
mm	-millimeter
MM	-man month
m	-meter
m/sec	-meter per second

Units

MWH	-mega watt hour
mm/year	-millimeter per year
ohm-m	-ohm meter
pc or pcs	-piece(s)
pc/ha	-piece per hectare
p/ha	-person per hectare
₱/annum	-peso per annum
₱/month	-peso per month
sq.cm/sec	-square centimeter per second
sq.km	-square kilometer
sq.m	-square meter
sq.m/day	-square meter per day

CHAPTER 1
SUMMARY AND RECOMMENDATION

CHAPTER 1 SUMMARY AND RECOMMENDATION

1.1 GENERAL

This Chapter presents a summary of the results and analyses of the field surveys conducted in Dagupan City for the Project. The Short Term Development Plan and Long Term Development Plan with special emphasis on the water resources are also incorporated.

In the course of study, planning stages are considered as Phase I from 1986 to 1995 for the Short Term Development and Phase II from 1996 to 2010 for the Long Term Development period, respectively. The Phase I project period is further divided into two stages; Stage 1 from 1986 to 1990 and Stage 2 from 1991 to 1995, considering the practical implementation period for the required facilities.

With regard to the criteria and approach of technical and financial studies, the Methodology Manual being established and adopted by the Local Water Utilities Administration (hereinafter referred to as LWUA) was employed through the thorough review with data and information collected during the field surveys. Some deviations to the Methodology Manual, such as system pressure during the Phase I period, were made by cost considerations. Also adopted at the request of the LWUA was the terms and conditions for financial analysis of the Project. Those which referred to the Methodology Manual are contained in APPENDIX of this report.

The fundamentals used for planning and study are shown in TABLE 1.1.1.

1.2 FINDINGS AND PROJECTIONS

1.2.1 Study Area

Dagupan City is located in the mid-north portion of the Province of Pangasinan, and is about 200 km away from Manila.

The City has a gross area of 4,404 ha which includes a total land area of 3,740 ha. It has 31 urban barangays. Land use in the City is divided into urban and non-urban. Urban land use includes residential,

TABLE 1.1.1 SUMMARY OF PROPOSED PROJECT (Dagupan City)

Description	Present (1986)	Phase I		Phase II (2010)
		Stage 1 (1990)	Stage 2 (1995)	
A. Population				
1. Total Population	110,850	118,730	128,610	159,880
2. Pop. in Service Area	65,520	70,340	79,430	112,610
% of Total Pop.	59	59	62	70
3. Served Population	23,430	32,910	48,840	90,130
% of Pop. in Service Area	36	47	61	80
% of Total Pop.	21	28	38	56
B. Served Area (ha)	711	711	740	1,042
C. Water Demand (cu.m/day)				
1. Domestic (Daily Ave.)	2,613	3,689	6,251	13,699
2. Commercial (Daily Ave.)	1,248	1,606	2,151	5,376
3. Institutional (Daily Ave.)	115	199	263	501
4. Industrial (Daily Ave.)	-	-	-	-
5. Total Water Demand				
a) Daily Ave.	3,976	9,160	12,380	24,470
b) Daily Max.	-	11,450	15,480	30,590
c) Peak Hour	-	19,920	26,160	49,250
D. Number of Connection				
1. Domestic (Individual)	3,060	5,124	8,737	16,385
2. Domestic (Public Faucet)	40	25	-	-
3. Commercial	1,124	1,339	1,537	2,829
4. Institutional	26	43	50	66
5. Industiral	-	-	-	-
6. Total	4,250	6,531	10,324	19,280
E. Water Sources and Treatment				
1. Existing Facility	15 wells	10 wells	10 wells	-
(capacity: cu.m/day)	11,760	6,550	6,550	-
2. New Facility				
Water Source	-	8 wells	7 wells	4 radial wells
(capacity: cu.m/day)		4,800	4,200	21,600
Water Treatment Facility	-	-	-	Slow sand filter
F. Transmission Facility	-	ϕ150 - ϕ350 12,650m	ϕ150 - ϕ350 7,200m	ϕ300 & ϕ600 28,400m
G. Distribution Facility				
1. Reservoir (capacity: cu.m)	-	2,400	-	4,550
2. Main Pipeline	-	ϕ300 - ϕ700 3,540m	ϕ200 - ϕ350 5,940m	ϕ150 - ϕ250 11,640m
3. Internal Network	ϕ50 - ϕ150 25,290m	ϕ75/ϕ100 21,700m	ϕ75/ϕ100/ϕ150 3,800m	ϕ75/ϕ100/ϕ150 25,400m
H. Number of Workers	50	52	72	87
I. Project Cost (Peso)				
1. Construction Cost				
a) Foreign Exchange	-	33,480,000	13,145,000	79,150,000
b) Local currency	-	29,460,000	10,982,000	69,086,000
c) Total	-	62,940,000	24,227,000	148,236,000
2. O & M Cost (₱/annum)	2,528,177 1/	2,855,000	4,214,000	7,028,000
J. Ave. Family Income of Low Income Group (₱/month)	650	1,120	2,150	-
K. Water Rate (₱/cu.m; 0-10 cu.m)				
1. Domestic	1.4 (1/2")	3.75	8.0	-
2. Commercial	4.0 (1/2")	7.50	16.0	-
3. Institutional	3.2 (3/4")	3.75	8.0	-

1/ : 1985

commercial and business, institutional, and others. Non urban land is exclusively used for farmlands and fishponds.

The total population of Dagupan City increased form 98,344 in 1980 to 110,850 in 1986.

The city revenue is derived from taxation, incidental revenue, receipts form operation and others. The revenue and expenditure of the City in 1985 were ₱24,494,074 and ₱25,929,254, respectively.

Regarding household revenue, 27.3% of the total population belongs to the bracket of ₱300/month and below, 26.8% to ₱301-500/month, 20.9% to ₱501-880/month and 25.0% to ₱881/month and above in 1981.

Most people in the City depend on agriculture for livelihood, with fishing as the second major industry.

As of 1985, there were 3,253 commercial establishments of which 59.0% were retail and wholesale businesses in the City.

The City has seven telegraph services: two government-owned and five privately-owned. The telephone system is managed by the Philippine Long Distance Telephone Company (hereinafter referred to as PLDT). Electricity is distributed by the Dagupan City Electric Corporation (hereinafter referred to as DECORP) which in turn gets its power from the National Power Corporation (hereinafter referred to as NPC).

1.2.2 Existing Water Supply and Sanitation Conditions

Approximately 36% of the present population is covered by the existing Dagupan City Waterworks System Administration (hereinafter referred to as DAWASA) which has been managing the system since its inauguration in the 1930's. Of the total 31 barangays, 14 barangays are served by the system. The water source of the water supply system is groundwater from 15 deep wells.

There are three barangays with Level II system and one barangay with Level III system which are under the Barangay Water Program (hereinafter referred to as BWP).

Aside from the above-mentioned water supply systems, there exist 248 deep wells distributed in 25 barangays of which 205 or about 80% are reported to be functioning. In addition, there is a great number of privately-owned shallow wells even in the areas served by Level III systems.

Level I system includes wells with jetmatic or pitcher pumps, while some are equipped with motor pumps for in-house services. The existing three Level II systems consist of wells, distribution tank and pipes, and public faucets.

With regard to the facilities of the DAWASA, 15 pumping stations are being operated which are equipped with borehole type electric motor driven turbine pumps. Groundwater is directly distributed without any treatment.

There are two concrete made storage tanks with capacities of 398 and 197 cu.m. However, these tanks are not being used due to insufficient water pressure of the pumps. The total length of the distribution pipes is 25,990 m with a pipe diameter of 50 mm and over. The distribution system comprises a variety in pipe materials, sizes and year of construction. There are a total of 4,250 registered service connections of which 3,060 are domestic, 1,124 are commercial and 40 are public faucets. Most of these connections are provided with water meters. There is an independent fire hydrant system managed by the Fire Department.

The existing independent Level III system in Barangay Carael has a deep well with a depth of 180 m equipped with a turbine pump. A storage tank with a capacity of 68 cu.m is installed and water is distributed from the tank. The diameter of transmission pipes ranges from 50 mm to 150 mm, while distribution pipe size is 25 mm.

The water quality of the wells of the DAWASA was examined. Three of the fifteen wells indicated considerably high electric conductivity ranging from 1,200 to 2,600 micro-Siemens/cm. The salty taste of the water was also confirmed. This is an indication that these wells are affected by salt water intrusion.

Operation and maintenance works are performed by 25 personnel assigned from the DAWASA. Major works are inspection and repair of turbine pumps and water leakage, and installation and repair of water meters. The DAWASA does not have an appropriate workshop for the operation and maintenance practices as well as insufficient equipment, tools and spare parts.

The water quality of the Level I system is reported to be unsatisfactory for the most of time due to inadequate construction methods. Some wells were abandoned due to salt water intrusion. It was found out that there is a high possibility of salt water intrusion into all existing wells. Further investigation and study of water source development will be required. Immediate improvement of pump house is a requisite to avoid short-circuit of electric current. Proper installation of pumps is also necessary. Repair of water meters is one of the most essential measures for improvement of the distribution system and the revenue from water sales.

The total water production of the DAWASA was estimated to be 9,640 cu.m/day based on the pump efficiency test and operation schedule.

Total water consumption in the DAWASA was estimated at about 4,100 cu.m/day. Accordingly, approximately 43% of the production is considered to be utilized.

With regard to drainage and sewage disposal, surface water runoff flows into the drainage system consisting of open and covered street canals. Sanitary sewage is disposed of at private septic tanks or pit privies. Solid wastes are collected by the City in a limited area and dumped into swampy areas outside the city proper. Uncollected wastes are burned.

1.2.3 Population Projection and Water Demand Projection

(1) Population projection

Population Projection was made using the breakdown method. Utilizing the provincial population, it was projected and compared with the National Economic and Development Authority (hereinafter referred to as NEDA) projections. The projected provincial population was then broken down into the City using the "sharing method". These projections were further broken down into barangay level using the same method.

The city population of 98,344 in 1980 is projected to increase to 159,880 in 2010. TABLE 1.1.1 shows projected population by design year.

(2) Population and Area to be Served

The potential service area to be covered by the water supply system in the future was established considering the existing water supply system, future development, results of market survey and special conditions of the locality.

Service area for the long and short term development covers 21 barangays and 15 barangays with a planned area of 1,042 ha and 740 ha, respectively. The served population percentages by barangay for the years 1995 and 2010 are recommended to be 60% and 80%, respectively. The served population for the target years are 48,840 in 1995 and 90,130 in 2010.

(3) Water Demand Projection

Future water consumption in the proposed service area was projected for the years 1986, 1990, 1995 and 2010.

Unit water consumption for the respective design years was estimated by type of consumer based on the analysis of the present water consumption. Increase rate for future figures are referred to the LWUA Methodology Manual. The unit water consumption employed for projection purposes is given below:

Consumer Type		Design Year			
		1986	1990	1995	2010
Domestic	(lpcd)	110	119	128	152
Commercial	(cu.m/conn.day)	1.1	1.2	1.4	1.9
Institutional	(ditto)	3.4	4.5	5.3	7.5
Public Faucet	(lpcd)	60	60	-	-

The total water consumption on the daily average basis is summarized below for each design year:

Item	Design Year		
	1990	1995	2010
No. of Connections	6,531	10,324	19,280
Water Consumption (cu.m/day)	5,500	8,700	19,600

The percentages of unaccounted-for water were assumed to be 40%, 30% and 20% in 1990, 1995 and 2010, respectively in consideration of the present figure obtained from the field investigation. Demand variations by design years are calculated based on the LWUA Methodology Manual and summarized below:

Demand (cu.m/day)	1990	1995	2010
Daily Average	9,200	12,400	24,500
Daily Maximum	11,400	15,500	30,600
Peak Hour	19,900	26,200	49,200

1.2.4 Water Resources

Potential water sources were identified and evaluated based on the results of field investigations and water demand projections for long and short term developments of water supply system. Among others, the maximum utilization of the existing deep well sources in a cost-effective manner was given due consideration associated with the extent of salt water intrusion in the study area.

Hydrogeological constraints of the study area, as determined through the georesistivity sounding and relevant field surveys, limited a choice of potential water sources for water supply purpose in relation to the necessary amount to be developed. The construction of new deep wells was then recommended for short term development at a portion of Calasiao area near the boundary of Dagupan City to exploit about 9,000 cu.m/day. For the long term development, the utilization of Agno River and other surface water sources in the mountain foot at northeastern direction of the city were considered necessary to cope with 21,500 cu.m/day of water demand. In the case of Agno River, the location of water intake facility was planned at about 26 km inland from Dagupan City.

1.2.5 Analysis and Evaluation of Alternative

Evaluation of alternatives was made taking into account the recommended water sources, water demand, locations and other conditions. The water supply system may be determined based on the source capacity and its location. It is recommended that the existing deep wells which are not affected by salt water intrusion be utilized, in addition to the construction of a number of new deep wells between Dagupan and Calasiao. However, further study and observation of the aquifer conditions in relation to the extent of salt water intrusion must be carried out to allow for the utilization of many wells. It is also recommended to explore the possibility of water source development on a joint effort with the neighboring Water Districts/municipalities to meet the requirement towards the target year of 2010 considering the least cost development strategy.

Alternative water supply system to cover the proposed 21 service area barangays of Dagupan City were studied using the result of the source alternative study. One system covering the said service area is recommended in consideration of groundwater conditions.

Economic cost comparison on distribution alternatives was made considering 12% per annum of the discount rate as instructed in the LWUA Methodology Manual.

1.2.6 Recommended Plan

The study of short term development plan was made corresponding to the selected long term development plan. The bases for planning the major facilities through the Phase II is as follows:

(1) Source: Major sources will be 15 additional new deep wells (Phase I) in Calasiao area and 4 radial wells at the Agno River (Phase II). Of the 15 existing deep wells, five will be abandoned during Phase I period due to salt water intrusion. Subsequently, all the remaining existing deep wells will also be abandoned for the same reason.

(2) Treatment: The constant flow chlorinator at the existing deep wells and at the reservoir for the water from the newly constructed deep wells and radial wells will be installed. The water from the Agno River will be filtered at slow sand filtration facilities before chlorination.

(3) Transmission: Transmission pipelines from the deep wells (Phase I) and from the radial wells (Phase II) will be constructed in parallel to each other.

(4) Distribution: New reservoir with a capacity of 2,400 cu.m in Phase I. Expansion of reservoir by 4,550 cu.m in Phase II.

(5) Electricity: Provision of power substation with a capacity of 200 KVA for pumping facilities at the reservoir (Phase I) and replacement of transformer unit with a capacity of 400 KVA (Phase II). Power for pumping facilities at deep wells and radial wells will be supplied directly from power supply network.

Construction, operation and maintenance costs by phase are estimated in accordance with the implementation plan. The followings are the summary of the costs.

(1) Construction Cost (in Thousand Pesos)

Phase I	Stage I	:	62,940
	Stage II	:	24,227
Phase II		:	148,236

(2) Operation and Maintenance Cost (in Thousand Pesos/Annum)

Phase I	Stage I	:	2,855
	Stage II	:	4,214
Phase II		:	7,028

1.3 FINANCIAL ASPECTS

1.3.1 Financial Feasibility

The financial feasibility of the project was analyzed in line with the LWUA's guideline.

The balance sheet shows that the water system has been earning since 1983. The water charge is the major source of the revenue for the water supply system. A flat rate is charged for public faucets regardless of meter and a metered rate for residential and commercial metered connections. The present water rates are ₱30.0 per month and ₱25.0 per month for the first 10 cu.m, respectively.

According to the result of the market survey, it was observed that the majority of the respondents, especially the low income group, were not willing to connect to the municipal water supply system.

The capital cost of the project is estimated to be ₱157.54 million; 50% is expected to be financed from the LWUA's regular loan, 45% from the LWUA's soft loan and remaining 5% from the Water District's equity participation taking into account a 15% per annum of the escalation rate as instructed in the LWUA Methodology Manual. The future water tariff structure as shown below was developed under these assumptions and following conditions.

(1) Minimum charge for the first 10 cu.m/month consumption must not exceed 5% of the monthly average family income of the low income group, and

(2) Increase of the minimum charge must be limited to be within 60% of that in the previous year.

WATER TARIFF IN THE FUTURE

Period	Rate/ Unit	Consumption (cu.m) First 10	11-20	21-35	Above 35
1988	₱1.0	₱25.0	₱3.4	₱4.6	₱6.5
1989	1.5	37.5	5.1	6.9	9.8
1990	1.5	37.5	5.1	6.9	9.8
1991	2.0	50.0	6.8	9.3	13.0
1992	2.6	65.0	8.8	12.0	16.9
1993	3.0	75.0	10.1	13.9	19.5
1994	3.2	80.0	10.8	14.8	20.8
1995	3.2	80.0	10.8	14.8	20.8
1996	3.9	97.5	13.2	18.0	25.4
1997	4.5	112.5	15.2	20.8	29.3

The rapid increase of the water rate will be inevitable due to the present water rate at comparatively low level. The estimated Financial Internal Rate of Return (hereinafter referred to as FIRR) is 13.1%. The recommended project for the Short Term Development Plan is seen to be financially feasible.

1.3.2 Economic Feasibility

The proposed improvement are expected to achieve considerable economic benefits to the municipality as a whole.

The economic analyses presented in CHAPTER 10 evaluate the effectiveness of the project in terms of socio-economic factors. The method adopted to give a synthetic measure of effectiveness is the Economic Internal Rate of Return (hereinafter referred to as EIRR). The benefits considered are the increase in land value, the economic value of water and health benefits. Results of the findings show that the EIRR is 6.0%.

1.4 ORGANIZATION AND MANAGEMENT

1.4.1 Existing Management System

The main root of the problems regarding organization is institutional weakness. It is the shortcoming of human resources that gives rise to inadequate physical systems and deficient water service.

For the DAWASA, functional responsibilities and jurisdiction have not been fully defined and enforced in accordance with the approved organization structure. Some personnel perform jobs where they are not qualified. Another constraint for efficient operation of the system is inadequate financing. As such, salary level is low and is not conducive to attracting qualified technical personnel. The system does not also have an effective program of training its available manpower.

1.4.2 Proposed Organization Structure

On March 31, 1986, the City Council of Dagupan decided for the formation of a Water District. The Japan International Cooperation Agency (hereinafter referred to as JICA) Study Team fully supported this decision as it believes that the water district concept has been proven to be the best organization structure available to manage water utility operations.

Using the LWUA Methodology Manual, the number of personnel required for the Dagupan City Water District is 93 for the year 1995 and 224 for the year 2010. Although the formula presented in the LWUA Methodology Manual is based on statistical data, no evaluation has been indicated whether the figures derived from the formula are appropriate or not.

The JICA Study Team is proposing a new staffing guideline regarding the number of personnel based on the appropriate performance of individual work. This is intended to help management carry its policy into effect efficiently within the given limits in order to attain maximum performance at minimum cost. In other words, all resources, particularly human resources, should be optimally utilized to realize the objectives of the water district.

