

JAPAN INTERNATIONAL COOPERATION AGENCY

No. 33

NATIONAL CAPITAL DISTRICT COMMISSION
PAPUA NEW GUINEA

**THE STUDY
ON
THE PORT MORESBY
WATER SUPPLY DEVELOPMENT PLAN
IN
PAPUA NEW GUINEA**

FINAL REPORT

MAIN REPORT

MARCH 1994

**TOKYO ENGINEERING CONSULTANTS
IN ASSOCIATION WITH
PACIFIC CONSULTANTS INTERNATIONAL**

SSS
JR
94-039

JAPAN INTERNATIONAL COOPERATION AGENCY

**NATIONAL CAPITAL DISTRICT COMMISSION
PAPUA NEW GUINEA**

**THE STUDY
ON
THE PORT MORESBY
WATER SUPPLY DEVELOPMENT PLAN
IN
PAPUA NEW GUINEA**

FINAL REPORT

MAIN REPORT

JICA LIBRARY



1119818[1]

27713

MARCH 1994

**TOKYO ENGINEERING CONSULTANTS
IN ASSOCIATION WITH
PACIFIC CONSULTANTS INTERNATIONAL**

国際協力事業団

27713

PREFACE

In response to a request from the Government of Papua New Guinea, the Government of Japan decided to conduct a master plan and feasibility study on the Port Moresby Water Supply Development Plan and entrusted the study to the Japan International Cooperation Agency (JICA).

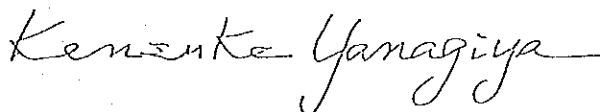
JICA sent to Papua New Guinea a study team headed by Mr. Kazufumi Momose, Tokyo Engineering Consultants Co., Ltd., and composed of members from the said company and Pacific Consultants International, 4 times between September 1992 and March 1994.

The team held discussions with the officials concerned of the Government of Papua New Guinea, and conducted field surveys at the study area. After the team returned to Japan, further studies were made and the present reports were 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 Papua New Guinea for their close cooperation extended to the team.

March 1994



Kensuke YANAGIYA

President

Japan International Cooperation Agency

THE STUDY
ON
THE PORT MORESBY WATER SUPPLY DEVELOPMENT PLAN
IN
PAPUA NEW GUINEA

MARCH, 1994

Mr. Kensuke YANAGIYA
President
Japan International Cooperation Agency

LETTER OF TRANSMITTAL

Dear Sir,


We are pleased to submit herewith the Final Report entitled "THE STUDY ON THE PORT MORESBY WATER SUPPLY DEVELOPMENT PLAN IN PAPUA NEW GUINEA".

This report has been prepared by the Study Team in accordance with the contract signed on August 1993 and May 1994 between the Japan International Cooperation Agency and the Joint Venture of Tokyo Engineering Consultants and Pacific Consultants International.

The report consists of the Summary in English and Japanese, the Main Report in English, the Immediate Remedial Measures in English, and the Appendix in English. The Summary summarizes the result of all studies concisely and includes conclusions and recommendation. The Main Report contains results of survey, analysis and explains about Master Plan and Feasibility Study. The Immediate Remedial Measures Portion are published separately. The Appendix includes data, details of investigations and analysis.

All members of the Study Team wish to express grateful acknowledgment to the personnel of your Agency, Advisory Committee, Ministry of Foreign Affairs, Ministry of Health and Welfare, Embassy of Japan and JICA in Papua New Guinea, and also to the officials of the Government of Papua New Guinea for all assistance extended to the Study Team. The Study Team sincerely hopes that the results of the study will contribute to the improvement of health and sanitary conditions of people in Port Moresby.

Yours faithfully,


Kazufumi MOMOSE
Team Leader

ABBREVIATIONS

BOD	Bio-chemical Oxygen Demand
BWL	Bottom Water Level
CD	Census Division
CICL	Cast Iron Pipe with Cement Lining
Coli	Coliform
CS	Department of Community Services of NCDC
EIRR	Economic Internal Rate of Return
ELCOM	Electricity Commission
FA	Department of Finance and Administration of NCDC
FIRR	Financial Internal Rate of Return
JICA	Japan International Cooperation Agency
K	Kina (Currency of Papua New Guinea; K1 = US Dollars 1)
Kina	Currency of Papua New Guinea; K1 = US Dollars 1
l/s	liter per second
lcd	liter per capita per day
mgd	million gallons per day
ml	million liters (=thousand cubic meters)
mld	million liters per day (=thousand cubic meters per day)
MSCL	Mild Steel Pipe with Cement Lining
m ³ /d	cubic meters per day
m ³ /s	cubic meters per second (=86.4 mld)
NCD	National Capital District
NCDC	National Capital District Commission
NPV	Net Present Value
NSO	National Statistical Office
OIDA	Office of International Development Assistance
P&T	Post and Telephone Corporation
TE	Department of Technical and Engineering of NCDC
TWL	Top Water Level
WS&S	Division of Water Supply and Sewerage, TE, NCDC
WHO	World Health Organization

