社会開発調査部報告書

REPUBLIC OF THE PHILIPPINES

METROPOLITAN WATERWORKS AND SEWERAGE SYSTEM

THE FEASIBILITY STUDY

ON

THE BALARA WATER TREATMENT PLANT REHABILITATION PROJECT

VOLUME I

SUMMARY

MARCH 1992

JAPAN INTERNATIONAL COOPERATION AGENCY

PREFACE

In response to a request from the Government of the Republic of the Philippines, the Government of Japan decided to conduct THE FEASIBILITY STUDY ON THE BALARA WATER TREATMENT PLANT REHABILITATION PROJECT and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to the Philippines a study team headed by Mr. Satoshi Kachi, Nippon Jogesuido Sekkei Co., Ltd, 2 times between August 1991 and February 1992.

The team held discussions with the officials concerned of the Government of the Philippine, and conducted field surveys at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

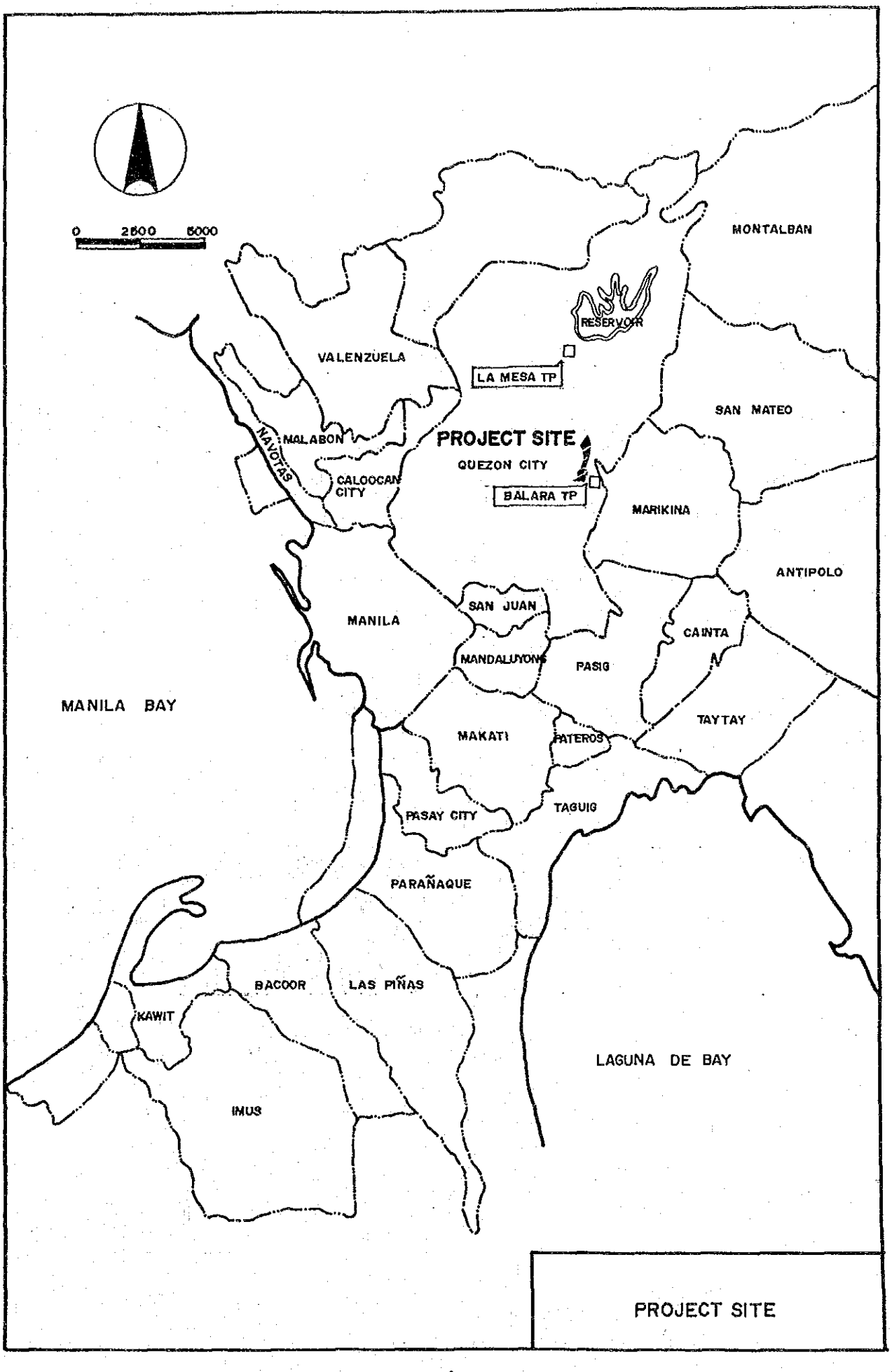
I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

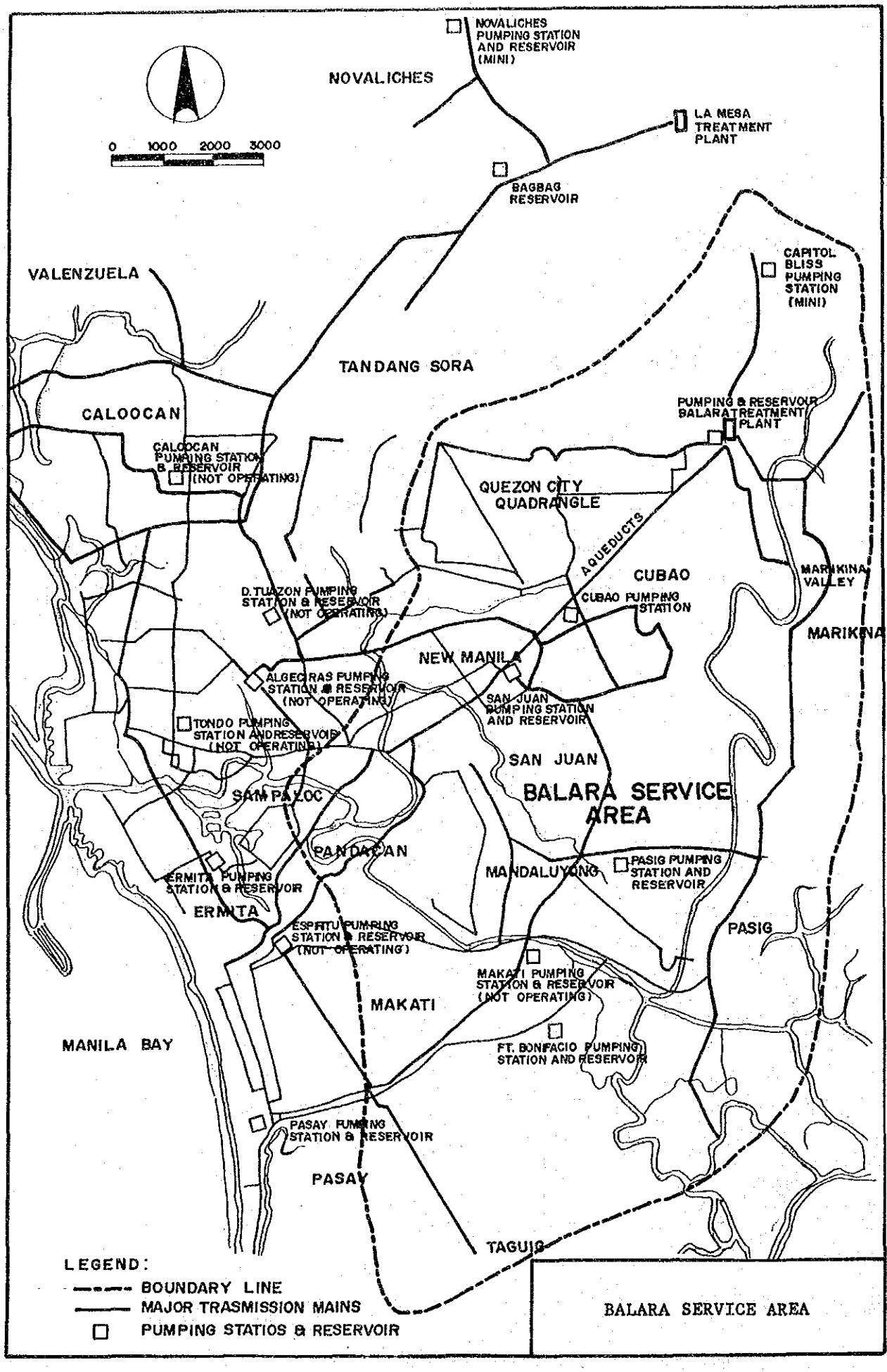
I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of the Philippines for their close cooperation extended to the team.

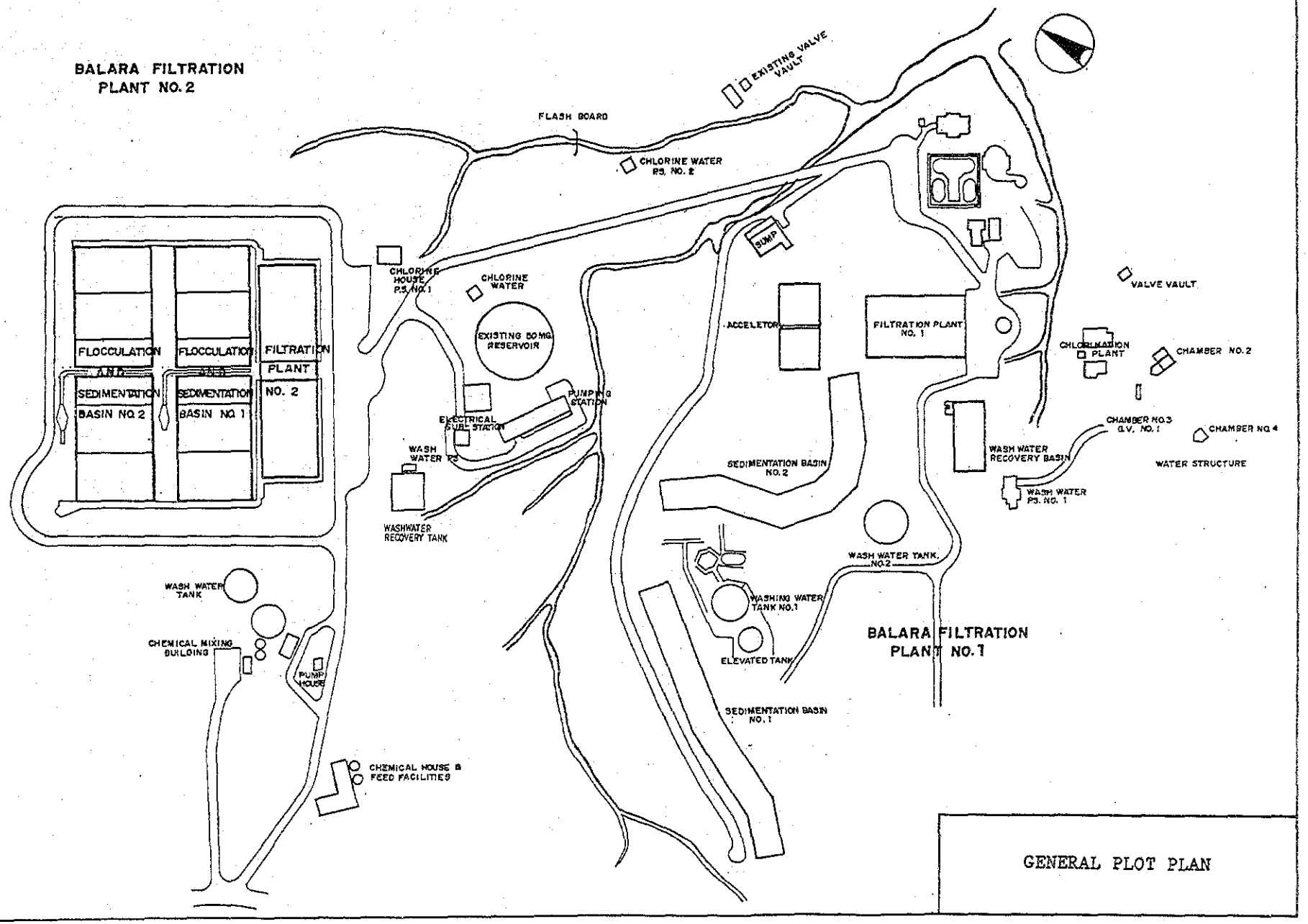
March, 1992

Kensuke Yanagiya

Kensuke Yanagiya
President
Japan International Cooperation Agency


0 2500 5000
MONTALBAN
RESERVOIR
VALENZUELA
LA MESA TP
SAN MATEO
PROJECT SITE
QUEZON CITY
MALABON
NAVOTAS
CALOOCAN CITY
BALARA TP
MARIKINA
ANTIPOLO
MANILA
SAN JUAN
CAINTA
MANDALUYONG
PASIG
MANILA BAY
TAYTAY
MAKATI
PATEROS
TAGUIG
PASAY CITY
PARAÑAQUE
BACOOR
LAS PIÑAS
KAWIT
LAGUNA DE BAY
IMUS
PROJECT SITE


NOVALICHES PUMPING STATION AND RESERVOIR (MINI)
NOVALICHES
LA MESA TREATMENT PLANT
0 1000 2000 3000
BAGBAG RESERVOIR
VALENZUELA
CAPITOL BLISS PUMPING STATION (MINI)
TANDANG SORA
CALOOCAN
PUMPING & RESERVOIR BALARA TREATMENT PLANT
CALOOCAN PUMPING STATION & RESERVOIR (NOT OPERATING)
QUEZON CITY QUADRANGLE
AQUEDUCTS
CUBAO
MARIKINA VALLEY
D. TUAZON PUMPING STATION & RESERVOIR (NOT OPERATING)
CUBAO PUMPING STATION
MARIKINA
NEW MANILA
ALGECIRAS PUMPING STATION & RESERVOIR (NOT OPERATING)
SAN JUAN PUMPING STATION AND RESERVOIR
TONDO PUMPING STATION AND RESERVOIR (NOT OPERATING)
SAN JUAN
BALARA SERVICE AREA
SAMPALOC
PANDACAN
PASIG PUMPING STATION AND RESERVOIR
MANDALUYONG
ERMITA PUMPING STATION & RESERVOIR
ERMITA
ESPIRITU PUMPING STATION & RESERVOIR (NOT OPERATING)
PASIG
MAKATI PUMPING STATION & RESERVOIR (NOT OPERATING)
MAKATI
MANILA BAY
FT. BONIFACIO PUMPING STATION AND RESERVOIR
PASAY PUMPING STATION & RESERVOIR
PASAY
TAGUIG
LEGEND:
BOUNDARY LINE
MAJOR TRASMISSION MAINS
PUMPING STATIOS & RESERVOIR
BALARA SERVICE AREA


BALARA FILTRATION
PLANT NO. 2
EXISTING VALVE VAULT
FLASH BOARD
CHLORINE WATER P.S. NO. 2
SUMP
VALVE VAULT
CHLORINE HOUSE P.S. NO. 1
CHLORINE WATER
EXISTING 50 MG. RESERVOIR
ACCELETOR
FILTRATION PLANT NO. 1
CHLORINATION PLANT
CHAMBER NO. 2
FLOCCULATION AND SEDIMENTATION BASIN NO. 2
FLOCCULATION AND SEDIMENTATION BASIN NO. 1
FILTRATION PLANT NO. 2
PUMPING STATION
ELECTRICAL SUB STATION
WASH WATER P.S.
CHAMBER NO. 3 G.V. NO. 1
CHAMBER NO. 4
WASH WATER RECOVERY BASIN
WATER STRUCTURE
SEDIMENTATION BASIN NO. 2
WASH WATER P.S. NO. 1
WASHWATER RECOVERY TANK
WASH WATER TANK NO. 2
WASH WATER TANK
WASHING WATER TANK NO. 1
CHEMICAL MIXING BUILDING
PUMP HOUSE
BALARA FILTRATION PLANT NO. 1
ELEVATED TANK
SEDIMENTATION BASIN NO. 1
CHEMICAL HOUSE & FEED FACILITIES
GENERAL PLOT PLAN

CONCLUSION AND RECOMMENDATION

CONCLUSION

The provision of safe and stable supply of water to the populace is of utmost importance particularly in Metro Manila. The rehabilitation of the Balara Water Treatment Plant one of two large water treatment plants providing water to 60% of the MWSS service area is therefore urgently required.

The capacity (nominal) to be rehabilitated in the proposed project is 1,600,000 m^3/d, the modified capacity in the project of 1981.

1. Highlights of the Project

Proposed rehabilitation work on the Balara Water Treatment Plant is presented in three levels of rehabilitation and the rehabilitation plan to be implemented shall be determined based on the following:

(1) Considering technical/engineering aspects, Level 2 is preferable since it will be fundamental rehabilitation. It includes the improvement of water quality management technically in corporated over and above Level 1 rehabilitation items. Furthermore it includes replacement of the worn-out equipment insuring steady O&M for years to come.

(2) In case of financial constraints, Level 1 (or equivalent alternative) could be the second choice since Level 1 consists only of minimal replacement of the worn-out equipment and of vital service devices such as chlorination. Level 1 can be defined as urgent and survivable rehabilitation.

(3) Economic and financial analysis indicate that the EIRR of Level 2 was computed at 32.4% and its FIRR at 5.4%. While the EIRR of Level 1 was computed at 63.8% and its FIRR at 7.8%. Therefore both levels are justified. Sensitivity analysis strongly indicates that Level 1 and Level 2 both can stand against the worst Scenario 3.

Considering all aspects of the Project, namely the engineering evaluation and economic/financial analysis and the present financial situation at MWSS, it is best to adopt Level 1 rehabilitation plan (or equivalent plan) first and implement it as closely as possible gradually to the grade of Level 2, should the two stage implementation be approved.

Table C-1 presents the targets for improvement and rehabilitation for Level 2 and the items for Level 1 are indicated in the column for the remarks.

2. **Expected Durability**

Most of the worn-out equipment will be replaced in the proposed Level 2 Rehabilitation Plan. Results of the structural examination on civil and architectural facilities revealed that the concrete structure will still last for more years. Therefore, the determining factor for the life of the Project is the durability of the replacement equipment. Usually the life of these equipment is 15 years. Accordingly, the expected life of Level 2 is 15 years.