Based on this guideline, the number of personnel required for efficient operation of the Dagupan City Water District is 72 for 1995 and 87 for 2010.

Organization-wise, the JICA Study Team also proposes to divide the water district organization into two main branches or divisions; the administrative and commercial division and the engineering and technical division.

1.4.3 Other Recommendations

It is believed that the promotion of the water district concept should be more aggressively undertaken by the LWUA. Many municipalities seem to be much interested in forming its water system into a water district only if the LWUA's assistance system is explained to them. Therefore, LWUA should address itself to effective public relations to promote the organization of water district through grass-roots and media based information campaigns.

Another recommendation is in the area of water resources. Some areas in the Philippines have difficulties in finding adequate water sources, quality or quantity wise. In the near future, it may be necessary to amend further the Presidential Decree No. 198 (hereinafter referred to as PD 198) to enable LWUA to implement without much difficulty the "bulk water supply" concept. For areas close to Metro-Manila, a "mutual interdependence" between MWSS and a water district where water-resource is scarce will have to be established to solve such problems.

It may also be worth noting that PD 198 provides for a "consolidation and joint operation" of these districts for the effective management of two or more water districts. It is believed that a merger or consolidation of the facilities or operations of two or more water districts can lower the operating cost of the system. This will result to the lower water rates to be charged to the consumers. If not, then subsidy may be granted to water districts whose construction costs may be too high for such districts can afford.

Subsidy is recommended if the resulting water rates would be impractically high. For example, a guideline may be set to subsidize for

the development of water resources that aims to double the quantity of the existing water source or for systems where the raw water conduit or transmission pipeline's length exceeds 20 km.

1.5 CONCLUSIONS

The Short Term and Long Term Development Plans were established for the improvement and expansion of the existing city water supply system as presented herein. The proposed project, which is in line with the Short Term Development Plan was verified to be feasible technically and financially and is recommended to be urgently implemented.

Full metering of the system should be given a priority to increase the revenue and to encourage the conservation of water. The cooperation of the residents is needed since the installation of house connections is the concessionaires' responsibility. The water district may attract the residents to be willing to connect to the system by making it easier for them to connect by giving financial assistance at low interest or by giving discounts.

Though the well sites are tentatively proposed outside the City, a surveillance system for both existing and newly constructed deep wells should be established to check the fluctuation of the groundwater table and the extent of salt water intrusion which affects the selection of additional deep well sites.

When the use of surface water is considered in the Long Term Plan, it should be reviewed comprehensively taking into account the joint development with the circumferential municipalities involved in the basin of the northeastern rivers which originate from the Baguio area and the Agno River, as well as adjustments of water rights with relevant agencies, especially for irrigation. Also, the route for the raw water transmission pipeline, and the selection of treatment process should be decided based on a more detailed survey as required.

It is recommended to repair all the not functioning water meters or replace with new one during the early stage of the project implementation. The leakage detection survey on all the existing service

connections shall be carried out at the same time. Through these activities, it is believed that the DAWASA will eventually regain the reasonable level of the unaccounted-for water.

In addition, the promulgation of the appropriate manner of water conservation to consuming public and the preventive maintenance program, especially periodical check up of water meters are indispensable for sound operation of the DAWASA.

CHAPTER 2
GENERAL BACKGROUND

CHAPTER 2 GENERAL BACKGROUND

2.1 AUTHORIZATION

In response to the request of the Government of the Republic of the Philippines (hereinafter referred to as GOP), the Government of Japan (hereinafter referred to as GOJ) has decided to conduct the Study on the Municipal Water Supply Project in the Republic of the Philippines.

The JICA is the official agency responsible for the implementation of the technical cooperation programs of the GOJ and the LWUA is the official agency responsible for the municipal water supply in the GOP. Both agreed on an Implementing Arrangement for Technical Cooperation for the Study on 23 October 1985. The study was commenced on the middle of February 1986 and completed on March 1987.

2.2 BACKGROUND OF THE PROJECT

Many of the water supply facilities of the local cities and municipalities in the Philippines do not meet the needs of the people due to the rapid increase of population and deterioration of such facilities.

The LWUA is responsible to promote countryside waterworks development in cities and municipalities with a population of 20,000 or more except the Metropolitan Manila area. Its aim is to improve public health and sanitation, and raise the standard of living.

This study is on four areas of local cities and municipalities, among which is Dagupan City in Pangasinan Province. Despite the wide area and large population of the City, the present conditions of the water supply are extremely unsatisfactory. The GOP, therefore, with high priorities requested the GOJ to cooperate in conducting a study on the improvement and development of the water supply system for the city.

2.3 OBJECTIVE AND SCOPE OF WORK

The basic objective of the study is to assist the implementing agency (LWUA) in the preparation of the Long Term Development Plan and the Short Term Development Plan for the water supply project in Dagupan City, Pangasinan.

The Scope of Work includes the following major elements:

A. General

1. Review and evaluate all the data and previous studies directly relevant to the study and conduct field investigations.
2. Conduct analysis mainly on general background, study area, existing facilities, population, water demand projection and water resources.
3. Examine and evaluate the schemes to seek the most favorable plan for feasibility analysis.

B. Specific

1. Data collection, review and field investigations. Collect and review the existing data and information including topography, hydrogeology, meteorology, population, existing land use and city planning, socio-economy, water supply statistics and existing water supply facilities.
2. Conduct the following field investigations;
   - field reconnaissance and demand survey,
   - georesistivity survey,
   - pumping test of existing well and test well drilling,
   - existing system hydraulic survey,
   - present unaccounted-for water survey, and
   - water quality survey.
3. Preparation of Long Term Development Plan (up to year 2010)
4. Preparation of Short Term Development Plan
5. Financial and Economic Study
6. Organizational and Managerial Study

CHAPTER 3
DESCRIPTION OF THE STUDY AREA

CHAPTER 3 DESCRIPTION OF THE STUDY AREA

3.1 GEOGRAPHIC LOCATION AND PHYSICAL FEATURES

Dagupan City is located in the mid-northern portion of the Province of Pangasinan, along the Gulf of Lingayen, and lies in the southwestern portion of the Region I. It lies at N 16°02'36" latitude and E 120°20'00" longitude.

The City is 212 km from Manila by road and 195 km by railway. It is bounded by the Municipalities of Binmaley and Lingayen on the west, Calasiao on the south and Mangaldan and San Fabian on the east.

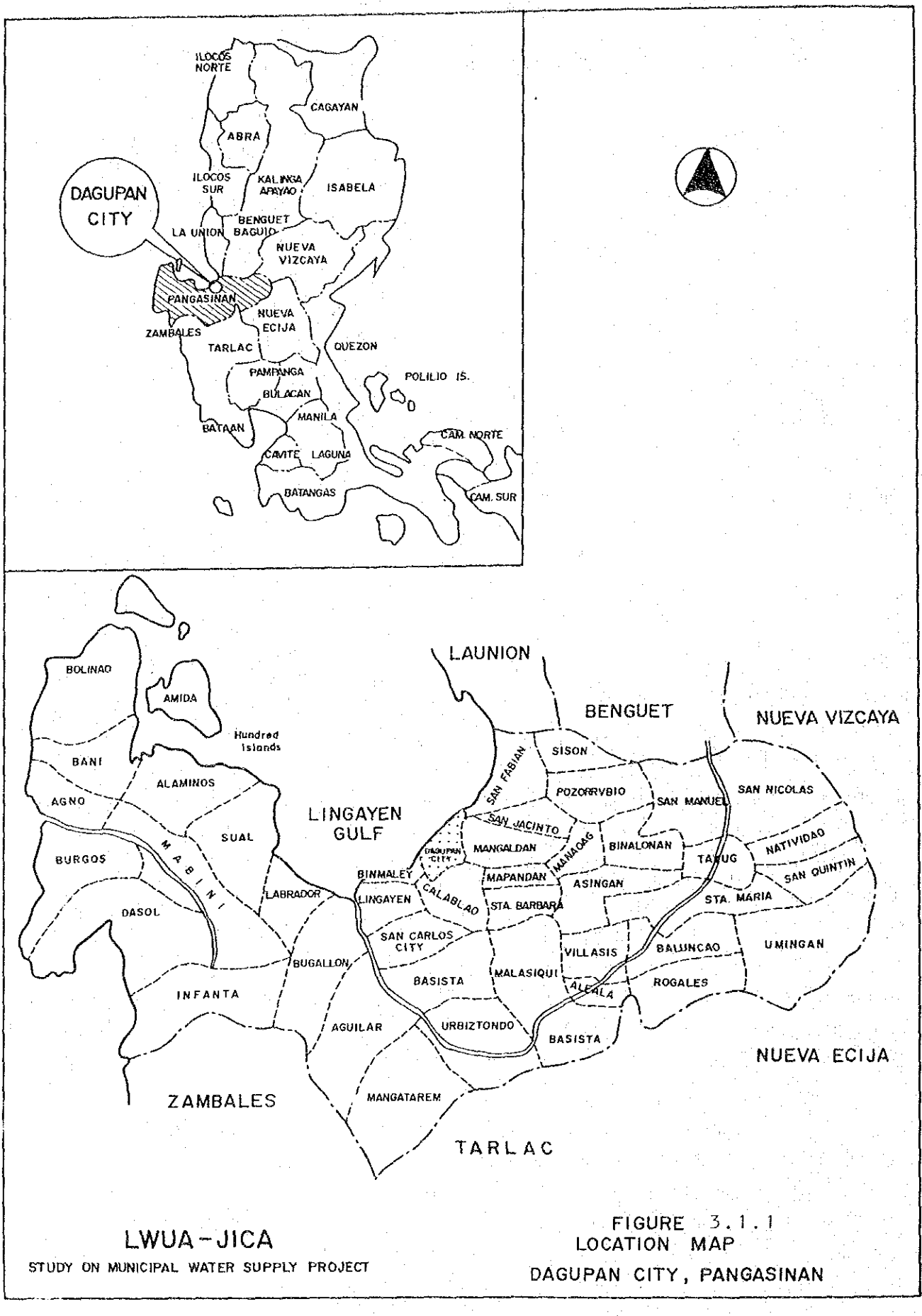
Dagupan City has a gross area of 4,404 ha, including the river areas, and an available land area of 3,734 ha. It has 31 urban barangays. FIGURE 3.1.1 shows the geographical location of Dagupan City.

The City's contour indicates a predominantly flat terrain (0-3%) and one meter above sea level.

The largest river in the City is Calmay River, which traverses the western side of the town and flows out to the mouth of the Dagupan River, before it empties into the Lingayen Gulf. The southeastern part of the City is drained by creeks that pass through A.B. Fernandez Perez Blvd., Zamora and Rizal Streets.

Dagupan City falls under Type I climate, characterized by two pronounced seasons: the dry season, which starts in November and ends in May; and rainy season, which starts in June and may last up to October. The average annual rainfall of the City is 2,3020.2 mm, of which 46% falls during July and August. Rainfall during the peak months in Dagupan City reaches an average of 565 mm. The typhoon season starts in May and may last up to November, and sometimes until December.

The Dagupan's hottest temperature is 29.7°C in May. The cooler months begin in November and may last up to February. With a mean temperature of 28.0°C, this temperature normally builds up to approximately 30°C, which marks the peak of the City's warm month.



LWUA - JICA

STUDY ON MUNICIPAL WATER SUPPLY PROJECT

FIGURE 3.1.1
LOCATION MAP
DAGUPAN CITY, PANGASINAN

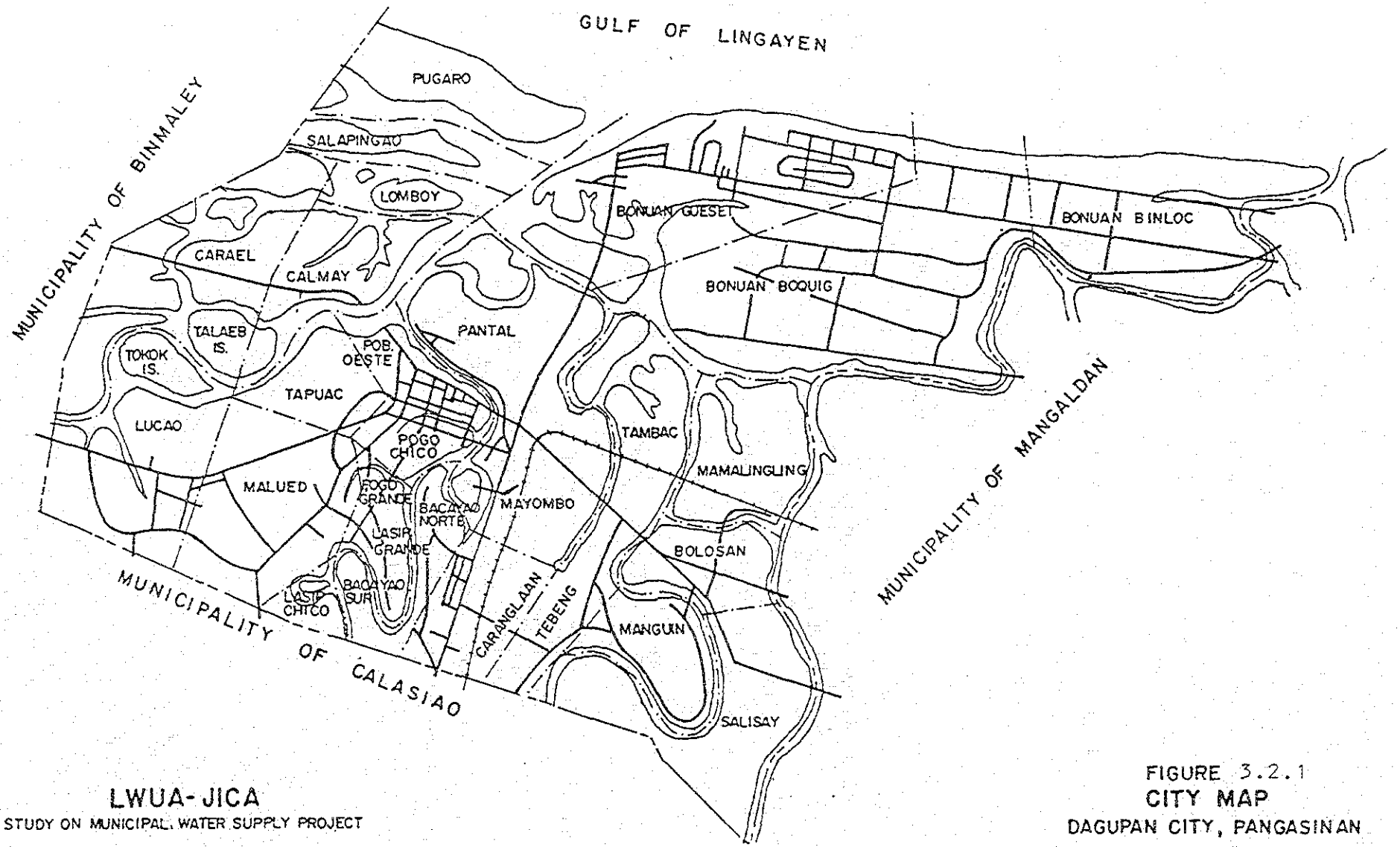
3.2 ADMINISTRATIVE COMPOSITION AND LAND USE

Dagupan City has a total land area of 3,734 ha, encompassing a total of 31 urban barangays. TABLE 3.2.1 shows the land area, population, density and respective percentages of the land area by barangay. Generally, land use of the City can be divided into urban and non-urban uses. Urban land uses include residential, commercial and business, institutional, open spaces and parks. The residential area occupies the second biggest area, covering 888 ha, or 23.78% of the total land area. It is still increasing with the rapid conversion of some agricultural land into residential areas. High density residential areas are located in the central business district along A.B. Fernandez Avenue.

A total of 18.6 ha or 0.50% of the total land area is devoted to commercial and business establishments and is concentrated in the central business district. Institutional areas comprise 65.4 ha or 1.75% of the total land area, with government institutions of 34.1 ha or 0.91%. Open spaces including parks and playgrounds account for 303.5 ha or 8.13% of the total land area, while water bodies occupy 650 ha or 17.41% of the gross area of the City.

Public health authorities recognize the correlation between the lack of safe water supply and sewerage facilities and the incidence of waterborne diseases. These occur particularly in the more densely populated sections of the City.

For non-urban land use, 581.5 ha or 15.57% of the total land area is devoted to farmlands and 1,227.0 ha or 32.86% are fishponds.



LWUA-JICA
STUDY ON MUNICIPAL WATER SUPPLY PROJECT

FIGURE 3.2.1
CITY MAP
DAGUPAN CITY, PANGASINAN

TABLE 3.2.1 LAND AREA, POPULATION DENSITY, PERCENT SHARE IN LAND AREA BY BARANGAY, DAGUPAN CITY

Barangay	Land Area (ha)	Popu-lation (1986)	Population Density (Persons/ha)	Share of Land Area (%)
1. Bacayao Norte	50	1,696	34	1.4
2. Bacayao Sur	28	1,197	42	0.8
3. Bgy. 1	12	1,275	108	0.3
4. Bgy. 2 & 3	7	2,982	445	0.2
5. Bgy. 4	8	5,354	637	0.2
6. Bolosan	81	2,716	34	2.2
7. Bonuan Binloc	291	3,226	11	8.1
8. Bonuan Boquig	480	6,108	13	13.3
9. Bonuan Guesset	382	10,686	28	10.6
10. Calmay	120	4,556	38	3.3
11. Carael	233	3,558	15	6.4
12. Caranglaan	81	5,886	73	2.2
13. Herrero	43	4,257	98	1.2
14. Lasip Chico	21	1,009	49	0.6
15. Lasip Grande	40	2,040	51	1.1
16. Lomboy	52	865	17	1.4
17. Lucao	209	5,332	26	5.8
18. Malued	180	6,263	35	5.0
19. Mamalingling	141	654	5	3.9
20. Manguin	86	1,474	17	2.4
21. Mayambo	75	5,853	78	2.1
22. Pantal	205	12,649	62	5.7
23. Pob. Oeste	39	4,068	105	1.1
24. Pogo Chico	25	5,565	225	0.7
25. Pogo Grande	19	1,707	89	0.5
26. Pugaro	180	2,084	12	5.0
27. Salapingao	78	1,674	22	2.1
28. Salisay	172	1,230	7	4.8
29. Tambac	148	1,286	9	4.1
30. Tapuac	73	2,284	31	2.0
31. Tebeng	59	1,319	22	1.6
Total	3,615	110,853	31	100.0

3.3 POPULATION AND LIVING CONDITIONS

3.3.1 Population

In the 1980 National Census and Statistics Office (hereinafter referred to as NCSO) report, the total population of Dagupan City was 98,344 and the total number of households was 17,323, with an average of 6 persons per household.