TABLE OF CONTENTS

Page

SUMMARY

PART 1 **MASTER PLAN & IMMEDIATE** **REMEDIAL MEASURES**

CHAPTER 1 INTRODUCTION

1.1 Background of The Study.....	1.1
1.2 Objective and Study Area.....	1.2
1.3 Scope of The Study.....	1.2
1.3.1 Master Plan.....	1.2
1.3.2 Immediate Remedial Measures.....	1.4
1.3.3 Feasibility Study of The High Priority Project.....	1.4
1.4 Organization and Staffing.....	1.4

CHAPTER 2 EXISTING CONDITIONS

2.1 Physical Environment.....	2.1
2.2 Population and Development.....	2.3
2.3 Economy and Employment.....	2.5

CHAPTER 3 EXISTING WATER SUPPLY FACILITIES

3.1 General.....	3.1
3.2 Current Service Level.....	3.1
3.3 Water Resources and Raw Water Main.....	3.2
3.4 Raw Water Quality.....	3.3
3.5 Treatment Plant.....	3.4
3.5.1 Plant Description.....	3.4
3.5.2 Present Plant Capacity.....	3.6
3.5.3 Plant Operation.....	3.6
3.6 Treated Water Mains.....	3.8
3.7 Treated Water Storages.....	3.10
3.8 Distribution System.....	3.12

CHAPTER 4 CURRENT MANAGEMENT AND FINANCE

4.1 General.....	4.1
4.2 Organization of NCDC.....	4.2
4.3 Present Management.....	4.3
4.3.1 Meter Reading.....	4.3
4.3.2 Meter Connections.....	4.3
4.3.3 Maintenance of Stand Pipes.....	4.4
4.3.4 Asset Management.....	4.4

4.3.5	Bill Collection.....	4.5
4.4	Present Operation and Maintenance.....	4.5
4.4.1	General.....	4.5
4.4.2	Public Relations.....	4.6
4.4.3	Water Resources Management.....	4.6
4.4.4	Record Keeping.....	4.6
4.4.5	Training.....	4.6
4.4.6	Maintenance Plan.....	4.7
4.5	Financial Analysis	4.7
4.5.1	Financial System, NCDC.....	4.7
4.5.2	Balance Sheet	4.8
4.5.3	Water Sale and Cash Inflow	4.9
4.5.4	Expenditure	4.9
4.5.5	Water Rate	4.9
4.5.6	Overall Comment	4.10
4.5.7	Marginal Cost.....	4.11

CHAPTER 5 DESIGN CRITERIA

5.1	System Design.....	5.1
5.1.1	General.....	5.1
5.1.2	System Criteria.....	5.1
5.1.3	Water Quality Standards.....	5.2
5.2	Population.....	5.5
5.2.1	Population Trend.....	5.5
5.2.2	Population Estimation.....	5.6
5.2.3	Future Population Distribution.....	5.7
5.3	Water Demand.....	5.13
5.3.1	Per Capita Consumption.....	5.13
5.3.2	Leakage.....	5.16
5.3.3	Demand Characteristics.....	5.17
5.3.4	Water Demand.....	5.19

CHAPTER 6 IMMEDIATE REMEDIAL MEASURES

6.1	Improvement of Financial Capability.....	6.1
6.1.1	Autonomy.....	6.1
6.1.2	Progressively Increasing Unit Charge	6.1
6.2	Water Conservation Measures.....	6.2
6.2.1	Necessity.....	6.2
6.2.2	Pressure Control.....	6.3
6.2.3	Leakage Control.....	6.4
6.2.4	Control of Illegal Connections and Wastage.....	6.5
6.3	Equal Distribution.....	6.5
6.3.1	Supply-Restriction Service Zoning.....	6.6
6.3.2	Duplication of Trunk Mains.....	6.8

