

社会開発調査部報告書

No. 22

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

HANOI PEOPLE'S COMMITTEE  
THE SOCIALIST REPUBLIC OF VIET NAM

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

FINAL REPORT

DATA BOOK

JICA LIBRARY



J1140916161

OCTOBER 1997

PACIFIC CONSULTANTS INTERNATIONAL  
HOKKAIDO ENGINEERING CONSULTANTS CO., LTD.

S S S

JICA

97-112

**JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)**

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

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

**FINAL REPORT**

**DATA BOOK**

**OCTOBER 1997**

**PACIFIC CONSULTANTS INTERNATIONAL  
HOKKAIDO ENGINEERING CONSULTANTS CO., LTD.**



1140916[6]

## **CONTENTS**

### **PART I GENERAL**

#### **APPENDIX (A) PRESENT CONDITIONS**

- A-1 Number of Households
- A-2 Past External Assistance and Past Study on Institutional, Organizational and Managerial Issues
- A-3 Financial Status
- A-4 Population Served (1995)
- A-5 Water Quality
- A-6 Water Leakage Survey Report
- A-7 Water Quality Survey for the Tap Water
- A-8 Hydrogeological Data

### **PART II MASTER PLAN**

#### **APPENDIX (B) FRAMEWORK FOR THE MASTER PLAN**

- B-1 Future Land Use
- B-2 Population Forecast
- B-3 Survey on Water Usage
- B-4 Field Survey on Private Wells
- B-5 Population Served and Domestic Water Demand Forecast by Commune

#### **APPENDIX (C) FORMULATION OF THE MASTER PLAN**

- C-1 Extension Schedule for Urban Water Supply System

## **APPENDIX (D) CASE STUDY ON SURFACE WATER INTAKE**

- D-1 Water Quality of Surface Water
- D-2 Jar Test for Coagulation

## **PART III FEASIBILITY STUDY FOR URBAN WATER SUPPLY SYSTEM**

### **APPENDIX (E) BASIC CONDITIONS OF THE PROJECT**

- E-1 Water Demand Forecast

### **APPENDIX (F) PRELIMINARY DESIGN**

- F-1 Existing Well List
- F-2 Existing Geological Column around the Proposed Wellfield
- F-3 Groundwater Quality in the Priority Project Area
- F-4 Study for the Design of Contact and Sedimentation Tank

## **PART IV DRAWINGS**

### **APPENDIX (G) DRAWINGS PREPARED IN M/P**

- G-1 Existing Distribution Networks

### **APPENDIX (H) DRAWINGS PREPARED IN F/S**

- H-1 General Arrangement
- H-2 Water Source
- H-3 Water Treatment Plant
- H-4 Distribution Networks

I

**PART I**

**GENERAL**

I

## **APPENDIX (A)      PRESENT CONDITIONS**

- A-1    Number of Households**
- A-2    Past External Assistance and Past Study on  
Institutional, Organizational  
and Managerial Issues**
- A-3    Financial Status**
- A-4    Population Served (1995)**
- A-5    Water Quality**
- A-6    Water Leakage Survey Report**
- A-7    Water Quality Survey for the Tap Water**
- A-8    Hydrogeological Data**

**APPENDIX A-1      Number of Households**



## NUMBER OF HOSEHOLD : SUMMARY

District (Quan / Huyen)	Area (ha)	Present (1995)				Average Family Size
		Population	Density (p/ha)	Number of Hosehold		
Tay Ho	1,907.8	80,638	42.3	19,794	4.07	
Ba Dinh	915.8	191,286	208.9	49,970	3.83	
Hoan Kiem	417.2	193,504	463.8	47,573	4.07	
Dong Da	1,484.6	391,686	263.8	102,010	3.84	
Hai Ba Trung	1,108.0	347,289	313.4	83,311	4.17	
<b>Total of Urban Area</b>	<b>5,833.4</b>	<b>1,204,403</b>	<b>206.5</b>	<b>302,658</b>	<b>3.98</b>	
Soc Son	31,466.9	211,186	6.7	42,771	4.94	
Dong Anh	18,920.0	221,229	11.7	51,011	4.34	
Gia Lam	13,810.0	302,566	21.9	70,785	4.27	
Tu Liem	9,125.2	241,848	26.5	55,383	4.37	
Thanh Tri	9,905.7	213,655	21.6	48,480	4.41	
<b>Total of Suburban</b>	<b>83,227.8</b>	<b>1,190,484</b>	<b>14.3</b>	<b>268,430</b>	<b>4.43</b>	
<b>Total of Whole City</b>	<b>89,061.2</b>	<b>2,394,887</b>	<b>26.9</b>	<b>571,088</b>	<b>4.19</b>	

**NUMBER OF HOUSEHOLDS BY COMMUNITY (1995)**

District (Quan)	Community (Phuong)	Area (ha)	Present (1995)			
			Population	Density (p/ha)	Number of Households	Average Family Size
Tay Ho	01 Buoï	106.0	16,612	156.7	3,936	4.22
	02 Thuy Khue	51.5	14,352	278.7	3,858	3.72
	03 Yen Phu	95.5	16,226	169.9	3,854	4.21
	04 Nhat Tan	299.6	5,695	19.0	1,356	4.20
	05 Phu Thuong	609.5	8,524	14.0	2,153	3.96
	06 Quang An	188.2	5,397	28.7	1,258	4.29
	07 Tu Lien	344.0	6,832	19.9	1,522	4.49
	08 Xuan La	213.5	7,000	32.8	1,857	3.77
Total		1,907.8	80,638	42.3	19,794	4.07

Ba Dinh	01 Cau Giay	99.0	18,067	182.5	4,385	4.12
	02 Cong Vi	136.7	22,379	163.7	5,668	3.95
	03 Dien Bien	134.2	12,508	93.2	4,101	3.05
	04 Doi Can	38.0	14,875	391.4	3,567	4.17
	05 Giang Vo	53.5	16,565	309.6	4,441	3.73
	06 Kim Ma	76.0	15,681	206.3	4,344	3.61
	07 Ngoc Ha	99.2	15,869	160.0	4,133	3.84
	08 Phuc Xa	50.0	14,112	282.2	3,564	3.96
	09 Quan Thanh	56.0	12,853	229.5	3,321	3.87
	10 Thanh Cong	63.6	18,966	298.2	4,978	3.81
	11 Truc Bach	38.7	14,138	365.3	3,730	3.79
	12 Trung Truc	18.9	11,545	610.8	2,775	4.16
		*Military area	39.0	3,728	95.6	966
	*Ho Chi Minh sq	13.0	0	0.0	0	0.00
Total		915.8	191,286	208.9	49,970	3.83

Hoan Kiem	01 Chuong Duoc	30.0	14,151	471.7	3,306	4.28
	02 Cua Dong	13.5	10,706	793.0	2,406	4.45
	03 Cua Nam	34.2	14,150	413.7	3,638	3.89
	04 Dong Xuan	12.6	13,607	1,079.9	3,247	4.19
	05 Hang Bac	22.0	8,844	402.0	2,162	4.09
	06 Hang Bai	29.4	10,474	356.3	2,686	3.90
	07 Hang Bo	7.5	10,564	1,408.5	2,709	3.90
	08 Hang Bong	14.8	9,368	633.0	2,330	4.02
	09 Hang Buom	13.2	12,773	967.7	3,309	3.86
	10 Hang Dao	8.0	8,590	1,073.8	2,126	4.04
	11 Hang Gai	12.0	11,761	980.1	2,800	4.20
	12 Hang Ma	21.7	9,832	453.1	2,375	4.14
	13 Hang Trong	37.6	9,628	256.1	2,389	4.03
	14 Ly Thai To	27.8	9,346	336.2	2,296	4.07
	15 Phan Chu Trinh	53.5	9,229	172.5	2,391	3.86
	16 Phuc Tan	36.0	10,971	304.8	2,234	4.91
	17 Tran Hung Dao	36.0	12,005	333.5	3,253	3.69
	18 Trang Tien	7.4	7,505	1,014.2	1,915	3.92
Total		417.2	193,504	463.8	47,573	4.07

Dong Da	01	Cat Linh	46.2	15,444	334.3	3,880	3.98
	02	Hang Bot	27.8	16,255	584.7	4,014	4.05
	03	Kham Thien	16.0	10,836	677.3	2,689	4.03
	04	Khuong Thuong	35.1	11,996	341.8	2,999	4.00
	05	Kim Giang	44.0	8,357	189.9	2,094	3.99
	06	Kim Lien	33.9	13,454	396.9	3,676	3.65
	07	Lang Ha	80.7	14,493	179.6	3,865	3.75
	08	Lang Thuan	123.0	13,879	111.2	3,361	4.07
	09	Nam Dong	40.2	16,239	404.0	4,153	3.91
	10	Nguyen Tra	42.5	28,389	668.0	7,151	3.97
	11	O Cho Dua	84.5	20,133	238.3	8,319	2.42
	12	Phuong Liet	65.0	13,354	205.4	3,364	3.97
	13	Phuong Lien	34.3	13,473	392.8	3,278	4.11
	14	Phuong Mai	43.9	13,904	316.7	3,669	3.79
	15	Quang Trun	50.2	9,812	195.5	2,298	4.27
	16	Quoc Tu Giam	22.7	8,917	392.8	2,202	4.05
	17	Thanh Xuan Bac	146.0	10,854	74.3	2,667	4.07
	18	Thanh Xuan Nam	72.0	28,858	400.8	7,306	3.95
	19	Thinh Quang	38.3	15,856	414.0	3,954	4.01
	20	Tho Quan	24.2	14,568	602.0	3,633	4.01
	21	Thuong Dinh	35.8	11,920	333.0	2,973	4.01
	22	Trung Liet	91.1	14,870	163.2	3,755	3.96
	23	Trung Phung	24.1	13,113	544.1	3,230	4.06
	24	Trung Tu	74.3	14,069	189.4	3,792	3.71
	25	Van Chuong	43.0	15,427	358.8	3,754	4.11
	26	Van Mieu	23.0	13,095	569.3	3,282	3.99
		*Bach Mai Airbase	122.8	10,321	84.0	2,653	3.89
		Total	1,484.6	391,686	263.8	102,010	3.84

Hai Ba Trung	01	Bach Dang	54.4	16,665	306.3	3,912	4.26
	02	Bach Khoa	29.0	11,592	399.7	2,264	5.12
	03	Bach Mai	29.5	16,576	561.9	3,864	4.29
	04	Bui Thi Xu	16.5	11,682	708.0	2,913	4.01
	05	Cau Den	24.0	12,512	521.3	3,105	4.03
	06	Dong Mac	17.0	9,570	562.9	2,300	4.16
	07	Dong Nhan	21.7	11,416	526.1	2,725	4.19
	08	Dong Tam	18.8	14,446	768.4	2,985	4.84
	09	Giap Bat	64.5	10,604	164.4	2,580	4.11
	10	Hoang Van Thu	60.0	8,675	144.6	2,075	4.18
	11	Le Dai Han	83.6	15,365	183.8	4,415	3.48
	12	Mai Dong	82.5	12,428	150.6	2,857	4.35
	13	Minh Khai	51.0	14,492	284.2	3,543	4.09
	14	Ngo Thi Nh	18.1	12,837	709.2	3,217	3.99
	15	Nguyen Du	29.3	11,019	376.1	2,931	3.76
	16	Pham Dinh Ho	23.5	10,158	432.3	2,559	3.97
	17	Pho Hue	20.1	15,461	769.2	3,975	3.89
	18	Quynh Loi	29.0	12,375	426.7	2,912	4.25
	19	Quynh Mai	37.6	13,088	348.1	3,192	4.10
	20	Tan Mai	63.7	17,704	277.9	4,079	4.34
	21	Thanh Luong	91.2	14,815	162.4	3,461	4.28
	22	Thanh Nhan	58.5	18,554	317.2	4,525	4.10
	23	Truong Dinh	30.0	17,145	571.5	3,960	4.33
	24	Tuong Mai	45.5	17,793	391.1	4,236	4.20
	25	Vinh Tuy(h	109.0	20,317	166.4	4,725	4.30
		Total	1,108.0	347,289	313.4	83,311	4.17
		Total of Urban Area	5,833.4	1,204,403	206.5	302,658	3.98

District (Huyen)	Community (Xa)	Area (ha)	Population	Density (p/ha)	Number of Households	Average Family Size
Soc Son	01 Bac Phu	998.1	7,671	7.7	1,467	5.23
	02 Bac Son	3,630.6	10,844	3.0	1,923	5.64
	03 Dong Xuan	648.2	8,642	13.4	1,786	4.84
	04 Duc Hoa	716.2	6,106	8.5	1,137	5.37
	05 Hien Ninh	897.1	8,114	9.0	1,483	5.47
	06 Hong Ky	1,800.0	8,199	4.6	1,663	4.93
	07 Kim Lu	470.9	6,875	14.6	1,335	5.15
	08 Mai Dinh	1,375.0	12,430	9.0	2,432	5.11
	09 Minh Phu	2,181.0	8,376	3.8	3,149	2.66
	10 Minh Tri	2,435.1	10,149	4.2	2,428	4.18
	11 Nam Son	2,900.0	6,679	2.3	1,275	5.24
	12 Phu Cuong	901.7	7,423	8.2	1,583	4.69
	13 Phu Linh	1,496.0	6,706	4.5	1,355	4.95
	14 Phu Lo	595.8	10,657	18.2	1,891	5.74
	15 Phu Minh(s)	743.8	6,948	9.3	1,289	5.39
	16 Quang Tien	1,469.7	6,066	4.1	994	6.10
	17 Soc Son To	60.0	2,497	31.2	626	3.99
	18 Tan Dan	998.1	8,801	8.8	1,531	5.75
	19 Tan Hung	899.9	8,230	9.1	1,488	5.53
	20 Tan Minh	1,072.4	10,381	9.7	1,933	5.37
	21 Thanh Xuan	726.6	9,173	12.6	2,210	4.15
	22 Tien Duc	1,426.2	9,751	6.8	1,829	5.33
	23 Trung Gia	833.3	9,861	11.8	1,813	5.44
	24 Viet Long	695.4	6,055	8.7	1,340	4.52
	25 Xuan Giang	835.5	7,270	8.7	1,374	5.29
	26 Xuan Thu	641.3	7,082	11.0	1,437	4.93
Total of Rural Area		27,342.7	167,009	6.1	34,206	4.88
Total of DID		4,124.2	44,177	10.7	8,565	5.16
Total		31,466.9	211,186	6.7	42,771	4.94

Dong Anh	01 Bac Hong	710.0	9,294	13.1	2,141	4.34
	02 Co Loa	830.0	12,835	15.5	2,971	4.32
	03 Dai Mach	920.0	7,457	8.1	1,628	4.58
	04 Dong Anh T	590.0	20,855	35.3	5,201	4.01
	05 Dong Hoi	720.0	8,065	11.2	1,821	4.43
	06 Duc Tu	840.0	12,089	14.4	2,741	4.41
	07 Hai Boi	800.0	9,874	12.3	2,165	4.56
	08 Kim Chung	590.0	6,873	10.0	1,617	4.25
	09 Kim No	650.0	8,078	12.4	1,676	4.82
	10 Lien Ha	870.0	11,711	13.5	2,445	4.79
	11 Mai Lam	570.0	8,134	14.3	2,113	3.85
	12 Nam Hong	840.0	8,830	10.5	2,092	4.22
	13 Nguyen Khe	940.0	9,550	10.2	2,185	4.37
	14 Tam Xa	510.0	3,580	7.0	780	4.59
	15 Thuy Lam	1,000.0	13,480	13.5	3,064	4.40
	16 Tien Duong	1,070.0	1,412	1.3	324	4.36
	17 Uy No	960.0	10,807	11.3	2,507	4.31
	18 Van Ha	540.0	6,979	12.9	1,638	4.26
	19 Van Noi	640.0	7,977	12.5	1,908	4.18
	20 Viet Hung	830.0	11,565	13.9	2,646	4.37
	21 Vinh Ngoc	960.0	8,915	9.3	1,999	4.46
	22 Vong La	730.0	5,226	7.2	1,253	4.17
	23 Xuan Canh	610.0	8,232	13.5	1,910	4.31
	24 Xuan Non	1,100.0	9,411	8.6	2,184	4.31
Total of Rural Area		7,590.0	89,190	11.8	22,252	4.01
Total of DID		11,330.0	132,039	11.7	28,758	4.59
Total		18,920.0	221,229	11.7	51,011	4.34

Gia Lam	01	Bat Trang	180.0	5,425	30.1	1,121	4.84
	02	Bo Do	310.0	5,597	18.1	1,089	5.14
	03	Co Bi	430.0	7,074	16.5	1,777	3.93
	04	Cu Khoi	360.0	4,948	13.7	1,135	4.36
	05	Da Ton	360.0	8,917	24.8	2,103	4.24
	06	Dang Xa	570.0	7,163	12.6	1,681	4.26
	07	Dinh Xuyen	240.0	6,684	27.9	1,475	4.53
	08	Dong Du	300.0	3,436	11.5	865	3.97
	09	Duc Giang T	210.0	21,056	100.3	4,690	4.49
	10	Duong Ha	250.0	4,389	17.6	1,314	3.34
	11	Duong Quang	500.0	8,389	16.8	1,852	4.53
	12	Duong Xa	350.0	7,434	21.2	2,555	2.91
	13	Gia Lam T	240.0	27,385	114.1	6,267	4.37
	14	Gia Thuy	280.0	6,468	23.1	1,494	4.33
	15	Giang Bien	340.0	4,260	12.5	1,090	3.91
	16	Hoi Xa	560.0	7,289	13.0	1,893	3.85
	17	Kieu Ky	340.0	7,668	22.6	1,751	4.38
	18	Kim Lan	260.0	4,309	16.6	943	4.57
	19	Kim Son	560.0	9,293	16.6	2,181	4.26
	20	Le Chi	870.0	8,498	9.8	1,851	4.59
	21	Long Bien	530.0	7,289	13.8	1,645	4.43
	22	Ngoc Thuy	250.0	12,851	51.4	3,104	4.14
	23	Ninh Hiap	490.0	11,635	23.7	2,233	5.21
	24	Phu Dong	1,090.0	10,126	9.3	2,458	4.12
	25	Phu Thi	440.0	5,773	13.1	1,394	4.14
	26	Sai Dong T	90.0	9,926	110.3	2,358	4.21
	27	Thach Ban	460.0	9,278	20.2	2,252	4.12
	28	Thuong Thanh	360.0	8,424	23.4	1,982	4.25
	29	Trau Quy	350.0	10,027	28.6	2,513	3.99
	30	Trung Mau	370.0	4,323	11.7	1,017	4.25
	31	Van Duc	460.0	5,908	12.8	1,310	4.51
	32	Viet Hung	390.0	12,056	30.9	2,791	4.32
	33	Yen Thuong	670.0	10,083	15.0	2,378	4.24
	34	Yen Vien	280.0	8,302	31.9	1,841	4.51
	35	Yen Vien T	90.0	10,885	120.9	2,382	4.57
Total of Rural Area			6,800.0	90,475	13.3	29,185	3.10
Total of DID			7,010.0	212,091	30.3	41,600	5.10
Total			13,810.0	302,566	21.9	70,785	4.27

Tu Liem	01	Cau Dien T	320.0	15,910	49.7	3,928	4.05
	02	Cau Giay T	91.4	13,129	139.1	2,879	4.56
	03	Co Nhue	570.0	12,437	21.8	2,770	4.49
	04	Dai Mo	470.0	10,717	22.8	2,219	4.83
	05	Dich Vong	319.1	8,340	23.9	2,075	4.02
	06	Dong Ngac	356.4	17,982	49.1	4,323	4.16
	07	Lien Mac	620.0	5,862	9.5	1,294	4.53
	08	Mai Dich	187.9	13,493	71.8	3,291	4.10
	09	Me Tri	706.6	12,645	17.9	2,544	4.97
	10	My Dinh	450.6	7,357	16.0	1,799	4.09
	11	Nghia Do T	180.0	11,744	65.2	2,844	4.13
	12	Nghia Tan T	53.6	14,948	278.9	3,923	3.81
	13	Nhan Chinh	254.3	8,865	34.9	2,393	3.80
	14	Phu Minh T	910.0	15,453	17.0	2,642	5.85
	15	Phu Thuong	0.0	0	0.0	0	0.00
	16	Tay Mo	580.0	8,951	15.4	1,892	4.73
	17	Tay Tuu	530.0	10,866	20.5	2,173	5.00
	18	Thuong Cat	380.0	5,216	13.7	1,260	4.14
	19	Thuy Phuong	250.0	5,945	23.8	1,318	4.51
	20	Trung Hoa	243.1	5,977	24.6	1,334	4.48
	21	Trung Van	289.2	7,823	27.1	1,841	4.25
	22	Xuan Dinh	560.0	11,369	20.3	2,388	4.76
	23	Xuan Phuon	550.0	8,918	16.2	2,093	4.26
	24	Yen Hoa	200.0	7,901	39.5	2,219	3.56
Total of Rural Area			1,660.0	28,735	17.3	4,267	6.73
Total of DiD			7,455.2	213,113	28.5	51,116	4.17
Total			9,125.2	241,848	26.5	55,383	4.37

Thanh Tri	01	Dai Ang	490.0	6,599	19.5	1,646	4.01
	02	Dai Kim	250.4	6,065	24.2	1,385	4.38
	03	Dinh Cong	239.4	6,400	26.7	1,379	4.64
	04	Dong My	250.0	5,008	20.0	1,237	4.05
	05	Duyen Ha	340.0	4,249	12.5	972	4.37
	06	Hoang Liet	467.2	8,370	17.9	2,007	4.17
	07	Huu Hoa	300.0	6,533	21.8	1,344	4.86
	08	Khuong Dinh	240.4	7,201	30.0	1,470	4.90
	09	Lien Minh	420.0	6,490	15.5	1,926	3.37
	10	Linh Nam	552.1	10,552	19.1	2,477	4.26
	11	Ngoc Hoi	330.0	6,408	19.4	1,310	4.89
	12	Ngũ Hiep	360.0	7,859	21.8	1,823	4.31
	13	Ta Thanh O	740.0	11,705	15.8	2,180	5.37
	14	Tam Hiep	313.2	8,707	25.4	1,931	4.51
	15	Tan Trieu	313.2	9,992	31.9	1,822	5.48
	16	Thanh Liet	334.2	8,264	18.7	1,657	3.78
	17	Thanh Tri	260.4	7,918	30.4	1,787	4.43
	18	Thinh Liet	301.8	9,047	30.0	2,051	4.41
	19	Trap Phu	357.9	4,764	13.3	1,145	4.16
	20	Tu Hiep	467.2	8,203	17.6	1,930	4.25
	21	Van Dien T	68.6	9,861	143.7	2,262	4.36
	22	Van Phuc	570.0	8,516	14.9	1,707	4.99
	23	Vinh Quynh	520.0	14,650	28.2	3,213	4.56
	24	Vinh Tuy (I)	180.6	20,317	112.5	4,837	4.20
	25	Yen My	498.4	3,948	7.9	1,012	3.90
	26	Yen So	710.7	8,039	11.3	1,970	4.08
Total of Rural Area			5,603.7	85,452	15.2	17,269	4.95
Total of DiD			4,302.0	123,203	29.8	31,212	4.11
Total			9,905.7	213,655	21.6	48,480	4.41

Total of Rural Area in Suburban	48,996.4	460,861	9.4	107,179	4.30
Total of DiD in Suburban	34,231.4	729,623	21.3	161,251	4.52
Total of Whole Suburban	83,227.8	1,190,484	14.3	268,430	4.43

Total of Rural Area in Hanoi City	48,996.4	460,861	9.4	107,179	4.30
Total of DiD in Hanoi City	40,064.8	1,934,026	48.3	463,909	4.17
Total of Whole Hanoi City	89,061.2	2,394,887	26.9	571,088	4.19

**APPENDIX A-2**

**Past External Assistance and Past Study on  
Institutional, Organizational  
and Managerial Issues**



## **Past external Assistance and Past study on Institutional, Organizational and Managerial issues till 1995 in the Water Supply Sector of Vietnam**

Prior to the lifting of US embargo, FINNIDA was the first bilateral donor to establish a funding program in water supply and sanitation in 1986, and has focused much of its resources since that time on the rehabilitation and upgrading of Hanoi and Hai Phong water supply systems. The projects in these centers have included the preparation of master plan as well as implementation and institutional strengthening. FINNIDA also involved in the National Urban Water Supply Strategy Study, which included a feasibility report for HCMC which sets out concisely the details of external assistance to the Water Supply and Sanitation Sector, as it was known at that time.

It explains that assistance has very limited due to the aid constraints which have affected Vietnam until very recently, with external support estimated at around US\$ 160 million during the period 1985 to 1992. Around 52% of this amount was provided by FINNIDA and some 30% by the Government of Italy for Saigon River Project. The remainder being provided by UNDP and UNICEF in the rural sector, and to a lesser extent by the Government of France and CIDA in the urban sector. The UNDP also funded the world bank executive National Water Supply Sector Study in 1989/89. The USSR has also reported water projects through the provision of equipment on a grant aid basis.

Activity on water supply development projects has been very high during the past year. Essentially, the key agencies currently involved in the external assistance are as follows:

### **(1) Asian Development Bank (ADB)**

Loan negotiation has been concluded for a rehabilitation and upgrading of water supply and sanitation systems project for HCMC. Implementation commenced in December 1995. Piggy-backed to this project, the ADB is funding six other technical assistance covering the institutional strengthening of Ho Chi Minh Water Supply Company, a national tariff study, a master plan for Ho Chi Minh City (HCMC), an environmental improvement study also in HCMC, and an Urban Sector Strategy. The technical assistance for the Second Provincial Towns Water

Supply and Sanitation Project is currently being undertaken and was appraised in early 1996. Loan negotiation for the first Provincial Town and Sanitation Project have been concluded and implementation commenced.

(2) Australian Agency for International Development (AustAID)

Project implementation for water supply schemes in the towns of Bac Giang, Ha Tinh, Tri Vinh, and Bac Ninh commenced in 1995 (US\$ 40 million approximately). Consideration is presently being given by AusAID to include Vin Long (US\$ 7 million). AusAID is currently funding on behalf of the world bank technical assistance for the preparation of a feasibility study for Da Nang. They have also provided funding for a world bank executed institutional strengthening program aimed at the development of policy guidelines, and the establishment of a Project Management Unit within the Management Board Water Supply and Sanitation Development Projects (MOC) in Hanoi.

(3) Danish International Development Agency (DANIDA)

Currently preparing project designs for the town of Da Lat, Hon Gai, Cam Pha, and also Buon Ma Thuot (US\$ 10 million). They are currently completing an immediate improvements program of work for the town of Buon Ma Thout in the south, and are about to undertake a National Rural water supply Strategy through the National Center for Rural Planning and Development (MOC).

