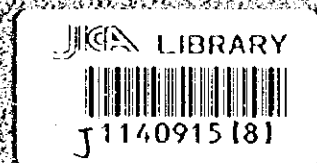


JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)  
HANOI PEOPLE'S COMMITTEE  
THE SOCIALIST REPUBLIC OF VIET NAM

THE STUDY  
ON  
HANOI WATER SUPPLY SYSTEMS  
IN  
THE SOCIALIST REPUBLIC OF VIET NAM

FINAL REPORT

EXECUTIVE SUMMARY



OCTOBER 1997

PACIFIC CONSULTANTS INTERNATIONAL  
HOKKAI DO ENGINEERING CONSULTANTS CO., LTD.

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**JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)**

**HANOI PEOPLE'S COMMITTEE  
THE SOCIALIST REPUBLIC OF VIET NAM**

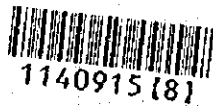
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**ESTIMATE OF PROJECT COST**

Estimate of Base Cost : At 1997 Price Level  
Currency Exchange Rate : US\$ 1 = Dong 11,000

## PREFACE

In response to the request from the Government of the Socialist Republic of Viet Nam, the Government of Japan decided to conduct the Study on Hanoi Water Supply Systems in the Socialist Republic of Viet Nam and entrusted the study to the Japan International Cooperation Agency (JICA).

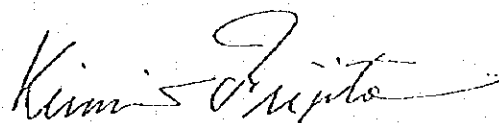
JICA sent to Viet Nam a study team headed by Mr. Toshifumi Okaga, Pacific Consultants International (PCI) and associated with Hokkaido Engineering Consultants, Co. Ltd. three times between March 1996 to August 1997.

The team held discussions with the officials concerned of the Government of Viet Nam, 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 Socialist Republic of Viet Nam for their close cooperation extended to the team.

October 1997



Kimio Fujita  
President

Japan International Cooperation Agency

**THE STUDY  
ON  
HANOI WATER SUPPLY SYSTEMS  
IN  
THE SOCIALIST REPUBLIC OF VIET NAM**

October 1997

Mr. Kimio FUJITA  
President  
Japan International Cooperation Agency

**LETTER OF TRANSMITTAL**

Dear Sir,

We are pleased to submit the final report entitled the "The Study on Hanoi Water Supply Systems in The Socialist Republic of Viet Nam." This report has been prepared by the Study Team in accordance with the contract signed on February 16, 1996, November 27, 1996 and April 24, 1997 between the Japan International Cooperation Agency and Pacific Consultants International in associate with Hokkaido Engineering Consultants Co., Ltd..

The report consists of the Executive Summary, Main Report, Supporting Report and Data Book. The Executive Summary summarizes the results of all studies. The Main Report presents the results of the whole study including analysis of existing conditions, study of water resources management, improvement plan of the existing facilities and the extension plan of the facilities, formulation of the water supply master plan and the feasibility study for the priority projects.

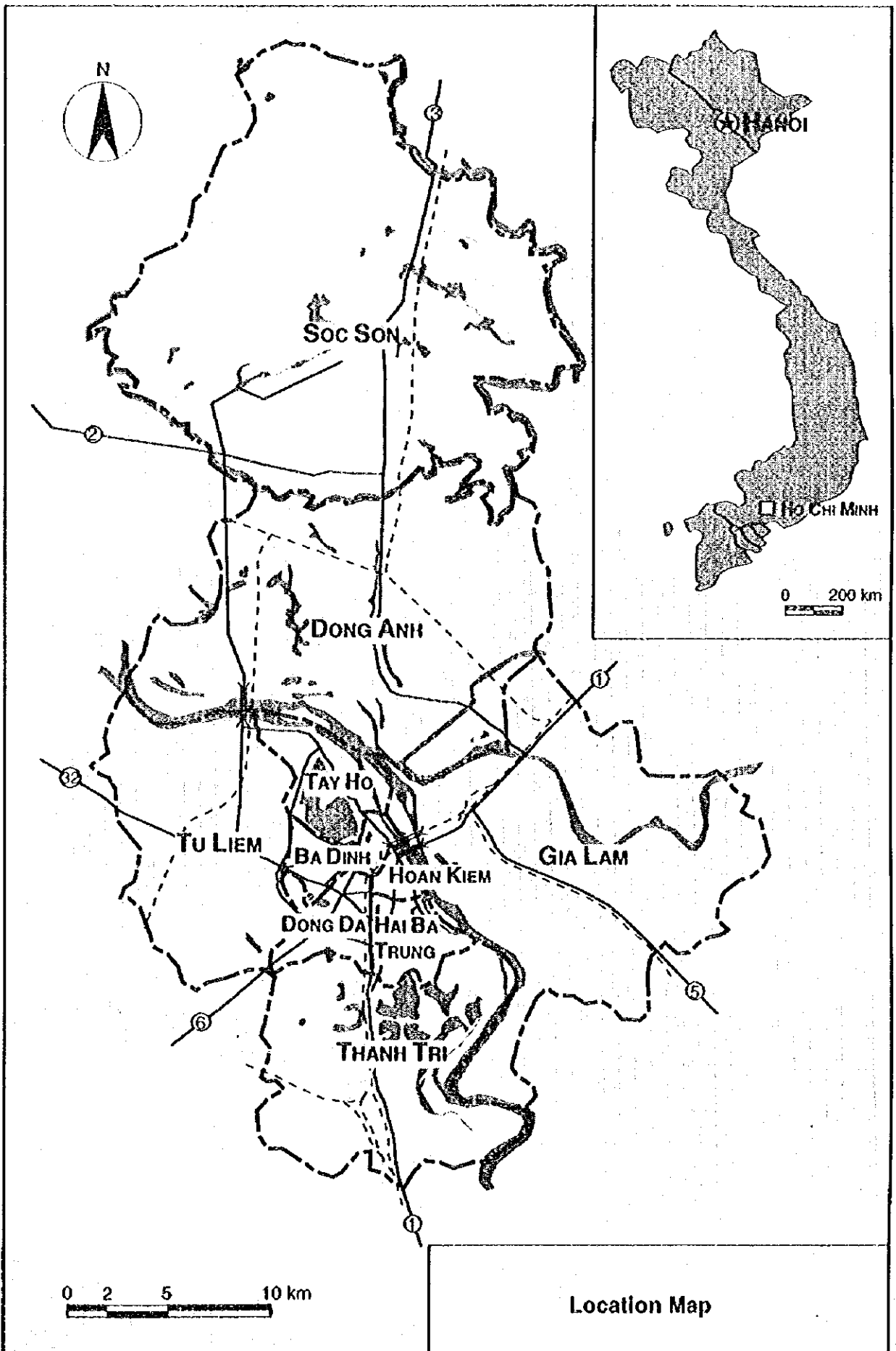
The Supporting Report describes in detail the technical aspects of the entire study. In addition, the Data Book has been prepared and submitted herewith. All members of the Study Team wish to express sincere appreciation to the personnel of your Agency, Advisory Committee, and Embassy of Japan in Viet Nam, and also to the officials and individuals of the Government of the Social Republic of Viet Nam for their assistance extended to the Study Team. The Study Team sincerely hopes that the results of the study will contribute to the water supply systems and the socio-economic development in Hanoi.

Yours Faithfully



Toshifumi OKAGA

Team Leader of the Study Team



**THE STUDY ON HANOI WATER SUPPLY SYSTEMS  
IN THE SOCIALIST REPUBLIC OF VIET NAM**

**ABSTRACTS**

**1 Framework for the Master Plan**

(1) Target Year : 2010

(2) Rate of population served and per capita water consumption in 2010 :

	Rate of Population Served	Per Capita Consumption
Urban Area	100%	180 l/c/d
DID	100%	165 l/c/d
Rural Area	85%	90 l/c/d

**2 Improvement of the Existing Facilities**

The improvement of UFW (Unaccounted-for Water) is projected as below.

Year	1996	2010
Physical loss	25%	15%
Administration loss	46%	15%
Total UFW	71%	30%

**3 Extension Project**

(1) Water Demand Forecast

Year	2000	2005	2010
1. Population served	2,587,770	2,885,325	3,183,792
2. Ave. Daily Water Demand (m <sup>3</sup> /day)	465,528	607,360	760,284
3. Ave. Daily Distribution Water (m <sup>3</sup> /day) (physical loss : 15%)	547,679	714,539	894,451
4. Daily Max. Distribution Water(m <sup>3</sup> /day) (peak factor : 1.35)	715,293	932,423	1,168,981
5. Capacity of Existing Facility (m <sup>3</sup> /day)	500,000	500,000	500,000
6. Water for Expansion project (m <sup>3</sup> /day)	215,293	432,423	668,981

(2) Water Sources

The available groundwater of 1,232,000 m<sup>3</sup>/day will satisfy the demand of 1,072,000 m<sup>3</sup>/day including private wells in the year 2010. Therefore, groundwater is available as the source for the water supply system for the whole Hanoi area up to the year 2010.