CHAPTER 7 LONG TERM PROGRAM

7.1	Basic Concept.....	7.1
7.1.1	Water Source.....	7.1
7.1.2	Zoning.....	7.2
7.1.3	Separation of Trunk Mains from Distribution System.....	7.4
7.2	Options.....	7.5
7.2.1	Location of Treatment Plant.....	7.5

7.2.2	Supply to High Zone.....	7.6
7.2.3	Comparison.....	7.7
7.2.4	Selection of Options.....	7.8
7.3	Major Works.....	7.12
7.3.1	General.....	7.12
7.3.2	Major Works in Each Zone.....	7.13

CHAPTER 8 SYSTEM MANAGEMENT

8.1	NCDC Organization.....	8.1
8.2	Management.....	8.2
8.2.1	Effective Meter Reading.....	8.2
8.2.2	Metering of The Whole Connections.....	8.3
8.2.3	Elimination of Illegal Connections.....	8.3
8.2.4	Decreasing of Stand Pipes.....	8.4
8.2.5	Strengthening of Asset Management.....	8.6
8.2.6	Improvement of Bill Collection.....	8.6
8.3	Operation and Maintenance.....	8.8
8.3.1	Appropriate Location of Meters.....	8.8
8.3.2	Promotion of PR Activities.....	8.8
8.3.3	Establishment of Water Committee in NCDC.....	8.8
8.3.4	Proper Record Keeping.....	8.9
8.3.5	Service Improvement.....	8.11
8.3.6	Strengthening of Training.....	8.11
8.3.7	Development of Maintenance Plan.....	8.12

CHAPTER 9 COST ESTIMATION AND IMPLEMENTATION PLAN

9.1	Cost Estimation.....	9.1
9.1.1	Project Cost.....	9.1
9.1.2	Management and Operation & Maintenance Cost.....	9.1
9.2	Implementation Schedule.....	9.3
9.2.1	General.....	9.3
9.2.2	Implementation Program Constraints.....	9.3
9.2.3	Implementation Program.....	9.4
9.2.4	Complementary Activities.....	9.5

CHAPTER 10 PROJECT EVALUATION

10.1	Financial Evaluation.....	10.1
10.1.1	General	10.1
10.1.2	Fund Requirements	10.1
10.1.3	Financial Plan	10.3
10.1.4	FIRR	10.4
10.1.5	Sensibility Analysis	10.5
10.1.6	Other Benefits	10.5
10.2	Environmental Aspects.....	10.8
10.2.1	Existing Condition.....	10.8
10.2.2	Future Condition.....	10.10
10.2.3	Conclusion.....	10.11

LIST OF FIGURES

EXISTING CONDITION

2.1	Elevations in Port Moresby.....	2.7
2.2	Seasonal Variation in Rainfall and Temperature.....	2.8
2.3	1990 Land Use.....	2.9
2.4	Predominant Housing Type According to Census Unit.....	2.10

EXISTING WATER SUPPLY FACILITIES

3.1	Existing Water Supply System.....	3.13
3.2	Low Water Pressure Areas.....	3.14
3.3	Trunk Main System Details.....	3.15
3.4	Distribution System.....	3.16

DESIGN CRITERIA

5.1	Population Distribution (1990).....	5.21
5.2	Population Estimation.....	5.22
5.3	Past Land Development (1972 - 1990).....	5.23
5.4	Land Ownership	5.24
5.5	Land Ownership Except High Area	5.25
5.6	Possible Development Area	5.26
5.7	Population Distribution (2015)	5.27
5.8	Water Demand Distribution (1990)	5.28
5.9	Water Demand Estimation (Daily Max)	5.29
5.10	Water Demand Distribution (2015)	5.30

IMMEDIATE REMEDIAL MEASURES

6.1	Concept of Immediate Remedial Measures	6.12
6.2	Iso-Residual Head Line	6.13
6.3	Zone-Restriction Service	6.14
6.4	Proposed Trunk Main	6.15
6.5	Longitudinal Section of Proposed Trunk Mains	6.16

LONG TERM PROGRAM

7.1	Intake Point	7.18
7.2	Distribution Zoning	7.19
7.3	Location of New Treatment	7.20
7.4	Alternation of System (Option A)	7.21
7.5	Alternation of System (Option B)	7.22
7.6	Alternation of System (Option C)	7.23
7.7	Proposed Facilities for Mater Plan	7.24
7.8	Schedule Layout of Proposed System	7.25
7.9	Mt. Eriama Treatment Plan	7.26
7.10	Nine (9) Mile Treatment Plant	7.27
7.11	Proposed Transmission	7.28
7.12	Improvement of Distribution in Existing Urban Area	7.29
7.13	Proposed Pressure and Flow Meter Installation Points	7.30
7.14	Water Supply System in 2015	7.31