(4) Finnish International Development Agency (FINNIDA)

FINNIDA is basically concentrating on the finalization of project designs for upgrading Hanoi and Hai Phong water supplies, the implementation of which is expected to be funded by the world bank. They are also providing institutional support to the Hanoi water Business Company, however this support is expected to phased out by the year 2000. FINNIDA have also recently completed the National Urban Water supply Strategy, and is implementing the National Urban Sanitation Strategy.

(5) France

France is currently considering the rehabilitation and upgrading of water supplies in Nam Dinh, Hue, Da Nang, and is conducting training courses for key people in France and in HCMC. They are also scheduled to undertake project preparation activities for the towns of Can Tho, Lao Cai, and Hoa Binh. A French consortium has recently signed a concession to manage and rehabilitate a section of Hanoi's distribution system as stated later.

(6) Germany

Germany has recently identified the town of Vicchy for feasibility and project preparation. Approximately US\$24 million has been provided for this project.

(7) Italy

Italy is currently involved in the implementation of an efficient pumping station in Hanoi. They are considering investing in a pipe and meter manufacturing factory in HCMC.

(8) Japan

Japan have recently started a program for the rehabilitation and upgrading of water supplies. Japan have also completed a master plan for Hanoi sewerage and also considering funding implementation of the project. They are also involved in upgrading water supply services in the Direct of Gia Lam, Hanoi.

(9) The World Bank

The bank undertakes some project implementation work in Hanoi and Haiphong, on both water supply and solid waste. Similarly, they will undertake project implementation in Da Nang and Hon Gia/Cam Pha, building on the work of AusAUD and DANIDA, respectively. The world bank has executed a technical assistance to strengthen the sector organization at the central level. This is due to completion at the end of 1995.

**APPENDIX A-3      Financial Statements of HWBC**

**(a) Income Statements**

**(b) Balance Sheets**

## Financial Statements of HWBC

### Income Statements

(Unit: Million VND)

	1991	1992	1993	1994	1995
A Gross Sales of Water	19,330	32,337	40,441	47,719	59,763
B Wastewater Surcharge	2,735	3,039	4,000	4,781	5,977
C Net Water Revenues (A-B)	16,595	29,338	36,441	42,938	53,786
D Net Connections	1,098	1,169	2,538	4,487	5,189
E Total Revenues (C+D)	17,693	30,507	33,903	47,425	58,975
F Cost of Staff	1,018	1,364	2,294	2,220	3,102
G Materials	292	642	699	653	626
H Electricity	9,445	14,793	20,520	22,990	26,667
I Administration Cost	2,083	3,863	4,083	4,935	5,513
J Other Cost	2,897	3,515	4,481	5,653	10,522
K Total O&M costs	15,735	24,177	32,077	36,451	46,430
L Operating Margin	1,958	6,330	1,826	10,974	12,545
M Depreciation	1,062	2,620	N.A	4,000	4,000
N Interest Cost	N.A	N.A	N.A	N.A	N.A
O Taxes	1,201	1,408	N.A	1,860	1,981
P Net Operating Profit	-1,403	1,133	453	627	1,375

(Source: HWBC Finance Dept.)

## Balance Sheets

**HWBC - 1991**

(Unit: VND)

Assets		Liabilities and Equity	
<b>Current Assets</b>	<b>6,100,432,122</b>	<b>Liabilities</b>	<b>4,697,043,068</b>
Cash	1,857,734	Due to the State	1,203,553,908
Deposits	648,294,718	Short-Term Bank Debt	700,000,000
Account Receivable	2,198,888,341	Long-Term Bank Debt	
Inventories	3,251,391,329	Account Payable	2,793,489,160
<b>Fixed Assets</b>	<b>46,035,099,027</b>	<b>Equity</b>	<b>28,648,948,403</b>
Land		Capital	27,757,260,260
Buildings		Revaluation	
Networks		Retained Profits	443,363,022
Machinery & Equipment		Profit of the Year	448,325,124
(Accumulated Depreciations)	-18,789,539,675	Capital for Basic Constructions	
<b>Total Assets</b>	<b>33,345,991,474</b>	<b>Total Liabilities &amp; Equity</b>	<b>33,345,991,472</b>

## Balance Sheets

HWBC - 1992

(Unit: VND)

Assets		Liabilities and Equity	
<b>Current Assets</b>	<b>8,719,644,370</b>	<b>Liabilities</b>	<b>2,068,855,374</b>
Cash	129,531,458	Due to the State	712,261,803
Deposits	764,250,926	Short-Term Bank Debt	
Account Receivable	3,743,177,384	Long-Term Bank Debt	
Inventories	4,082,684,602	Account Payable	1,356,593,571
<b>Fixed Assets</b>	<b>62,051,594,424</b>	<b>Equity</b>	<b>41,614,981,678</b>
Land		Capital	35,928,616,650
Buildings		Revaluation	
Networks		Retained Profits	558,145,156
Machinery & Equipment		Profit of the Year	1,200,868,414
		Capital for Basic Constructions	3,927,351,458
<b>(Accumulated Depreciations)</b>	<b>-27,087,401,744</b>		
<b>Total Assets</b>	<b>43,683,837,052</b>	<b>Total Liabilities &amp; Equity</b>	<b>43,683,837,052</b>

## Balance Sheets

**HWBC - 1993**

(Unit: VND)

Assets		Liabilities and Equity	
<b>Current Assets</b>	<b>16,698,555,529</b>	<b>Liabilities</b>	<b>10,983,910,857</b>
Cash	24,008,423	Due to the State	1,829,630,042
Deposits	586,855,500	Short-Term Bank Debt	2,900,000,000
Account Receivable	6,618,182,935	Long-Term Bank Debt	
Inventories	9,469,508,671	Account Payable	6,254,280,815
<b>Fixed Assets</b>	<b>62,612,563,760</b>	<b>Equity</b>	<b>38,898,597,842</b>
Land		Capital	34,152,476,887
Buildings		Revaluation	
Networks		Retained Profits	1,190,311,922
Machinery & Equipment		Profit of the Year	627,561,955
(Accumulated Depreciations)	-29,428,610,591	Capital for Basic Constructions	2,928,247,078
<b>Total Assets</b>	<b>49,882,508,698</b>	<b>Total Liabilities &amp; Equity</b>	<b>49,882,508,698</b>



## Balance Sheets

**HWBC - 1994**

(Unit: VND)

Assets		Liabilities and Equity	
<b>Current Assets</b>	<b>20,380,647,508</b>	<b>Liabilities</b>	<b>13,019,295,614</b>
Cash	818,145,489	Due to the State	2,898,423,924
Deposits	1,250,823,149	Short-Term Bank Debt	2,000,000,000
Account Receivable	5,193,942,683	Long-Term Bank Debt	
Inventories	13,117,736,187	Account Payable	8,120,871,690
<b>Fixed Assets</b>	<b>63,432,745,464</b>	<b>Equity</b>	<b>35,215,517,334</b>
Land		Capital	31,428,349,608
Buildings		Revaluation	
Networks		Retained Profits	120,538,146
Machinery & Equipment		Profit of the Year	896,833,087
(Accumulated Depreciations)	-33,509,611,286	Capital for Basic Constructions	2,769,796,493
<b>Total Assets</b>	<b>48,234,812,948</b>	<b>Total Liabilities &amp; Equity</b>	<b>48,234,812,948</b>

## Balance Sheets

HWBC - 1995

(Unit: VND)

Assets		Liabilities and Equity	
<b>Current Assets</b>		<b>Liabilities</b>	
Cash		Due to the State	
Deposits		Short-Term Bank Debt	
Account Receivable		Long-Term Bank Debt	
Inventories		Account Payable	
<b>Fixed Assets</b>	<b>62,719,441,000</b>	<b>Equity</b>	
Land		Capital	
Buildings		Revaluation	
Networks		Retained Profits	
Machinery & Equipment		Profit of the Year	
<b>(Accumulated Depreciations)</b>	<b>-37,004,144,000</b>	Capital for Basic Constructions	
<b>Total Assets</b>		<b>Total Liabilities &amp; Equity</b>	

**APPENDIX A-4      Population Served (1995)**

Table PRESENT (Year 1995) WATER SERVICE POPULATION (Capacity)

(1/10)

District: TAY HO		Year 1995									
No.	Community Name	Total Population	Piped Water Supply System				Rate of Service (%)			Hand Pump System	
			Service Population		Sub-total	Rate for Sub-total	Capacity (persons/pump)	Rate of Service (%)	Service Population		
			HWBC	Others						estimated Rate for HWBC's Service	
1	Buoi	16,612	14,458	0	14,458	87.0	87.0	0	0.0		
2	Thuy Khue	14,352	14,352	0	14,352	100.0	100.0	0	0.0		
3	Yen Phu	16,226	16,226	0	16,226	100.0	100.0	0	0.0		
4	Nhat Tan	5,695	0	0	0	0.0	0.0	2,040	35.8		
5	Phu Thuong	8,524	0	0	0	0.0	0.0	9,000	105.6		
6	Quang An	5,397	1,815	0	1,815	33.6	33.6	2,160	40.0		
7	Tu Lien	6,832	5,997	0	5,997	87.8	87.8	2,400	35.1		
8	Xuan La	7,000	0	0	0	0.0	0.0	14,280	204.0		
	Total	80,638	52,848	0	52,848	65.5	65.5	29,880	37.1		

Note: Though Phu Thuong belonged to the administrative area of Tu Liem District in the urban development plan of 1992, it has been incorporated into Tay Ho District since 1995.

Table PRESENT (Year 1995) WATER SERVICE POPULATION (Capacity)

(2/10)

No.	Community Name	Total Population	Year 1995									
			Piped Water Supply System					Hand Pump System				
			Service Population		Rate of Service (%)		Rate for Sub-total	Service Population		Rate of Service (%)		Rate of Service (%)
			HWBC	Others	Sub-total	estimated Rate for HWBC's Service		Capacity (120-persons/pump)	Rate of Service (%)			
1	Cau Giay	18,067	18,067	0	18,067	100.0	100.0	0	0.0	0.0		
2	Cong Vi	22,379	22,379	0	22,379	100.0	100.0	0	0.0	0.0		
3	Dien Bien	12,508	12,508	0	12,508	100.0	100.0	0	0.0	0.0		
4	Doi Can	14,875	14,875	0	14,875	100.0	100.0	0	0.0	0.0		
5	Giang Vo	16,565	16,565	0	16,565	100.0	100.0	0	0.0	0.0		
6	Kim Ma	15,681	15,681	0	15,681	100.0	100.0	0	0.0	0.0		
7	Ngoc Ha	15,869	15,869	0	15,869	100.0	100.0	0	0.0	0.0		
8	Phuc Xa	14,112	14,112	0	14,112	100.0	100.0	0	0.0	0.0		
9	Quan Thanh	12,853	12,853	0	12,853	100.0	100.0	0	0.0	0.0		
10	Thanh Cong	18,966	18,966	0	18,966	100.0	100.0	0	0.0	0.0		
11	Truc Bach	14,138	14,138	0	14,138	100.0	100.0	0	0.0	0.0		
12	Trung Truc	11,545	11,545	0	11,545	100.0	100.0	0	0.0	0.0		
13	Military Area	3,728	0	3,728	3,728	0.0	100.0	0	0.0	0.0		
	Total	191,286	187,558	3,728	191,286	98.1	100.0	0	0.0	0.0		

Table PRESENT (Year 1995) WATER SERVICE POPULATION (Capacity)

(3/10)

No.	Community Name	Total Population	Year 1995									
			Piped Water Supply System					Hand Pump System				
			Service Population		Rate of Service (%)		Rate for Sub-total	Service Population		Rate of Service (%)		Rate of Service (%)
			HWBC	Others	Sub-total	estimated Rate for HWBC's Service		Capacity	Others	Sub-total	Capacity (120persons/pump)	
1	Chuong Duo	14,151	14,151	0	14,151	100.0	100.0	100.0	0	0	0.0	
2	Cua Dong	10,706	10,706	0	10,706	100.0	100.0	100.0	0	0	0.0	
3	Cua Nam	14,150	14,150	0	14,150	100.0	100.0	100.0	0	0	0.0	
4	Dong Xuan	13,607	13,607	0	13,607	100.0	100.0	100.0	0	0	0.0	
5	Hang Bac	8,844	8,844	0	8,844	100.0	100.0	100.0	0	0	0.0	
6	Hang Bai	10,474	10,474	0	10,474	100.0	100.0	100.0	0	0	0.0	
7	Hang Bo	10,564	10,564	0	10,564	100.0	100.0	100.0	0	0	0.0	
8	Hang Bong	9,368	9,368	0	9,368	100.0	100.0	100.0	0	0	0.0	
9	Hang Buom	12,773	12,773	0	12,773	100.0	100.0	100.0	0	0	0.0	
10	Hang Dao	8,590	8,590	0	8,590	100.0	100.0	100.0	0	0	0.0	
11	Hang Gai	11,761	11,761	0	11,761	100.0	100.0	100.0	0	0	0.0	
12	Hang Ma	9,832	9,832	0	9,832	100.0	100.0	100.0	0	0	0.0	
13	Hang Trong	9,628	9,628	0	9,628	100.0	100.0	100.0	0	0	0.0	
14	Ly Thai To	9,346	9,346	0	9,346	100.0	100.0	100.0	0	0	0.0	
15	Phan Chu Trinh	9,229	9,229	0	9,229	100.0	100.0	100.0	0	0	0.0	
16	Phuc Tan	10,971	10,971	0	10,971	100.0	100.0	100.0	0	0	0.0	
17	Tran Hung Dac	12,005	12,005	0	12,005	100.0	100.0	100.0	0	0	0.0	
18	Trang Tien	7,505	7,505	0	7,505	100.0	100.0	100.0	0	0	0.0	
	Total	193,504	193,504	0	193,504	100.0	100.0	100.0	0	0	0.0	

Table PRESENT (Year 1995) WATER SERVICE POPULATION (Capacity)

(4/10)

No.	Community Name	Total Population	Year 1995									
			Piped Water Supply System					Hand Pump System				
			Service Population		Rate of Service (%)		Sub-total	Service Population		Rate of Service (%)		Sub-total
			HWBC	Others	HWBC's Service	Sub-total		Capacity (120-persons/pump)	Rate of Service (%)			
1	Cat Linh	15,444	15,444	0	100.0	15,444	0	100.0	0	0.0		
2	Hang Bot	16,255	16,255	0	100.0	16,255	0	100.0	0	0.0		
3	Kham Thien	10,836	10,836	0	100.0	10,836	0	100.0	0	0.0		
4	Khuong Thuong	11,996	11,996	0	100.0	11,996	0	100.0	0	0.0		
5	Kim Giang	8,357	8,357	0	100.0	8,357	0	100.0	0	0.0		
6	Kim Lien	13,454	13,454	0	100.0	13,454	0	100.0	0	0.0		
7	Lang Ha	14,493	14,493	0	100.0	14,493	0	100.0	0	0.0		
8	Lang Thuong	13,679	13,679	0	100.0	13,679	0	100.0	0	0.0		
9	Nam Dong	16,239	16,239	0	100.0	16,239	0	100.0	0	0.0		
10	Nguyen Trai	28,389	0	0	0.0	0	0	0.0	0	0.0		
11	O Cho Dua	20,133	20,133	0	100.0	20,133	0	100.0	0	0.0		
12	Phuong Liet	13,354	13,354	0	100.0	13,354	120	100.0	120	0.9		
13	Phuong Lien	13,473	13,473	0	100.0	13,473	0	100.0	0	0.0		
14	Phuong Mai	13,904	13,904	0	100.0	13,904	0	100.0	0	0.0		
15	Quang Trun	9,812	9,812	0	100.0	9,812	0	100.0	0	0.0		
16	Quoc Tu Giam	8,917	8,917	0	100.0	8,917	0	100.0	0	0.0		
17	Thanh Xuan Bac	-	-	-	-	-	-	-	-	-		
18	Thanh Xuan Nam	-	-	-	-	-	-	-	-	-		
19	Thinh Quang	15,856	15,856	0	100.0	15,856	0	100.0	0	0.0		
20	Tho Quan	14,568	14,568	0	100.0	14,568	0	100.0	0	0.0		
21	Thuong Dinh	11,920	6,792	0	57.0	6,792	0	57.0	0	0.0		
22	Trung Liet	14,870	14,870	0	100.0	14,870	0	100.0	0	0.0		
23	Trung Phung	13,113	13,113	0	100.0	13,113	0	100.0	0	0.0		
24	Trung Tu	14,069	14,069	0	100.0	14,069	0	100.0	0	0.0		
25	Van Chuong	15,427	15,427	0	100.0	15,427	0	100.0	0	0.0		
26	Van Mieu	13,095	13,095	0	100.0	13,095	0	100.0	0	0.0		
27	Bach Mai Airbase	10,321	0	10,321	0.0	10,321	0	100.0	0	0.0		
Total		351,974	308,136	10,321	87.5	318,457	120	90.5	120	0.0		

Note: Thanh Xuan Bac and Thanh Xuan Nam belong to the service area of Tu Lien Enterprise, though they belong to the administrative area of Dong Da District.

Table PRESENT (Year 1995) WATER SERVICE POPULATION (Capacity)

District: HAI BA TRUNG		Year 1995										
No.	Community Name	Total Population	Piped Water Supply System					Hand Pump System				
			Service Population		Rate of Service (%)		Capacity		Service Population		Rate of Service (%)	
			HWBC	Others	Sub-total	estimated Rate for HWBC's Service	Sub-total	Capacity (120persons/pump)	Rate of Service (%)	Sub-total	Capacity (120persons/pump)	Rate of Service (%)
1	Bach Dang	16,665	16,665	0	16,665	100.0	100.0	0	0	0.0		
2	Bach Khoa	11,592	11,592	0	11,592	100.0	100.0	0	0	0.0		
3	Bach Mai	16,576	16,576	0	16,576	100.0	100.0	0	0	0.0		
4	Bui Thi Xu	11,682	11,682	0	11,682	100.0	100.0	0	0	0.0		
5	Cau Den	12,512	12,512	0	12,512	100.0	100.0	0	0	0.0		
6	Dong Mac	9,570	9,570	0	9,570	100.0	100.0	0	0	0.0		
7	Dong Nhan	11,416	11,416	0	11,416	100.0	100.0	0	0	0.0		
8	Dong Tam	14,446	14,446	0	14,446	100.0	100.0	0	0	0.0		
9	Giap Bat	10,604	10,604	0	10,604	100.0	100.0	0	0	0.0		
10	Hoang Van Thu	8,675	8,675	0	8,675	100.0	100.0	0	0	0.0		
11	Le Dai Han	15,365	15,365	0	15,365	100.0	100.0	0	0	0.0		
12	Mai Dong	12,428	12,428	0	12,428	100.0	100.0	0	0	0.0		
13	Minh Khai	14,492	14,492	0	14,492	100.0	100.0	0	0	0.0		
14	Ngô Thi Nh	12,837	12,837	0	12,837	100.0	100.0	0	0	0.0		
15	Nguyen Du	11,019	11,019	0	11,019	100.0	100.0	0	0	0.0		
16	Pham Dinh Ho	10,158	10,158	0	10,158	100.0	100.0	0	0	0.0		
17	Pho Huc	15,461	15,461	0	15,461	100.0	100.0	0	0	0.0		
18	Quynh Loi	12,375	12,375	0	12,375	100.0	100.0	0	0	0.0		
19	Quynh Mai	13,088	13,088	0	13,088	100.0	100.0	0	0	0.0		
20	Tan Mai	17,704	17,704	0	17,704	100.0	100.0	0	0	0.0		
21	Thanh Luong	14,815	14,815	0	14,815	100.0	100.0	0	0	0.0		
22	Thanh Nhan	18,554	18,554	0	18,554	100.0	100.0	0	0	0.0		
23	Truong Dinh	17,145	17,145	0	17,145	100.0	100.0	0	0	0.0		
24	Tuong Mai	17,793	17,793	0	17,793	100.0	100.0	0	0	0.0		
25	Vinh Tuy (h)	20,317	17,018	0	17,018	83.8	83.8	0	0	0.0		
	Total	347,289	343,990	0	343,990	99.1	99.1	0	0	0.0		

(5/10)



Table PRESENT (Year 1995) WATER SERVICE POPULATION (Capacity)

(6/10)

No.	Community Name	Total Population	Year 1995									
			Piped Water Supply System					Hand Pump System				
			Service Population		Rate of Service (%)		Service Population		Rate of Service (%)			
			FWBC	Others	Sub-total	estimated Rate for HWBC's Service	Sub-total	Capacity (120persons/pump)	Rate of Service (%)			
1	Bac Phu	7,671	0	0	0	0.0	0.0	5,280	68.8			
2	Bac Son	10,844	0	0	0	0.0	0.0	8,400	77.5			
3	Dong Xuan	8,642	0	0	0	0.0	0.0	1,320	15.3			
4	Duc Hoa	6,106	0	0	0	0.0	0.0	1,320	21.6			
5	Hien Ninh	8,114	0	0	0	0.0	0.0	3,960	48.8			
6	Hong Ky	8,199	0	0	0	0.0	0.0	5,640	68.8			
7	Kim Lu	6,875	0	0	0	0.0	0.0	1,560	22.7			
8	Mai Dinh	12,430	0	0	0	0.0	0.0	1,320	10.6			
9	Minh Phu	8,376	0	0	0	0.0	0.0	4,800	57.3			
10	Minh Tri	10,149	0	0	0	0.0	0.0	4,920	48.5			
11	Nam Son	6,679	0	0	0	0.0	0.0	4,800	71.9			
12	Phu Cuong	7,423	0	0	0	0.0	0.0	11,400	153.6			
13	Phu Linh	6,706	0	0	0	0.0	0.0	3,840	57.3			
14	Phu Lo	10,857	0	0	0	0.0	0.0	5,760	53.1			
15	Phu Minh (s)	6,948	0	0	0	0.0	0.0	4,680	67.4			
16	Quang Tien	6,066	0	0	0	0.0	0.0	3,600	59.3			
17	Soc Son I	2,497	0	0	0	0.0	0.0	3,240	129.8			
18	Tan Dan	8,801	0	0	0	0.0	0.0	2,640	30.0			
19	Tan Hung	8,230	0	0	0	0.0	0.0	2,160	26.2			
20	Tan Minh	10,381	0	0	0	0.0	0.0	5,160	49.7			
21	Thanh Xuan	9,173	0	0	0	0.0	0.0	2,160	23.5			
22	Tien Duoc	9,751	0	0	0	0.0	0.0	2,400	24.6			
23	Trung Gia	9,861	0	0	0	0.0	0.0	3,600	36.5			
24	Viet Long	6,055	0	0	0	0.0	0.0	840	13.9			
25	Xuan Giang	7,270	0	0	0	0.0	0.0	4,200	57.8			
26	Xuan Thu	7,082	0	0	0	0.0	0.0	1,200	16.9			
Total		211,186	0	0	0	0.0	0.0	100,200	47.4			

Table PRESENT (Year 1995) WATER SERVICE POPULATION (Capacity)

(7/10)

No.	Community Name	Total Population	Year 1995									
			Piped Water Supply System					Hand Pump System				
			Service Population		Rate of Service (%)		Service Population		Rate of Service (%)			
			HWBC	Others	Sub-total	estimated Rate for HWBC's Service	Sub-total	Capacity (120persons/pump)	Rate of Service (%)			
1	Bac Hong	9,294	0	0	0	0.0	0.0	2,880	31.0			
2	Co Loa	12,835	0	0	0	0.0	0.0	12,600	98.2			
3	Dai Mach	7,457	0	0	0	0.0	0.0	1,320	17.7			
4	Dong Anh T	20,855	1,349	0	1,349	6.5	6.5	1,680	8.1			
5	Dong Hoi	8,065	0	0	0	0.0	0.0	1,800	22.3			
6	Duc Tu	12,089	0	0	0	0.0	0.0	7,440	61.5			
7	Hai Boi	9,874	0	0	0	0.0	0.0	3,120	31.6			
8	Kim Chung	6,873	0	0	0	0.0	0.0	3,360	48.9			
9	Kim No	8,078	0	0	0	0.0	0.0	9,600	118.8			
10	Lien Ha	11,711	0	0	0	0.0	0.0	12,120	103.5			
11	Mai Lam	8,134	0	0	0	0.0	0.0	8,280	101.8			
12	Nam Hong	8,830	0	0	0	0.0	0.0	7,200	81.5			
13	Nguyen Khe	9,550	2,088	0	2,088	21.9	21.9	8,160	85.4			
14	Tam Xa	3,580	0	0	0	0.0	0.0	5,760	160.9			
15	Thuy Lam	13,480	0	0	0	0.0	0.0	7,920	58.8			
16	Tien Duong	1,412	0	0	0	0.0	0.0	3,600	255.0			
17	Uy No	10,807	0	0	0	0.0	0.0	8,160	75.5			
18	Van Ha	6,979	0	0	0	0.0	0.0	360	5.2			
19	Van Noi	7,977	0	0	0	0.0	0.0	7,920	99.3			
20	Viet Hung	11,565	0	0	0	0.0	0.0	10,920	94.4			
21	Vinh Ngoc	8,915	0	0	0	0.0	0.0	5,400	60.6			
22	Vong La	5,226	0	0	0	0.0	0.0	1,200	23.0			
23	Xuan Canh	8,232	0	0	0	0.0	0.0	7,920	96.2			
24	Xuan Non	9,411	1,477	0	1,477	15.7	15.7	4,200	44.6			
Total		221,229	4,914	0	4,914	2.2	2.2	142,920	64.6			

Note: Existing HWBC's data of 5,397/212 (total number of service population/total number of service consumers) is adopted for a unit service population per consumer.