Should Level 1 be adopted, the life of the system will be approximately 5 years because the components of the worn-out equipment to be replaced are limited to the bare minimum level, as an emergency countermeasure. Consequently, additional replacement of the equipment will be needed during or after the rehabilitation.

3. **Project Cost and Implementation schedule**

Total project cost of Level 2, consisting of construction cost, engineering fee and physical contingency, amounts to ₱686,947 thousand at 1991 price level. For reference, total project cost of Level 1 is estimated at ₱285,556 thousand.

Construction/Rehabilitation shall cover two years. Assuming that negotiations for external financial resources commence in early 1992, the proposed rehabilitation work will be completed until the end of 1995 including engineering service and bidding procedure.

4. Economic and Financial Analysis

Both Level 1 and Level 2 projects are feasible on economic and financial grounds. Furthermore, both Level 1 and Level 2 can stand adverse situations affecting the project situations.

While it is difficult to determine whether Level 1 or Level 2 will be adopted, the project should definitely be approved. An attempt was made to examine the trade off between Level 1 and Level 2, taking into account some qualitative differences between these two rehabilitation levels of the project. The results that are summarized in Table C-2 indicate that there exists a range of options somewhere closer to 50% increase of Level 1 funds over to current ₱286 million if a mid point between adjusted curve of Level 1 and horizontal line of Level 2 were to be preferred.

This does not necessarily reflect our concerted assessment among our study team, but indicates a reasonable solution to the trade off issue facing the assessment committee of the Balara Rehabilitation Project.

A summary of selected key indicators is presented in Table C-2.

RECOMMENDATION

After a detailed evaluation of the existing conditions of the Balara Water Treatment Plant and the proposed rehabilitation works and the benefits to be derived, the team recommends that:

(1) The Government of the Philippines and MWSS proceed with execution of the detailed design as soon as possible because of the urgency of the rehabilitation work required to cope with the advancing stage of deterioration of the existing facilities.

(2) Should financial limitations exist as stated in Chapter 15, Main Report, MWSS should implement the Level I rehabilitation or equivalent plan which are within Level 2 as allowable.

(3) MWSS strongly desires Japanese Grant-Aid. As the completion of the work will take about four years in any case, some equipment in the Plant will breakdown and MWSS have to cope with the situation without reservation as soon as possible. Because of this the possibility of change order for items to be rehabilitated will exist until bidding procedure commences.

(4) In connection with the Balara Plant, the following items are recommended:

a. After the rehabilitation work, MWSS should always establish periodic preventive repair scheme including spare parts purchase, replacement of worn-out equipment, and painting of steel portions. Simultaneously the budgets for it shall be ensured by the management.

b. In order to facilitate for future rehabilitation work on the Balara or the La Mesa plant on a large scale, the interconnection pipe between the La Mesa No. 2 and the Balara plant will have to be implemented.

c. At present, the distribution pipelines of the Balara and the La Mesa service area are interconnected only at the Manila South

portion and there is no provision for utilization of water in their respective pipelines in the event of emergencies. Should one of the plants or one of the main lines stop functioning, a major shutdown of water supply will occur. Hence, MWSS could not stop the operation of each plant should there be a need. Therefore, interconnection in a number of points between both service areas are recommended.

d. More distribution reservoirs should be rehabilitated to allow for emergency situations.

e. Leakage prevention in the distribution network should be attended to make the plant perform efficiently, to prevent vain expansion of the plant and to make the system financially stable by deducting non-revenue water.

f. While La Mesa Water Treatment Plant No. 1 has a sludge lagoon, the Balara Plant does not. Standard designs and programs to furnish unified facility plan on sludge treatment facilities for the Balara Plant should be prepared.

Table C-1 RECOMMENDED REHABILITATION PLAN

PLANT NO.1

* indicates common items with Level 1

DESCRIPTION	Q'TY	REHABILITATION	REMARKS
Aqueduct No.1 & No.2 Guide of Sluice Gates	4 units	Replacement	*
Rapid Mixing			
Rapid mixers	2 units	Replacement	*
Baffle walls	L.S.	Construction	
Flocculation			
Flocculators	26 units (2 units for spare)	Replacement	Spare only for Level 1
Control panel house	L.S	Construction	
Sedimentation			
Drain valves for Sedimentation Basin No.1 & No.2	6 units (basin)	Replacement	
	4 units (channel)	Replacement	
Collecting launders with perforated baffle wall	20	Construction	
Baffle walls	L.S.	Construction	
Sludge discharge creek	L.S.	Excavation	*
Accelator			
Driving units	2 units	Replacement	
Sludge blow-off equipment	2 sets	Replacement	
Corroded steel members	L.S.	Repair	
Operation house	L.S.	Repair	*
Filtration			
Sheets of inlet and drain sluice gates	10 units	Replacement	
Pumps and air compressors for hydraulic control	2 units each	Replacement	
Anthracite	810 m^3	Replacement	Supplement only for
Surface wash	L.S.	Improvement	Level 1
Venturi tube	10 units	Replacement	
Washwater pumps	3 units	Replacement	*
Pump house	L.S.	Repair	*
Washwater Recovery			
Washwater pumps	3 units	Replacement	*
Pump house	L.S.	Reconstruction	*
Washwater returning points	L.S.	Change of point	

PLANT NO.2

DESCRIPTION	Q'TY	REHABILITATION	REMARKS
Flocculation			
Flocculators	12 units	Replacement	Only driving unit,chains, sprockets for Level 1
Baffle walls	L.S.	Construction	Replacement of wooden plated for Level 1
Control panel house	L.S.		
Sedimentation			
Foundation of inflow sluice gate guide	24 units	Replacement	*
Launders with perforated baffle walls	96 units	Construction	
baffle walls			
Shaft support for drain sluice gate	12 sets	Replacement	*
Flushing pumps	2 units	Replacement	*
Flushing pump house	L.S.	Construction	*
Filtration			
Sheets of influent and drain sluice gate	20 units each	Replacement	
Pumps and air compressors for hydraulic	2 units each	Replacement	
Control			
Anthracite	1,620 m^3	Replacement	Supplement for Level 1
Surface wash	L.S.	Improvement (Replacement)	
Washwater troughs	L.S.	Improvement of drainage cap.	*
Washwater			
Washwater pumps	3 units	Replacement	*
pump house	L.S.	Repair	*
Washwater Recovery			
Washwater recovery pumps	3 units	Replacement	
Washwater recovery storage tank and pump house	L.S.	Construction	
Washwater returning point	L.S.	Change of point	

CHEMICAL/CHLORINE FACILITIES

DESCRIPTION	Q'TY	REHABILITATION	REMARKS
Alum Dose			
Feeders	6 units	Replacement	Spare only for Level 1
Calibration flow meter	L.S.	Installation	
Elevated foundation of feeders	6 sets	Construction	
Polymer Dosing			
Feeders	5 units	Replacement	*
Calibration flow meter	L.S.	Installation	
Chlorination			
Chlorinators	4 units	Replacement	*
Evaporators	2 units	Replacement	*
Chlorine leak detectors	3 units	Replacement	*
Exhaust fan	3 units	Replacement	*
Hoist	3 units	Replacement	*
Chlorine booster pumps	3 units	Replacement	*
Dosing pipings	3 units	Replacement	*
Roof	L.S.	Repair	*
Chlorine storage house	L.S.	Expansion	*
Hoisting rail	L.S.	Installation	
Laboratory Equipment	L.S	Replacement	Partly for Level 1

ELECTRICAL EQUIPMENT AND INSTRUMENTATION

DESCRIPTION	Q'TY	REHABILITATION	REMARKS
Power Receiving			
Poles and wires	24 pcs	Replacement & Improvement	Replacement only for Level 1
Power Receiving Panel and Others	1 unit	Installation	
Low Voltage Main Service Line			
Overhead wires	L.S.	Replacement	*
Low Voltage Power Line Improvement Equipment	6 units	Installation	
Motor Control Panels	28 units	Replacement	Partly for Level 1
Lighting Panel	2 units	Replacement & Modification	
Distribution Panel	2 units	Replacement	*
Starter Switch for Chlorine Booster Pump	1 unit	Replacement	*
Flow Meter			
Flow Meter (1)	10 units	Replacement	Only Accelator & Parshall
Flow Meter (2)	2 units	Installation	Flume
Level Meter	7 units	Replacement	*
Instrumentation of Filter beds			
Loss of Head Devices	30 units	Replacement & Modification	*
Rate of Flow Devices	30 units	Replacement & Modification	*
Instrument Panel	1 unit	Replacement & Modification	Partly for Level 1
Interior Lighting	L.S.	Replacement & Improvement	
Street Lighting	L.S.	Replacement	
Lightning Facilities	L.S.	Installation & Modification	Partly for Level 1
Generator for chlorination Equipment	1 unit	Installation	*
Testing Equipment	L.S.	Procurement	*

Table C-2 BALARA REHABILITATION PROJECT : SELECTED INDICATORS

Project Level	Local Funds	Foreign Funds	Total Funds	Equipment Cost	WACC (%)	EIRR (%)	FIRR (%)	ADJUSTED Level 1 FIRR	Level 1 Bud't Inc	Adj'd BUDGET
Level 1	53.913 (290.583)	231.643	285.556 (522.226)	147.310 (305.090)	5.02	63.8	7.8	Max: 7.02	None	285.556
Level 2	155.621	531.326	686.947	336.580	5.49	32.4	5.4		50%	428.334
Level 3	189.930	715.780	905.710	446.301	5.28	26.3	0.1	Min: 4.31	100%	571.112

Note: 1 Additional amount of 236.67 million pesos as local funds in level 1 is required in keeping functional effectiveness at its minimum, and is not intended to upgrade toward level 2.
2 The figure of 290.583 of level 1 local funds is the sum of 53.913 and 236.67. The present value of 290.533 at the end of 1998 at SDR of 15% = 125.627.
3 The figure 522.226 = 290.583 + 231.643. The present value of 522.226 = 225.773 at the end of 1998 at SDR of 15%.
4 Total cost of equipment = 147.310 + 157.780 = 305.090. The present value of 305.090 = 131.899 at the end of 1998 at SDR of 15%.

COMPILATION OF THE REPORT

The study report for the Feasibility Study on the Balara Water Treatment Plant Rehabilitation Project is composed of the following four volumes.

Volume I	SUMMARY
Volume II	MAIN REPORT
Volume III	SUPPORTING REPORT
Volume IV	DRAWINGS

This report (Volume I) represents a summary setting forth the conclusion and recommendation of the study.

TABLE OF CONTENTS

Page

PREFACE

PROJECT SITE i

BALARA SERVICE AREA ii

GENERAL PLOT PLAN iii

CONCLUSION AND RECOMMENDATION iv

CONCLUSION iv

1. Highlights of the Project iv
2. Expected Durability v
3. Project Cost and Implementation Schedule .. v
4. Economic and Financial Analysis vi

RECOMMENDATION vii

COMPILATION OF THE REPORT xiv

TABLE OF CONTENTS xv

1. INTRODUCTION..... 1

1.1 Background 1
1.2 Study Area 1
1.3 Objectives 1
1.4 Scope of Work 2

2. NATURAL CONDITIONS

2.1 Topography 2
2.2 Geology 3
2.3 Climate 3
2.4 Groundwater Sources 3
2.5 Population 4
2.6 Economy 4

Page

2.7 Income and Expenditure 5

3. EXISTING WATER SUPPLY FACILITIES OF MWSS 5

3.1 Raw Water Sources 5
3.2 Water Treatment Facilities 6
3.3 Distribution Facilities 6

4. PRESENT FINANCIAL SITUATION 7

5. PRESENT CONDITIONS OF THE BALARA PLANT 7

6. OUTLINE OF THE BALARA PLANT 8

6.1 Plant Capacity 8
6.2 Design Criteria 9
6.3 Existing Structures 9
6.4 Mechanical, Electrical Facilities and Instrumentation 9
6.5 Chemical Dosing 15
6.6 Water Quality Control 17
6.7 Operation and Maintenance Cost 19

7. ORGANIZATION AND INSTITUTION 20

7.1 Organization of MWSS 20
7.2 Organization for the Balara Plant 20

8. REHABILITATION PLAN 22

8.1 Basic Principles of Rehabilitation Plan ... 22
8.2 Design Capacity 23
8.3 Rehabilitation Levels as Alternatives 23
8.4 Project Costs 25
8.5 Recommendation for Rehabilitation 26
8.6 Environmental Assessment 27

Page

9. IMPLEMENTATION SCHEDULE 28

10. FINANCIAL AND ECONOMIC ANALYSIS 29

11. PROJECT EVALUATION 33

11.1 Socio-Economic Aspects 33

11.2 Technical Aspects 33

11.3 Environmental Aspects 34

14.4 Financial and Economic Analysis 35

1. INTRODUCTION

1.1 Background

The present water system for Metro Manila is dependent mainly on surface water with groundwater as supplement. However, due to the rapid increase in the population of Metro Manila, the present water supply is insufficient in meeting the expected demand for water.

In order to solve the shortage of water supply, several projects have been undertaken by MWSS. While these projects are already in progress, the Balara Water Treatment Plant needs immediate rehabilitation. The Balara Plant consists of Plant No. 1 and Plant No. 2 which were constructed in 1935 and 1958, respectively. While both were modified in 1981, no thorough rehabilitation of any kind was implemented since then. The Plant presently performs a vital role in the water supply system since it accounts for about 60% of the total water production for Metro Manila. However, the facilities and equipment of the Plant are superannuated and difficulties have been encountered in trying to operate the plant efficiently.

Therefore, it is imperative that the rehabilitation of the Balara Plant be implemented immediately in order to restore the designed capacity of the Plant and continue providing the much needed adequate and safe water supply to Metro Manila residents.

1.2 Study Area

The Study area is the Balara Plant premises (Refer to the figure in the beginning of this report). In addition, in order to study the water quality management focusing on residual chlorine, water sampling near the distribution trunk mains were taken in the Balara Plant service area.

1.3 Objective

The objective of the Study is to formulate the rehabilitation plan for the existing Balara Plant taking into consideration the operation

and maintenance aspects.

1.4 Scope of Work

The main scope of work consists of the following:

- Study for Rehabilitation

  The main scope of rehabilitation work is a planning scheme which seeks to recover the current design capacity of the existing treatment process and equipment. The Study will not include any rehabilitation of aqueducts, distribution pipeline and distribution reservoirs, nor alterations on the building structure. However, some exceptions may include alterations related to the placement of equipment or to some changes in the treatment process.

- Study for Water Quality Management in Pipeline Networks

  A study is undertaken for the water quality management and operating procedure of the water treatment plant. The study focuses on the residual chlorine concentration check based on the water quality analysis and coliform tests and on the water samples obtained from sampling points near the distribution trunk line.

2. NATURAL CONDITIONS

2.1 Topography

The Balara Water Treatment Plant is located at 50m to 75m above mean sea level at an undulating topography in Quezon City, Metropolitan Manila. The service area of the Balara Plant at an elevation of 40-200 m exist in the southern part of the Luzon Central Plain East Side Hill. West of the Balara service area, the Marikina River flows from north to south and inflows into the Pasig River turning at a right angle direction pouring to the Manila Bay.

2.2 Geology

The Balara Plant and its service area is underlain by the Guadalupe Formation and Alluvium of Quaternary age. The Marikina Fault is approximately 500 meters away from the Balara Plant and has been traced to be at least 23 km from Lower Macabod, Rodriguez in the north down to the vicinity of the Ultra Sports Complex in Pasig, Metro Manila.

2.3 Climate

The Philippines generally experiences the tropical monsoon. However, due to the complex topography, the climate varies in different parts of the country. Metro Manila has two pronounced seasons: the dry season from December to May and rainy season from June to October.Annual average precipitation is 1885.0 mm from 1951 to 1977. Maximum rainfall occurs in the rainy season from June to October. Average monthly temperature in May is 29.4°C and which reaches up to 36 to 37°C. Humidity increases steadily in June to September from 80 to 86%.

2.4 Groundwater Sources

Total water production is approximately 3,310 MLD in the whole MWSS Service Area for 1990. Surface water of the Angat River System provides 2,400 MLD out of 3,310 MLD which is distributed by the Central Distribution System (CDS). The remaining 910 MLD is supplemented by deepwell water of which 90 MLD is supplied from MWSS controlled wells and 820 MLD is pumped by the private sector.

Approximately 3000 deepwells and 20,000 shallow wells exist within the Central Distribution System. Out of 3000, 220 deepwells are maintained by MWSS and only 120 operational wells producing an average of 90 MLD. The private sector utilizes approximately 780 MLD deepwell water and approximately 40 MLD of shallow well water.

Groundwater pumped from these wells is causing ground water table decline at the rate of 4m to 8m annually. Elevation of groundwater

has lowered to 50m to 120m below sea water and salt water intrusion into groundwater has occurred specifically on the coastal areas.

2.5 Population

Metro Manila has total population of 7,833,000 and the most urbanized and economically developed area of the country. The MWSS service area covers the whole of NCR and 3.2% of the Region IV. It comprises of five cities and thirty two municipalities with a combined population of 9,172,379 (6,805,630 in 1980). This figure presents 15.17% of the country's total population and reflects an increase of 34.78% over the 1980 figure, or an annual growth rate of 3.03%.

2.6 Economy

Economy, as measured by the constant Gross National Product (GNP) in 1972 rose by 5.1%, 10.8%, and 5.3% in 1987, 1988, and 1989, respectively. Per capita income at 1972 prices was ₱1463 in 1989.

The manufacturing sector consistently contributed to GNP growth by 6.3%. Agriculture and fishery improved by 4.6% while the services sector gained by 5.5%.

In 1991, the growth of GNP was expected to increase at a lower rate due to natural calamities which besieged the country such as the Pinatubo Eruption, earthquake and typhoons.

Economic growth rate for the period between 1990 and 1995 is projected at 3.5% per year to accelerate at 5.7% during the period between 1995 and 2000, according to the International Monetary Fund (IMF).

Among the Asian countries, the Philippine's economic growth rate was lower than that of other Asian nations. Thailand recorded an annual rate of 6.5%; Malaysia, 5.5%; Indonesia, 5.1%; and Philippines, 2.3% during the period between 1980 and 1990.