(3) Construction Plan

Construction Schedule for the facilities :

Project	Capacity of the facility till 2005 (m <sup>3</sup> /day)	Capacity of the facility till 2010 (m <sup>3</sup> /day)
<b>HWBC</b>		
Construction of Water supply system	170,000	250,000
<b>HWBC No.2</b>		
Construction of Water supply system	330,000	390,000
Construction of the transmission main	62,000	62,000
<b>Rural Waterworks</b>	63,600	63,600
Construction of Water supply system	63,600	63,600

(4) Construction cost schedule

Schedule for construction cost :

Year	(Million US\$)		
	1999-2005	2006-2010	Total
HWBC No.2	304	9	313
HWBC	172	21	193
Rural Waterworks	33	0	33
Total	509	30	539

(5) Financial Analysis

	HWBC	HWBC No.2	Rural Waterworks
FIRR (%)	14.12	14.71	6.76
Break-Even Point	year 2006	year 2009	year 2018
Projected Fund Flow	quite smooth	quite smooth	smooth *1

Note : The projected fund flows statement demonstrates positive net cash positions owing to the subsidized half (1/2) of Investment cost (Construction).



(6) Outlook for Work Force

	HWBC	HWBC No.2	Rural	Total
Total Employees in year 2000	1,390	104	200	1,694
Total Employees in year 2005	1,361	617	600	2,578
Total Employees in year 2010	1,271	688	600	2,559

4 PRIORITY PROJECT

(1) Project area : Western part of Central Hanoi

(2) Objectives of the project and water demand in 2005:

Category of Water Demand	Average Daily Water Demand	Average Daily Water Distribution
(1) Project Area	12,600	14,800
(2) Mai Dich Water Supply System	-	20,000
(3) Future Development Area	(11,000)	12,900
Total	-	47,700

(m<sup>3</sup>/day)

Note: A physical loss of 15% is included in distribution volume, that is,  
 [Distribution] = [Water Demand] / (1-0.15)

(3) Facilities and project cost

Component	Qty	Cost (Million VND)
(A) Facility construction Water intake, treatment plant, pipelines	Production capacity : 60,000 m <sup>3</sup> /day, 22 intake wells, 91km pipe length	332,150
(B) Land cost	Lump sum	78,000
(C) Engineering services	Lump sum	41,518
(D) Physical contingency	10 %	37,366
(E) Price contingency	F/C 2%, L/C 9%	98,514
Total project cost		587,548 (=53.42 Million US\$)

(4) Implementation Schedule

Implementation Schedule

Procedure	Year	1	2	3	4	5	6
		1997	1998	1999	2000	2001	2002
Feasibility Study (F/S).....		■					
Approval by the Government.....		■	■				
Loan Procedure.....			■	■			
Land Acquisition.....			■	■	■		
Detail Design.....				■	■		
Test Wells (Groundwater).....				■			
Tendering.....					■		
Construction.....					■	■	■
Test Operation.....							■

(5) Managerial approach

Organization : One water plant and one water business enterprise under HWBC.

Work force : 35 staff at the water plant and 30 staff at the business enterprise.

(6) Financial analysis

IRR (FIRR) : 9.03%

Break-even point : year 2004

(7) Economical analysis

EIRR : 9.6%

(8) Environmental Impact Assessment (EIA)

In general, most impacts caused by the project are considered to be positive, and negative impacts are predicted to be insignificant. Therefore the project is feasible from the viewpoint of environmental consideration if the negative impacts are carefully taken into consideration and necessary mitigating measures are implemented.

## EXECUTIVE SUMMARY

### TABLE OF CONTENTS

<b>1</b>	<b>BACKGROUND</b> .....	<b>1</b>
<b>2</b>	<b>SUMMARY OF ISSUES</b> .....	<b>2</b>
<b>3</b>	<b>FRAMEWORK FOR THE MASTER PLAN</b> .....	<b>4</b>
3.1	Study Area .....	4
3.2	Target Year and Goal .....	4
<b>4</b>	<b>FORMULATION OF THE MASTER PLAN</b> .....	<b>6</b>
4.1	Improvement of the Existing Facilities .....	6
4.2	Extension Project .....	7
<b>5</b>	<b>PRIORITY PROJECT</b> .....	<b>19</b>
5.1	Project Area .....	19
5.2	Water Demand .....	20
5.3	Preliminary Design .....	20
5.4	Cost Estimation .....	24
5.5	Implementation Schedule .....	25
5.6	Managerial Approach .....	25
5.7	Financial Analysis .....	26
5.8	Economic Analysis .....	27
5.9	Environmental Impact Assessment (EIA) .....	27
	for the Priority Project	
5.10	Social Analysis .....	28
<b>6</b>	<b>RECOMMENDATION</b> .....	<b>29</b>

## SUMMARY

### 1 BACKGROUND

Hanoi is located in the upper stream of the Red River Delta. The city area including five suburban districts is 924.5 km<sup>2</sup> with a population of about 2,394,887 (1995). The city is undergoing rapid urbanization with high population growth rate in recent years. However, it is rather undeniable that the city virtually lacks environmentally and sanitarily acceptable water supply systems to meet its urbanization and growth of population.

With regard to the water supply system covering the urban districts, improvement and extension of the system have been implemented under the Hanoi Water Supply Project (FINNIDA assistance) since 1985. The project has made continuous efforts for improving the Hanoi water supply over a decade.

In 1993 the project formulated a water supply master plan toward 2010, which covered only the urban districts.

In consideration of recent urbanization and foreign investments, Hanoi needs a more comprehensive water supply master plan covering the whole area of Hanoi city including the estranged suburban districts.

With this background, the Study on Hanoi Water Supply Systems was undertaken by Japan International Cooperation Agency responding to the request made by the Government of Vietnam.

The Study Area covers the whole Hanoi area. It is shown in Location Map.

The objectives of the study are :

- A. To establish an overall and strategic master plan covering the whole Hanoi city area with the planning target year 2010.
- B. To conduct a feasibility study for the priority projects identified in the Master Plan.
- C. To conduct technology transfer to the Vietnamese counterpart personnel.

## 2 SUMMARY OF ISSUES

### (1) Rate of Population Served

In the core of Hanoi City and its outskirts, at present, the rate of population served is as high as nearly 100%. On the other hand, however, in its suburban area, the rate is still low at approximately 14%. The rate of population served in the entire Hanoi city is estimated at 53% on an average.

Many people in non-piped water service areas desire clean and sufficient water conveniently supplied by piped water system. People in these areas get water from poor water sources such as shallow wells, rain water, irrigation ponds or channels. Their water consumption is quite low.

### (2) Water Sources

Laws and regulations related to the development of the groundwater are still under preparation and have not been enacted yet. At present, the decline in groundwater levels at the wellfields in the center of Hanoi area due to excessive exploitation of groundwater has been pointed out.

### (3) Water Quality

The treatment practice of the treatment plants is basically appropriate to the raw water quality, except plants in Phap Van, Tuong Mai and Ha Dinh, where high concentration of ammonia (8 - 25 mg/l) presents in raw water makes the current processes inadequate for their removal.

### (4) Institution and Management

#### A. Unaccounted-for Water

The most serious problem in the water supply system in Hanoi is the extremely high level of Unaccounted-for Water (UFW, 70% of total production capacity). Administrative cause seems to amount to 45% and it is the major part of the total UFW.

**B. Poor Marketing Activities**

In 1995, the ratio of employees per 1000 consumers in Hanoi recorded, 16.6 higher than that of HCMC at 6.5 and Khanh Hoa at 11.6. This shows that HWBC has too many staff.

**C. Potential Conflicts of Interest in Decision Making**

Potential conflicts of interest do exist because the board of directors not only perform the ownership function on behalf of HPC, but also is responsible for managing HWBC toward profit based efficiency. Under the circumstances the board of directors would face a dilemma whether water charges should be kept at an affordable level or at the level that allow the company to cover costs and make future investments.

**(5) Financial Status**

**A. Standard Difference from IAS**

Financial practice of HWBC is still apart from the International Accounting Standard (IAS). On surface, by the financial statements submitted by HWBC, historical performance of HWBC has not been that bad, however, proper accounting process has not been applied. This results in difficulties in assessment of creditworthiness of the company.

**B. Insufficient Water Tariffs**

Historically, water tariffs in Vietnam has been kept lower than full cost recovery level. The water tariff is cross-subsidized by non-domestic customers, however, earliest effort to raise water tariff is required.

**C. Lack of Expertise**

In respect of finance, lack of staff expertise in HWBC is a major concern. In order to improve financial practices to international level, much expertise should be gained by managers and clerks of Finance Department and Business Department.

### 3 FRAMEWORK FOR THE MASTER PLAN

#### 3.1 STUDY AREA

The study area covers approximately 924.5 km<sup>2</sup> consisting of five urban districts and five suburban districts in Hanoi as shown in Location Map.

The urban districts and the suburban districts differ in the water supply consumption conditions due to difference in living standards. The study area is categorized into three groups as below :

- Group U : The core of Hanoi and its surroundings. The area has been supplied with piped water.
- Group D : The future development area and Densely Inhabited Areas (DID).
- Group R : Sparsely populated areas such as agricultural farm lands.

#### 3.2 TARGET YEAR AND GOAL

The target year of the Master Plan is the year 2010. The following are tangible contents of the target year and goal.

##### (1) Improvement of the Existing Facilities

In order to strengthen financial status of the waterworks, the rate of UFW be improved by 30 % from the current status of 71%.

