2.3 OUTLINE OF WATER SUPPLY

2.3.1 Water Coverage and Population Served

(1) Water Coverage

1) Urban Water Supply Systems (HWBCs)

The current service area is shown in Fig. 2.3-1. According to the Fig. 2.3-1, The water coverage administrated by HWBC is appointed to 3 individual area as shown below :

- Five urban and a part of two suburban districts administrated by five water supply enterprises in Hanoi
- A part of Dong Anh districts administrated by Gia Lam enterprise
- A part of Gia Lam district administrated by Gia Lam enterprise.

2) Communal Water Supply Systems

There are three communal water supply systems administrated by People's Committee of town or the village shown in Table 2.3-1.

Table 2.3-1 Water Supply System in Suburban District

Location	Thanh Tri Town	Phu Dien Commune	Tay tuu Commune
District	Thanh Tri	Tu Liem	Tu Liem
Administration	District	Village	Village
Population	17,000	10,000	12,000
System Capacity	2,500 m3/d	2,000 m3/d	360 m3/d
Construction	1995 (Reconstruction)	1995	1995
Service Level	House Connection	House Connection	House Connection

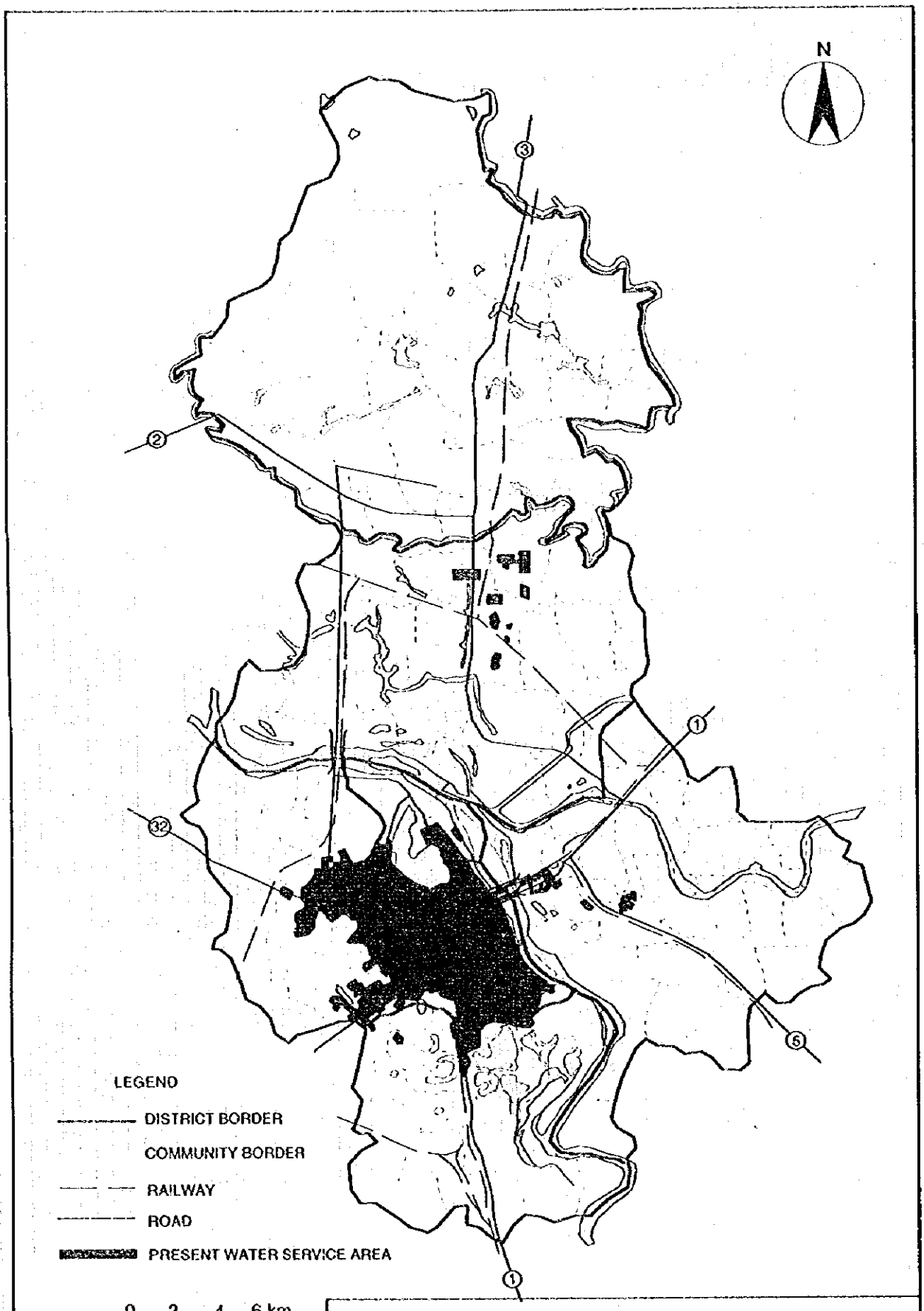


Fig. 2.3-1 Present Water Service Area (1996)

(2) Population Served

Present population served is shown in Table 2.3-2. The rate of population served of the five urban districts (the core of Hanoi) including illegal connections amount to 94.4%. However, the water service rate in other five suburban districts is only less than 14%. Therefore, the rate of the whole city is calculated at about 53%.

There are three water service levels in the suburban area shown as below :

(a) In some densely inhabited areas, piped water supply systems are managed by Hanoi Water Business Company (HWBC). The water quality is higher and safer for drinking because water supply engineers control. The water service rate of these area is about 14%.

(b) The diffusion of hand pump is more than 50 % of population in rural areas. According to the criteria, a hand pump can supply water to 120 persons on average. Sometimes, the people can not be supplied with water in dry season due to shallow wells being dried up. The water of some shallow wells which are less than 10m deep is contaminated by domestic sewage and livestock.

(c) In other rural areas, no water supply system is serviced. The people in the areas get domestic water from rain-water, irrigation ponds or channels. Their water consumption is quite a small volume.

Table 2.3-2 Present Population Served (Year 1995)

The North Hanoi

Area / District	Total Population	Piped Water System		Hand Pump System	
		Population Served	Rate	Hand Pump	Rate
DID	388,307	17,069	4.4%	195,000	50.2%
Soc Son	44,177	0	0.0%	14,040	31.8%
Dong Anh	132,039	4,914	3.7%	80,400	60.9%
Gia Lam	212,091	12,155	5.7%	100,560	47.4%
Rural	346,674	281	0.1%	190,920	55.1%
Soc Son	167,009	0	0.0%	86,160	51.6%
Dong Anh	89,190	0	0.0%	62,520	70.1%
Gia Lam	90,475	281	0.3%	42,240	46.7%
Total	734,981	17,350	2.4%	385,920	52.5%
Soc Son	211,186	0	0.0%	100,200	47.4%
Dong Anh	221,229	4,914	2.2%	142,920	64.6%
Gia Lam	302,566	12,436	4.1%	142,800	47.2%

Urban Area of the South Hanoi

District	Total Population	Piped Water System		Hand Pump System	
		Population Served	Rate	Hand Pump	Rate
Tay Ho	80,638	52,848	65.5%	29,880	37.1%
Ba Dinh	191,286	191,286	100.0%	0	0.0%
Hoan Kiem	193,504	193,504	100.0%	0	0.0%
Dong Da	351,974	318,457	90.5%	120	0.0%
Hai Ba Trung	347,289	343,990	99.1%	0	0.0%
Total	1,164,691	1,100,085	94.5%	30,000	2.6%

Suburban Area of the South Hanoi

Area / District	Total Population	Piped Water System		Hand Pump System	
		Population Served	Rate	Hand Pump	Rate
DID	381,028	151,702	39.8%	146,280	38.4%
Tu Liem	262,807	135,452	51.5%	98,280	37.4%
Thanh Tri	118,221	16,250	13.7%	48,000	40.6%
Rural	114,187	5,800	5.1%	99,120	86.8%
Tu Liem	28,735	4,200	14.6%	35,400	123.2%
Thanh Tri	85,452	1,600	1.9%	63,720	74.6%
Total	495,215	157,502	31.8%	245,400	49.6%
Tu Liem	291,542	139,652	47.9%	133,680	45.9%
Thanh Tri	203,673	17,850	8.8%	111,720	54.9%

2.3.2 Institution and Management

(1) Existing Institutional Framework in the Water Supply Sector of the Central Government

In urban areas each provincial authorities have been entrusted the direct power to implement the water supply sector by the central government. However, in suburban and rural areas the central government is essentially responsible for preparing national plans, approving regulation, implementing standards, allocating budgets on investment and project, engineering, designing and supervising some aspects of construction. Many administrative agencies of the central government are closely and unclosely related to the water supply.

(2) Existing Institutional Framework in the Water Supply Sector of the Provincial Authorities

Provincial authorities are mainly responsible for the construction, operation and maintenance of urban water supply and sanitation system. The provincial authorities are also responsible for the financial management of the public water and sanitation services, and for setting water tariff.

(3) Hanoi Water Business Company

In April 1994, Hanoi Water Business Company (HWBC) was reorganized from Hanoi Water Supply Company (HWSC) which had operated under the auspices of PPCs or CPCs as set out in decree 388, September 1991, and supported by circular letter 34, November 1991. The new company is a state economic enterprise, which is directly managed by Transportation and Urban Public Works Services (TUPWS) which is a department of Hanoi People's Committee (HPC). The company's duties are defined by Hanoi People's Committee's Decree No. 564/QDUB as follows:

(a) to produce and sell treated water to consumers,
(b) to produce and repair water pipes, water meters, mechanical products and special equipment to meet the demand of water sector to be authorized by HPC. The company is responsible for coordination with local authorities and special inspection force to protect groundwater resources and water supply systems,

(c) refining of the classification made by HPC and TUPWS, to prepare investments and projects at certain periods in accordance with Hanoi Water Planning, to cooperate with advisory group in order to have effective implementation of Hanoi Water Development Program,

(d) to manage funds (including loans), production development funds, and joint-venture resources with organizations and individuals in Vietnam and abroad according to the water development investment plan, to manage budgetary funds which are delegated by HPC and TUPWS.

Organization chart of HWBC as of March 1996 is presented in Fig. 2.3-2.

The official operating area of HWBC in March 1996 consists of the four urban districts of Hoan Kiem, Ba Dinh, Dong Da and Hai Ba Trung and the five suburban districts of Tu Liem, Gia Lam, Thanh Tri, Dong Anh, Soc Son. The organization chart of HWBC shows the eight water plants of Yen Phu, Luong Yen, Ngoc Ha, Tuong Mai, Ngo Si Lien, Ha Dinh, Mai Dich and Phap Van.

Under HWBC, there are six water business enterprises that are mainly engaged in collecting water revenue, carrying out the water-cut when consumer does not pay the water charge, repairing leakage network, installing meters, recording the initial data correctly and timely for introducing internal accounting. They are stationed at Hoan Kiem, Dong Da, Ba Dinh, Hai Ba Trung in urban districts and Tu Liem, Gia Lam in suburban districts. The water business enterprises are not legal enterprises but subordinate units of HWBC. After the introduction of the new organization in April 1994, there were some transfers of personnel including from headquarters staff into water business enterprises in February 1995.

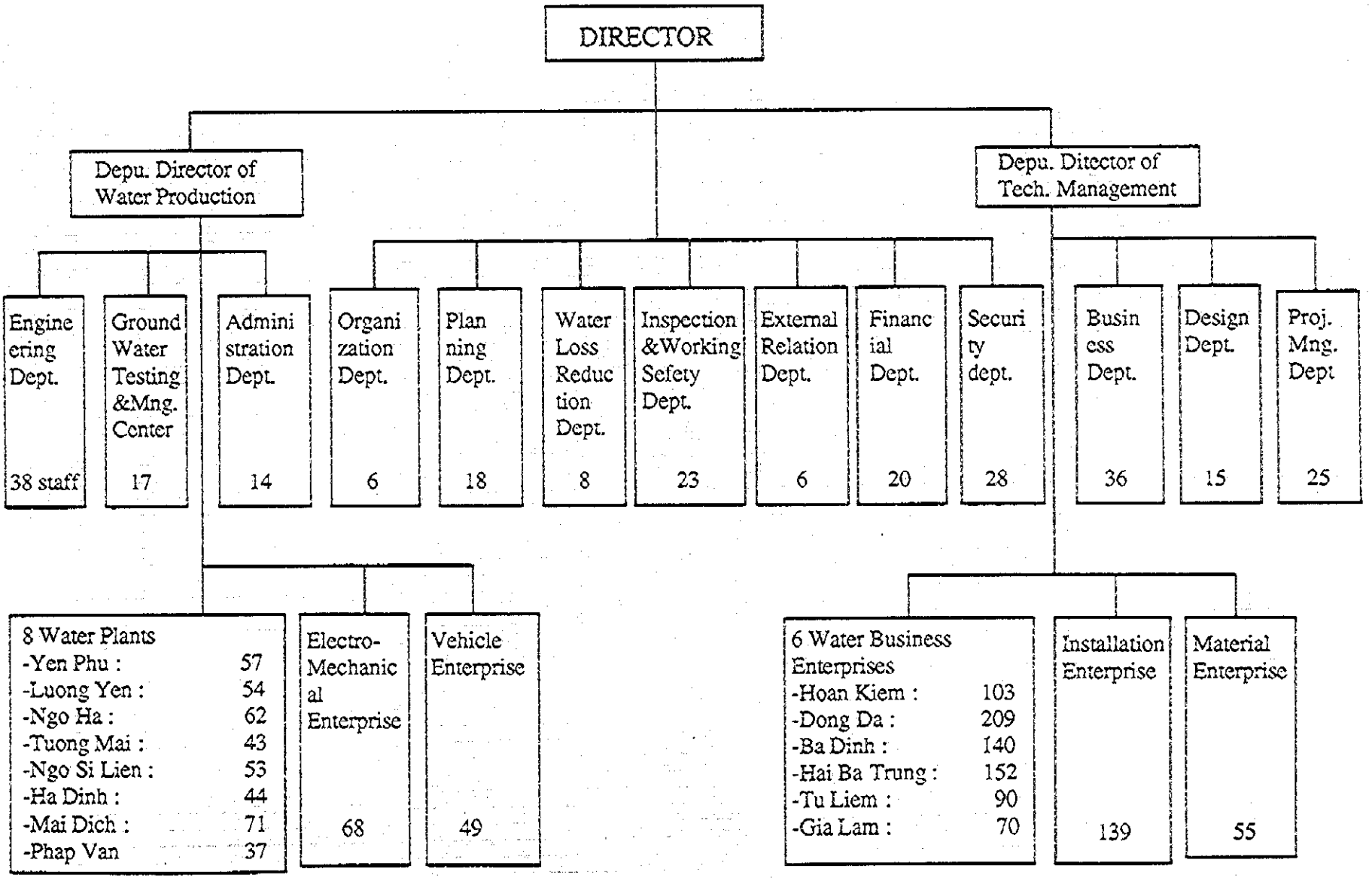


Fig. 2.3-2 The Organization Chart of HWBC (March 1996)

2.3.3 Financial Status of HWBC

The present financial condition of HWBC are summarized as tables below:

Spreadsheets provided by the Finance Department of HWBC for the period of FYE 1991 to 1995 are attached in Appendix. (* There were several discrepancies in the financial statements. Figures were left uncorrected as originally provided unless clarified.)

Profitability

	1991	1992	1993	1994	1995
Operating Margin /Total Revenues	11.1%	20.7%	5.4%	23.1%	21.3%
Electricity Cost / Total Revenues	53.4%	48.5%	60.5%	48.5%	45.2%
Depreciation / Total Revenues	6.0%	8.6%	N.A.	8.4%	6.8%
Interest / Total Revenues	-	-	-	-	-
Tax / Operating Margin	61.3%	22.2%	N.A.	16.9%	15.8%
Net Operating Profit / Total Revenues	-7.9%	3.7%	1.3%	1.3%	2.3%

Liquidity, Asset Turnover

	1991	1992	1993	1994
Sales / Net Plant	0.73	0.87	1.02	1.58
Accumulated Depreciation / Net Plant	0.78	0.78	0.89	1.12
Accumulated Depreciation / Depreciation	17.7	10.3	N.A.	8.4
Current Ratio	1.30	4.21	1.52	1.56
Quick Ratio	0.61	2.24	0.66	0.56
Account Receivables Days-On-Hand	42 days	43 days	60 days	40 days

Capital Structure

	1991	1992	1993	1994
Short-Term Borrowings to Total Footing	2.1%	-	5.8%	4.1%
Long-Term Borrowings to Total Footing	-	-	-	-
Networth to Total Footing	85.9%	95.3%	78.0%	73.0%
Leverage	0.16	0.05	0.28	0.37

On surface, HWBC has been recording positive Net Operating Profit. However, (a) Appropriate maintenance costs have been too low to keep up the sufficient service. (b) Proper depreciation has not been charged based on the fixed assets revaluation. (c) Uncollected bills have been included in the Revenues.

In reality, liquidity and asset turnover of HWBC must have been much lower than appearance, considering the convertibility of Account Receivables and benefits

from HWSP.

By appearance, HWBC has enjoyed ample Net Worth and low leverage. But in fact, this is due to (a) subsidies from the Government, (b) free use of assets contributed by HWSP and (c) surface profitability based on the above paragraph.

HWBC has a limited access to the financial market and the capital market. Given the status of the London Club negotiation, primitive domestic markets in Vietnam, and disclosure level on HWBC's financial information, it is quite difficult for the company to get commercial based fundings, especially long term ones.

In accordance with Decision No. 1141 issued in Jan. 11. 1995 by the Ministry of Finance of Vietnam, the New Accounting System has been officially applied to all enterprises of all economic sectors throughout the country from January 1, 1996. The new system is based on international accounting standard close to the American standard.

However, two problems should be pointed out in this matter.

(a) Most staffs in HWBC were not yet familiar with the new system.

(b) The new system is closer to the international accounting standard (IAS) than the previous socialism standard, but still different from the exact IAS.
The differences for example are summarized as below :

	New Accounting System	IAS
Chart of Accounts	Inflexible	Flexible
Depreciation Method	Only one method (Straight-line method)	More than five methods
Accrual Base Accounting	Cash base mixed	Accrual base accounting in strict form
Disclosure	Limited	Strictly required
Internal / External Control	Limited	Strictly required

2.3.4 Billing and Collection System of HWBC – Administration Loss

(1) Introduction

Water charges are the very main revenue source for HWBC. Therefore, billing and collection is one of the most important operations for the company.

There have been several deficiencies in the process of billing and collection of HWBC. Unaccounted-for water (UFW) ratio is estimated to be 71% which was composed of 25% physical loss and 46% administration loss. Administration loss is considered to be composed of the below four elements.

1) Illegal Connections

Statistical figure has not been available as of October 1996 for this category. But not only HWBC themselves but also outside experts claim illegal connections are main financial drains for HWBC. Illegal connections are mainly done among unregistered household customers and other individuals like job-seekers by connecting private pipes to the network without official permissions.

2) Excess Use over the Flat Rate

In case of no water meter installed, HWBC charges customer at the flat rate. For domestic customers the company charges at the assumption of 4 m^3 /capita / month in principle, and for non-domestic and foreign customers on negotiation basis.