2.7 Income and Expenditure

The 1988 survey on family income and expenditures indicates an average annual family income of ₱40,408, an increase of 30% from the 1985 average of ₱31,052.

Families in urban areas earned an average of ₱60,330, more than twice that of rural families at ₱28,284. Metro Manila is the top income earner posting an average of ₱79,314.

The distribution of income by income class shows that families under ₱30,000 constituted 32.9%; those between ₱30,000 and ₱39,999, 20.1%; those between ₱40,000 and ₱59,999, 21.5%; those between ₱60,000 and ₱99,999, 16%; and those over ₱100,000, 9.5%, respectively.

Prices of consumer goods and services increased at a faster rate in 1989, compared to the price increases in 1986-1988. A double-digit increase occurred for the first time in three years as the consumer price index (CPI) rose at an annual rate of 10.6%. The inflation rate was estimated at 14% in 1990, at 12% in 1992 and 7 to 8% during the period between 1992 and 2000.

Food items rank the top among family expenditures. The percentage distribution of family expenditures in 1988 shows that food items amounted to 51%; housing, 13%; fuel, light, and water, 5%; transportation and communication, 5%; clothing and other wear, 4%; education, 3%; personal care, 3%; and alcoholic beverages and tobacco, 3%.

3. EXISTING WATER SUPPLY FACILITIES OF MWSS

3.1 Raw Water Sources

The present raw water sources of MWSS are surface water and groundwater which contribute 96.3% and 3.7% of the supply, respectively.

Surface water, the major water source, comes from the Angat Dam (storage capacity of 850 million m^3, MWSS allocation from the Angat

reservoir is 1,900,000 m^3/day) and the Ipo Dam (storage capacity of 5.9 million m^3), which comprise the Angat-Novaliches Water Supply System. Water flows by gravity from water sheds to the Angat dam, the Ipo dam, the Bicti headworks, and the La Mesa dam (storage capacity of 45.42 million m^3). Thereafter, it is channeled to the Balara Water Treatment Plant and the La Mesa Water Treatment Plant No. 1 (Fig. 3.1)

3.2 Water Treatment Facilities

MWSS supplies potable water to Metro Manila through two large water treatment plants, the Balara Plant and the La Mesa Plant, with the Angat-Novaliches Water Supply System as source of supply. The Balara Plant and the La Mesa Plant have a current design capacity of 1.6 and 1.5 million m3/d, respectively and a capacity of 3.1 million m3/d. In addition to these, the construction of La Mesa Plant No. 2 of which design capacity is 0.9 million m^3/d was commenced in the beginning of 1991.

3.3 Distribution Facilities

The water distribution facilities of the MWSS has been undergoing a series of expansion and rehabilitation under the MWSP I and II, MWSRP I, MWSRP II and AWSOP to meet the increasing demand in Metro Manila.

The existing MWSS distribution facilities are shown in the Figure "LOCATION OF STUDY AREA & BALARA SERVICE AREA" in the beginning of this reports.

The distribution facilities include 472 km of pipelines, 185 reservoirs with a total storage capacity of 650,000 m3 and 13 major pumping stations. However, 6 reservoirs were not utilized in 1989 due to the breakdown of the pumping facilities and leakage problems on the reservoir structures. Likewise, only 7 pumping stations are presently operational.

4. PRESENT FINANCIAL SITUATION

Table 4.1 shows from major categories of financial data: total receipt, current expenditure, capital expenditure, and the balance (total receipt - current and capital expenditures)

The balance shows negative during the period between 1991 and 1995 and turns to be positive in the years of 1996 and 1998. This indicates there is serious problem of cash flow to MWSS. While total receipt continues to rise from 3,654 million pesos to 10,833 million pesos by year 2000, capital expenditure may not rise much, ranging from 3,380 million pesos to 4,068 million pesos during the same period.

On the other hand, current expenditure increases from 2,642 to 6,098 million pesos.

Still another indicator is the financial rate of return on assets. The rate of return shows around 10 percent for 1991 and 1993, but continue to decrease gradually over the year and is expected to reach 5.43 percent by year 2000. There appears a problem of capital or financial management.

5. PRESENT CONDITIONS OF THE BALARA PLANT

In order to meet the rapidly increasing demand, MWSS has been intensifying water production. The MWSS is exerting all efforts to maintain water production at its treatment capacity. The capacity of the Balara Plant is 1.60 million m^3/day while the La Mesa capacity is 1.50 million m^3/day. The recent output of the Balara Plant is 51.60% of the total production of the two treatment plants, showing the important role of the Balara Plant in the MWSS system. (Actual production in September 1990 of the La Mesa Plant was recorded at 1.05 million m^3/day for the Balara Plant indicating a 60% share in the total production output)

After the completion of the La Mesa No. 2, its capacity will increase

by 0.90 million m^3/day. Even at this stage, the Balara Plant still performs a major function since it will be supplying 40% of the total water production.

After the year 1997, as shown in Fig. 5.1 construction of an additional plant will be necessary to cope with the ever increasing water demand. Also to be taken into consideration are the number of years required for land acquisition, design, fund allotment, and actual construction. In view of this, the performance of the Balara Plant will have to be maintained on a long-term basis.

6. OUTLINE OF THE BALARA PLANT

General plot plan of the existing Balara Plant is shown in the figure at the beginning of this report, the flow diagram of Plant No. 1 and Plant No. 2 are shown in Fig. 6.1 and Fig. 6.2, respectively. Outline of facilities is shown in Table 6.1.

At present, Plant No. 1 consists of 2 units of sedimentation basins and 2 units of Accelators as pre-treatment facilities, and 10 units of high rate dual media filters, while Plant No. 2 consists of 2 units of parshall flume, 12 units of flocculation and sedimentation basins and 20 units of high rate dual media filters.

6.1 Plant Capacity

The existing Balara Plant is mainly composed of two Plants. Their respective capacities are summarized in Table 6.2. The combined total design capacity of the Plants is 1,600,000 m^3/d.

While available raw water is conveyed from the La Mesa Dam by three aqueducts with a combined capacity of 1,705,000 m^3/d, extra available raw water amount against the existing design capacity is calculated to be only 105,000 m^3/d.

Expandability for production capacity of the Balara Plant is limited to and depends upon the capacity of raw water conveyance facilities.

On the other hand, another limitation is the hydraulic condition of the distribution main to the San Juan Reservoir and it is reported that water level in the Reservoir is controlled between E.L. 48.5 m and E.L. 47.0 m. The upper limit is to reduce pressure thereby preventing leakage in the system and the lower limit is to ensure suction for the pumps on the San Juan Pumping Station.

The actual water production listed in Table 6.3 shows the results of water production in the Balara Plant in 1989 and 1990.

6.2 Design Criteria

Design criteria for major treatment facilities used during the modification project in 1981 are shown in Table 6.4 and 6.5 with the actual operating conditions and their reference values compared.

6.3 Existing Structures

The survey was executed by ocular inspection and concrete compressive strength test using test hammer. The results of the ocular inspection showed that there are no major defects except for some minor repairs. The concrete compressive test indicated that the structures have sufficient strength.

6.4 Mechanical, Electrical Facilities and Instrumentation

The following are findings and recommendations relating to the processes of the Balara Plant.

(1) Plant No.1

1) Raw Water Conveyance

Four out of the five units of sluice gates are not functioning due to worn-out sluice gate guides.

2) Rapid Mixing

Although two units of rapid mixers are operational at present, frequency and cost of maintenance are increasing due to superannuation. The shafts has been rotating eccentrically due to the length of shaft and the rapid stream flowing in the channel.

3) Flocculation

Although most of the flocculators are operational at present, frequency and cost of maintenance are also increasing due to superannuation. Four flocculators out of the twenty four units have no motor due to burn-out. Frequency and cost of maintenance for the equipment, especially drive units, are increasing due to superannuation.

4) Sedimentation

Weur loading rate is calculated to be over 6,000 $m^3/m/d$ which extremely deviates from the 300 to 500 $m^3/m/d$ standard. Accordingly, flocs being carried over to filters are observed and filter run may be shortened.

Sludge discharge is not functioning due to insufficient hydraulic gradient between the sedimentation basin No. 1/No. 2 and the discharge creek inside the premises of the Plant due to accumulation of discharged sludge.

5) Accelators

Two units of rotor mixing units are operational at present, frequency and cost of maintenance for the reduction gears and worm gears, which are installed in 1958, are increasing due to superannuation. Submersible steel structures are partly corroded. Also, the sludge blow-off system, which bears an essential role in maintaining a stable slurry concentration is out of order.

6) Filtration

Most of the equipment such as rate of flow control system for filtration, rate of flow control system for surface wash and backwash, sheets of influent and drain sluice gate, pumps and air compressors for hydraulic control, and air compressors for pneumatic instrumentation are superannuated.

The existing surface wash system is ineffective especially during initial operation due to the improper angle of the perforations of the surface wash pipe to the anthracite level.

The results of grain size analysis show that sand is still useful. However, specifications of anthracite such as size and specific gravity deviate from the designed values. Depth of filter media is also not in accordance with the designed values.

7) Washwater and Recovery Pump

These second hand pumps had been transferred to the present locations in 1981, some pumps , however, were not very suitable for the usage. Efficiency of pump is low compared to the designed value due to superannuation and apparent leakage at the pump bearings.

The pump houses are also superannuated, and this affects maintenance conditions.

Recovery water is returned to the sedimentation No. 2 in which treatment effects are most likely to be worse than that of No. 1 due to the unstable current caused by the curved section of the Sedimentation basin.

(2) Plant No.2

1) Rapid mixing

At present the parshall flume is working effectively as a hydraulic rapid mixer, however, due to worn-out of flow indicators, accurate measurement of raw inflow rate cannot be conducted.

2) Flocculation

Several units of flocculators are not functioning due to the defective driving gears , chain and severe water leakages at the driving shafts. Even for the operating units of flocculators, frequency and cost of maintenance are increasing due to superannuation. Metal parts are corroded and rotation is not smooth. Short-circuiting might occur in the tank due to the installation level of flocculators and baffle walls.

3) Sedimentation

Some cracks on the foundation of the headstocks of the influent sluice gates are apparent. In addition , shaft supports of the drain sluice gate are corroded. Weir loading rate of the existing weir of each sedimentation basin is calculated to be 5000 $m^3/m/d$, extremely deviating from the 300 to 500 $m^3/m/d$ standard. Carrying over of particles which were stirred up after settling, were also observed in the basin.

4) Filtration

Most of the items related to the control of the filtration system such as the control units, flow control systems for filtration, surface wash and backwash, sheets of inlet and drain sluice gate, pumps and air compressors for hydraulic control, and air compressors for pneumatic instrumentation are all superannuated.

Washwater troughs are not functioning due to submergence during backwash, caused by a series of hydraulic problems such as the

opening size of wash drain sluice gates and available hydraulic gradient through drainage channel.

5) Washwater Pump

One of three washwater pumps has no motor due to burn-out. Although the remaining pumps are operational at present, frequency and cost of maintenance are increasing due to superannuation.

The pump house is also decrepit, thus affecting maintenance conditions.

6) Washwater Recovery

Washwater from filters in Plant No.2 is discharged to creeks, then, it is stored and introduced to Washwater Recovery Pumps by flush boards on the creeks. At present, water is not returned to the Accelators affecting their stable operation.

(3) Chemical/Chlorine Facilities

Mechanical parts controlling the rotational speed of alum feeders and polymer feeders are so superannuated that the actual dosing amount is not consistent.

According to the actual dose test made by the Study Team, accuracy of dose amount of polymer is not consistent.

Although chlorination facilities including chlorinators, evaporators, chlorine leak detectors, exhaust fan, chlorine booster pumps and dosing pipelines are operational at present, frequency of maintenance and cost are increasing due to superannuation.

The existing chlorine storage house can store chlorine for only one week's use, and it is necessary to extend the area.

(4) Laboratory Equipment

Almost all of the equipment used at the plant laboratory are obsolete. Some equipment which requires a degree of accuracy are utilized even without any calibration.

(5) Electrical Facilities

1) Substation

The overhead distribution lines have difficult points of maintenance due to the lack of isolation devices at the point of tapping. Also, the existing lines are installed on wooden poles which are mostly deteriorated and hazardously inclined.

2) Diesel Engine Generator

During power interruptions (brown-outs) the booster pumps of the chlorinators are inoperational, cutting-off the supply of chlorine to the distribution pipeline for the entire duration of the brown-out.

3) Low Voltage Distribution Lines

Although low voltage distribution lines in Plant No.1 was rehabilitated by replacing wooden poles in 1981, these lines at present are not properly maintained. The lines have large voltage fluctuations and voltage imbalance among three phases at Motor Control Center (MCC) in Plant No.1 Filter Building were recorded.

4) Control Facilities

Most of DP/MCC are installed near their loads and with enough maintenance spaces. However, they have been deteriorating due to corrosion brought about by high humidity and temperature and suffer from shortage of spare parts.

Houses for control facilities at Settling Basins No. 1 & No. 2 are

not spacious enough for maintenance purposes. MCC of flocculators in Plant No. 2, also has a very narrow space near the locker room in the Filter Building. These conditions are not appropriate from the viewpoint of safety.

5) Instrumentation & Supervision Systems

Instrument information is not monitored by the sanitary engineer due to damages on the instrumentation system caused by lightning in 1984 and voltage fluctuations. At present, the operator takes the manometer readings of the venturi tube on aqueducts and relays the flow to the engineer by telephone. At the same time, the engineer informs the operators at the reservoir as to the opening of gates at the intake for water inflow control to the plant.

6) Lightning Protection Equipment

In comparison to other areas, frequent occurrence of lightning is evident in the Balara area. Due to this, some electrical and instrumentation facilities in the Plant have been damaged, namely, the ground wire of 34.5 kV overhead distribution line; lightning arresters in substations and the surge absorbers at service points of low voltage distribution lines.

7) Others

There is a very limited quantity of instruments and tools used for maintenance in the Plant and this directly contributes to the lack of proper maintenance of the facilities. As a result, maintenance of electrical equipment and instrumentation is limited to visual inspection and regular cleaning.

6.5 Chemical Dosing

(1) Method of Dosing

1) Alum

In the Chemical House, six Rotodips including one stand-by unit measure alum dosage by proportioning feed method controlled by Pelton wheels. Dosing points of five Rotodips are as follows.

a. Rapid mixer at Sedimentation Basin No. 1 in Plant No. 1
b. Rapid mixer at Sedimentation Basin No. 2 in Plant No. 1
c. Accelators in Plant No. 1
d. Parshall Flume (North) in Plant No. 2
e. Parshall Flume (South) in Plant No. 2

The Rotodip doses alum to two Accelators then two rotameters are installed near Accelators to evenly deliver it to each Accelator.

2) Polymer

During usage, polymer is at first manually transferred to a measuring tank with wheels for measurement of quantity for one mixing tank. Then, the polymer is poured into a mixing tank which is filled with water for dilution.

Four plunger pumps supply diluted polymer to the following dosing points:

a. Rapid mixer at Sedimentation Basin No. 1 & No. 2 in Plant No. 1
b. Accelators in Plant No. 1
c. Parshall Flume/Flocculation Basin (North) in Plant No. 2
d. Parshall Flume/Flocculation Basin (South) in Plant No. 2

Same as Alum dosing, rapid mixer at Sedimentation Basin No. 1 & No. 2 and Accelators in Plant No. 1, two rotameters are installed to confirm a uniform flow to each unit of basin and Accelator, respectively.

3) Chlorine

Dosing points of chlorine gas solution are as follows:

a. Pre-Chlorination

- Aqueduct No. 1 near Chemical house for Plant No. 1
- Receiving well of Accelators in Plant No. 1
- Receiving well in Plant No. 2

b. Intermediate-Chlorination

- Inflow Channel to Filter Building in Plant No. 1
- Inflow Channel to Filter Building (East wing) in Plant No. 2
- Inflow Channel to Filter Building (West wing) in Plant No. 2

c. Post-Chlorination

- Effluent aqueduct from Plant No. 1
- Effluent aqueduct (84") from Plant No. 2
- Effluent aqueduct (72") from Plant No. 2

(2) Actual Dosage

Amount of chemicals like alum, chlorine, cationic, and anionic polymer, consumed in 1990 are shown in Table 6.6.

Dosage of alum and cationic polymer was extremely increased in July, August, and September during the rainy season when the raw water turbidity increases, while dosage of chlorine and anionic polymer was not varied much.

6.6 Water Quality Control

(1) Water Quality Standard

The National Standards for Drinking Water, 1978, prepared by the Ministry of Health, prescribes the maximum permissible level of the parameters that affect the quality of drinking water. Table 6.7 presents the water quality standards on physical, chemical and radio-

logical requirement. Residual chlorine is also regulated in the Standards to maintain not less than 0.1 mg/l at the furthest point of distribution system.

(2) **Process Water Quality Control**

Table 6.8 and 6.9 show the results of the latest water turbidity test which was recorded by the Plant Laboratory of PQU of Plant No. 1 and No. 2 from April to October 1991. Turbidity of finished water exceeds the drinking water standard of 5 mg/l when raw water is very turbid specifically when raw water turbidity is beyond 40 mg/l during rainy season.

Monitoring process water of the Balara Plant was conducted by the Study Team from 20th September to 22nd October 1991 considering the pH, conductivity, alkalinity, and turbidity. Results revealed that pH, conductivity, and alkalinity were fair since pH values ranged from 6.4 to 7.3, conductivity ranged from 115 to 150 μs/cm, and alkalinity ranged from 45 to 60 mg/l. From 0.24 mg/l of theoretical reduction ratio of alkalinity by unit alum dosage and desirable residual alkalinity of 20 mg/l in filtered water, 25 mg/l of alkalinity is available at least in the worst case. Thus, the raw water is of desirable quality after undergoing the existing water treatment process in the Balara Plant. These findings are supported by the data prepared by the PQU during January to December in 1990 as shown in Table 6.10.

