

**MINISTRY OF INTERIOR
PROVINCIAL WATERWORKS AUTHORITY
DEVELOPMENT PLAN AND FEASIBILITY STUDY
ON
PROVINCIAL WATER SUPPLY PROJECTS
IN
THE KINGDOM OF THAILAND**

**FINAL REPORT
FOR
PATUM THANI & PRACHATIPAT
APPENDICES**

MARCH 1990

JAPAN INTERNATIONAL COOPERATION AGENCY

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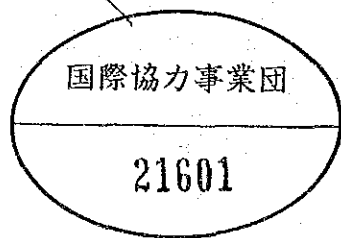


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APPENDIX A-1-1

Meteorological Data

APPENDIX A-1-1 METEOROLOGICAL AND HYDROLOGICAL DATA

1 Meteorological Data

Table A1-1-1 : Monthly Rainfall at Don Muang Airport

Code; RM

Station; Amphur Bangkhen, Bangkok

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1951	0.2	0.0	2.2	43.5	154.0	168.6	232.8	211.0	337.5	581.4	84.6	11.2	1827.0
1952	0.0	8.9	155.1	70.1	169.1	232.9	197.3	296.4	273.1	413.1	8.4	2.7	1827.1
1953	20.3	29.6	88.4	35.8	177.0	257.1	263.8	115.9	391.9	159.3	77.6	0.0	1616.7
1954	5.3	25.0	72.3	86.4	140.8	174.7	262.8	236.8	206.6	71.8	0.0	8.2	1290.7
1955	2.2	8.0	14.0	80.0	219.7	223.5	200.3	112.4	195.2	243.5	54.6	1.1	1354.5
1956	5.6	0.0	46.9	180.8	251.6	223.2	164.7	365.8	462.0	204.0	49.3	0.8	1954.7
1957	1.1	0.3	53.2	100.1	18.5	174.9	139.9	295.8	489.5	727.6	50.0	0.1	2051.0
1958	0.3	3.5	7.9	14.6	75.0	227.4	101.4	239.6	317.7	177.3	5.0	0.0	1169.7
1959	0.0	36.4	31.0	31.0	204.8	155.4	246.2	211.6	335.6	243.9	47.4	0.8	1544.1
1960	0.0	0.0	8.4	20.7	85.2	50.0	175.3	266.6	429.4	353.8	42.9	4.5	1436.8
1961	2.1	93.5	26.2	149.6	135.8	228.4	100.7	243.2	76.7	320.0	25.9	17.1	1419.2
1962	0.0	8.9	13.1	46.3	100.8	185.8	161.7	375.3	335.7	304.2	12.2	0.0	1544.0
1963	0.0	14.6	10.4	30.8	132.5	162.3	164.7	175.0	467.3	244.0	85.2	26.2	1513.0
1964	0.8	15.3	22.0	54.5	302.6	102.2	257.9	239.6	223.0	164.3	6.7	15.9	1404.8
1965	0.0	69.3	44.0	24.1	231.3	73.9	37.5	219.5	469.2	110.7	15.0	7.5	1302.0
1966	0.1	33.4	13.8	21.2	355.3	123.8	135.4	192.1	117.8	208.3	8.8	50.7	1260.7
1967	0.0	0.1	1.1	120.5	256.6	95.0	228.7	173.1	343.2	193.3	42.5	0.0	1454.1
1968	4.8	43.8	26.3	45.4	147.3	130.1	121.2	342.1	253.9	84.8	50.5	0.7	1250.9
1969	34.0	1.3	20.5	60.9	111.8	135.3	89.2	274.0	259.1	136.9	48.1	22.4	1193.5
1970	20.3	27.7	80.1	109.4	301.1	316.2	176.6	238.2	308.9	148.4	41.2	134.1	1902.2
1971	0.0	17.6	6.1	35.0	192.7	109.7	151.3	345.1	169.0	192.7	4.4	0.3	1223.9
1972	0.0	9.8	84.9	96.9	62.2	158.4	102.7	60.6	551.6	173.8	71.5	106.4	1478.8
1973	0.0	0.0	34.6	0.0	68.9	157.3	107.4	98.3	251.1	146.2	32.7	4.5	901.0
1974	0.3	2.1	61.3	120.3	117.5	95.1	186.4	120.1	115.1	267.5	42.0	0.0	1127.7
1975	86.4	0.0	26.3	3.7	125.4	121.3	107.4	134.5	214.9	102.0	13.2	9.9	945.0
1976	0.0	28.8	3.0	33.9	163.2	60.3	288.5	262.7	186.5	110.9	25.1	14.7	1177.6
1977	30.7	21.6	0.0	82.8	48.9	85.7	192.2	161.0	150.5	89.8	10.6	12.0	885.8
1978	6.1	103.3	0.0	18.0	237.7	79.7	294.7	96.1	289.9	117.6	3.1	0.0	1246.2
1979	0.0	0.8	0.0	34.5	128.4	78.4	47.0	97.4	150.8	25.3	22.3	0.0	584.9
1980	0.0	0.0	12.7	22.5	96.9	238.4	89.2	196.6	394.3	224.3	56.6	0.0	1331.5
1981	0.0	11.6	18.8	62.3	243.3	114.9	140.8	94.9	294.6	97.0	131.4	-	1209.6
1982	0.0	0.0	27.5	157.6	153.7	198.9	95.6	93.9	156.4	172.1	30.7	1.4	1087.8
1983	-	0.0	-	0.0	198.6	135.3	160.5	414.3	237.2	267.0	94.2	15.0	1522.1
1984	2.1	46.9	119.4	149.0	24.9	100.6	103.4	150.4	208.9	111.8	2.0	-	1019.4
1985	35.6	-	-	78.1	87.2	90.7	108.1	75.6	284.5	209.5	11.4	0.0	980.7
1986	0.0	-	0.0	134.7	225.2	88.6	157.9	132.0	249.2	128.0	26.1	34.2	1175.9
1987	-	1.4	10.2	8.5	93.1	85.9	97.2	30.4	263.9	160.0	107.8	0.0	858.4