##### (2) Extension Program of the Water Supply Systems

Service conditions of the water supply are formulated as below :

	Group U	Group D	Group R
Rate of Population Served	100%	100%	85%
Unit Water Demand (Domestic Use)	180 l/c/day	165 l/c/d	90 l/c/d
Service Level	House connections	House connections	Public taps

### **(3) Institutional Strengthening**

The urban water supply systems are proposed to be operated under self-standing conditions of the waterworks.

As for the rural water supply systems, the facilities are constructed with subsidies. After construction, the systems are to be transferred to HWBC/HWBC No.2.



## 4 FORMULATION OF THE MASTER PLAN

The Master Plan consists of improvement of the existing facilities and the extension projects to supply water for the non-water service area.

### 4.1 IMPROVEMENT OF THE EXISTING FACILITIES

In order to strengthen financial status of the waterworks, the rate of UFW is to be improved gradually.

At present, there is an on-going project (the World Bank 1A project) and some actual implementation plans for water supply improvement project in Hanoi. These on-going projects targeting up to 2000 are not included in formulation of this improvement plan in future.

The improvement of UFW will be projected for future as given in Table 1.

Table 1 Improvement of UFW

Year	1996	2000	2005	2010
Physical loss (%)	25	21	16	15
Administration loss (%)	46	32	21	15
Total (%)	71	53	37	30

Based on the production water by the on-going project in 2000, the production water will be saved by 23 % with about 83,490 m<sup>3</sup>/day of distribution water of the existing facilities from 2001 to 2010.

The improvement plans are : (a) improvement of physical loss with renovation of old pipes on the distribution pipelines, (b) water meters are to be supplied and installed to all households in the service area and (c) water bill and tariff systems are to be modified to be a new structure.

The cost for the implementation work ((a)+(b)) is estimated at US\$ 7,200,000.

## 4.2 EXTENSION PROGRAM

### 4.2.1 Water Demand Forecast

The water demand forecast and the projected water capacity for extension program are shown in Table 2.

Table 2 Water Demand Forecast

Year	2000	2005	2010
1. Population served	2,587,770	2,885,325	3,183,792
2. Ave. Daily Water Demand (m <sup>3</sup> /day)	465,528	607,360	760,284
3. Ave. Daily Distribution Water (m <sup>3</sup> /day) (physical loss : 15%)	547,679	714,539	894,451
4. Daily Max. Distribution Water(m <sup>3</sup> /day) (peak factor : 1.35)	715,293	932,423	1,168,981
5. Capacity of Existing Facility (m <sup>3</sup> /day)	500,000	500,000	500,000
6. Water for Extension Program (m <sup>3</sup> /day)	215,293	432,423	668,981

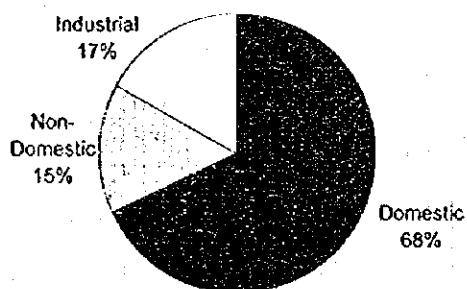
The per capita demand including all water use categories are shown in Table 3. This is an index for evaluation of the future conditions of water supply in Hanoi.

Table 3 Per Capita Water Demand

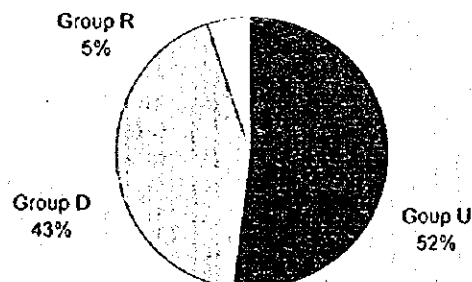
Year	2000	2005	2010
Group U (Urban area)	238	271	303
Group D (DID area)	232	279	316
Group R (Rural area)	60	75	90

(l/c/d)

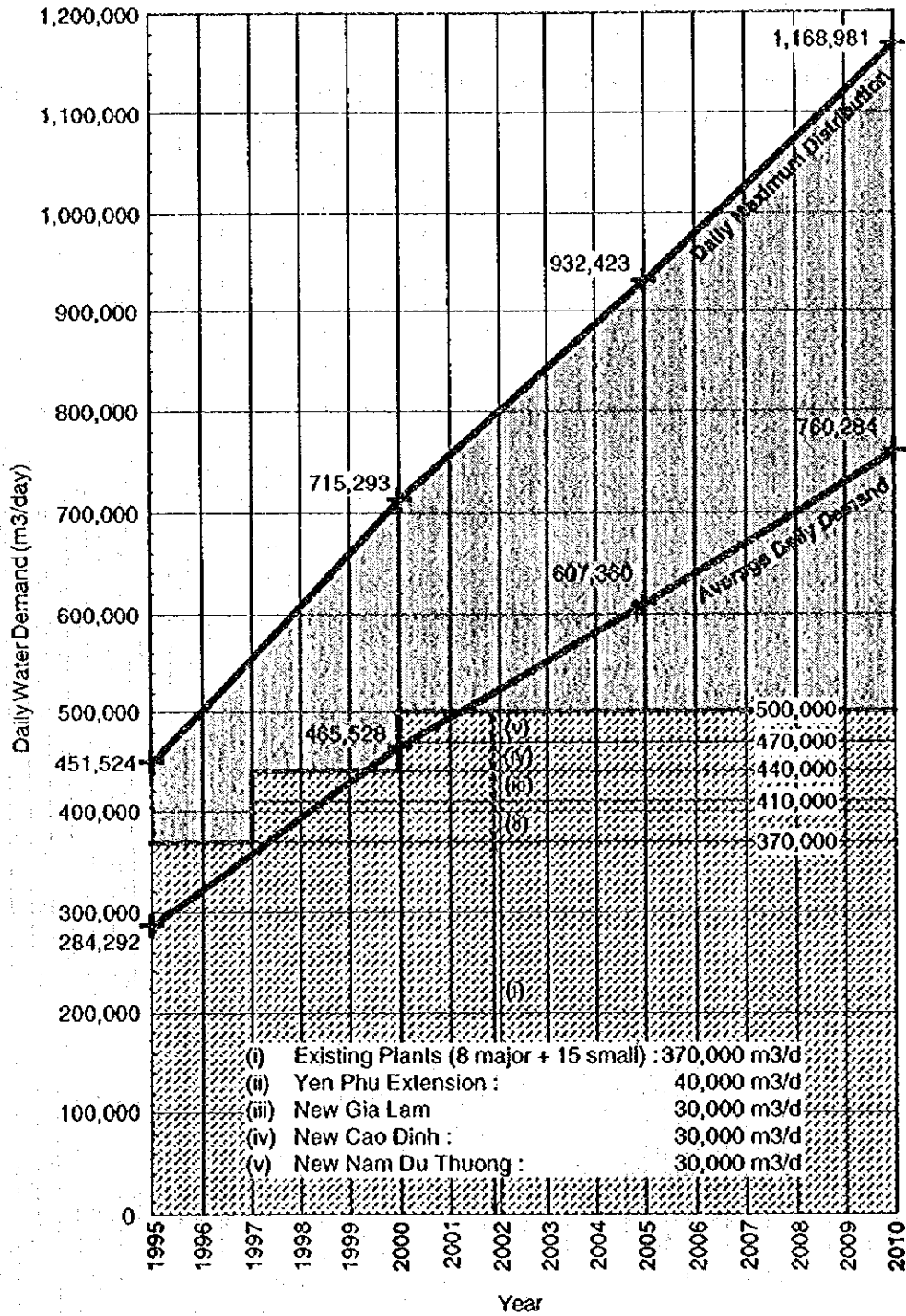
Ratio of water demand by usage and by group are presented below.



Ratio of Water Demand by Usage



Ratio of Water Demand by Group



Water Demand Forecast  
( Whole Hanoi City )

#### 4.2.2 Water Sources

The available groundwater of 1,232,000 m<sup>3</sup>/day will satisfy the demand of 1,072,000 m<sup>3</sup>/day (including private wells) until the year 2010. Therefore, groundwater is available as the source for the water supply system in the whole area of Hanoi until the year 2010.

Although, the exploitable groundwater will meet the demand of Hanoi, some suburban districts such as Soc Son and Dong Anh may experience lack of the groundwater resources before 2010. These districts can supplement the shortage of groundwater from Gia Lam district.



**Soc Son**

Year	2000		2005		2010	
Available	66,000		66,000		66,000	
Development	A 24,000	B 12,000	A 45,000	B 16,000	A 62,000	B 22,000
	36,000		61,000		84,000	
Balance	30,000		5,000		-18,000	

**Soc Son (B)**

**Dong Anh (A)**

Year	2000	2005	2010
Available	59,000	59,000	59,000
Development	37,000	62,000	85,000
Balance	22,000	-3,000	-26,000

**Soc Son (A)**

**Dong Anh (B)**

Year	2000	2005	2010
Available	50,000	50,000	50,000
Development	37,000	51,000	68,000
Balance	13,000	-1,000	-18,000

18,000 m<sup>3</sup>/d (2010)

**Dong Anh (C)**

**Dong Anh (C)**

Year	2000	2005	2010
Available	20,000	20,000	20,000
Development	3,000	4,000	5,000
Balance	17,000	16,000	15,000

**Dong Anh (B)**

**Dong Anh (A)**

4,000 m<sup>3</sup>/d (2005)  
62,000 m<sup>3</sup>/d (2010)

**Gia Lam**

**South Hanoi**

**Gia Lam**

Year	2000	2005	2010
Available	337,000	337,000	337,000
Development	93,000	130,000	160,000
Balance	244,000	207,000	177,000

**South Hanoi**

Year	2000	2005	2010
Available	700,000	700,000	700,000
Development	478,000	569,000	670,000
Balance	222,000	131,000	30,000



**Groundwater Balance & Plan of Water Source**

### 4.2.3 Construction Plan

#### (1) Facilities

The facilities to be constructed include intake facilities, treatment plants, distribution facilities and networks.