(3) **Service Water Quality Control**

In order to study the water quality of the Balara Water Supply System in which some 111 representative sampling points were indicated to be zero in residual chlorine (as reported in the "PRELIMINARY ENGINEERING REPORT WATER DISTRIBUTION SYSTEM; VOL. 1 - TEXT", in November, 1989 on the ANGAT WATER SUPPLY OPTIMIZATION PROJECT), an analysis of the residual chlorine in the distribution lines was conducted. The area being served solely by the Balara Plant was isolated and divided into four districts for the sake of convenience as shown in Fig. 6.3. Sampling points were identified on the basis of its proximity to the

trunk main. This was done to prevent the distributed water contaminated through the service pipings from being sampled, otherwise, unreliable test results will be obtained. Coliform test, turbidity test, conductivity and pH check were conducted.

As shown in Table 6.11, residual chlorine was sufficiently detected to be ranging from an average of 0.2 to 0.7mg/l in all parts of the study area. This is stressed further depending on the proximity of the sampling point from the trunk main where high residual chlorine levels were monitored. However there are some service pipelines which have been monitored to contain only traces of residual chlorine. Such a situation occasionally occurs due to changes in the distribution pressure. Almost all of the trace level of residual chlorine was monitored in areas where there is low water pressure and the service pipelines are antiquated, specifically the Makati and Manila areas. In Marikina and Pasig, where numerous construction developments are taking place, some areas were observed to be low in residual chlorine due to the shortage of water supply.

6.7 Operation and Maintenance Cost

The O & M costs for the last five years of the Balara Plant is summarized in Table 6.12.

The composition ratio of total repair expenses (material of the Instrumentation Field Service Section, preventive maintenance and general repair of the TP Mechanical & Electrical Section) indicates only 3.5% for all the ratio appears very low, comparing with that one ranging 15% to 20% of Tokyo Metropolitan Government Waterworks Bureau.

Taking into consideration the difference of personnel expenses, welfare expenses and etc., the value of the ratio further becomes low, which seems that repair expenses for all budget has been made light.

7. ORGANIZATION AND INSTITUTION

7.1 Organization of MWSS

After World War II, in 1955, in order to accelerate the restoration for devastated facilities, the National Waterworks and Sewerage Authority (NWSA) was established. In 1971, NWSA was reorganized into two water-related organizations, namely MWSS and LWUA by the Act No. 6234, "An Act Creating the Metropolitan Waterworks and Sewerage System and Dissolving the National Waterworks and Sewerage Authority, for Other Purposes".

The organization of MWSS is shown in Fig. 7.1. The Board of Trustees is an organ for "decision-making" and is composed of ten members including Board Secretary. It is the rule that the Secretary of the Department of Public Works and Highways (DPWH) plays the role of ex-officio as the Chairman unless the President of the Philippines shall appoint another person as Chairman. And the Administrator of MWSS plays as the Vice-Chairman. According to the rule, the Undersecretary (for Construction) of Public Works and Highways is placed as the Administrator, unless another person shall be appointed designated by the President of the Philippines. Six members of the Board shall be appointed by the President and the one remainder is placed from the Government Corporate Council as a legal Adviser of the Board.

One Senior Deputy Administrator and six Deputy Administrators are supporting the Administrator.

Number of MWSS employee is 8,962 persons as of August 31, 1991, of which 4,803 are permanent employees and the rest are casual employees. Table 7.1 shows the number of MWSS personal by Department.

7.2 Organization for the Balara Plant

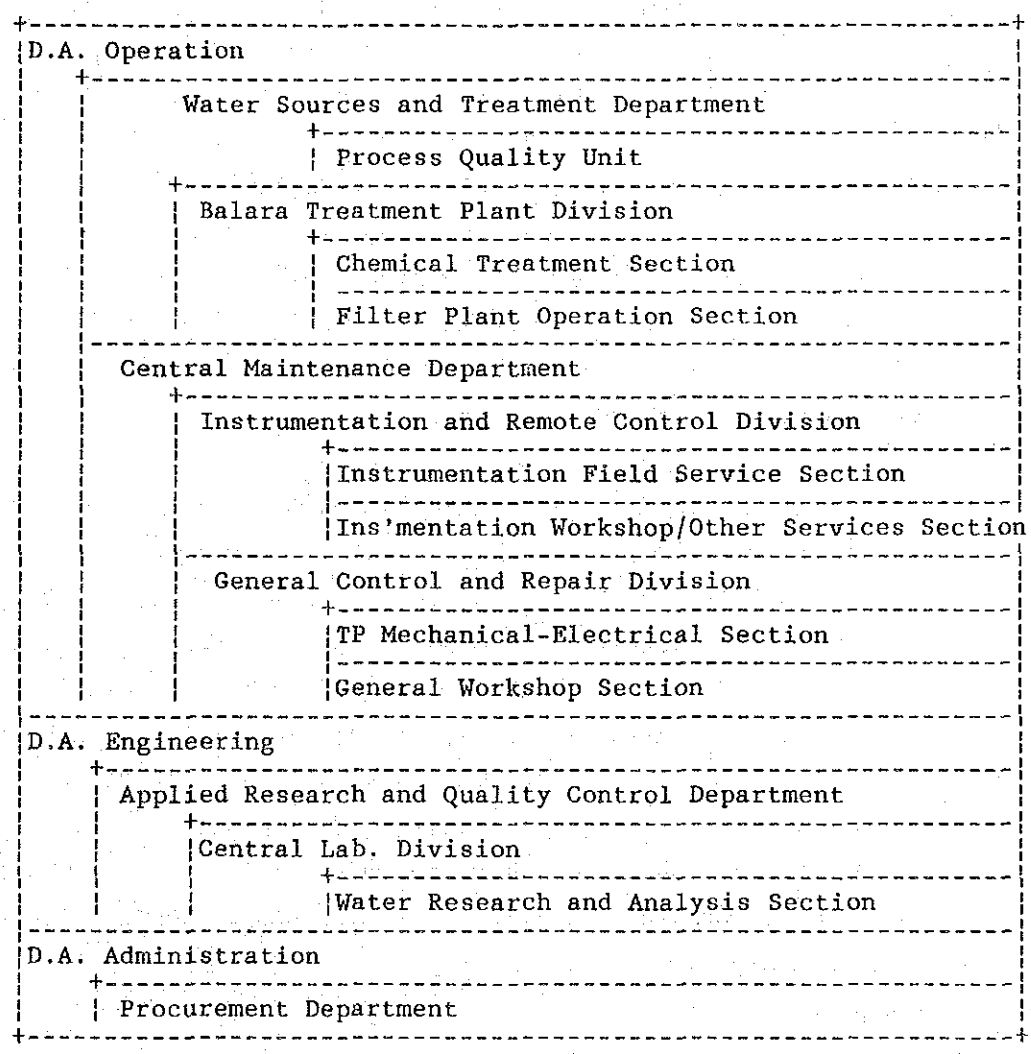
(1) General Observation

The operation and maintenance of the Balara Plant, the La Mesa Plant, Distribution and Sewerage System is under the Deputy Administrator

for Operations. (See Fig. 7.1 Organization Chart of MWSS). However, to operate and maintain the Balara Plant, the Procurement Department under the D.A. for Administration and the Applied Research and Quality Control Department under the D.A. for Engineering which are concerned with the processing of purchase orders. Although at present, this complicated organizational set-up was observed to attain mutual cooperation, it will become more difficult once the La Mesa No. 2 commences its operation.

(2) Organizations

The following are the Deputy Administrators, Departments, Divisions and Sections concerned with the O & M of the Balara Plant.



8. REHABILITATION PLAN

8.1 Basic Principles of Rehabilitation Plan

The principles with which this study would follow to come up with an optimum rehabilitation plan are as follows:

1) Design capacity is restricted by the hydraulic performance of the conveyance aqueducts from the La Mesa Dam to the Balara Plant. Therefore, the capacity is proposed as 1,600,000 m^3/day.

2) Replacement is applied for such equipment and facilities that is projected to be worn-out after the completion of the project taking into consideration O & M problems.

3) Stable Plant Operation

The rehabilitation plan also intends to maintain a stable operation of the Plant after its completed rehabilitation. Also, the rehabilitation intends to furnish only the mechanical and electrical equipment which is suitable to Philippine conditions.

4) Enhancement of O & M Procedures

The actual modification items involved in this aspect is the plan to improve the efficiency of each treatment process. To specifically elaborate, by increasing the efficiency of the sedimentation process through the proposed rehabilitation items intended for this purpose will reduce the load of work that will be conveyed to the filters, thereby maximizing the capability of each facility.

Secondly, when the proper, suitable equipment is installed, a certain degree of reliability is attained. For instance, in the chemical dosing facilities where the proper dosage of chemicals is critical, accurate measuring devices should always be functioning properly.

Lastly, vital information that is utilized in the overall opera-

tion of the Plant should be obtained from accurate instrumentation and measuring devices. A specific example which illustrates this idea is the proposal for installation of flow meters to accurately measure capacity treated that should reflect to the overall operation of the Plant.

8.2 Design Capacity

The total combined capacity of the aqueducts is limited to 1,705,000 m^3/d taking into consideration the hydraulic performance and size, available head between the water level of the La Mesa Dam and the Plant.

Design capacity applied in the modification project in 1981 was reported to be 1,600,000 m^3/d. However, the actual amount of filtered water in the Plant had a varying range of 1,364,000 m^3/d to 1,554,000 m^3/d from 1989 to 1990, as shown in Table 6.3. Average water production at present is approximately 1,450,000 m^3/d which deviates from the 1,600,000 m^3/d design capacity, even taking consideration of 2 % of water losses through the treatment process.

External causes were also identified. The transmission mains from the Balara Plant to the San Juan Reservoir which has a total capacity of 1,610,000 m^3/d, based on the report entitled, "REPORT ON OPTIMIZING THE OPERATION OF THE BALARA AND LA MESA WATER FILTRATION PLANTS" which is sufficient to cover the design capacity of the Plant, has not been used effectively in order to avoid leakage problems in the service systems. Therefore the design capacity is herewith proposed at 1,600,000 m^3/d.

8.3 Rehabilitation Levels as Alternatives

Possible equipment plans have been further evaluated technically taking into consideration the construction plan, hydraulic constraints, water quality control and O & M. Then, the final classification of rehabilitation is formulated according to three levels as shown below:

(1) Level 1

Consists of the minimum replacement of equipment and resumption of the same existing conditions during the modification project in 1981. Necessary review of performance of equipment which will be replaced will be considered. In addition, replacement of vital facilities which are even operational at present such as chlorination facilities are included with Level 1 as a minimum replacement. This level is based on actual successfully managed performance of existing facilities as a whole, but items are limited to only urgent matters.

(2) Level 2

Consists of and in addition to Level 1, stable supply and safe quality of water to be achieved in connection with the improvement of water quality control and O & M. Rehabilitation items will be expanded which will not only involve the replacement of equipment as in Level 1, but also the improvement of process water quality control and the repair of existing structural defects, taking into consideration the actual O & M procedures and financial measures. In addition, the design of this rehabilitation plan is based on necessary and normally prevailing technology.

(3) Level 3

Consists of modernization and possible expansion in terms of water treatment process will be added to Level 2, provided that technical, financial, socio-economic, and environmental aspects are all satisfied.

As a result of the preparation of the Rehabilitation Plan, Table 8.1 itemizes the three levels of rehabilitation for each facility.

Based on Table 8.1 which compares the different levels of rehabilitation, the most appropriate level of rehabilitation which corresponds adequately to the existing hydraulic and physical conditions of the plant and the accompanying financial considerations is Level 2. This

level involves the replacement of defective equipment and facility, improvement of the process water quality control, and repair of existing structural defects thus providing a complete approach to the solution of the urgent rehabilitation requirements of the Treatment Plant. The expected durability of Level 2 is 15 years since the civil and architectural structures will last in the years ahead and normally, equipment of the plant will approximately last 15 years.

Level 1 which consists of minimum replacement of equipment and the resumption of existing conditions after the modification project in 1981, is more of short-term in approach. Although this level of rehabilitation will be comparatively lesser in cost and the actual construction will be easily implemented with minor inconveniences, the benefits derived will be superficial. In addition, the expected durability appears to be about 5 years as a whole because the components of Level 1 are minimal replacement as an urgent countermeasure.

Level 3 offers a rehabilitation scheme based on a long-term outlook. The scheme which involves the modernization and expansion of the treatment process will entail huge costs as compared to Level No. 1 and 2 which may not be within the existing financial conditions. However, this rehabilitation scheme will provide future generations with an advanced and much-better equipped Treatment Plant.

8.4 Project Costs

The total project cost of Level 2, consisting of construction cost, engineering charge and physical contingency, amounts to 686,947 thousand Peso at 1991 price as given below.

SUMMARY OF PROJECT COST COMPARISON OF REHABILITATION PLAN

Cost Item	Amount (1,000 Peso) Level 1	Level 2	Level 3
A. Construction Cost			
a. Plant No. 1	28,182	96,047	145,669
b. Plant No. 2	59,278	248,269	355,729
c. Chemical/chlorination/Others	34,925	51,560	52,602
d. Electrical equipment	117,982	182,362	208,382
Sub Total	240,367	578,238	762,382
B. Engineering charge (D/D,C/S, 10%)	24,037	57,824	76,238
Total	264,404	636,062	838,620
C. Physical Contingency (8%)	21,152	50,885	67,090
Grand Total	285,556	686,947	905,710

Note: D/D---Detailed Design
C/S---Construction Supervision

8.5 Recommendation for Rehabilitation

In the view points both of engineering and financial aspects, Level 2 is the most recommendable. The level can be said basic or fundamental plan because Level 2 includes the improvement for water quality control and for stable O & M after years ahead.

On the other hand, Level 1 (rehabilitation plan consists of urgent and survivable replacement of the worn-out equipment) is acceptable. From the results of economic and financial analyses both levels are justified feasible. The EIRR of Level 2 was computed at 32.4% and its FIRR at 5.4%, while the EIRR of Level 1 was computed at 63.8% and its FIRR at 7.8%. The base funds of Level 1 was assumed at approximately 286 million pesos. When the base funds increase by

10%, the adjusted Level 1 FIRR turns to 6.69%. Similarly as base funds increase by 20%, 30%, and 40%, the adjusted Level 1 FIRR are 6.37%, 6.06% and 5.78%, respectively.

Based on the aforementioned reasons, Table C-1 presents the recommended rehabilitation Plan.

8.6 Environmental Assessment

The following description is to show the potential effects of this project on the environmental resources of the study area. A summary impact matrix is shown in Table 8.2.

The plan will be confined to replacement equipment and some minor civil works. The civil works shall consists of provision of launders and perforated baffles for existing sedimentation basins; small scale excavation to build washwater recovery basin (L-20.0 m X W-16.0 m X H-4.0 m), and repair of roofs/doors/windows. These works are of the type that the contractor will be able to implement control measures to protect the river and its environment from new water pollution. Also, there will be very minor temporary inconveniences like noise and air pollution inside the premises during the rehabilitation works. Removal of excess soil will be conducted within the premises and the means of grading and seeding are controllable activities.

During the operation of the facility, inorganic & harmless sludge removed from raw water is discharged to the creeks within the Plant. This has been the practice ever since the plant commenced its operation in 1935. In the future it would be appropriate to treat the sludge after the completion of sewage treatment plants for Metro Manila. In addition, since the sludge is harmless and the volume discharged is approximately 30 t/d of dry solid which is relatively small as compared to the flow rate of 38.9×10^6 to 58.8×10^6 m^3/day of the Marikina River. Also the quality of water in the River is very contaminated and no utilization occurs in the downstream.

No chronic air pollution is expected from the operation of the facil-

ities. There is a minor air quality risk which is associated with the storage, handling, and use of chlorine gas in the disinfection house. The record of the existing facilities in this regard is satisfactory, with few accidents reported from chlorine leaks. Existing safety practices for handling chlorine should be reviewed and updated as needed, and subsequently implemented. Actually, the rehabilitation plan includes improvement of the storage house and replacement of superannuated chlorinators, evaporators, chlorine leak detectors, exhaust fan, hoist for handling chlorine cylinders, and chlorine booster pumps.

From a human resource point of view, the reliability of the water quality will be vastly improved with the upgraded plant. The plant regarded as one of the important infrastructures in Manila is presently yielding and transforming about 60% of the total safe water supply in Metro Manila thus performing a crucial function in meeting one of the basic needs of Metro Manila residents.

Accordingly, from a human resource and public health aspect, the implementation of the project should be conducted immediately.

9. IMPLEMENTATION SCHEDULE

In the formulation of the construction schedule, the following items were taken into consideration:

1) Possibility of reduced water production
2) Possible duration of suspended operation
3) Fluctuation of raw water quality
4) Electricity
5) Possibility of isolating each basin/bed

The implementation schedule is shown in Fig.9.1.

10. FINANCIAL AND ECONOMIC ANALYSIS

Financial analysis has two planning objectives, one is to determine if the net financial benefits are justifiable enough in some adverse situations, and the other to assess the cash flow situations in which selected policy parameters may contribute to an improvement of financial status.

The analysis is focused upon the net financial benefits, defined as the difference in benefits between with rehabilitation and without rehabilitation. The rehabilitation is to replace worn-out equipment and to restore and maintain the initial level of water production capacity of the Balara Plant.

The Balara Plant responsible for supplying 60% of safe drinking water to Metro Manila, have been confronted not only with serious deterioration of the equipment but also with the expected difficulty in maintaining safety standards of water.

Financial benefits with rehabilitation will be the expected financial benefits that could be prevented from being lost. On the other hand, those expected benefits could be lost without rehabilitation. The expected costs with rehabilitation includes (1) investment of equipment, (2) O & M cost, (3) depreciation, (4) interest payment, and (5) tax. On the other hand, this expected costs without rehabilitation consists of (1) loss of water revenue, (2) loss of other revenue, and (3) O & M cost. While O & M cost appears on both sides, O & M cost without rehabilitation is higher than that of with rehabilitation. The cost of importing parts and materials from abroad will contribute to the increase of O & M cost without rehabilitation. This difference is reflected in 15% increase of O & M cost without rehabilitation and in 10% increase of O & M cost with rehabilitation.

The net financial benefits are the net cash flow from the difference in net cash between with rehabilitation and without rehabilitation. The FIRR is then computed for each of the three levels of the rehabilitation project. The FIRR of Level 1, Level 2, and Level 3 is 7.8%, 5.4%, and 0.1%, respectively.