In the seven census years, the highest rate of increase of the City's population was from 1939 to 1948, with an annual growth rate of 3.35; and the lowest was from 1903 to 1918, which reflects a rate of 0.65. The population had increased from 1975 to 1980 by 1.77%; or, in absolute terms to 8,252. Listed below are the population trends.

TABLE 3.3.1 POPULATION TREND OF DAGUPAN CITY

Year	Population	Annual Growth Rate (%)
1903	20,357	-
1918	22,441	0.65
1939	32,602	1.79
1948	43,838	3.35
1960	63,191	3.09
1970	83,582	2.84
1975	90,092	1.51
1980	98,344	1.77

Source: 1980 Census on Population and Households, NCSO

According to the population projection for 1980-2000 by the NEDA, the projected population for 1985 is 106,409.

The population density of the City has been estimated at 26.6 persons per hectare, based on an estimated population of 99,664 in 1981, and a land area of 3,740 ha. From the projections of the NEDA, the City had a population of 106,409 in 1985, with a population density of 28 persons per hectare.

The general characteristics of the population are listed in TABLE 3.3.2.

TABLE 3.3.2 GENERAL POPULATION CHARACTERISTICS [1/]

Classification	% of City Population
General Composition	
Urban	100
Rural	-
Sex Composition	
Male	49
Female	51
Age Composition	
0 - 14	41
15 - 64	55
65 and above	4
Education [2/]	
No grades completed	5
Elementary	40
High School	29
College	9
Academic Degree Holder	15
Not stated	2
Dialects	
Pangasinan	92
Ilocano	3
Tagalog	4
Others	1

3.3.2 Living Conditions

Physical indicators of the living standard of the City are listed in TABLE 3.3.3. These indicators include dwelling units, household facilities and utilities.

[1/] Source: 1980 Census on Population and Households, NCSO

[2/] For population 25 years and above.

TABLE 3.3.3 CLASSIFICATION OF HOUSEHOLDS BY TYPE OF FACILITIES (1980)

Item	% to Total Households	Item	% to Total Households
Water Facilities		Lighting Facilities	
Piped Water	35.6	Electricity	68.9
Artesian Well	27.8	Kerosene (Gas)	28.9
Pump Well	36.3	Oil	0.1
Open Well	0.2	Liquidated Petroleum Gas	1.8
Spring	0.1	Other	0.3
Toilet Facilities		Type of Dwelling Units	
Flush/Water Sealed	53.2	Single	92.2
Antipolo/Closed Pit	25.5	Duplex	1.8
Open Pit	5.0	Apartment/Accessories	2.9
Public Toilet	2.9	Barong-Barong	1.2
None	13.4	Others	1.9

Source: 1980 Census on Population and Households, NCSO

TABLE 3.3.4 shows the recorded morbidity and mortality cases due to water-borne diseases in the City.

TABLE 3.3.4 REPORTED MORBIDITY AND MORTALITY CASES DUE TO WATER-BORNE DISEASES PER 100,000 POPULATION (1979-1984)

Year	Morbidity		Mortality	
	Number	Rate(%)	Number	Rate(%)
5 year average	461	4.63	70	0.70
1979 - 1983	376	3.56	57	0.54

Source: City Health Office, Dagupan City, Pangasinan

3.4 SOCIO-ECONOMIC CONDITIONS

3.4.1 City Revenue

Revenues of the City are derived from taxation, incidental revenue, receipts from operation and other miscellaneous sources. Its revenue showed the increasing trend from 1980 to 1985. In 1981, it increased by ₱2.1 million, or 17% from 1980. In the following years, the increase was ₱3.1 million or 21% from 1981 to 1982, ₱1.0 million or 6% from 1982 to 1983, ₱1.3 million or 7% from 1983 to 1984, and ₱4.2 million or 20% from 1984 to 1985. The total revenue increase from 1980 to 1985 was ₱11.9 million or 94%. The following is a summary of revenue and expenditure for Dagupan City from 1980 to 1985.

TABLE 3.4.1 REVENUE AND EXPENDITURE OF DAGUPAN CITY

Year	Revenue	Expenditure	Surplus (Deficit)
1980	₱12,618,928	₱10,359,525	₱ 2,239,403
1981	14,780,683	13,745,583	1,035,100
1982	17,901,888	14,491,248	3,401,640
1983	18,950,656	20,843,955	(1,893,299)
1984	20,285,803	26,264,164	(5,978,361)
1985	24,494,074	25,929,254	(1,435,180)

3.4.2 Family Income

As of 1981, there are 38,346 workers in Dagupan, employed as follows: 17.5% sales workers, 15.40% farmers, fishermen, hunters, loggers and related workers, 13.80% services, sports and related workers, 9.19% workers in transport and communication, 8.66% craftsman, production process workers and related laborers, 8.61% administrative, executive and managerial workers, 5.75% professionals, 5.10% bricklayers, masonry and other construction workers, 0.28% miners, quarrymen and related workers, and 15.71% other unidentified occupations.

The monthly family income of the 38,346 workers as of 1981 is as following:

TABLE 3.4.2 FAMILY INCOME LEVEL OF DAGUPAN CITY

Income Bracket	%	No. of Workers
₱300 & below	27.32	10,476
301 - 500	26.83	10,288
501 - 880	20.86	7,999
881 & above	24.99	9,583
	100.00	38,346

3.4.3 Agriculture, Livestock Farming and Fisheries

Many people of Dagupan City depend on agriculture for livelihood. The land area devoted to agriculture is 581.5 ha. The main agricultural products of the City are rice, corn, coconuts and other minor products.

Fishing is also one of the major industries of Dagupan City and fishponds occupy 1,277.0 ha. These are strategically located along the estuaries and tributaries of the rivers making them profitable, especially for milkfish culture. Also, Lingayen Gulf is another major fishing ground of the people.

3.4.4 Commerce and Industry

As of 1985, there were 3,253 commercial establishments in the City constituting retail/wholesale business, manufacturing firms, financial, banking, insurance and real estate firms. A total of thirty-three (33) banks and financing institutions are found in Dagupan City. Private banks and financial institutions are predominant, with only 2 government controlled banks. TABLE 3.4.3 shows a summary of the above-mentioned establishments.

TABLE 3.4.3 COMPOSITION OF COMMERCIAL ESTABLISHMENTS

Type of Establishment	Number	%
Retail/Wholesale Business	1,918	58.96
Community, social, recreational and personal services	794	24.41
Financing, banking, insurance, real estate firms	273	8.39
Manufacturing firms	146	4.49
Fisheries	90	2.76
Contractors	31	0.96
Hog raisers	1	0.03
Total	3,253	100.00

3.4.5 Transportation and Communication

Dagupan City has 106.07 km of road way, of which 13.14 km are paved with concrete, 15.37 km with a high-grade type of asphalt, 46.42 km with gravel, 3,88 km are unsurfaced and the remaining represents the farm to market road.

There are four bus companies operating between Dagupan and Manila. The Philippine National Railways, the government railway entity, likewise serves the City. Mini-buses, jeepneys and tricycles are the common means of public transport within the City.

The telephone facility of Dagupan City is owned and operated by the PLDT. Mail and postal services are provided by the Bureau of Posts. Telegraph services are operated by two government-owned and five private institutions. There are also several branches of these private telegraph companies within the central business district for the convenience of their customers. Dagupan City has three private messengerial services which are all located along A.B. Fernandez Avenue.

The City has ten radio stations, one of which is owned by the government. There is no local television station in Dagupan and so TV Programs in Manila are transmitted via satellite.

Almost all kinds of newspapers and magazines are available in Dagupan, including three weekly publications of local news.

3.4.6 Power Supply

Electricity is distributed by the DECORP, which in turn gets its power from the NPC.

The electric charges per classification of consumers are given in APPENDIX 3.4.1.

Dagupan City's type of lighting are electricity 71.51%, kerosene 27.61%, candle 0.19% and others 0.69%. For cooking fuel, 49.44% of the total population uses firewood, 17.84% liquified petroleum gas, 9.43% kerosene, 9.29% charcoal, 5.35% sawdust, 3.06% electricity, 0.05% a combination of charcoal and sawdust, and 5.54% others.

3.5 CITY DEVELOPMENT PLAN

Dagupan City has been confronted with an ever increasing demand for developing urban infrastructures in response to the growth of population and economic activities. To meet the future urban development, the City Planning and Development Office established the proposed land use plan as shown in FIGURE 3.5.1. In this land use plan, the zoning and type of proposed land use are delineated to lead to a well balanced city development. The major targets in the city development are the establishment of appropriate flood control measures, improvement of water supply and traffic control in the core business district.

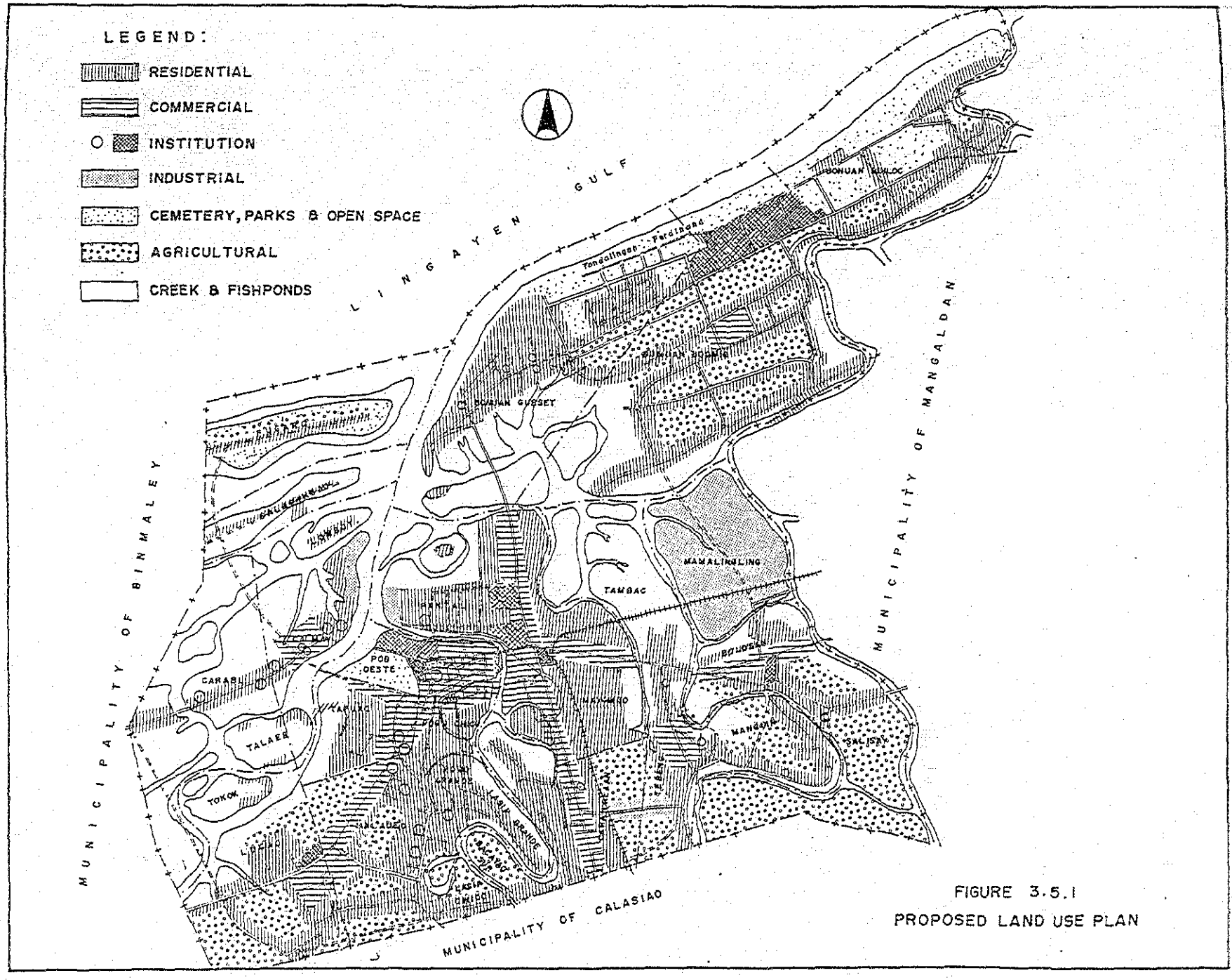


FIGURE 3.5.1
PROPOSED LAND USE PLAN

CHAPTER 4
EXISTING WATER SUPPLY AND SANITATION CONDITIONS

CHAPTER 4 EXISTING WATER SUPPLY AND SANITATION CONDITIONS

4.1 PRESENT WATER SUPPLY IN THE CITY

The present water supply in Dagupan City maybe categorized as follows:

(1) Waterworks (Level III)
- Dagupan City Waterworks System Administration (DAWASA)
- Barangay Carael Waterworks (BWP)

(2) Communal Water Supply (Level II)
- Barangay Bonuan Boquig communal water supply system (BWP)
- Barangay Calmay " (")
- Barangay Manguin " (")

(3) Private and point source water supply system (Level I)
- Privately-owned well with hand pump or motor driven pump
- Public well with hand pump

As of 1980, approximately 23.97% of the total population of 98,344 was catered by the DAWASA through the registered service connections. The rest of the population obtained their drinking water as follows:

- 56.64% by artesian well,
- 14.05% by piped water supply outside the house,
- 2.77% by privately-owned well,
- 2.24% by communal faucet,
- 0.44% by rainwater,
- 1.46% by purchased or rationed water, and
- 0.49% by other means not stated above.

Note: Total percentage exceeds 100% due to overlapping answers as to the source of water.

Source: Socio-Economic Profile, City Planning and Development Office, Dagupan City, 1980.

Among the above-mentioned different levels of water supply systems in Dagupan City, the main waterworks is the DAWASA, which has been managed by the City since its inauguration in the 1930's.

The DAWASA is simply utilizing groundwater as its source and is operating 15 deep wells. The total number of service connections as of October 1985 reached 4,299 of which 3,070 were domestic, 1,194 were commercial and the remaining 35 were public faucets. These connections were widely spreaded over 14 barangays in the city proper out of the 31 barangays in the City's administrative jurisdiction. Meter reading during this period registered a volume of 108,236 cu.m/month covering some 24,241 persons which was 22% of the estimated total population of 110,853 in the City.

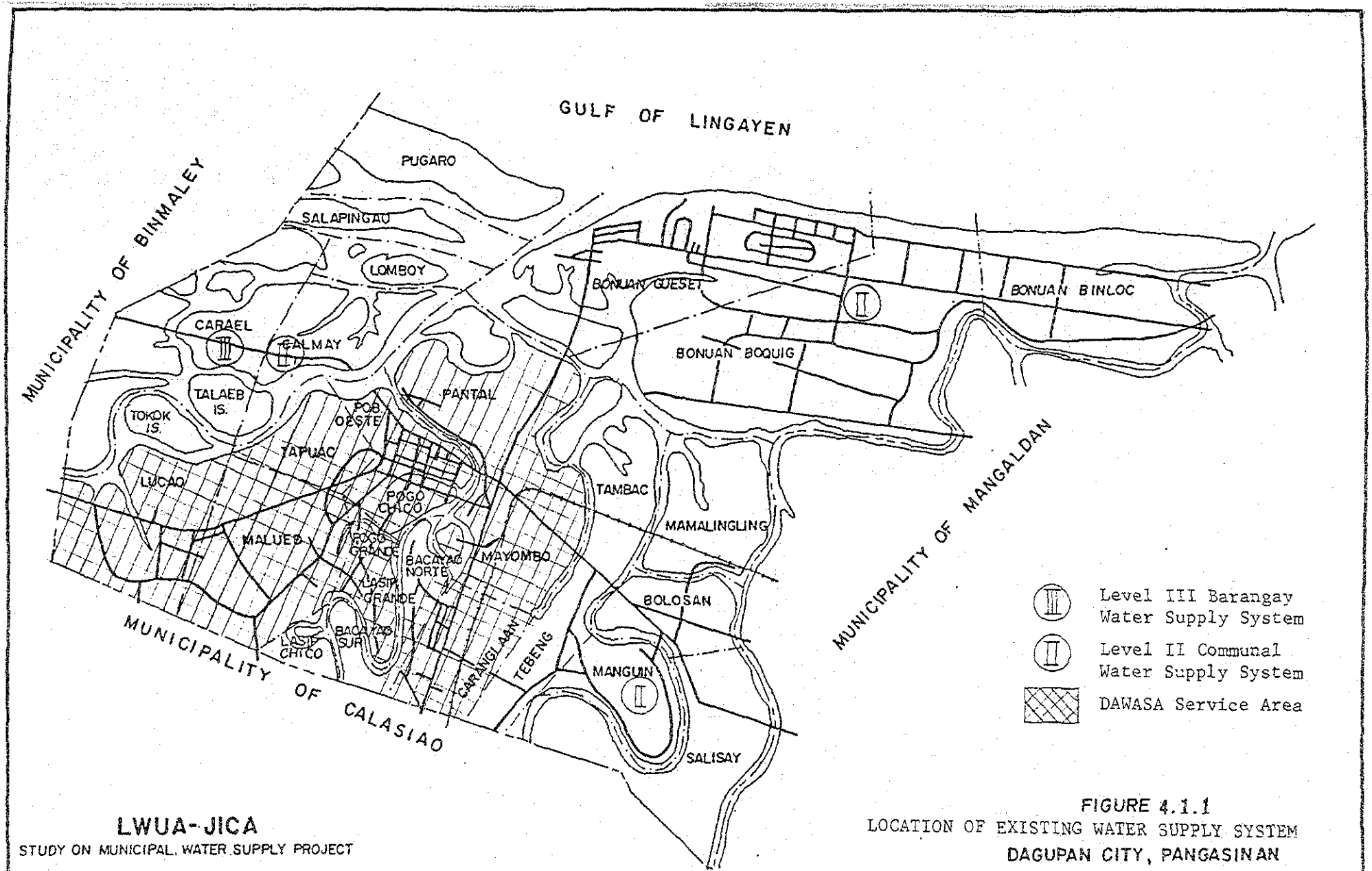
Aside from the above 14 barangays covered by the DAWASA, 4 barangays are receiving water from the BWP; Barangay Carael with a Level III system and Barangays Bonuan Boquig, Calmay and Manguin, a Level II system. The CITY WATER RESOURCE INVENTORY CY-1986 prepared by the City Planning and Development Office reported that of the total 248 existing deep wells, only 205 or 83% are functioning. FIGURE 4.1.1 presents the location of the existing Level II and Level III systems.

4.2 WATER SUPPLY FACILITIES BY DIFFERENT LEVEL OF SERVICE

4.2.1 Level I System

Of the total 31 barangays of Dagupan City, 25 barangays have 205 functioning deepwells. TABLE 4.2.1 presents a list of these water sources.

Aside from those listed, there are a large number of privately-owned shallow wells. Most of them are equipped with jetmatic or pitcher pumps, while some are rigged with motor pumps for in-house service.