The water supply system for the rural area is an independent water supply system by each commune. Treated water is to be supplied to consumers through public taps equipped with water meters. The public taps will be located within a distance of less than 100 m. Each tap will serve about 100 people.

Groundwater in Soc Son and Dong Anh may experience shortage. Groundwater of Gia Lam is planned to be transmitted to Soc Son and Dong Anh. The transmission pipeline is to be constructed in year 2002 to 2003.

Construction schedule for the facilities is planned as shown in Table 4.

Table 4 Construction Schedule for the facilities

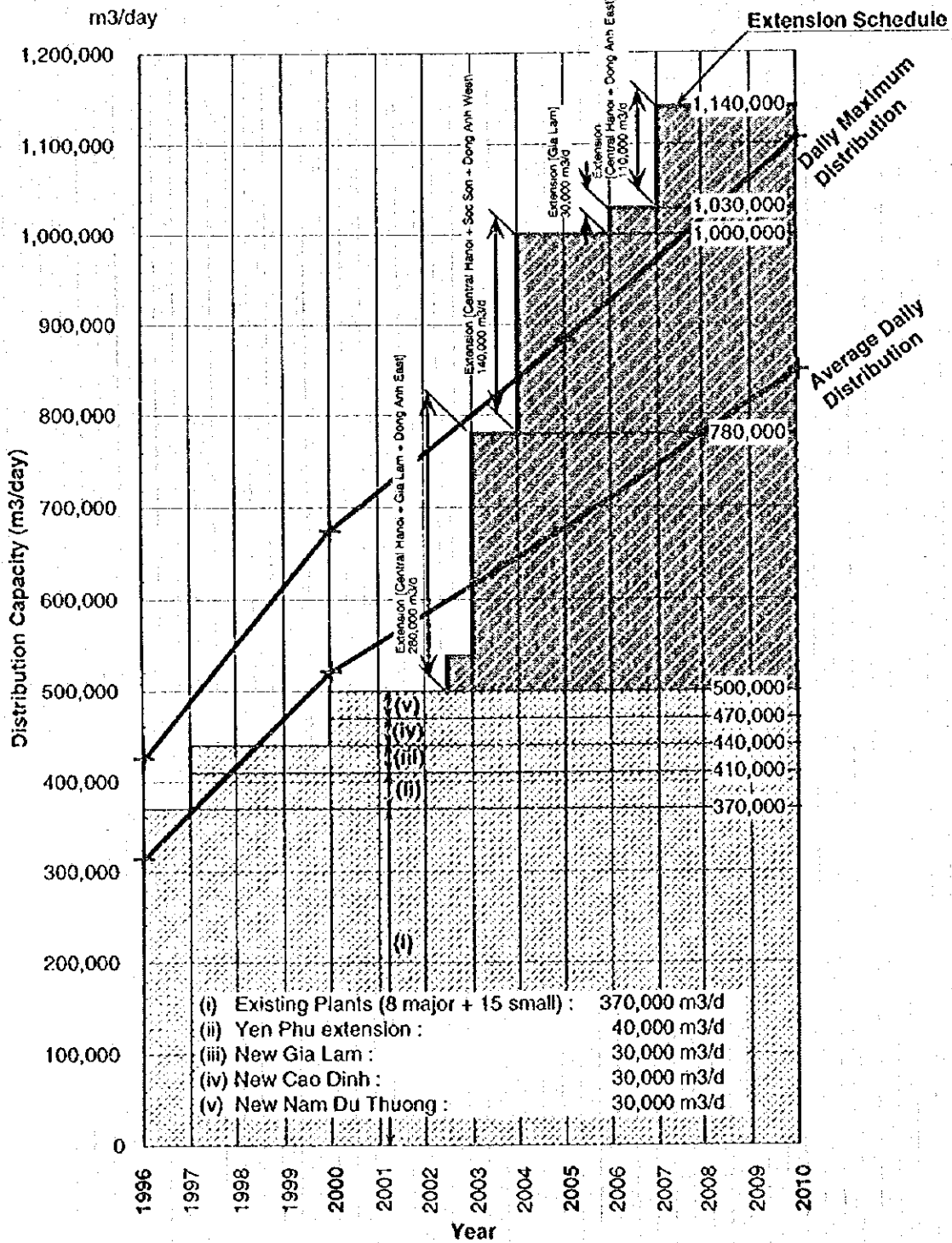
Project	Capacity of the facility till 2005 (m <sup>3</sup> /day)	Capacity of the facility till 2010 (m <sup>3</sup> /day)
<b>HWBC (the south Hanoi)</b>		
Construction of Water supply system	170,000	250,000
<b>HWBC No.2 (the north Hanoi)</b>		
Construction of Water supply system	330,000	390,000
Construction of the transmission main	62,000	62,000
<b>Rural Waterworks</b>		
Construction of Water supply system	63,600	63,600

#### (2) Disbursement Schedule of Construction Cost (Table 5)

Table 5 Disbursement schedule of construction cost

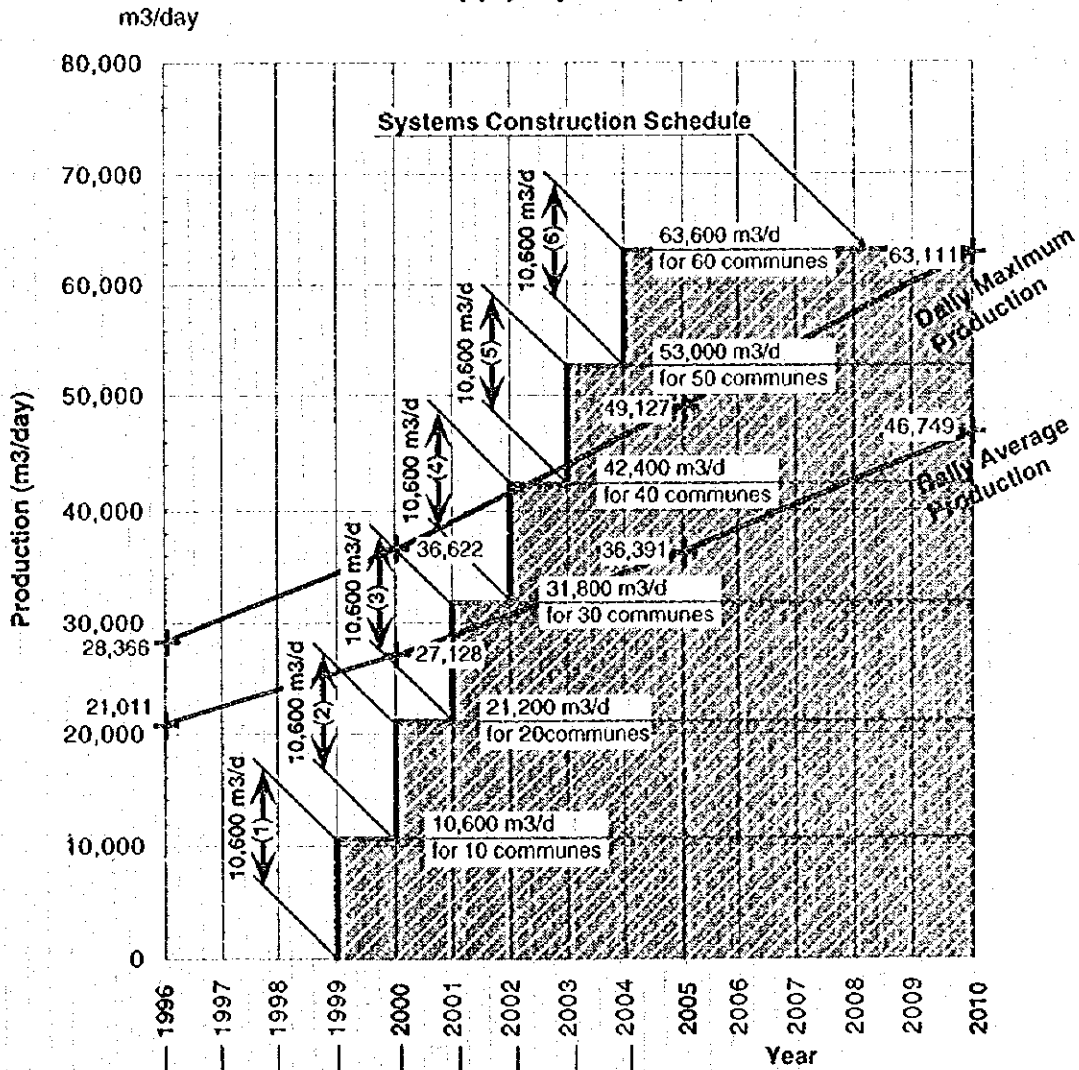
Year	(Million US\$)		
	1999-2005	2006-2010	Total
HWBC	172	21	193
HWBC No.2	304	9	313
Rural Waterworks	33	0	33
<b>Total</b>	<b>509</b>	<b>30</b>	<b>539</b>