Sensitivity analysis is made in assessing to what extent, adverse changes of the financial environment will impact upon FIRR. Three scenarios are described. Scenario 1 assumes that O & M cost with rehabilitation increase at 15% compounded annually. Scenario 2 assumes that loss of revenue is 10% of total revenue (the sum of col(1) and col(2) in table 13.3.2, Main Report) Scenario 3 is a combination of Scenario 1 and Scenario 2. The impact of scenario 1 upon the FIRR is 6.2 % in Level 1, 4.1% in Level 2, and -1.9% in Level 3, respectively. The impact of scenario 2 upon to FIRR is 3.9% in Level 1, 2.3% in Level 2, and -4.2% in Level 3, respectively. The impact of scenario 3 upon the FIRR is 1.8% in Level 1, 0.3% in Level 2, and -7.9% in Level 3, respectively.

Both Level 1 and Level 2 can be justified on financial and economic grounds. Furthermore, sensitivity analysis of Level 1 and Level 2 both has been made in terms of adverse scenarios affecting the project environment. Both Level 1 and Level 2 can stand against each of the three different scenarios.

This will lead to a trade off problem between Level 1 and Level 2 project in terms of the efficient allocation of a given budget. Since Level 2 is a more efficient and lasting project than Level 1, a qualitative adjustment has been made in such a way that Level 1 may be comparable to that for Level 2. This has resulted in "adjusted Level 1", as indicated in Chapter 15, Main Report.

Assume that both Level 1 and Level 2 are acceptable to political decision-makers. Then Fig. 10.1 (Trade off between FIRR and funds) will demonstrate the relationship between FIRR of adjusted Level 1 and to extent of Level 1 budget increase on one hand, and the relationship between FIRR of Level 2 and adjusted FIRR of Level 1. Should adjusted Level 1 be preferred, the budget of adjusted Level 1 could range between 286 and 428 million pesos (50% increase of Level 1 budget). When the budget goes beyond 428 million pesos, FIRR of adjusted Level 1 decreases below that of Level 2. Should it be the case, Level 2 would be preferred over Level 1.

On the other hand, should Level 2 be preferred, the budget would be

687 million pesos.

Cash flow of MWSS is a great concern not only to those who are affected by the project but also to those who make a decision on the project. Sensitivity analysis of cash flow has been made in terms of MWSS self helping effort. Three scenarios have been projected. Scenario 1 (improvement of total revenue increase by 2% from year 2001) would contribute to 3.9% improvement of cash flow. Scenario 2 (total expenditure decrease by 2% from year 2001) would improve 6% on cash flow, while scenario 3 (a combination of scenario 1 and scenario 2) would further improve 9.9% on cash flow.

Nevertheless, MWSS self helping effort would not be sufficient to generate positive cash flow from 1991 and beyond while some positive cash flow could be traced in 1993, 1995, and 1999 (Table 13.7.4 , col (12), Main Report).

This appears to indicate that MWSS cash flow position would become serious for the period between 1993 and beyond, in spite of self helping effort.

Economic analysis has two primary objectives, one is to quantify the difference in economic benefits between with rehabilitation and without rehabilitation, and the other to assess whether the net economic benefits are justifiable in some adverse situation.

The analysis will be focused upon quantification of two major costs, i,e, health and private water. Water borne diseases are still serious health hazards, leading to loss of working days, sickness, and death of infants. Health cost can be quantified by the difference in cost between without rehabilitation and with rehabilitation. Health cost is assumed to be directly proportional to the extent that MWSS water supply marginal area (low pressure area) decreases.

Without rehabilitation, the low pressure population in which residents in the affected area must depend upon private water will increase from 9.3% to 17.6%. On the other hand, the dependence on private water of same area will remain approximately at 3% with

rehabilitation. The difference in private cost of purchasing water between without rehabilitation and with rehabilitation will be considered the economic benefits in the form of reduced private cost.

Water production could be reduced without rehabilitation. This is primarily due to deterioration of the equipment of the Balara Plant.

Another cost without rehabilitation will include O & M cost that will increase at 15% compounded annually, while those with rehabilitation at 10% increase.

The net economic benefits are then derived from the difference in benefits between without rehabilitation and with rehabilitation. The EIRR for Level 1, Level 2, and Level 3 is 63.8%, 32.4% , and 26.3%, respectively.

Sensitivity analysis is focused upon adverse situation in assessing to what extent adverse changes of the economic environment will affect EIRR. Three scenarios are presented: Scenario 1 assumes that health cost and cost of private water both increase by 10%. Scenario 2 assumes that there is 10% loss of revenue expected. The revenue is based on total revenue, the sum of col(2) and col(3) of Table 14.2.1, Main Report.

Scenario 3 is a combination of scenario 1 and scenario 2.

Scenario 3, the worst of all, reduces EIRR from 63.8% to 61.3% in Level 1, from 32.4% to 31.3% in Level 2, and from 26.3% to 25.4% in Level 3, respectively.

Sensitivity analysis indicates that Level 1 is justifiable enough to stand against such adverse economic grounds, followed by Level 2 and Level 3.

11. PROJECT EVALUATION

11.1 Socioeconomic Aspects

(1) Needs and Beneficiary

The Balara plant serves 6,000,000 persons, approximately 60% of MWSS service area population. After the modification of 1981, they have not been rehabilitated sufficiently and large scale rehabilitation for existing facilities is urgently required.

(2) Cost effectiveness in Relation to Other Projects

If the growth and concentration of population of Metro Manila will continue, conservation and development of water resources will be most important so as to meet the increasing future demand of clean water. However, this would require huge investment and longer implementation. To effect immediate impact, rehabilitation of the Balara Plant can be undertaken instead in a shorter period and at a much lower cost.

In addition, rehabilitation works on the existing facilities will be required so as to cope with the future demand of clean water even when other future expansion projects are implemented by MWSS.

(3) Social Impact

The Balara service area covers half of Metro Manila including Manila, Quezon City, San Juan, Mandaluyong, Makati and Pasay. To maintain public health in these areas, ample and clean water supply shall be provided for. Consequently a healthy environment in Metro Manila for international relations will in turn benefit the whole area in the Philippines.

11.2 Technical Aspects

(1) Principle of Rehabilitation Plan

As previously mentioned, equipment in the Balara Plant are superannuated. If simultaneous breakdowns occur with the main equipment namely: flash mixer, alum feeder, chlorinator, the supply of sufficient amount of safe water cannot be insured. Over and above the need of replacing these equipment, existing facilities have some deficiencies in the light of prevailing technological standards.

Level 1 rehabilitation plan consists of urgent and survivable replacement of equipment, while Level 2 includes more equipment and considers steady operation and maintenance after completion of this project.

(2) Water Quality

Turbid water supply exceeding the National Standards for Drinking Water, 1978 should be avoided even occasionally in rainy season. In view point of this, the importance of rehabilitation of the Balara Plant is further stressed.

(3) Cost Performance

The plant capacity (nominal) at present and that which is to be rehabilitated is 1,600,000 m^3/d, one of the largest water treatment plant capacities in the world. The project cost of Level 2 rehabilitation is estimated at approximately ₱687 million and Level 1 is ₱286 million. The above stated rehabilitation costs are quite minimal for the capacity of the plant that shall be operational.

11.3 Environmental Aspects

The proposed project consists mainly of the replacement of existing equipment and very minor civil works. The purpose of the rehabilitation is to recover the capacity as modified in 1981 in case of Level 1 or of Level 2 to improve the water quality and proper operation

and maintenance to obtain greater benefits. Therefore, there are no potential lasting adverse environmental effects.

11.4 Financial and Economic Analysis

Level 1 and Level 2 are both justified on financial and economic grounds. Level 1 and Level 2 can stand against the worst financial scenario 3 as well as the worst economic scenario 3.
Since Level 2 is preferred on engineering grounds, the trade off between Level 1 and Level 2 needs examination. Level 1 adjusted by 90% engineering efficiency of Level 2, gives the adjusted Level 1 FIRR for comparison. Fig. 10.1 shows the relationship between the adjusted Level 1 FIRR and the percentage increase of funds.

When the base funds of Level 1 increase, the adjusted FIRR decreases. A point of intersection between the adjusted Level 1 FIRR and Level 2 FIRR is a maximum allowable increase of Level 1 funds beyond which the adjusted Level 1 FIRR falls below that of Level 2.

Given the Level of water production and quality management, two parameters are vital in affecting water revenue. One is distribution efficiency, and the other bill collection efficiency. Revenue efficiency is 32% at present while MWSS tries to increase the revenue efficiency up to 40% by year 2000.

Given the improved revenue efficiency of 40%, two other policy parameters, namely, operating revenue is assumed to increase by 2%, total expenditure by 2% from year 2001 and beyond. The cash flow position will be improved by 9.9% on the annualized rate.

Table 4.1 PROJECTED FINANCIAL DATA
(million pesos)

Year	1991	1995	2000	2010	2013
(1) Total Revenue	3397	6813	11114	16635	18712
(2) Total Expenditure	5959	7695	13728	29639	37337
(3) Financing Requirement	2562	882	2614	13004	18624
(4) External Finance	711	1106	-98	1508	1899
(5) Domestic Finance	1099	-220	-8	754	949
(6) Net Cash	-752	4	-2720	-10741	-15776

Source : Data from 1991 to 2000 were taken from Financial Projection by Corplan of MWSS, Feb.6, 1992.

TABLE 6.1 OUTLINE OF PLANT (1/3)

NAME OF PLANT: PLANT NO.1

NAME OF FACILITIES AND SPECIFICATION	QTY	NAME OF EQUIPMENT AND SPECIFICATION	QTY
Rapid Mixing - Concrete structure - channel - Dimension 2.0m Wx2.8m D	2	Rapid Mixer - Vertical fixed speed mixer - Dia. of turbine 831 mm - Revolution 104 rpm	2
Flocculation Basin - Concrete structure with partition - Dimension 32.44m Lx21.25m Wx5.0m D	2	Flocculator - Vertical variable speed mixer - Dia. of turbine 838 mm - Revolution 13.7-34.2 rpm	24
Sedimentation Basin - Concrete structure - Dimension No.1 190.2m Lx21.25m Wx5.0m D No.2 199.4m Lx21.25m Wx5.0m D	2		
Accelator - Concrete structure - Dimension 29.56m x 29.56m x7.1m D	2	Accelator - Dia. of impeller 8.5m - Drive unit motor 1 pc variable speed gear 1 pc. reduction gear 1 pc. worm reduction gear 1 pc.	2
Filter - Concrete structure - Dimension 15.3m Lx(5.3+5.3)m W - Filter bed 162 m2/bed - Thickness of filter media Anthracite 500mm Sand 250mm Gravel 450mm	10	Filter - Sluice gate and valve Influent sluice gate 600mm dia. Wash drain sluice gate 1,200mm Wx600mm H Effluent valve 450mm dia. Washwater valve 800mm dia Surface wash valve 450mm dia. Filter drain valve 150/250mm dia. - Surface wash pipe PVC fixed grid piping	10 10 10 10 10 20 10
Washwater Pumping House - Concrete structure - Dimension 24.4m x 47.42m x 2.0mD	1	Washwater pump - Double suction centrifugal pump No.1 / No.2 / No.3 - Capacity (l/sec) 110 / 117 / 110 - Head (m) 33.5 / 21 / 33.5 - Motor (kw) 45 / 49 / 45	3
Aerator (Recovery Water Basin) - Concrete structure - Dimension	1		
Recovery Pump Station - Steel framed structure - Dimension 14m Lx4.7m L	1	Recovery Pump - Double suction centrifugal pump End suction centrifugal pump -Capacity - Head N/A - Motor 45kW/37.3kW	2

TABLE 6.1 OUTLINE OF PLANT (2/3)

NAME OF PLANT: PLANT NO. 2

NAME OF FACILITIES AND SPECIFICATION	QTY	NAME OF EQUIPMENT AND SPECIFICATION	QTY
Receiving well - Concrete structure	1		
Parshall flume - Concrete structure - Size of throat 3.658m	2		
Flocculation Basin - Concrete structure - Dimension 16.02m Wx19.25m L x3.5-6.02m D	12	Flocculator - Horizontal fixed speed paddle - Motor 3.7kW 1st: - Dia. of paddle (m) 2.72; - Length of paddle (m) 3.01; - No. of paddle 3x4x4; - Revolution(rpm) 2.83 2nd: - Dia. of paddle (m) 3.54; - Length of paddle (m) 3.07; - No. of paddle 2x4x4; - Revolution(rpm) 2.12 3rd: - Dia. of paddle (m) 3.6; - Length of paddle (m) 3.15; - No. of paddle 1x4x4; - Revolution(rpm) 2.12	2
Seddimentation Basin - Concrete structure - Dimension 18.3m Wx73.2m Lx6.77-7.68m D	12	Flushing Pump - End suction centrifugal pump - Capacity N/A - Head N/A - Motor 18.5 kW	12
Filter - Concrete structure - Dimension 15.3m Lx(5.3+5.3)mW - Filter bed area 162 m2 - Thickness of filter media Anthracite 400mm Sand 250mm Gravel 410mm	20	Filter - Sluice gate and valve Influent sluice gate 920mm W x 760mm H	20
		Wash drain sluice gate 1120mm W x 610mm H	20
		Effluent valve 500mm dia.	20
		Effluent control valve 500mm dia.	20
		Washwater valve 1000mmdia.	20
		Surface wash valve 300mm dia.	20
		Filter drain valve 300mm dia.	20
		- Surface wash pipe PVC fixed grit piping	20
Washwater Pumping house - Concrete structure - Dimension		Washwater pump - Double suction centrifugal pump No.1: - Capacity N/A; - Head N/A; - Motor(kW) 94 No.2: - Capacity N/A; - Head N/A; - Motor(kW) 45 No.3: - Capacity N/A; - Head N/A; - Motor(kW) 49	3
Recovery Sump - Concrete structure - Dimension 3.0m Wx19.8m Lx4.9mD			
Recovery Pump Station - Steel framed structure - Dimension 10.5m Wx19.8m L		Recovery Pump - Double suction centrifugal pump - Capacity N/A - Head N/A - Motor 45kw	3

TABLE 6.1 OUTLINE OF PLANT (3/3)

NAME OF PLANT: CHEMICAL/CHLORINE HOUSE

NAME OF FACILITIES AND SPECIFICATION	QTY	NAME OF EQUIPMENT AND SPECIFICATION	QTY
Chemical House	1	Alum Feeder (Rotodip)	6
- Steel framed structure		- Volumetric liquid feeder	
- Dimension 12m Wx(36+18)m L		- Capacity 113-6.813 l/H	
- Area 1st floor 648 m2		- Motor 0.25 KW	
Basement 144 m2			
		Polymer Mixing Tank	4
		- FRP cylindrical tank	
		- Dimension Dia 1.7m x 2mH	
		- Capacity 4.5 m3	
		Polymer Mixer	4
		- Vertical type	
		- Motor 1.12 kW	
		Polymer Feeder	5
		- Plunger pump	
		- Capacity N/A	
		- Head N/A	
		- Motor 0.37 kW	
Chlorine House	1	Chlorinator	
- Concrete sturcture		- Wet vacuum type	4
- Dimension 12.2m Wx25.4m L		- Capacity 160 kg/h	
		Evaporator	
		- Electric immersion heater type	2
		- Capacity 160 kg/h	
		- Heater 15 kW	
		Booster Pump	3
		- End suction centrifugal	
		- Capacity N/A	
		- Head N/A	
		- Motor N/A	

Table 6.2 DESIGN CAPACITY AND RAW WATER SUPPLY

PLANT	SUB-SYSTEM FOR COAGULATION FLOCCULATION	DESIGN CAPACITY(m^3/d)	POTENCIAL RAW WATER AMOUNT (m^3/d)
No. 1	Sedimentation basin No.1	140,000	Aqueduct # 1
	Sedimentation basin No.2	140,000	Aqueduct # 1
	Accelators (2 tanks)	190,000	Aqueduct # 2
	Sub-Total	470,000	565,000
No. 2	Sedimentation basin (4 lines)	1,130,000	Aqueduct # 3 1,140,000
Combined	Total	1,600,000	1,705,000

Table 6.3 COMPARATIVE QUANTITY OF RAW, FILTERED, AND DISTRIBUTED WATER FOR THE YEAR 1989-1990

UNIT	MIN.		AVE.		MAX.	
X 1000 m^3/d	1989	1990	1989	1990	1989	1990
Raw Water	1,376	1,354	1,454	1,432	1,515	1,545
Filtered Water	1,379	1,364	1,452	1,435	1,514	1,554
Distribution Water	1,335	1,319	1,400	1,380	1,456	1,488

Source: 1) Water Sources Division Annual Report for the Calendar year 1990.

2) Figures in filtered water includes some of raw water and recovered washwater amount.

Table 6.4 DESIGN CRITERIA OF PLANT NO. 1

ITEM NO.	DESCRIPTION	UNIT	DESIGN VALUE	ACTUAL OPERATION	REFERENCE VALUE
1	Rapid mixing				
	Velocity gradient	sec -1	1000	867	>100
2	Flocculation				
	No. of basins	basin	2	2	-
	Detention time	min	20	20.2	20-40
	Velocity gradient	sec -1	Max. 100	12.7-33.6	10-80
3	Sedimentation				
	No. of basins	basins	2	2	-
	Detention time	hr	2.28	2.68,2.81	2-5
	Surface loading	mm/min	27.8	23.96,22.95	15-30
	Mean passing velocity	m/min	1.38	* 1.18	0.4
4	Accelators				
	No. of tanks	tank	2	2	-
	Clarification time	min	48	* 64	90-120
	Upflow rate	mm/min	100	* 92	40-60
5	Filtration				
	No. of beds	bed	10	10	-
	Filtration area	m2	162	162	-
	Filtration rate **	m/d	288	288	-
	Filter media depth **				
	Anthracite	mm	500	480	-
	Sand	mm	250	280	-
	Media effective size **				
	Anthracite	mm	0.9-1.1	* 0.57	0.7-1.5
	Sand	mm	0.45-0.55	0.69	0.45-0.70
	Backwash				
	Type		Perforated pipings		
	Rate	m3/m2/min	0.6	0.6-0.65	0.6-0.9
	Surface wash				
	Type		Perforated pipings		
	Rate	m3/m2/min	0.2	0.15-0.2	0.15-0.2

(Notes) * Shows deviation from reference value.