LWUA-JICA
STUDY ON MUNICIPAL WATER SUPPLY PROJECT

FIGURE 4.1.1
LOCATION OF EXISTING WATER SUPPLY SYSTEM
DAGUPAN CITY, PANGASINAN

TABLE 4.2.1 EXISTING LEVEL I SYSTEM IN DAGUPAN CITY

	Name of Barangay	No. of Deep Wells	Functioning
1.	Bacayao Norte	7	4
2.	Bacayao Sur	9	7
3.	Bolosan	27	24
4.	Bonuan Binloc	9	7
5.	Bonuan Boquig	15	13
6.	Bonuan Guesset	16	10
7.	Calmay	6	3
8.	Carael	3	3
9.	Caranglaan	10	9
10.	Herrero-Perez	3	2
11.	Lasip Chico	6	6
12.	Lasip Grande	7	7
13.	Lucao	12	8
14.	Malued	8	8
15.	Mamalingling	8	6
16.	Manguin	22	20
17.	Mayambo	10	8
18.	Pantal	11	11
19.	Pogo Chico	4	4
20.	Pogo Grande	5	2
21.	Pugaro-Suit	1	1
22.	Salapingao	2	2
23.	Salisay	16	12
24.	Tambac	11	10
25.	Tapuac	1	0
26.	Tebeng	19	18
	TOTAL	248	205

4.2.2 Level II System

Presently, there are 3 Level II systems in Barangays Bonuan Boquig, Calmay and Manguin, all of which have been constructed under the aforementioned BWP. Water sources of these systems are deep wells and elevated water tanks are installed for each system. The depth of the deep wells ranges from about 50 m in Manguin to about 200 m in Calmay. Service population is about 200 persons in Manguin, 350 persons each in Calmay and Bonuan Boquig.

4.2.3 Level III System (Dagupan City Water works System)

(1) Water Source and Treatment

The DAWASA has 15 operating deep wells, each of which is equipped with a bore-hole type electric motor-driven turbine pump. Groundwater pumped from these water sources is directly transmitted into a distribution network without any water treatment or chlorination. The inventory of these wells is given in TABLE 4.2.2. A typical feature of a deep well is given in APPENDIX 4.2.1.

The discharge rate and pump efficiency of the existing deep well pumping stations were examined. TABLE 4.2.3 shows the discharge rate of 15 pumping stations. Location of these pumping stations are shown in FIGURE 4.2.1. The total present production of the existing wells in the system is about 9,640 cu.m/day as obtained through field measurements. It was confirmed that the total rated capacity of the existing pumps is almost equal to the estimation based on the measurement result. However, a considerable difference among the two figures (rated and measured) were observed at some pumps with a maximum of 60%. Six (6) out of the total 15 pumps were measured to have smaller capacity by more than 20% in comparison to the rated capacity (Pump Nos. 5, 6, 8, 11, 12 and 16). Of these pumps, Pump Nos. 5 and 15 maybe caused by improper repair works. Details are given in APPENDIX 4.2.2.

Due to the small capacity and low water pressure of the existing pumps, there seems to be no considerable influence to the non-operating pumps by the operating pumps. The water supplied by the two pumping stations (Nos. 2 and 4) during night time may satisfy the minimum requirement of the total system.

Pumping efficiency test was conducted at No. 10 pumping station. Details are given in APPENDIX 4.2.2. The performance curves which is developed based on the measurement result, show the maximum efficiency of 42.10% at the discharge capacity of 7.32 liter/sec (632 cu.m/day) and with a total dynamic head (TDH) of 21.9 m (see FIGURE 4.2.2). During the measurement period conducted on July 31, 1986, the pump was operated at an efficiency

TABLE 4.2.2 EXISTING WATER SOURCES OF DAWASA

PS NO.	Pumping Station	Depth of Well (M)	Casing Diameter (MM)	Power of Motor (HP)	Esti-mated Cap.(CMD)	Year of Construc-tion
# 1	Galvan	117	150	10	540	N.D.A**
2	Magsaysay	195	250	25	1,370	N.D.A.
3	Rizal (A.B. Fernandez-East)	183	250	20	1,370	1952
4	T. Bugallon (Old)	189	250	30	1,320	N.D.A.
5	Burgos	195	300	15	540	1960
6	Perez	192	*150-91.5m; 100-104 m	10	1,090	1978
7	Malued	165	150	10	540	1967
8	Pantal (Noble)	192	*150-140 m; 100-104 m	10	540	1974
9	Caranglaan	177	150	10		
10	Arellano	192	*150-91 m; 100-104 m	10	540 540	1974 1971
11	Lasip Chico	189	*150-76 m; 100-116 m	10	540	1972
12	Tapuac	192	*150-76 m; 100-119 m	10	540	1973
13	Tondaligan	A b a n d o n e d				1976
14	Patalan	192	*150-104 m; 100-91 m	10	540	1970
15	Green Field	204	*150-104 m; 100-104 m	10	540	1977
16	A.B. Fernandez West	192	*200-91 m: 150-104 m	25	1,320	1980
17	Bonuan	A b a n d o n e d				

* : Telescopic Casing ** : No Data Available

TABLE 4.2.3 DISCHARGE RATE OF 15 PUMPING STATIONS

Pump Station No.	Measurement Result (cu.m/hr)	Pump Capacity (1) JICA (cu.m/day)	(2) Rated (cu.m/day)	(1) (2) (%)	Present Water Production Operation Hours (hr)	Discharge Rate (cu.m/day)	Electric Consumption (KWH/hr)	Power of Motor
1	23	552	540	102	18	414	4.29	10
2	62	1,488	1,370	107	24	1,488	-	25
3	76	1,824	1,370	133	20	1,520	17.02	20
4	63	1,512	1,320	115	24	1,512	14.93	30
5	19	456	540	84	18	342	-	15
6	19	456	1,090	42	18	342	6.00	10
7	31	744	540	136	18	558	6.09	10
8	19	456	540	84	18	342	3.47	10
9	25	600	540	111	18	450	2.00	10
10	25	600	540	111	18	450	4.43	10
11	18	432	540	80	18	324	4.21	10
12	18	432	540	80	18	324	17.03	10
14	24	576	540	107	18	432	6.42	10
15	28	672	540	124	18	504	5.65	10
16	40	960	1,320	73	16	640	10.89	25
TOTAL	490	11,760	11,870	99	-	9,642	-	-

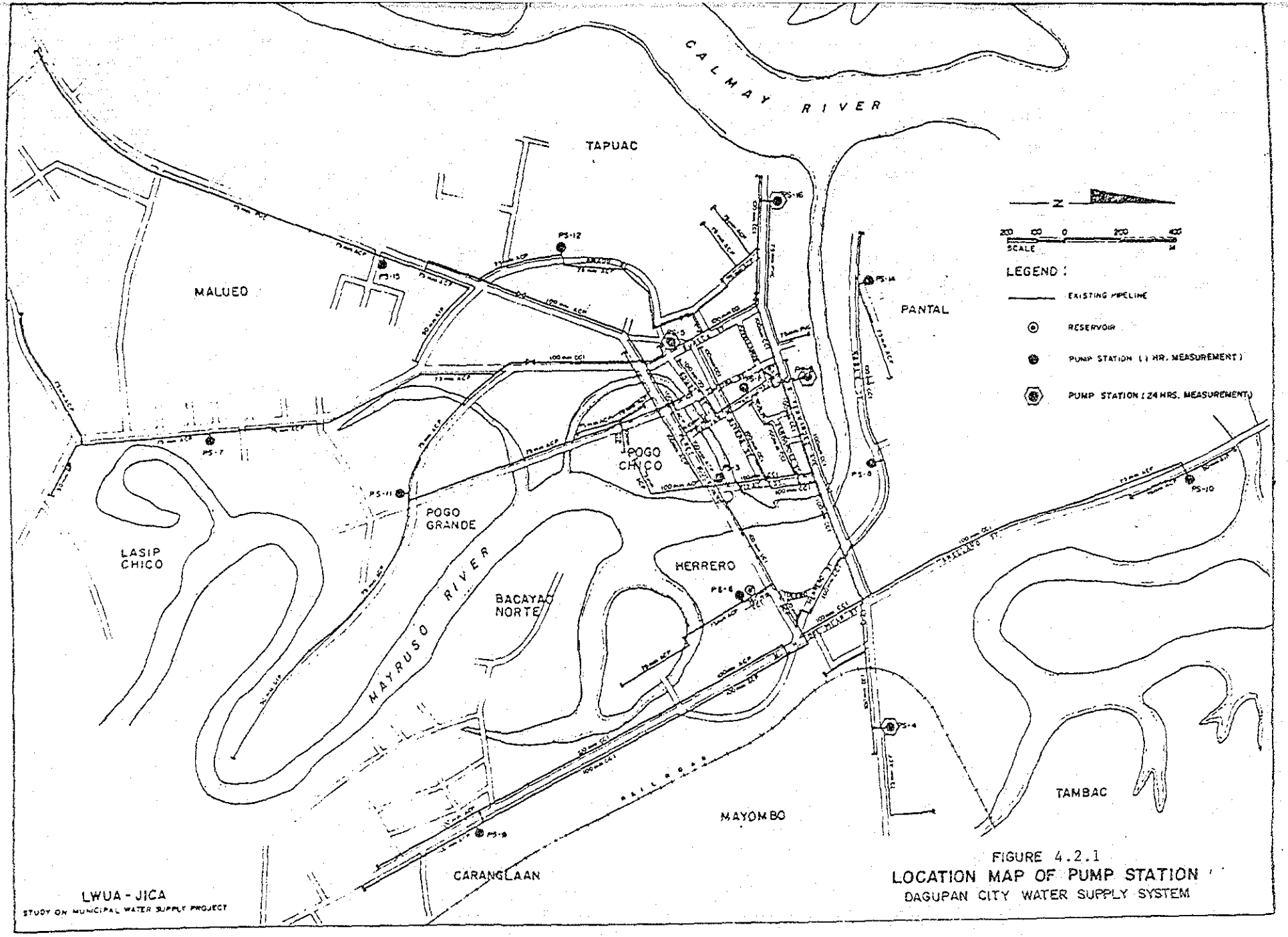


FIGURE 4.2.1
LOCATION MAP OF PUMP STATION
DAGUPAN CITY WATER SUPPLY SYSTEM

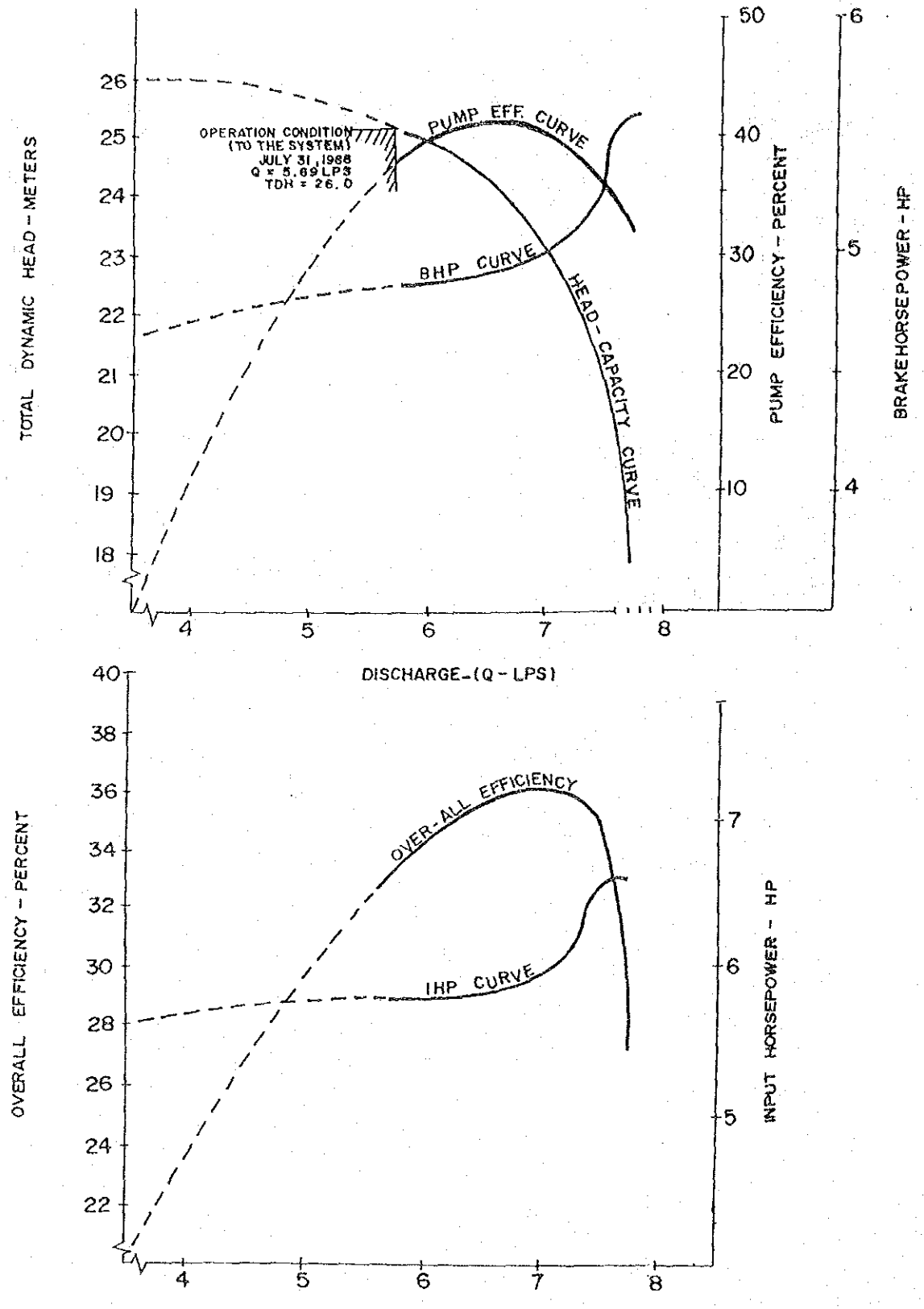


FIGURE 4.2.2
PERFORMANCE CURVES OF
PUMP STATION NO. 10

of 41.0% with a discharge rate of 5.69 liter/sec (491.6 cu.m/day) and with a TDH of 25.2 m. The low efficiency of the pump is due to its age, mechanical defects and inadequate maintenance of the pump.

(2) Transmission and Distribution

a) Storage Facility

The DAWASA has two functional concrete-made storage tanks with capacities of 398 cu.m and 197 cu.m. However, these are not in use due to insufficient water pressure from the pump to the tank. A typical feature of the storage tank is shown in FIGURE 4.2.3 and the dimensions of these tanks are given in TABLE 4.2.4.

TABLE 4.2.4 DIMENSIONS OF STORAGE TANKS

	Tank #1	Tank #2
Location	City Hall Compound	Perez Public Market
Height	30 m	24 m
Diameter	9 m	7.5 m
Capacity	398 cu.m	197 cu.m
Major Connection	ϕ 150 mm GIP	ϕ 100 mm GIP

b) Distribution Facilities

As indicated in FIGURE 4.2.1, the existing water supply system of Dagupan City is based on the direct distribution of water from each water source. In this regard, it is not practical to specify a given pipe as being connected to a certain pump.

The distribution network of DAWASA presently covers 14 barangays in the city proper, with a total length of 25,290 m (ϕ50 mm and over). The configuration of the distribution network is shown in TABLE 4.2.5.

TABLE 4.2.5 CONFIGURATION OF DISTRIBUTION NETWORK

Diameter (mm)	Material	Length (m)
150	CCI	800
100	CCI	8,720
100	ACP	4,470
75	ACP	8,960
75	PVC	1,140
50	GIP	1,200
TOTAL		25,290

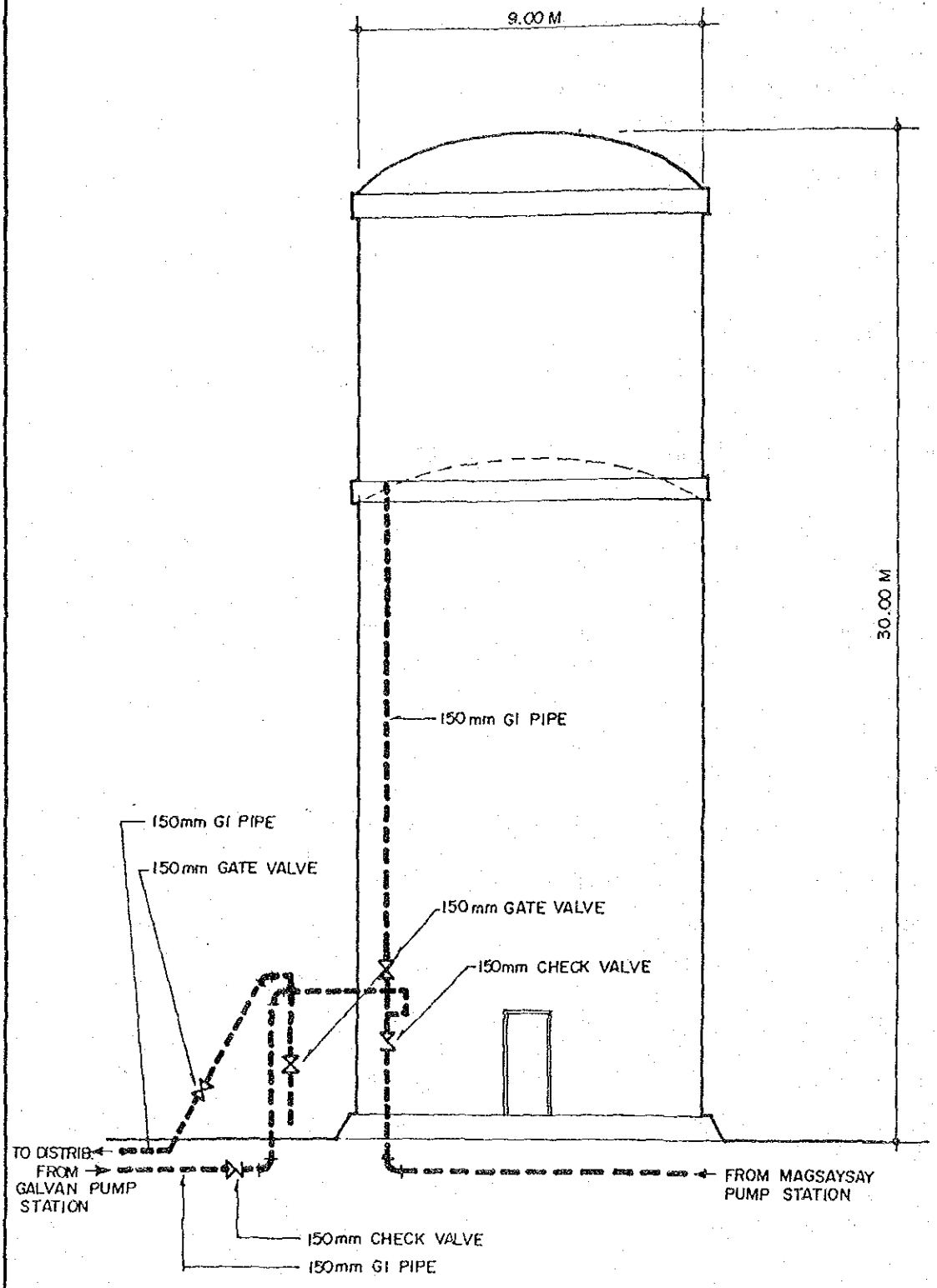


FIGURE - 4.2.3
398 m^3 STORAGE TANK
DAGUPAN CITY

Since the inauguration of the Dagupan City Waterworks System in the 1930's, water sources (deep wells) and distribution lines have been expanded continuously corresponding to the increase of water demand. In this connections, the existing distribution facilities have a variety of pipe materials, sizes and years of construction.