Table PRESENT (Year 1995) WATER SERVICE POPULATION (Capacity)

(8/10)

No.	Community Name	Total Population	Year 1995									
			Piped Water Supply System					Hand Pump System				
			Service Population		Rate of Service (%)		Service Population		Rate of Service (%)			
			HWBC	Others	Sub-total	estimated Rate for HWBC's Service	Sub-total	Capacity (12persons/pump)	Rate of Service (%)			
1	Bat Trang	5,425	0	0	0	0.0	0.0	0.0	480	8.8		
2	Bo De	5,597	281	0	281	5.0	5.0	5.0	4,440	79.3		
3	Co Bi	7,074	0	0	0	0.0	0.0	0.0	5,760	81.4		
4	Cu Khoi	4,948	0	0	0	0.0	0.0	0.0	10,560	213.4		
5	Da Ton	8,917	0	0	0	0.0	0.0	0.0	12,000	134.6		
6	Dang Xa	7,163	0	0	0	0.0	0.0	0.0	1,320	18.4		
7	Dinh Xuyen	6,684	0	0	0	0.0	0.0	0.0	2,760	41.3		
8	Dong Du	3,436	0	0	0	0.0	0.0	0.0	3,240	94.3		
9	Duc Giang T	21,056	0	0	0	0.0	0.0	0.0	6,480	30.8		
10	Duong Ha	4,389	0	0	0	0.0	0.0	0.0	1,440	32.8		
11	Duong Quang	8,389	0	0	0	0.0	0.0	0.0	1,320	15.7		
12	Duong Xa	7,434	0	0	0	0.0	0.0	0.0	4,920	66.2		
13	Gia Lam T	27,385	9,978	0	9,978	36.4	36.4	36.4	9,480	34.6		
14	Gia Thuy	6,468	772	0	772	11.9	11.9	11.9	960	14.8		
15	Giang Bien	4,260	0	0	0	0.0	0.0	0.0	5,880	138.0		
16	Hoi Xa	7,289	0	0	0	0.0	0.0	0.0	1,800	24.7		
17	Kieu Ky	7,668	0	0	0	0.0	0.0	0.0	3,120	40.7		
18	Kim Lan	4,309	0	0	0	0.0	0.0	0.0	240	5.6		
19	Kim Son	9,293	0	0	0	0.0	0.0	0.0	1,440	15.5		
20	Le Chi	8,496	0	0	0	0.0	0.0	0.0	2,280	26.8		
21	Long Bien	7,289	0	0	0	0.0	0.0	0.0	2,760	37.9		
22	Ngoc Thuy	12,851	0	0	0	0.0	0.0	0.0	4,320	33.6		
23	Ninh Hiep	11,635	0	0	0	0.0	0.0	0.0	4,680	40.2		
24	Phu Dong	10,126	0	0	0	0.0	0.0	0.0	4,680	46.2		
25	Phu Thi	5,773	0	0	0	0.0	0.0	0.0	2,280	39.5		
26	Sai Dong T	9,926	1,405	0	1,405	14.2	14.2	14.2	360	3.6		
27	Thach Bao	9,278	0	0	0	0.0	0.0	0.0	9,720	104.8		
28	Thuong Thanh	8,424	0	0	0	0.0	0.0	0.0	6,960	82.6		
29	Trau Quy	10,027	0	0	0	0.0	0.0	0.0	7,320	73.0		
30	Trung Mau	4,323	0	0	0	0.0	0.0	0.0	5,760	133.2		
31	Van Duc	5,908	0	0	0	0.0	0.0	0.0	1,440	24.4		
32	Viet Hung	12,056	0	0	0	0.0	0.0	0.0	5,880	48.8		
33	Yen Thuong	10,083	0	0	0	0.0	0.0	0.0	1,200	11.9		
34	Yen Vien	8,302	0	0	0	0.0	0.0	0.0	0	0.0		
35	Yen Vien T	10,885	0	0	0	0.0	0.0	0.0	5,520	50.7		
Total		302,566	12,436	0	12,436	4.1	4.1	4.1	142,800	47.2		

Table PRESENT (Year 1995) WATER SERVICE POPULATION (Capacity)

(9/10)

District: TU LIEM		Year 1995									
No.	Community Name	Total Population	Piped Water Supply System				Hand Pump System				
			Service Population		Rate of Service (%)		Service Population		Rate of Service (%)		
			HWBC	Others	Sub-total	estimated Rate for HWBC's Service	Sub-total	Capacity (120persons/pump)	Rate of Service (%)		
1	Cau Dien T	15,910	1,591	7,000	8,591	10.0	54.0	600	3.8		
2	Cau Giay T	13,129	13,129	0	13,129	100.0	100.0	0	0.0		
3	Co Nhae	12,437	1,737	0	1,737	14.0	14.0	1,440	11.6		
4	Dai Mo	10,717	0	0	0	0.0	0.0	8,640	80.6		
5	Dich Vong	8,340	8,340	0	8,340	100.0	100.0	360	4.3		
6	Dong Ngac	17,982	0	0	0	0.0	0.0	7,800	43.4		
7	Lien Mac	5,862	0	0	0	0.0	0.0	5,400	92.1		
8	Mai Dich	13,493	12,422	0	12,422	92.1	92.1	240	1.8		
9	Me Tri	12,645	3,511	0	3,511	27.8	27.8	360	2.8		
10	My Dinh	7,357	2,554	0	2,554	34.7	34.7	1,920	26.1		
11	Nghia Do T	11,744	11,020	0	11,020	93.8	93.8	5,520	47.0		
12	Nghia Tan T	14,948	14,948	0	14,948	100.0	100.0	0	0.0		
13	Nhan Chinh	8,865	2,660	0	2,660	30.0	30.0	3,720	42.0		
14	Phu Minh T	15,453	0	0	0	0.0	0.0	2,400	15.5		
15	Phu Thuong	8,951	0	0	0	0.0	0.0	14,400	160.9		
16	Tay Mo	10,866	0	4,200	4,200	0.0	38.7	10,080	92.8		
17	Tay Tuu	5,216	0	0	0	0.0	0.0	7,680	147.2		
18	Thuong Cat	5,945	0	0	0	0.0	0.0	6,000	100.9		
19	Thuy Phuong	5,977	5,977	0	5,977	100.0	100.0	240	4.0		
20	Trung Hoa	7,823	1,491	0	1,491	19.1	19.1	7,680	98.2		
21	Trung Van	11,369	0	0	0	0.0	0.0	28,800	253.3		
22	Xuan Dinh	8,918	0	0	0	0.0	0.0	10,920	122.4		
23	Xuan Phuon	7,901	7,901	0	7,901	100.0	100.0	600	7.6		
24	Yen Hoa	10,854	10,854	0	10,854	100.0	100.0	0	0.0		
25	Thanh Xuan B	28,858	28,858	0	28,858	100.0	100.0	0	0.0		
26	Thanh Xuan N	9,982	1,459	0	1,459	14.6	14.6	8,880	89.0		
27	Tan Trieu	291,542	128,452	11,200	139,652	44.1	47.9	133,680	45.9		

Note: 1) Thanh Xuan Bac and Thanh Xuan Nam belong to the service area of Tu Liem Enterprise, though they belong to the administrative area of Dong Da District.  
 2) Though Phu Thuong belonged to the administrative area of Tu Liem District in the urban development plan of 1992, it has been incorporated into Tay Ho District since 1995.  
 3) Tan Trieu belongs to the service area of Tu Liem Enterprise, though it belongs to the administrative area of Thanh Tri District.

Table PRESENT (Year 1995) WATER SERVICE POPULATION (Capacity)

(10/10)

No.	Community Name	Total Population	Year 1995									
			Piped Water Supply System					Hand Pump System				
			Service Population		Rate of Service (%)		Service Population		Rate of Service (%)			
			HWBC	Others	Sub-total	estimated Rate for HWBC's Service	Sub-total	Rate for Sub-total	Capacity (130persons/pump)	Rate of Service (%)		
1	Dai Ang	6,599	0	0	0	0.0	0.0	2,520	38.2			
2	Dai Kim	6,065	2,585	0	2,585	42.6	42.6	6,000	98.9			
3	Dinh Cong	6,400	1,449	0	1,449	22.6	22.6	120	1.9			
4	Dong My	5,008	0	0	0	0.0	0.0	6,360	127.0			
5	Duyen Ha	4,249	0	0	0	0.0	0.0	6,960	163.8			
6	Hoang Liet	8,370	1,948	0	1,948	23.3	23.3	7,440	88.9			
7	Huu Hoa	6,533	0	0	0	0.0	0.0	0	0.0			
8	Khuong Dinh	7,201	0	0	0	0.0	0.0	9,000	125.0			
9	Lien Minh	6,490	0	0	0	0.0	0.0	5,520	85.1			
10	Linh Nam	10,552	0	0	0	0.0	0.0	9,720	92.1			
11	Ngoc Hoi	6,408	0	0	0	0.0	0.0	1,800	28.1			
12	Ngui Hiep	7,859	0	0	0	0.0	0.0	1,800	22.9			
13	Ta Thanh O	11,705	0	0	0	0.0	0.0	2,400	20.5			
14	Tam Hiep	8,707	0	0	0	0.0	0.0	7,440	85.4			
15	Tan Trieu											
16	Thanh Liet	6,264	0	0	0	0.0	0.0	1,680	26.8			
17	Thanh Tri	7,918	0	1,600	1,600	0.0	20.2	12,120	153.1			
18	Thinh Liet	9,047	8,357	0	8,357	92.4	92.4	120	1.3			
19	Trop Phu	4,764	0	0	0	0.0	0.0	5,040	105.8			
20	Tu Hiep	8,203	0	0	0	0.0	0.0	1,800	21.9			
21	Van Dien T	9,861	0	0	0	0.0	0.0	120	1.2			
22	Van Phuc	8,516	0	0	0	0.0	0.0	10,320	121.2			
23	Vinh Quynh	14,650	0	0	0	0.0	0.0	5,760	39.3			
24	Vinh Tuy (t)	20,317	1,911	0	1,911	9.4	9.4	2,040	10.0			
25	Yen My	3,948	0	0	0	0.0	0.0	4,920	124.6			
26	Yen So	8,039	0	0	0	0.0	0.0	720	9.0			
Total		203,673	16,250	1,600	17,850	8.0	8.8	111,720	54.9			

Note: Tan Trieu belongs to the service area of Tu Lien Enterprise, though it belongs to the administrative area of Thanh Tri District.

**APPENDIX A-5 Water Quality**

- (a) Comparison of Several Water Quality Criteria
- (b) Water Quality of Production Wellfields
- (c) Groundwater Quality in the Suburban District

Table (a) 1 Comparison of Several Water Quality Criteria

(unit: mg/liter)

Substance	Criteria for Drinking Water		WHO Guidelines	Criteria for Water Supply (Ground Water)		Water Quality Standard	
	Vietnamese			Minimum Requirement	Maximum Requirement	TCVN5944-1995	TCVN5942-1995
	Urban Area	Distribution System & Rural Area					
Antimony (Sb)		0.005	0.005				
Arsenic (As)	0.05	0.05	0.01	0.1	0	0.05	0.1
Barium (Br)			0.7			1	4
Boron (B)			0.3				
Cadmium (Cd)	0.005	0.005	0.003	0.01	0	0.01	0.02
Chromium Cr (VI)						0.05	0.05
Chromium Cr (III)						0.1	1
total-Cr	0.05	0.05	0.05				
Copper (Cu)	1	1	2	1.5	0.05	1.0	1
Cyanide (CN)	0.1	0.1	0.07	0.05	0	0.01	0.05
Fluoride (F)	1.5	1.5	1.5	1.5	0.75	1.0	1.5
Lead (Pb)	0.05	0.05	0.01	0.05	0	0.05	0.1
Manganese (Mn)	0.1	0.1	0.5	0.5	0.3	0.1~0.5	0.8
Mercury (total-Hg)	0.001	0.001	0.001	0.001	0	0.001	0.002
Molybdenum (Mo)			0.07				
Nickel (Ni)			0.02				0.1
Nitrate (NO <sub>3</sub> )	10	10	50	50	25	45	10 (as N) 15 (as N)
Nitrite (NO <sub>2</sub> )	0	0	3				0.01 (as N) 0.05 (as N)
Selenium (Se)	0.01	0.01	0.01			0.01	1
Tin (Sn)							2

Note: 1) In Vietnamese surface water quality standards, values in "class A" are applied to the water using for source of domestic water supply with appropriate treatment.

2) Values in "class B" are applied to the surface water using for the purposes other than domestic water supply.

Table (a) 2 Comparison of Several Water Quality Criteria

(unit:  $\mu\text{g}/\text{liter}$ )

Substance	Criteria for Drinking Water			Criteria for Water Supply (Ground Water)		Water Quality Standard	
	Vietnamese		WHO	Min. Requirement	Max. Requirement	Ground Water	Surface Water (class A)
	Urban Area	Distribution System & Rural Area	Guidelines				
<b>Chlorinated Alkanes</b>							
Carbon Tetrachloride	3	3	2				TCVN5942-1995
Dichloromethane			20				
1,1-dichloroethane	0.3	0.3					
1,2-dichloroethane	10	10	30				
1,1,1-trichloroethane			2000				
<b>Chlorinated Ethenes</b>							
Vinyl Chloride			5				
1,1-dichloroethene			30				
1,2-dichloroethene			50				
Trichloroethene	30	30	70				
Tetrachloroethene	10	10	40				
<b>Aromatic Hydrocarbons</b>							
Benzene	10	10	10				
Toluene			700				
Xylenes			500				
Ethylbenzene			300				
Styrene			20				
Benz[a]pyrene	0.01	0.01	0.7				
<b>Chlorinated Benzenes</b>	0 mg/liter	0 mg/liter					
Monochlorobenzene			300				
1,2-dichlorobenzene			1,000				
1,4-dichlorobenzene			300				
Trichlorobenzenes (total)			20				
<b>Miscellaneous</b>							
Di(2-ethylhexyl)adipate			80				
Di(2-ethylhexyl)phthalate			8				
Acrylamide			0.5				
Epichlorohydrin			0.4				
Hexachlorobutadiene			0.6				
Edetic Acid (EDTA)			200				
Nitrotriacetic Acid			200				
Tributyltin Oxide			2				



Table (a) .3 Comparison of Several Water Quality Criteria

(unit:  $\mu\text{g/liter}$ )

Substance	Criteria for Drinking Water		WHO Guidelines	Criteria for Water Supply (Ground Water)		Water Quality Standard	
	Vietnamese			Min. Requirement	Max. Requirement	TCVNS944-1995 Ground Water	TCVNS942-1995 Surface Water (class A)
	Urban Area	Distribution System & Rural Area					
Aldicarb			20				
Aldrin/Dieldrin	0.03	0.03	10				
Atrazine			0.03				
Benzazone			2				
Carbofuran			30				
Chlordane	0.3	0.3	5				
Chlorotoluron			0.2				
DDT	1	1	30			10	10
1,2-dibromo-3-chloropropane			2				
2,4-D	100	100	1				
1,2-dichloropropane			30				
1,3-dichloropropane			20				
Heptachlor and Heptachlor Epoxide	0.1	0.1	0.03				
Hexachlorobenzene	0.01	0.01	1				
Isoproturon			9				
Lindane	3	3	2				
MCPA			2				
Methoxychlor	30	30	20				
Metolachlor			10				
Molinate			6				
Pendimethalin			20				
Pentachlorophenol	10	10	9				
Permethrin			20				
Propanil			20				
Pyridate			100				
Simazine			2				
Trifluralin			20				
Chlorophenoxy Herbicides other than 2,4-D and MCPA							
2,4-DB			50				
Dichloroprop			100				
Fenoprop			9				
Mesoprop			10				
2,4,5-T			9				
Total Pesticides (except DDT)						150	150

Table (a) 4 Comparison of Several Water Quality Criteria

Substance	Criteria for Drinking Water		WHO Guidelines	Criteria for Water Supply (Ground Water)		Water Quality Standard	
	Vietnamese			Min. Requirement	Max. Requirement	TCVN 5942-1995	
	Urban Area	Distribution System & Rural Area				Ground Water	Surface Water
<b>Disinfectants</b> Monochloramine			3 mg/liter				
Chlorine	Turbidity < 1 NTU, disinfection with chlorine pH preferably < 8.0, free chlorine residual 0.2-0.5 mg/liter following 30 minutes contact		3 mg/liter 5 mg/liter (For effective disinfection there should be a residual chlorine of $\geq 0.5$ mg/liter after at least 30 minutes contact time at pH < 8.0.)				
<b>Disinfectant By-products</b>							
Bromate				35			
Chlorite				200			
Formaldehyde				900			
Cyanogen Chloride				70			
(Chlorophenols)							
2,4,6-trichlorophenol	10		10	200			
(Trihalomethanes)							
Bromoform	30		30	100			
Dibromochloromethane				100			
Bromodichloromethane				60			
Chloroform	30		30	200			
(Chlorinated Acetic Acids)							
Dichloroacetic Acid				50			
Trichloroacetic Acid				100			
(Chloral Hydrate)							
(Trichloroethylene)				10			
(Halogenated Acetonitriles)							
Dibromoacetonitrile				90			
Dibromoacetonitrile				100			
Trichloroacetonitrile				1			

Table A1.5 Comparison of Several Water Quality Criteria

Substance	Criteria for Drinking Water		WHO Guidelines	Criteria for Water Supply (Ground Water)		Water Quality Standard	
	Vietnamese			Min. Requirement	Max. Requirement	TCVN 5942-1995	
	Urban Area	Distribution System & Rural Area				Ground Water	Surface Water
Gross Alpha Activity	0.1	0.1				0.1	0.1
Gross Beta Activity							

Table (a) 6 Comparison of Several Water Quality Criteria

Substance	Criteria for Drinking Water		WHO Guidelines	Water Quality Standard	
	Vietnamess Distribution System & Rural Area			TCVN5944-1995	
	Urban Area	Urban Area		Ground Water	Surface Water (class A)
<b>Bacteriological Quality</b>					
<b>General</b>					
E. Coli or Thermotolerant Coliform Total Coliform Bacteria				not detectable	not detectable
All Water intended for Drinking				3	3
E. Coli or Thermotolerant Coliform				not detectable	not detectable
Treated Water entering the Distribution System				3	3
E. Coli or Thermotolerant Coliform Total Coliform Bacteria				not detectable	not detectable
Untreated Water entering the Distribution System				3	3
E. Coli or Thermotolerant Coliform				not detectable	not detectable
Total Coliform Bacteria				3	3
Water in the Distribution System				not detectable	not detectable
E. Coli or Thermotolerant Coliform				not detectable	not detectable
Total Coliform Bacteria				3	3
Unpiped Water Supplies				not detectable	not detectable
E. Coli or Thermotolerant Coliform				10	10
Total Coliform Bacteria				not detectable	not detectable
Bottled Drinking Water				not detectable	not detectable
E. Coli or Thermotolerant Coliform Total Coliform Bacteria				not detectable	not detectable
Emergency Water Supplies				not detectable	not detectable
E. Coli or Thermotolerant Coliform				not detectable	not detectable
Total Coliform Bacteria				not detectable	not detectable
Biological Quality				not detectable	not detectable
Protozoan (pathogenic)				not detectable	not detectable
Helminths (pathogenic)				not detectable	not detectable
Free-living Organisms (Algae, others)				not detectable	not detectable

(unit: number/100ml)

Table (a) 7 Comparison of Several Water Quality Criteria

Substances and Parameters in Drinking Water that may give rise to Complaints from Consumers

Substance	Criteria for Drinking Water		WHO Guidelines	Criteria for Water Supply (Ground Water)		Water Quality Standard	
	Vietnamese Distribution System & Rural Area			Man. Requirement	Max. Requirement	Ground Water	Surface Water
	Urban Area	10 (Pt-Co) 0 point > 30 cm 10 (Pt-Co) 0 point > 25 cm		50 (Pt-Co) 5 (Pt-Co)	5 NTU 20 NTU	5~50 (Pt-Co)	TCVN 5942-1995 Surface Water (class A)
<b>Physical Parameters</b>							
Colour			15 PCU				
Odor and Taste (after heating 50-60°C)							
Purity							
Turbidity			5 NTU				
<b>Inorganic Constituents</b>							
Aluminium	0.2 mg/liter	0.2 mg/liter	0.2 mg/liter				
Ammonia	0 mg/l (surface water), 3.0 mg/l (ground water)	0 mg/l (surface water), 3.0 mg/l (ground water)	1.5 mg/l			0.95 mg/l	1 mg/l
BOD <sub>5</sub>			250 mg/l	200 mg/l	200 mg/l	4 mg/l	25 mg/l
Chloride					200~600mg/l		
COD			1 mg/l	1 mg/l	1 mg/l	10 mg/l	35 mg/l
Copper					0.05 mg/l	0.1 mg/l	1 mg/l
Dissolved Oxygen					≥ 6 mg/l		
Hardness (CaCO <sub>3</sub> )	500 mg/l	500 mg/l	500 mg/l	500 mg/l	300~500mg/l		
Hydrogen Sulfide	0 mg/l	0 mg/l	0.05 mg/l				
Iron	0.3 mg/l	0.5 mg/l	0.3 mg/l	10 mg/l	3 mg/l	1~5 mg/l	2 mg/l
Manganese	0.1 mg/l	0.1 mg/l	0.1 mg/l	0.5 mg/l	0.3 mg/l	0.1~0.5 mg/l	0.8 mg/l
pH	6.5~8.5	6.5~8.5	6.5~8.5	6.5~8.0	6.5~8.0	6.0~8.5	5.5~9.0
Sodium	200 mg/l	200 mg/l	200 mg/l				
Sodium Chloride	250 mg/l	250 mg/l	250 mg/l	250 mg/l	250 mg/l	200~400mg/l	
Sulfate	400 mg/l	400 mg/l	400 mg/l				
Suspended Solids	5 mg/l	10 mg/l					
Total Suspended Solids	500 mg/l	1,000 mg/l	1,000 mg/l	100 mg/l	25 mg/l	750~1,500mg/l	
Total Dissolved Solids							
Total Solids							
Total Organic Carbon	0.5~2.0mg/l	2.0~4.0mg/l	3 mg/l	5 mg/l	1 mg/l	5 mg/l	1 mg/l
Zinc	5 mg/l	5 mg/l					2 mg/l
<b>Organic Constituents</b>							
Toluene			24~170 μg/l				
Xylene			20~1800 μg/l				
Ethylbenzene			2~200 μg/l				
Styrene			4~200 μg/l				
Monochlorobenzene			10~120 μg/l				
1,2-dichlorobenzene			1~10 μg/l				
1,4-dichlorobenzene			0.3~30 μg/l				
Trichlorobenzenes (total)			5~50 μg/l				
Synthetic Detergents							
Phenol Compounds	0 mg/l	0 mg/l				0.5 mg/l	0.5 mg/l
Oil and Grease						0.001 mg/l	0.02 mg/l
<b>Disinfectants and Disinfectant By-products</b>						not detectable	0.2 mg/l
Chlorine			0.6~1.0mg/l				
Chlorophenols							
2-chlorophenol			0.1~10 μg/l				
2,4-dichlorophenol			0.3~40 μg/l				
2,4,6-trichlorophenol			2~300 μg/l				

Table (b) 1 Water Quality of Production Well Fields (Mai Dich) for the past Five Years (1990-->1995)

No.	Well No.	pH			NH <sub>4</sub> <sup>+</sup> (mg/l)			NO <sub>3</sub> (mg/l)			Fe (mg/l)			Cl <sup>-</sup> (mg/l)			Hardness (°G)			Mn <sup>2+</sup> (mg/l)			Acid-based			Alkali-based		
		max.	ave.	min.	max.	ave.	min.	max.	ave.	min.	max.	ave.	min.	max.	ave.	min.	max.	ave.	min.	max.	ave.	min.	max.	ave.	min.	max.	ave.	min.
1	MD H2	8.0	6.8	6.6	0.3	0.1	0.0	1.3	0.4	0.0	0.9	0.5	0.1	16	11	7	8	5	3	1.1	0.9	0.7	2.6	0.7	0.0	1.8	0.5	0.0
2	MD H3	8.0	6.8	6.4	0.0	0.0	0.0	2.2	0.4	0.0	0.5	0.3	0.1	28	24	17	8	7	4	1.5	1.0	0.1	0.6	0.4	0.2	0.6	0.4	0.2
3	MD H4	7.0	6.9	6.7	0.3	0.0	0.0	2.5	0.8	0.0	1.2	0.7	0.4	16	12	7	6	5	5	1.1	0.8	0.6	1.9	0.3	0.0	1.3	0.2	0.0
4	MD H5	7.2	6.8	6.6	0.0	0.0	0.0	3.1	0.6	0.0	0.2	0.1	0.0	26	17	10	5	5	4	1.2	0.7	0.4	0.3	0.2	0.0	0.3	0.1	0.0
5	MD H7	8.0	6.9	6.4	0.3	0.2	0.0	4.0	1.0	0.0	0.7	0.3	0.1	26	17	12	6	6	5	0.9	0.7	0.5	0.8	0.2	0.0	0.5	0.2	0.0
6	MD H8	6.8	6.7	6.5	0.1	0.0	0.0	4.4	1.2	0.0	0.5	0.2	0.0	51	33	21	8	6	5	0.7	0.5	0.4	1.2	0.4	0.0	0.8	0.1	0.0
7	MD H9	6.8	6.5	6.1	1.3	0.1	0.0	4.4	1.6	0.0	1.5	0.4	0.1	43	32	23	7	5	4	0.5	0.4	0.3	0.6	0.1	0.0	0.3	0.1	0.0
8	MD H10	6.6	6.4	6.3	0.0	0.0	0.0	2.5	1.6	1.3	1.7	0.7	0.4	77	59	51	10	7	5	0.8	0.7	0.6	0.6	0.2	0.0	0.2	0.0	0.0
9	MD H11	6.7	6.5	6.4	0.0	0.0	0.0	3.5	1.2	0.0	0.7	0.2	0.1	26	19	14	5	4	4	0.9	0.6	0.5	0.6	0.2	0.0	0.5	0.2	0.0
10	MD H12	6.8	6.6	6.4	0.0	0.0	0.0	3.5	0.6	0.0	1.7	1.1	0.7	17	16	14	5	4	1	0.4	0.3	0.2	1.4	0.3	0.0	0.0	0.0	0.0
11	MD H13	6.3	6.2	6.2	0.1	0.0	0.0	5.0	2.4	0.0	2.4	1.7	1.5	48	39	28	5	4	3	0.5	0.4	0.3	0.3	0.1	0.0	0.0	0.0	0.0
12	MD H14	7.0	6.6	6.4	0.3	0.0	0.0	1.3	0.4	0.0	3.3	2.6	0.3	37	10	6	4	3	3	0.5	0.3	0.2	3.0	0.5	0.0	0.3	0.1	0.0
13	MD H15	6.8	6.5	6.4	0.3	0.0	0.0	3.0	1.3	0.0	0.2	0.1	0.0	31	22	14	4	4	3	0.8	0.6	0.5	1.0	0.3	0.0	0.2	0.0	0.0
14	MD H16	6.2	6.1	6.0	0.0	0.0	0.0	12.3	5.3	0.0	2.4	1.6	0.5	74	70	65	7	5	5	0.3	0.2	0.1	0.5	0.2	0.0	0.2	0.0	0.0
15	VC H1	6.9	6.7	6.2	0.1	0.0	0.0	4.4	1.1	0.0	0.3	0.1	0.0	17	12	9	5	4	4	2.0	1.4	1.0	0.3	0.1	0.0	1.0	0.3	0.0
16	VC H2	7.0	6.7	6.2	0.3	0.0	0.0	3.1	0.9	0.0	0.3	0.1	0.0	20	15	11	6	5	4	0.9	0.8	0.7	0.6	0.3	0.0	0.8	0.3	0.0
17	VC H3	7.1	6.8	6.3	0.3	0.0	0.0	1.3	0.7	0.0	1.5	0.4	0.0	17	11	9	5	4	4	1.8	1.5	1.2	0.3	0.2	0.0	0.3	0.2	0.0
	Max.	8.0	6.9	6.7	1.3	0.2	0.0	12.3	5.3	1.3	3.3	2.6	1.5	77	70	65	10	7	5	2.0	1.5	1.2	3.0	0.7	0.2	1.8	0.5	0.2
	Min.	6.2	6.1	6.0	0.0	0.0	0.0	1.3	0.4	0.0	0.2	0.1	0.0	16	10	6	4	3	1	0.3	0.2	0.1	0.3	0.1	0.0	0.0	0.0	0.0
	Ave.	7.0	6.6	6.4	0.2	0.0	0.0	3.6	1.3	0.1	1.2	0.7	0.3	32	25	19	6	5	4	0.9	0.7	0.5	1.0	0.3	0.0	0.5	0.2	0.0
	Water Quality Standard	6.5	~	8.5	~	~	~	45.0	~	~	1.0	~	5.0	200	~	400	300~500	mg/l	0.1	~	0.5	~	~	~	~	~	~	~
	Criteria for Water Supply	6.0	~	8.0	~	~	~	50.0	~	~	10.0	~	~	200	~	~	500	mg/l	0.5	~	~	~	~	~	~	~	~	~
	Criteria for Drinking Water	6.5	~	8.5	~	~	~	25.0	~	~	3.0	~	~	200	~	~	300	mg/l	0.3	~	~	~	~	~	~	~	~	~
	Urban	6.5	~	8.5	~	~	~	10.0	~	~	0.3	~	~	250	(as NaCl)	~	500	mg/l	0.1	~	~	~	~	~	~	~	~	~
	Rural	6.5	~	8.5	~	~	~	10.0	~	~	0.5	~	~	250	(as NaCl)	~	500	mg/l	0.1	~	~	~	~	~	~	~	~	~
	WHO Guideline	~	~	~	~	~	~	50.0	~	~	0.3	~	~	250	~	~	~	~	0.1	~	~	~	~	~	~	~	~	~

Note: The unit °C of Hardness is German degree; 1°G is equivalent to 17.9mg/l(CaCO<sub>3</sub>).