### Extension Schedule Hanoi Total (Urban and DID)



Extension Schedule  
Hanoi Total (Urban and DID)

## Construction Schedule Rural Water Supply Systems (60 Communes)



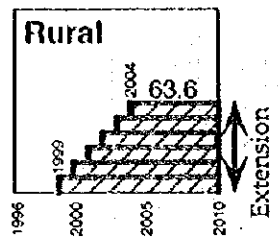
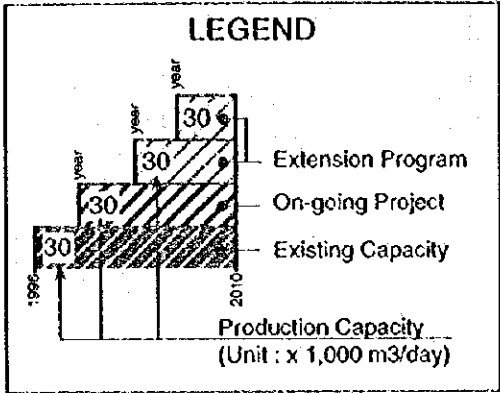
### Investment Schedule

Year	Investment (\$)
1996	0
1997	0
1998	(1) 10 @ \$58,100 = \$5,811,000
1999	(2) 10 @ \$58,100 = \$5,811,000
2000	(3) 10 @ \$58,100 = \$5,811,000
2001	(4) 10 @ \$58,100 = \$5,811,000
2002	(5) 10 @ \$58,100 = \$5,811,000
2003	(6) 10 @ \$58,100 = \$5,811,000
2004	(6) 10 @ \$58,100 = \$5,811,000
2005	Total (1 - 6) = \$33,486,000

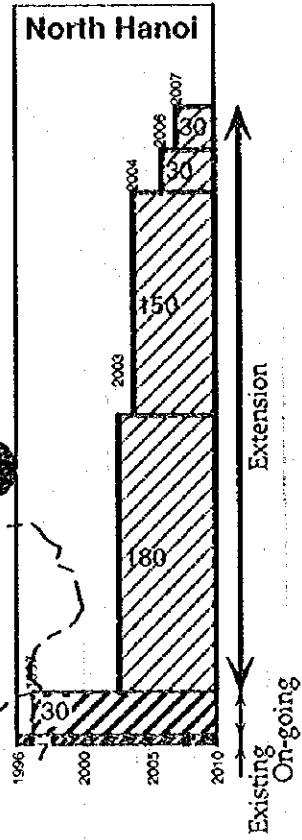
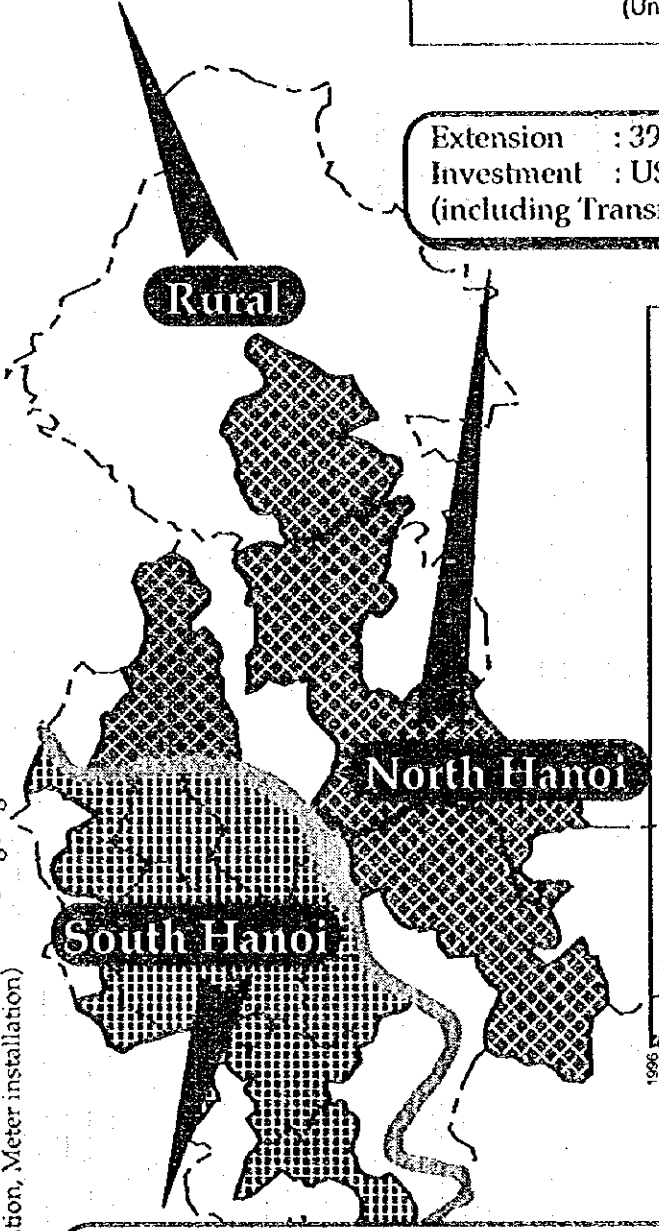
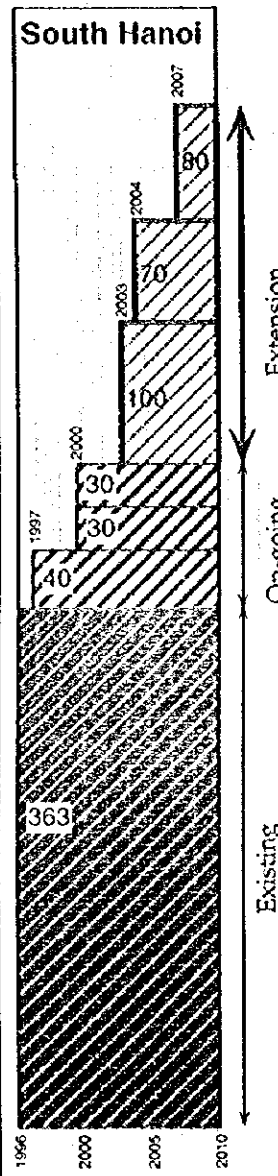
## Construction Schedule Rural Water Supply Systems (60 Communes)



Development: 63,600m<sup>3</sup>/day  
(60 communes)  
Investment : US\$ 33,486,000



Extension : 390,000m<sup>3</sup>/day  
Investment : US\$ 314,100,000  
(including Transmission : 26 km)



Extension : 250,000m<sup>3</sup>/day  
Investment : US\$ 186,600,000  
(including Pipe Renovation and Meter Installation)

## Extension Schedule

#### 4.2.4 Financial Analysis

The financial analysis for each program is summarized in Table 6.

Table 6 Summary of Financial Analysis

	HWBC	HWBC No.2	Rural Waterworks
FIRR (%)	14.12	14.71	6.76
Breakeven Point	year 2006	year 2009	year 2018
Projected Fund Flow	quite smooth	quite smooth	smooth *1

Note : The projected fund flows statement demonstrates positive net cash positions owing to the subsidized half (1/2) of Investment cost (Construction).

Overall estimated FIRR of urban waterworks are just moderate until year 2030, but FIRR of rural waterworks is expected to be rather low of 6.7 % even with the construction cost subsidies.

Considering the present financial status of HWBC, fund raising ability in the three areas remains vulnerable at least until target year of 2010.

Estimated FIRRs are at least higher than the anticipated financing cost of 2.30%. Assumptions in the calculations are fairly conservative, like 15% administration loss even for the brand new water supply systems. Because of its primitive financial market in Vietnam, the yield curve is inverted, as such low FIRR for a long term project can be justified.

Affordability does not seem the problem according to the projection until 2010.

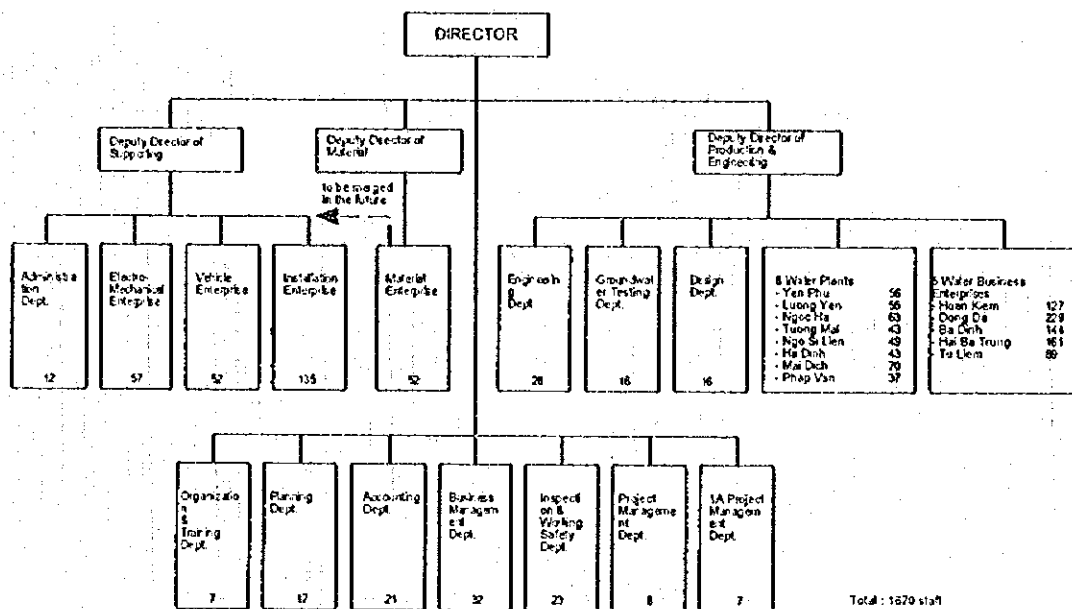
Therefore from the viewpoint of the financial aspect, the Master Plan is viable.