Water pressure status of the distribution system throughout the day was investigated at the thirty-eight (38) measuring points including 15 pumping stations (see APPENDIX 4.2.3).

The test results showed that the pressures in the distribution network ranges from 0 to 2.2 kg/sq.cm. FIGUREs 4.2.4 and 4.2.5 show the system pressure contours during the peak hour and minimum demand periods throughout the day. The water pressure in the distribution network during the peak hour demand period ranges from 0.0 kg/sq.cm to 1.4 kg/sq.cm while for the minimum demand period, the water pressure ranges from 0.3 kg/sq.cm to 2.2 kg/sq.cm.

Reasons for the low pressures in the said areas are the excessive demand due to leakage and wastage and the generally insufficient pump capacity. Improvement/augmentation of the pumps and distribution facilities are urgent requirements.

Minimum demand period is usually between the hours of 9:00 P.M. to 11:00 P.M. The peak hour demand period is from 6:00 A.M. to 11:00 A.M.

In addition, two (2) maps of pressure contours are also prepared based on the records at 7:00 A.M. and 9:00 P.M. which represent the peak hour demand period and minimum demand period, respectively (see FIGUREs 4.2.6 and 4.2.7).

The pressure contours are presented in FIGUREs 4.2.4 to 4.2.7.

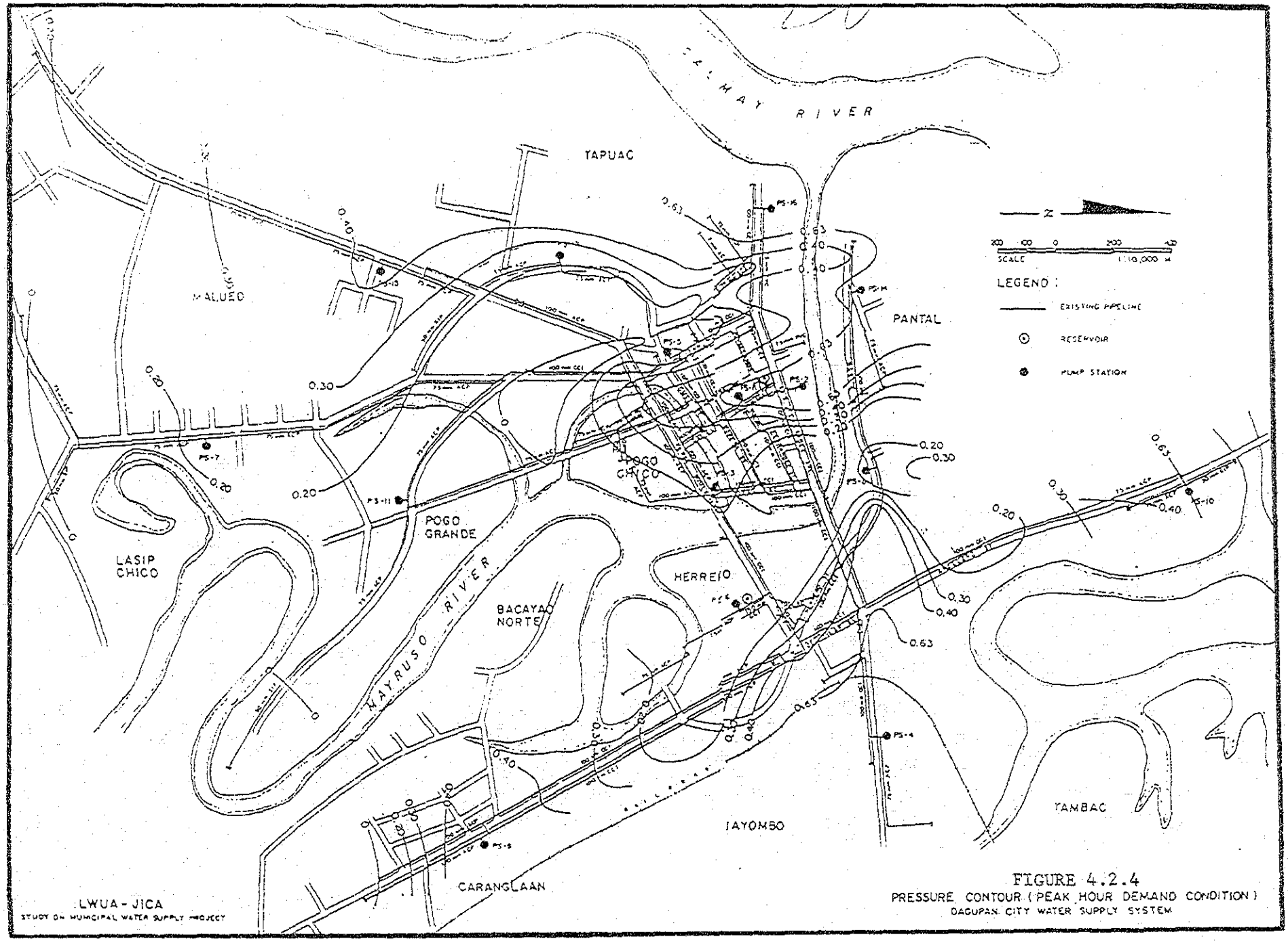


FIGURE 4.2.4
PRESSURE CONTOUR (PEAK HOUR DEMAND CONDITION)
DAGUPAN CITY WATER SUPPLY SYSTEM

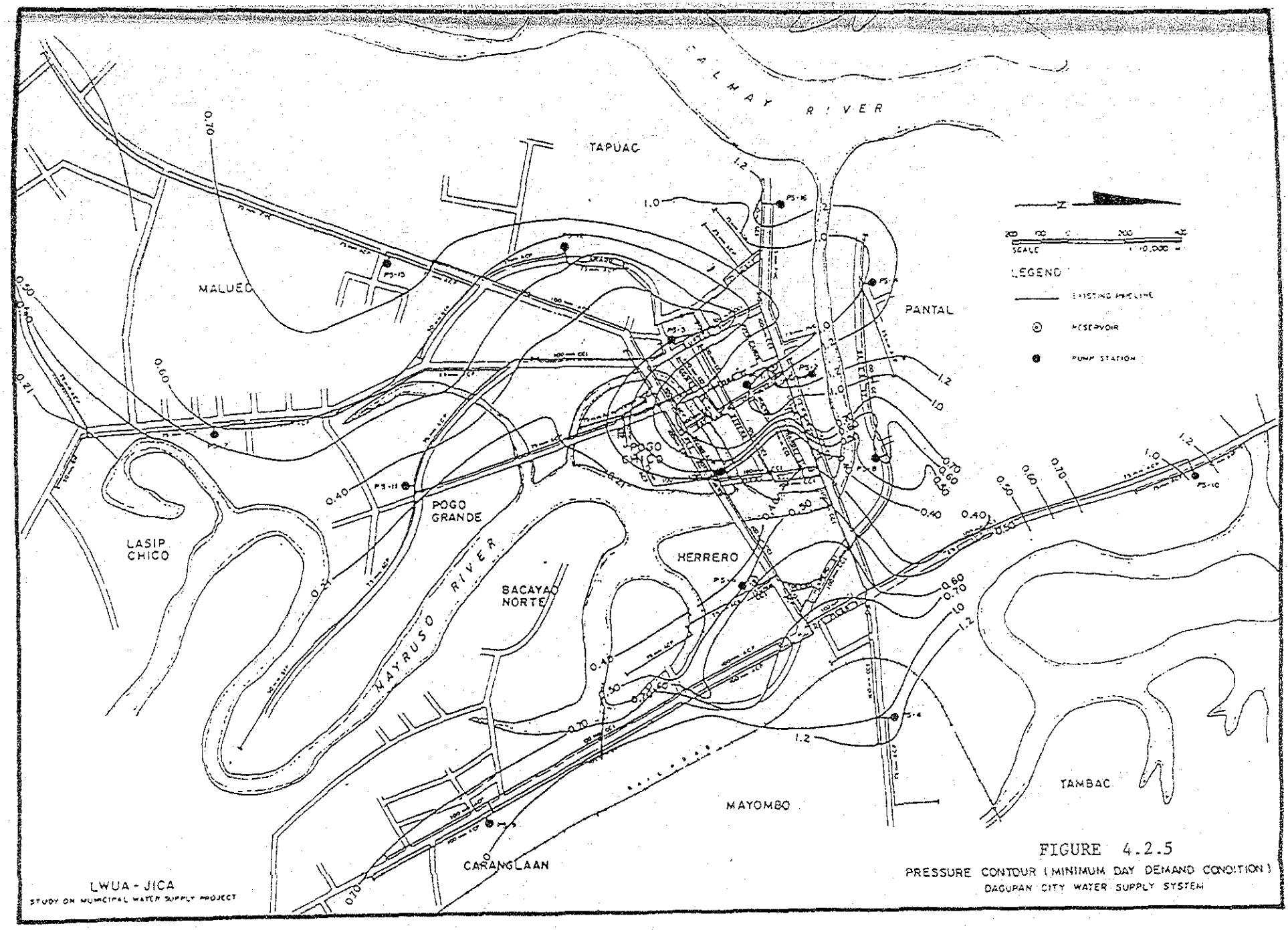


FIGURE 4.2.5

PRESSURE CONTOUR (MINIMUM DAY DEMAND CONDITION)

DAGUPAN CITY WATER SUPPLY SYSTEM

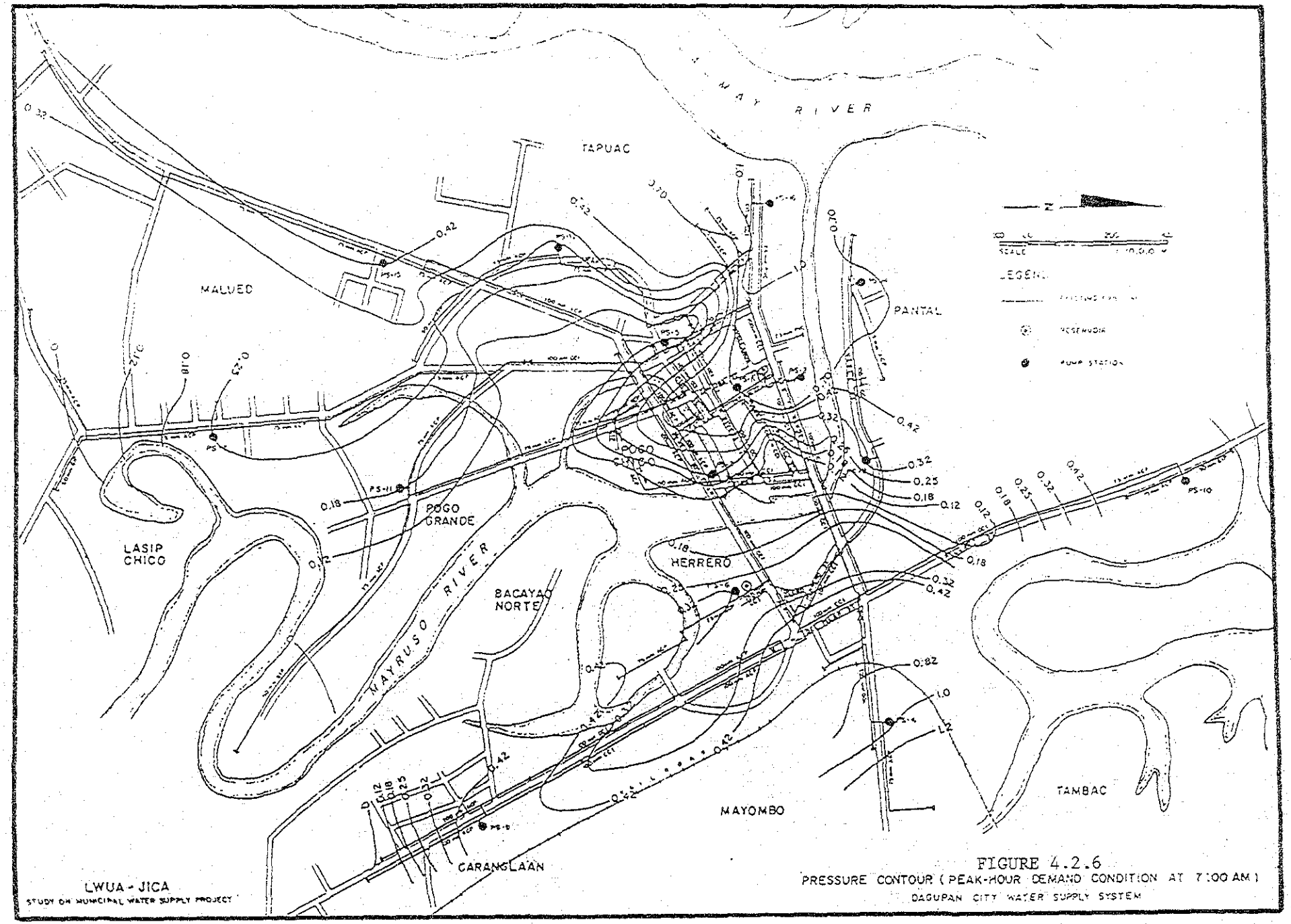
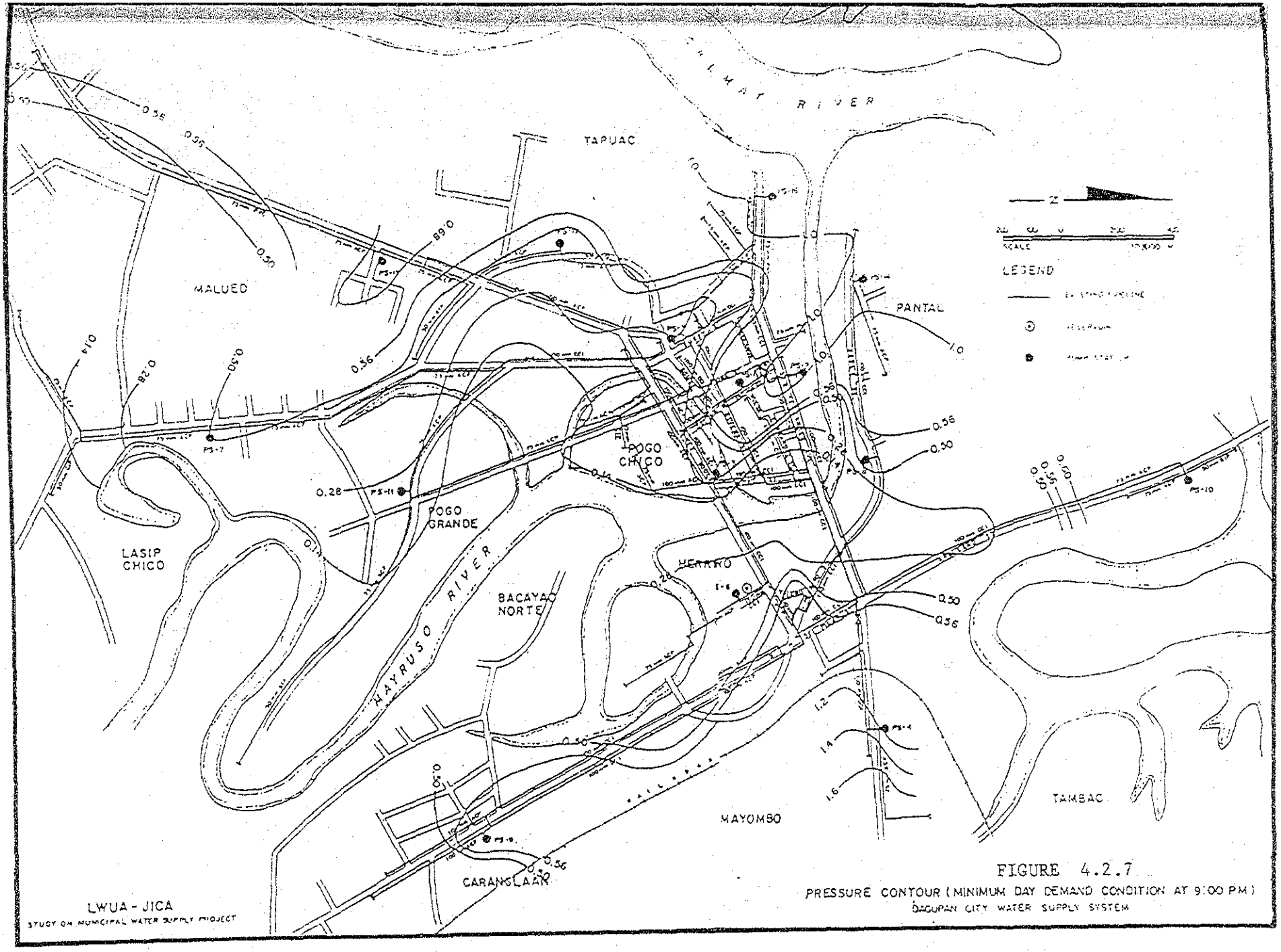


FIGURE 4.2.6
PRESSURE CONTOUR (PEAK-HOUR DEMAND CONDITION AT 7:00 AM)
DAGUPAN CITY WATER SUPPLY SYSTEM



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STUDY ON MUNICIPAL WATER SUPPLY PROJECT

FIGURE 4.2.7
PRESSURE CONTOUR (MINIMUM DAY DEMAND CONDITION AT 9:00 PM)
DAGUPAN CITY WATER SUPPLY SYSTEM

(3) Discussions and Conclusions

The topography of the study area is predominantly flat. There are fifteen pumping stations operating in the study area, but only two (2) of them, namely, Nos. 2 and 4, are operated for 24 hours, and the rest are operated for 18 hours a day from 4:00 A.M. to 10:00 P.M.

Based on the pressure contour figures, the pressures at the service area, especially the areas located in the southern and southeastern sections of the City are generally low. Better conditions prevail in the northern, northwestern and northeastern areas which cover the barangays of Pantal, Poblacion Oeste and some parts of A.B. Fernandez East. In some barangays, only a limited area located in the vicinity of the pumping station receives quite a high pressure throughout the day.

4.3 WATER PRODUCTION

The total amount of production from the 15 existing wells equipped with pump facilities was estimated at 11,760 cu.m/day when all the pumps are operated the whole day. The amount is almost equal to the total rated capacity of each pump.