Naturally flat rate is not a system to solicit customers to save water, thus excessive use could be considered common.

According to the data from HWBC's Business Department for February 1996, in terms of registered connection numbers, 65.6% of domestic customers are flat rate charged, and 43.2% of non-domestic customers, 53.0% of foreigners respectively.

* Grand total connection number in the service area by HWBC was 126,293 as of Feb. 1996. For detail, see the tables in 4) Defective Billing and Collection.

3) Waste of Water at Public Taps

HPC has been bearing charges for public taps, assuming 10% of total water production at the rate of 1,000 VND / m^3.
Same as the case of flat rate use, consumers of public taps tend to use water excessively.

In June 1996, number of public taps is estimated some 700, and HWBC's policy is to convert the public taps into house connection by 10% annually to reduce waste of water.

4) Defective Billing and Collection

Defective Billing and Collection might be the biggest headache among administrative losses for HWBC. There are three types of defective billing and collection in HWBC: (A) no bill or zero bill, (B) incorrect billing (C) non-collection and partial collection

A. No Bill or Zero Bill

Table of Billing Situation as of Feb. 1996

District	Total of Connections	Total of Bill	Total of No Bill	Water Meter		Flat Rate	
				Bill	No Bill	Bill	No Bill
Total Domestic Customers	121,499	85,178	36,321	29,471	12,321	55,707	24,000
Non-Domestic Customers	3,884	3,380	504	1,934	273	1,446	231
Foreign Customers	910	819	91	382	46	437	45

Source: HWBC Business Department

In February 1996, 29.9% of registered domestic connections was non-billed or zero billed, 13.1% of non-domestic and 10.0% of foreign connections respectively.

B. Incorrect Billing

Two main reasons of incorrect billing were:

a) There were out of order meters in the area. Meters could show much lower volume than actually used. HWBC has been undertaking replacement into proper meters.
b) Readers in WBE's could mistakenly read water meters. As long as reading were done by human beings, those cases were inevitable.

C. Non-Collection and Partial Collection

In 1995 year average, uncollected amount of total bill accounted for only 2.0% which is significantly lower than the estimated some 10% indicated in the Final Report of World Bank in November 1995.

Basically in HWBC organization water charges are collected by collectors in WBEs. Collectors physically visit each customer and collect charges by cash. From 1995 in some areas as a test case, a domestic representative has collected charges from other households in exchange for some incentive money rewards. In any case it is difficult to expect 100% collection in those circumstances.

As shown in the interview survey by JICA Study Team and the National Water Tariff Policy Study, affordability is not a big bottleneck, but willingness to pay is. In summary, low service level provided by HWBC is the problem. Based on the interviews with HWBC Business Dept. officers, customers did not pay at all or pay only partially of water charge because of (a) lack of enough water supply (e.g. low water pressure, etc.) (b) too high deemed flat rate in case of no meters (c) refusal to pay metered bill in case meter was out of order to show higher than actual volume.

From the viewpoint of financial aspects, overdue interest or penalty payment should be levyed theoretically, but not in use as of April 1997. Disconnection policy has not been strictly applied either.

2.4 WATER SOURCES

2.4.1 Groundwater

The present source of water used for the Hanoi public water supply system is groundwater exploited from a confined aquifer (almost all from so called Pleistocene or Lower aquifer: Qa) in Quaternary deposits laying beneath the city.

(1) Main Groundwater Wellfields

There are totally 104 wells (about 60-70 m deep) providing water to the Hanoi water supply system. Those wells are located in the wellfields around the main eight (8) treatment plants managed by HWBC. The main groundwater wellfields and their pumping discharge are presented in Table 2.4-1. Location map of the wellfields is shown in Fig. 2.4-1.

Table 2.4-1 Main Groundwater Wellfields and Their Pumping Discharge

No.	Name of Wellfields	Number of Wells	Pumping Discharge (m^3/d)	Feasible Discharge (m3/d)
1	Yen Phu	13	44,500	110,000
2	Ngo Si Lien	19	43,200	30,000
3	Ngoc Ha	11	50,300	30,000
4	Phap Van	9	27,700	30,000
5	Mai Dich	18	64,200	45,000
6	Ha Dinh	9	27,200	25,000
7	Luong Yen	15	79,500	80,000
8	Tuong Mai	10	29,200	30,000
	Total	104	365,800	380,000

Note: 1) Figures as of 1995.
2) Pumping Discharge means raw water discharge calculated as 110% of the treated water.
3) Number of Wells includes standby wells.
4) The column "Feasible Discharge" shows the most feasible discharge which was reported in "FINNIDA M/P, 1993" and approved by the Government.

Actual pumping discharges of Ngo Si Lien, Ngoc Ha and Mai Dich considerably exceed the most feasible discharge.

It can be said that environmental impacts such as land subsidence tend to occur in and around these three wellfields.

(2) Small Wellfields

In addition to the above mentioned main plants, there exist 15 small wellfields which are managed by the five(5) enterprises under HWBC. Those small wellfields are listed in Table 2.4-2. Location map of the small wellfields is shown in Fig. 2.4-1 together with the main wellfields.

Table 2.4-2 Small Wellfields and Their Pumping Discharge

No.	Name of Enterprises & Wellfields	Number of Wells	Pumping Discharge (m^3/d)
I.	Ba Dinh	(7)	(2,000)
1	H31 An Duong	1	1,200
2	Thuy Khue	6	800
II.	Hoan Kiem	(6)	(12,200)
1	Don Thuy	3	7,800
2	Thuy Loi	2	1,100
3	Phuc Tan	1	3,300
III.	Dong Da	(8)	(4,900)
1	Bach Mai	3	2,200
2	KH. Trung	2	700
3	Kim Giang	2	1,500
4	Giap Bat	1	500
IV.	Hai Ba Trung	(5)	(6,400)
1	Bach Khoa	2	1,800
2	Quynh Mai	2	2,100
3	Van Don	1	2,500
V.	Gia Lam	(7)	(9,000)
1	Gia Lam	2	5,200
2	Sai Dong	2	1,100
3	Dong Anh	3	2,700
	Total	V/33	34,500

Note: 1) Figures as of 1995.
2) Pumping Discharge means raw water discharge calculated as 110% of the treated water.
3) Number of Wells includes standby wells.
4) "2.Thuy Khue" in "I.Ba Dinh" is not under HWBC. HWBC buys the water of 800 m^3/d from the plant.

(3) Private Wells

Furthermore, approximately 300 private wells possessed by about 240 owners are identified in the study area. They are being operated continuously or discontinuously, also discharging from the lower aquifer Qa, and supplying water to institutions, factories, domestic purposes, etc. Table 2.4-3 shows the number of private wells and their discharge in each district.

Table 2.4-3 Number of Private Wells and Their Discharge in Each District

No.	Name of Districts	Number of Wells	Pumping Discharge (m^3/d)	Estimated Discharge (m^3/d)
I.	South Hanoi	184	78,900	100,000
(1)	Tu Liem	(80)	(9,900)	-
(2)	Thanh Tri	(50)	(18,800)	-
(3)	Hai Ba Trung	(18)	(19,400)	-
(4)	Ba Ding	(11)	(16,900)	-
(5)	Dong Da	(25)	(13,900)	-
II.	Soc Son	9	2,400	6,000
III.	Dong Anh	31	10,100	10,000
IV.	Gia Lam	76	13,200	13,000
Total		300	104,600	129,000

Note: 1) Figures are based on the data of K2(1994) and HWBC(1995)
2) Estimated Discharge is estimated considering the data of HWBC and the results of sample survey by interview in this study.

(4) Water Use for Water Supply

Present water use for water supply (groundwater) in each area is tabulated in Table 2.4-4.

Table 2.4-4 Present Water Use in Each Area(m^3/s)

Name of Area	Public (HWBC)	Public (Enterprise)	Private	Total
Soc Son	-	-	6,000	6,000
Dong Anh	-	3,000	10,000	13,000
Gia Lam	-	6,000	13,000	19,000
South Hanoi	370,000	30,000	100,000	500,000
Total	370,000	39,000	129,000	538,000

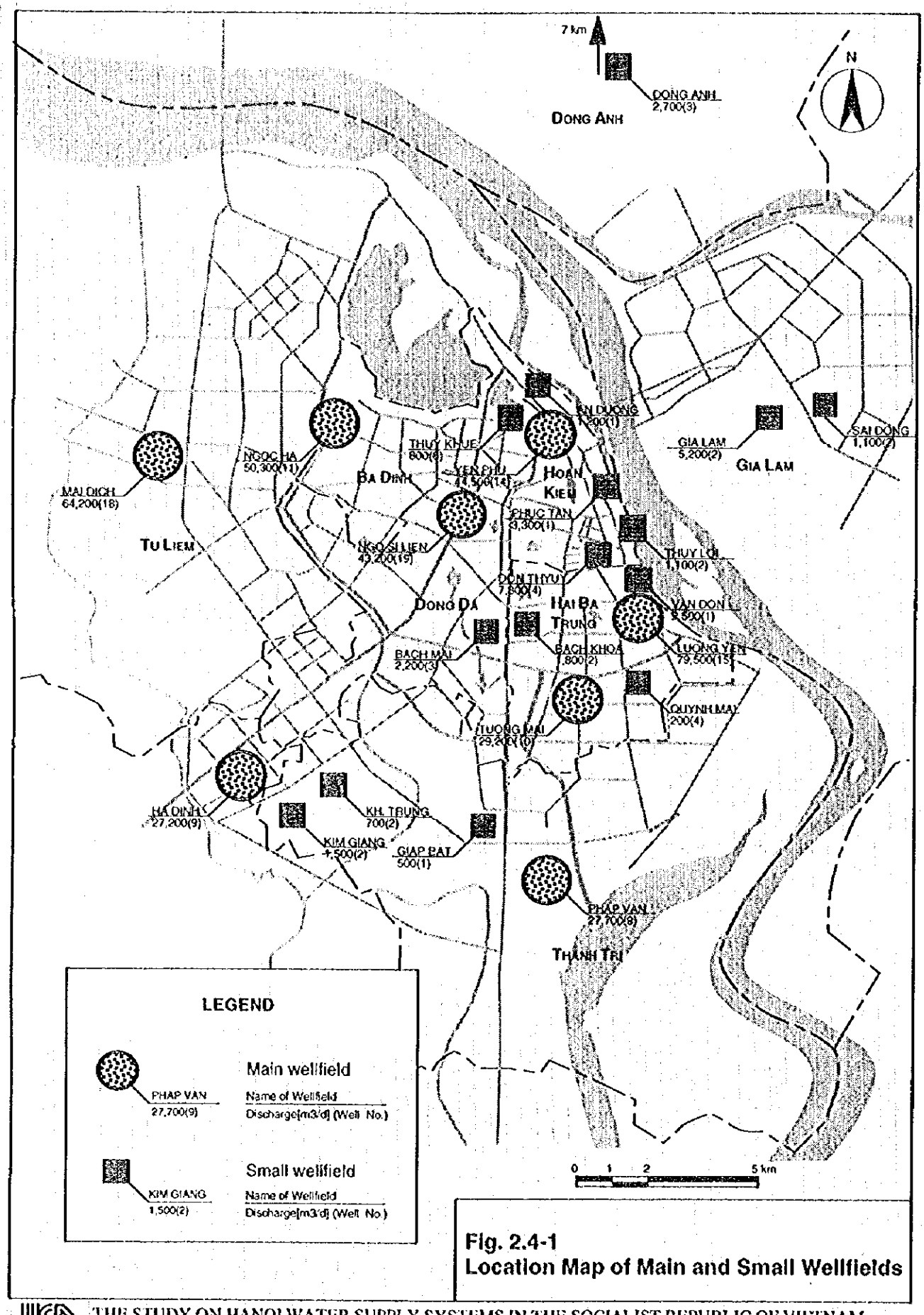


Fig. 2.4-1
Location Map of Main and Small Wellfields

2.4.2 Water Quality

(1) Water Quality Criteria

There are some effective water quality criteria in Vietnam that are described in "Provisional Environmental Criteria" (issued by MOSTE in 1993) and "Vietnamese Environmental Standards" (issued by MOSTE in 1995). Criteria on drinking water, water supply and environment are chosen and shown in tables in Appendix. In these tables, WHO's guidelines are attached for reference.

As for criteria for drinking water, same limit values as WHO's guidelines are adopted for most parameters prescribed in Vietnamese criteria. As for criteria for raw water, groundwater should be evaluated by "criteria for water supply" and surface water should be evaluated by "water quality standard (class A for surface water)".

(2) Water Quality of the Sources for Water Supply

Fig. 2.4-2 and Table 2.4-5 show averaged water quality characteristics of the existing public/private production wells or observation wells.

In general, concentration values of iron and manganese are high and do not meet the requirements of the criteria for drinking water or the criteria for water supply in the whole city. The concentration of iron tends to show higher values in the southern part of the south Hanoi, Gia Lam district and Dong Anh district. Manganese tends to show higher values in the northern part of the south Hanoi, however the values in the Soc Son district seem to meet the criteria. Ammonia in the southern part of the south Hanoi shows higher values and does not meet the criteria for drinking water or the criteria for water supply. Distribution pattern of organic matter concentration seems to be similar to that of ammonia concentration.

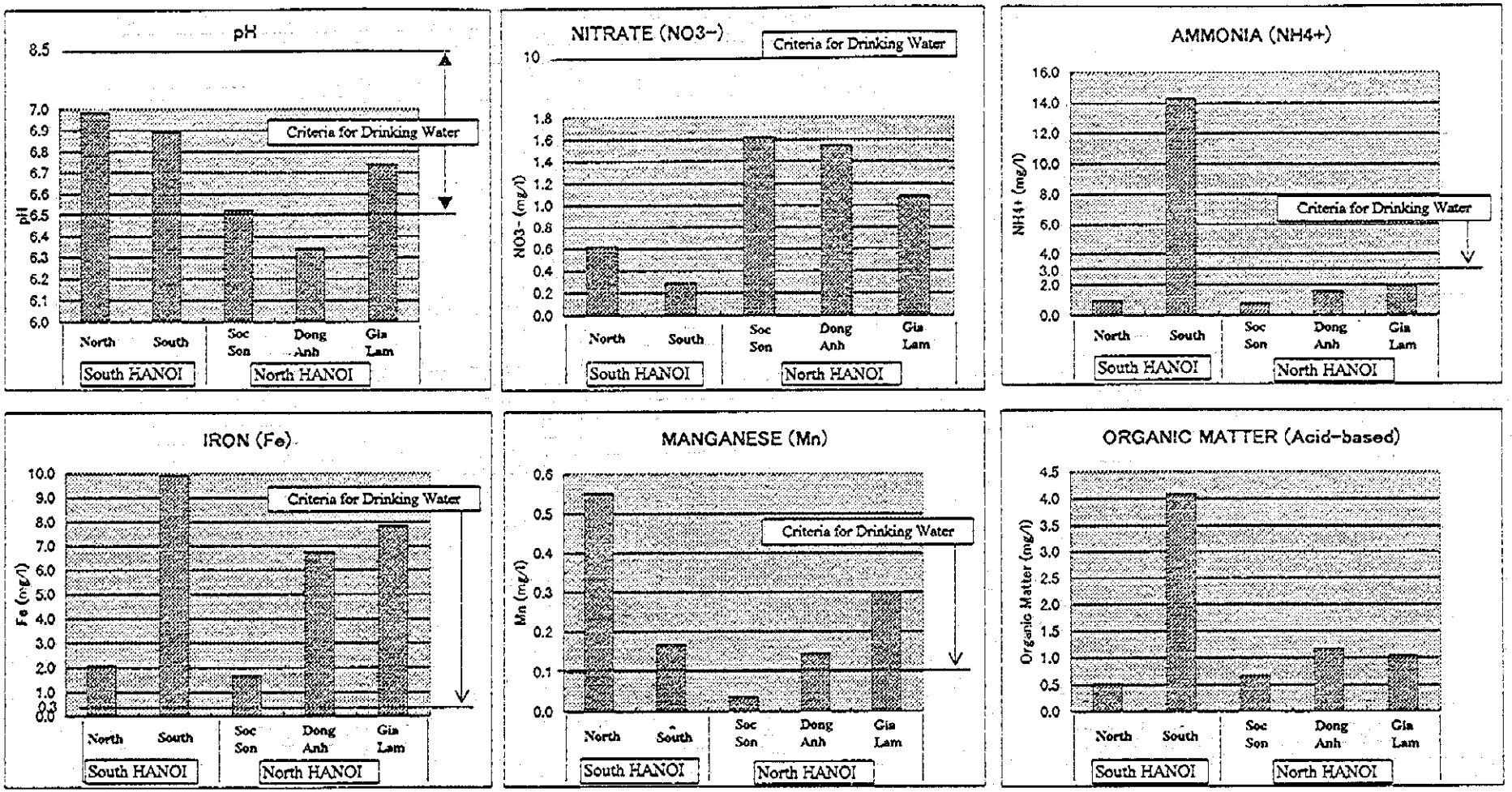


Fig. 2.4-2 Groundwater Quality Characteristics in Hanoi

Table 2.4-5 Groundwater Quality in Hanoi (Average)

Region		South Hanoi		North Hanoi			Water Quality Criteria				
							Criteria for Drinking Water			Criteria for Water Supply	
Area		North	South	Soc Son	Dong Anh	Gia Lam	Urban	Distribution & Rural	WHO's Guidelines	Min. Requirement	Max. Requirement
Parameter	Unit										
pH		7.0	6.9	6.5	6.3	6.7	6.5～8.5	6.5～8.5	-	6.0～8.0	6.5～8.0
NH_4^+	mg/l	0.9	14.3	0.8	1.5	2.0	3.0	3.0	1.5	-	-
NO_3^-	mg/l	0.6	0.3	1.6	1.5	1.1	10	10	50	50	25
Fe	mg/l	2.1	9.9	1.7	6.8	7.8	0.3	0.5	0.3	10	3
Hardness	°G	8	7	-	-	-	-	-	-	-	-
($CaCO_3$)	mg/l	174	-	118	155	198	500	500	-	500	300
Mn^{2+}	mg/l	0.6	0.2	0.0	0.1	0.3	0.1	0.1	0.1	0.5	0.3
Organic matter (Acid-based)	mg/l	0.5	4.1	0.7	1.2	1.0	-	-	-	-	-

Note: 1) The unit "°G" of Hardness is German degree; 1°G is equivalent to 17.9mg/l($CaCO_3$).

2.5 WATER SUPPLY FACILITIES

(1) Water Production and Consumption

Based on the HWBC's latest data (January-June 1996) on water production and consumption, their fundamental figures are as follows, on the daily average basis.

(a) Production Capacity 370,000 m3/d

Out of the above,

(b) Billed Water	192,500 m3/d	(52%)
(c) HWBC's Own Use	400 m3/d	(0.1%)
(d) Physical Loss	92,500 m3/d	(25%)
(e) Administration Loss	84,600 m3/d	(22.9%)

(Note)

(b) Billed water is calculated based on the following assumptions:

(b1) Billing water records (107,829 m3/d : 29.1% of (a))
From the monthly billing records, water consumption by customers' category are identified. It is 107,829 m3/d in total. As for customers using flat rate, their consumption are calculated as 4 m3/person/month.