## 4.2.5 Institution and Management

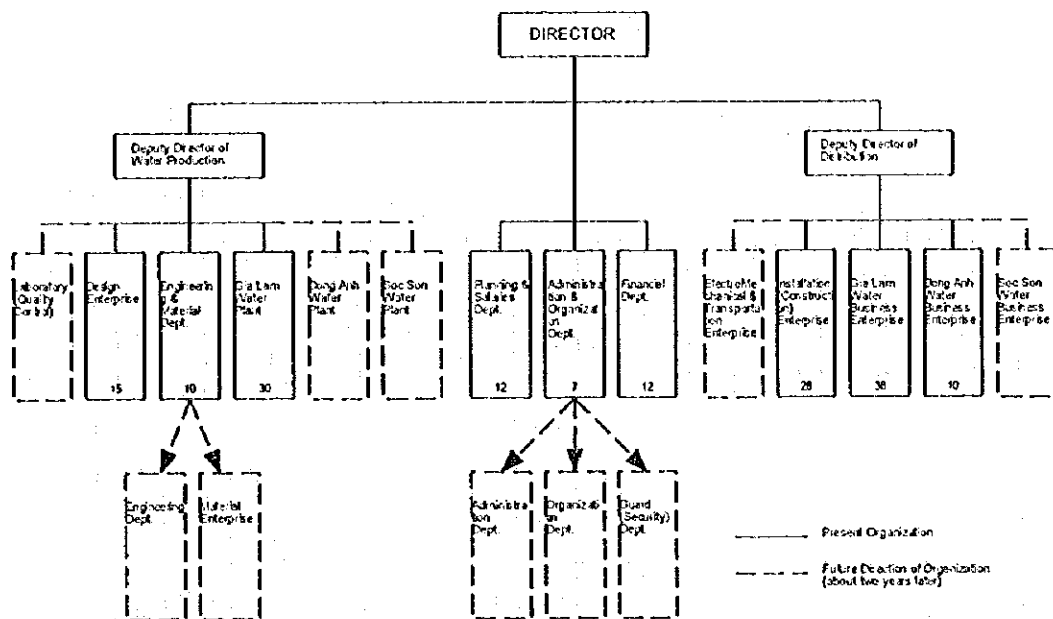
### (1) Future Organizational Structure

Waterworks of Hanoi are divided by Red River as a boundary. The southern area of the Red River is administrated by the existing HWBC. The northern area (Soc Son, Dong Anh, Gia Lam) is to be administrated by HWBC No.2. As for the rural water supply for Group R, it is to be managed by HWBC/HWBC No.2.

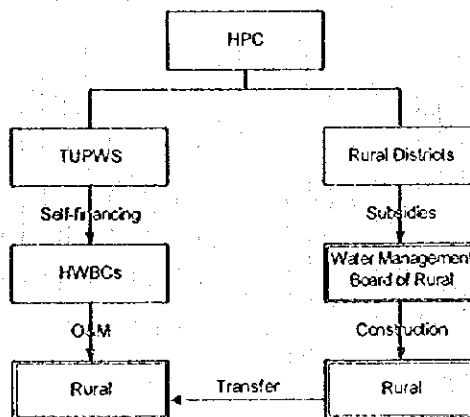
For the rural water supply, the construction management board would be organized in TUPWS. The facilities are to be constructed by the management board with subsidies. After construction, the systems are to be transferred to HWBC/HWBC No.2 for their operation and maintenance works.



The organization chart of HWBC in March 1997 and Future Direction



The organization chart of HWBC No.2 in March 1997 and Future Direction



Future Organization Structure of Rural Area

(2) Outlook for Work Force

Table 7 Outlook for the Number of Workers by Water Supply System

	HWBC	HWBC No.2	Rural	Total
Total Employees in year 2000	1,390	104	200	1,694
Total Employees in year 2005	1,361	617	600	2,578
Total Employees in year 2010	1,271	688	600	2,559

#### 4.2.6 Initial Environmental Examination

The city center has expanded to the east (Gia Lam), the south-west (Thanh Tri) and the north-west (Tu Liem), resulting in urbanization of the areas that were formerly the suburban districts. Hanoi has a population of 2.39 million (year 1995) and about a half of the population are concentrating in five (5) urban districts with an average population density of 207 persons/ha.

Although an effort has been made to develop urban water supply systems, the rate of urbanization was too high to catch up with. Then consumers who could not be satisfied with insufficient and intermittent water supply service have uncontrollably developed their own wells or installed private water tanks in their houses. In these areas, serious depression of groundwater level or deteriorated drinking water quality resulting in hygienic problems are suspected. Whether public water supply systems are developed or not, Hanoi will rapidly grow and develop due to its ongoing economic expansion. However, Hanoi would not soundly develop if this water supply master plan would not be implemented.

Environmental impacts caused by the implementation of the Master Plan were identified according to the relations with existing environmental conditions at the sites proposed. Then the extent of impacts was examined using an impact matrix table, and the Master Plan in this study was comprehensively evaluated. In general, most impacts are considered to be positive. Negative impacts seem to be insignificant and most of them will be controlled or mitigated if the measures proposed in this study are undertaken appropriately.

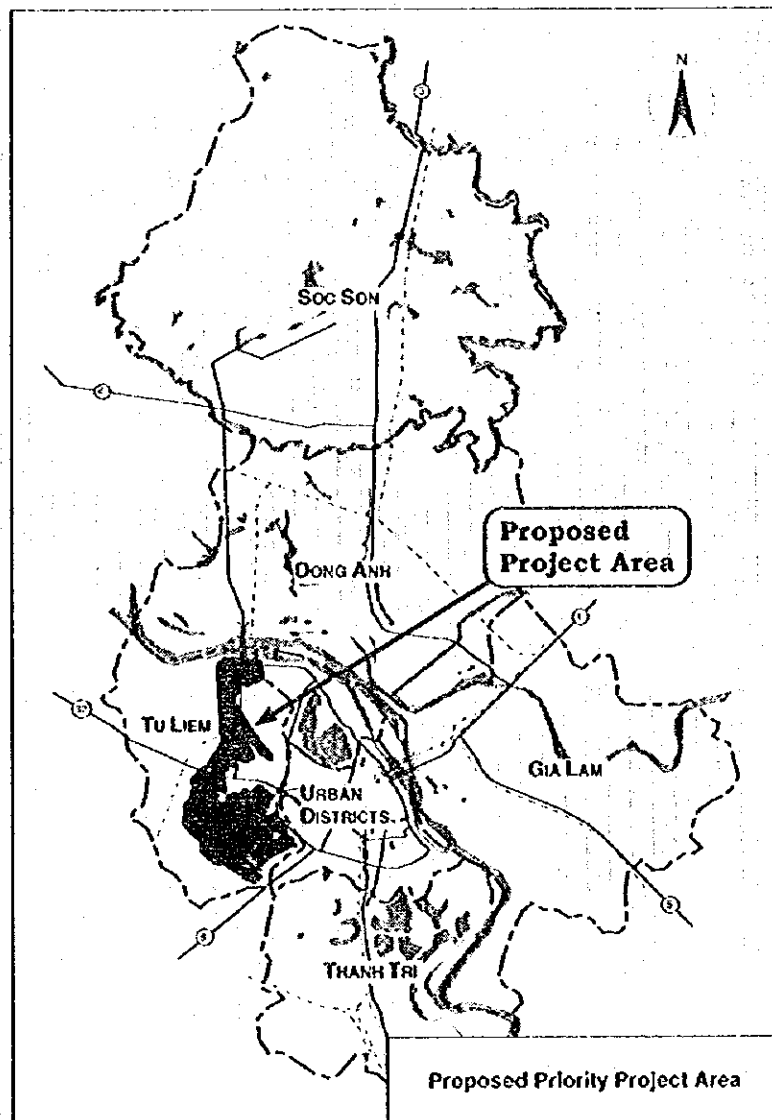
The total volume of groundwater discharge proposed in this Master Plan falls within the limited exploitable capacity that was predicted by the Vietnamese Geological Survey and has been accepted in Hanoi. However, as the groundwater discharge capacity is nearly reaching to the exploitable capacity, land subsidence and deterioration of groundwater quality seems to be the most important concern among all environmental factors. Therefore, all possible measures should be taken against those problems of groundwater, even if the risk of such environmental impacts is not significant.