Table (b) 2. Water Quality of Production Well Fields (Ngoc Ha) for the past Five Years (1990--->1995)

No.	Well No.	pH		NH <sub>4</sub> <sup>+</sup> (mg/l)		NO <sub>3</sub> <sup>-</sup> (mg/l)		Fe (mg/l)		Cl <sup>-</sup> (mg/l)		Hardness (°G)		Mn <sup>2+</sup> (mg/l)		Acid-based		Alkali-based							
		max.	ave.	min.	max.	ave.	min.	max.	ave.	min.	max.	ave.	min.	max.	ave.	min.	max.	ave.	min.	max.	ave.				
1	NH H4	7.0	6.9	6.8	2.2	1.2	0.3	1.3	0.2	0.0	1.6	1.1	0.7	43	11	11	1.4	0.6	0.2	1.0	0.4	0.0			
2	NH H5	7.0	6.8	6.6	3.0	2.1	0.2	2.5	0.6	0.0	2.8	1.2	0.7	45	31	11	1.1	0.5	0.0	1.0	0.4	0.0			
3	NH H6	7.0	6.8	6.6	2.5	1.4	0.4	4.0	0.8	0.0	1.0	0.5	0.1	57	46	36	2.2	0.6	0.0	1.0	0.4	0.0			
4	NH H7	7.1	6.8	6.4	2.0	0.9	0.2	3.9	1.0	0.0	1.6	1.2	0.9	37	28	11	2.1	0.5	0.0	1.9	0.5	0.0			
5	NH H8	7.1	6.7	6.4	2.0	1.4	0.8	3.1	0.6	0.0	2.8	1.6	0.6	54	43	20	2.1	0.7	0.0	1.4	0.5	0.0			
6	NH H9	7.0	6.9	6.6	1.3	0.3	0.0	2.5	0.9	0.0	1.2	0.7	0.3	43	35	28	0.8	0.5	0.0	0.7	0.3	0.2			
7	NH H10	7.0	6.7	6.5	0.3	0.1	0.0	7.0	1.2	0.0	1.8	1.6	1.2	57	41	20	2.6	0.4	0.0	2.2	0.4	0.0			
8	NH H11	6.8	6.6	6.5	0.5	0.2	0.0	2.6	0.6	0.0	3.0	2.1	0.9	45	35	14	1.0	0.2	0.0	0.5	0.2	0.0			
9	NH H12	6.8	6.7	6.5	0.5	0.3	0.1	4.8	1.2	0.0	4.7	3.3	1.8	45	30	9	1.4	0.5	0.0	1.0	0.3	0.0			
10	NH H13	6.6	6.4	6.1	0.5	0.2	0.1	4.8	1.0	0.0	3.1	2.4	1.6	31	29	7	1.3	0.4	0.0	1.0	0.3	0.0			
11	NH H14	6.7	6.4	6.1	0.3	0.1	0.0	7.5	1.5	0.0	1.7	1.4	1.0	34	27	6	1.9	0.3	0.0	0.5	0.1	0.0			
	Max.	7.1	6.9	6.8	3.0	2.1	0.8	7.5	1.5	0.0	4.7	3.3	1.8	57	43	14	2.6	0.7	0.2	2.2	0.5	0.2			
	Min.	6.6	6.4	6.1	0.3	0.1	0.0	1.3	0.2	0.0	1.0	0.5	0.1	31	27	14	0.8	0.2	0.0	0.5	0.1	0.0			
	Ave.	6.9	6.7	6.5	1.4	0.7	0.2	4.0	0.9	0.0	2.3	1.6	0.9	43	37	27	1.6	0.5	0.0	1.1	0.3	0.0			
	Water Quality Standard	6.5	~	8.5	—	—	—	45.0	—	—	1.0	~	5.0	200	~	400	300	~	500	mg/l	0.1	~	0.5	—	—
	Criteria for Water Supply	6.0	~	8.0	—	—	—	50.0	—	—	10.0	—	—	200	—	—	—	—	—	—	—	—	—	—	—
	Criteria for Drinking Water	6.5	~	8.5	3.0	3.0	10.0	10.0	0.3	—	3.0	—	—	200	—	—	—	—	—	—	—	—	—	—	—
	WHO Guideline	6.5	~	8.5	3.0	3.0	10.0	10.0	0.5	—	250	—	—	250	(as NaCl)	500	—	—	—	—	—	—	—	—	—
		—	—	—	1.5	1.5	—	50.0	—	—	0.3	—	—	250	(as NaCl)	500	—	—	—	—	—	—	—	—	—

Note: The unit "°G" of Hardness is German degree; 1°G is equivalent to 17.9mg/(CaCO<sub>3</sub>).

Table (b) 3 Water Quality of Production Well Fields (Yen Phu) for the past Five Years (1990--->1995)

No.	Well No.	pH			NH <sub>4</sub> <sup>+</sup> (mg/l)			NO <sub>3</sub> <sup>-</sup> (mg/l)			Fe (mg/l)			Cl <sup>-</sup> (mg/l)			Hardness (°G)			Mn <sup>2+</sup> (mg/l)			Organic matter					
		max.	ave.	min.	max.	ave.	min.	max.	ave.	min.	max.	ave.	min.	max.	ave.	min.	max.	ave.	min.	max.	ave.	min.	max.	ave.	min.	max.	ave.	
1	YP H10	7.8	7.5	7.0	2.0	1.1	0.3	1.3	0.1	0.0	3.8	2.3	1.7	20	10	6	8	7	6	0.3	0.2	0.1	1.0	0.4	0.0	0.8	0.2	0.0
2	YP H12	7.5	7.2	6.9	10.4	1.9	0.0	5.0	0.7	0.0	3.5	2.8	1.3	17	12	9	11	9	8	0.6	0.4	0.3	1.1	0.4	0.0	0.5	0.3	0.0
3	YP H15	7.1	7.0	6.5	2.0	1.4	0.7	1.3	0.2	0.0	2.7	1.6	1.1	14	8	4	13	11	10	1.8	0.9	0.4	1.6	0.4	0.0	1.0	0.2	0.0
4	YP H16	7.4	7.0	6.7	2.5	2.0	1.1	0.0	0.0	0.0	3.0	2.1	1.3	11	7	6	11	10	9	1.1	1.0	0.7	1.4	0.5	0.0	1.3	0.4	0.0
5	YP H17	7.8	7.3	6.6	4.4	1.9	0.3	1.3	0.1	0.0	1.7	1.1	0.5	9	7	6	13	10	8	1.2	0.7	0.4	1.6	0.7	0.0	1.0	0.5	0.0
6	YP H18	7.2	7.1	6.7	6.0	3.1	1.7	0.0	0.0	0.0	3.8	3.0	1.7	26	19	14	13	11	9	1.8	0.8	0.6	2.9	1.0	0.0	2.7	0.8	0.2
7	YP H19	8.2	7.3	6.7	7.0	3.2	1.0	1.3	0.1	0.0	7.4	4.9	2.3	31	18	6	14	11	8	0.7	0.4	0.2	3.5	1.3	0.0	3.2	0.8	0.0
8	YP H20	7.2	7.0	6.6	8.0	5.1	2.0	0.0	0.0	0.0	11.4	8.8	6.0	31	26	20	12	11	11	0.6	0.4	0.3	2.7	1.0	0.5	1.0	0.7	0.3
9	YP H21	7.2	6.9	6.3	20.0	9.5	1.5	1.3	0.3	0.0	11.6	8.5	2.0	40	32	23	15	13	11	2.9	1.3	0.5	4.3	1.4	0.2	4.2	1.2	0.0
10	YP H22	7.2	7.0	6.3	9.0	4.2	2.0	1.3	0.2	0.0	9.9	7.6	5.9	26	18	14	17	14	11	0.7	0.4	0.2	6.6	1.6	0.2	5.1	1.3	0.2
11	YP H26	8.0	7.6	7.0	1.8	0.7	0.3	2.5	0.4	0.0	2.2	1.5	0.8	51	12	9	12	11	7	0.7	0.5	0.3	1.9	0.4	0.0	1.6	0.4	0.0
12	YP H27	8.0	7.4	6.4	3.7	1.4	0.5	0.0	0.0	0.0	4.3	3.0	1.7	28	14	9	16	12	9	0.7	0.5	0.4	1.6	0.7	0.2	1.4	0.5	0.0
13	YP H28	7.5	7.1	6.4	12.0	4.2	0.5	1.3	0.1	0.0	10.5	6.4	1.7	43	24	9	15	12	8	0.7	0.4	0.1	2.9	1.2	0.2	1.4	0.8	0.0
14	YP H29	7.4	7.0	6.2	4.0	1.3	0.5	1.3	0.2	0.0	2.9	1.3	0.4	9	7	6	13	11	10	1.1	0.8	0.3	0.8	0.2	0.0	0.6	0.1	0.0
15	YP H30	7.6	7.1	6.7	1.5	0.9	0.5	1.3	0.2	0.0	0.9	0.6	0.3	11	7	6	10	8	6	1.0	0.7	0.3	0.8	0.3	0.0	1.9	0.3	0.0
	Max.	8.2	7.6	7.0	20.0	9.5	2.0	5.0	0.7	0.0	11.6	8.8	6.0	51	32	23	17	14	11	2.9	1.3	0.7	6.6	1.6	0.5	5.1	1.3	0.3
	Min.	7.1	6.9	6.2	1.5	0.7	0.0	0.0	0.0	0.0	0.9	0.6	0.3	9	7	4	8	7	6	0.3	0.2	0.1	0.8	0.2	0.0	0.5	0.1	0.0
	Ave.	7.5	7.2	6.6	5.3	2.8	0.9	1.3	0.2	0.0	5.3	3.7	1.9	24	15	10	13	11	9	1.0	0.6	0.3	2.3	0.8	0.1	1.8	0.6	0.0
	Water Quality Standard	6.5	~	8.5	—	—	—	45.0	—	—	1.0	~	5.0	200	~	400	300~500mg/l	0.1	~	0.5	—	—	—	—	—	—	—	—
	Criteria for Min. Requirement	6.0	~	8.0	—	—	—	50.0	—	—	10.0	—	—	200	—	—	500 mg/l	—	—	0.5	—	—	—	—	—	—	—	—
	Water Supply Max. Requirement	6.5	~	8.0	—	—	—	25.0	—	—	3.0	—	—	200	—	—	300 mg/l	—	—	0.3	—	—	—	—	—	—	—	—
	Criteria for Urban	6.5	~	8.5	3.0	—	—	10.0	—	—	0.3	—	—	250 (as NaCl)	—	—	500 mg/l	—	—	0.1	—	—	—	—	—	—	—	—
	Drinking Water	6.5	~	8.5	3.0	—	—	10.0	—	—	0.5	—	—	250 (as NaCl)	—	—	500 mg/l	—	—	0.1	—	—	—	—	—	—	—	—
	WHO Guideline	—	—	—	1.5	—	—	50.0	—	—	0.3	—	—	250	—	—	—	—	—	0.1	—	—	—	—	—	—	—	—

Note: The unit °G of Hardness is German degree; 1°G is equivalent to 17.9mg/l(CaCO<sub>3</sub>).

Table (b) 4 Water Quality of Production Well Fields (Ngo Si Lien) for the past Five Years (1990--->1995)

No.	Well No.	pH			NH <sub>4</sub> <sup>+</sup> (mg/l)			NO <sub>3</sub> <sup>-</sup> (mg/l)			Fe (mg/l)			Cl <sup>-</sup> (mg/l)			Hardness (°G)			Mn <sup>2+</sup> (mg/l)			Organic matter					
		max.	ave.	min.	max.	ave.	min.	max.	ave.	min.	max.	ave.	min.	max.	ave.	min.	max.	ave.	min.	max.	ave.	min.	max.	ave.	min.			
1	NSL H9	7.0	6.6	6.3	1.3	0.2	0.0	4.0	0.7	0.0	8.3	5.1	3.7	57	47	37	11	7	5	1.3	0.8	0.5	1.9	0.7	0.0	0.5	0.2	0.0
2	NSL H10	6.7	6.4	6.2	2.5	1.1	0.6	10.6	1.7	0.0	14.0	9.2	2.7	88	77	50	8	8	7	2.1	1.4	0.9	6.1	2.3	0.6	2.6	1.1	0.5
3	NSL H14	7.6	6.9	6.8	10.0	3.7	1.0	10.1	1.4	0.0	7.5	4.8	3.9	84	48	34	11	10	9	1.3	0.7	0.2	1.4	0.9	0.0	1.1	0.5	0.0
4	NSL H16	7.0	6.6	6.2	0.7	0.4	0.0	2.6	0.5	0.0	2.5	1.3	0.6	40	33	28	10	7	1	1.6	1.2	0.8	1.3	0.5	0.0	0.8	0.3	0.0
5	NSL H17	6.8	6.7	6.4	3.5	0.8	0.0	2.5	0.6	0.0	3.0	1.7	1.2	54	38	23	9	8	7	1.4	0.9	0.4	1.1	0.5	0.0	1.0	0.4	0.0
6	NSL H18	7.0	6.6	6.2	0.5	0.3	0.2	4.0	1.1	0.0	2.8	2.3	1.7	37	32	20	8	6	4	1.0	0.9	0.8	1.8	0.6	0.0	0.6	0.3	0.0
7	NSL H21	7.4	6.8	6.5	1.5	0.6	0.0	3.0	0.6	0.0	2.2	1.5	0.5	82	65	57	13	11	8	1.9	1.0	0.0	3.2	0.8	0.0	3.4	0.6	0.0
8	NSL H22	6.9	6.7	6.4	2.0	1.4	0.6	4.8	0.8	0.0	1.7	1.2	1.0	45	36	31	11	10	9	2.3	1.4	0.7	2.8	0.7	0.0	1.7	0.6	0.0
9	NSL H23	7.2	6.9	6.5	1.5	1.0	0.4	1.3	0.4	0.0	1.9	1.2	0.4	57	46	43	11	10	10	1.4	0.8	0.2	0.6	0.2	0.0	0.5	0.2	0.0
10	NSL H25	8.0	6.9	6.7	1.5	0.9	0.1	2.6	0.5	0.0	1.7	1.0	0.7	82	60	51	11	10	7	1.3	0.8	0.6	1.9	0.5	0.0	1.9	0.4	0.0
11	NSL H27	6.9	6.8	6.5	2.0	0.5	0.0	2.6	0.6	0.0	1.7	1.1	0.4	68	62	37	12	11	7	1.3	0.9	0.0	1.9	0.3	0.0	0.5	0.1	0.0
12	NSL H28	7.0	6.8	6.4	1.0	0.6	0.2	2.3	0.3	0.0	2.6	1.6	0.8	54	50	37	11	10	9	1.5	1.0	0.8	0.8	0.2	0.0	0.5	0.2	0.0
13	NSL H29	7.2	6.8	6.4	8.3	1.7	0.3	0.0	0.0	0.0	16.7	6.2	2.2	77	45	20	13	10	9	1.3	0.9	0.6	2.4	1.0	0.0	1.6	0.6	0.0
14	NSL H31	7.1	6.9	6.5	13.3	7.4	2.7	1.8	0.5	0.0	6.4	5.1	4.5	40	32	26	11	10	9	1.0	0.8	0.7	1.9	1.1	0.6	1.8	1.0	0.2
Max.		8.0	6.9	6.8	13.3	7.4	2.7	10.6	1.7	0.0	16.7	9.2	4.5	88	77	57	13	11	10	2.3	1.4	0.9	6.1	2.3	0.6	3.4	1.1	0.5
Min.		6.7	6.4	6.2	0.5	0.2	0.0	0.0	0.0	0.0	1.7	1.0	0.4	37	32	20	8	6	4	1.0	0.7	0.0	0.9	0.2	0.0	0.5	0.1	0.0
Ave.		7.1	6.7	6.4	3.5	1.5	0.4	3.7	0.7	0.0	5.2	3.1	1.7	62	48	35	11	9	7	1.5	1.0	0.5	2.1	0.7	0.1	1.3	0.5	0.0
Water Quality Standard		6.5	~	8.5	---	---	---	45.0	~	5.0	1.0	~	5.0	200	~	400	300	~	500mg/l	0.1	~	0.5	---	---	---	---	---	---
Criteria for Min. Requirement		6.0	~	8.0	---	---	50.0	---	---	---	10.0	---	---	200	---	---	500	mg/l	---	---	---	---	---	---	---	---	---	---
Water Supply Max. Requirement		6.5	~	8.0	---	---	25.0	---	---	---	3.0	---	---	200	---	---	300	mg/l	---	---	---	---	---	---	---	---	---	---
Criteria for Urban		6.5	~	8.5	3.0	---	10.0	---	---	---	0.3	---	---	250	(as NaCl)	---	500	mg/l	---	---	---	---	---	---	---	---	---	---
Criteria for Rural		6.5	~	8.5	3.0	---	10.0	---	---	---	0.5	---	---	250	(as NaCl)	---	500	mg/l	---	---	---	---	---	---	---	---	---	---
WHO Guideline		---	---	---	1.5	---	50.0	---	---	---	0.3	---	---	250	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Note: The unit "°G" of Hardness is German degree, 1°G is equivalent to 17.0mg/l(CaCO<sub>3</sub>).



Table (b).5 Water Quality of Production Well Fields (Luong Yen) for the past Five Years (1990--->1995)

No.	Well No.	pH		NH <sub>4</sub> <sup>+</sup> (mg/l)			NO <sub>3</sub> <sup>-</sup> (mg/l)			Fe (mg/l)			Cl <sup>-</sup> (mg/l)			Hardness (°G)			Mn <sup>2+</sup> (mg/l)			Organic matter						
		max.	ave.	min.	max.	ave.	min.	max.	ave.	min.	max.	ave.	min.	max.	ave.	min.	max.	ave.	min.	max.	ave.	min.	max.	ave.	min.			
1	LY H3	8.0	7.7	7.2	1.3	0.7	0.0	2.5	0.4	0.0	11.4	9.0	5.7	2	1	1	8	6	5	0.4	0.2	0.1	1.8	0.5	0.0	0.6	0.2	0.0
2	LY H4	8.0	7.6	7.4	5.0	1.4	0.5	1.3	0.2	0.0	19.9	9.3	5.7	3	2	1	7	6	6	0.2	0.1	0.0	1.1	0.5	0.2	1.1	0.4	0.0
3	LY H5	8.0	7.6	6.9	2.1	1.4	0.5	4.0	0.7	0.0	14.2	9.2	5.7	2	1	1	8	7	6	0.4	0.2	0.0	1.0	0.4	0.0	1.0	0.4	0.0
4	LY H6	7.8	7.2	6.8	5.0	2.8	2.0	0.4	0.1	0.0	14.2	9.9	8.5	4	3	1	9	7	6	0.5	0.4	0.2	1.6	0.7	0.0	1.5	0.5	0.0
5	LY H8	7.8	7.3	7.0	2.0	1.5	1.0	1.3	0.4	0.0	8.5	7.1	5.7	3	3	2	9	7	6	0.5	0.4	0.4	0.6	0.4	0.2	0.3	0.2	0.0
6	LY H9	8.0	8.0	8.0	0.5	0.4	0.3	1.8	0.4	0.0	5.7	4.6	4.3	1	1	1	6	6	6	0.3	0.1	0.1	0.6	0.2	0.0	0.6	0.2	0.0
7	LY H10	8.0	7.6	7.2	2.1	1.2	1.0	0.0	0.0	0.0	8.5	6.2	2.8	2	2	1	7	7	7	0.3	0.2	0.2	1.0	0.4	0.0	0.2	0.1	0.0
8	LY H11	8.0	7.6	7.4	1.5	0.8	0.5	0.0	0.0	0.0	11.4	6.2	2.8	2	2	2	8	7	7	0.3	0.3	0.3	0.5	0.2	0.0	0.2	0.1	0.0
9	LY H12	8.0	8.0	8.0	0.5	0.4	0.3	2.2	1.1	0.0	5.7	5.0	2.8	1	1	1	9	7	6	0.3	0.1	0.0	0.3	0.2	0.0	0.5	0.2	0.0
10	LY H13	8.0	7.9	7.6	0.5	0.5	0.4	0.0	0.0	0.0	11.4	6.2	2.8	2	2	1	7	6	6	0.2	0.2	0.1	1.0	0.4	0.0	0.6	0.3	0.0
11	LY H14	8.0	7.7	7.4	1.5	1.0	0.5	0.0	0.0	0.0	8.5	7.6	5.7	3	2	2	9	9	8	0.4	0.3	0.2	0.6	0.5	0.5	0.6	0.4	0.0
12	LY H17	8.0	8.0	8.0	0.3	0.3	0.3	1.0	1.0	1.0	5.7	5.7	5.7	2	2	2	6	6	6	0.1	0.1	0.1	0.5	0.5	0.5	0.2	0.2	0.2
	Max.	8.0	8.0	8.0	5.0	2.8	2.0	4.0	1.1	1.0	19.9	9.9	8.5	4	3	2	9	9	8	0.5	0.4	0.4	1.8	0.7	0.5	1.6	0.6	0.2
	Min.	7.8	7.2	6.8	0.3	0.3	0.0	0.0	0.0	0.0	5.7	4.6	2.8	1	1	1	6	6	5	0.1	0.1	0.0	0.3	0.2	0.0	0.2	0.1	0.0
	Ave.	8.0	7.7	7.4	1.8	1.0	0.6	1.2	0.4	0.1	10.4	7.2	4.9	2	2	1	8	7	6	0.3	0.2	0.1	0.9	0.4	0.1	0.6	0.2	0.0
	Water Quality Standard	6.5	~	8.5	—	—	—	45.0	—	—	1.0	~	5.0	200	~	400	300	~	500	mg/l	0.1	~	0.5	—	—	—	—	—
	Criteria for Water Supply	6.0	~	8.0	—	—	—	50.0	—	—	10.0	—	—	200	—	—	500	—	—	—	0.5	—	—	—	—	—	—	—
	Criteria for Drinking Water	6.5	~	8.5	3.0	3.0	10.0	25.0	10.0	0.3	3.0	—	—	250	(as NaCl)	500	mg/l	—	—	—	0.1	—	—	—	—	—	—	—
	WHO Guideline	6.5	~	8.5	3.0	3.0	10.0	10.0	0.5	0.5	500	mg/l	—	250	(as NaCl)	500	mg/l	—	—	—	0.1	—	—	—	—	—	—	—
		—	—	—	1.5	1.5	50.0	50.0	0.3	0.3	—	—	—	250	—	—	—	—	—	—	0.1	—	—	—	—	—	—	—

Note: The unit °G of Hardness is German degree; 1°G is equivalent to 17.9mg/(CaCO<sub>3</sub>).