(b2) Estimation on excessive use on flat rate (84,651 m3/d : 22.9% of (a))
Excessive use on flat rate over 4 m3/person are estimated to be 84,651 m3/d in total.

(c) Physical loss is calculated based on the leakage survey report which concluded the rate of physical loss is 25% in average.

As for the excessive use on flat rate, it is included in (b) billed water on the above table, because the customers are charged properly according to their contracts on water charge. The present tariff system exempts these customers from water charge for their excessive use over 4 m3/person/month. But essentially, the capacity of these excessive use should be charged in conformity with their consumption

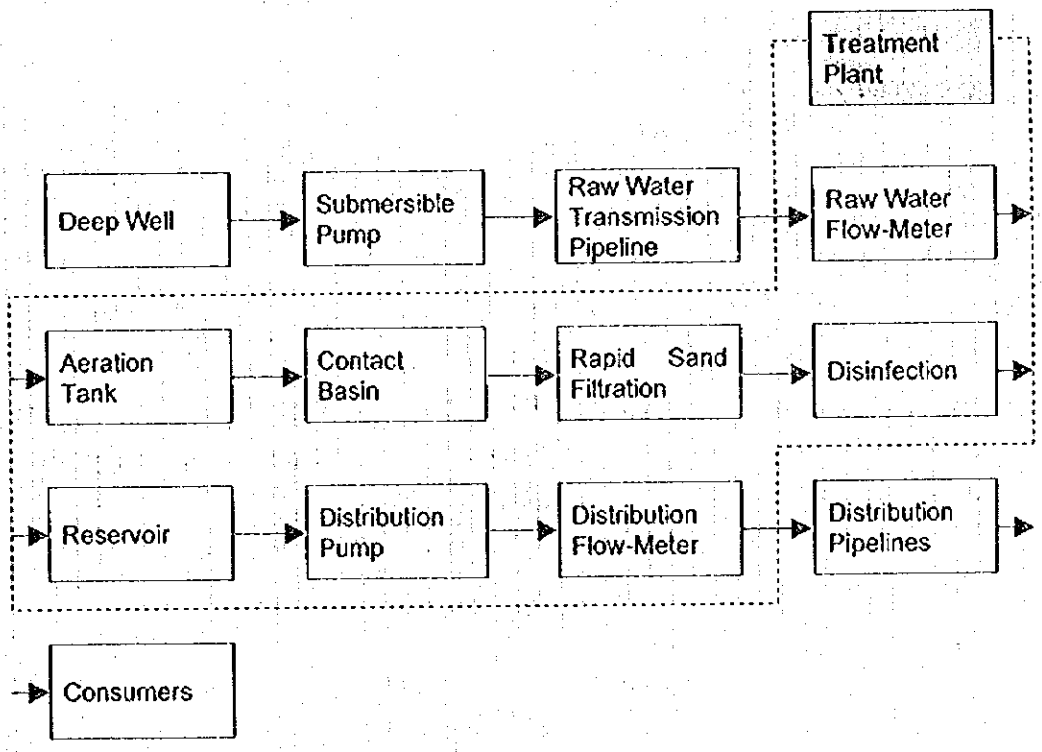
In this study, the excessive use on flat rate is regarded to be included in administration loss. Consequently, the Administration loss including the excessive use on flat rate is :

(e') Administration loss = (e) + (excessive use on flat rate)
= 84,600 m3/d + 84,600 m3/d
= 199,200 m3/d (45.8% of (a)).

(2) Treatment Plants

There are eight (8) major treatment plants in the urban center of Hanoi, all operated by HWBC. The production capacity of these major plants is 67,000-22,000 m3/day, averaging 41,000 m3/day; totaling 330,800 m3/day. Additionally, there are 15 small plants operated by HWBC; their capacities range 9,000-600 m3/day, averaging 2,600 m3/day; totaling 39,200 m3/day.

The main objectives of the treatment are removal of iron and manganese predominantly contained in the groundwater source in Hanoi area. The treatment is done with a traditional treatment process for groundwater containing them. That is:



(3) Intake Facilities

Intake facilities consist of deep wells, intake submersible pumps, pump houses and raw water pipelines going toward treatment plants.

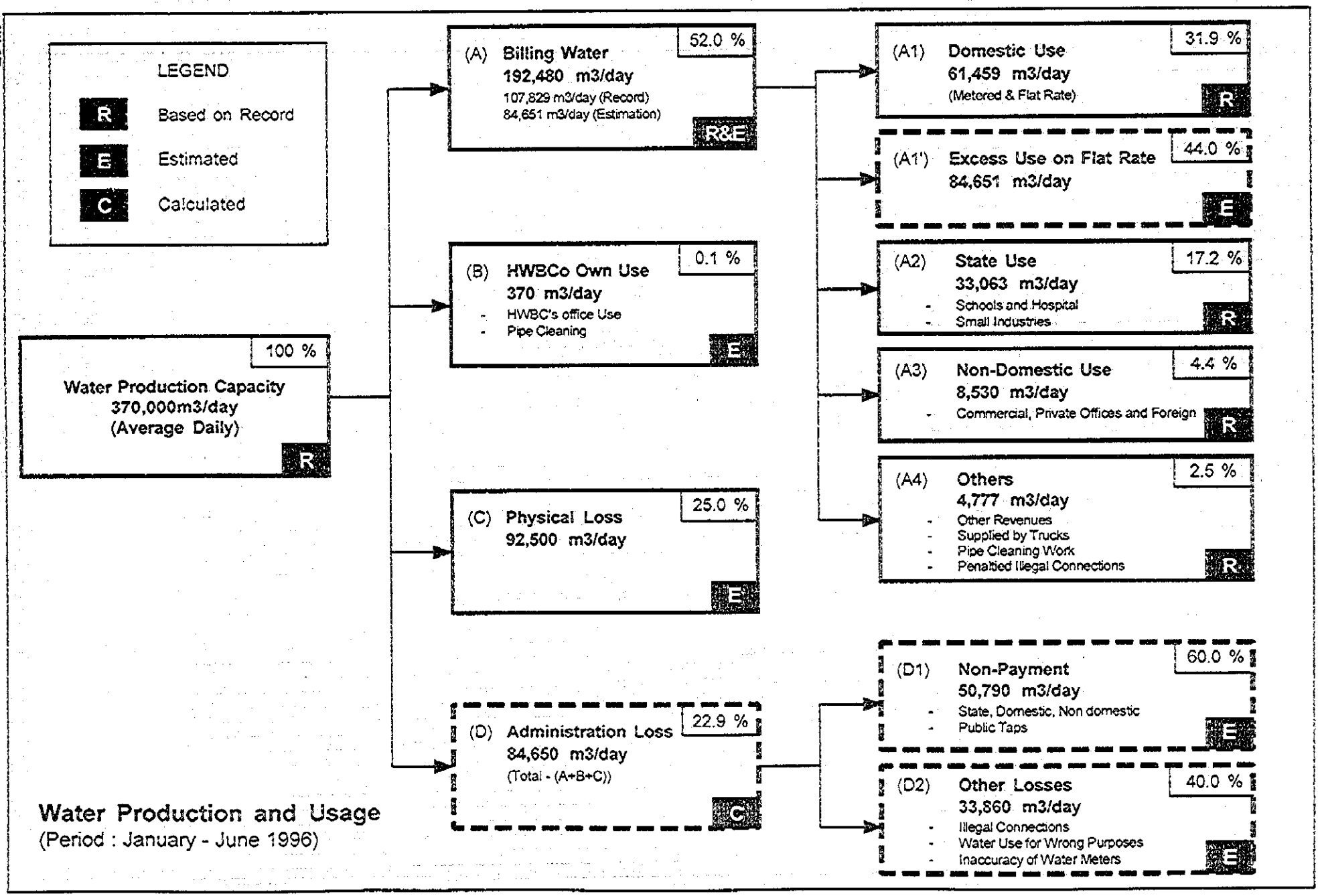
The present water source is groundwater existing beneath the city. There are 105 deep wells (about 60-70 m deep) located in the wellfields around 8 major treatment plants taking 365,800 m^3/d (as raw water) in the average. In addition, there are 15 small plants taking about 40,000 m3/d with 36 deep wells. Raw water taken from the deep wells is lifted by an intake submersible pump placed in the well's tube (casing pipe). Raw water is transmitted to a treatment plant through a raw water pipeline. Most of the pipelines collect water from other wells on the way going to the plant, and some pipelines solely head toward the plant. The pipelines have diameters of 200 - 600 mm and materials of ductile cast iron or plastics (PVC and HDPE). Total length of the transmission pipelines is 34,800 m

(4) Distribution Pipelines

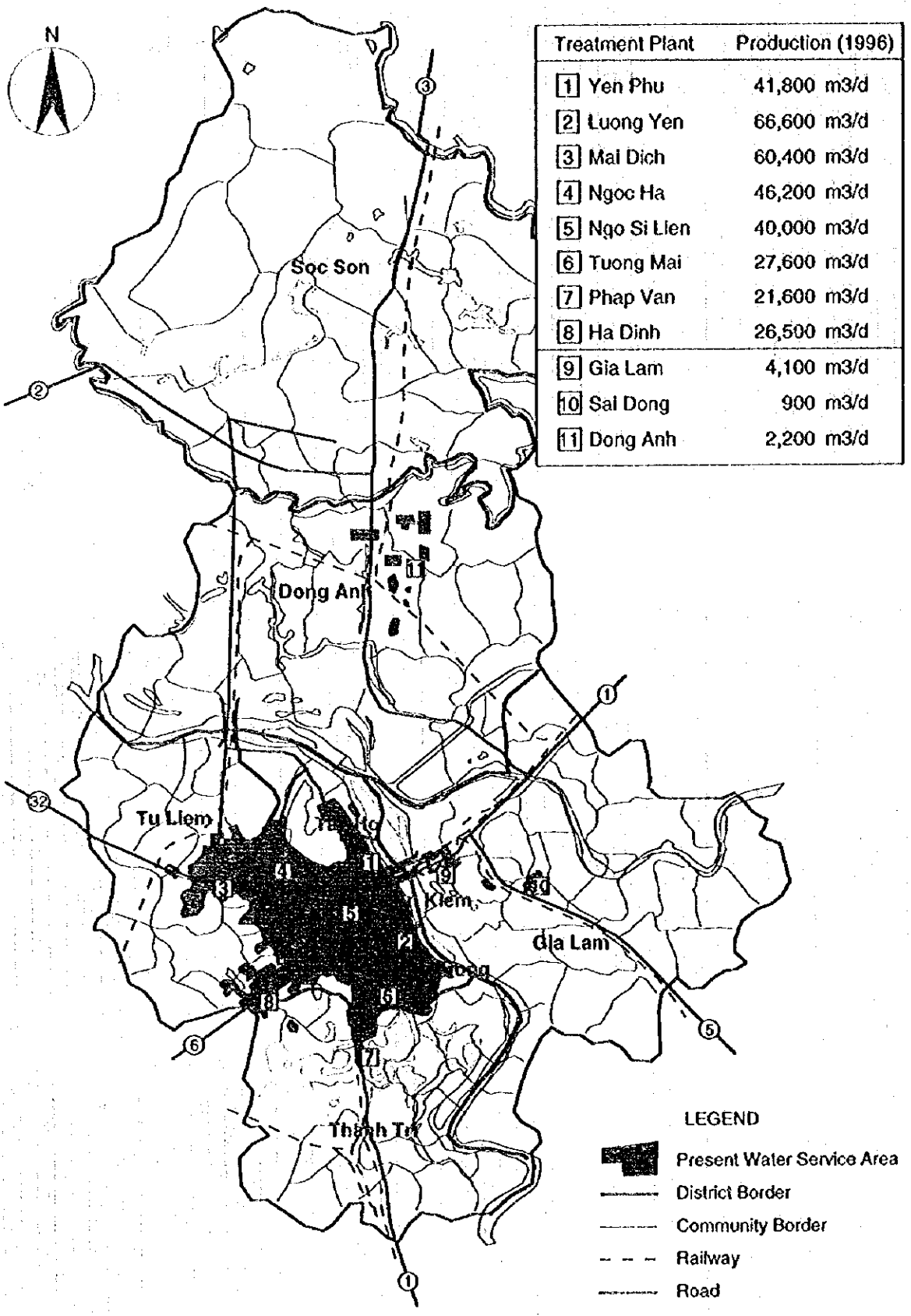
Water is distributed to the consumers through the distribution pipelines and networks. The basic framework of the distribution system is formed by the transmission mains with diameter of 300 mm or more. The mains feed a secondary network of distribution mains with diameter of 60-250 mm. Total length of the distribution pipes is 512,500m as of December 1995.

(5) Service Connections

Water is supplied to the consumers mainly by individual service connections and partly through public taps. The total number of the service connections was 136,900 at the end of March 1996. At the same time, the number of public taps was counted at about 700. HWBC has determined to reduce the number of public taps by 20% annually, which is planned to be transferred to individual service connections.

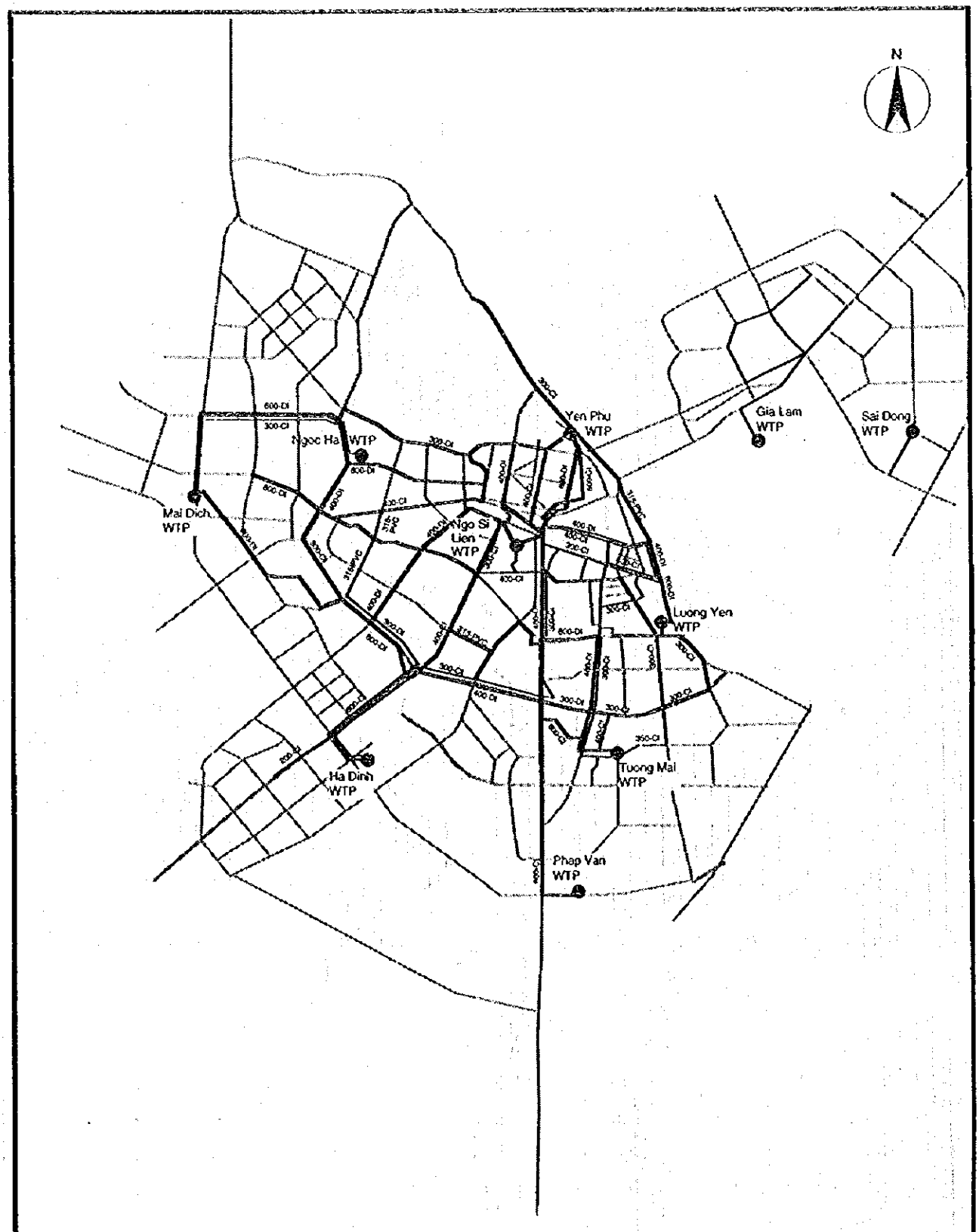


Water Production and Usage
(Period : January - June 1996)



Treatment Plant	Production (1996)
[1] Yen Phu	41,800 m3/d
[2] Luong Yen	66,600 m3/d
[3] Mai Dich	60,400 m3/d
[4] Ngoc Ha	46,200 m3/d
[5] Ngo Si Lien	40,000 m3/d
[6] Tuong Mai	27,600 m3/d
[7] Phap Van	21,600 m3/d
[8] Ha Dinh	26,500 m3/d
[9] Gia Lam	4,100 m3/d
[10] Sai Dong	900 m3/d
[11] Dong Anh	2,200 m3/d

Location of HWSC's Treatment Plants



Distribution Networks in June 1996

2.6 RELATED WATER SUPPLY PROJECTS

(1) Introduction

1) On-going Projects

At present there are two on-going projects and some actual implementation plans for water supply improvement project in Hanoi. These projects and plans will contribute a great deal to the water supply in Hanoi in future.

The two projects are going on as :
- World Bank Program, and
- JICA's Gia Lam water supply project,

which will expand the present water coverage of Hanoi.

For the formulation of the M/P by the target year of 2010, the recognition of these projects is important factor, since the water supply plan is based on current situation of water coverage and service population. And these on-going projects are not included in formulation of water supply plan in future, but the distribution capacity of these projects is considered as the existing capacity.

2) Population Served

Population served to be increased by the World Bank Program can not be distributed directly to new areas. Therefore, the number of service population was calculated at the almost some figure estimated by overlaying the future water coverage on the present one. As for JICA's Gia Lam Project, water served population was estimated by the same manner.

Predicted rate of population served in 2000 is to be 94%, because of the same water service area in 1996. The water service rate of two suburban districts near urban district is expected to increase to 24%, because of completion of the World Bank Program. Other three suburban districts also will increase service rate to 33% after completion of Gia Lam Project in 1996.

Population served to be increased by the both projects is shown in Table 2.6-1.

Table 2.6-1 Increase of the Population Served

Year		1996	2000	Increase
Population Served	Urban Districts	1,100,085	1,110,677	10,592
	Suburban Districts	174,852	377,677	202,825
	Total	1,274,937	1,488,354	213,417
City population		2,394,887	2,683,851	-
Rate of population served		53.2%	55.5%	-

The increase rate of water service population in urban district is still low, since population growth rate is low for four years up to 2000. Both on-going project contributes to the increase of population served in suburban districts.

(2) World Bank Program

HWBC has established an extension program to be financed by the World Bank for about 68% of the total cost. The detail design work for the program was already completed and the construction work is scheduled to be implemented in years of 1997-2000. The program components are summarized below, together with cost estimates.