## 5 PRIORITY PROJECT

### 5.1 PROJECT AREA

Urbanization of Hanoi tends to spread out from the central Hanoi toward west, north and south. The selected priority project area is planned to be developed in near future and is not supplied with piped-water at present.

In addition to supplying water to the project area, it is required to supplement the Mai Dich plant where the lowering of the groundwater level is observed. Moreover it is required to supply water to the new development area adjacent to the project area. The proposed project site is shown below.



THE STUDY ON HANOI WATER SUPPLY SYSTEMS IN THE SOCIALIST REPUBLIC OF VIET NAM

## 5.2 WATER DEMAND

Average daily water demand in year 2005 is summarized in Table 8.

Table 8 Average Daily Water Demand in the Priority Project (Year 2005)

Category of Water Demand	Average Daily Water Demand (m <sup>3</sup> /day)	Average Daily Water Distribution (m <sup>3</sup> /day)
(1) Project Area	12,600	14,800
(2) Mai Dich Water Supply System	-	20,000
(3) Future Development Area	(11,000)	12,900
Total	-	47,700

Note: A physical loss of 15% is included in distribution volume, that is,  
[Distribution] = [Water Demand] / (1-0.15)

## 5.3 PRELIMINARY DESIGN

### 5.3.1 Design Capacity

Design capacity of facilities is decided as below:

- (a) Average Daily Distribution Capacity : 47,700 m<sup>3</sup>/day
- (b) Daily Maximum Distribution Capacity : 57,000 m<sup>3</sup>/day  
(Peak day factor : 1.35, It is not applicable to the capacity for supplement to Mai Dich)
- (c) Daily Maximum Intake/Treatment Capacity : 60,000 m<sup>3</sup>/day  
(Plant loss : 5%)

### 5.3.2 Facility Plan

#### (1) Water Source Facilities

The groundwater is to be taken through deep wells to be equipped with submersible pumps (one pump to one well). The safe yield of one well is determined at 50 l/sec (180 m<sup>3</sup>/hr). Assuming 20 hours' operation of pump, 3,600 m<sup>3</sup>/day of water is available from a single well. Number of standby pump/well is proposed to be 30% of operating pumps.

#### (2) Treatment Facilities

Groundwater in the area contains iron and manganese, concentration of which is higher than the drinking water standard. Accordingly, the groundwater needs treatment. Treatment process, aim of which is removal of iron and manganese, is to be composed of aeration, sedimentation, filtration and disinfection.

#### (3) Sludge Treatment

Sludge drained from filter-backwash water and drainage of coagulation/sedimentation shall be treated in the yard of treatment plant, prior to disposal, from a viewpoint of environmental protection. The sludge treatment is planned to be processed by the sludge-drying bed system.

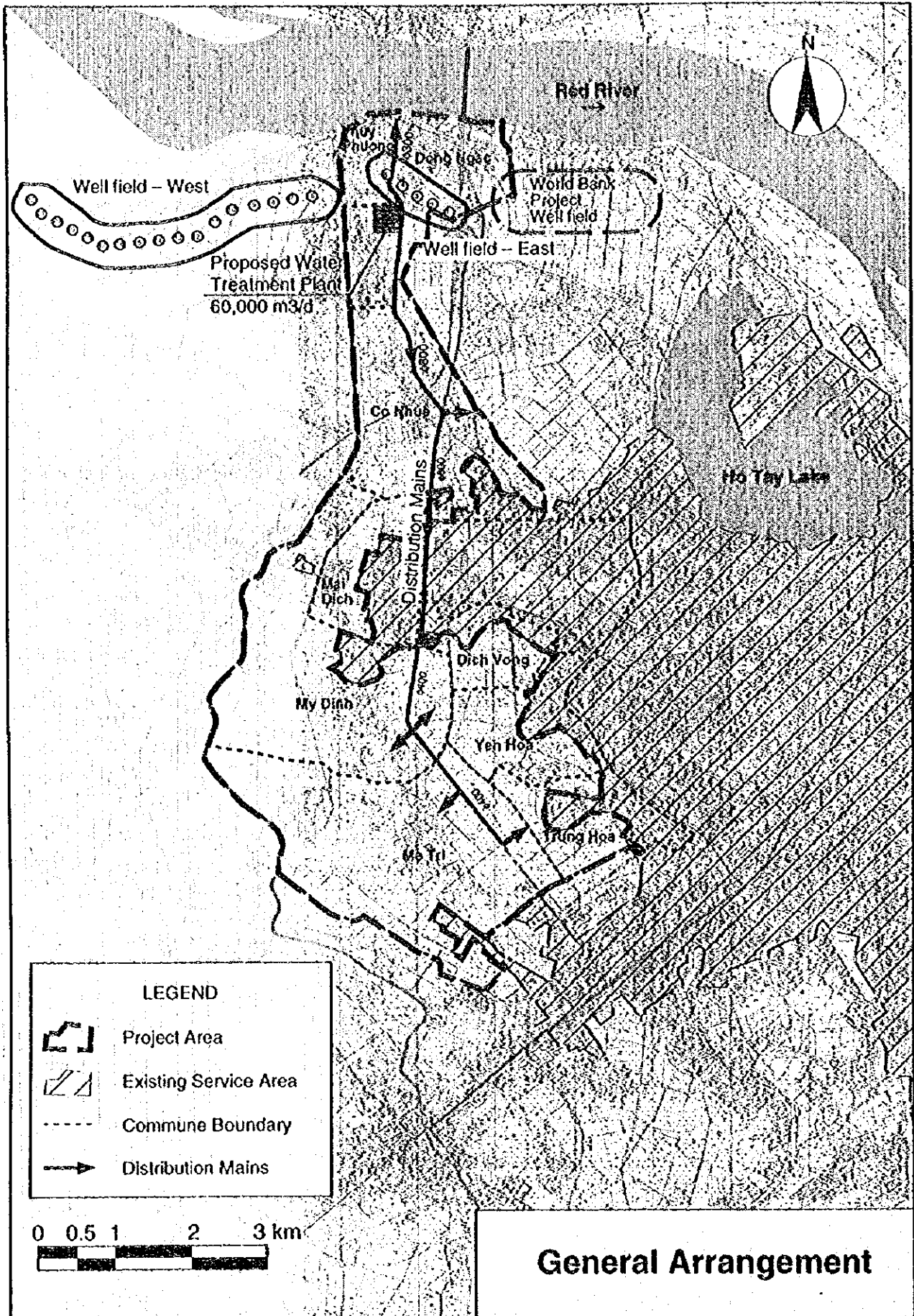
Clear water generated through the sludge treatment process is to be returned to the aeration towers to save raw water.