However, a total of 9,640 cu.m/day is produced at present in accordance with the operation schedule of each pump. TABLE 4.3.1 shows the measured pump discharge rate of each pumping station and their rated capacity.

It is worthwhile to note that three wells (Nos. 6, 10 and 14), out of the 15 existing wells, from two wells are affected by salt water intrusion. In addition, the color of water (Nos. 12 and 16) exceeds the standard for drinking purposes with values of 20 and 30 unit. Considering these situations, the total possible production amount is 7,580 cu.m/day excluding the above-mentioned five wells.

TABLE 4.3.1 PUMP DISCHARGE RATE AND RATED CAPACITY

Pump Station No.	Rated Capacity (cu.m/day)	Result of Field Measurement				
		Operation Time (hr)	Discharge Rate Measured (cu.m/hr)	Distributed Water Amount (cu.m/day)	Pump Capacity Estimated (2) (cu.m/day)	(1)/(2) (%)
1	540	18	23	414	552	102
2	1,370	24	62	1,488	1,488	107
3	1,370	20	76	1,520	1,824	133
4	1,320	24	63	1,512	1,512	115
5	540	18	19	342	456	84
6	1,090	18	19	342	456	42
7	540	18	31	558	744	138
8	540	18	19	342	456	84
9	540	18	25	450	600	111
10	540	18	18	450	600	111
11	540	18	18	324	432	80
12	540	18	18	324	432	80
14	540	18	24	432	576	107
15	540	18	28	504	672	124
16	1,320	16	40	640	960	73
TOTAL	11,870	-	483	9,642	11,760	99

4.4 WATER CONSUMPTION

4.4.1 Unit Water Consumption by Consumer Type

(1) Number of Connections by Consumer Type

The concessionaires in the system are categorized into four types as shown in TABLE 4.4.1. All house connections (domestic) and commercial connections are metered, while all public faucets and some of the institutional connections are unmetered. Metered connections are further categorized into functioning and not-functioning ones as summarized in TABLE 4.4.1. TABLE 4.4.2 shows the connections by barangay including all information mentioned above.

TABLE 4.4.1 NUMBER OF CONNECTIONS (METERED AND UNMETERED)

Type of Consumer	Metered				
	Functioning	Not-Functioning	Sub-Total	Unmetered	Total
Domestic	1,969	1,091	3,060	0	3,060
commercial	823	301	1,124	0	1,124
Public Faucet	0	2	0	38	40
Institutional	10	9	19	7	26
Total	2,802	1,403	4,203	45	4,250

1) Domestic Connections

Although all house connections are metered, approximately 36% of the total is not functioning as shown in TABLE 4.4.1. With regard to the served population with house connections, the result of the field interviews revealed that secondary users and borrowers are negligible. Therefore, the served population and the number of connections by functioning and not-functioning category were calculated using a predetermined average number of persons per household (5.64). The average per capita water consumption estimated from the served population and reported water consumption of the functioning metered connections may be considered as the representative figure at present.

Water consumption reported for the not-functioning metered connections was estimated using the data obtained before the meter broke down. The average per capita consumption for this category was also calculated for reference purposes. TABLE 4.4.3 presents the estimated population served and per capita water consumption by barangay.

TABLE 4.4.2 NUMBER OF CONNECTIONS BY CONSUMER TYPE BY EACH BARANGAY

Type of Consumer / Name of Barangay	Domestic connection			Commercial Connections			Public Faucet				Institutional Connections			
							Metered		Unmetered		Metered			
	Total	Functioning	Not Functioning	Total	Functioning	Not Functioning	Total	Not Functioning	Flat Rate	Free of Charge	Total	Functioning	Not Functioning	Unmetered
Barangay I	19	9	10	179	126	53	5	0	2	3	1	1	0	0
Barangay II & III	402	225	177	82	62	20	2	0	1	1	4	3	1	0
Barangay IV	627	397	230	233	164	69	1	0	0	1	3	1	0	2
Caranglaan	146	93	53	18	13	5	0	0	0	0	1	0	0	1
Herrero	215	138	77	137	106	31	4	0	1	3	3	2	0	1
Lasip Grande	64	38	26	2	0	2	0	0	0	0	1	0	1	0
Lucao	22	18	4	1	1	0	0	0	0	0	0	0	0	0
Malued	367	262	105	17	17	0	0	0	0	0	1	0	0	1
Mayambo	145	90	55	75	48	27	1	0	0	1	0	0	0	0
Pantal	420	278	142	250	183	67	16	1	2	13	3	1	1	1
Pob. Oeste	197	115	82	15	12	3	8	1	5	2	8	2	5	1
Pogo	100	79	21	1	1	0	2	0	0	2	1	0	1	0
Tapuac	336	227	109	114	90	24	1	0	0	1	0	0	0	0
Total	3,060	1,969	1,091	1,124	823	301	40	2	11	27	26	10	9	7

TABLE 4.4.3 SERVED POPULATION AND PER CAPITA WATER CONSUMPTION

Barangay	Served Population			Water Consumption			Unit Water Consumption		
							Functioning		Not-Functioning
	Functioning	Not-Functioning	Total	Not-Functioning (cu.m/day)	Functioning (cu.m/day)	Total (cu.m/day)	Per Capita (lpcd)	Per Conn. (cu.m/day)	Per Capita (lpcd)
Barangay I	51	56	107	10.9	2.8	13.7	214	1.21	49
Barangay II & III	1,269	998	2,267	157.7	91.5	249.2	124	0.70	92
Barangay IV	2,239	1,297	3,536	278.1	113.9	392.0	124	0.70	87
Caranglaan	525	299	824	63.9	31.4	95.3	122	0.69	105
Herrero	778	434	1,212	115.3	46.7	162.0	148	0.84	107
Lasip Grande	214	147	361	15.3	9.3	24.6	71	0.40	63
Lucao	102	23	125	8.8	3.1	11.9	87	0.49	136
Malued	1,478	592	2,070	135.0	46.6	181.6	91	0.52	79
Mayambo	508	310	818	79.9	30.7	110.6	157	0.89	99
Pantal	1,568	801	2,369	220.5	93.5	314.0	141	0.79	117
Pob. Oeste	649	462	1,111	105.3	64.9	170.2	162	0.92	140
Pogo Chico & Grande	446	118	564	40.1	7.9	48.0	90	0.51	66
Tapuac	1,280	615	1,895	179.0	63.1	242.1	140	0.79	103
Total	11,107	6,152	17,259	1,409.8	605.4	2,015.2	127	0.72	98

The City's average per capita water consumption for the functioning and not-functioning metered connections were estimated at 127 lpcd (0.72 cu.m/conn.day) and 98 lpcd, respectively. The average of the two categories was calculated at 117 lpcd. For the barangay level, the consumption seems to be affected by the water pressure of the system which ranges from 71 to 214 lpcd.

2) Commercial Connections

Approximately 27% of the total connections is not functioning. TABLE 4.4.4 shows the unit water consumption by functioning and not-functioning connection. The water consumption by functioning and not-functioning connections are 1.19 and 0.88 cu.m/conn.day, respectively with an average of 1.11 cu.m/conn.day.

3) Public Faucet

There is no available record on the water consumption by the existing public faucets. Of the total 40 faucets in the system, only two are metered, however, these are defective. The water consumption and population served by faucets were investigated and surveyed. The number of household and served population by faucets are given in TABLE 4.4.5. It was found out that one of the faucets in barangay Pantal is being utilized by the people from nearby island. This faucet serves estimated 3,530 inhabitants of the island or approximately 76% of the island's total population.

TABLE 4.4.4 COMMERCIAL UNIT WATER CONSUMPTION

Barangay	Number of Connection			Water Consumption (cu.m/day)			Unit Consumption (cu.m/conn.day)	
	Functioning	Not-Functioning	Total	Functioning	Not-Functioning	Total	Functioning	Not-Functioning
Barangay I	126	53	179	170.0	15.8	185.8	1.35	0.30
Barangay II & III	62	20	82	77.2	15.2	92.4	1.25	0.76
Barangay IV	164	69	233	170.4	62.4	232.8	1.04	0.90
Caranglaan	13	5	18	12.5	10.5	23.0	0.97	2.09
Herrero	106	31	137	90.5	19.9	110.4	0.85	0.64
Lasip Grande	0	2	2	-	0.2	0.2	-	0.10
Lucao	1	0	1	3.2	-	3.2	3.16	-
Malued	17	0	17	5.1	-	5.1	0.30	-
Mayambo	48	27	75	46.4	23.5	69.9	0.97	0.87
Pantal	183	67	250	281.2	100.1	381.3	1.54	1.49
Pob. Oeste	12	3	15	15.3	3.6	18.9	1.28	1.20
Pogo Chico & Grande	1	0	1	0.5	-	0.5	0.48	-
Tapuac	90	24	114	108.3	12.3	120.6	1.20	0.51
Total	823	301	1,124	980.6	263.5	1,244.1	1.19	0.88

TABLE 4.4.5 POPULATION SERVED BY PUBLIC FAUCETS

Barangay	No. of Public Faucets	No. of HHs Served	Served Population
Barangay I	5	108	609
Barangay II & III	2	75	423
Barangay IV	1	10	56
Herrero	4	79	446
Mayambo	1	40	226
Pantal	16	443	2,499
	(1,096)	(1,069)	
Pob. Oeste	8	221	1,246
Pogo	2	66	372
Tapuac	1	52	293
Total	40	1,094	6,170
	(1,720)	(9,700)	

Note: Figures in parentheses include those of the nearby island.

The average number of households and served population per public faucet are 27 and 154 persons, respectively excluding the served population of the island.

Water consumption at the public faucet was measured using a water meter. A total of eight faucets were selected for this purpose. Two representative faucets by different number of household served, i.e., more than 41, 31-40, 21-30 and less than 20 households were covered. Water pressure measurement at the selected points were also conducted to support the measurement of water consumption using automatic pressure recorder.

The measurement of water consumption per faucet were categorized into three groups with reference to the water pressure and consumption. TABLE 4.4.6 summarizes the per capita water consumption by category.

TABLE 4.4.6 PER CAPITA WATER CONSUMPTION BY CATEGORY

Group	Description	Per Capita Consumption (lpcd)	Barangay
A	Comparatively high water pressure and higher consumption	60	Pantal, Herrero and Pob. Oeste
B	Water pressure is almost same as that of Group A, but less water consumption	50	Bgy. I, II, III & Tapuac and Mayambo
C	Low water pressure and the least water consumption	20	Pogo and nearby island

4) Institutional Connections

There are 19 metered connections (10 functioning and 9 not-functioning) and 7 unmetered connections. TABLE 4.4.7 shows the composition of institutional connection.

TABLE 4.4.7 COMPOSITION OF INSTITUTIONAL BUILDINGS

Type of User	Metered			Non-Metered	Total
	Functioning	Not-Functioning	Sub-Total		
Government Office	2	4	6	0	6
School	5	4*	9	7	16
Hospital	3	1	4	0	4
Total	10	9	19	7	26

Note: Two have no available data on water consumption.

Since there are no available data on the water consumption for the schools, including the two schools with not-functioning meters and the 7 schools without meter, the field measurements were conducted after the selection of the two schools. An average consumption of 2.2 cu.m/conn.day was obtained.

The average unit water consumption using the recorded water consumption and number of connections (a total of 17 connections) was

calculated at 7.0 cu.m/conn.day, while 9.0 cu.m/conn.day, and 4.2 cu.m/conn.day are for functioning and not-functioning meters, respectively.

Considering the field measurement results, the average water consumption was recomputed as 6.5 cu.m/conn.day.

TABLE 4.4.8 UNIT WATER CONSUMPTION

Type of User	Water Consumption (cu.m/day)			Unit Water Consumption (cu.m/conn.day)		
	Functioning	Not-Functioning	Total	Functioning	Not-Functioning	Average
Government Office	13.5	4.4	17.9	6.8	1.1	3.0
School	12.8	20.5	33.3	2.6	10.3	4.3
Hospital	63.4	4.3	67.7	21.1	4.3	16.9
Total	89.7	29.2	118.9	9.0	4.2	7.0

4.4.2 Total Water Consumption

The total water consumption was estimated based on the afore-mentioned study of the service connections, served population and unit water consumption by consumer type.

The following are the methods used in the calculation.

a) Domestic Consumption (House Connections)

The average per capita consumption of the functioning metered connections of 127 lpcd was applied to the not-functioning metered connections. The served population is obtained from the number of connections and average persons per household.

b) Commercial Consumption

The average consumption per connection of the functioning metered connections of 1.19 cu.m/day was used for all connections.

c) Public Faucet

The average per capita consumption by the size of served population per faucet was used. The served population was obtained from the interview result.

d) Institutional Consumption

The average water consumption of the functioning metered connections and the result of measurement at the two schools were used.

TABLE 4.4.9 shows the computed total water consumption by consumer type.

TABLE 4.4.9 TOTAL WATER CONSUMPTION

	Unit Water Consumption		No. of Population Served	No. of Connections	Total Water Consumption (cu.m/day)
	lpcd	cu.m/conn.day			
Domestic	127	0.72	17,258	3,060	2,192
Commercial	-	1.19	-	1,124	1,338
Public Faucet					
Group A	60	8.98	4,191	28	251
Group B	50	8.04	1,607	10	80
Group C	20	3.72	372	2	7
Group C (nearby island)	20	70.6	3,530	1	71
Institutional	-	6.50	-	26	169
Total	-	-	26,958	4,251	4,108

4.5 ANALYSIS ON WATER SUPPLY AND CONSUMPTION

The water production was estimated to be 9,640 cu.m/day based on the field survey. The total water consumption including that of the island (71 cu.m/day) is estimated to be 4,108 cu.m/day which is approximately 43% of the water production. Hence, the water not utilized is estimated to be 5,532 cu.m/day which is about 57% of the total water production.

FIGURE 4.5.1 shows the water balance in the total service area.

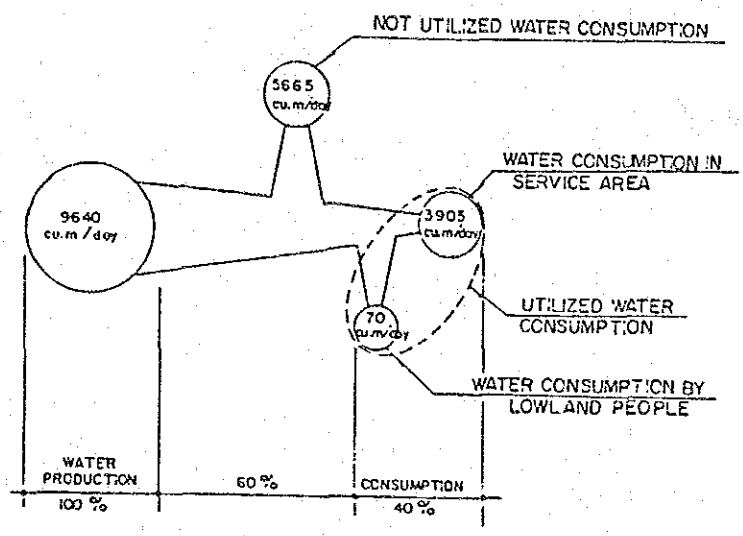

FIGURE 4.5.1 RELATIONSHIP BETWEEN PRODUCTION & CONSUMPTION

4.6 EXISTING SANITATION CONDITIONS

4.6.1 Drainage and Sewage Disposal

The existing drainage system of Dagupan City consists of networks of open and covered street canals. On the main streets, the most of canals are covered concrete culverts. The rest of the canals are open concrete-lined and earthened canals. The latter are usually dry during the dry season. The Lingayen Bay, through the Calmay, Mayruso, and Dagupan rivers, is the final discharge point of the drainage system

Domestic and commercial wastewaters are largely disposed in private septic tanks or pit privies. However, wastewater is sometimes directly discharged into the street canals, and culverts serve as a combined drainage and sewerage facilities. There are no major industries discharging significant quantities of wastewater in Dagupan City.

4.6.2 Solid Waste Disposal

Solid wastes are collected by garbage collectors of Dagupan especially from the public market and are dumped into swampy areas outside the city proper far from the residential areas. Uncollected solid wastes are burned and dumped in garbage pits and sometimes in vacant lots.

CHAPTER 5
POPULATION AND WATER DEMAND PROJECTIONS

CHAPTER 5 POPULATION AND WATER DEMAND PROJECTION

5.1 GENERAL

The population projection of the study area is based on past population trends and potential population growth. The figures are further modified on the basis of field investigation and comparison with the NEDA-POPCOM projections.

The provincial population figures were projected by the method of least squares, using population data in the years 1960, 1970, 1975 and 1980. The projected provincial population data was broken-down into Dagupan City using the sharing method. Likewise, the population in urban and non-urban areas were projected. Population by barangay in the urban and non-urban areas was finally projected based on historical data. (See TABLE 5.2.1)

5.2 POPULATION PROJECTION

5.2.1 Population Projection of the Province and City

TABLE 5.2.1 presents the historical record, annual growth rate and the percentage to the provincial population of the City as well as those of the Province. The NEDA's low assumption for the provincial population shows a very close approximation to the actual population in 1975 and 1980 as shown below.

Year	Provincial Population	Growth Rate (%)	NEDA Projection (Low Assumption)	Growth Rate (%)
1975	1,520,085	1.86(1970-75)	1,523,405	1.91
1980	1,636,057	1.48	1,637,950	1.46
1985	-	-	1,773,886	1.61
1990	-	-	1,885,307	1.23
1995	-	-	2,005,267	1.24
2000	-	-	2,107,903	1.00

TABLE 5.2.1 HISTORICAL POPULATION

City/Province	1903	1918	1939	1948	1960	1970	1975	1980
Dagupan								
Population	20,357	22,441	32,602	43,838	63,191	83,582	90,092	98,344
Growth Rate	-	0.65	1.79	3.35	3.09	2.84	1.51	1.77
% to Total	4.64	3.97	4.39	4.76	5.62	6.03	5.93	6.01
Pangasinan								
Population	439,135	565,922	742,475	920,491	1,124,144	1,386,143	1,520,085	1,636,057
Growth Rate	-	1.71	1.30	2.42	1.68	2.12	1.06	1.48
% to Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Note: Growth Rate : Between Census Years
Percent to Total : City Population/Provincial Population
Source : National Censuses

Population projection of the Province and City was made by the following procedures:

1. Project the provincial population by the method of least squares.

2. Project the percentage of the city population to the provincial population by the method of least squares.

3. Calculate the city population by multiplying the projected percentage of the city population to the provincial population by the projected provincial population.

Projected population of the Province were found between the medium and low of the NEDA projections and were compared with the actual population figures, hence, this method was found to be most practical.
(Error Mean Square; r = 0.9997)

The results of the population projection for the Province and City are shown in TABLE 5.2.2 and FIGURE 5.2.1 shows the historical and projected population of the City from 1903 to 2010 in connection with NEDA-POPCOM's projections.