Summary of World Bank Program

(Implementation period : 1997-2000)

Category	Component (Construction Work)	Quantity	Cost (*) US$ million
(A) Treatment Plant	(A1) Cao Dinh Plant	30,000 m3/day x 1	9.62
	(A2) Nam Du Thuong Plant	30,000 m3/day x 1	
(B) Water Source	(B1) Wellfield for Cao Dinh	9 wells	1.89
	(B2) Wellfield for Nam Du Thuong	9 wells	
	(B3) Replacement well in the existing wellfields	4 wells	
(C) Network	(C1) Transmission pipelines	21 km	15.87
	(C2) Distribution pipelines	80 km	
	(C3) Secondary / tertiary pipes	250 km	
	(C4) Zone flowmeter	25 – 30 Nos.	
	(C5) Installation of new service connections	60,000 Nos.	
	(C6) Replacement of old service connections	30,000 Nos.	
Total (A+B+C)			27.38
Consulting services, training cost, land acquisition, contingencies, etc.			20.52
Grand Total (Budget)			47.90 (US$ million)

(3) New Gia Lam Project

For Gia Lam district which is located east of the Red River, a new water supply system with capacity of 30,000 m3/day is now under progress. In 1996, construction of a new treatment plant (30,000 m3/day) was completed, with grant aid assistance of the Japanese Government. As for distribution pipelines, a part of networks and service connections was already in use; and new construction of pipelines and service connections is in rapid progress.

The new Gia Lam treatment plant is located almost at the center of Gia Lam district. The water source is groundwater and it is taken through 12 deep wells; four of which are located nearby the treatment plant and other 8 wells in the left bank of the Red River. As the groundwater contains high concentration of iron and manganese, the treatment process includes two steps' rapid sand filtration in order to remove iron and manganese respectively.

(4) Yen Phu Extension Project

In Yen Phu treatment plant, an extension work is being executed with assistance of FINNIDA. The present capacity of Yen Phu is 40,000 m3/d and that of the new one is also 40,000 m3/d; making 80,000 m3/d in total. The water source is groundwater and 12 deep wells are to be constructed adjacent to the existing Yen Phu wellfields along the right bank of the Red River. It is expected that the extension work will contribute to improvement of water supply conditions of the central Hanoi.

2.7 ENVIRONMENTAL CONDITIONS

2.7.1 Current Legislation Systems for Environmental Protection

(1) Laws and Regulations for Environmental Protection

It was ratified by the National Assembly on December 27, 1993, and the statute was issued on August 18,1994. In this law, there are very clear articles to prevent environmental pollution in general, also articles concerning water supply.

(2) EIA System and Necessary Procedures

In September 1993, the Minister of MOSTE (Ministry of Science, Technology and Environment) signed the temporary guidelines on EIA. This guidelines gave general conception and contents of an EIA report and determined organizations having a function of EIA reporting and a schedule of approving an EIA report.

The available guidance does not require an EIA for domestic water supply projects. In the final workshop of the feasibility study on water supply project financed by the World Bank, however, a vice-minister of MOSTE clearly spelled out that an assessment of environmental impact is needed as a necessary pre-condition for the government approval of the project. The costs for preparation of EIA and costs for appraisal of EIA report will be taken from the project's funds. An approval must be given within two (2) months after receipt of the EIA report on the project.

2.7.2 Existing Environmental Conditions of the Study Area

(1) Natural Environment

Hanoi is a capital city which lies in the north of Viet Nam: at 21° north latitude and 106° east longitude. Hanoi is situated in the lowland plain of the Red River, and 75 km away from the west coast of Gulf of Tongking. The Red River runs through Hanoi from the north-west to the south-east. The city owes it to the river that there are plenty of water resources. There are extensive rice paddies in the north of the city, green, wooded and hilly countryside in the west that marks the beginning of the highlands, and rice fields in the south and east that stretch across the Red River delta to the coast.

Groundwater is available all around the city. Water bearing formation in the city consist of loose and alternating quaternary sediments. In general, there exist two aquifers. The deep one with the depth of 40~80m is the main aquifer that consists of gravel, cobbles and coarse sand.

There are 19 large and small rivers with a total surface area of 32.6 km^2 in Hanoi. The Red River is the largest river that runs through Hanoi with a width of 1~1.5 km in the vicinity of Hanoi. It originates in the Nguy Son mountains in China. The reach of the stream which runs through Hanoi city has a length of 30 kilometers from Tu Liem district to Thanh Tri district. Flood season lasts for five months from June to October and the peak level of river water appears in August. Its flow fluctuates between 350 and 22,000 m^3/sec and its water level fluctuates between 1.7 and 14.1 m above mean sea level. About 75% of the river water is carried during rainy season and the remaining 25% is carried during dry season. Water of the Red River is not used for water supply in Hanoi, but it plays an important role for irrigation and waterway transportation.

The Nhue River is functioning as a main drainage which receives wastewater from the city. Its catchment area in Hanoi is 57.9 km^2 and the river water is used for irrigation. Other rivers in the southern area of the Red River are To Lich River, Lu River, Kim Nguu River and Set River which are small and mainly functioning as drainage of the city. All sewage of Hanoi is discharged into these four rivers during dry season.

In the northern area of the Red River, there exist some medium-sized rivers which are mainly utilized for irrigation. The largest river is the Cau River which originates in the northern highland regions, runs through Bac Thai province and Ha Bac province, and finally reaches Hanoi. Its total catchment area is 5,780 km^2 and the length is 255 km. The Cong River is a tributary of the Cau River and its confluence with the Cau River is at Trung Gia on the northern boarder. The Cong River has a total catchment area of 951 km^2 and a length of 96 km. The Ca Lo River is also a tributary of the Cau River and it has a total catchment area of 881 km^2 and a length of 89 km. Annual average flows of these rivers are 51 m^3/sec (Cau River), 15 m^3/sec (Cong River) and 29 m^3/sec (Ca Lo River). Minimum flow of the Cau River is 4.3 m^3/sec and others are almost zero.

Hanoi has numerous lakes and ponds. The largest one is the West Lake that was created by separation when the Red River was embanked. Main functions of lakes and ponds are recreation, retention of storm water, regulation of microclimate, fish farming and receiving bodies of wastewater. In the suburban districts, lakes are utilized for irrigation and water supply.

As a northern region of Viet Nam, Hanoi has tropical monsoon climate. The climate is humid and hot with an average temperature of 30°C from May to October. Rainfall mainly occurs during the period from April to October. The climate is rather cold with an average temperature of 10～20°C during the period from November to April.

Wildlife in Hanoi seems to be very poor. Almost all wild animals were hunted for food, and capturing of rare and endangered species is another threat to fauna. Deforestation, industrial pollution and excessive usage of agricultural chemicals cause negative effects on wildlife. Hanoi is surrounded by vast delta plain covered with fields of rice and other crops, and trees are only found in small villages.

(2) Socioeconomic Environment

In the course of time , the city center has expanded to the east (Gia Lam), the south-west (Thanh Tri) and the north-west (Tu Liem) urbanizing the areas which were formerly situated in the suburban districts. At present (year 1994), industrial areas cover an area of 537ha and they would expand to 990ha according to Hanoi Urban Planning Institute.

Hanoi has a population of 2.39 million (year 1995) and an average population density of 27 persons/ha. About a half of the population are concentrating in five (5) urban districts with an average population density of 207 persons/ha. Another half of the population spread over five (5) suburban districts where an average population density is 14 persons/ha. Northern districts such as Soc Son and Dong Anh have lower population density of around 10 persons/ha due to isolation from the urban area by the Red River. Present natural population growth is 1.6% in the urban districts, and 2.1% in the suburban districts.

Inundation usually occurred in many streets of Hanoi during rainy season. In urban area, flood occurs more frequently, that causes a lot of serious effects to social life, environmental pollution and damage to national economy. If a rainfall intensity exceed 50 mm/hr., inundated places will be more than 42 and equivalent to a length of 14,293 m along the street, and the flood will last for three hours. In 1994, 2,918 ha of rice paddies and 543 ha of vegetable fields were damaged by the typhoon No.6 and No.7.

Economic development of Hanoi depends on conditions of transportation. 60 percent of goods and 70 percent of passengers reach the city via national road network. The road network is a radial structure with a multi-setting ring system. A total length of the road network is 295 km and a road density is 0.66 km/km^2 on average. The density is rather lower than international standard and it could be a bottleneck factor for future urban development. Hanoi has seven national roads; Routes No.1, No.2, No.5, No.6, No.23, No.32 and Thang Long - Noi Bai highway.

Industry of Hanoi is changing for a market economy. All industrial sectors are seeking the way to fit their activities and operations to a new system. Development plans for industrial sectors focus on renewal of technology,

equipment as well as construction of synchronized workshops in each industry. Minh Khai - Vinh Tuy, Thuong Dinh, Dong Anh and Van Dien - Phap Van are typical existing large-scale industrial zones in Hanoi.

At present , drainage system in Hanoi are used for both storm water drainage and domestic/industrial wastewater sewer. Most wastewater are directly discharged into roadside drains and channels without any treatment. Some of existing facilities of wastewater treatment are not enough or not effective. Particularly, septic tanks are not correctly connected to existing drainage system. In some cases, untreated wastewater overflow the treatment facility to the street. Kim Lien-Trung is only one existing sewage treatment plant in Hanoi, however it is out of function at present. There are some factories install wastewater treatment facilities, however most factories discharge their wastewater into sewerage systems without pre-treatment. There exist wastewater treatment plants for hospital wastewater.

The total volume of domestic and street wastes generated in the city is estimated to be about 3,000 m^3/day. Density of solid wastes in Hanoi is relatively high due to high organic contents, high moisture and construction materials. Construction wastes contain all materials for building or road construction. They are sometimes placed on the roads near the construction sites, and collected by URENCO (Hanoi Urban Environmental Company) free of charge. They consist of excavated earth, concrete, bricks, lime, stones, mortar, gypsum, metals, wood, etc.. The landfills for construction wastes are Tam Hiep (Thanh Tri district)and Bo De (Gia Lam district).

Most collected wastes are currently dumped in Me Tri landfill which is controlled not to pollute the environment. Me Tri landfill covers an area of 3.2 ha west to north of the urban area. There are several proposed future landfills which are under investigation. Soc Son landfill is designed to have its area of 50 ha. Tam Hiep landfill (5 ha) and Lam Du landfill (23 ha) are designed to be used till 2000. Wastes from several hospitals are incinerated.

(3) Pollution

The monitoring results shows that the concentration values except TSP are still lower than Vietnamese air quality standards. TSP at Cua Nam is three times higher than the limit of the standards.

Urbanization and industrialization in Hanoi is under developing with high speed. However, most pollutant sources never have install their wastewater treatment systems. Therefore, industrial and municipal wastewater causes pollution of water bodies in Hanoi. Some hospitals discharge their wastewater directly into drainage system in the city.

In general, water quality of the Red River and the Duong River seem to be still good. However, other rivers in the city seem to be seriously affected by wastewater. Kim Nguu, To Lich, Lu and Set are the river which link with sewerage systems and function as main drainage system of the city. Their concentration values of BOD_5 are ranging from 14 to 150 mg/l. In the rural area, river water has been worried by contamination caused by agricultural chemicals such as fertilizer or pesticide.

In the regions within a few kilometers along the rivers, there is a close relationship between groundwater and rivers through the hydrogeological "windows". Groundwater level has not been considerably lowered by exploitation in these regions, because river water seems to recharge ground water. Therefore, these areas are rich in groundwater resources enough to locate production wells. On the other hand, there is no close relationship between groundwater and river in the regions far from the rivers. Groundwater level easily decline, because discharge volume often exceeds recharge volume in these areas. In the southern area of the Red River, contour map of groundwater level shows a shape of cone of depression.

Groundwater exploitation seems to have lowered groundwater level and caused soil subsidence in Hanoi City. However, relationship between groundwater exploitation and land subsidence has not been clarified well. The settlement has decreased over the period of years (1988-1995) because of stable exploitation: from 58 mm/year to 35 mm/year in the area of strong land subsidence, from 38 mm/year to 21 mm/year in the area of medium land subsidence, and from 19 mm/year to 5 mm/year in the area of weak land subsidence.

2.8 SUMMARY OF ISSUES

2.8.1 Technical Aspects

(1) Rate of Population Served

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

Many people in non-piped water supplied areas desire safe and sufficient water supply by way of piped water system. People in these areas get water for their domestic use from poor water sources such as shallow wells, rain water, irrigation ponds or channels. Their water consumption in general is quite small.

(2) Water Sources

1) Groundwater

Ministry of Agriculture and Rural Development has been authorized to approve and permit everything related to the development of the water resources with the "Decision of Prime Minister" dated May, 1996 (Ministry of Water Resources had been authorized before). Laws and regulations related to the development of the water resources, particularly from the viewpoint of water resources protection, however, are still under preparation and have not been enacted yet. Therefore, at present, there is no actual control of the development of the water resources.

In the water resources development, the groundwater development through private wells in particular is required to be controlled theoretically from the view point hydrogeology, in order to avoid serious environment impacts. Therefore, immediate enactment and effect of the laws and regulations are desired.

2) Water Quality

In the whole city, groundwater contains high concentration of iron and manganese which do not meet the criteria for drinking water. In the southern part of the south Hanoi, groundwater also contains high concentration of ammonia. Although data are not enough, slightly high concentration of toxic substances such as cadmium, lead or phenols were detected in some wells.

(3) Facilities

1) Water Distribution

Domestic water is not necessarily obtainable whenever wanted; or rather, water is intermittently supplied in some places and in some months.

Although the total production capacity is apparently reasonable and satisfactable, people are not able to actually enjoy public water supply. It is because of the fact that the produced water is not distributed enough to consumers evenly, because of physical loss in pipelines, wastage at upper stream of pipelines, etc.

Therefore, it is strongly required to remedy such adverse conditions, by replacement work of old pipelines, and with efforts to reduce administration losses.

2) 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 ppm) presents in raw water which is not able to be removed by the current process. Furthermore, iron removal at Tuong Mai and Ha Dinh plants seems to be a problem (treated water : 1.3 - 1.5 ppm Fe) probably due to technical defects of filters.

As to tap water quality of end users, it could be said to be satisfactory to consumers in general, as a result of water quality analysis and personal interviews carried out at ten points in the city during April-May 1996. All of ten samples of tap water presented residual chlorine of 0.07 – 1.0 ppm.

3) Facilities

Facilities in water treatment process are judged to be in reasonable conditions in general. Although mechanical troubles and difficulties happen sometimes, they are usually not fatal, but they can be repaired or replaced with ordinary routine work or by some budget for repair cost.

Raw water intake facilities such as deep wells, intake submersible pumps and raw water pipelines tend to be deteriorated and to lose their original capacities, comparing with facilities in treatment plants. Accordingly, special attention for maintenance and inspections shall be paid to these intake facilities.

2.8.2 Institution and Management

(1) 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.

(2) Credit Quality Lowering

When HWBC borrows the funds from the World Bank and foreign governments, the credit quality (=bankability) is the most serious thing. Credit Quality becomes lower due to the cutting of government subsidies, as it is difficult for HWBC to expect the governmental financial assistance. Low credit quality leads to high interest rate expenses and low availability of loan.

(3) Poor Management Activities

When we look at the staff/customer comparison surveyed by SPC (former State Planning Committee, present Ministry of Planning and Investment) and MOC in 1995, the ratio employees per 1000 connections in Hanoi recorded 16.6 higher than that of HCMC at 6.5, Khanh Hoa at 11.6, Thanh Hoa at 16.0. This shows that HWBC has too many staff.

(4) Under-estimation of Depreciation Cost

As fixed assets has not yet re-evaluated in the price movement of around 244% over 1990~1994, profits of HWBC may be pointed out as over-calculation due to the under-estimation of depreciation cost from the viewpoint of the international accounting standards.

(5) Potential Conflicts of Interest in Decision Making

The board of directors of HWBC seems presently to involve in the combination of ownership and management. Ownership function results from the present situation that fixed assets of HWBC belong to TUPWS or HPC and that directors, managers of HWBC are mostly appointed or approved by TUPWS or HPC.

Potential conflicts of interest have existed because that 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.

To keep the affordable level of water charges means that the government continuously give subsidies to water consumers via HWBC. This has resulted in weak motivation to workers of collecting water charges. Additionally HWBC could not have the self-funding ability for replacement of fixed assets.

(6) Poor Motivation System

At the moment, the water plants and the business enterprises in HWBC are defined as internal cost units and introduced internal cost accounting. This means to place workers low profit responsibility.

(7) Out-of-dated Accounting System

The company's fixed assets are formally owned by TUPWS, although they are stated in the balance sheet of HWBC. This is different from the international accounting standards. There are two alternatives for countermeasures.

(8) Financial Status

1) Standard Difference from IAS

The New Accounting System has been officially applied from January 1, 1996, however, financial practice of HWBC is still apart from the International Accounting Standard (IAS). Currently in Vietnam some officials in the Ministry of Finance and the General Auditing Office have just started to gain IAS training, and independent auditors are still scare resource.

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 made. For example, revaluation of fixed assets has not been done in due course, thus depreciation charges were too low to show the real replacement cost. This results in difficulties in assessment of creditworthiness of the company, and furthermore, difficulties in formulating future Master Plan.

2) Weak Fundraising Ability

Present funding ability of HWBC is quite vulnerable.

(a) Due to accounting standard difference, credit assessment is difficult for external fund providers for both governmental and private sources. Although the London Club negotiation has just started to break the ice, private sources represented by international commercial financial institutions are still cautious to extend credits to State Enterprises (SEs) in Vietnam.
(b) Owing to the primitive financial market in Vietnam, it is currently difficult for SEs including HWBC to obtain long-term finances at a reasonable pricing from domestic sources.

In order to change the situation, structural improvement of financial market is necessary.

3) Insufficient Water Tariffs

Historically, water tariffs in Vietnam has been kept lower than full cost recovery level. As for Hanoi, cost of water supply is estimated 3,900 VND/ m^3 according to the opinion letter by HWBC/TUPWS to NWTS dated March 1996 (breakdown not available). Even after recent raise in August 1996, water tariff for domestic customers are just 1,200 VND/m^3. This is cross-subsidized by non-domestic customers, however, earliest effort to raise water tariff is required, same suggested by the World Bank and the Asian Development Bank.

4) Lack of Expertise

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

(a) lack of expertise in international accounting practices, and
(b) expertise in automated equipment and computers.

PART II

MASTER PLAN

PART II MASTER PLAN

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CHAPTER 1 FRAMEWORK FOR THE MASTER PLAN

1 FRAMEWORK FOR THE MASTER PLAN

1.1 STUDY AREA AND ITS SERVICE CONDITIONS

The study area covers approximately 924.5 km² consisting of five urban districts (Ba Dinh, Hoan Kiem, Hai Ba Trung, Dong Da and Tay Ho) and five suburban districts (Thanh Tri, Tu Liem, Dong Anh, Soc Son and Gia Lam) in Hanoi.

The urban districts and suburban districts in the study area differ in the water consumption conditions due to the living standards. Some areas in suburban districts will be urbanized by the development plan in future and likewise the residents' living standard will be improved. The new urbanization area consists of residential, commercial, institutional and other public areas depending on population growth. Therefore, the formulation of the water supply plan is based on the grouping by type of the area.
In this Study, the study area is categorized into three groups described as below :

(1) Group U : The core of Hanoi that consists of the five urban districts and the surroundings of the two suburban districts. The area has been supplied with water by public water supply.