SYSTEM MANAGEMENT

8.1	Existing Organization of Water Supply Sewerage Division	8.13
8.2	Service Zones of Water Supply in NCD	8.14

COST ESTIMATION AND IMPLEMENTATION PLANT

9.1	Implementation Schedule (Option A)	9.11
9.2	Water Supply and Demand (Option A).....	9.12
9.3	Implementation Schedule (Option B)	9.13
9.4	Water Supply and Demand (Option B)	9.14
9.5	Implementation Schedule	9.15
9.6	Implementation Schedule - Mjoir Facility -	9.16
9.7	Implementation Schedule - Distribution -	9.17

LIST OF TABLES

EXISTING CONDITION

2.1	Temperature in Port Moresby in 1991	2.2
2.2	Monthly Rainfall for 1980 to 1991 and Mean Monthly Evaporation (1991) in Port Moresby	2.3
2.3	Port Moresby Development Area	2.4

EXISTING WATER SUPPLY FACILITIES

3.1	Main Features of Trunk Mains	3.9
3.2	Existing Treated Water Storages	3.10
3.3	Existing Pump And Tank Schemes	3.11
3.4	Main Features of Distribution Pipe	3.12

CURRENT MANAGEMENT AND FINANCE

4.1(A)	Financial Statement of Ws & S (Cumulative)	4.13
4.1(B)	Financial Statement of Ws & S (Yearly Increment)	4.13
4.2	Sale, Income & Receivable of Water Supply	4.14
4.3	Expenditure of Water Supply	4.15
4.4	Water Rates	4.16
4.5(A)	Marginal Cost	4.17
4.5(B)	Combined Marginal Cost	4.17

DESIGN CRITERIA

5.1	Standards for Raw Water (1984)	5.3
5.2	Standards for Drinking Water (1984)	5.4
5.3	Population Growth Rate in NCD	5.5
5.4	Population Distribution and Growth Rate	5.6
5.5	Possible Development Area	5.10
5.6	Population Density	5.11
5.7	Current Land Use in Km ²	5.12
5.8	Population Distribution	5.12
5.9	Leakage in Three Model Areas	5.17
5.10	Water Demand (Daily Max) by Census Division 1990	5.19
5.11	Future Water Demand (Daily Max) by 5 Years	5.20

IMMEDIATE REMEDIAL MEASURES

6.1	Characteristics of Water Shortage Areas	6.8
6.2	Comparison of Additional Trunk Main Alignment	6.9
6.3	Improvement by The Proposed Mains	6.11

LONG TERM PROGRAM

7.1	Water Amount for NCD Water Supply System	7.2
7.2	Head Loss from Rouna 4 to Consumer	7.3
7.3	Demand in Zones and Reservoir Block	7.4
7.4	Supply and Demand	7.6
7.5	Locations of Treatment Plants	7.8
7.6	Main Facilities of Each Option	7.8

7.7	Cost of Options	7.10
7.8	Salient Feature of Options	7.12
7.9	Trunk Mains	7.14
7.10	Additional Distribution Pipes by 2015	7.15
7.11	Service Reservoir	7.16

SYSTEM MANAGEMENT

8.1	Water Service Connections of NCD	8.3
8.2	Number of Disconnection, Reconnections and New Connections	8.5
8.3	Water Consumption by Category	8.6
8.4	Efficiency of Bill Collection	8.7
8.5	Repair and No Water Calls to NCDC	8.10

COST ESTIMATION AND IMPLEMENTATION PLAN

9.1	Project Cost	9.2
9.2	Cost Estimates for Management and O/M	9.2
9.3	Reservoir Works	9.6
9.4	Transmission Pipe Works by Year	9.6
9.5	Distribution Pipe Installation Works in Existing Urban Area by Year	9.7
9.6	Pipe Installation Works in New Development Area by Year and Diameter	9.8
9.7	Summary of Distribution Pipe Installation Schedule	9.9
9.8	Recommended Complimentary Activities	9.10

PROJECT EVALUATION

10.1	Investment Schedule	10.2
10.2	Financial Statements of Water Supply Enterprise: M/P	10.6
10.3	FIRR : M/P	10.7

PART 2 **FEASIBILITY STUDY**

CHAPTER 1 INTRODUCTION

CHAPTER 2 ENGINEERING DESIGN.