TABLE 5.2.2 POPULATION PROJECTION OF DAGUPAN CITY AND PANGASINAN PROVINCE

	Dagupan City			Pangasinan Province		
Year	Population	Growth Rate	Percent	Population	Growth Rate	Percent
1980	98,344	1.77	6.01	1,636,057	1.48	100
1986	110,855	2.02	6.17	1,796,670	1.57	100
1990	118,734	1.73	6.25	1,899,737	1.40	100
1995	128,611	1.61	6.34	2,028,572	1.32	100
2000	138,721	1.52	6.43	2,157,407	1.24	100
2010	159,878	1.43	6.62	2,415,076	1.13	100

Note: Figures in 1980 are actual.

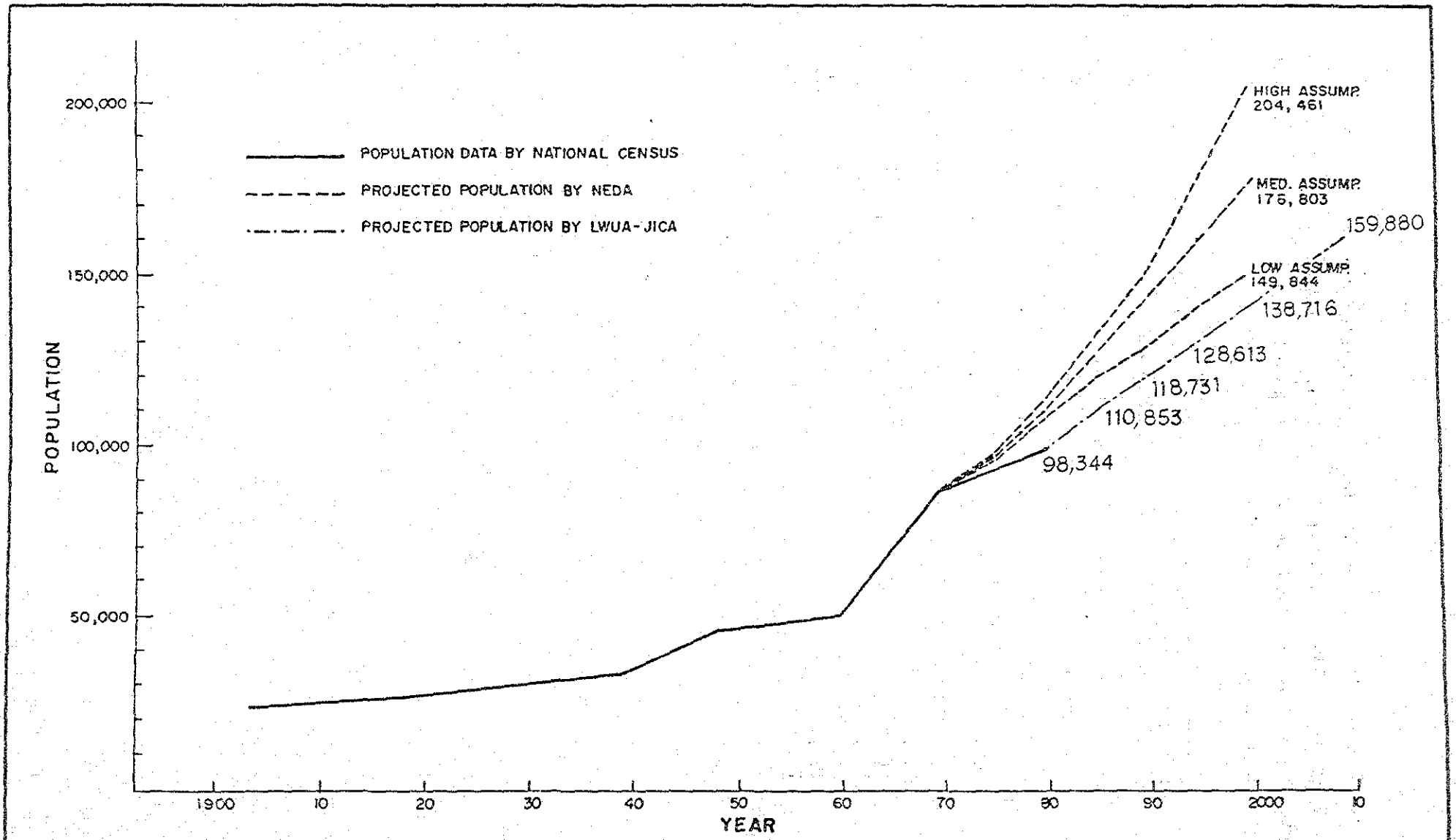

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FIGURE 5.2.1
POPULATION PROJECTION
DAGUPAN CITY, PANGASINAN

5.2.2 Population Projection by Barangay

The 1970 to 1980 historical population of the barangays is shown in TABLE 5.2.3. Barangays without any value were not independent during the said period, but only a part of other barangays.

The population of the barangays was projected by using the same method used in the projection of the city population. TABLE 5.2.4 shows the projected ratios and population figures from 1980 to 2010.

5.2.3. Projections of Number of Households

The actual number of persons per household of Dagupan City in 1980 was 5.68. Assuming that the number of persons per household decreases to 5.5 in the year 2010, the number of households of Dagupan City from 1980 to 2010 was projected by the method of linear interpretation as shown in TABLE 5.2.5.

TABLE 5.2.5 PROJECTIONS OF NUMBER OF PERSONS PER HOUSEHOLD AND NUMBER OF HOUSEHOLDS IN DAGUPAN CITY

Year	1980	1986	1990	1995	2000	2010
Population	98,344	118,853	118,731	128,613	138,716	159,880
Persons per Household	5.68	5.64	5.62	5.59	5.56	5.50
No. of Household	17,323	19,655	21,127	23,008	24,949	29,069

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

5.3.1 General

One of the necessary steps in developing a water supply system is the projection of the future population for the delineated service area. This section deals mainly with the served population forecasts for 1990, 1995 and 2000 in the City, and the population distribution in each barangay of the service area for each corresponding year.

TABLE 5.2.3 HISTORICAL POPULATION AND NUMBER OF HOUSEHOLD BY BARANGAY, DAGUPAN CITY

Name of Barangay	1970 Pop'n	1970 Percent	1970 H.H.	1975 Pop'n	1975 Percent	1975 H.H.	1975 Per's/HH	1980 Pop'n	1980 Percent	1980 H.H.	1980 Per's/HH
1. Bacayao Norte	741	0.89		1,012	1.12	186	5.44	1,286	1.31	210	6.12
2. Bacayao Sur	915	1.10		925	1.03	154	6.01	1,101	1.12	200	5.51
3. Barangay I	-	0.00		-	0.00	-	-	764	0.78	127	6.02
4. Barangay II & III	-	0.00		-	0.00	-	-	1,783	1.81	302	5.90
5. Barangay IV	-	0.00		-	0.00	-	-	3,202	3.26	538	5.95
6. Bolosan	1,469	1.76		1,813	2.01	305	5.94	2,195	2.23	379	5.79
7. Bonuan Binloc	2,082	8.94		2,392	2.66	394	6.07	2,750	2.80	500	5.50
8. Bonuan Gusset	7,468	5.19		8,821	2.79	1,468	6.01	10,788	10.97	2,136	5.05
9. Bonuan Bonquig	4,341	4.11		4,416	4.90	871	5.07	5,754	5.85	999	5.76
10. Calmay	3,433	3.82		3,879	4.31	676	5.74	4,073	4.14	736	5.53
11. Carael	3,195	4.85		3,163	3.51	523	6.05	3,458	3.52	600	5.76
12. Caranglaan	4,053	2.52		4,525	5.02	752	6.02	5,200	5.29	935	5.56
13. Herrero	2,104	1.07		3,111	3.45	504	6.17	3,275	3.33	623	5.26
14. Lasip Chico	897	1.37		906	1.01	153	5.92	972	0.99	166	5.86
15. Lasip Grande	1,141	0.83		1,508	1.67	251	6.01	1,636	1.66	277	5.91
16. Lomboy	691	3.28		635	0.71	99	6.41	826	0.84	137	6.03
17. Lucao	2,744	5.26		3,152	3.50	522	6.04	4,307	4.38	700	6.15
18. Malued	4,393	0.83		4,711	5.23	784	6.01	5,553	5.65	982	5.65
19. Mamalingling	697	1.75		552	0.61	87	6.34	597	0.61	96	6.22
20. Manguin	1,459	7.46		1,354	1.50	231	5.86	1,511	1.54	256	5.90
21. Mayombo	6,234	12.25		5,774	6.41	948	6.09	6,190	6.29	1,121	5.52
22. Pantal	10,241	15.15		10,231	11.36	1,633	6.27	11,358	11.55	1,919	5.92
23. Poblacion Oeste	12,663	5.80		11,557	12.83	1,853	6.24	4,149	4.22	714	5.81
24. Pogo Chico	4,847	1.80		4,437	4.93	691	6.42	4,683	4.76	787	5.95
25. Pogo Grande	1,543	1.85		1,630	1.81	273	5.97	1,646	1.67	282	5.84
26. Pugaro	1,424	1.70		1,762	1.96	298	5.91	2,108	2.14	385	5.48
27. Salapingao	1,568	1.88		1,284	1.43	194	6.62	1,299	1.32	205	6.34
28. Salisay	971	1.16		1,074	1.19	188	5.71	1,126	1.15	202	5.57
29. Tambac	1,052	1.26		1,052	1.17	176	5.98	1,119	1.14	203	5.51
30. Tapuac	359	0.43		3,188	3.54	476	6.84	2,358	2.40	378	6.24
31. Tebeng	857	1.03		1,228	1.36	211	5.82	1,277	1.30	228	5.60
Total	83,582	100.00		90,092	100.00	14,891	6.05	98,344	100.00	17,323	5.68

TABLE 5.2.4 POPULATION AND NUMBER OF HOUSEHOLD BY BARANGAY, DAGUPAN CITY

Name of Barangay	1980 Percent	1980 Pop'n	1986 Percent	1986 Pop'n	1990 Percent	1990 Pop'n	1995 Percent	1995 Pop'n	2000 Percent	2000 Pop'n	2010 Percent	2010 Pop'n
1. Bacayao Norte	1.31	1,286	1.53	1,696	1.68	1,995	1.83	2,350	2.06	2,859	2.39	3,821
2. Bacayao Sur	1.12	1,101	1.08	1,197	1.09	1,294	0.80	1,033	0.77	1,065	1.10	1,759
3. Barangay 1	0.78	746	1.15	1,275	1.18	1,401	1.18	1,523	1.21	1,681	1.22	1,951
4. Barangay 2 & 3	1.81	1,783	2.69	2,982	2.75	3,265	2.77	3,563	2.83	3,924	2.86	4,573
5. Barangay 4	3.26	3,202	4.83	5,354	4.95	5,877	4.99	6,415	5.08	7,050	5.14	8,218
6. Bolosan	2.23	2,195	2.45	2,716	2.61	3,099	2.78	3,575	3.03	4,205	3.38	5,404
7. Bon. Binloc	2.80	2,750	2.91	3,226	3.01	3,574	3.11	4,001	3.22	4,471	3.46	5,532
8. Bon. Gusset	10.97	10,788	9.64	10,686	9.54	11,327	9.35	12,030	9.39	13,022	9.18	14,677
9. Bon. Bonquig	5.85	5,754	5.51	6,108	5.47	6,495	5.32	6,841	5.34	7,401	5.23	8,362
10. Calmay	4.14	4,073	4.11	4,556	4.08	4,844	4.13	5,305	4.03	5,593	3.98	6,363
11. Carael	3.52	3,458	3.21	3,558	3.06	3,633	2.83	3,640	2.72	3,770	2.38	3,805
12. Caranglaan	5.29	5,200	5.31	5,886	5.50	6,530	5.63	7,241	5.84	8,101	6.11	9,769
13. Herrero	3.33	3,275	3.84	4,257	4.11	4,880	4.41	5,667	4.76	6,602	5.39	8,617
14. Lasip Chico	0.99	972	0.91	1,009	0.87	1,033	0.80	1,033	0.77	1,065	0.68	1,087
15. Lasip Grande	1.66	1,636	1.84	2,040	1.94	2,303	2.03	2,607	2.17	3,013	2.42	3,869
16. Lomboy	0.84	826	0.78	865	0.78	926	0.77	994	0.78	1,079	0.77	1,231
17. Lucao	4.38	4,307	4.81	5,332	5.17	6,139	5.62	7,228	6.08	8,438	7.02	11,223
18. Malued	5.65	5,553	5.65	6,263	5.75	6,827	5.82	7,486	5.98	8,298	6.26	10,008
19. Mamalingling	0.61	597	0.59	654	0.59	701	0.58	749	0.58	799	0.56	895
20. Manguin	1.54	1,511	1.33	1,474	1.23	1,460	1.11	1,433	1.01	1,401	0.79	1,263
21. Mayambo	6.29	6,190	5.28	5,853	4.79	5,687	4.13	5,305	3.56	4,934	2.44	3,901
22. Pantal	11.55	11,358	11.41	12,649	11.29	13,405	11.94	15,360	11.11	15,417	10.86	17,363
23. Poh. Oeste	4.22	4,149	3.67	4,068	3.34	3,966	3.10	3,988	2.88	3,995	2.11	3,373
24. Pogo Chico	4.76	4,683	5.02	5,565	4.97	5,901	4.92	6,325	4.90	6,797	4.78	7,642
25. Pogo Grande	1.67	1,646	1.54	1,707	1.45	1,722	1.35	1,730	1.24	1,724	1.06	1,695
26. Pugaro	2.14	2,108	1.88	2,084	1.86	2,208	1.83	2,350	1.82	2,523	1.79	2,862
27. Salapingao	1.32	1,299	1.51	1,674	1.48	1,757	1.46	1,871	1.43	1,977	1.43	2,286
28. Salisay	1.15	1,126	1.11	1,230	1.09	1,294	1.09	1,407	1.10	1,527	1.01	1,615
29. Tambac	1.14	1,119	1.16	1,286	1.15	1,365	1.12	1,446	1.12	1,556	1.10	1,759
30. Tapuac	2.40	2,358	2.06	2,284	2.04	2,422	2.04	2,620	2.04	2,831	1.97	3,150
31. Tebeng	1.30	1,277	1.19	1,319	1.18	1,401	1.16	1,497	1.15	1,598	1.13	1,807
Total	100.00	98,344	100.00	110,853	100.00	118,731	100.00	128,613	100.00	138,716	100.00	159,880

5.3.2 Population and Area to be Served

A planned served population in each target year is established based on the result of the field survey.

The island barangays are excluded in this plan because they have their own waterworks program. A total of 22 barangays including 14 barangays being served by the existing system were recommended for the year 2010. Based on the land use plan of the City, barangay Bacayao Norte was added to the service area for the year 1995 and another six barangays (Bacayao Sur, Bolosan, Lasip Chico, Salisay, Tambac and Tebeng) for the year 2010, aside from present 14 barangays, as shown in FIGURE 5.3.1.

The present served population was investigated and the results are summarized in TABLE 5.3.1. The average served population percentages by house connections and public faucets are estimated at 26.3 and 9.4%, respectively. The served population by house connections by barangay ranges from 2.3 to 83.0%.

Public faucets will be abandoned during the Phase I period (1995). At present, about 1,110 households are currently being served by the existing 40 public faucets, hence, more than 1,100 domestic service connections will be required.

The target percentages of the served population in the City for the years 1995 and 2010 are assumed to be 60 and 80%, respectively. The figure for the year 1995 is based on the present percentage. Likewise, for the year 1990, it is assumed to be 40%. TABLE 5.3.2 shows the estimated served population by barangay. The present figures were used for some barangays owing to the fact that the present served population is more than the estimated served population in 1990/1995.

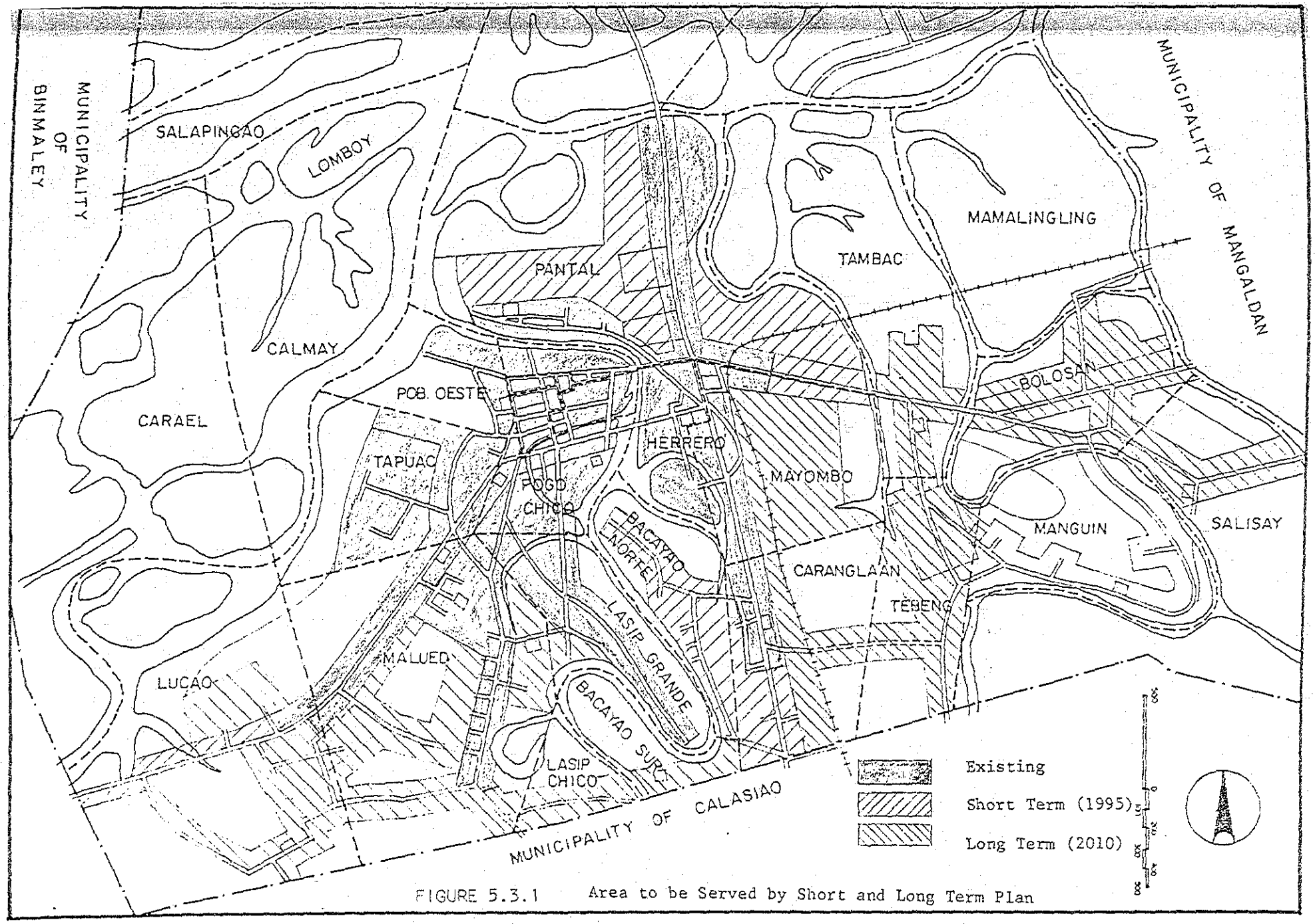

FIGURE 5.3.1 Area to be Served by Short and Long Term Plan

TABLE 5.3.1 PRESENT SERVED POPULATION

	Population (1986)	NO. OF CONNECTION					POPULATION SERVED				
		Domestic Connection	Commercial Connection	Public Faucet	Institutional Connection	Total	Domestic	Water Supply Service Ratio %	Public Faucet	Total	Water Supply Service Ratio %
Barangay I	1,275	19	179	5	1	204	107	8.4	609	716	56.2
Barangay II & III	2,982	402	82	2	4	490	2267	76.0	423	2690	90.2
Barangay IV	5,354	627	233	1	3	864	3536	66.0	56	3592	67.1
Caranglaan	5,886	146	18	0	1	165	823	14.0	0	823	14.0
Herrero	4,257	215	137	4	3	359	1213	28.5	446	1659	39.0
Lasip Grande	2,040	64	2	0	1	67	361	17.7	0	361	17.7
Lucao	5,332	22	1	0	0	23	124	2.3	0	124	2.3
Malued	6,263	367	17	0	1	385	2070	33.1	0	2070	33.1
Mayombo	5,853	145	75	1	0	221	818	14.0	226	1044	17.8
Pantal	12,649	420	250	16	3	689	2369	18.7	2499	4868	38.5
Pob. Oeste	4,068	197	15	8	8	228	1111	27.3	1246	2357	57.9
Pogo Chico & Grande	7,272	100	1	2	1	104	654	9.0	372	936	12.9
Tapuac	2,284	336	114	1	0	451	1895	83.0	293	2188	95.8
	65,515	3060	1124	40	26	4250	17258	26.3	6170	23428	35.8