(2) Group D : The future development area planned by Hanoi People's Committee and Densely Inhabited Area (hereinafter called DID) area in the five suburban districts of which population density is forecast to be more than 20 persons/ha. in 2010.

(3) Group R : This area is sparsely populated as agricultural farm lands.

The area categorized into the above three groups is shown in the map of Fig. 1.1-1.

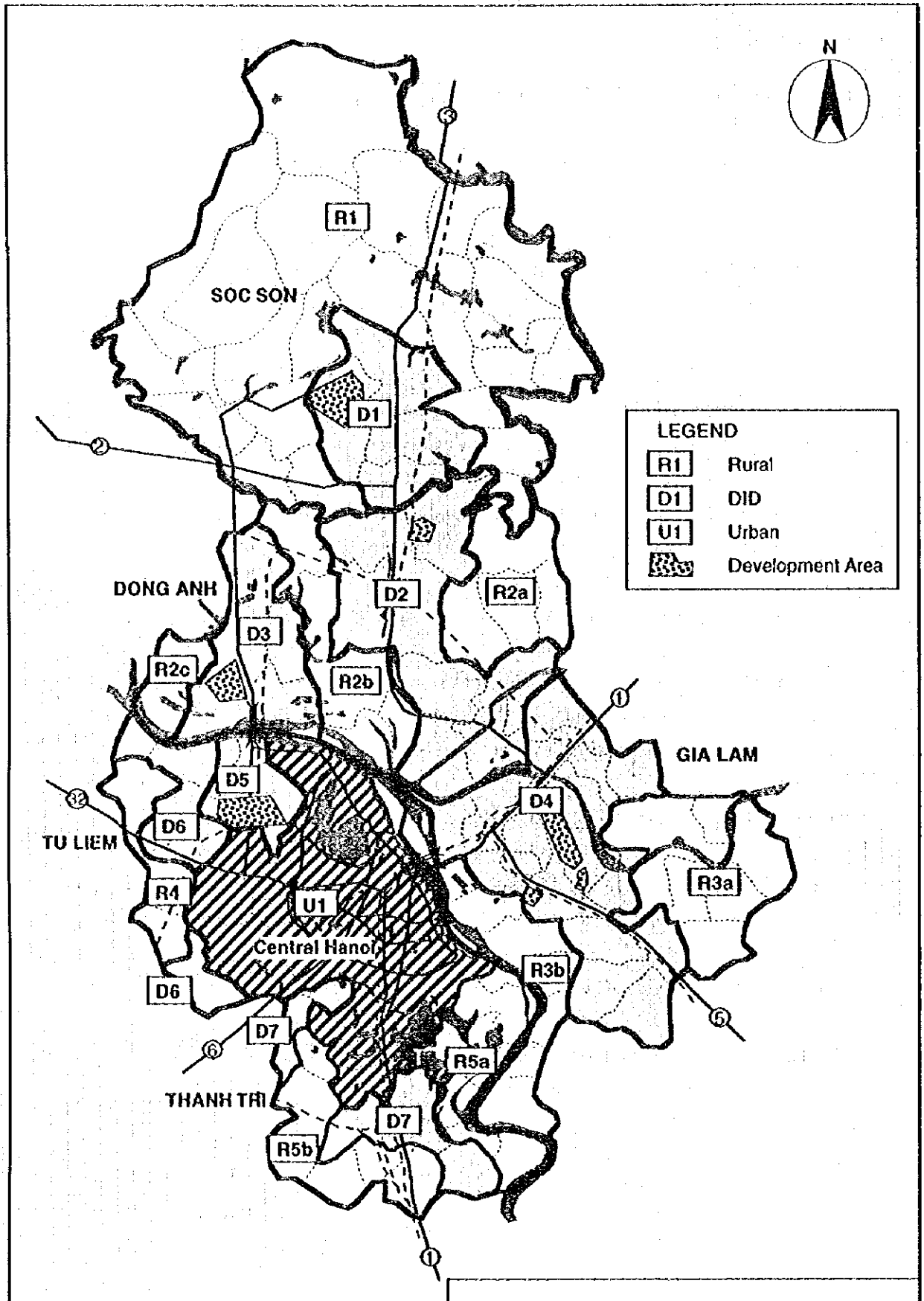


Fig. 1.1-1
Three Gruops of the Study Area

1.2 TARGET AND GOAL

The target year of the Master Plan is the year 2010. The final goal of the Master Plan is to achieve the suitable improvement of living standards and the promotion of healthy socio-economic activities depending on implementation of a suitable project for to providing the people of Hanoi with systems for adequate city-wide water supply.

The following is tangible contents of the target year and the goal:

(1) Improvement of the Existing Facilities

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

(2) Extension Program of the Water Supply Systems

Service level of Group U and D is to be 24-hours consecutive water supply by way of house connections. Group R is to be served with sufficient water by way of public taps.

Service conditions of the water supply systems are shown in Table 1.2-2.

Table 1.2-2 Service Conditions of the Water Supply

	2000		2005		2010	
	Unit Water Demand (l/c/d)	Rate of Population Served (%)	Unit Water Demand (l/c/d)	Rate of Population Served (%)	Unit Water Demand (l/c/d)	Rate of Population Served (%)
Group U	150	100	165	100	180	100
Group D	105	100	135	100	165	100
Group R	60	30	75	85	90	85

(3) Institutional Strengthening

The urban water supply systems are proposed to be operated under self-standing conditions such as self-financing and self-autonomy.

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

1.3 URBAN DEVELOPMENT PLAN AND POPULATION FORECAST

1.3.1 Urban Development Plan

(1) Land Use Plan for 2010

With a rapid increase of the population, the urban area has considerably expanded to the suburban area. The Government of Vietnam is controlling the flow of rural migration to the city and disordered expansion of urban function. A policy could control land use of Hanoi to new settlement of industries and residents.

The presented Study Team's forecast of Hanoi's population is based on a relatively preferable urban environment of Hanoi as the urban center of the region as well as capital city of the nation. The expansion of urban Hanoi means conversion of agricultural land to urban uses. The certain area of agricultural land included in the urban area, depends on the size of urban expansion within Hanoi city.

(2) Urban Development Plan for 2010

1) Industrial Development

At present, some industrial establishments are scattered in the urban area but there have also been established concentrated industrial areas located both in urban and suburban area.

Basic policy of industrial development in Hanoi follows the idea that main industrial establishments will be concentrated in separate zones in which each zone consists of certain types of industries having relatively similar characteristics.

There are in total five industrial zones in land use planning for future which was authorized by past JICA study of "Master Plan of Industrial Development in the Hanoi Area".

2) City and Housing Development

There are many plan of commercial development as a new town and housing estates. But, some of plan are not mentioned development outline. However, most of these development will be accumulated for future trend of water demand consist of social activities with population growth.

3) Future Land Use Plan in the Target Year

Future land use plan for Hanoi city in 2010 is appeared from formulation of before-mentioned each development plans.

These trends of urban development will reflect to the demand of urban water supply by category such as commercial use, industrial use, institutional use, mixed use, residential use, village area, green and park area, water area and others.

4) Implementation Plan

The implementation period for the industrial estate is followed by the past JICA study which was authorized by the Government of Vietnam. The other development schedule is not shown clearly in this moment. Tentative development schedule for the planned projects in suburban area is summarized in Fig. 1.3-2.

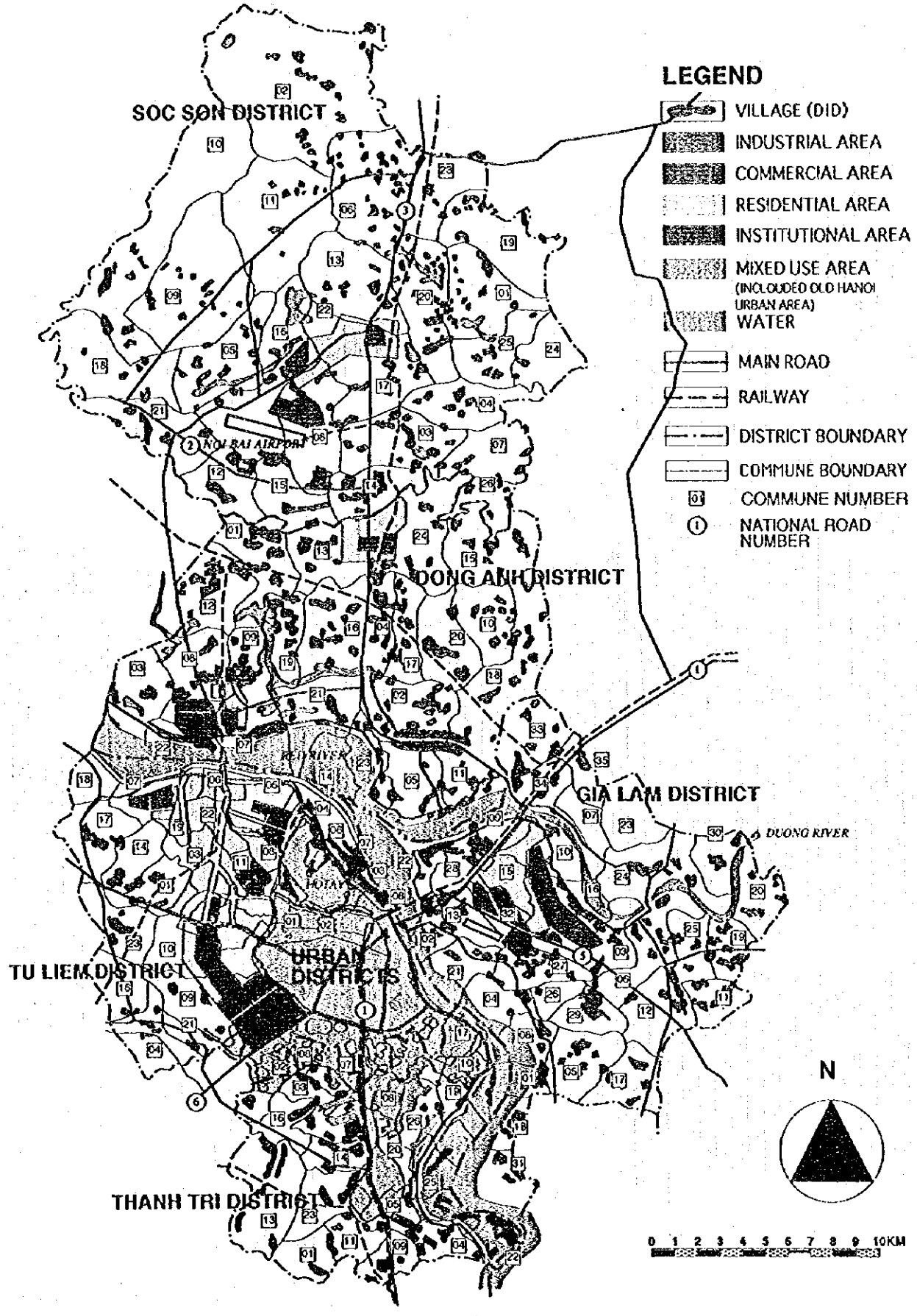


Fig. 1.3-1 Land Use for Hanoi City 2010

Year	1995	2000	2005	2010	
INDUSTRIAL ESTATE					
1. Thang Long North IE		1st phase 330ha	2nd phase 330ha	3rd phase 330ha	
2. Thang Lomg South IE (or CBD)			220ha		
3. Dong Anh IE			92ha	92ha	
4. Gia Lam IE		1st phase 367ha	2nd phase 528ha	3rd phase 528ha	
5. Soc Son EPZ (or IE)		1st phase 100ha	2nd phase 300ha	3rd phase 430ha	
6. Other IE(Daewoo, Taiwan.etc)		80ha	80ha	80ha	
Total Area		**877ha**	**1,550ha**	**1,460ha**	
•NEW TOWN & HOUSING ESTATE					
1. New Van Tri Town		(10ha)	(150ha) 310ha	(150ha)	
2. Ciputra New Town			(300ha) 400ha	(100ha)	
3. South Thang Long City		(100ha)	(350ha) 800ha	(350ha)	
4. Nghia Do International Village		11ha			
5. Red River City				6ha	
6. Trung Yen Housing Project			N.A.		
7. Linh Dam - Dinh Cong Project				292ha	
Total Area		**121ha**	**(800ha++)**	**(898ha)**	

Fig. 1.3-2 Development Schedule for Planned Projects in Suburban Area

1.3.2 Population Forecast

(1) Analysis of Growth

Future population of the city is estimated in relation to considerable reference data such as annual average population growth, economical growth, trend of industrial and commercial development. It is necessary to corporate structural changes into the forecast method.

Based on the statistics, the natural population growth in Hanoi has over 30 years been greatly reducing from 3.89% in 1960 to 1.73% in 1991. This is partly due to social reasons such as; higher education of people, improved living conditions, so that more time is demanded to be reserved for other activities, increasing number of working women, methods and policies of government to restrict and control the population growth, application of contraceptives is popularized, etc.
Based on an official population projections for Hanoi, there are remarkable related studies such as :

- "Water Master Plan of Hanoi City by FINNIDA in 1993",
- "Water Supply Project, Feasibility Study by World Bank in 1994" ,
- "The Study on Urban Drainage and Wastewater Disposal System in Hanoi City in 1995" and
- On going project "The Master Plan of Urban Transport for Hanoi City by JICA, Interim Report issued on Mach 1996"

These projects were projected future trend of population.
From these authorized study and recent data should be considered on this projection.

(2) Population Forecast for 2010

Population forecast by "District" based on the "Community" is summarized in the attached table and figure.

The figure shows trends of rapid growth for suburban area comparing with urban area. Therefore, future trend of urban area is growing up slightly. Exceptionally, districts of Hoan Kiem and Hai Ba Trung are slightly going down considerably to improving of high density and policy for conservation of historical town in Hoan Kiem.

On the other hand, unregistered people could be as high as 20 to 30% of the registered population which estimated by the World Bank report. This population also must be considered for estimation of future water demand.

Average annual population growth rates are 0.24% for the urban area constantly and 4.20% up to 2000, 3.47% up to 2005, 2.95% up to 2010 for suburban area.
Therefore, average of whole Hanoi city is 2.28% up to 2000, 2.05% up to 2005 and 1.86% up to 2010.
According to the population forecast concluded under the above assumptions, the urban population will reach 1.25 million, 2.01 million for suburban and the total population of Hanoi city will reach 3.25 million in the year 2010.

According this analysis, population densities in urban area in 2010 will be high varying from 97.0 to 320.4 persons/ha by district in average.
Besides the suburban area there will be still low varying from 10.6 to 41.5 persons/ha by district in average.

Based on this analysis, the water supply area for the target year will be designated by density in each Commune together with considerable trends and new development.

Formulated population and its densities in each Commune is shown on the following tables and maps.

Table 1.3-1 Population Forecast : Summary

District (Quan / Huyen)	Area (ha)	Present		Forecast					
		Population in 1995	Density (p/ha)	Population in 2000	Density (p/ha)	Population in 2005	Density (p/ha)	Population in 2010	Density (p/ha)
Tay Ho	1,907.8	80,638	42.3	115,451	60.5	150,265	78.8	185,075	97.0
Ba Dinh	915.8	191,286	208.9	191,848	209.5	192,411	210.1	192,968	210.7
Hoan Kiem	417.2	193,504	463.8	173,556	416.0	153,606	368.2	133,653	320.4
Dong Da	1,484.6	391,686	263.8	403,851	272.0	416,016	280.2	428,173	288.4
Hai Ba Trung	1,108.0	347,289	313.4	337,044	304.2	326,800	294.9	316,548	285.7
Total of Urban Area	5,833.4	1,204,403	206.5	1,221,750	209.4	1,239,098	212.4	1,256,417	215.4
(Growth rate per year)				(0.29%)		(0.28%)		(0.28%)	
Soc Son	31,466.9	211,186	6.7	252,349	8.0	293,511	9.3	334,667	10.6
Dong Anh	18,920.0	221,229	11.7	329,806	17.4	438,383	23.2	546,955	28.9
Gia Lam	13,810.0	302,566	21.9	364,760	26.4	426,956	30.9	489,139	35.4
Tu Liem	9,125.2	241,848	26.5	287,439	31.5	333,027	36.5	378,606	41.5
Thanh Tri	9,905.7	213,655	21.6	227,747	23.0	241,840	24.4	255,926	25.8
Total of Suburban	83,227.8	1,190,484	14.3	1,462,101	17.6	1,733,717	20.8	2,005,293	24.1
(Growth rate per year)				(4.20%)		(3.47%)		(2.95%)	
Total of Whole City	89,061.2	2,394,887	26.9	2,683,851	30.1	2,972,815	33.4	3,261,710	36.6
(Growth rate per year)				(2.30%)		(2.07%)		(1.87%)	

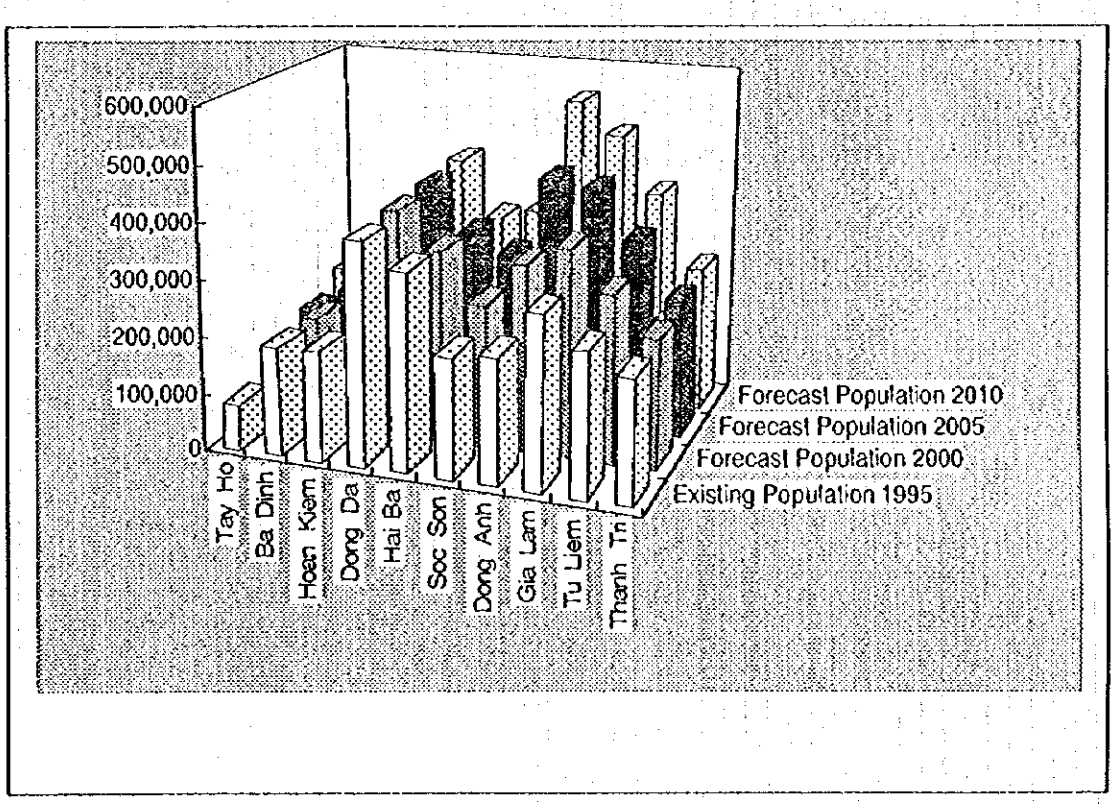


Fig. 1.3-3 Population Growth in Each District by 5 years

1.3.3 Population Served

Table 1.3-2 summarizes the population served of the year 2000, 2005 and 2010 on a basis of multiplying the future population which was forecast in urban development plan by the rate of population served. The domestic water demand is calculated on the basis of population served.