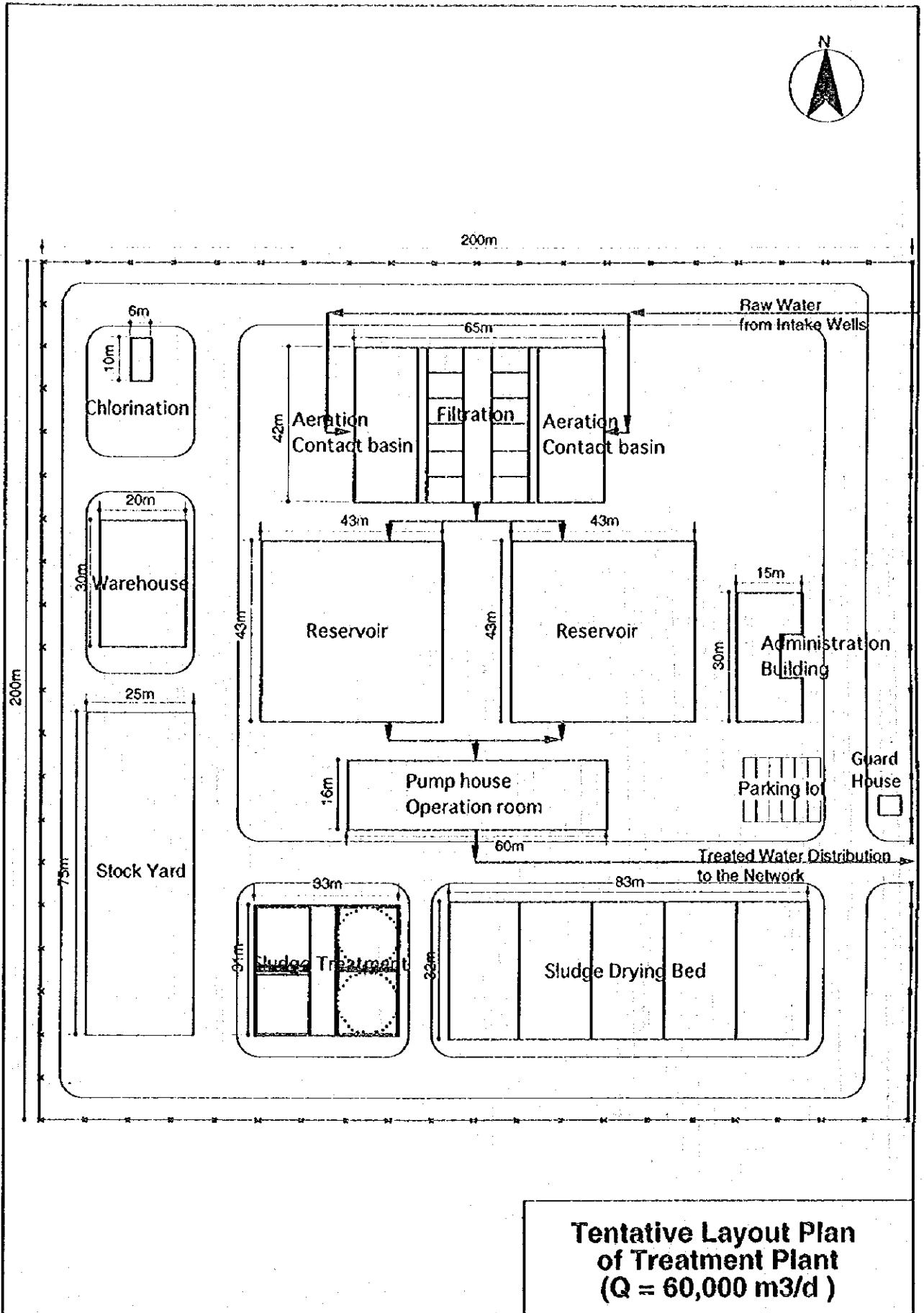
#### (4) Distribution Facilities

Ductile cast iron pipes with mortar lining (push-on type joint) will be used for diameters of 100 mm or larger. Polyvinyl chloride pipes (PVC pipes) with rubber ring joint type will be used in principle for 75 mm pipes or less.

The arrangement of water supply system facility is shown as the General Arrangement in the following page.







**Tentative Layout Plan  
of Treatment Plant  
(Q = 60,000 m<sup>3</sup>/d)**

## 5.4 COST ESTIMATION

The total project cost is estimated to be 489,034 million VND: equivalent to US\$ 44.46 million.

As for financing, price contingency shall be added to the above cost, for future price escalation (inflation). The total financing required will be 587,548 million VND: equivalent to US\$53.42 million.

Table 9 Cost Estimation

Item	Year	(Million VND)			
		1999	2000	2001	2002
(a) Construction cost Cost = 332,150 mil VND		-	51,774	140,188	140,188
(b) Land cost Cost = 78,000 mil VND		52,000	26,000	-	-
(c) Engineering Cost = 41,518 mil VND		18,268	4,650	9,300	9,300
(d) Base cost ( a + b + c ) Cost = 451,668 mil VND = 41.06 mil US\$		70,268	82,424	149,488	149,488
(e) Physical contingency Cost = 37,366 mil VND		1,826	5,642	14,949	14,949
(f) Total cost ( d + e ) Cost = 489,034 mil VND = 44.46 mil US\$		72,094 mil VND = 6.55 mil US\$	88,066 mil VND = 8.01 mil US\$	164,437 mil VND = 14.95 mil US\$	164,437 mil VND = 14.95 mil US\$
(g) Price contingency Cost = 98,514 mil VND		11,632	15,774	30,982	40,126
(h) Total financing required ( f + g ) Cost = 587,548 mil VND = 53.42 mil US\$		83,726 mil VND = 7.61 mil US\$	103,840 mil VND = 9.44 mil US\$	195,419 mil VND = 17.77 mil US\$	204,563 mil VND = 18.60 mil US\$

## 5.5 IMPLEMENTATION SCHEDULE

The priority project is scheduled to be implemented during six years as below :

Implementation Schedule

Procedure	Year	1	2	3	4	5	6
		1997	1998	1999	2000	2001	2002
Feasibility Study (F/S).....		■					
Approval by the Government.....		■	■				
Loan Procedure.....			■				
Land Acquisition.....			■	■	■		
Detail Design.....				■	■		
Test Wells (Groundwater).....				■			
Tendering.....					■		
Construction.....					■	■	■
Test Operation.....							■

## 5.6 MANAGERIAL APPROACH

The priority project area should have one water treatment plant and one water business enterprise. Water treatment plants and business enterprises should be redefined as different internal profit units in order to motivate workers to reduce water leakage and increase water tariff collection ratio.

For the proposed facility which has a treatment capacity of 60,000 m<sup>3</sup>/d, the work force engaged in the operation and maintenance of the priority project area is assumed at 35 staff at the water plant and 30 staff at the business enterprise.

## 5.7 FINANCIAL ANALYSIS

### (I) Water Tariff

In tariff setting, two objectives should be achieved, one is to cover the necessary costs and the other is to keep the affordable price for all customers.

In the priority project, three types of water tariffs are projected in conformity with the three types of the water business transactions, namely, (a) Retail to the priority project area, (b) Wholesale to the Mai Dich and (c) Bulk Retail to the new development area. The tariff is shown in Table 10.

Table 10 Water Tariff by Categories

Year	Retail Tariff (Priority Project Area)				Wholesale Tariff (Mai Dich)	Bulk Retail Tariff (Development Area)
	Domestic	State & Public	Private & Foreign	Weighted Average		
2003	3,350	6,700	10,000	5,083	4,168	4,371
2005	3,750	8,135	11,340	5,818	4,771	5,003
2010	4,700	10,390	14,470	7,369	6,043	6,337

(Note) The above table is an extraction of only for the year 2003, 2005 and 2010 for reference.

Profit and Loss Statement for the period from 1999 to 2010 is presented below for reference. It is evident from the table, projected revenue can cover the expenditures (O&M, Depreciation and Interest) from the year 2004. According to the affordability analysis, the projected tariff is also kept within the affordable level. These justify the projected water tariff.

Table 11 Profit & Loss Statement (1999 - 2010)

Year	Revenue	O&M Costs	Depreciation	Interest Costs	Profit & Loss
1999			3,605	13,514	-17,119
2000			8,008	13,064	-21,072
2001			16,230	12,613	-28,843
2002			24,452	12,163	-36,615
2003	54,276	22,294	24,452	11,712	-4,182
2004	66,290	25,338	24,452	11,262	5,238
2005	76,087	29,597	24,452	10,811	11,227
2006	79,533	30,582	24,452	10,361	14,138
2007	83,549	31,624	24,452	9,910	17,563
2008	87,677	32,726	24,452	9,460	21,039
2009	91,960	33,891	24,452	9,009	24,608
2010	96,287	35,124	24,452	8,559	28,152

## (2) Results of the Financial Analysis

- (a) The proposed priority project will have moderate Financial IRR (FIRR) of 9.03%, which is higher than the suggested funding cost and is higher than the prevailing long-term interest rate in Vietnam.
- (b) According to the Profit & Loss statement of the priority project until year 2030, the break-even point is estimated to be achieved by the year 2004, quite early given the start of operation in the year 2003.
- (c) The repayment of the loan principal and interest can be covered by the anticipated free cash flows.
- (d) The suggested water tariff is within the affordability target.

Therefore, from the view point of financial analysis, the priority project is feasible.

## 5.8 ECONOMIC ANALYSIS

The calculated EIRR (9.6%) is not so high at best. However, considering the 'said to be' around 10% opportunity cost of capital in Vietnam and the urgent social requirement of the project, this figure is within an acceptable level. Therefore, from the view point of EIRR, the priority project is feasible.

## 5.9 ENVIRONMENTAL IMPACT ASSESSMENT (EIA) FOR THE PRIORITY PROJECT

The priority project area consists of some suburban settlements and agricultural lands at present. However, this area is the most potential area in the west Hanoi and is expected to be developed rapidly, Therefore, several development plans have been proposed in this area. At the north end of the project area, the Red River flows and provides the area with water for irrigation and also for recharging to groundwater. There are some small settlements, some official institutes and factories around the proposed water treatment plant. There is no restricted area for development in the project area.

New water supply system proposed by the project will increase sewage volume in

proportion to the increase of supplied water. It would affect the quality of water bodies in the area, if the sewage is not properly treated.

In general, most impacts caused by the project are considered to be positive, and negative impacts are predicted to be insignificant. No houses will be demolished or no people will be displaced by this project, though about six (6) hectares of site acquisition will reduce agricultural productivity and the farmers' earnings to some extent. Therefore the project is feasible from the viewpoint of environmental consideration if the negative impacts are carefully taken into consideration and necessary mitigation measures are implemented.

## **5.10 SOCIAL ANALYSIS**

The following viewpoints were taken into consideration for social analysis :

- (a) Impartial utilization of the water supply systems
- (b) Receptivity on the Cultural Background

As a result, the project turned out to be positive in general. Therefore the priority project is recommendable.

## 6 RECOMMENDATION

- (1) The Master Plan should be reviewed and updated periodically, every three to five years, reflecting the actual development of the city and actual increase of the population and water demand.
- (2) To prepare drainage or sewerage systems in parallel with the development of water supply system.
- (3) To continue systematic groundwater monitoring of water quality as well as water level and mitigate adverse effects due to human activities.
- (4) To commence the surface water study for alternative water sources
- (5) To prepare law and regulation to control groundwater
- (6) To construct the new security main to facilitate emergency operation
- (7) Financial assistance in construction for rural water supply facilities by Government or City
- (8) To restructure HWBC and establish a new water business company
- (9) Introduction of IAS system
- (10) Development of human resources and its training
- (11) To establish new organization, namely, one water treatment plant and one water business enterprise.
- (12) To set water tariff so as to cover all the relating costs as well as to ensure affordability of water charge for all customers.
- (13) Earlier implementation of the sewerage project in the priority project area.



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