** Filtration particulars were designed based on the result of a pilot scale plant.

Table 6.5 DESIGN CRITERIA OF PLANT NO. 2

ITEM NO.	DESCRIPTION	UNIT	DESIGN VALUE	ACTUAL OPERATION	REFERENCE VALUE
1	Rapid mixing				
	Velocity gradient	sec -1	800	866	>100
2	Flocculation				
	No. of basins	basin	12	12	-
	Detention time	min	21	20.2	20-40
	Velocity gradient	sec -1	30-47	26-31	10-80
3	Sedimentation				
	No. of basins	basins	12	12	-
	Detention time	hr	1.7	* 1.61	2-5
	Surface loading	mm/min	48.3	* 52	15-30
	Mean passing velocity	m/min	0.498	* 0.71	0.4
4	Filtration				
	No. of beds	bed	20	20	-
	Filtration area	m2	162	162	-
	Filtration rate **	m/d	348	** 348	-
	Filter media depth **				
	Anthracite	mm	400	370	-
	Sand	mm	250	292	-
	Media effective size **				
	Anthracite	mm	0.9-1.1	* 0.53	0.7-1.5
	Sand	mm	0.45-0.55	0.64	0.45-0.70
	Backwash				
	Type			Perforated pipings	
	Rate	m3/m2/min	0.6	0.6-0.65	0.6-0.9
	Surface wash				
	Type			Perforated pipings	
	Rate	m3/m2/min	0.6	0.15-0.2	0.15-0.2

(Note) * Shows deviation from reference value.

** Filtration particulars were designed based on the result of a pilot scale plant.

Table 6.6 CHEMICALS CONSUMED & VOLUME OF WATER TREATED BY MONTH

JANUARY - DECEMBER, 1990

MONTH	VOLUME WATER TREATED (MLD)	CHEMICAL CONSUMPTION (M.T.)				D O S E (mg/l)			
		ALUM	CHLORINE	CATIONIC	ANIONIC	ALUM	CHLORINE	CATIONIC	ANIONIC
January	42,752.50	537.931	40.424	0.592	0.169	6.29	0.94	*0.03	*0.03
February	37,939.70	348.018	37.1645	0.245	0.137	4.59	0.98	*0.03	*0.03
March	42,085.00	413.561	41.694	0.186	-	4.91	0.99	*0.03	-
April	40,086.90	402.618	39.47	-	-	5.01	0.95	-	-
May	40,595.30	443.135	41.303	0.028	-	5.48	1.02	*0.03	-
June	40,363.20	957.051	50.457	1.729	-	11.86	1.25	0.04	-
July	44,556.50	1938.805	61.95	5.253	0.471	21.75	1.39	0.012	*0.03
August	46,134.20	2316.431	60.227	2.938	0.959	25.1	1.30	0.06	*0.03
September	47,430.00	2012.364	55.971	1.603	1.338	21.21	1.18	0.03	0.03
October	47,899.10	936.415	45.644	0.472	1.360	9.77	0.95	*0.03	0.03
November	46,457.10	533.362	59.336	0.342	3.606	5.74	1.28	*0.03	0.08
December	46,714.00	659.860	60.941	1.134	1.585	7.06	1.30	*0.03	*0.03
TOTAL	523,013.50	11499.571	594.581	14.822	9.625	128.77	13.56	0.46	0.29
AVERAGE	43,584.45	958.297	49.548	1.235	0.802	10.73	1.13	0.07	*0.03
MAXIMUM	47,899.10	2316.431	61.95	5.253	3.606	25.1	1.39	0.12	0.08
MINIMUM	37,939.70	348.018	37.1645	0.028	0.137	4.59	0.94	0.03	0.03

* Only a portion of the total volume was treated.

Table 6.7 WATER QUALITY STANDARD ON PHYSICAL, CHEMICAL AND RADIOLOGICAL REQUIREMENTS

Parameter	Maximum Permissible level*
Turbidity	5 units
Color	5 units (s) **
Odor	Unobjectionable
Threshold odor number	Not more than 3
Taste	Unobjectionable
Total Solids	500 (s)
pH	6.5 - 8.5
Phenolic substances	0.001
Radioactive Substances	
Gross Alpha	3 pCi/1
Gross Beta	30 pCi/1
Trace Elements	
Arsenic	0.05
Barium	1.0
Cadmium	0.01
Chromium	0.05
Copper	1.0
Cyanide	0.05
Fluoride	0.6
Iron	1.0 (s)
Lead	0.05
Manganese	0.5 (s)
Mercury	0.002
Selenium	0.01
Zinc	5.0 (s)
Organic Chemicals	
Synthetic	
Detergents (MBAS)	0.5
Oil & Grease	Nil
Persistent Pesticides	
Aldrin	0.001
DDT	0.05
Dieldrin	0.001
Chlordane	0.003
Endrin	0.0002
Heptachlor	0.0001
Lindane	0.004
Toxaphane	0.005
Methoxychlor	0.1
2,4-D	0.1
2,4,5-T	0.01
PCB	Nil
Other Chemicals	
Calcium	75
Chloride	200 (s)
Magnesium	50 (s)
Nitrate (NO_3)	30
Sulfate	200 (s)
Hydrogen sulfide	0.05 (S)

* All units are in mg/l unless, otherwise stated.
** (S)- Secondary standards; Compliance with the standard and analysis are not obligatory.

Table 6.8 WATER TURBIDITY (mg/l) IN PLANT NO. 1

PERIOD IN 1991	RAW WATER	TREATED WATER	INFLOW WATER	FILTERED WATER	FINISHED WATER
April	9.69	-	5.11	2.36	3.40
May	11.21	5.35	5.59	1.98	3.42
June	33.25	12.34	7.41	3.36	3.92
July	73.47	18.47	15.73	5.46	5.63
August	50.80	18.80	14.54	6.22	6.33
September	42.07	10.57	8.76	5.00	5.21
October	13.05	6.65	6.84	3.03	3.50

Source: Plant Laboratory of PQU

Table 6.9 WATER TURBIDITY (mg/l) IN PLANT NO. 2

PERIOD IN 1991	RAW WATER	TREATED WATER	INFLOW WATER 1	INFLOW WATER 2	FILTERED WATER	FINISHED WATER
April	10.51	-	5.74	6.78	3.31	3.26
May	10.61	9.08	6.04	7.17	2.83	3.02
June	27.91	25.75	7.28	9.23	3.54	3.50
July	54.06	50.63	6.94	14.78	4.98	5.14
August	52.15	49.63	14.81	22.90	6.75	5.56
September	37.64	37.18	8.82	9.84	5.64	4.18
October	12.13	10.65	7.70	8.75	3.72	4.27

Source: Plant Laboratory of PQU

Table 6.10 PHYSICAL AND CHEMICAL ANALYSIS DATA OF BALARA RAW, TREATED, INFLUENT, FILTERED AND FINISHED WATER FROM JAN., 1990 TO DEC., 1990

	Water Samples	pH	Acidity mg/l	Free CO_2 mg/l	Alkalinity mg/l	Bicarbonates mg/l	Hardness mg/l	Chlorides mg/l	Iron mg/l	Residual Chlorine mg/l
AVERAGE	Raw	7.45	6.43	5.66	51.22	62.49	53.49	7.74	0.12	
	Treated	7.17	9.27	8.16	51.40	62.71	52.62	7.50		
	Influent	7.20	8.70	7.66	51.07	62.31	50.82	7.38		
	Filtered	7.19	5.58	4.91	48.60	59.29	51.36	7.45		
	Finished	7.05	8.18	7.20	48.38	59.02	50.22	7.59	0.08	0.53
MAXIMUM	Raw	7.48	12.40	10.91	57.00	69.54	69.00	8.50	0.18	
	Treated	7.19	13.20	11.61	57.40	70.03	62.00	8.35		
	Influent	7.45	12.10	10.64	56.00	68.32	62.00	8.18		
	Filtered	7.41	11.80	10.38	53.00	64.66	64.00	8.45		
	Finished	7.30	10.60	9.32	54.68	66.71	60.00	8.39	0.10	0.66
MINIMUM	Raw	7.31	6.40	5.63	46.00	56.12	45.67	7.52	0.08	
	Treated	6.74	6.40	5.63	46.39	56.60	45.28	5.84		
	Influent	6.94	6.30	5.54	45.28	55.24	40.09	6.10		
	Filtered	6.95	6.30	5.54	43.08	52.56	42.22	6.47		
	Finished	6.95	6.60	5.81	41.61	50.76	41.17	6.61	0.06	0.38

Table 6.11 SUMMARY OF WATER QUALITY ANALYSIS DISTRIBUTED IN BALARA SERVICE AREA

No.	District		Temp. (°C)	Res. Chlorine (mg/l)	Turbidity (NTU)	pH	Conductivity (uS/cm)	Coliform (Count/ml)
1	Quezon city	MAX	31.5	1.3	9.4	7.24	164.6	15
		MIN	26.4	0.0	1.3	6.30	119.3	ND
		AVE	28.4	0.4	4.1	6.82	135.5	<1
2	San Juan - Mandaluyong	MAX	29.5	1.2	9.9	7.16	150.2	ND
		MIN	26.0	0.0	1.5	6.51	118.8	ND
		AVE	27.5	0.5	4.4	6.82	132.5	ND
3	Manila	MAX	31.4	1.2	6.6	7.02	154.0	ND
		MIN	26.8	0.0	1.9	6.50	123.1	ND
		AVE	27.7	0.2	4.0	6.77	135.8	ND
4	Makati	MAX	30.0	1.3	19.0	7.23	153.7	ND
		MIN	26.3	0.1	1.9	6.30	123.3	ND
		AVE	27.6	0.7	4.7	6.83	134.9	ND

Table 6.12 O & M IN LAST 5 YEARS 1986-1990

Section/Items	FY 1986	FY 1987	FY 1988	FY 1989	FY 1990
Chemical Treatment Section					
Chemicals	28,133,894.00	19,656,836.04	19,656,836.04	34,697,447.63	33,894,146.40
Official Supplies & Materials	49,252.13	64,626.78	64,626.78	64,447.46	72,348.87
Personnel	1,159,971.00	1,178,789.49	1,198,789.49	1,754,867.31	1,963,245.27
Filter Plant Operation Section					
Office Supplies & Materials	3,000.00	3,500.00	3,000.00	3,000.00	24,873.33
Personnel	1,372,984.87	1,517,701.56	2,073,128.79	2,522,386.66	3,466,171.94
Instrument Field Service Section					
Materials	231,689.75	220,990.01	400,815.91	393,762.31	212,821.08
Personnel	197,460.61	191,031.97	188,144.35	199,912.19	189,477.55
Treatment Plants Mechanical &					
Electrical Section					
Prevention Maintenance	115,872.19	353,575.98	180,555.61	59,914.51	150,100.95
General Repair	1,895,083.88	703,163.85	1,840,850.73	1,730,207.61	1,318,326.78
Personnel	348,872.64	438,834.61	481,533.82	576,283.65	702,808.40
Electricity	1,973,275.40	2,143,463.00	1,973,275.40	5,333,564.21	6,329,952.62
TOTAL	37,481,356.47	26,472,513.29	28,061,556.92	47,335,793.54	48,323,273.19

Table 7.1 NUMBER OF MWSS PERSONNEL BY DEPARTMENT AS OF AUGUST 31, 1991

EMPLOYMENT STATUS/DEPARTMENT	Total	Regular	Casual
Total Employees	8,962	4,803	4,159
Office of the Board of Trustees	13	13	0
(Sub Total)	13	13	0
Office of the Administrator		40	
Public Information		35	
Corplan Group		15	
MIS Group		4	
PMED		26	
System Development		17	
Computer Service center		124	
(Sub Total)	282	261	21
Engineering		26	
Planning & Programming		66	
Design		97	
Applied Res. & Quality Con.		34	
(Sub Total)	367	223	144
Construction Management		7	
MWSP II		15	
MWSP III		5	
MWSP		7	
MWSRP I		8	
MWSRP II		8	
Locally Founded		146	
(Sub Total)	2,988	196	2,792
Operations		6	
Water Sources & Treatment		260	
Water Distribution & Maint.		816	
Sewerage Systems		283	
Central Maintenance		212	
(Sub Total)	1,859	1,577	282
Customers Services		6	
North Sector		313	
East Sector		364	
South Sector		367	
West Sector		363	
Cavite-Muni Sector		300	
Big Accounts & Census Sector		125	
(Sub Total)	2,737	1,838	899
Finance		5	
Financial Control		71	
Accounting		141	
Treasury		161	
(Sub Total)	388	378	10
Administration		5	
Personnel Management		47	
Human Resource Dep.t		33	
Health & Safety		39	
Procurement		20	
Legal		28	
General Services		145	
(Sub Total)	328	317	11

Table 8.1 COMPARISON OF ALTERNATIVE PLAN (1/8)

PLANT NO. 1

ITEM	FACILITIES	ALTERNATIVES	LEVEL 1	LEVEL 2	LEVEL 3	REMARKS
1	Aqueduct No. 1 & No. 2	Replacement of headstocks (4 units)	0	0	0	
2	Rapid Mixing	Replacement of rapid mixers (2 units)	0	0	0	
		Construction of baffle walls	-	0	0	
		Replacement of rapid mixers to higher performance of rapid mixing	-	-	-	
3	Flocculation	Replacement of Flocculators (24 + 2 units)	0*	0	0	* Spare only (2 units)
		Replacement of flocculators to widen range of agitation	-	-	-	
		Reconstruction to baffled channel flocculation	-	-	-	
		Construction of control panel house (5 m X 3m X 2 houses)	-	0	0	
4	Sedimentation	Replacement of drain valves (basin-6 units) (channel-4 units)	-	0	0	
		Construction of collecting troughs with perforated baffle walls.	-	0	0	
		Construction of baffle walls in the basin No. 2 (L.S.)	-	0	0	
		Installation of inclined plates with sludge removal system.	-	-	-	
		Excavation of the sludge discharge creek.	0	0	0	
5	Accelators	Replacement of driving units. (2 units)	-	0	0	
		Replacement of sludge blow-off equipment (2	0	0	0	including quick-open valves.

Table 8.1 COMPARISON OF ALTERNATIVE PLAN (2/8)

PLANT NO. 1

ITEM	FACILITIES	ALTERNATIVES	LEVEL 1	LEVEL 2	LEVEL 3	REMARKS
		sets)				
		Repair of corroded steel members	-	0	0	
		Installation of inclined plates	-	-	-	
		Repair of operation house	0	0	0	
6	Filtration	Replacement of venturi tubes (10 units)	0	0	0	
		Replacement of sheets of inlet and drain penstocks (10 units each)	0	0	0	
		Replacement of pumps and air compressors for hydraulic control	-	0	0	
		Replacement of anthracite	0 *	0	0	* Supplement
		Improvement of surface wash system (10 basins)	-	0*	0**	* PVC ** PVC with nozzles
		Installation of surface wash pumps and pipes	-	-	0	
		Modification of filtration system from constant flow rate (the existing system) to variable declining rate.	-	-	-	
		Construction of surface wash pump room	-	-	0	
7	Washwater	Replacement of washwater pumps (3 units)*	0	0	0	* Pumps were manufactured in 1940's and deteriorated.
		Repair of pump house (L.S.)	0	0	0	
8	Washwater recovery	Replacement of washwater recovery pumps. (3 units)*	0	0	0	* Pumps were manufactured in 1950's
		Reconstruction of pump house (7m X 5m:L.S)	0	0	0	
		Change of washwater returning point (L.S.)	-	0	0	

Table 8.1 COMPARISON OF ALTERNATIVE PLAN (3/8)

PLANT NO. 2

ITEM	FACILITIES	ALTERNATIVES	LEVEL 1	LEVEL 2	LEVEL 3	REMARKS
9	Rapid mixing (parshall flume)	Installation of rapid mixers	-	-	-	
10	Flocculation	Replacement of flocculators	0*	0	0	* Only driving unit chains, sprockets, and bearings
		Construction of baffle walls (L.S.)	0*	0	0	* replacement of wooden plates
		Change from the existing horizontal paddle type to vertical turbine type	-	-	-	
		Construction of control panel house (6m X 4m X 1 house)	-	0	0	
11	Sedimentation	Reinforcement of foundations of inflow headstocks. (24 units)	0	0	0	
		Construction of collecting troughs with perforated baffle walls.	-	0	0	
		Installation of inclined plates with sludge removal system.	-	-	-	
		Replacement of shaft support for drain penstock	0	0	0	
		Replacement of flushing pump (2 units)	0	0	0	
		Construction of flushing pump house	0	0	0	
12	Filtration	Replacement of sheets of inlet and drain penstocks (20 units each)	0	0	0	
		Replacement of pumps and air compressors for hydraulic control	-	0	0	
		Replacement of anthracite	0*	0	0	* Supplement

Table 8.1 COMPARISON OF ALTERNATIVE PLAN (4/8)

PLANT NO. 2

ITEM	FACILITIES	ALTERNATIVES	LEVEL 1	LEVEL 2	LEVEL 3	REMARKS
		Installation of surface wash pumps	-	-	0	
		Replacement of surface wash system (20 basins)	-	0*	0**	* PVC ** PVC with nozzles
		Improvement of washwater troughs	0	0	0	
		Construction of roof for basi No. 1, 2, 3, 4, 17, 18, 19, and 20.	-	-	0	
		Construction of surface wash pump house	-	-	0	
13	Washwater	Replacement of pumps (3 units)	0	0	0	* one motor is removed three pumps is deteriorated
		Repair of pump house (L.S.)	0	0	0	
14	Washwater recovery	Replacement of pumps (3 units)	-	0	0	
		Construction of washwater recovery storage tank and pumphouse (L.S.)	-	0	0	
		Change of washwater returning point (L.S.)	-	0	0	

Table 8.1 COMPARISON OF ALTERNATIVE PLAN (5/8)