Table 1.3-2 Population Served by Group

	Group	District	Acreage (ha)	Population Served		
				2000	2005	2010
South Hanoi	U1	Urban Districts	5,833.40	1,221,750	1,239,098	1,256,417
	U1	Suburban Districts	5,121.40	214,781	242,525	270,259
	D5+D6	Tu Liem	4,126.40	106,536	128,089	149,639
	D7	Thanh Tri	2,519.40	80,446	91,596	102,743
	Total		17,600.60	1,623,513	1,701,308	1,779,058
North Hanoi	D1	Soc Son	4,124.20	66,659	89,140	111,620
	D2+D3	Dong Anh	11,330.00	238,239	344,438	450,636
	D4	Gia Lam	7,010.00	275,040	337,993	400,936
	Total		22,464.20	579,938	771,571	963,192
Rural Hanoi	R1	Soc Son	27,342.70	148,553	168,604	189,589
	R2	Dong Anh	7,590.00	73,252	77,505	81,872
	R3	Gia Lam	6,800.00	71,777	73,395	74,974
	R4	Tu Liem	1,660.00	23,241	24,229	25,232
	R5	Thanh Tri	5,603.70	67,496	68,713	69,875
	Total		48,996.40	384,319	412,446	441,542
Hanoi Total			89,061.20	2,587,770	2,885,325	3,183,792

(Note)
Population served is calculated on the basis of the population forecast and the rate of population served.

1.4 WATER DEMAND FORECAST

1.4.1 Rate of Population Served

Rate of population served in 2010 by public water supply has been set forth as follows :

(1) Group U : 100 %

(2) Group D : 100 %

(3) Group R : 85 %

Based on the above target, the rate of population served of whole Hanoi will reach about 98 % in 2010.

1.4.2 Population Served

The population served is calculated based on the population forecast and the rate of population served.

The population served of the year 2000, 2005 and 2010 are summarized in Table 1.4-1, multiplying the future population by the rate of population served.

Table 1.4-1 Population Served

Area	Acreage (ha)	Population Served			
		1996	2000	2005	2010
South Hanoi	17,600.6	1,545,719	1,623,513	1,701,308	1,779,058
North Hanoi	22,464.2	388,307	579,938	771,571	963,192
Rural Area	48,996.4	357,164	384,319	412,446	441,542
Hanoi Total	89,061.2	2,291,190	2,587,770	2,885,325	3,183,792

1.4.3 Water Usage and Unit Water Demand

(1) Domestic water

The domestic water is for living purpose such as for drinking, cooking, washing, bathing and sanitation.

In the case of Group R (rural area), domestic water includes non-domestic water use in small shop, school and public office, since these facilities are on a small scale and scarcely exist in the area (villages).

As a result of the study, the unit water demand is forecast as Table 1.4-2.

Table 1.4-2 Domestic Unit Water Demand Forecast by Group

(l/c/d)

	1996	2000	2005	2010
Group U	120	150	165	180
Group D	70	105	135	165
Group R	50	60	75	90

(2) Non-domestic water

A. Non-domestic water for Group U

Non-domestic water for Group U is classified according to the category of the water charge ledger of HWBC. The ratio of each category is shown in Table 1.4-3 where the whole domestic water is 100.

Table 1.4-3 Ratio of Non-Domestic Water Use

Domestic	100	(77%)
State	24	(18%)
Commercial	4	(3%)
Public	2	(2%)

B. Non-domestic Water for Group D

Non-domestic water for Group D is classified based on land use. Unit water demand of non-domestic use for Group D is shown in Table 1.4-4.

Table 1.4-4 Unit Water Demand for Non-Domestic Purpose

Water usage category	Unit water demand
Schools and Institutions	13 l/c/d
Hospitals	400 l/bed/day
Small markets, Restaurants, Markets, and Shopping centers	6 l/m²/day
Public office, Multipurpose halls, Administration offices and Libraries	7 l/m²/day
Miscellaneous use, Sprinkling for green area / road and Pipe flashing	2% of domestic water use

(3) Industrial water

The industrial water demand includes process water for production and miscellaneous water for industry-related facilities.

At present, the revenue from the industrial use accounts for more than 37% of the total revenue. In order to strengthen the management, the revenue from the industrial water is essential for the waterworks. Meanwhile, excessive development of the private wells will cause serious land subsidence. The groundwater balance of extraction and recharge will be increasingly biased toward more extraction from the year 2010 onward. From financial and environmental aspects, therefore, the industrial water is needed to be included in the water demand.

Taking into consideration the previous data and other information, the industrial water demand is concluded to be 45 m³/ha./day . Miscellaneous water use for ancillary facilities and their workers is estimated at 5 m³/ha/day.

Accordingly, the unit demand for industrial use is estimated at **50 m³/ha/day.**

(4) Fire Prevention Water

Fire prevention is an important function of waterworks. A total amount of water used in a year for extinguishing fire is a negligible part of the total water demand, but during a fire the rate of demand is so great. Therefore, the water used for fire prevention is not included in water demand forecast, but the design of fire hydrant equipment and capacity of distribution reservoir should be taken into account of fire prevention activities.

1.4.4 Water Demand Forecast

(1) Procedure for Forecast

The water demand is forecast on the bases of the unit water demand and the water consumption conditions such as population, land use plan and urban development plan. The process of estimation is illustrated in Fig. 1.4-1.

(2) Average Daily Water Demand

The Average Daily Water Demand of each Group is summarized in Table 1.4-5(1).

Table 1.4-5(1) Average Daily Water Demand (1)

Year		2000	2005	2010
Group	U	290,951	341,373	393,545
Group	D	151,518	235,054	327,002
Group	R	23,059	30,933	39,737
Total		465,528	607,360	760,284

Based on the water use category and corresponding unit water demand, the Average Daily Water Demand by usage and zone is forecast as Table 1.4-5(2). The trend-curve is given in Fig. 1.4-2 to -5.

Table 1.4-5 Average Daily Water Demand (2)

(m3/day)

	South Hanoi	North Hanoi	Rural Area	Total
Year 2000				
Domestic	220,749	60,891	23,059	304,699
Non-Domestic	64,657	14,322	0	78,979
Industrial	29,500	52,350	0	81,850
Total	314,906	127,563	23,059	465,528
Year 2005				
Domestic	266,712	104,163	30,933	401,808
Non-Domestic	76,313	19,739	0	96,052
Industrial	33,200	76,300	0	109,500
Total	376,225	200,202	30,933	607,360
Year 2010				
Domestic	316,447	158,928	39,737	515,112
Non-Domestic	88,761	25,411	0	114,172
Industrial	47,300	83,700	0	131,000
Total	452,508	268,039	39,737	760,284

(2) Average Daily Distribution Water

For determination of the Average Daily Distribution, a physical loss should be included. Based on formulation of the design criteria, the rate of physical loss is determined to be a 15 %. Based on assumption that pipe-renovation plan is proposed to replace the old distribution pipes, the actual physical loss will be decreased as Table 1.4-6.

Table 1.4-6 Proposed improvement of the loss

Year	1996	2000	2005	2010
Physical loss (%)	25.0	21.0	16.0	15.0

Water to be consumed in treatment plant is defined as plant loss which is 5% of the total treated water according to the design criteria.

(3) Daily Maximum Production and Distribution

The peak factor is given as 1.35 in accordance with the design criteria. The water capacity multiplied by the peak factor comes to Daily Maximum Production and Distribution water.

The Average Daily Distribution and the Daily Maximum Distribution water forecast every five years is summarized in Table 1.4-7.

Table 1.4-7 Water Demand Forecast (Daily Maximum Water)

(m3/day)

	South Hanoi	North Hanoi	Rural Area	Total
Year 2000				
ADWD	314,906	127,563	23,059	465,528
ADDW	370,478	150,074	27,128	547,680
DMDC	491,468	187,203	36,622	715,293
Year 2005				
ADWD	376,225	200,202	30,933	607,360
ADDW	442,618	235,532	36,392	714,541
DMDC	587,769	295,526	49,128	932,423
Year 2010				
ADWD	452,508	268,039	39,737	760,284
ADDW	532,362	315,340	46,749	894,452
DMDC	704,777	401,092	63,112	1,168,981

(Note) ADWD Average Daily Water Demand
ADDW Average Daily Distribution Water
DMDC Daily Maximum Distribution Capacity

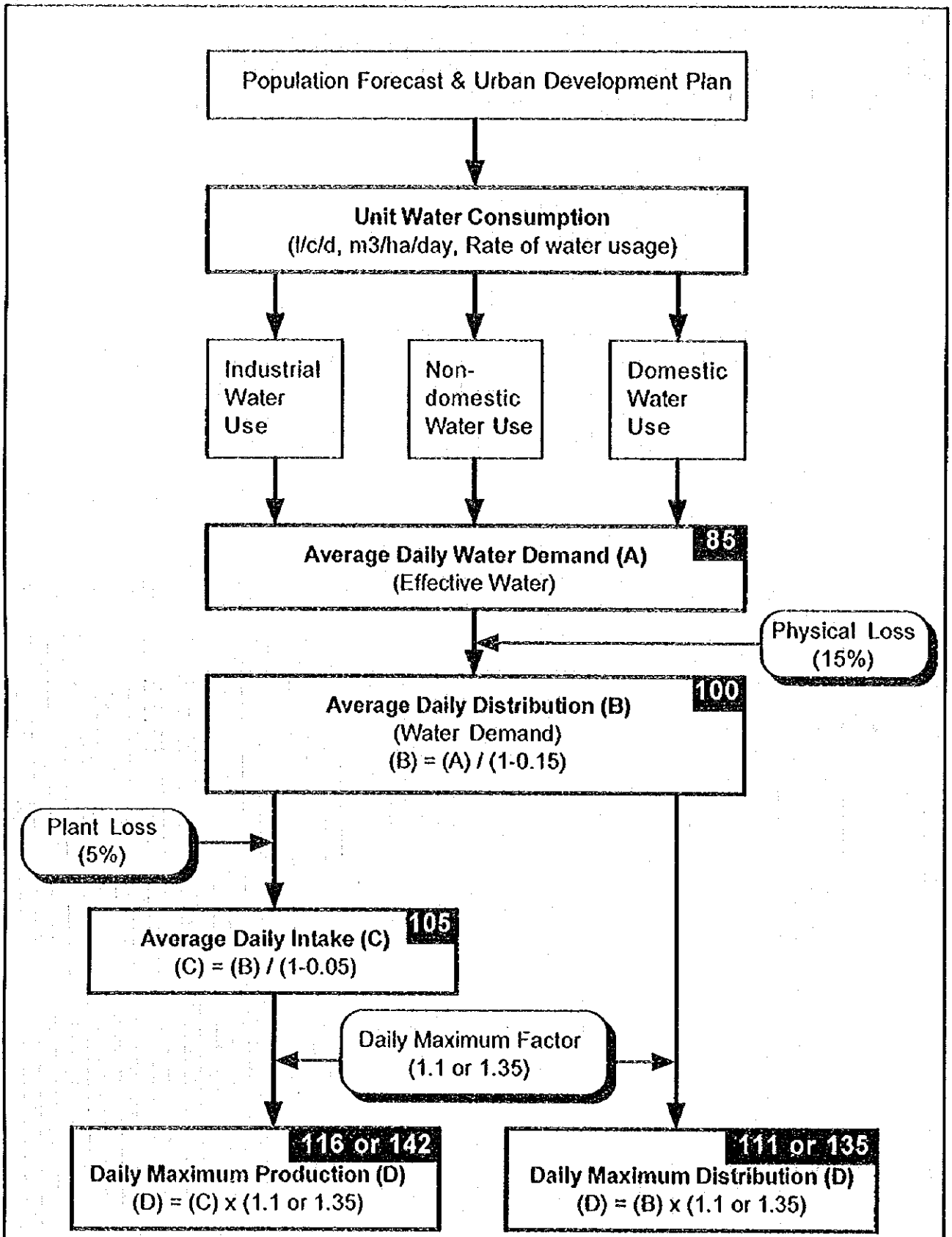


Fig. 1.4-1
Estimation of Water Demand Forecast

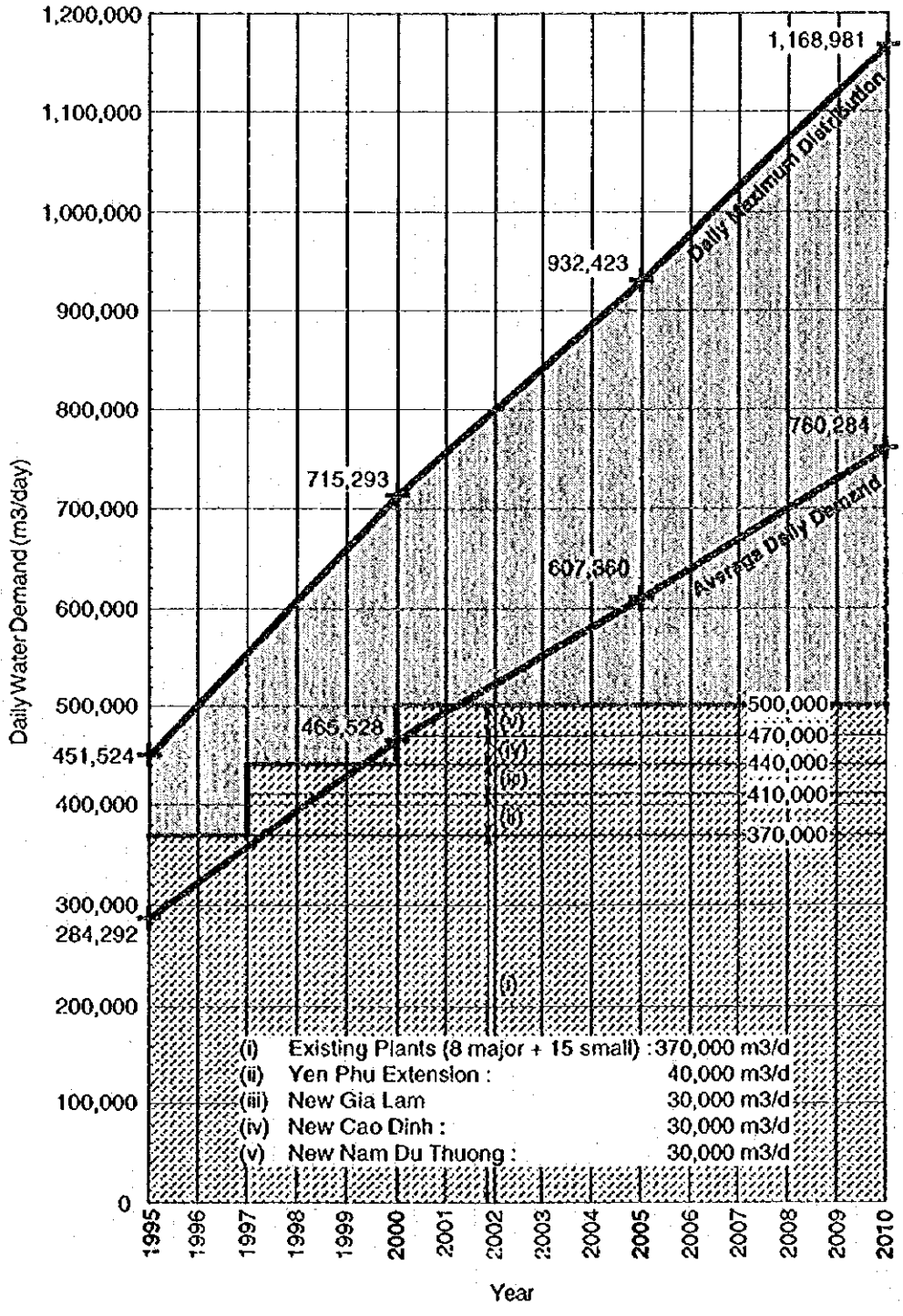


Fig. 1.4-2 Water Demand Forecast
(Whole Hanoi City)