Table (b).6 Water Quality of Production Well Fields (Tuong Mai) for the past Five Years (1990---->1995)

No.	Well No.	pH			NH <sub>4</sub> <sup>+</sup> (mg/l)			NO <sub>3</sub> <sup>-</sup> (mg/l)			Fe (mg/l)			Cl <sup>-</sup> (mg/l)			Hardness (°G)			Mn <sup>2+</sup> (mg/l)			Organic matter					
		max.	ave.	min.	max.	ave.	min.	max.	ave.	min.	max.	ave.	min.	max.	ave.	min.	max.	ave.	min.	max.	ave.	min.	max.	ave.	min.			
1	TM H8	7.2	6.8	6.4	30.0	16.3	8.0	1.3	0.1	0.0	14.6	9.9	7.5	37	29	20	11	8	7	0.6	0.3	0.1	6.2	4.6	3.0	6.1	3.6	2.9
2	TM H9	7.1	6.7	6.4	18.0	9.4	4.6	3.5	0.3	0.0	27.4	19.3	11.7	105	96	70	10	10	8	0.7	0.4	0.3	7.2	3.3	1.9	5.0	2.2	1.1
3	TM H10	7.0	6.7	6.3	20.0	12.3	4.5	2.2	0.4	0.0	20.0	13.2	6.8	71	54	11	9	9	9	0.4	0.3	0.0	5.0	2.5	0.2	4.0	2.1	0.2
4	TM H11	7.6	6.9	6.4	18.0	9.5	4.3	1.3	0.1	0.0	11.4	9.4	6.7	43	22	11	9	7	5	0.4	0.2	0.0	5.9	2.5	1.1	4.0	1.4	0.5
5	TM H13	7.0	6.8	6.4	16.5	10.2	5.0	1.3	0.3	0.0	12.8	9.9	8.3	17	11	9	8	7	6	0.5	0.3	0.1	11.2	2.9	0.6	5.3	1.7	0.6
6	TM H13	7.0	6.8	6.4	16.6	10.2	5.0	1.3	0.3	0.0	12.8	9.9	8.3	17	11	9	8	7	6	0.5	0.3	0.1	11.2	2.9	0.6	5.3	1.7	0.6
7	TM H14	6.9	6.8	6.5	10.0	6.4	3.0	1.3	0.3	0.0	10.0	7.8	6.2	11	8	6	6	6	6	0.4	0.2	0.1	3.5	1.5	1.0	1.3	0.9	0.6
8	TM H15	8.0	6.8	6.4	10.0	7.1	4.0	5.0	0.5	0.0	10.7	7.8	5.0	20	15	11	10	7	5	0.6	0.3	0.0	7.7	2.5	1.0	2.6	1.6	0.8
9	TM H16	7.6	7.0	6.5	30.0	16.5	4.2	1.3	0.1	0.0	13.0	8.3	4.4	28	21	17	9	8	7	1.5	0.3	0.2	12.8	5.1	2.6	8.0	4.1	2.2
10	TM H18	7.0	6.8	6.4	15.0	9.8	4.5	1.3	0.2	0.0	13.6	9.9	7.1	31	20	14	9	6	3	0.4	0.2	0.0	6.2	3.1	0.8	3.2	2.0	0.8
11	TM H19	7.4	6.8	6.4	10.0	6.3	2.6	1.0	0.3	0.0	8.6	7.4	6.4	14	11	9	8	6	4	0.4	0.3	0.2	2.1	1.4	1.1	1.1	1.0	0.8
	Max	8.0	7.0	6.5	30.0	16.5	8.0	5.0	0.5	0.0	27.4	19.3	11.7	105	96	70	11	10	9	1.5	0.4	0.3	12.8	5.1	3.0	8.0	4.1	2.9
	Min	6.9	6.7	6.3	10.0	6.3	2.6	1.0	0.1	0.0	8.6	7.4	4.4	11	8	6	6	6	3	0.4	0.2	0.0	2.1	1.4	0.2	1.1	0.9	0.2
	Ave	7.3	6.8	6.4	17.7	10.4	4.5	1.9	0.3	0.0	14.1	10.3	7.1	36	27	17	9	7	5	0.6	0.3	0.1	7.2	2.9	1.3	4.2	2.0	1.0
	Water Quality Standard	6.5	~	8.5	—	—	—	45.0	—	—	1.0	~	5.0	200	~	400	300	~	500mg/l	0.1	~	0.5	—	—	—	—	—	—
	Criteria for Water Supply	6.0	~	8.0	—	—	—	50.0	—	—	10.0	—	—	200	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	Criteria for Drinking Water	6.5	~	8.5	3.0	—	—	10.0	—	—	0.3	—	—	250	(as NaCl)	—	—	—	—	—	—	—	—	—	—	—	—	—
	WHO Guideline	6.5	~	8.5	3.0	—	—	10.0	—	—	0.5	—	—	250	(as NaCl)	—	—	—	—	—	—	—	—	—	—	—	—	—
		—	—	—	1.5	—	—	50.0	—	—	0.3	—	—	250	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Note: The unit "°G" of Hardness is German degree; 1°G is equivalent to 17.9mg/(CaCO<sub>3</sub>).

Table (b).7 Water Quality of Production Well Fields (Ha Dinh) for the past Five Years (1990---->1995)

No.	Well No.	pH			NH <sub>4</sub> <sup>+</sup> (mg/l)			NO <sub>3</sub> <sup>-</sup> (mg/l)			Fe (mg/l)			Cl <sup>-</sup> (mg/l)			Hardness (°G)			Mn <sup>2+</sup> (mg/l)			Organic matter					
		max.	ave.	min.	max.	ave.	min.	max.	ave.	min.	max.	ave.	min.	max.	ave.	min.	max.	ave.	min.	max.	ave.	min.	max.	ave.	min.			
1	HD H5	7.0	6.8	6.5	20.0	14.3	7.6	1.3	0.3	0.0	14.3	11.9	10.0	23	20	17	9	8	4	0.1	0.0	0.0	3.4	2.7	1.9	2.6	2.1	1.4
2	HD H6	7.0	6.9	6.5	20.0	15.4	6.6	5.0	1.0	0.0	15.0	12.2	9.0	45	32	26	9	8	7	0.1	0.0	0.0	8.0	4.2	2.1	4.0	2.3	1.6
3	HD H7	7.0	6.9	6.5	20.0	13.4	6.0	5.0	0.5	0.0	12.3	10.1	7.8	45	41	34	10	8	8	0.3	0.1	0.0	8.2	3.2	1.4	4.0	2.1	1.3
4	HD H8	6.9	6.8	6.6	20.0	13.8	10.0	1.3	0.4	0.0	19.7	13.5	10.1	43	29	23	9	8	8	0.2	0.1	0.0	4.8	3.3	2.1	3.7	2.4	1.8
5	HD H10	7.1	6.8	6.6	20.0	13.6	6.6	1.3	0.1	0.0	18.9	14.7	7.0	17	16	14	9	8	7	0.2	0.1	0.0	7.2	3.2	1.8	3.2	1.9	1.0
6	HD H12	7.0	6.9	6.6	15.0	9.9	4.4	1.3	0.1	0.0	12.2	10.3	8.3	20	17	10	9	7	5	0.2	0.0	0.0	3.0	2.1	1.7	2.6	1.6	0.8
7	HD H15	7.6	7.0	6.8	20.0	12.9	9.9	1.3	0.3	0.0	10.7	8.3	6.7	28	22	20	9	8	7	0.3	0.1	0.0	5.3	3.0	1.3	2.6	2.1	1.4
8	HD H17	7.3	6.9	6.6	20.0	10.9	6.0	1.5	0.3	0.0	10.7	9.6	7.3	20	16	11	7	6	6	0.2	0.1	0.0	5.8	2.3	1.3	2.9	1.5	0.8
9	HD H18	7.6	7.0	6.6	15.0	10.8	4.0	1.0	0.1	0.0	17.2	11.8	7.7	37	28	26	10	9	8	0.4	0.1	0.0	5.1	2.9	1.6	5.1	2.9	1.6
	Max.	7.6	7.0	6.8	20.0	15.4	10.0	5.0	1.0	0.0	19.7	14.7	10.1	45	41	34	10	9	8	0.4	0.1	0.0	8.2	4.2	2.1	5.1	2.9	1.8
	Min.	6.9	6.8	6.5	15.0	9.9	4.0	1.0	0.1	0.0	10.7	8.3	6.7	17	16	10	7	6	4	0.1	0.0	0.0	3.0	2.1	1.3	2.6	1.5	0.8
	Ave.	7.2	6.9	6.6	18.9	12.8	6.8	2.1	0.4	0.0	14.6	11.4	8.2	31	25	20	9	8	7	0.2	0.1	0.0	5.6	3.0	1.7	3.4	2.1	1.3
	Water Quality Standard	6.5	~	8.5	—	—	—	45.0	—	—	1.0	~	5.0	200	~	400	300	~	500mg/l	0.1	~	0.5	—	—	—	—	—	—
	Criteria for Min. Requirement	6.0	~	8.0	—	—	—	50.0	—	—	10.0	—	—	200	—	—	—	—	500 mg/l	—	—	—	—	—	—	—	—	
	Water Supply Max. Requirement	6.5	~	8.0	—	—	—	25.0	—	—	3.0	—	—	200	—	—	—	—	300 mg/l	—	—	—	—	—	—	—	—	
	Criteria for Urban	6.5	~	8.5	3.0	—	—	10.0	—	—	0.3	—	—	250 (as NaCl)	—	—	—	—	500 mg/l	—	—	—	—	—	—	—	—	
	Rural	6.5	~	8.5	3.0	—	—	10.0	—	—	0.5	—	—	250 (as NaCl)	—	—	—	—	500 mg/l	—	—	—	—	—	—	—	—	
	Drinking Water	6.5	~	8.5	3.0	—	—	10.0	—	—	0.1	—	—	250 (as NaCl)	—	—	—	—	500 mg/l	—	—	—	—	—	—	—	—	
	WHO Guideline	—	—	—	1.5	—	—	50.0	—	—	0.3	—	—	250	—	—	—	—	—	—	—	—	—	—	—	—	—	

Note: The unit °G of Hardness is German degree; 1°G is equivalent to 17.9mg/(CaCO<sub>3</sub>).

Table (b).8 Water Quality of Production Well Fields (Phap Van) for the past Five Years (1990---->1995)

No.	Well No.	pH		NH <sub>4</sub> <sup>+</sup> (mg/l)		NO <sub>3</sub> <sup>-</sup> (mg/l)		Fe (mg/l)		Cl <sup>-</sup> (mg/l)		Hardness (°G)		Mn <sup>2+</sup> (mg/l)		Organic matter													
		max.	ave.	min.	max.	ave.	min.	max.	ave.	min.	max.	ave.	min.	max.	ave.	min.	max.	ave.											
1	PV H1	7.8	7.0	6.6	30.0	17.2	10.0	1.3	0.3	0.0	12.0	7.9	4.5	31	21	17	11	8	6	0.6	0.2	0.0	14.2	6.3	3.8	9.4	4.7	2.1	
2	PV H2	7.4	7.0	6.5	21.6	15.1	12.0	1.3	0.2	0.0	10.1	8.4	6.8	26	22	18	8	7	6	0.2	0.1	0.0	8.0	5.4	3.4	6.7	4.2	1.9	
3	PV H3	7.0	7.0	6.6	25.0	18.8	12.0	3.0	0.6	0.0	9.8	8.3	7.6	23	20	20	9	7	6	0.9	0.2	0.0	6.7	4.7	2.9	5.3	3.8	2.9	
4	PV H4	7.2	7.0	6.9	20.0	15.2	6.6	1.3	0.1	0.0	10.0	7.9	5.5	28	24	21	9	7	6	0.3	0.1	0.0	10.4	6.0	4.5	5.8	4.5	3.5	
5	PV H5	7.2	7.0	6.8	20.0	16.7	7.0	0.0	0.0	0.0	8.8	7.8	7.2	28	26	23	10	8	7	0.2	0.1	0.0	12.6	6.0	3.8	7.8	5.1	3.8	
6	PV H6	7.0	6.9	6.6	30.0	21.4	12.0	1.0	0.1	0.0	10.3	8.5	7.5	26	21	17	8	7	7	0.3	0.2	0.1	10.2	7.0	5.6	9.0	6.0	4.3	
7	PV H7	7.3	6.9	6.6	40.0	23.1	10.0	2.8	0.5	0.0	10.0	7.5	3.8	26	21	11	9	8	5	0.2	0.1	0.0	11.0	7.2	5.0	8.6	5.4	3.7	
8	PV H8	7.8	7.1	6.6	60.0	28.0	20.0	1.3	0.1	0.0	10.8	8.3	7.2	23	19	9	11	9	8	0.2	0.1	0.0	10.2	8.6	7.2	7.8	6.4	4.8	
9	PV H9	7.6	6.9	6.5	30.0	21.6	15.0	1.3	0.2	0.0	10.5	8.2	6.0	23	21	17	9	8	7	0.4	0.2	0.0	7.2	5.8	3.5	6.6	4.5	3.2	
	Max	7.8	7.1	6.9	60.0	28.0	20.0	3.0	0.6	0.0	12.0	8.5	7.6	31	26	23	11	9	8	0.9	0.2	0.1	14.2	8.6	7.2	9.4	6.4	4.8	
	Min.	7.0	6.9	6.5	20.0	15.1	6.6	0.0	0.0	0.0	8.8	7.5	3.8	23	19	9	8	7	5	0.2	0.1	0.0	6.7	4.7	2.9	5.3	3.8	1.9	
	Ave.	7.4	7.0	6.6	30.7	19.7	11.6	1.5	0.2	0.0	10.2	8.1	6.2	27	22	17	9	8	7	0.4	0.1	0.0	10.1	6.3	4.4	7.4	5.0	3.4	
	Water Quality Standard	6.5	~	8.5	—	—	—	45.0	—	1.0	~	5.0	300~500mg/l	0.1	~	0.5	—	—	—	—	—	—	—	—	—	—	—	—	—
	Criteria for Water Supply	6.0	~	8.0	—	—	—	50.0	—	10.0	—	10.0	500 mg/l	0.1	—	0.5	—	—	—	—	—	—	—	—	—	—	—	—	—
	Criteria for Drinking Water	6.5	~	8.5	3.0	3.0	10.0	10.0	0.3	0.3	250 (as NaCl)	500 mg/l	500 mg/l	0.1	—	0.1	—	—	—	—	—	—	—	—	—	—	—	—	—
	WHO Guideline	6.5	~	8.5	3.0	3.0	10.0	10.0	0.5	0.5	250 (as NaCl)	500 mg/l	500 mg/l	0.1	—	0.1	—	—	—	—	—	—	—	—	—	—	—	—	—
	Note:	The unit °G of Hardness is German degree. 1°G is equivalent to 17.9mg/(CaCO <sub>3</sub> ).																											

Table (c) Ground Water Quality in the Suburban Districts

District	Well No.	pH			NH <sub>4</sub> <sup>+</sup> (mg/l)			NO <sub>3</sub> <sup>-</sup> (mg/l)			Fe (mg/l)			Cl <sup>-</sup> (mg/l)			Hardness (°G)			Mn <sup>2+</sup> (mg/l)			Organic matter												
		max.	ave.	min.	max.	ave.	min.	max.	ave.	min.	max.	ave.	min.	max.	ave.	min.	max.	ave.	min.	max.	acid-based	alkali-based	acid-based	alkali-based											
Soc Son	P66a	6.0	5.9	5.8	6.0	3.4	0.8	2.5	1.3	0.0	3.4	2.0	0.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
	P68a	6.4	6.3	6.1	0.8	0.4	0.0	5.4	3.0	0.5	9.5	5.6	1.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
	SSPC	7.4	7.4	7.4	0.1	0.1	0.1	1.0	1.0	1.0	0.4	0.4	0.4	47	47	47	6	6	6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
	Max.	7.4	7.4	7.4	6.0	3.4	0.8	5.4	3.0	1.0	9.5	5.6	1.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
	Min.	6.0	5.9	5.8	0.1	0.1	0.0	1.0	1.0	0.0	0.4	0.4	0.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
	Ave.	6.6	6.5	6.4	2.3	1.3	0.3	3.0	1.7	0.5	4.4	2.7	0.9	47	47	47	6	6	6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
	P71a	6.7	6.1	5.6	1.0	0.4	0.0	0.5	0.3	0.0	11.5	5.8	0.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
P73a	6.1	6.1	6.1	6.0	6.0	6.0	2.5	2.5	2.5	15.0	15.0	15.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
P69a	6.7	6.0	5.6	2.0	0.8	0.3	1.3	0.4	0.0	10.3	5.8	1.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
P67a	7.0	6.8	6.6	2.0	1.5	1.1	7.6	4.1	0.5	13.8	12.4	11.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
P65a	7.1	6.5	5.8	7.0	3.1	0.6	2.6	1.2	0.5	13.1	6.0	0.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
P72a	7.0	6.6	5.9	0.4	0.2	0.0	2.5	1.0	0.1	3.9	2.6	1.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Max.	7.1	6.8	6.6	7.0	6.0	6.0	7.6	4.1	2.5	15.0	15.0	15.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Min.	6.1	6.0	5.6	0.4	0.2	0.0	0.5	0.3	0.0	3.9	2.6	0.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ave.	6.8	6.3	6.0	3.1	2.0	1.3	2.8	1.6	0.6	11.3	7.9	5.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P79a	7.0	6.7	6.4	1.6	0.7	0.1	10.0	5.1	1.1	9.2	5.1	2.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P78a	6.5	6.5	6.5	0.3	0.3	0.3	1.0	1.0	1.0	9.0	8.0	8.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P15a	6.8	6.6	6.4	3.7	2.1	0.1	1.3	0.5	0.0	12.3	7.9	4.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P77a	6.7	6.6	6.4	1.0	0.8	0.7	0.6	0.5	0.5	17.0	14.2	11.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P80a	7.1	6.7	6.5	7.4	3.5	0.4	0.5	0.4	0.0	8.4	7.4	5.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P75a	7.0	6.6	5.9	0.4	0.2	0.0	2.5	1.0	0.1	3.9	2.6	1.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
P76a	7.3	7.1	6.8	8.0	6.0	3.2	1.0	0.6	0.1	17.0	12.3	7.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
P49a	8.2	7.2	5.8	8.7	3.1	0.3	0.6	0.4	0.0	13.6	7.6	0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Max.	8.2	7.2	6.8	8.7	6.0	3.2	10.0	5.1	1.1	17.0	14.2	11.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Min.	6.5	6.5	5.8	0.3	0.2	0.0	0.5	0.4	0.0	3.9	2.6	0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ave.	7.1	6.7	6.3	3.9	2.1	0.6	2.2	1.2	0.3	11.2	8.1	5.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Water Quality Standard		6.5	~	8.5	—	—	—	45.0	—	1.0	~	5.0	200	~	400	300~500mg/l	0.1	~	0.5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
Criteria for Water Supply	Min. Requirement	6.0	~	8.0	—	—	—	50.0	—	10.0	—	—	200	—	—	500 mg/l	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
Criteria for Drinking Water	Max. Requirement	6.5	~	8.0	—	—	—	25.0	—	3.0	—	—	200	—	—	300 mg/l	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Urban		6.5	~	8.5	3.0	—	—	10.0	—	0.3	—	—	250 (as NaCl)	—	—	500 mg/l	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
Rural		6.5	~	8.5	3.0	—	—	10.0	—	0.5	—	—	250 (as NaCl)	—	—	500 mg/l	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
WHO Guideline		—	—	—	1.5	—	—	50.0	—	0.3	—	—	250	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	

Note:  
 1) The unit "°G" of Hardness is German degree; 1°G is equivalent to 17.9mg/(CaCO<sub>3</sub>).  
 2) As for the well of SSPC (Soc Son People's Committee), data are quoted from the source:  
 HPC, FINNIDA, "SOC SON WATER SUPPLY AND SANITATION PROJECT FIS FINAL REPORT", 1995

**APPENDIX A-6      Water Leakage Survey Report**

**(a) Part I      Water Leakage Survey**

**(b) Part II     Methodology of Water Leak Protection**

## **PART 1 Water Leakage survey**

- 1. Introduction**
- 2. Survey Practice**
  - 2.1 Preparation of Network Maps**
  - 2.2 Survey Procedure**
- 3. Result of Survey**
- 4. Conclusion**

## **PART 2 Methodology of Water Leak Reduction**

- 1. General**
  - 1.1 Aims of Water Leak Reduction**
  - 1.2 Pipelines**
  - 1.3 Water Leak Reduction Measure**
- 2. Reasons of Water Loss in Hanoi**
  - 2.1 Physical Losses**
  - 2.2 Administration Loss**
- 3. Water Loss Components**
- 4. Method of Leakage Reduction**
  - 4.1 General**
  - 4.2 Basic Conditions for Leakage Reduction Program**

## Part 1 Water Leakage Survey



## **PART 1: WATER LEAKAGE SURVEY**

### **1. INTRODUCTION**

Hanoi water supply system comprises 8 major water treatment plants and 15 small water treatment plants with total capacity of about 370,000 m<sup>3</sup>/day on the daily average basis.

One of the most serious problems in the water supply service is the extremely high level of unaccounted-for water (U.F.W) : i.e. water which was distributed but could not obtain revenue of HWBC. UFW consists of physical loss, unmetered water, unbilled water, illegal connections' water, etc.

The aim of this water leakage survey was to grasp the rate of the physical loss included in the UFW.

Eight (8) blocks were selected among the urban districts in Hanoi water supply area for the purpose of the leakage survey.

## 2. SURVEY PRACTICE

### 2.1 Preparation of Network Maps

Prior to execution of the leakage survey, pipelines' network maps, 20 sheets in total were prepared. They show locations both of new pipelines constructed or replaced during 1985 - 1995 and old pipelines constructed before 1985. They are :

- One key map showing transmission pipelines (Scale = 1:25,000)  
and
- 19 network maps showing both transmission and distribution pipelines (Scale = 1:5,000)

#### LIST OF NETWORK MAPS

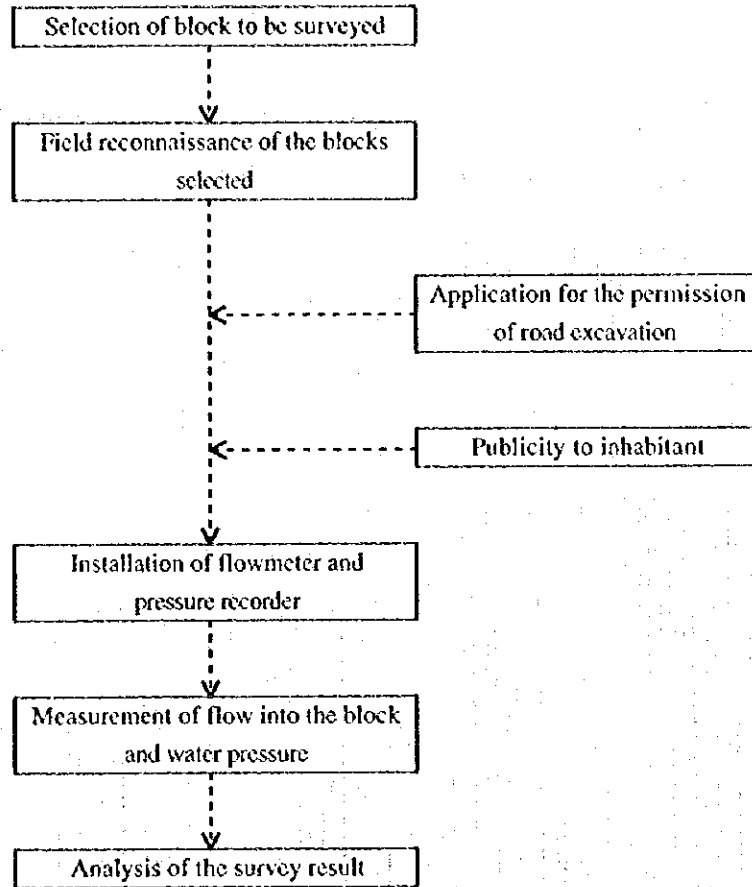
Scale = 1:5,000

Map No.	Index No. of Base map	Name of Districts
1	304 (F - 48 <sup>a</sup> - 104)	TU LIEM
2	326 (F - 48 <sup>a</sup> - 104)	TU LIEM
3	327 (F - 48 <sup>a</sup> - 104)	TU LIEM, BA DINH
4	328 (F - 48 <sup>a</sup> - 104)	TU LIEM, BA DINH
5	329 (F - 48 <sup>a</sup> - 104)	BA DINH, TU LIEM, GIA LAM
6	350 (F - 48 <sup>a</sup> - 104)	TU LI
7	351 (F - 48 <sup>a</sup> - 104)	TU LIEM, DONG DA, BA DINH
8	352 (F - 48 <sup>a</sup> - 104)	BA DINH, DONG DA
9	353 (F - 48 <sup>a</sup> - 104)	DONG DA, BA DINH, HOAN KIEM
10	354 (F - 48 <sup>a</sup> - 104)	HOAN KIEM, GIA LAM
11	375 (F - 48 <sup>a</sup> - 104)	TU LIEM, DONG DA
12	376 (F - 48 <sup>a</sup> - 104)	DONG DA, BA DINH, TU LIEM
13	377 (F - 48 <sup>a</sup> - 104)	HAI BA TRUNG, HOAN KIEM, DONG DA
14	378 (F - 48 <sup>a</sup> - 104)	HAI BA TRUNG, HOAN KIEM, GIA LAM
15	15 (F - 48 <sup>a</sup> - 116)	HA DONG, TU LIEM, THANH TRI
16	16 (F - 48 <sup>a</sup> - 116)	THANH TRI, DONGDA, TULIEM
17	17 (F - 48 <sup>a</sup> - 116)	HAI BA TRUNG, DONG DA, THANH TRI
18	18 (F - 48 <sup>a</sup> - 116)	THANH TRI, HAI BA TRUNG
19	41 (F - 48 <sup>a</sup> - 116)	THINH TRI

## 2.2 SURVEY PROCEDURE

The leakage survey was carried out according to the procedure shown below :

### PROCEDURE OF THE LEAKAGE SURVEY



#### (1) Selected of Blocks to be surveyed

1) Preliminary, the block to be survey was selected on the network maps and drawings, under discussion with HWBC. It was determined and agreed that the block to be surveyed should not have looped networks, but have only single pipeline, due to convenience of the leakage survey.

2) The preliminarily selected survey block was checked by the Enterprise which maintains the block area, on the following items :

- a) Pipe diameter and material
- b) Pipe laying date
- c) Number of house connections in the block
- d) Number of private reservoirs in the block

3) Field reconnaissance was carried out prior to the survey practice. Where and when some difficulties were found, the procedure was returned to 1).

Block selected for the leakage survey are given below and their detailed maps are shown in Appendix-1.

### SURVEY BLOCKS SELECTED

Survey point No.	Name of Block Surveyed	Date of Survey
1	YEN PHU	16 Apr - 17 Apr, 1996
2	QUAN NGUA	2 May - 3 May, 1996
3	LANG THUONG	15 May - 16 May, 1996
4	THUONG DINH	9 May - 10 May, 1996
5	PHAP VAN	17 May - 18 May, 1996
6	AN SON	21 May - 22 May, 1996
7	HUONG VIEN	10 May - 11 May, 1996
8	221 NGUYEN KHUYEN	14 May - 15 May, 1996

(2) Publicity to Inhabitants in the Survey Block.

The survey requested the inhabitants' cooperation that not to use water or not to open water taps during midnight hours in the survey day. The publicity and announcement for the cooperation was done by the staff of the Enterprise.

(3) Blockwise Flow Measurement.

To measure total flow to the block, an ultrasonic flowmeter was installed at the inflow point on a distribution pipeline for 24 hours.

### 3. RESULT OF SURVEY

The measurement of flow and water pressure on a distribution pipeline was executed for 24 hours by each survey point. The survey results are given in Appendix-2 and summarized below.