Source : Meteorological Department

PROGRESS REPORT
Patum Thani & Prachatiapat

Table AI-1-2 Meteorological Data at Pathum Thani, Prachativate

Station : Don Huang
 Latitude : 13 55' N.
 Longitude : 100.36' E.
 Elevation of station above MSL 4 meters

Items	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
<u>Temperature (C.degree)</u>													
Mean	26.0	27.5	29.0	29.9	29.4	28.9	28.5	28.3	28.0	28.0	27.2	25.5	28.0
Mean Max.	31.7	32.9	34.2	35.1	34.3	33.2	32.7	32.4	31.9	31.5	31.0	30.7	32.6
Mean Min.	20.2	22.3	24.0	25.2	25.5	25.3	25.0	25.0	24.8	24.8	23.5	20.9	23.9
Ext. Max.	36.6	37.4	40.0	39.9	40.8	38.1	36.8	36.4	36.5	35.3	35.6	34.8	40.8
Ext. Min.	11.6	16.0	16.8	19.6	20.0	21.2	21.9	20.3	21.2	20.6	15.0	10.0	10.0
<u>Relative Humidity (%)</u>													
Mean	69.7	73.4	73.8	74.3	76.7	76.2	77.2	78.2	79.9	78.2	75.1	71.3	75.3
Mean Max.	89.6	92.3	91.9	91.4	91.3	90.0	90.5	91.2	91.9	91.3	89.2	88.6	90.8
Mean Min.	47.0	50.1	49.8	52.2	56.7	58.2	59.7	61.3	63.4	63.2	58.0	51.4	55.9
Ext. Min.	20.0	20.0	25.0	25.0	30.0	30.0	38.0	40.0	40.0	28.0	25.0	26.0	20.0
<u>Evaporation (mm.)</u>													
Mean - Pan	136.0	141.0	182.0	188.0	171.0	150.0	148.0	147.0	130.0	128.0	126.0	133.0	1780.0
<u>Sunshine Duration (hr.)</u>													
Mean	No Observation												
<u>Wind (knots)</u>													
Prevailing Wind	E	S	S	S	S	S	SW	SW	SW	N	N	N	-
Mean Wind Speed	4.1	5.8	6.7	6.6	5.9	5.7	5.6	5.5	4.6	4.2	4.2	4.0	-
Max. Wind Speed	35 E, ESE	33 E	85 NE	65 SE	50 SE, WSW,NNW	55 W	60 SSW,55 WSW	60 SW	60 SW	60 E,S	45 ESE	24 ENE	85 NE
<u>Rainfall (mm.)</u>													
Mean	7.7	19.7	26.7	63.5	155.3	140.3	149.2	208.4	284.8	197.6	36.1	14.8	1304.1
Mean Rainy Days	1.1	2.0	2.5	6.2	14.1	14.3	16.5	19.0	20.5	14.9	5.5	1.4	118.0
Greatest in 24 hr.	34.3	48.4	58.1	106.2	78.6	67.0	81.8	117.5	148.4	132.9	53.8	48.8	148.4
Day / Year	26/85	18/61	21/84	26/61	4/64	2/70	3/60	23/62	6/72	1/57	9/83	13/70	6/72