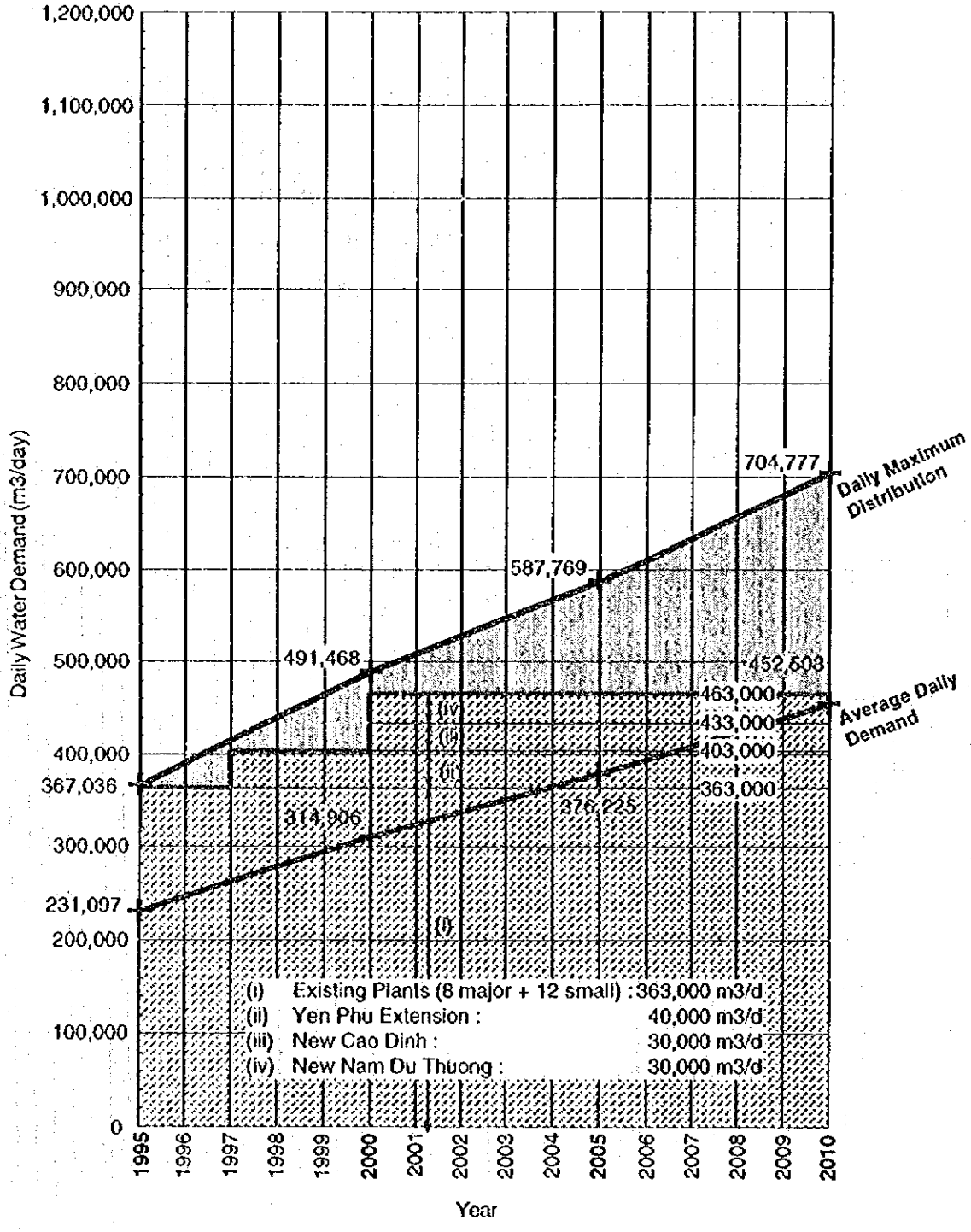


Fig. 1.4-3 Water Distribution Forecast South Hanoi

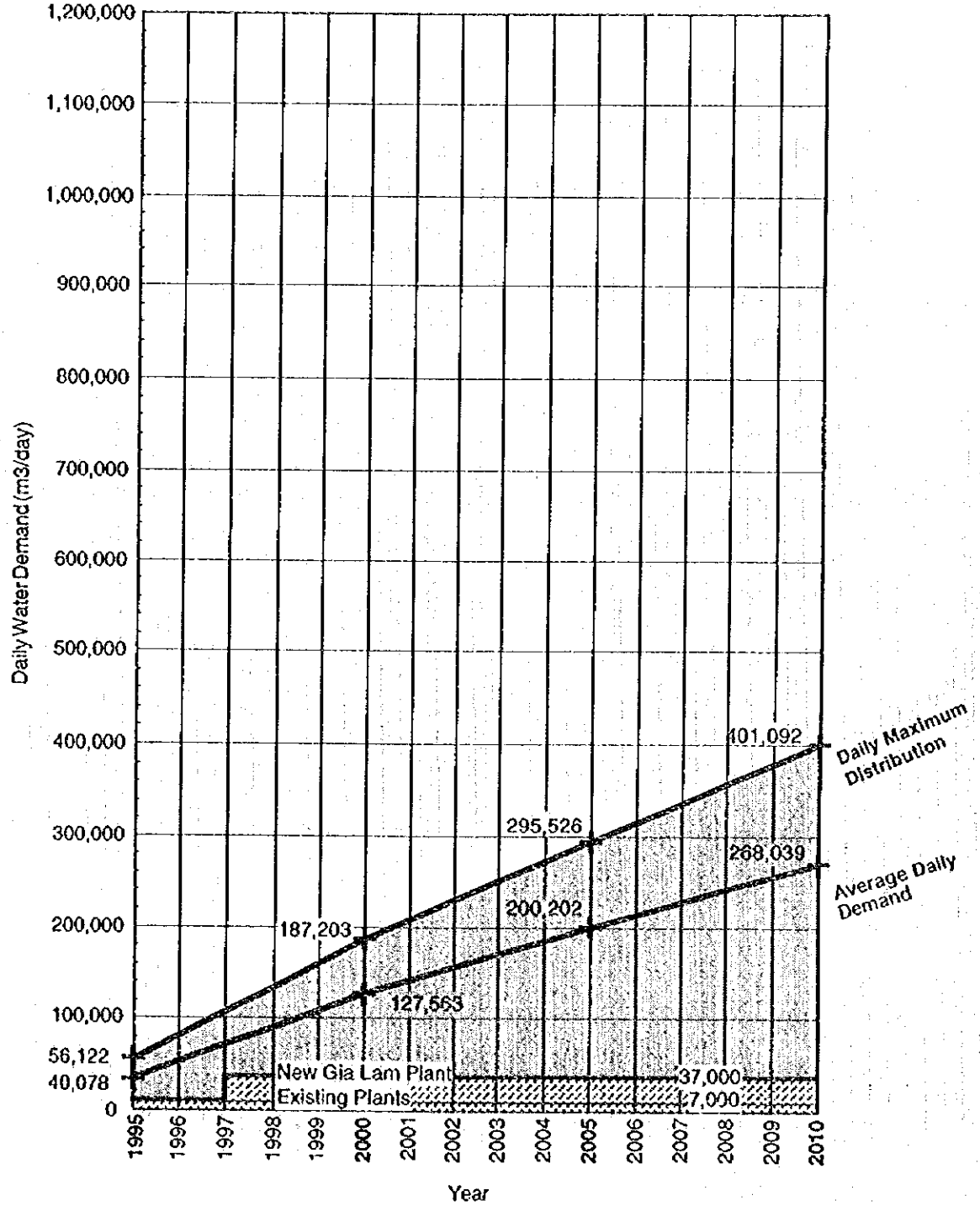


Fig. 1.4-4 Water Distribution Forecast North Hanoi

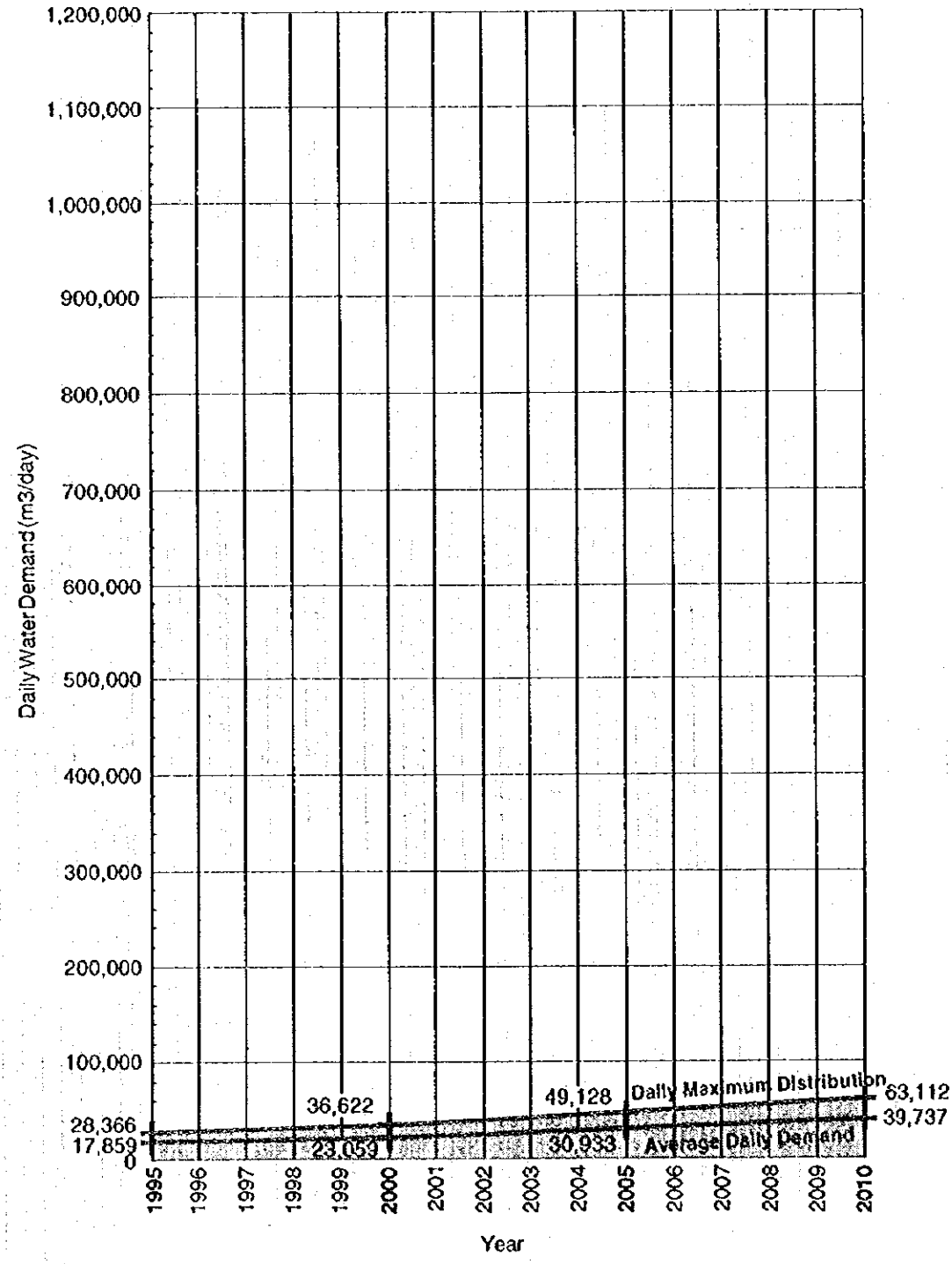


Fig. 1.4-5 Water Distribution Forecast
Rural Area
(Group R)

(4) Examination for the water demand forecast

Total water demand of all categories on a per capita basis is shown in Table 1.4-7.

Table 1.4-7 Per Capita Water Demand Including All Categories (l/c/d)

Year	2000	2005	2010
Group U	238	271	303
Group D	232	279	316
Group R	60	75	90
Average	177	208	236

The per capita water demand of Group D is higher than Group U in 2005 onward, because of the high industrial water demand.

The per capita water demand of Group U and D is exceeds 300 l/c/d in 2010 which is a reasonable figure for Hanoi as a capital in a country.

Water usage is of whole Hanoi shown in Fig. 1.4-6.

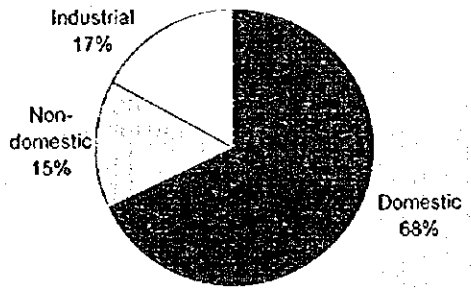


Fig. 1.4-6 Water Usage in 2010

In the case of Group D, the rate of domestic water demand among all usage in Group D accounts for 61%, that is lower than the case of the whole Hanoi. On the other hand, the industrial water demand amounts to 29% whereas 17% of whole Hanoi. This is because many industrial estates are going to be rapidly developed in these areas.

The water demand of each group in 2010 is presented in Fig. 1.4-7.

The rate of water to be provided by HWBC (South Hanoi) in 2010 is estimated at 60% of the total water demand of about 760,284 m3/d.

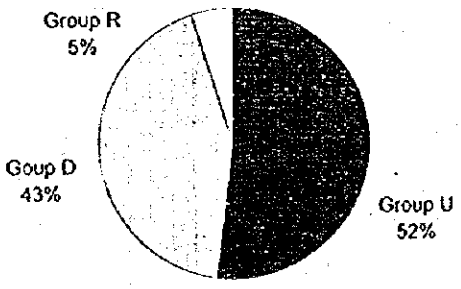


Fig. 1.4-7 Water Demand of Group

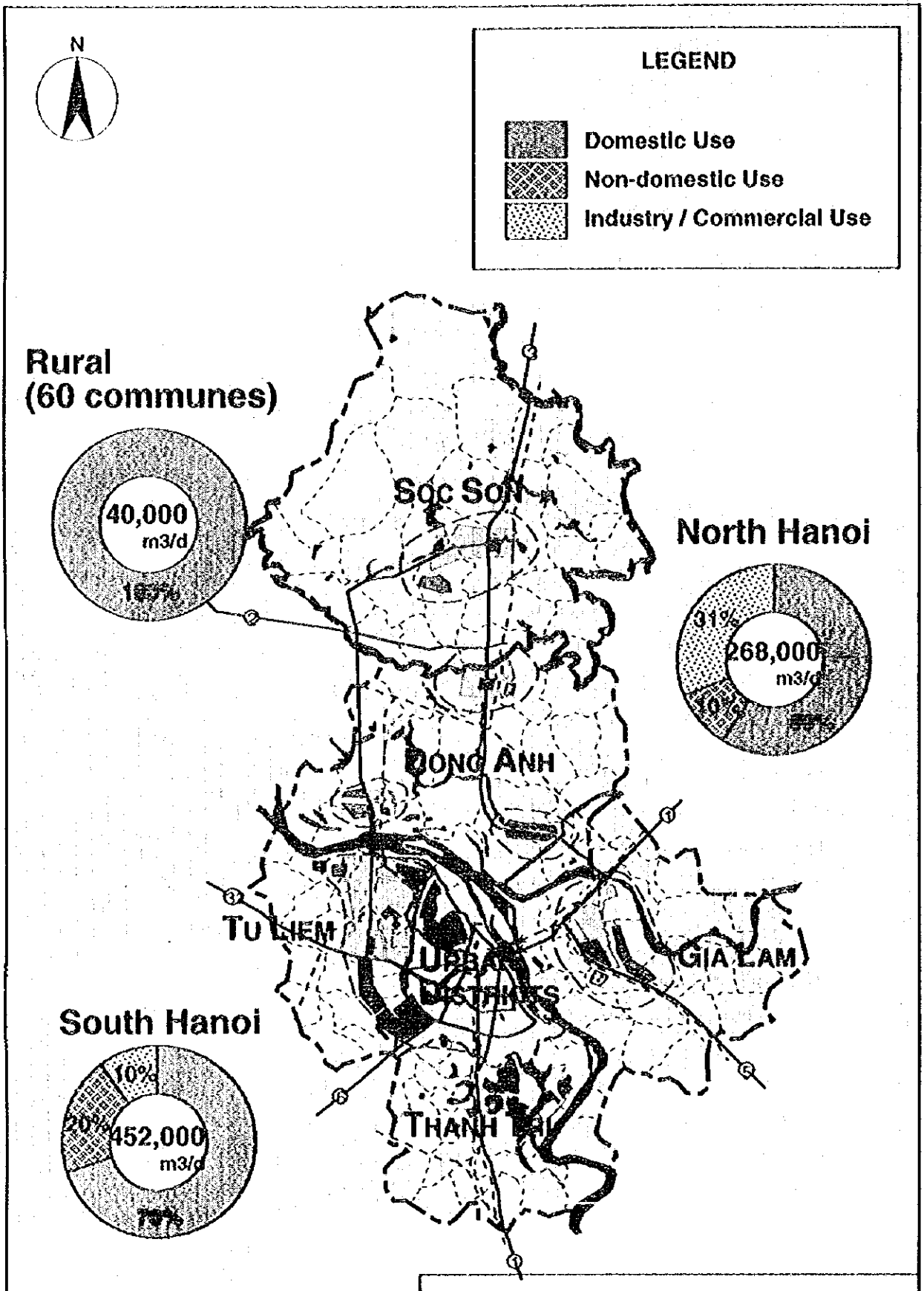


Fig. 1.4-8
Ratio among Water Usage by Area

1.5 WATER SOURCES

1.5.1 Priority Water Sources

Hanoi city has been taking groundwater as the water source for its public water supply. In recent years, however, the water demand has been rapidly increasing due to the commercial and industrial development of the city. Taking into account of this quick changeful situation, it is important to examine whether the groundwater is appropriate for and adaptable as water source till 2010. From the several view-points, it has been examined in below.

(1) Water quality

According to the existing data (see Part I, 2.4.2 Water Quality) on water quality of rivers, higher concentration of toxic chemicals such as arsenic, lead and phenol was detected in the Red River and the Da River sometimes. A peril of contamination by pesticide can not be denied with regard to the other small rivers in Hanoi City such as the Cau River and the Cong River. For this reasons, it seems that the river water may be infeasible to utilize for water supply.

On the other hand, from the groundwater, iron, manganese and ammonia is detected. Iron, manganese and ammonia can be removed by the existing water treatment technology with reasonable cost. Therefore, it seems to be more realistic to utilize groundwater for water supply.

(2) Facility

Construction cost of a treatment plant for groundwater is lower than that for surface water on account of the viewpoints below :

(a) Construction cost of a treatment plant, because of high turbidity.

(b) Chemical cost (one component of the operation cost), because of treatment process without chemical sedimentation.

(c) Construction cost of the pipeline and transmission cost, because intake site for surface water is remote from populated area where water is consumed.

(d) Construction cost of intake facilities in the river for surface water.

Cost comparison are given in table below in terms of Construction cost, O&M cost and Water cost.

	Groundwater	Surface Water	
		Da River	Red River
Construction Cost	100	210	185
(Intake Facility)	(10)	(20)	(35)
(Treatment Facility)	(35)	(50)	(80)
(Transmission Facility)	(15)	(100)	(30)
(Distribution Facility)	(40)	(40)	(40)
O&M Cost	100	120	150
Water Cost (O&M + Capital)	100	150	160

(Notes)

1) Above figures indicate the costs of each comparing item where the costs for groundwater system are 100.
2) Breakdown of the construction cost are shown as figures in brackets.
3) Water Cost, which includes O&M and Capital costs, is regarded as the base cost of water tariff.

In conclusion, the groundwater can be available to the source for the water supply system.

1.5.2 Development Potential of Groundwater

(1) Basic conditions

A computerized groundwater model in Hanoi area has been established, by which groundwater conditions in future is simulated for the assessment of groundwater resources. The simulation has been revised every year using new observation data. The analysis of the development potential of groundwater in this study also follows basically the results of the simulation study in the area south and west of the Red River. Basic conditions of the analysis are shown in Fig. 1.5-1 schematically.

Results of the analysis are shown in Table 1.5-1 through Table 1.5-4.

Table 1.5-1 Groundwater Budget

	Name of Area	Area (km^2)	Rechargeable Groundwater (m^3/d)	Present Water Use (m^3/d)	Groundwater Budget (m^3/d)
1	Soc Son	313.86	66,000	6,000	60,000
2	Dong Anh	184.16	129,000	13,000	116,000
3	Gia Lam	175.79	337,000	19,000	318,000
4	South Hanoi	253.58	700,000	500,000	200,000
	Total	923.79	1,232,000	538,000	694,000

Note: Groundwater Budget = Potential of the groundwater development in future
This figure will be restricted with the conditions of the space for the wellfields.

A. South Hanoi (S.H)

In South Hanoi, the rechargeable groundwater of 700,000 m^3/d, which was proposed in the "Water Master Plan" by FINNIDA in 1993 and has been approved by the State Council of Mineral Reserves, covers the water demand of 670,000 m^3/d in the year 2010.

B. North Hanoi (N.H)

In North Hanoi, the rechargeable groundwater of 532,000 m^3/d have been estimated through the study based on results of the simulation study in S.H and the existing data. Although the rechargeable groundwater of 532,000 m^3/d will meet the water demand of 402,000 m^3/d in the year as a whole, some districts such as Soc Son and Dong Anh will lack the groundwater resources before 2010.