**TABLE OF SURVEY RESULT**

No.	Block Name	Max Flow (m <sup>3</sup> /h)	Ave. Flow (m <sup>3</sup> /h)	Min Flow (m <sup>3</sup> /h)	Rate of Min. Flow (%)	Physical Loss (Estimated) (%)
1	YEN PHU	30.71	22.17	15.34	69	15-20
2	QUAN NGUA	2.93	0.42	0.09	20	5-10
3	LANG THUONG	5.31	3.66	1.82	50	15-20
4	THUONG DINH	4.04	1.71	0.43	25	5-10
5	PHAP VAN	5.06	1.56	0.27	17	5-10
6	AN SON	12.16	7.09	4.23	60	10-15'
7	HUONG VIEN	6.11	3.14	1.58	50	20-30
8	221 NGUYEN KHUYEN	0.93	0.24	0.16	66	15-20

Before the survey was executed, it was expected that the minimum flow in the midnight would represent the physical loss, provided that water was not used by consumers during the midnight hours. However, the minimum flow actually measured in the midnight hours was judged to include much actual water use or actual waste through the pipeline and service connections. It was because of that i) some of survey blocks were not supplied with piped water in daytime; there, water is taken only in the night time, and ii) many of households had private reservoirs which were not equipped with water taps; there, water was taken whenever available.

Accordingly, the minimum flow did not present the actual physical loss, but just include. Therefore, the physical loss in the above tables is the probable figure estimated by the expert who carried out the survey, based on (a) the result of visual inspection on the conditions of the existing pipes, (b) his experience on leakage survey, and (c) opinions of officials of HWBC and Enterprises concerned.

#### No.1 YEN PHU (Managed by Ba Dinh Enterprise)

The rate of the Minimum flow was 69% to the average flow. The minimum flow must include physical loss. Within this minimum flow, physical loss was judged to be 15 - 20% by the expert who actually measured the flow, taking the following conditions confirmed by the Ba Dinh Enterprise and its opinions into consideration.

- 1) All of private reservoirs (30 Nos.) did not have water taps and flow could not be stopped in the midnight.
- 2) Some registered users used water in the midnight.
- 3) This block has some illegal connections.
- 4) On this pipeline, pressure test was not carried out when it was constructed.

#### No.2 QUAN NGUA (Ba Dinh Enterprise)

The rate of the minimum flow was 20%; and 5 - 10% physical loss, based on the following conditions confirmed by the Ba Dinh Enterprise.

- 1) All of private reservoirs (9 Nos.) did not have water taps.
- 2) Some users used water in the midnight.
- 3) The pipeline was constructed in 1995.

No.3 LANG THUONG (Dong Da Enterprise)

Minimum flow : 50%  
Physical loss : 15 - 20%

- 1) All of private reservoirs (37 Nos.) did not have water taps.
- 2) Some users used water in the midnight.
- 3) This block has many illegal connections.
- 4) The pipeline was constructed in 1992.

No.4 THUONG DINH (Dong Da Enterprise)

Minimum flow : 25%  
Physical loss : 5 - 10%

- 1) Some of private reservoirs (35 Nos.) did not have water taps.
- 2) The pipeline was constructed in 1995.

No.5 PHAP VAN (Hai Ba Trung Enterprise)

Minimum flow : 17%  
Physical loss : 5 - 10%

- 1) A few of users used water in the midnight.
- 2) This distribution pipeline was constructed in 1990 and service pipelines; and house connections in 1994-1995.

No.6 AN SON (Hai Ba Trung Enterprises)

Minimum flow : 60%  
Physical loss : 10 - 15%

- 1) All of private reservoirs (25 Nos.) did not have water taps.
- 2) Houses located on the edges of the block could not obtain water during the daytime; and took water in the midnight.
- 3) The pipeline was constructed in 1993.

No.7 HUONG VIEN (Hai Ba Trung Enterprise)

Minimum flow : 50%  
Physical loss : 20 - 30%

- 1) Almost all of private reservoirs (7 Nos.) did not have water taps.
- 2) About 20% of illegal connections existed in the block.
- 3) The pipeline was constructed in 1980.

No.8 221 NGUYEN KHUYEN (Dong Da Enterprise)

Minimum flow : 66%  
Physical loss : 15 - 20%

- 1) Most of private reservoirs (12 Nos.) did not have water taps.
- 2) There was no water pressure in the pipeline during daytime; therefore all consumers were taking water in night time.
- 3) The pipeline was constructed in 1993.

#### 4. CONCLUSION

(1) It was found by this leakage survey that rates of physical leakage in pipelines constructed or replaced during recent years of 1985 - 1995 were rather not so high : approximately 10 -15% estimated. These rates, however, were actual under the present low water pressure conditions. When the supply pressure increases in the future, rates of the leakage might be raised to some extent.

In several areas where pipeline were installed before 1985, rates of leakage are estimated to be about 30%. In old towns such as Hoan Kiem District, proper leakage survey was judged by discussion between HWBC and JICA Study Team to be almost impossible due to a lot of various situation. These areas might show higher rates of leakage.

It could be concluded that in the whole city, consisting of old pipe areas and new pipe areas, the rate of physical leakage was 20 - 25%, or rather 25% on the average.

(2) Actual situation of water supply in Hanoi were observed :

a) Water supply pressure is generally very low in most areas of Hanoi. Some areas were not being supplied for long time, particularly in high demand months in summer season. Because of low pressure and rationing supply prevailing in the service areas, many consumers are storing water in their own storage tanks in midnight time or whenever water is available, even using their own suction pumps installed on service connections for themselves against scarce availability of domestic use water.

b) Water meters have not been necessarily installed on house connections. Number of illegal connections seems very large at present; however actual status of illegal connections is not well known.

c) Rationing water supply or intermittent supply is very common particularly in summer season. This is controlled by pump operation in treatment plants and operational valves on the distribution pipelines.

(3) Leakage survey

It was very difficult to select places for the survey and to carry out the survey due to various problems and complexity of the current water supply conditions.

Because of the above-mentioned difficulty, so far such leakage survey has not been practiced well although some equipment for leakage survey were supplied by FINNIDA Program in the past. But visible leakage on the ground and leakage found and informed by customers are being repaired.

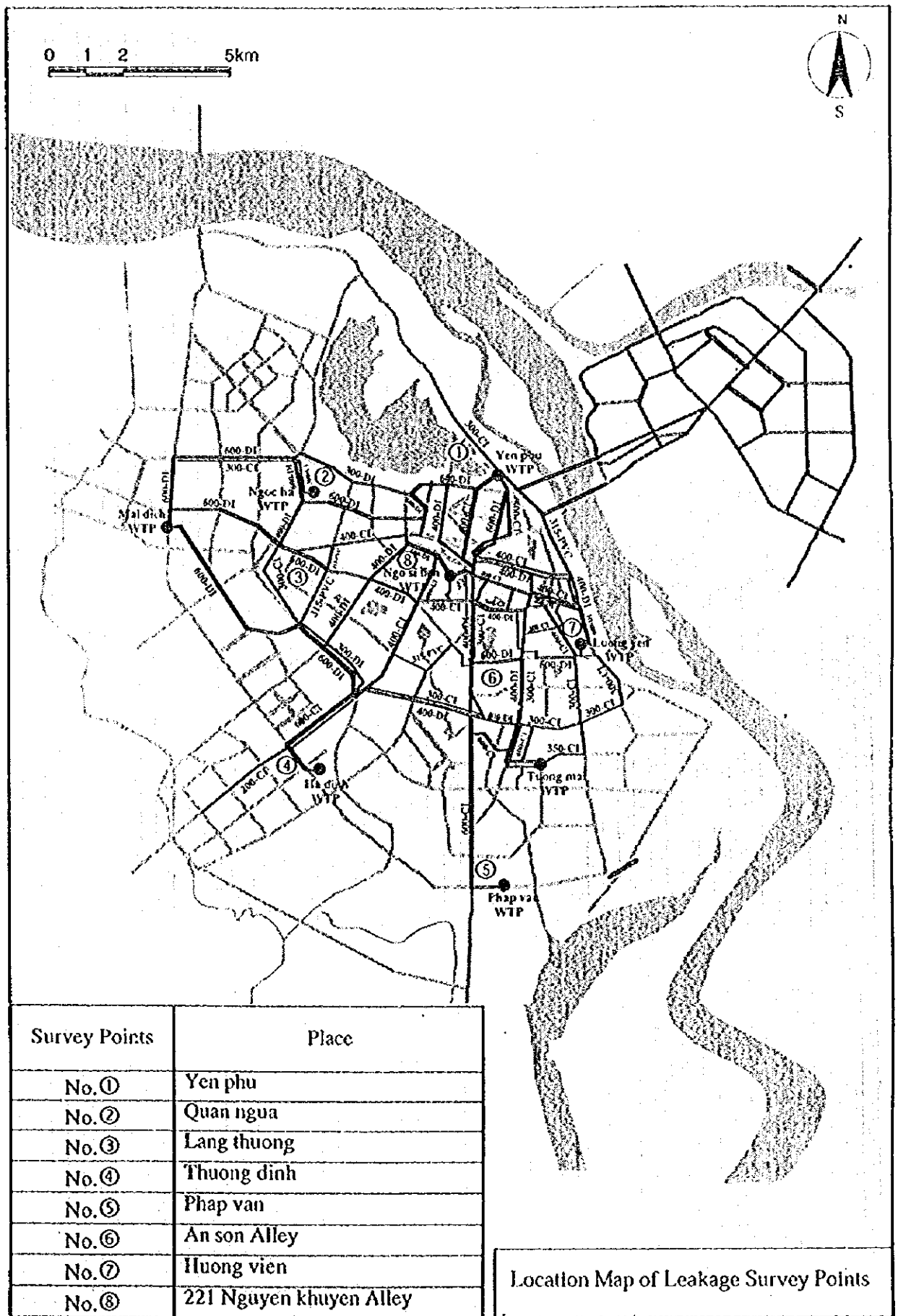
The leakage survey carried out by the JICA Study Team has shown present status for the subsequent survey to be done by HWBC.

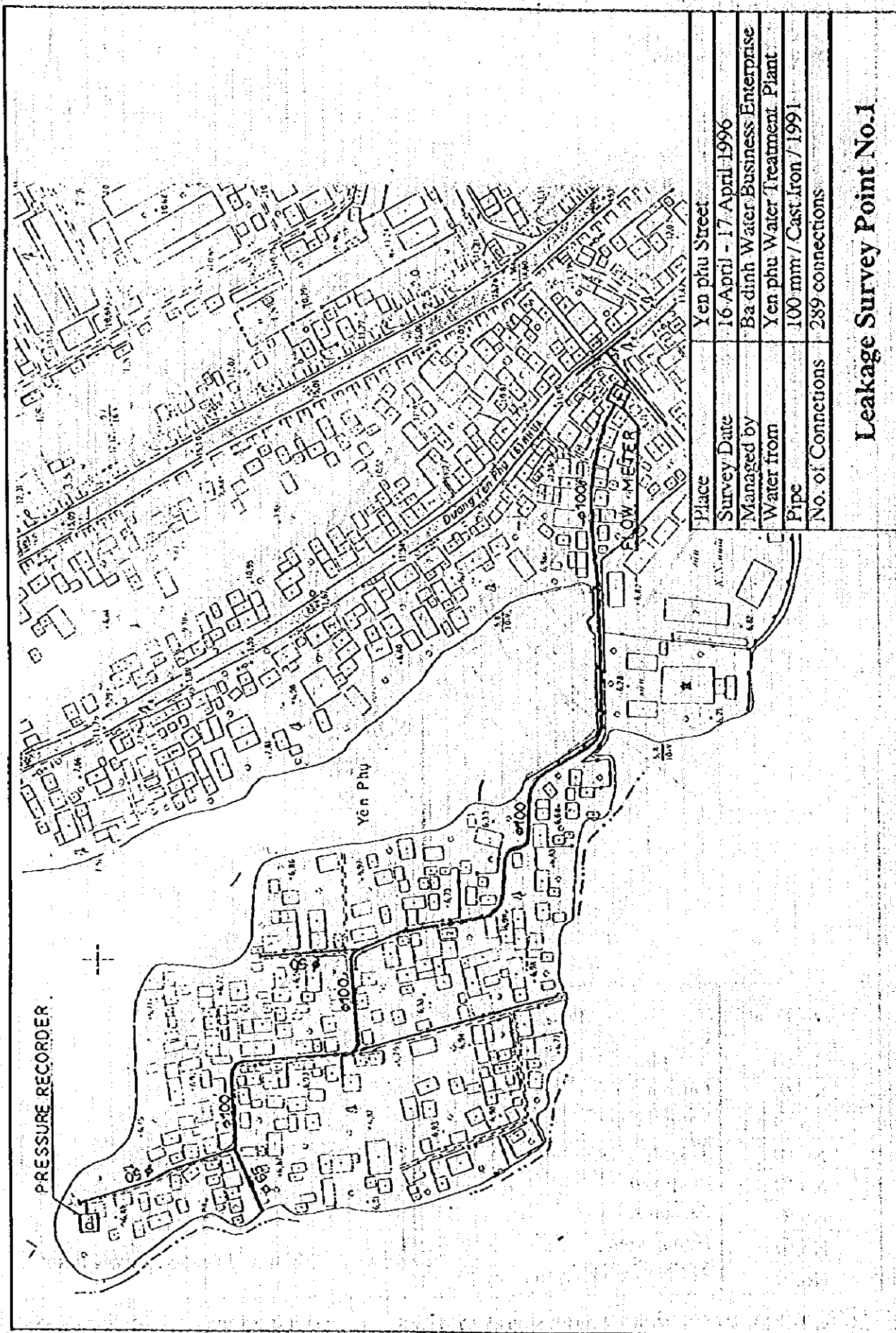
The leakage control works should be practiced after that old pipelines be replaced and water be supplied under sufficient conditions of flow and pressure.

**Appendix-1**

**Site Maps of Leakage Survey Points**

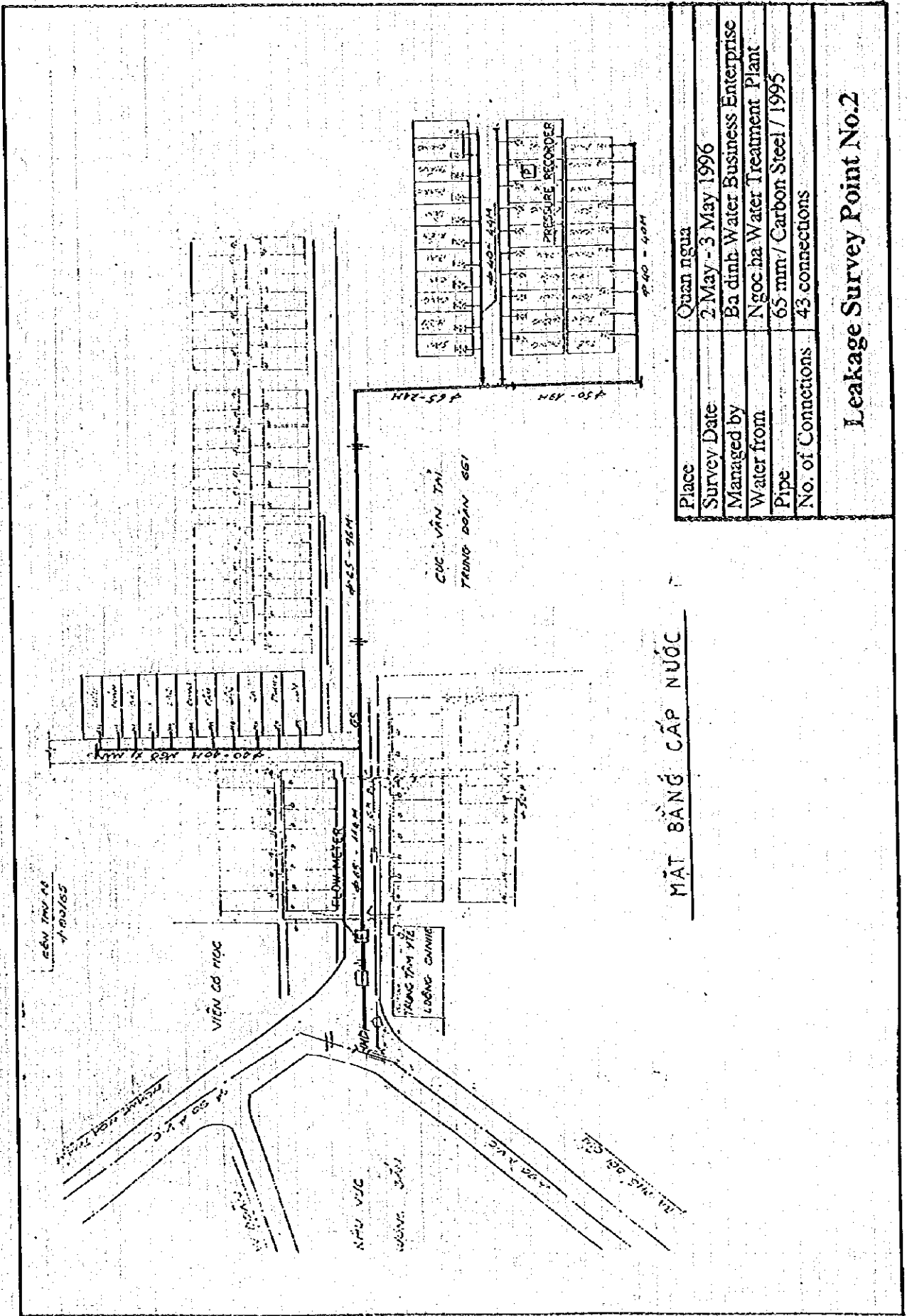






Place	Yen phu Street
Survey Date	16 April - 17 April 1996
Managed by	Ba dinh Water Business Enterprise
Water from	Yen phu Water Treatment Plant
Pipe	100 mm / Cast Iron / 1991
No. of Connections	289 connections

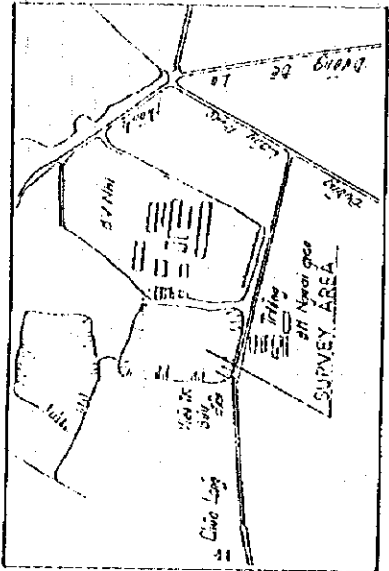
**Leakage Survey Point No.1**



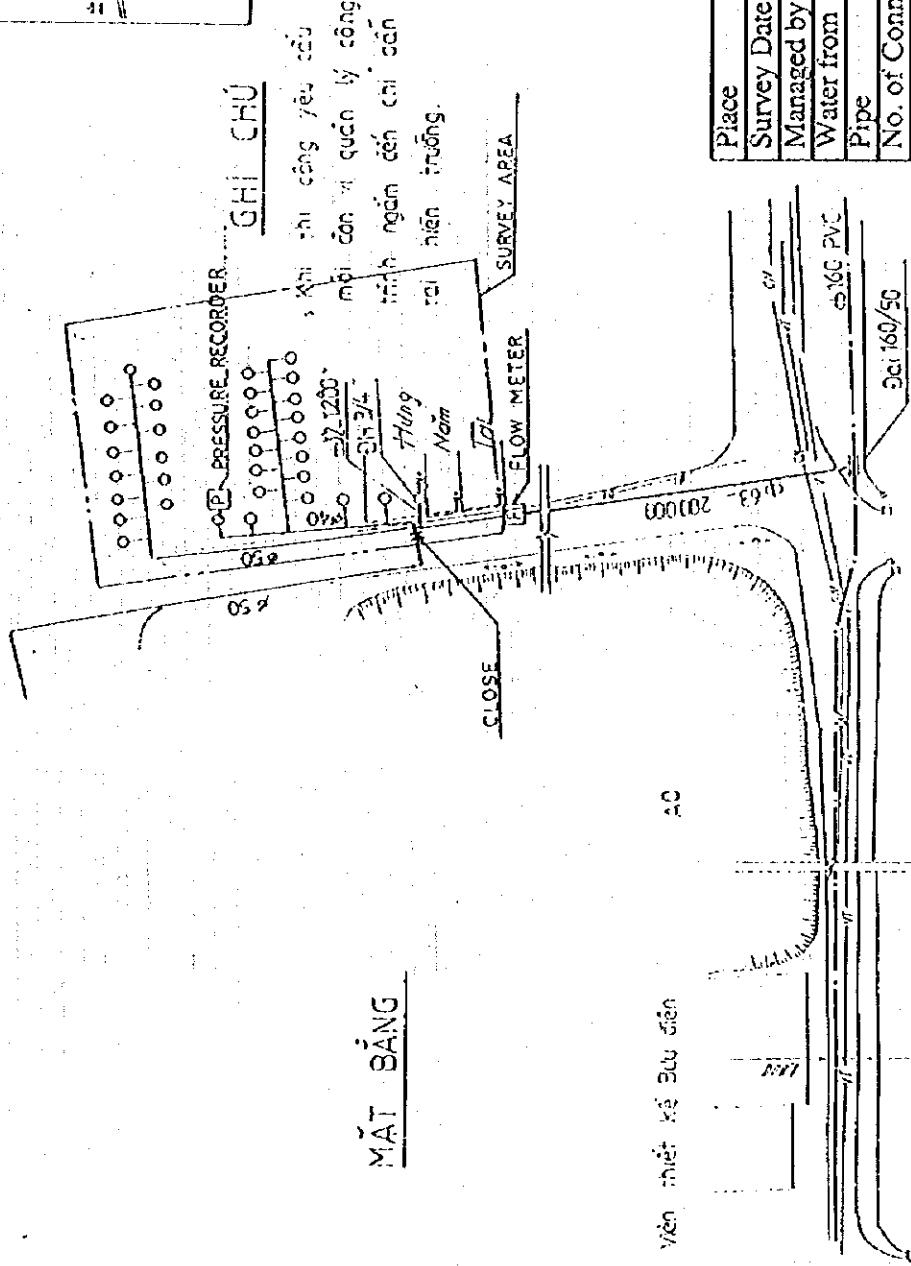
MẶT BẰNG CẤP NƯỚC

Place	Quan nưa
Survey Date	2 May - 3 May 1996
Managed by	Ba dinh Water Business Enterprise
Water from	Ngoc ha Water Treatment Plant
Pipe	65 mm / Carbon Steel / 1995
No. of Connections	43 connections
<b>Leakage Survey Point No.2</b>	

**MẶT BẰNG TỔNG THỂ**



**MẶT BẰNG**



**GHI CHÚ**

Khi thi công yêu cầu  
mỗi công nhân phải  
trình nghiệm để chỉ dẫn  
tại hiện trường.

Viện thiết kế Bưu điện

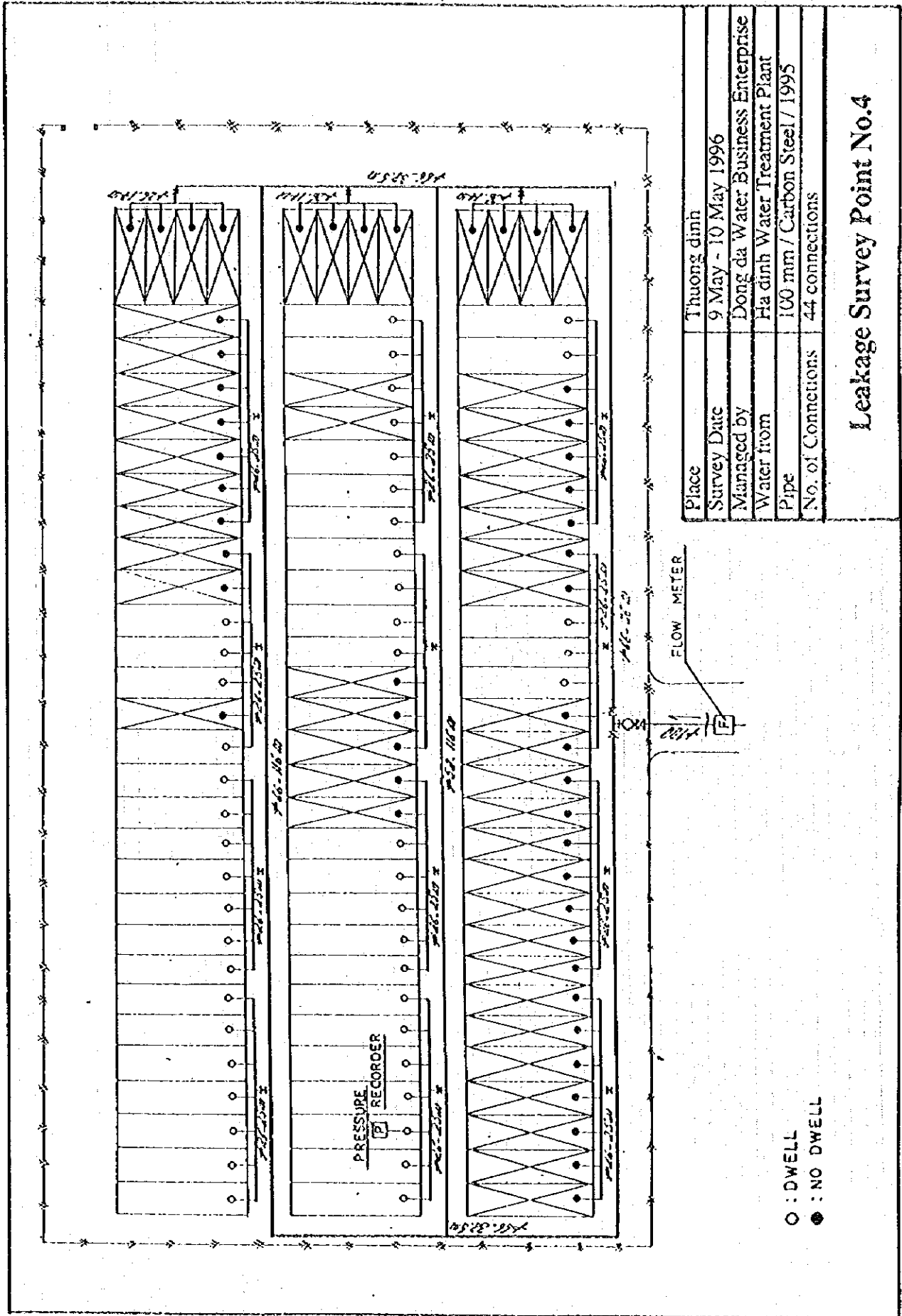
AC

ĐẠI HỌC NGOẠI THƯƠNG

ĐẠI HỌC NGCAI GIAO

Place	Lang thuong
Survey Date	15 May - 16 May 1996
Managed by	Dong da Water Business Enterprise
Water from	Mai dich Water Treatment Plant
Pipe	63 mm / PVC / 1993
No. of Connections	37 connections