2.1	Major Works	2-1
2.2	Intake Facility.....	2-2
	2.2.1 Rouna 4 Head Pond.....	2-2
	2.2.2 Design.....	2-2
2.3	Raw Water Main.....	2-4
	2.3.1 Alternatives.....	2-4
	2.3.2 Cost Comparison.....	2-6
	2.3.3 Others.....	2-9
2.4	Pumping Station.....	2-9
	2.4.1 Location of Pumping Station.....	2-9
	2.4.2 Pump Specification.....	2-10
2.5	Mt. Eriama Expansion Works.....	2-11
	2.5.1 Introduction.....	2-11
	2.5.2 Receiving Well.....	2-12
	2.5.3 Circular Clarifier.....	2-12
	2.5.4 Filter Basin.....	2-12
	2.5.5 Drainage System.....	2-13
	2.5.6 Chemical Dosing Equipment.....	2-13
	2.5.7 Electric Equipment.....	2-14
	2.5.8 Administrative Building.....	2-15
	2.5.9 Arrangement of Proposed Facilities.....	2-15
2.6	9 Mile WTP.....	2-15
	2.6.1 Introduction.....	2-15
	2.6.2 Proposed Facilities.....	2-16
	2.6.3 Receiving Well.....	2-17
	2.6.4 Rapid Mixing Chamber.....	2-17
	2.6.5 Flocculation Basin.....	2-17
	2.6.6 Sedimentation Basin.....	2-18
	2.6.7 Filter Basin.....	2-18
	2.6.8 Chemical Dosing Equipment.....	2-19
	2.6.9 Clear Water Reservoir.....	2-20
	2.6.10 Drainage System.....	2-20
	2.6.11 Electrical Equipment.....	2-20
	2.6.12 Administrative Building.....	2-21
	2.6.13 Arrangement of Proposed Facilities.....	2-21
2.7	Service Reservoir and Transmission & Distribution Pipes.....	2-21
	2.7.1 New Water Supply System.....	2-21
	2.7.2 Service Reservoirs.....	2-22
	2.7.3 Transmission and Distribution Pipes.....	2-23
2.8	Summary of Proposed Facilities.....	2-25

CHAPTER 3 MANAGEMENT

3.1	Introduction.....	3-1
3.2	New Organization of NCDC.....	3-1
3.3	Managerial Issues.....	3-2
3.4	New Organization of Water Supply Division.....	3-4
	3.4.1 General.....	3-4
	3.4.2 Service System.....	3-5
	3.4.3 Staffing Requirement.....	3-7
	3.4.4 Implementation Schedule and Management.....	3-9
	3.4.5 Personnel Cost.....	3-11
	3.4.6 Personnel Costs for F/S Implementation.....	3-13
3.5	New Organization of Sewerage Division.....	3-13
3.6	Recommendations.....	3-13

CHAPTER 4 OPERATION AND MAINTENANCE

4.1	Introduction.....	4-1
4.2	Current Issues of OM.....	4-1
	4.2.1 Total Metering.....	4-1
	4.2.2 Leakage Prevention.....	4-6
	4.2.3 Mapping.....	4-10
	4.2.4 Tariff Study.....	4-13
	4.2.5 Asset Registration.....	4-13
	4.2.6 Bill Collection.....	4-13
4.3	Recommendations.....	4-14
4.4	Summary of F/S Implementation.....	4-14

CHAPTER 5 COST ESTIMATION & IMPLEMENTATION SCHEDULE

5.1	Construction Consideration.....	5-1
5.2	Project Cost.....	5-2
5.3	Implementation Schedule.....	5-3

CHAPTER 6 PROJECT APPRAISAL

6.1	Financial Evaluation.....	6-1
	6.1.1 All Metering.....	6-1
	6.1.2 Financial Plan.....	6-1
	6.1.3 FIRR.....	6-1
	6.1.4 EIRR.....	6-2
	6.1.5 Other Benefit	6-2
	6.1.6 Appraisal.....	6-3
6.1	Environmental Assessment.....	6-7
	6.2.1 General.....	6-7
	6.2.2 Summary of Implementation Schedule.....	6-8
	6.2.3 Possible Environmental Impacts.....	6-9
	6.2.4 Environmental Assessment During Operation.....	6-13