CHEMICAL/CHLORINATION/OTHERS

ITEM	FACILITIES	ALTERNATIVES	LEVEL 1	LEVEL 2	LEVEL 3	REMARKS
15	Chemical dosing (Alum)	Replacement of feeders (6 units)	0*	0	0	* Spare only (1 unit)
		Installation of calibration flow meter (L.S.)	-	-	0	
		Construction of elevated foundation for feeders	-	0	0	
16	Chemical dosing (Chlorine)	Replacement of chlorinators (4 units) Replacement of evaporators (2 units) Replacement of chlorine leak detectors (3 units) Replacement of exhaust fan (3 units) Replacement of hoist (1 unit) Replacement of chlorine booster pumps (3 units) Replacement of Dosing pipelines (3 lines)	0	0	0	
		Repair of roof	0	0	0	
		Expansion of chlorine storage house/generator room.	0	0	0	
		Installation of hoisting rail.	0	0	0	
17	Chemical dosing (Polymer)	Replacement of feeders (5 units)	0	0	0	
		Installation of calibration flow meter (L.S.)	-	-	0	
18	Laboratory Equipment	Replacement for Plant No. 2 and Central Lab.	0*	0	0	* partly

ALT-A1.WK1

Table 8.1 COMPARISON OF ALTERNATIVE PLAN (6/8)

ELECTRICAL EQUIPMENT

ITEM	FACILITIES	ALTERNATIVES	LEVEL 1	LEVEL 2	LEVEL 3	REMARKS
19	Power Receiving	Replacement of wooden poles for 34.5 kV O/H distribution line (24 pcs.)	0	-	-	
		Installation of new concrete poles (24 pcs)	-	0	0	
		Installation of new 34.5 kV switching station	-	0	0	
20	Low Voltage Main Service Line	Replacement of O/H wires	0	0	0	
		Establishment of improvable equipment for voltage fluctuation on low voltage power line	-	0	0	
21	Motor Control Panel Plant No. 1 - Settling Basin Nos. 1 & 2 - Accelator - Washwater pump - Recovery pump	Replacement	0 *	0	-	* except Plant No. 1 - Sedimentation Basin No. 1 & 2, Plant No. 2 - Recovery pump
	Plant No. 2 - Flocculation - Wahwater pump - Recovery pump	Modification of operation system	-	-	0	
22	Lighting Panel Plant No. 1	Replacement	-	-	-	
	- Settling Bain Nos. 1 & 2 - Filter Building - Recovery pump	Modification of interior devices and installation new meters on panel	-	0	0	
23	Distribution Panel Plant No. 1	Replacement	0	0	-	
	- Washwater pump Plant No. 2 - Filter Building	Modification of interior devices and installation new meters on panel	-	-	0	
24	Starter switch Booster Pump of Chlorination House	Replacement	0	0	0	
25	Flow Meter	Replacement Plant No. 1 - Accelator (2 units) - Surface wash - Wash water - Recovery water Plant No. 2 - Parshall Flume (2 units) - Surface Wash	0*	0	0	* Only Accelator and Parshall Flume

Table 8.1 COMPARISON OF ALTERNATIVE PLAN (7/8)

ELECTRICAL EQUIPMENT

ITEM	FACILITIES	ALTERNATIVES	LEVEL 1	LEVEL 2	LEVEL 3	REMARKS
		- Wash water - Recovery Water				
		Installation Plant No. 1 - Settling Basin Plant No. 2 - Effluent	0	0	0	
26	Level meter Plant No. 1 - Wash water Tank Plant No. 2 - Washwater Tank - Chemical Alum Tank	Replacement	0	0	0	
27	Instrumentation of filter beds	- Replacement of Filter No. 1 & No. 2 loss of head devices including modification (30 units)	0	0	0	
		- Replacement of Filter No. 1 & No. 2 rate of flow devices including modification (30 units)	0	0	0	
28	Instrument Panel	Replacement & installation of new instrument panel for supervision (2 panels)	0*	0	0	* Partly according to necessity
29	Interior lighting	Replacement	-	-	-	
		Replacement & improvement of illumination	-	0	-	
		Modification of lighting fixtures (by site condition)	-	-	0	
30	Street lighting	Replacement	-	0	-	
		Replacement & improvement of illumination	-	-	0	
31	Lightning Facilities	Replacement of existing surge absorber	-	-	-	
		Installation of new lightning protective devices including air terminals for building				

Table 8.1 COMPARISON OF ALTERNATIVE PLAN (8/8)

ELECTRICAL EQUIPMENT

ITEM	FACILITIES	ALTERNATIVES	LEVEL 1	LEVEL 2	LEVEL 3	REMARKS
		Replacement of existing surge absorber and installation of new lightning arrester for instrument devices & 34.5 kV O/H line.	-	-	-	
		Installation of new lightning rod devices for all bldg. in addition to above Alt.	0	0	0	
32	Generator for Chlorine House	Installation of Generator	0	0	0	
33	Testing Equipment	Procurement	0	0	0	

ALT-B1.WK1

Table 8.2 ENVIRONMENTAL CHECKLIST (WATER SUPPLY)

	CHECK ITEMS	MAJOR	SMALL	NONE	NOT CLEAR	PROBLEMS	ACTION TO COUNTERMEASURES PLANNED	REMARKS
POLLUTION	1.Air pollution resulting from chlorination		X				Monitoring and alarm system included in design	
	2.Soil erosion following the cutting of trees, etc, facility construction and consequent deterioration of water quality downstream		X				Construction site management practice recommended	Scale of excavation is very small. Implementation of control measures should be a condition stipulated in the contract documents.
	3.Noise and vibration around water treatment plant			X				Premises is broad and equipment of the noise free type
	4.Ground subsidence			X				No related works
	5.Treatment of sludge from water treatment plant							Inorganic constituents and harmless
NATURAL ENVIRONMENT	1.Effect of construction on the ecology			X				Main work is Mechanical & Electrical Equipment
	2.Effect on landscape			X				same as existing
HUMAN ENVIRONMENT	1.Effect of construction of the facility on the historical and cultural heritage			X				
	2.Effect on existing infrastructure			X				
	3.Effect on other water uses			X				
OTHERS	1.Effect on the environment during construction period			X				
	2.Environmental monitoring			X				not necessary

TAB6-1.WK1

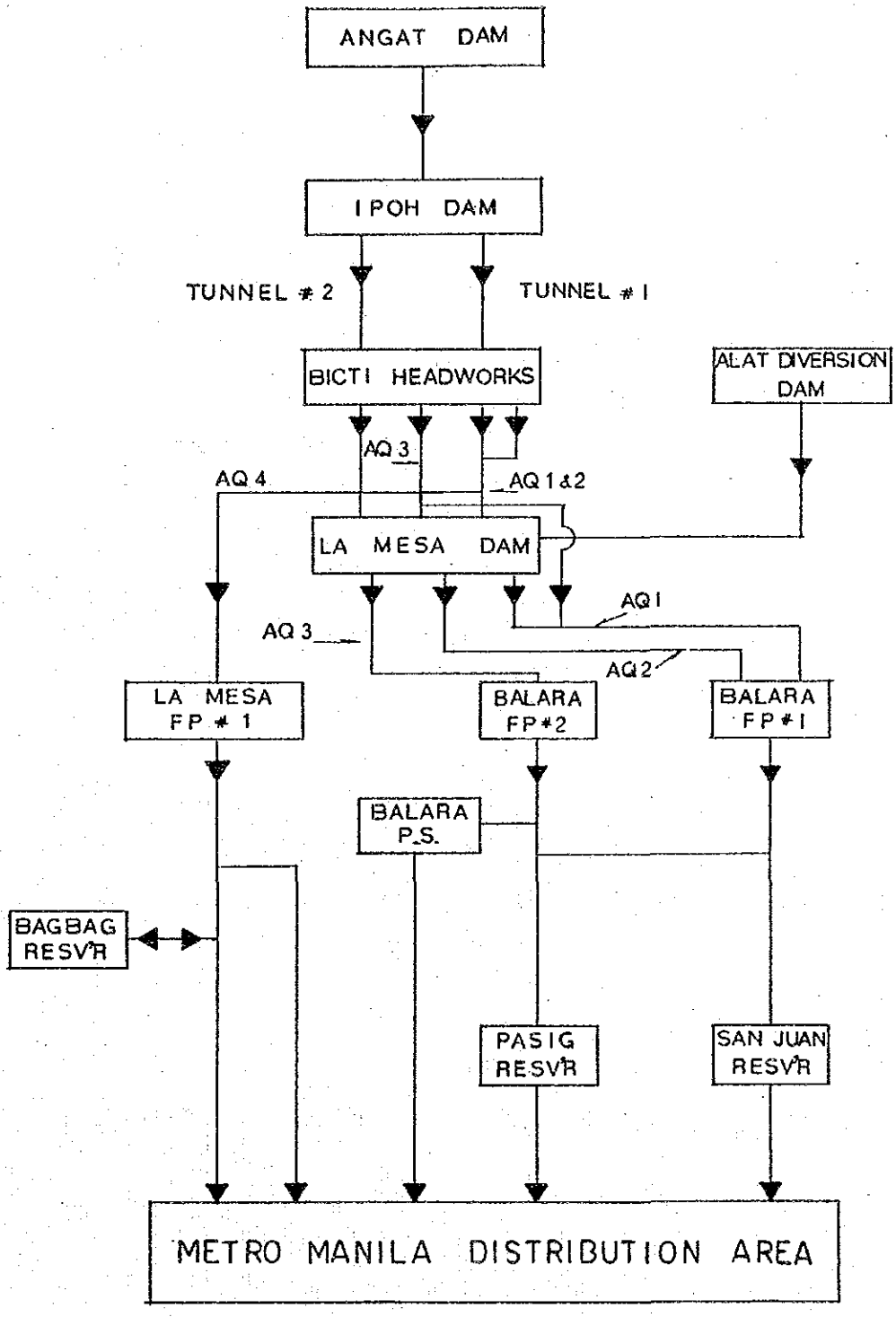
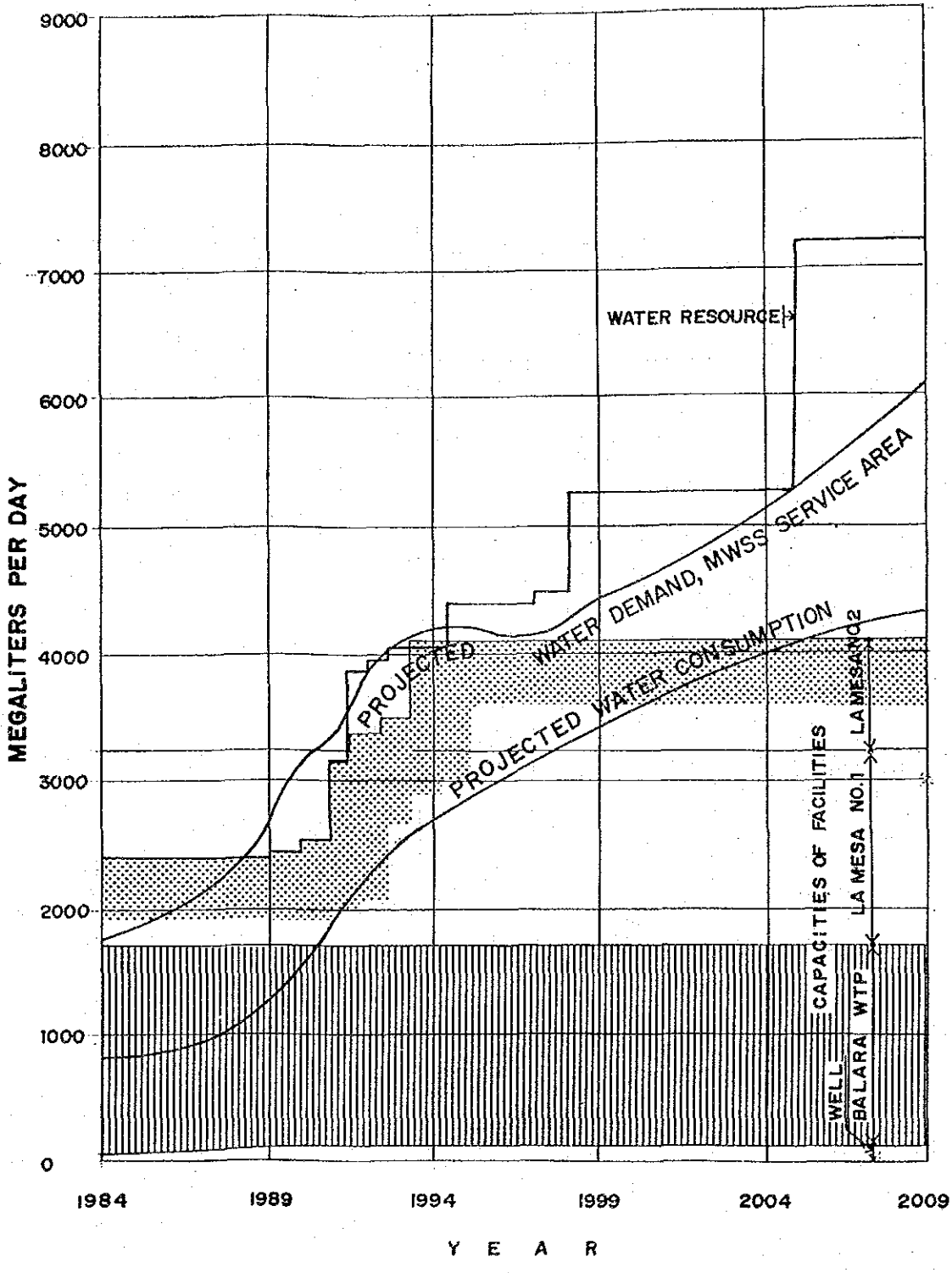


Fig. 3.1
ANGAT-NOVALICHES WATER SUPPLY SYSTEM



SOURCE ; PPD

Fig. 5.1
WATER SUPPLY AND DEMAND
PROJECTION (AS OF MAY 1991)