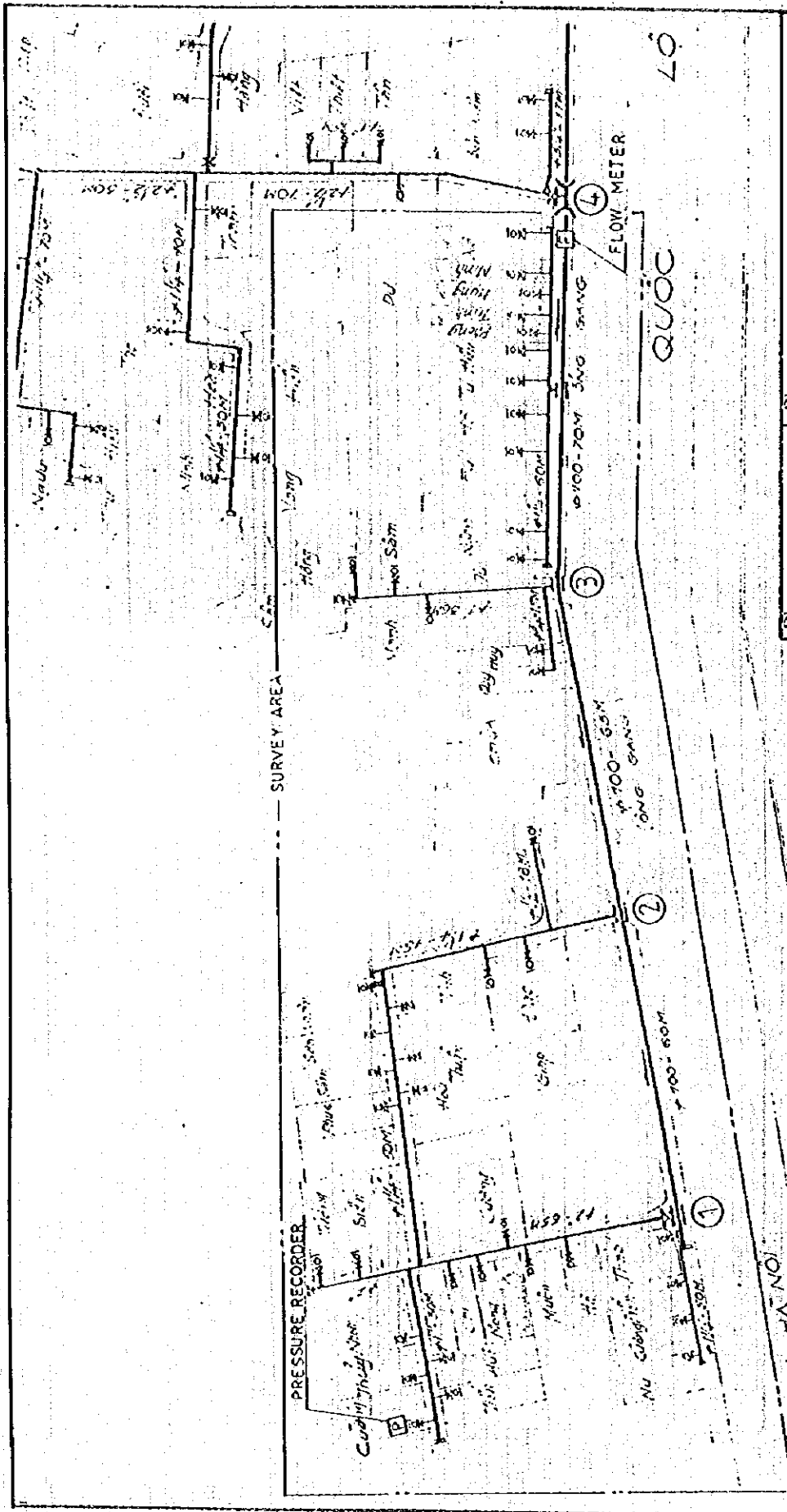
**Leakage Survey Point No.3**



Place	Thuong dinh
Survey Date	9 May - 10 May 1996
Managed by	Dong da Water Business Enterprise
Water from	Ha dinh Water Treatment Plant
Pipe	100 mm / Carbon Steel / 1995
No. of Connections	44 connections

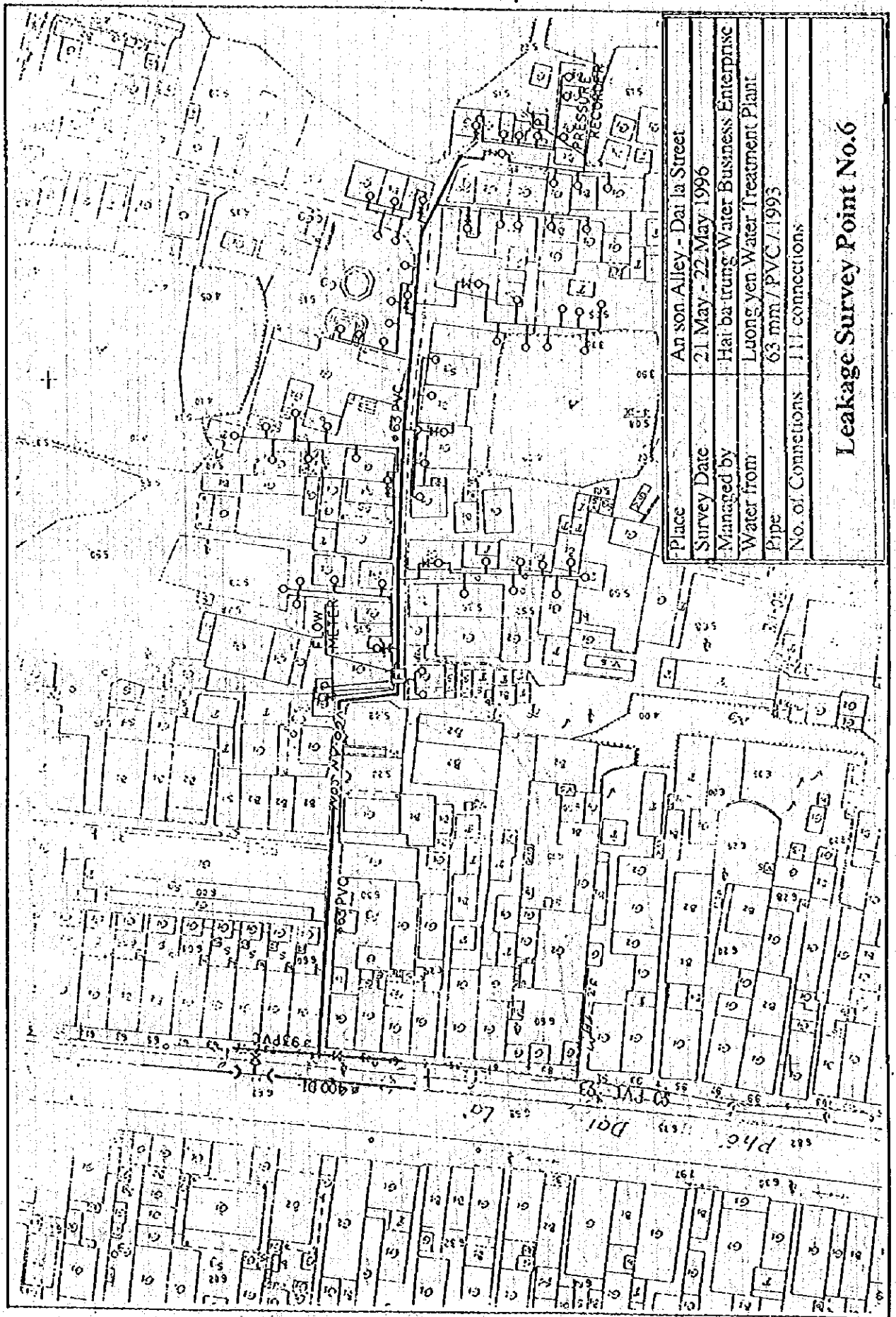
**Leakage Survey Point No.4**

○ : DWELL  
● : NO DWELL



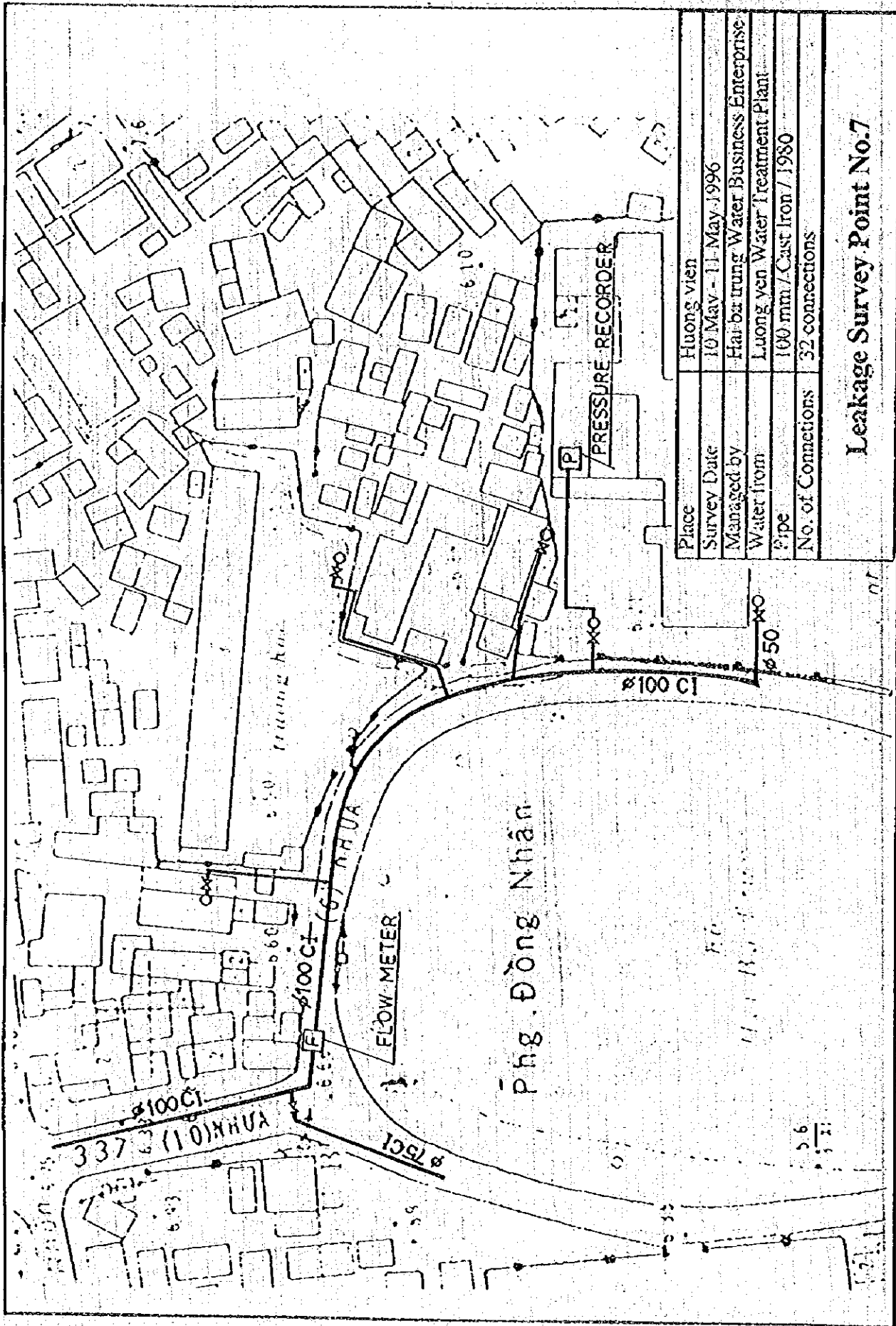
Place	Phap van
Survey Date	17 May - 18 May 1996
Managed by	Hai ba trung Water Business Enterprise
Water from	Phap van Water Treatment Plant
Pipe	100 mm / Cast-iron / 1990
No. of Connections	45 connections

Leakage Survey Point No.5



Place	An son Alley - Dai la Street
Survey Date	21 May - 22 May 1996
Managed by	Hai ba trung Water Business Enterprise
Water from	Luong yen Water Treatment Plant
Pipe	63 mm / PVC / 1993
No. of Connections	117 connections

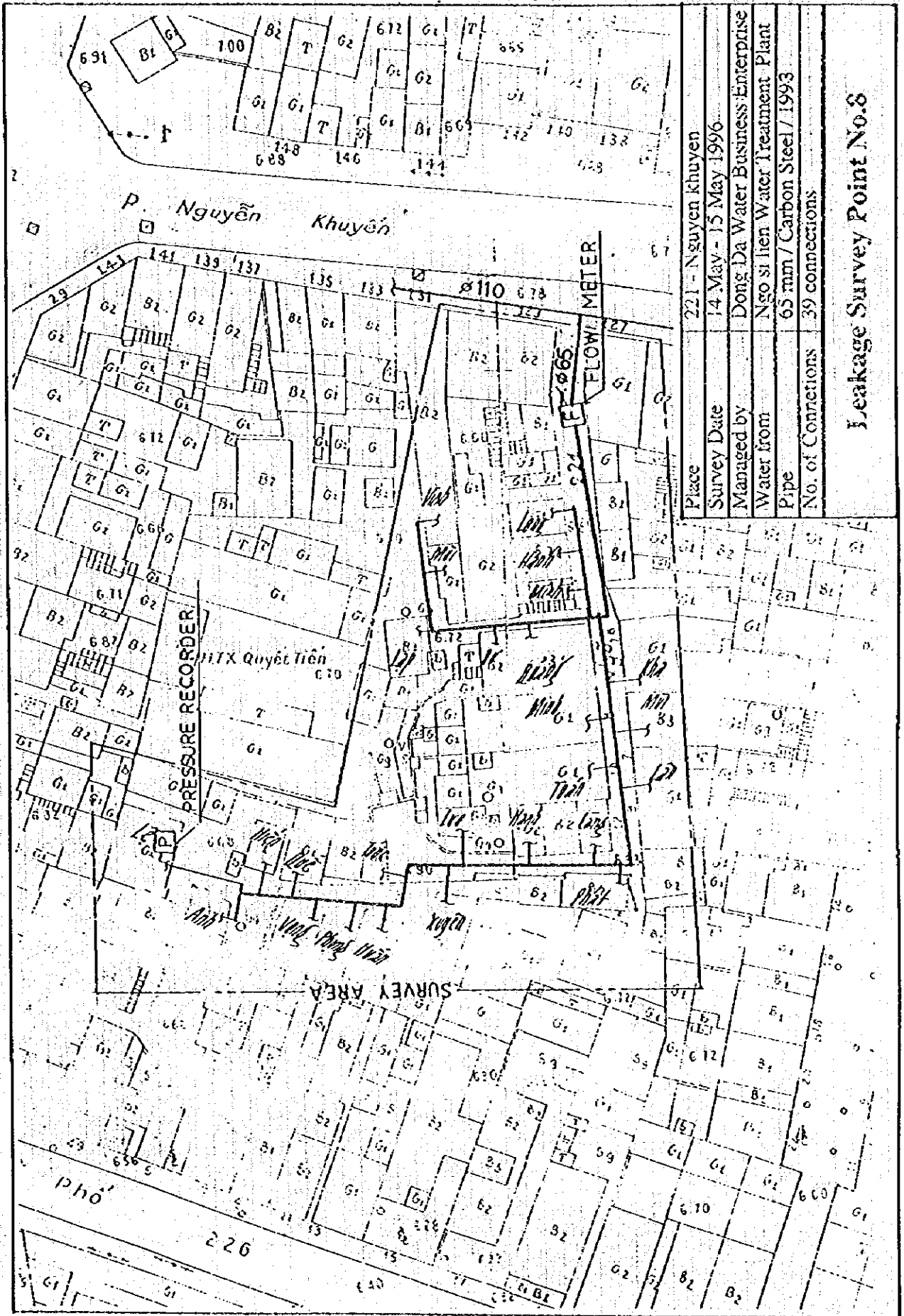
**Leakage Survey Point No.6**



Place	Huong vien
Survey Date	10 May - 11 May 1996
Managed by	Hai ba trung Water Business Enterprise
Water from	Luong yen Water Treatment Plant
Pipe	100 mm / Cast Iron / 1980
No. of Connections	32 connections

Leakage Survey Point No.7





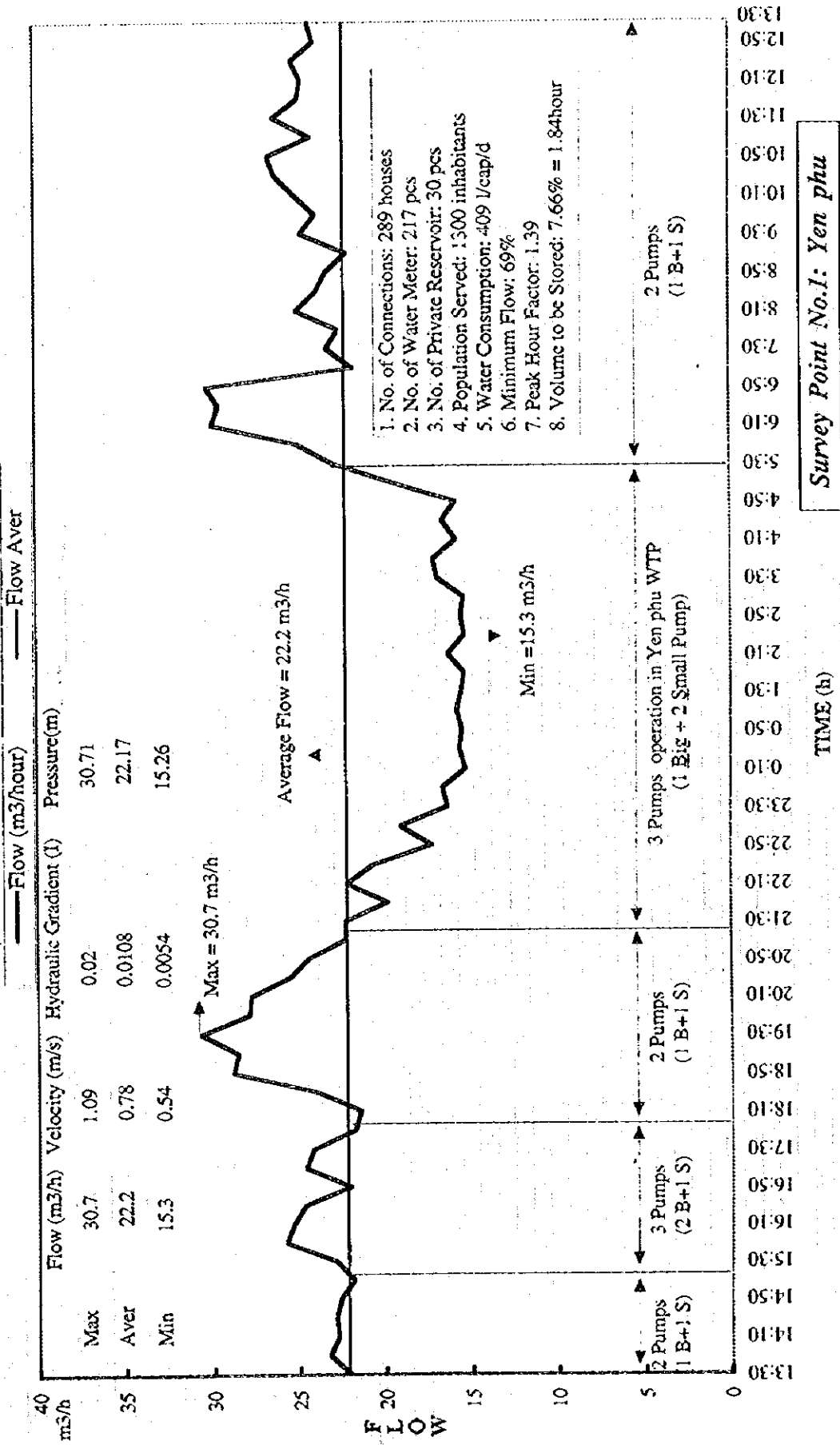
Leakage Survey Point No.8

## **Appendix-2**

### **Graphs of Survey Results**

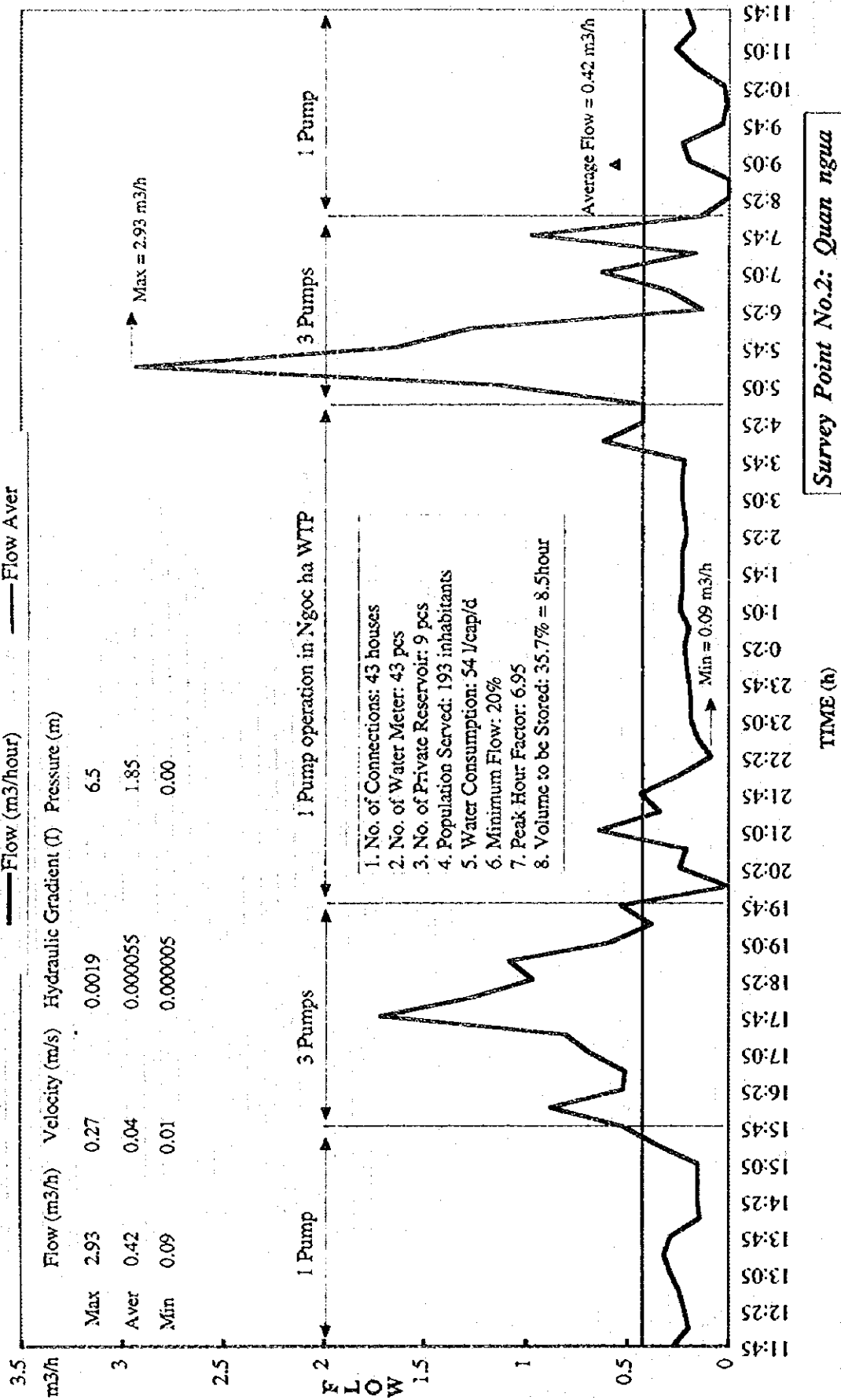
Pipe Material: Cast Iron  
 Year of Pipeline Construction: 1991  
 Outer/Inner Diameter: 117.2/100 mm  
 Wall thickness: 8.6 mm  
 Sectional Pipe Area: 0.00790 m<sup>2</sup>

Survey Point No. 1: Yen phu  
 Survey Time: 13:20 April 16  
 13:20 April 17, 1996



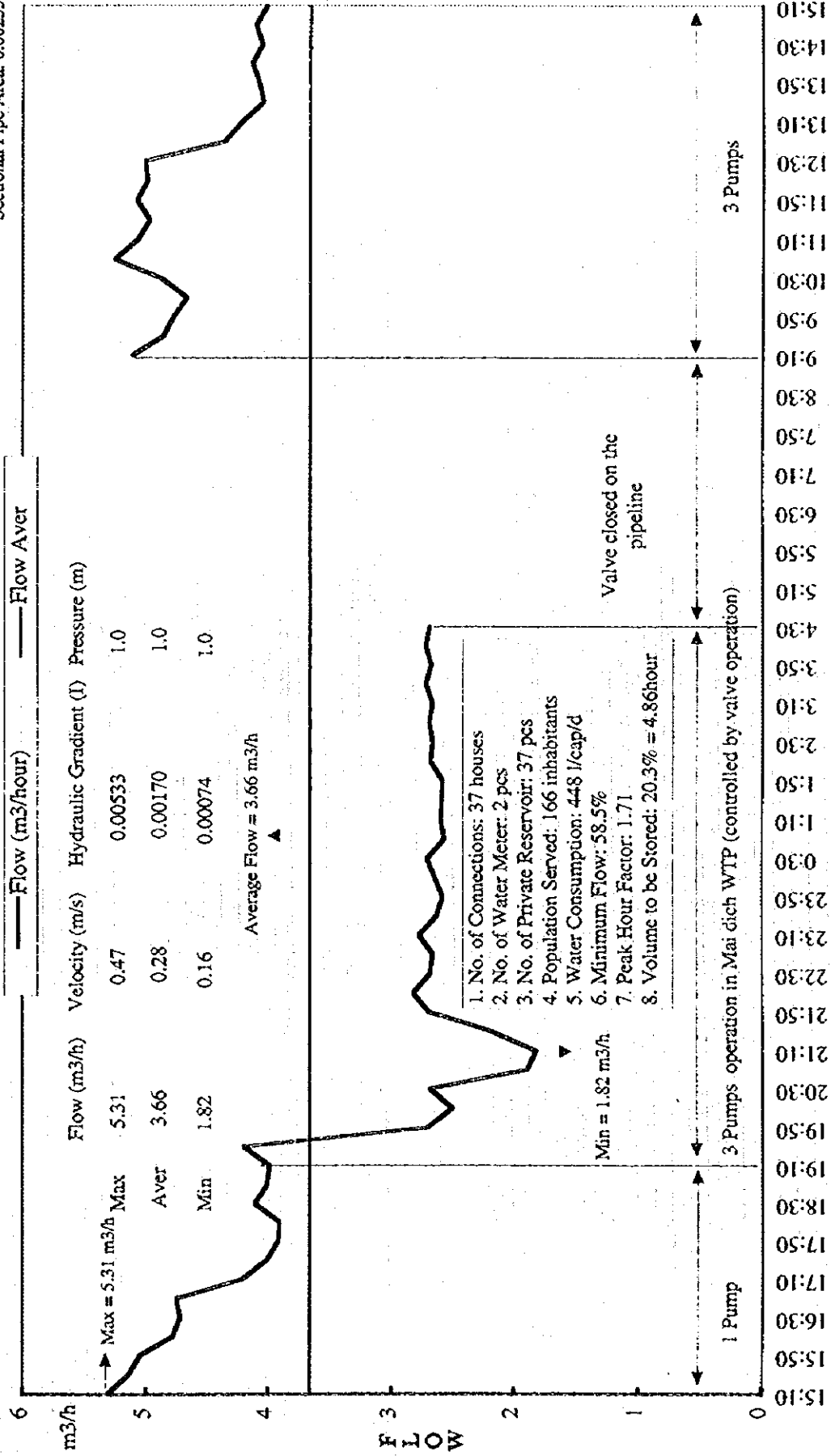
Survey Point No 2: Quan ngua  
 Survey Time : 11:45 May 2  
 11:45 May 3, 1996