TABLE 5.3.2 PLANNED SERVICE POPULATION BY BARANGAY

NAME OF BARANGAY	1986 SERVICE POPULATION					1990 SERVICE POPULATION					1995			2010		
	POP'N	HOUSE CONN.	PUBLIC FAUCET	TOTAL	SERV.%	POP'N	HOUSE CONN.	PUBLIC FAUCET	TOTAL	SERV.%	POP'N	SERV. POP'N	SERV.%	POP'N	SERV. POP'N	SERV.%
BACAYAO N	-	-	-	-	-	-	-	-	-	-	2,350	1,410	60	3,820	3,060	80
BACAYAO S	-	-	-	-	-	-	-	-	-	-	-	-	-	1,760	1,410	80
BARANGAY 1	1,275	107	609	716	56	1,400	110	610	720	51	1,520	910	60	1,950	1,560	80
BARANGAY 2 & 3	2,982	2,267	423	2,690	90	3,270	2,270	420	2,690	82	3,560	2,690	76	4,570	3,660	80
BARANGAY 4	5,354	3,536	56	3,592	67	5,880	3,530	60	3,590	61	6,420	3,850	60	8,220	6,580	80
BOLOSAN	-	-	-	-	-	-	-	-	-	-	-	-	-	5,400	4,320	80
CARANGLAAN	5,886	832	0	823	14	6,530	6,210	0	2,610	40	7,240	4,340	60	9,770	7,820	80
HERRERO	4,257	1,213	446	1,659	39	4,880	1,729	230	1,950	40	5,670	3,440	60	8,020	6,900	80
LASIP CHICO	-	-	-	-	-	-	-	-	-	-	-	-	-	1,090	870	80
LASIP GRANDE	2,040	361	0	361	18	2,300	920	0	920	60	2,610	1,570	60	3,870	3,100	80
LUCAO	5,332	124	0	124	2	6,140	2,460	0	2,460	40	7,230	4,340	60	11,220	8,980	80
MALUED	6,263	2,070	0	2,070	33	6,830	2,730	0	2,730	40	7,490	4,490	60	10,010	8,010	80
MAYAMBO	5,853	818	226	1.044	18	5,690	2,050	230	2,280	40	5,310	3,190	60	3,900	3,120	80
PANTAL	12,649	2,369	2,499	4,868	39	13,410	3,680	1,680	5,360	40	15,360	9,220	60	17,360	13,890	80
POB. OESTE	4,068	1,111	1,246	2,357	58	3,970	2,200	160	2,360	59	3,990	2,390	60	3,370	2,700	80
POGO CHICO	5,565	500	372	4,872	15	5,900	2,170	190	2,360	40	6,330	3,800	60	7,040	6,110	80
POGO GRANDE	1,707	154	0	154	6	1,720	690	0	690	40	1,730	1,040	60	1,700	1,360	80
SALISAY	-	-	-	-	-	-	-	-	-	-	-	-	-	1,620	1,300	80
TAMBAC	-	-	-	-	-	-	-	-	-	-	-	-	-	1,760	1,410	80
TABUAC	2,284	1,895	293	2,188	96	2,420	1,900	290	2,190	90	2,620	2,190	84	3,150	2,520	80
TEBENG	-	-	-	-	-	-	-	-	-	-	-	-	-	1,810	1,450	80
SUB-TOTAL	65,515	17,348	6,170	23,518	36	70,340	29,040	3,870	32,910	47	79,430	48,830	61	112,610	90,130	80

5.4 WATER DEMAND PROJECTION FOR THE PROPOSED SERVICE AREA

5.4.1 General

Based on the results of the study derived from various field surveys, the design unit water consumption by consumer type was established and the water demand in the respective design years was projected.

To determine the domestic unit water consumption, the present water supply situation, water usage as well as the socio-economic conditions were taken into account. For the commercial and institutional unit water consumption, the LWUA Methodology Manual was adopted in principle.

5.4.2 Design Unit Water Consumption by Consumer Type

(1) Domestic Unit Water Consumption

A study of the current unit water consumption for domestic use was conducted to establish the base figure in 1986. The average per capita water consumption of 117 lpcd was obtained using available data including field measurement results. The base figure (1986) for the design purpose was recommended to be 110 lpcd considering the experience in similar cities/municipalities of the country.

(2) Commercial Unit Water Consumption

The present unit water consumption per commercial connection was calculated at 1.1 cu.m/conn.day. The present connection density ratio per 100 persons shows a high value of 4.8 because that the present system serves only the urbanized core area of the City. However, considering the characteristics of the area in the future, it is not likely to expect such a high ratio, hence the lower value is considered appropriate. In this plan, as the ratio of the number of connections per hundred (100) persons in the service area (1.7) is adopted for the base figure in 1986.

(3) Public Faucet

Although all public faucets will be abandoned up to the target year 1995, a number of public faucets are considered necessary yet in the

interim year 1990. The average unit water consumption for public faucet of 60 lpcd, which is the standard volume for Level II Rural Water Supply, was also obtained during the field measurement. Increase of future unit water consumption is not considered for design purposes.

(4) Institutional

Though a high unit water consumption was given in the survey, it is considered that this result comes from particular water usage condition from a limited number of connections. Hence, the unit consumption in the LWUA Methodology Manual is used.

The unit water consumption by consumer type for the different target years is shown in TABLE 5.4.1.

TABLE 5.4.1 UNIT WATER CONSUMPTION BY CONSUMER TYPE BY TARGET YEARS

Consumer Type	Unit	1986	1990	1995	2010
Domestic Water Consumption					
Unit water consumption	lpcd	110	119	128	152
Commercial Water Consumption					
Unit water consumption	cu.m/conn.day	1.1	1.2	1.4	1.9
No. of commercial connection per 100 persons		1.7	1.9	2.0	2.9
Public Faucet					
Unit water consumption	cu.m/conn.day	20-60	60	-	-
No. of public faucet		40	25	-	-
Institutional Water Consumption					
Unit water consumption	cu.m/conn.day	3.4	4.5	5.3	7.5
No. of connection	One connection for every 2,000 population in the service area will be provided.				

5.4.3 Water Demand Projection

Based on the results of the field investigation , the percentage of unaccounted-for water was determined at 60% in the year 1986. The percentages of unaccounted-for water in the years 1990, 1995 and 2010 were assumed to be 40, 30 and 20%, respectively.

The daily average water consumption is shown in TABLE 5.4.2. Considering the percentage of unaccounted-for water, the water demand by barangay was estimated as shown in TABLEs 5.4.3 to 5.4.5.

The number of commercial and institutional connections were determined for each target year using the LWUA Methodology Manual and the projected population to be served.

TABLE 5.4.2 DAILY AVERAGE WATER CONSUMPTION

	1990	1995	2010
Population in the Service Area	70,340	79,430	112,610
Domestic Water Consumption			
Unit Water Consumption (lpcd)	119	128	152
Population to be served	29,040	48,840	90,130
Water Consumption (cu.m/day)	3,456	6,251	13,699
Commercial Water Consumption			
Unit Water Consumption (cu.m/conn.day)	1.2	1.4	1.9
No. of connection per 100 served persons	1.9	2.0	2.9
Water Consumption (cu.m/day)	1,606	2,151	5,376
Public Faucet			
Unit Water Consumption (lpcd)	60	-	-
No. of population served by public faucet (persons/PF)	155	-	-
No. of public faucet	25	-	-
Water consumption by P/F	233	-	-
Institutional Consumption			
Unit Water Consumption (cu.m/conn.day)	4.5	5.3	7.5
No. of connections (pop'n/2000)	43	50	66
Water Consumption	199	263	501
Total	5,494	8,665	19,576

TABLE 5.4.3 WATER DEMAND PROJECTION IN SERVICE AREA (1990)

NAME OF BARANGAY	1990	SERVED POP'N		NUMBER OF CONNECTION				WATER DEMAND				SUB TOTAL	UNACTO -FOR- WATER	TOTAL DEMAND (D.AV.)	DEMAND DAILY MAX.	DEMAND HOURLY MAX.
	POP'N	H.C	P.F	HOUSE	COMM.	P.F.	INST.	HOUSE	COMM.	P.F.	INST.					
BACAYAO N	2,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BACAYAO S	1,290	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BGY.1	1,400	110	610	56	179	5	1	13	215	37	5	270	180	450	563	980
BGY.2 & 3	3,270	2,270	420	428	82	2	4	270	98	25	18	411	274	685	856	1.489
BGY.4	5,880	3,530	60	632	233	1	3	420	280	4	14	718	479	1,197	1.496	2,603
BOLOSAN	3,100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CARANGLAAN	6,530	2,610	0	464	50	0	3	311	60	0	14	385	257	642	803	1.397
HERRERO	4,880	1,720	230	294	137	2	3	205	164	14	14	397	265	662	828	1,441
LASIP CHICO	1,030	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LASIP GRANDE	2,300	920	0	164	17	0	1	109	20	0	5	134	89	223	279	485
LUCAO	6,140	2.460	0	438	47	0	3	293	56	0	14	363	242	605	756	1,315
MALUED	6,830	2,730	0	486	52	0	3	325	62	0	14	401	267	668	835	1.453
MAYAMBO	5,690	2,050	230	379	75	1	3	244	90	14	14	362	241	603	754	1,312
PANTAL	13,410	3,680	1,680	657	250	11	6	438	300	101	27	866	577	1,443	1.804	3,139
POB.OESTE	3,970	2,200	160	272	45	1	8	262	54	10	36	362	241	603	754	1,312
POGO CHICO	5,900	2,170	190	376	45	1	3	258	54	11	14	337	225	562	703	1,223
POGO GRANDE	1.720	690	0	123	13	0	1	82	16	0	5	103	69	172	215	374
SALISAY	1,290	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TAMBAC	1,370	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TAPUAC	2,420	1,900	290	355	114	1	1	226	137	17	5	385	257	642	803	1,397
TEBENG	1,400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SUB-TOTAL	81,820	29,040	3,870	5.124	1.339	25	43	3.456	1.606	233	199	5,494	3,663	9.157	11.449	19,920

TABLE 5.4.4 WATER DEMAND PROJECTION IN SERVICE AREA (1995)

NAME OF BARANGAY	1995	SERVED POP'N		NUMBER OF CONNECTION				WATER DEMAND				SUB	UNACTO -FOR-	TOTAL DEMAND	DEMAND DAILY	DEMAND HOURLY
	POP'N	H.C	P.F	HOUSE	COMM.	P.F.	INST.	HOUSE	COMM.	P.F.	INST.	TOTAL	WATER	(D.AV.)	MAX.	MAX.
BACAYAO N	2.350	1,410	0	252	28	0	1	180	39	0	5	224	96	320	400	676
BACAYAO S	1.030	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BGY.1	1.520	910	0	163	178	0	1	116	249	0	5	370	159	529	661	1.117
BGY.2 & 3	3.560	2,690	0	481	82	0	4	344	115	0	21	480	206	686	858	1.450
BGY.4	6.420	3,850	0	689	233	0	3	493	326	0	16	835	358	1,193	1.491	2.520
BOLOSAN	3.580	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CARANGLAAN	7,240	4,340	0	776	87	0	4	556	122	0	21	699	300	999	1.249	2,111
HERRERO	5,670	3,400	0	608	137	0	3	435	192	0	16	643	276	919	1,149	1,942
LASIP CHICO	1,030	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LASIP GRANDE	2.610	1.570	0	281	31	0	1	201	43	0	5	249	107	356	445	752
LUCAO	7.230	4,340	0	776	87	0	4	556	122	0	21	699	300	999	1.249	2.111
MALUED	7.490	4,490	0	803	90	0	4	575	126	0	21	722	309	1.031	1.289	2.178
MAYAMBO	5,310	3,190	0	571	75	0	3	408	105	0	16	529	227	756	945	1,597
PANTAL	15.360	9,220	0	1,649	250	0	8	1,180	350	0	42	1.572	674	2.246	2,808	4,746
POB.OESTE	3.990	2,390	0	428	48	0	8	306	67	0	42	415	178	593	741	1.252
POGO CHICO	6,330	3,800	0	680	76	0	3	486	106	0	16	608	261	869	1,086	1.835
POGO GRANDE	1.730	1,040	0	186	21	0	1	133	29	0	5	167	72	239	299	505
SALISAY	1.410	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TAMBAC	1.450	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TAPUAC	2.620	2.200	0	394	114	0	2	282	160	0	11	453	194	647	809	1,367
TEBENG	1.500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SUB-TOTAL	89.430	48.840	0	8,737	1.537	0	50	6.251	2.151	0	263	8.665	3.717	12.382	15.479	26.159

TABLE 5.4.5 WATER DEMAND PROJECTION IN SERVICE AREA (2010)

NAME OF BARANGAY	2010	SERVED POP'N		NUMBER OF CONNECTION				WATER DEMAND				SUB	UNACTD -FOR-	TOTAL DEMAND	DEMAND DAILY	DEMAND HOURLY
	POP'N	H.C	P.F	HOUSE	COMM.	P.F.	INST.	HOUSE	COMM.	P.F.	INST.	TOTAL	WATER	(D.AV.)	MAX.	MAX.
BACAYAO N	3,820	3,060	0	556	89	0	2	465	169	0	15	649	162	811	1.014	1.633
BACAYAO S	1.760	1,410	0	256	41	0	1	214	78	0	8	300	75	375	469	755
BGY.1	1,950	1,560	0	284	179	0	1	237	340	0	8	585	146	731	914	1,472
BGY.2 & 3	4,570	3,660	0	665	106	0	4	556	201	0	30	787	197	984	1,230	1.980
BGY.4	8,220	6,580	0	1,196	233	0	4	1,000	443	0	30	1,473	368	1,841	2,301	3.705
BOLOSAN	5,400	4,320	0	785	125	0	2	657	238	0	15	910	228	1.138	1,423	2,291
CARANGLAAN	9,770	7.820	0	1,422	227	0	5	1,189	431	0	38	1,658	415	2.073	2,591	4.172
HERRERO	8.620	6,900	0	1,255	200	0	4	1,049	380	0	30	1,459	365	1,824	2,280	3.671
LASIP CHICO	1,090	870	0	158	25	0	1	132	48	0	8	188	47	235	294	473
LASIP GRANDE	3,870	3,100	0	564	90	0	2	471	171	0	15	657	164	821	1.026	1.652
LUCAO	11,220	8,980	0	1,633	260	0	6	1,365	494	0	45	1.904	476	2,380	2,975	4.790
MALUED	10,010	8,010	0	1,456	232	0	5	1,218	441	0	38	1.697	424	2.121	2,651	4,268
MAYAMBO	3,900	3,120	0	567	90	0	3	474	171	0	23	668	167	835	1,044	1.681
PANTAL	17,360	13,890	0	2,525	403	0	9	2,111	766	0	68	2,945	736	3,681	4,601	7.408
POB.OESTE	3,370	2,700	0	491	78	0	8	410	148	0	60	618	155	773	966	1.555
POGO CHICO	7,640	6.110	0	1.111	177	0	3	929	336	0	23	1,288	322	1,610	2.013	3,241
POGO GRANDE	1,700	1,360	0	247	39	0	1	207	74	0	8	289	72	361	451	726
SALISAY	1.620	1,300	0	236	38	0	1	198	72	0	8	278	70	348	435	700
TAMBAC	1,760	1,410	0	256	41	0	1	214	78	0	8	300	75	375	469	755
TAPUAC	3,150	2,520	0	458	114	0	2	383	217	0	15	615	154	769	961	1.547
TEBENG	1.810	1.450	0	264	42	0	1	220	80	0	8	308	77	385	481	774
SUB-TOTAL	112,610	90,130	0	16,385	2,829	0	66	13,699	5,376	0	501	19,576	4,895	24,471	30,589	49,249

5.4.4 Demand Variations

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

(1) Daily Maximum Water Demand

The ratio of the daily maximum water demand to the daily average water demand is estimated in proportionate to the served population, as follows:

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

(1) Peak Hour Water Demand (Hourly Maximum Water Demand)

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

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

where, C = Factor of demand variation for peak hour water demand

Phase I, Stage 1 (1990) : 1.74
Stage 2 (1995) : 1.69
Phase II (2010) : 1.61

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

Unit: cu.m/day

Water Demand	1990	1995	2010
Daily Average	9,160	12,380	24,470
Daily Maximum	11,450	15,480	30,590
Peak Hour	19,920	26,160	49,250

5.4.5 Number of Connections

The service connections are classified into domestic, commercial and institutional categories. The total number of connections for each category is projected in accordance with the LWUA Methodology Manual. It is expected that waterworks will have total connections of 6,531 in 1990; 10,324 in 1995; and, 19,280 in 2010, respectively. The number of connections by consumer type, and by barangay for the design years, are shown in TABLEs 5.4.3 to 5.4.5.