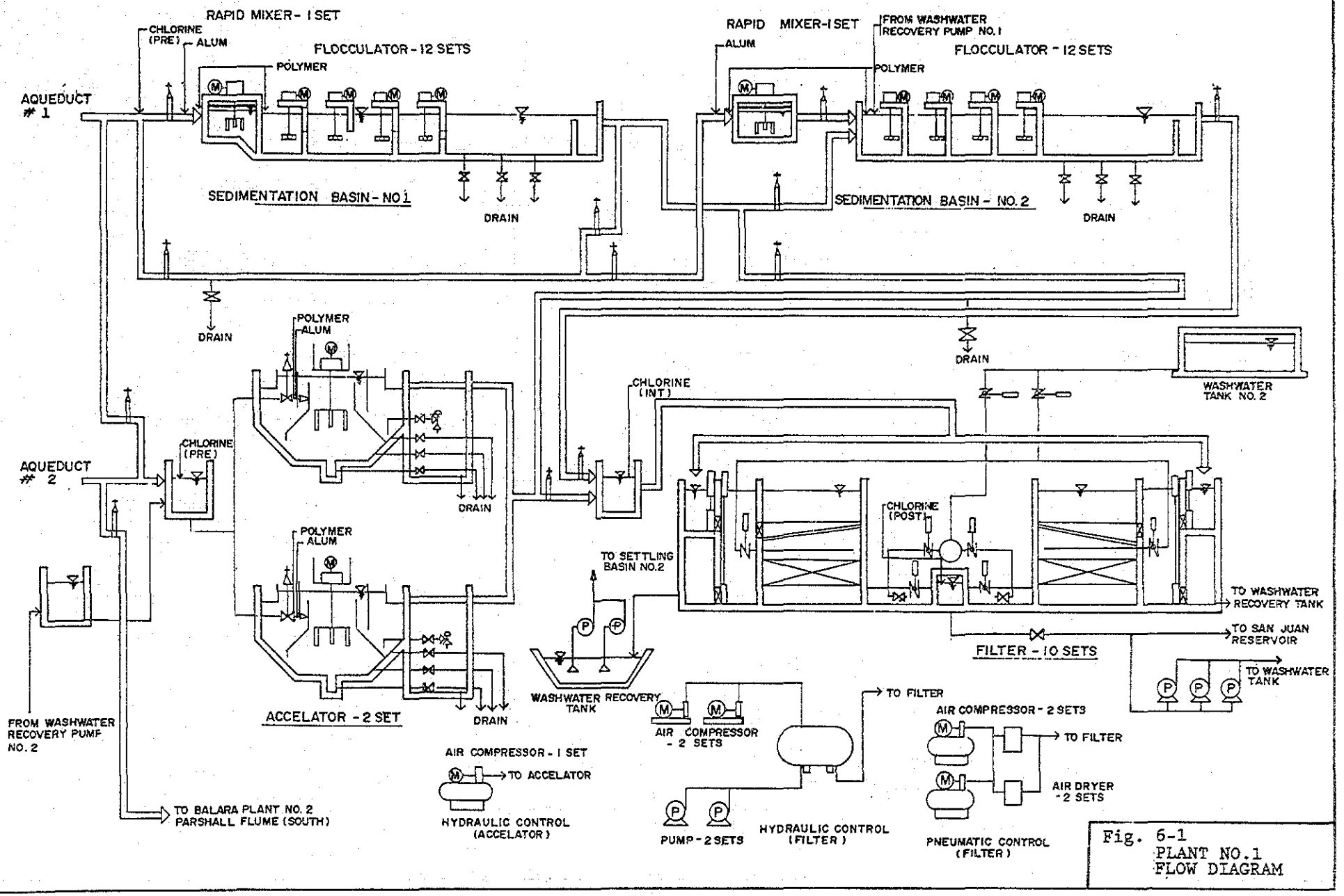


Fig. 6-1
PLANT NO.1
FLOW DIAGRAM

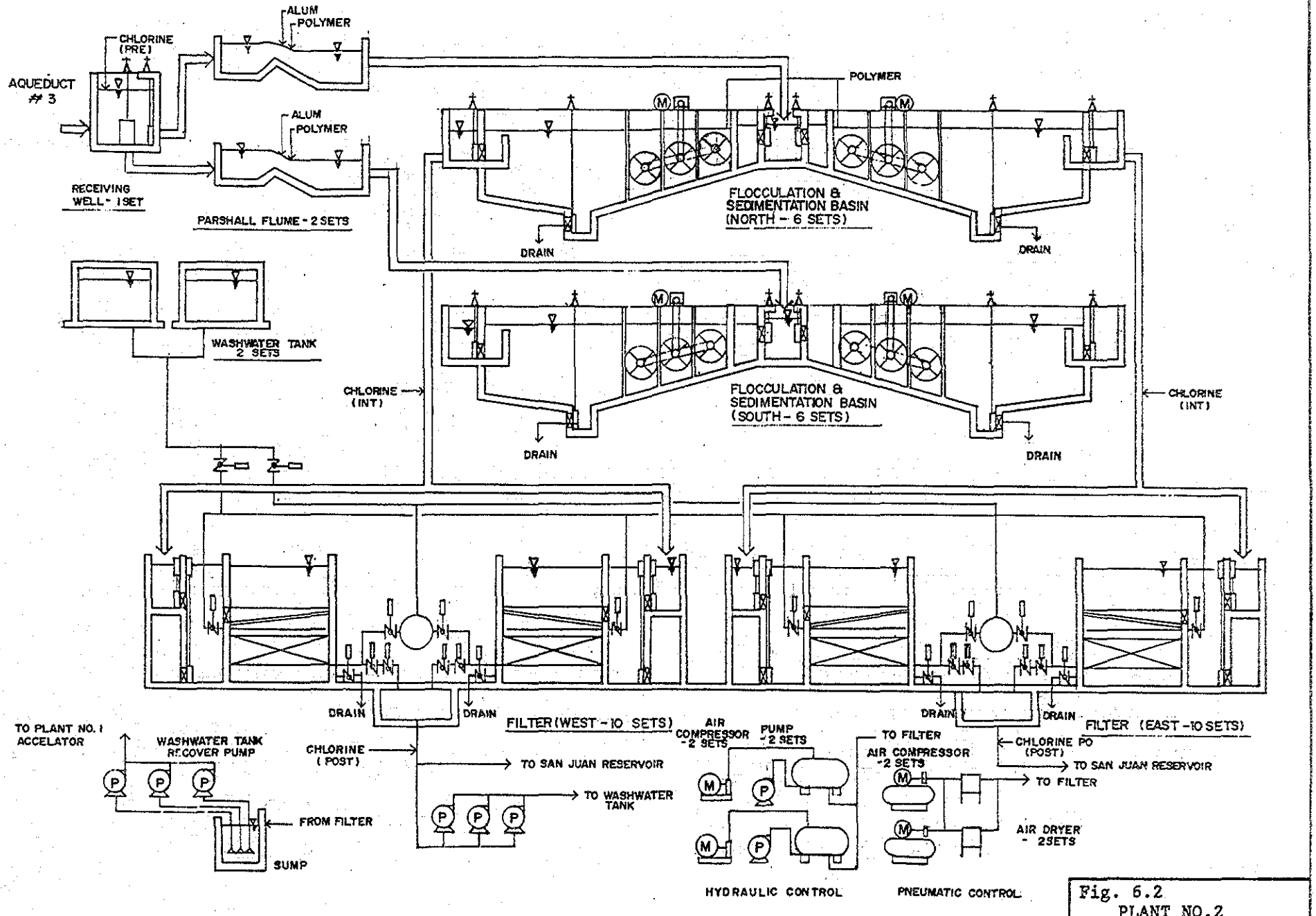


Fig. 6.2
PLANT NO.2
FLOW DIAGRAM

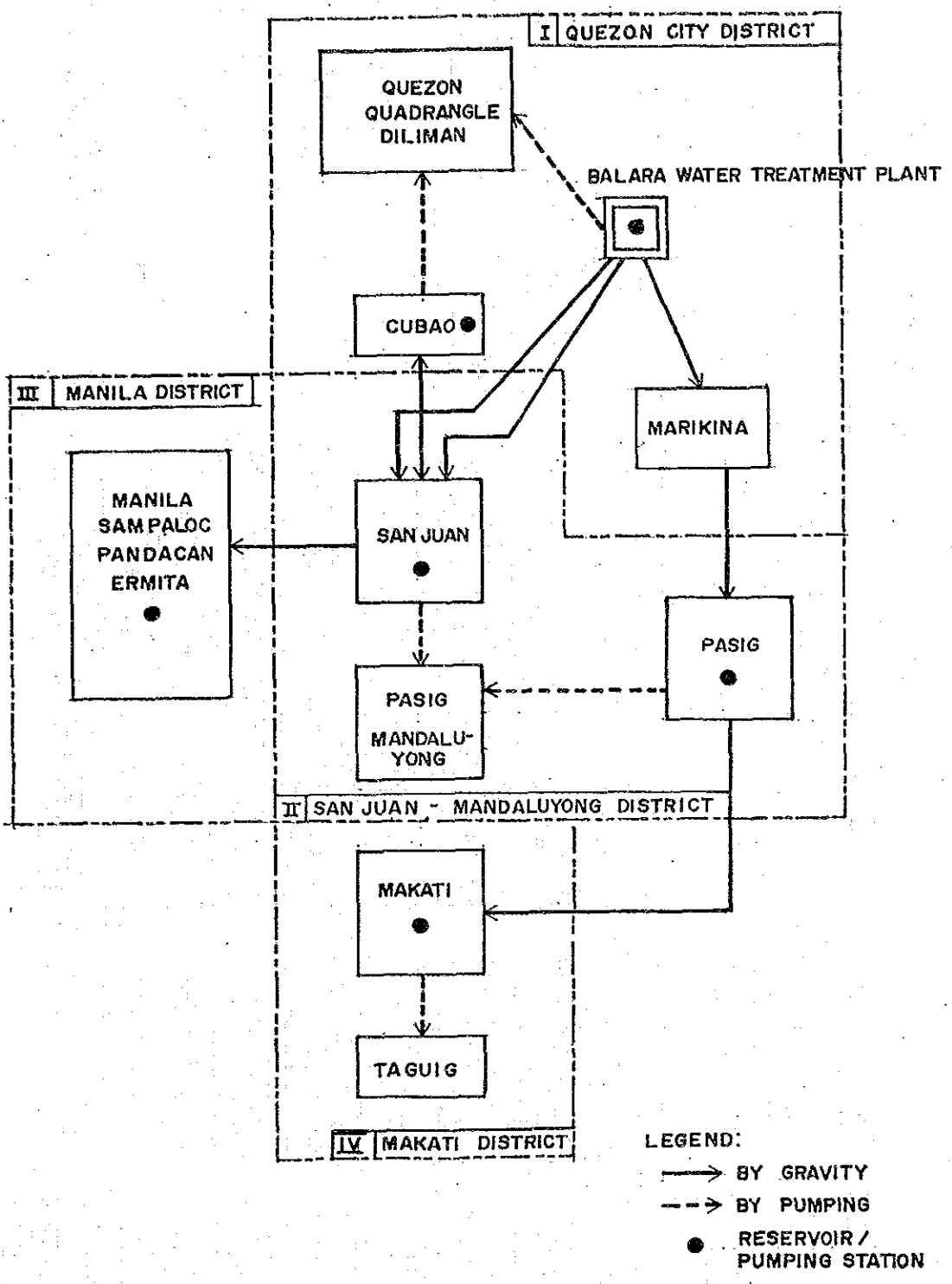


Fig. 6.3
BALARA WATER SUPPLY SYSTEM

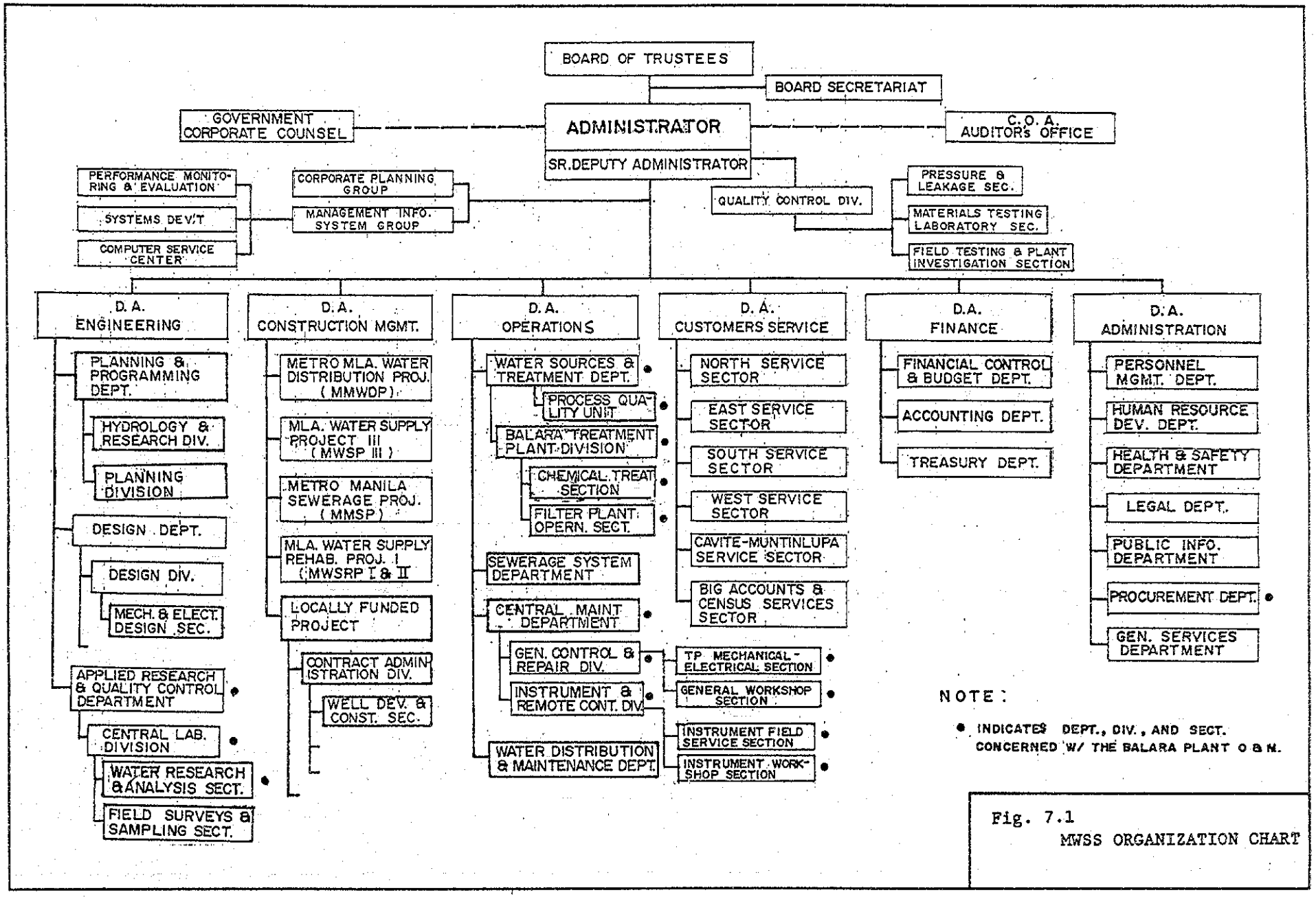
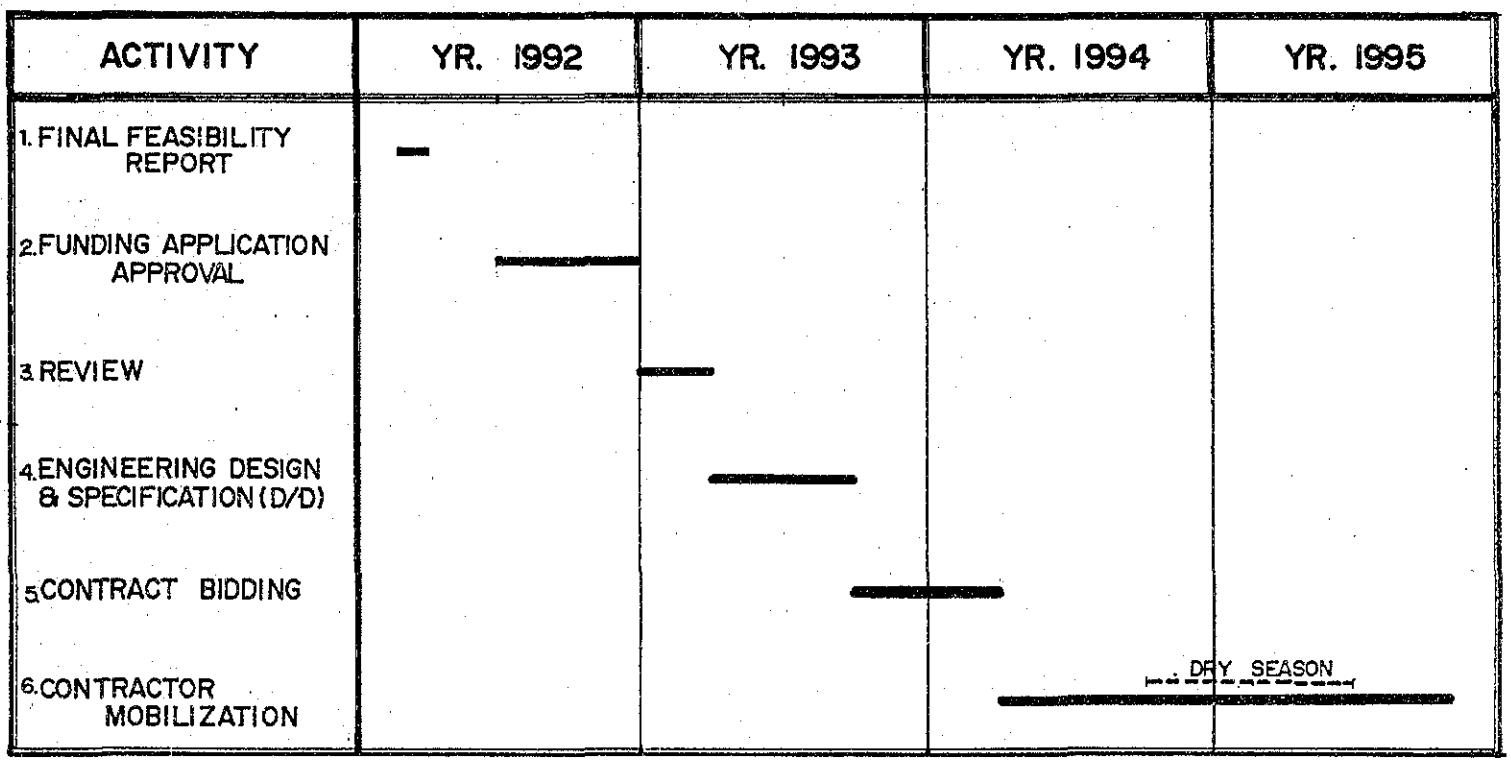


Fig. 7.1
MWSS ORGANIZATION CHART

Fig. 9.1 IMPLEMENTATION SCHEDULE



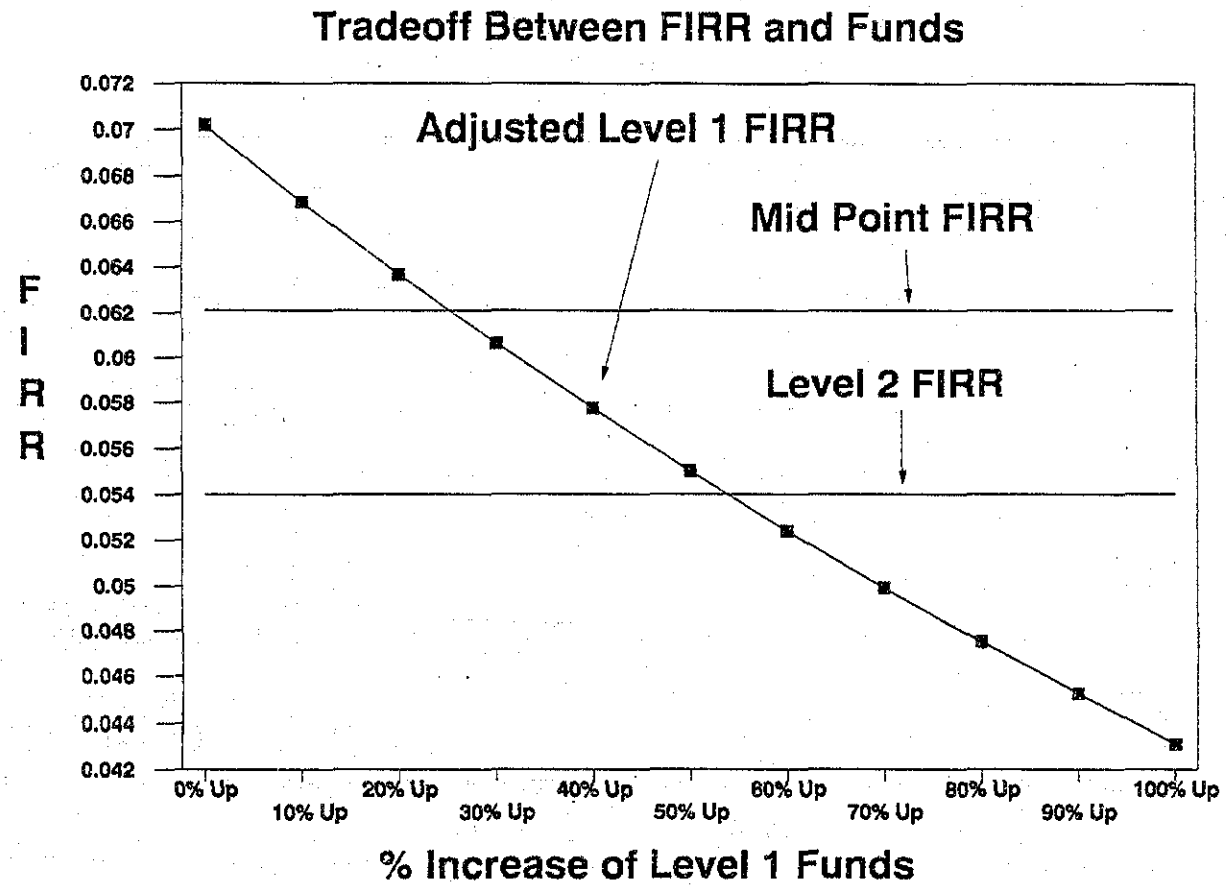


Fig. 10.1
TRADE OFF BETWEEN
FIRR & FUNDS