LIST OF FIGURES

Page

CHAPTER 2 ENGINEERING DESIGN

2.1	Proposed Facilities .	2.26
2.2	Rouna 4 Head Pond.....	2.27
2.3	Alternative Routes of The Raw Water Main	2.28
2.4	Proposed Location of Pumping Station	2.29
2.5	Expansion Works	2.30
2.6	Proposed Facilities .	2.31
2.7	Plant Flow of 9 Mile WTP	2.32
2.8	The Proposed Facilities for 9 Mile WTP	2.33
2.9	Schematic Layout of The Future Water Supply System	2.34
2.10	Future Water Supply System With Elevation	2.35
2.11	Proposed Transmission Lines for The Feasibility Study	2.36
2.12	Proposed Distribution Lines for The Feasibility Study	2.37

CHAPTER 3 MANAGEMENT

3.1	New Organization of NCDC.....	3.15
3.2	New Organization of NCDC for Water Supply	3.16
3.3	Water Supply Management (Common)	3.17
3.4	New Organization of Water Supply Division (System 1).....	3.18
3.5	New Organization of Water Supply Division (System 2).....	3.19
3.6	New Organization of Water Supply Division (System 2).....	3.20

CHAPTER 4 OPERATION AND MAINTENANCE

4.1	Metering System Flow Chart	4.16
4.2	Metering Schedule	4.17
4.3	Manning and Equipment of Metering System	4.18
4.4	Procedure of Above-Grand Leakage Control	4.19
4.5	Procedure of Underground Leakage Control	4.20
4.6	Leakage Control Schedule	4.21
4.7	Manning Equipment and Tools for Leakage.....	4.22
4.8	Mapping System Flow Chart	4.23

CHAPTER 5 COST AND IMPLEMENTATION SCHEDULE

5.1	Implementation Schedule.....	5.6
-----	------------------------------	-----

CHAPTER 6 PROJECT APPRAISAL

LIST OF TABLES

Page

CHAPTER 2 ENGINEERING DESIGN

2.1	Cost Comparison of The Alternatives	2.6
2.2	Comparison in NPV	2.7
2.3	Cost Comparison (Single Or Duplication Line)	2.8
2.4	Cost Comparison in NPV	2.8
2.5	Required Capacity By Year	2.22
2.6(A)	Proposed Transmission	2.23
2.6(B)	Proposed Distribution - Existing Urban Area -	2.23
2.6(C)	Proposed Distribution - Development Area -	2.24
2.7	Summary of Proposed Facilities	2.25

CHAPTER 3 MANAGEMENT

3.1	Basic Functions for Water Supply	3.3
3.2	Water Service Zones of NCDC	3.5
3.3	Operator's Duty Roster for Plant and P/S	3.6
3.4	Connection and Staffing	3.8
3.5	Implementation Schedule and Management	3.10
3.6	Number of NCDC Employees	3.11
3.7	Salary Structure of NCDC	3.12
3.8	Staffing Structure of Water Supply (1989)	3.12
3.9	Personnel Costs for F/S Implementation	3.13

CHAPTER 4 OPERATION AND MAINTENANCE

4.1	Selection of Type of Meter	4.3
4.2	Meter Problems, Causes and Solutions	4.4
4.3	Cost Estimates of Operation and Maintenance	4.15

CHAPTER 5 COST AND IMPLEMENTATION SCHEDULE

5.1	Project Cot	5.3
5.2	Cost Estimation by Year	5.3
5.3(A)	Implementation Schedule - Transmisson -	5.4
5.3(B)	Implementation Schedule - Distribution Pipe, Existing Urban Area	5.4
5.3(C)	Implementation Schedule - Distribution Pipe, Development Area	5.5

CHAPTER 6 PROJECT APPRAISAL

6.1	Financial Statements of Water Supply Enterprise : F/S	6.4
6.2	FIRR : F/S	6.5
6.3	EIRR : F/S	6.6

LIST OF APPENDICES

APPENDIX A	POTENTIAL SURFACE WATER RESOURCES
APPENDIX B	WATER QUALITY
APPENDIX C	POPULATION ESTIMATION AND DISTRIBUTION
APPENDIX D	WATER CONSUMPTION
APPENDIX E	LEAKAGE
APPENDIX F	NETWORK ANALYSIS
APPENDIX G	COMPARISON OF ALTERNATIVES
APPENDIX H	MANAGEMENT / OPERATION AND MAINTENANCE
APPENDIX I	FINANCIAL ANALYSIS
APPENDIX J	ENVIRONMENTAL ASPECTS
APPENDIX K	COST ESTIMATION
APPENDIX L	WATER RATIONING PLAN