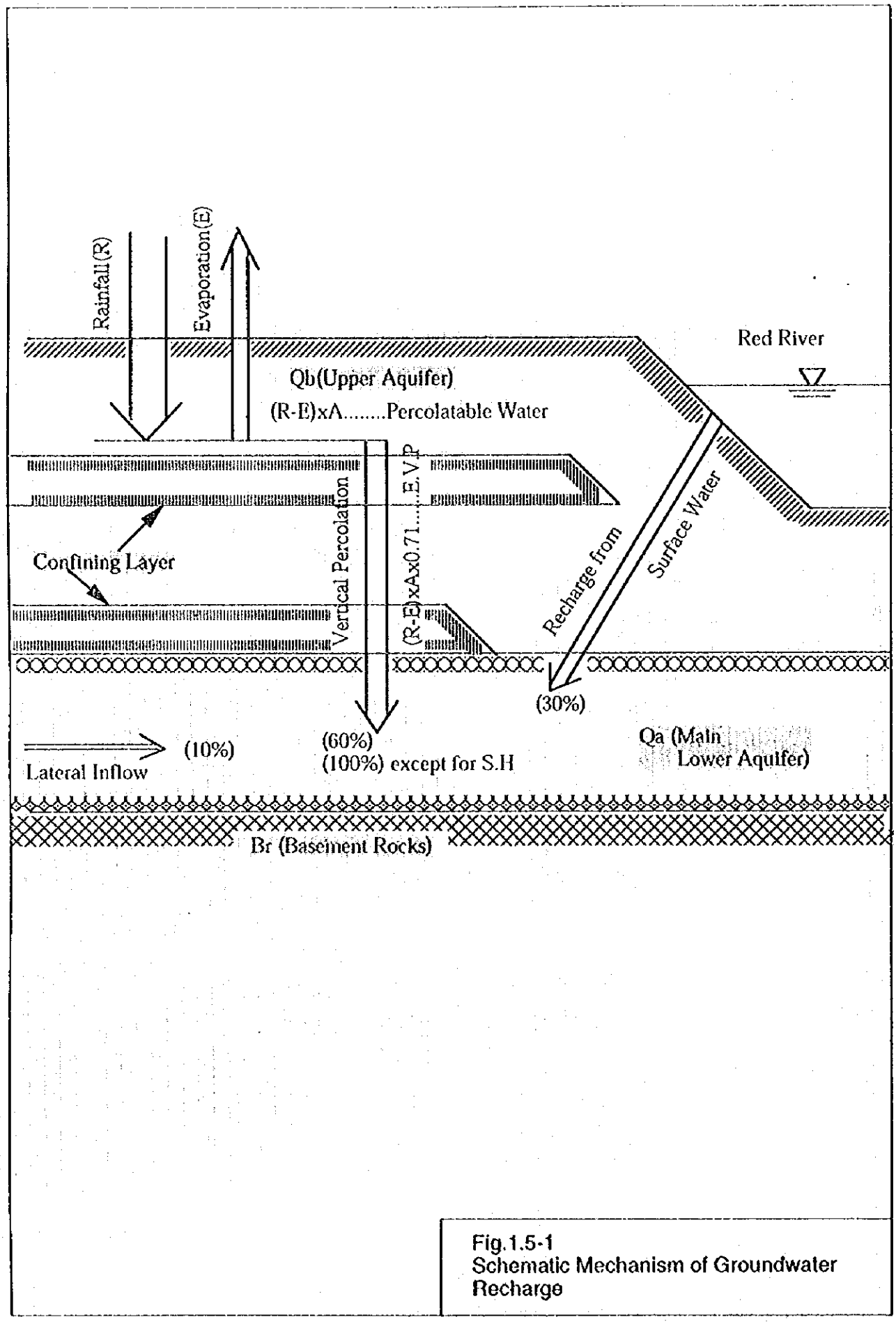


Fig.1.5-1
Schematic Mechanism of Groundwater Recharge

Table 1.5-2 Balance of Groundwater Resources in 2000

(m^3/d)

Area	Budget	T. Demand	P.W.U.	I. Demand	Balance
Soc Son	60,000	36,000	6,000	30,000	30,000
(A)	-	24,000	6,000	18,000	-
(B)	-	12,000	0	12,000	-
Dong Anh	129,000	77,000	13,000	64,000	52,000
(A)	59,000	37,000	13,000	24,000	22,000
(B)	50,000	37,000	0	37,000	13,000
(C)	20,000	3,000	0	3,000	17,000
Gia Lam	337,000	93,000	19,000	74,000	244,000
South Hanoi	700,000	478,000	500,000	-22,000	222,000
Total	1,232,000	684,000	538,000	146,000	548,000

Table 1.5-3 Balance of Groundwater Resources in 2005

(m^3/d)

Area	Budget	T. Demand	P.W.U.	I. Demand	Balance
Soc Son	60,000	61,000	6,000	55,000	5,000
(A)	-	45,000	6,000	39,000	-
(B)	-	16,000	0	16,000	-
Dong Anh	129,000	117,000	13,000	104,000	12,000
(A)	59,000	62,000	13,000	49,000	-3,000
(B)	50,000	51,000	0	51,000	-1,000
(C)	20,000	4,000	0	4,000	16,000
Gia Lam	337,000	130,000	19,000	111,000	207,000
South Hanoi	700,000	569,000	500,000	69,000	131,000
Total	1,232,000	877,000	538,000	339,000	355,000

Table 1.5-4 Balance of Groundwater Resources in 2010

(m^3/d)

Area	Budget	T. Demand	P.W.U.	I. Demand	Balance
Soc Son	60,000	84,000	6,000	78,000	-18,000
(A)	-	62,000	6,000	56,000	-
(B)	-	22,000	0	22,000	-
Dong Anh	129,000	158,000	13,000	145,000	-29,000
(A)	59,000	85,000	13,000	72,000	-26,000
(B)	50,000	68,000	0	68,000	-18,000
(C)	20,000	5,000	0	5,000	15,000
Gia Lam	337,000	160,000	19,000	141,000	177,000
South Hanoi	700,000	670,000	500,000	170,000	30,000
Total	1,232,000	1,072,000	538,000	534,000	160,000

(Note)

Budget : Potential of groundwater development in future

T. Demand : Total Demand including estimated increasing private well intake (128,000 m^3/d)

P.W.U. : Present Water Use

I. Demand : Increased Demand = (T. Demand - P.W.U.)

Balance : (Budget - I. Demand)

To supplement the shortage of available groundwater both in Soc Son and Dong Anh districts, the following two plans are proposed:

Plan A : Groundwater from Gia Lam
Plan B : Intake from the Cau River

Fig.1.5-2 and Table 1.5-5 show the system of the alternative plans and the summary of comparison between them, respectively.

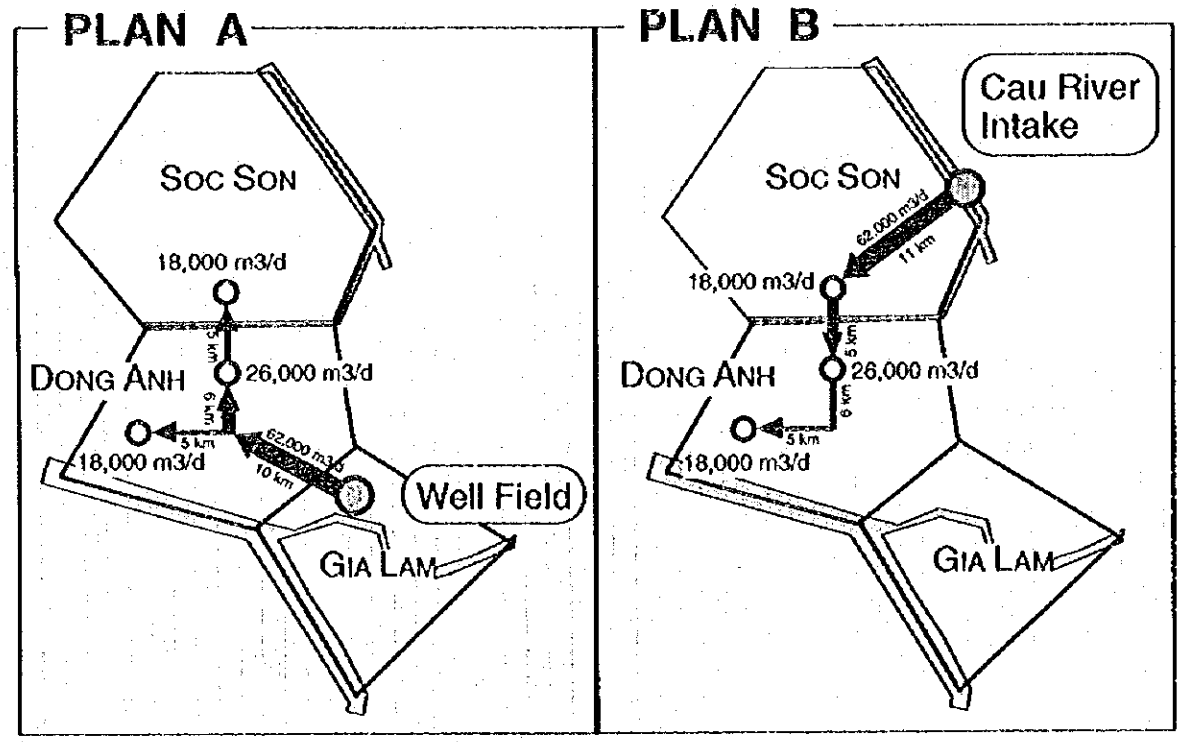


Fig. 1.5-2 The Alternative Plans

Table 1.5-5 Summary of the Comparison

	Plan A	Plan B
Water source	Groundwater (Gia Lam: North of Duong River) enough capacity for the discharge in 2010	Surface Water (Cau River) enough capacity for the discharge but detailed data is necessary.
Water discharge	more than 65,000 m^3/d	more than 65,000 m^3/d (Detailed data is necessary)
Water quality	Iron, manganese and ammonium Low seasonal fluctuation	Prone to be contaminated More subject to seasonal fluctuation
Proposed Treatment Process	Iron, manganese and ammonium removal system (Aeration + Filtration)	Turbidity and other organic matter removal system (Coagulation+Sedimentation +Filtration)
Construction Cost	The construction cost for the transmission main is lower than Plan B. ø900 mm x 10 km ø800 mm x 6 km ø500 mm x 10 km The construction cost for the treatment plant is lower than Plan B.	The construction cost for the transmission main is costly. ø900 mm x 11 km ø800 mm x 5 km ø500 mm x 11 km The construction cost for the treatment plant is costly, because of construction of the sedimentation basin.
Operation and Maintenance Cost	Approx. 800 - 950 VND/ m^3	Approx. 970 VND/ m^3 or more

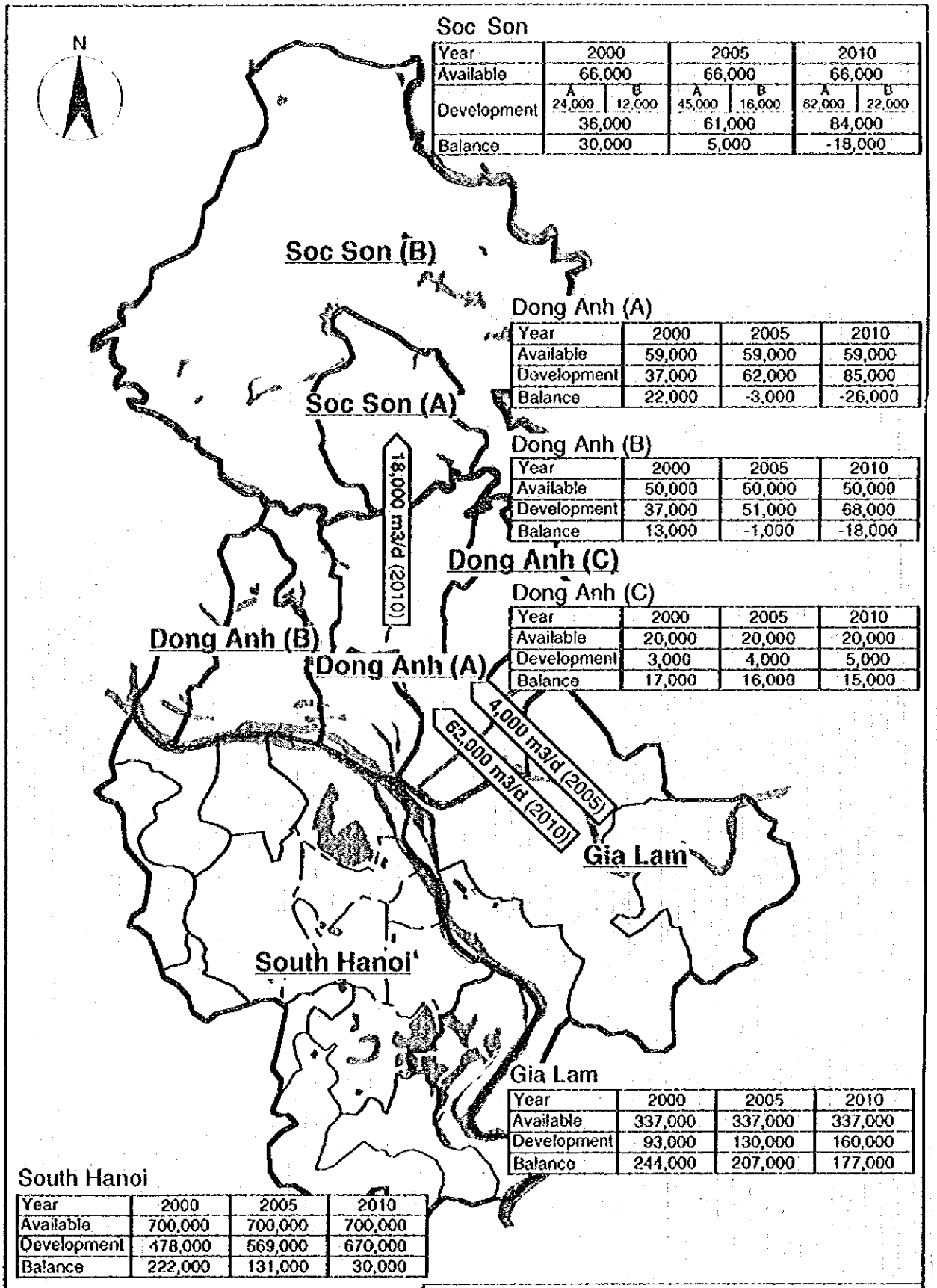
From the above comparison, Plan A is concluded to be more practical. These districts can obtain water from Gia Lam district (See, Fig.1.5-3).

On the other hand, a feasibility study will be required in future on whether the surface water sources are applicable to the water supply system, because the groundwater will become insufficient from 2010.

In the case of surface water use in future, the Cau River water for the both of two districts via Soc Son district could be considered. In this case, however, more detailed data as below for water balance analysis will be necessary to be prepared by the Government of Vietnam.

- Rainfall data at the stations in the catchment area both of the Con River and the Cau River.
- Intake data for the irrigation canals at the Nui Coc dam and Thac Huong weir.
- Flow data of the Cau River in Soc Son district.
- Water quality data, particularly such as toxic matters.
- Other water intake rights data of the Con River and The Cau River in and around Soc Son district.

In order to suggest future water source, the case study on surface water intake has been made for reference, which is presented in ANNEX of the Supporting Report "Case Study on Surface Water Intake".



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	

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

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

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

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

Fig. 1.5-3
Groundwater Balance & Plan of Water Source

1.5.3 Water Quality of Groundwater

Probably higher concentration values are generally used for facilities design. The values for raw water quality were basically estimated referring concentration appearance probability. The values with non-excess probability of 75% were adopted for probably high values of raw water quality. In other words, three fourths of all values do not exceed this probably high value with non-excess probability of 75%. The results are summarized in Table 1.5-6.

Table 1.5-6 Probable High Concentration of Raw Groundwater

Parameter	Unit	South Hanoi		North Hanoi			Criteria for Drinking Water	
		North	South	Soc Son	Dong Anh	Gia Lam	Vietnamese (Urban Area)	WHO Guidelines
pH	-	6.7~8.3	6.8~7.0	6.1~6.8	6.1~6.6	6.6~6.8	6.5~8.5	-
NH_4^+	mg/l	1.8	17.8	0.4	1.9	3.1	3	1.5
NO_3^-	mg/l	1.3	0.4	1.7	2.6	1.0	10	50
Fe^{2+}	mg/l	2.6	10.9	-	-	-	-	-
Fe^{3+}	mg/l	0.2	0.4	-	-	-	-	-
Total Iron	mg/l	2.8	11.3	2.0	7.6	8.0	0.3	0.3
Hardness	mg/l	11	8	125	158	193	500	-
Mn	mg/l	1.0	0.3	0.1	0.2	0.3	0.1	0.5
TS	mg/l	153	-	122	166	303	-	-
SO_4^{2-}	mg/l	80	-	12	111	41	400	250
Phenols	mg/l	0.000	0.000	0.000	0.038	0.007	-	-
As	mg/l	0.00	0.00	0.00	0.00	0.00	0.05	0.01
Zn	mg/l	0.5	0.7	0.4	0.7	0.4	5	3
Cd	mg/l	0.008	0.006	0.005	0.020	0.008	0.005	0.003
Pb	mg/l	0.11	0.12	0.08	0.05	0.14	0.05	0.01
CN	mg/l	0.00	0.00	0.00	0.00	0.00	0.1	0.07
Hg	mg/l	0.000	0.000	0.000	0.000	0.000	0.001	0.001
Cu	mg/l	0.2	-	0.1	0.3	0.0	1	2
Cr	mg/l	0.01(VI)	-	0.00(VI)	0.02(VI)	0.01(VI)	0.05	0.05
F	mg/l	0.7	-	0.4	0.8	0.5	1.5	1.5

1.6 DESIGN CRITERIA

(1) Peak Day Factor

The peak day factor which will be applied to size dimensions of facilities of treatment plants, raw water intakes is to be 1.35 (135%). (1997-2010: Constant 1.35)

(Note 1)
Above factors are to be applied constantly through planning period till the year 2010.

(Note 2)
Supply to industrial estates is to be done on the basis of 24 hours constant supply as bulk water supply method, and peak factors are as follows :

- Peak day factor : 1.10 (110%) for industrial estates (1997 - 2010 : Constant 1.10)
- Peak hour factor : 1.00 (100%) for industrial estates (1997 - 2000 : Constant 1.00)

In the case that factories located in the industrial estates need storage facilities, the storage reservoirs shall be constructed by each factory in the factory yard and by the expense of the factory, in order to receive public water for 24 hours a day at a constant rate.

(2) Peak Hour Factor

The peak hour factor which will be applied to determine diameters of distribution pipelines is to be 1.40 (140%) of the peak day demand. (1997-2010: Constant 1.40).

(3) Volume of Distribution Reservoir

Volume of distribution reservoirs is to be 20% of the daily maximum (4.8 hours equivalent).

(Note)
Water storage for fire fighting :
In the case that the volume of the reservoir is less than 1,000 m3, a volume of 50 m3 or 100 m3 for fire fighting will be added to the reservoir volume.

(4) Water Pressure

The final target of supply pressure in distribution pipelines are to be :

- 30 meters in densely inhabited districts (DID) in order to supply four (4) storied dwellings or buildings and,
- 15 meters in rural areas.

(5) Raw Water Intake Capacity

Taking consideration of loss in the course of treatment, i.e. filter back-wash water and other miscellaneous use in the treatment plants, raw water intake capacity is set to be 105% of the production .