Pipe Material : Carbon Steel  
 Year of Pipeline Construction: 1995  
 Outer/Inner Diameter: 70/62mm  
 Wall Thickness : 4 mm  
 Sectional Pipe Area : 0.003 m<sup>2</sup>



Survey Point No.3: Lang thuong  
 Survey Time: 15:10 May 15  
 15:10 May 16, 1996

Pipe Material: PVC  
 Year of Pipe Construction: 1993  
 Outer/Inner Diameter: 63/57 mm  
 Wall Thickness: 3 mm  
 Sectional Pipe Area: 0.00255 m<sup>2</sup>

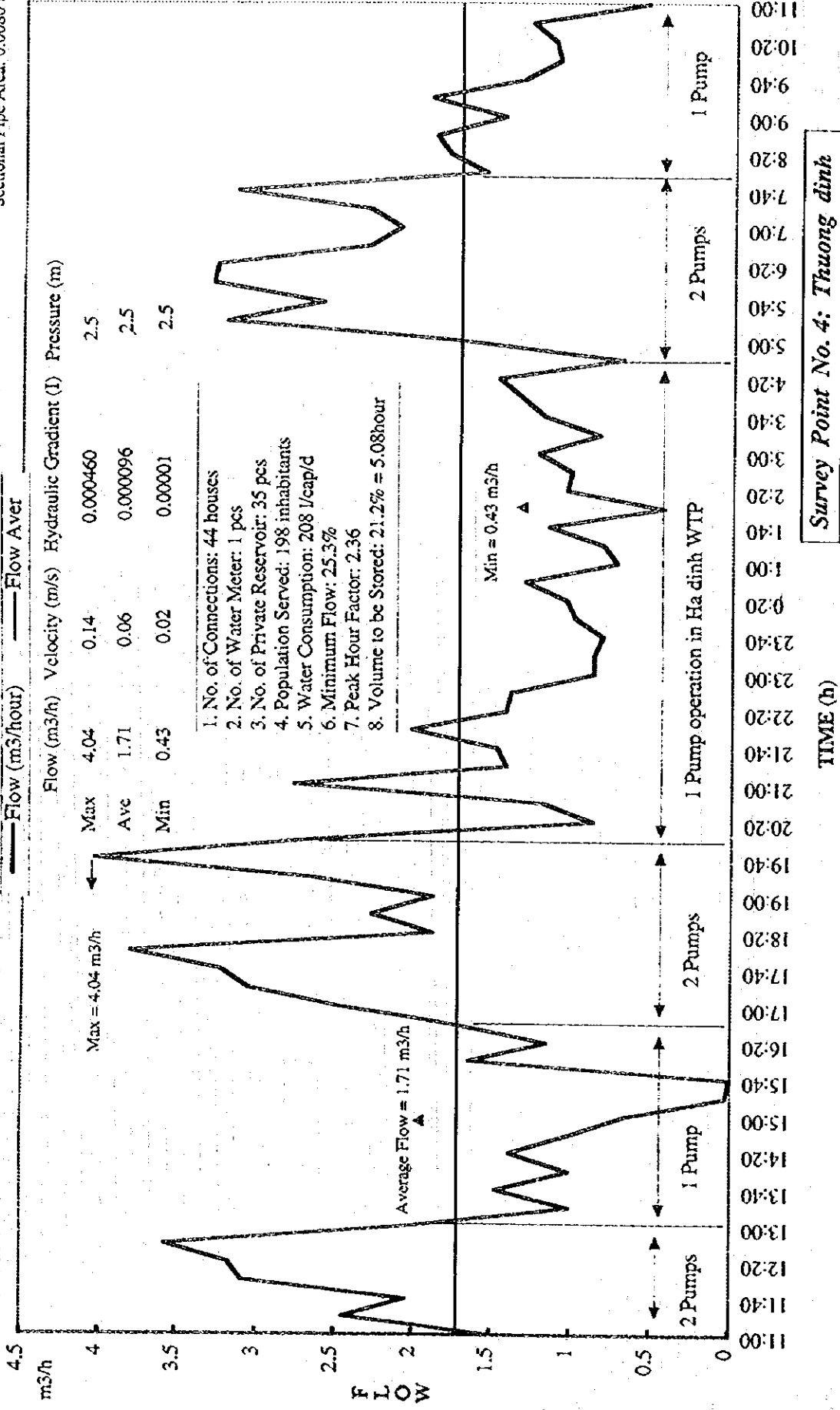


Survey Point No.3: Lang thuong

TIME (h)

Survey Point No.4: Thuong dinh  
 Survey Time: 11:00 May 9  
 11:00 May 10,1996

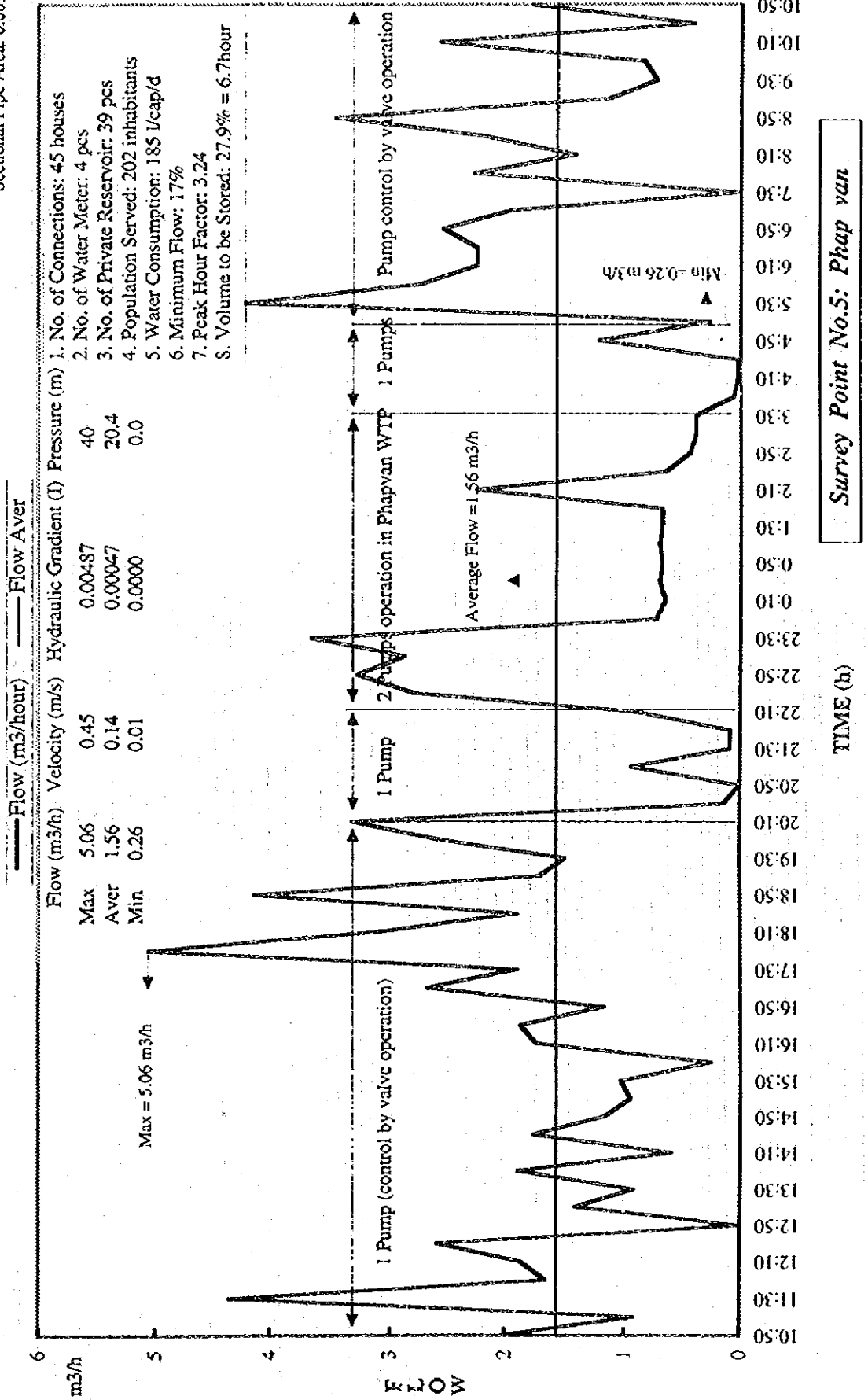
Pipe Material: Carbon Steel  
 Year of Pipe Construction: 1995  
 Outer/Inner Diameter: 114/100 mm  
 Wall Thickness: 6.5 mm  
 Sectional Pipe Area: 0.0080 m<sup>2</sup>



Survey Point No. 4: Thuong dinh

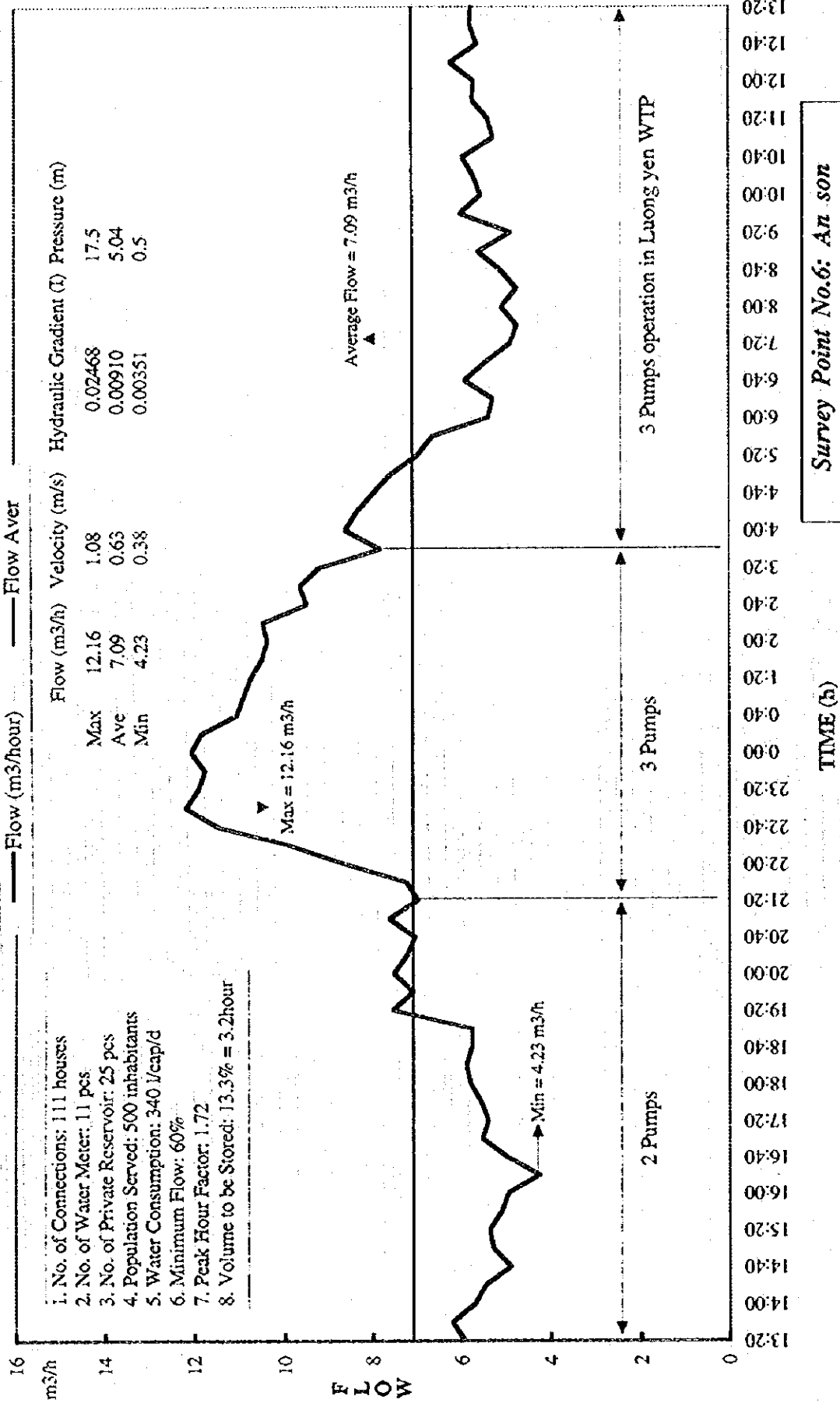
Survey Point No.5: Phap van  
 Survey Time: 10:50 May 17  
 10:50 May 18,1996

Pipe Material: Cast Iron  
 Year of Pipe Construction:1990  
 Outer/Inner Diameter: 18/100 mm  
 Wall Thickness:6.1 mm  
 Sectional Pipe Area: 0.0095 m<sup>2</sup>



Pipe material: PVC  
 Year of Pipe Construction: 1993  
 Outer/Inner Diameter: 63/57 mm  
 Wall Thickness: 3 mm  
 Sectional Pipe Area: 0.00255 m<sup>2</sup>

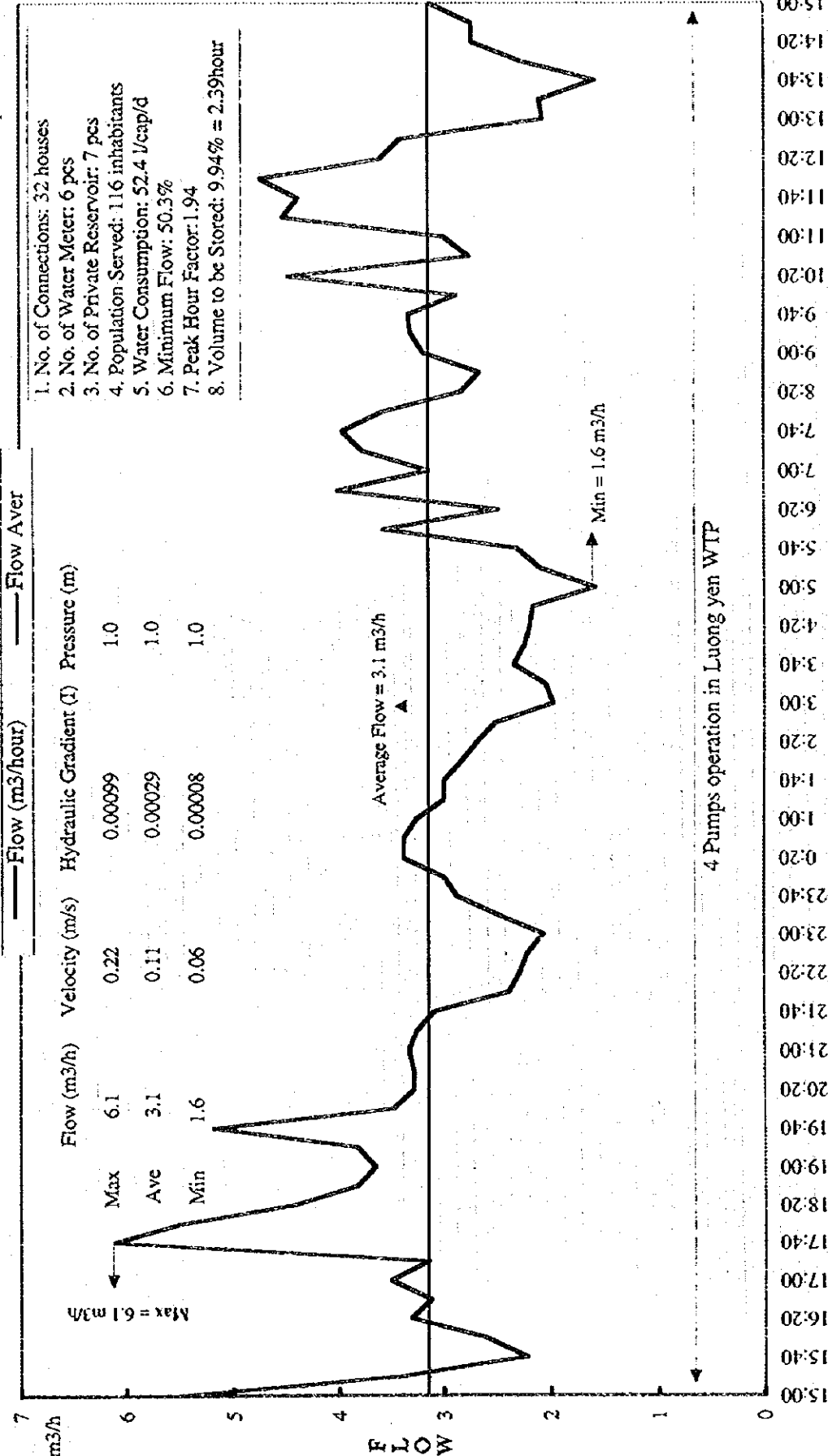
Survey Point No.6: An Son  
 Time: 13:20 May 21  
 13:20 May 22, 1996





Survey Point No7: Huong vien  
 Survey Time: 15:00 May 10  
 15:00 May 11.1996

Pipe Material: Cast Iron  
 Year of Pipe Construction: 1980  
 Outer/Inner Diameter: 113/100 mm  
 Wall Thickness: 6.1 mm  
 Sectional Pipe Area: 0.0068 m<sup>2</sup>

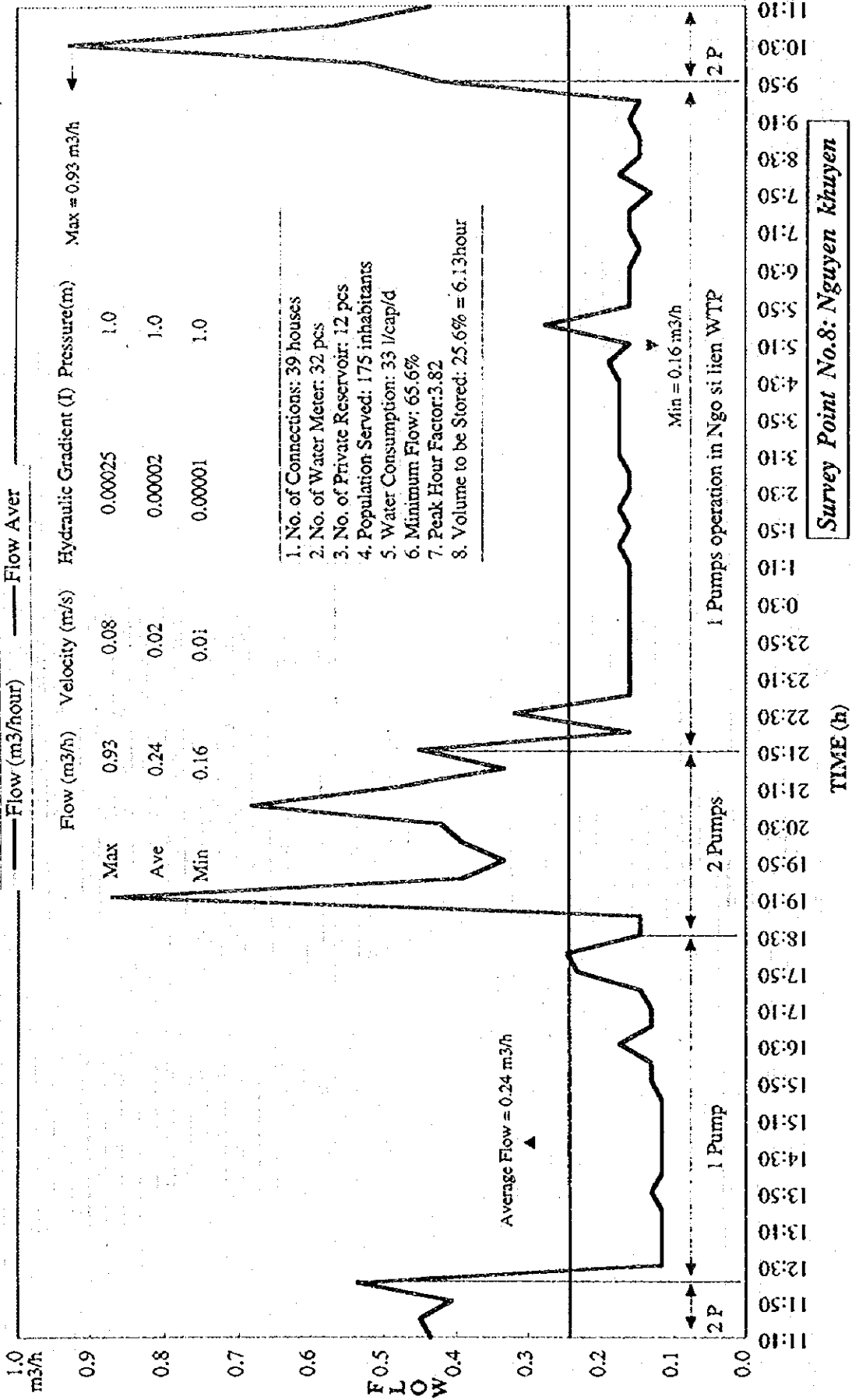


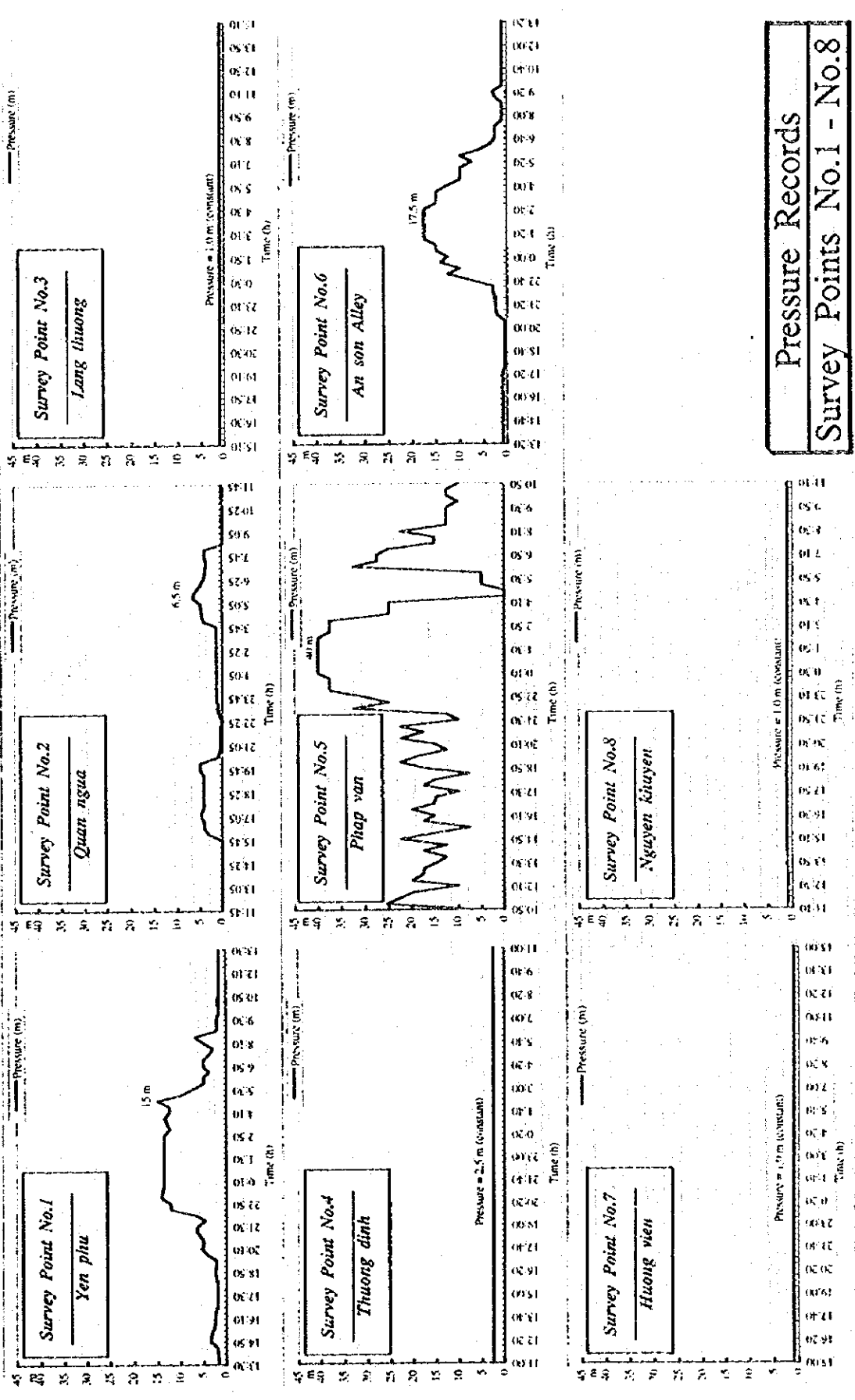
Survey Point No.7: Huong vien

TIME (h)

Survey Point No8: 221 Nguyen Khuyen  
 Survey Time: 11:10 May 14  
 11:10 May 15 1996

Pipe Material: Carbon Steel  
 Year of Pipe Construction: 1993  
 Outer/Inner Diameter: 79.6/65 mm  
 Wall Thickness: 4.2 mm  
 Sectional Pipe Area: 0.005 m<sup>2</sup>





**Pressure Records**  
**Survey Points No.1 - No.8**