Source : Meteorological Department

APPENDIX A-2-1

Log and Water Quality of Deep Wells

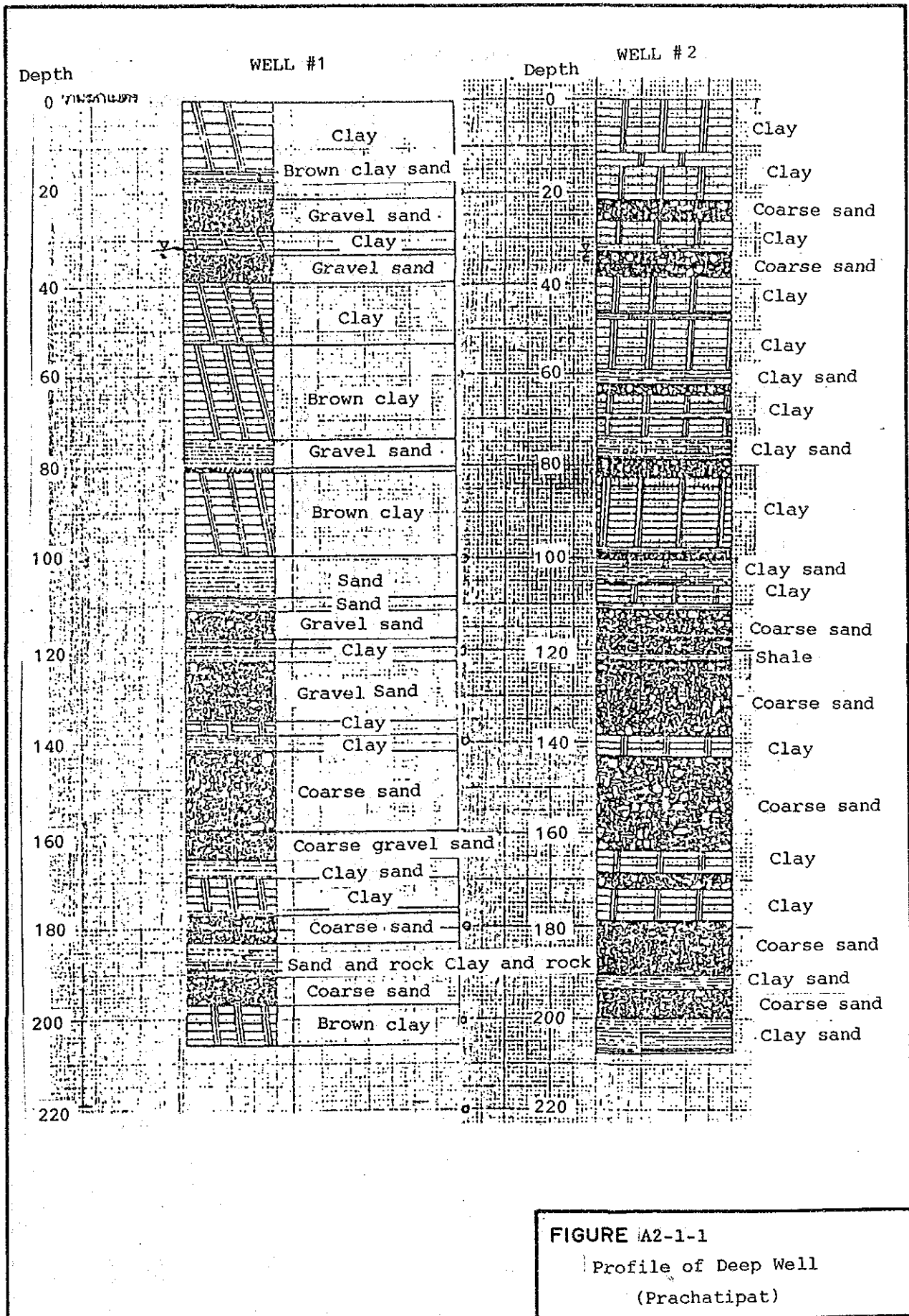
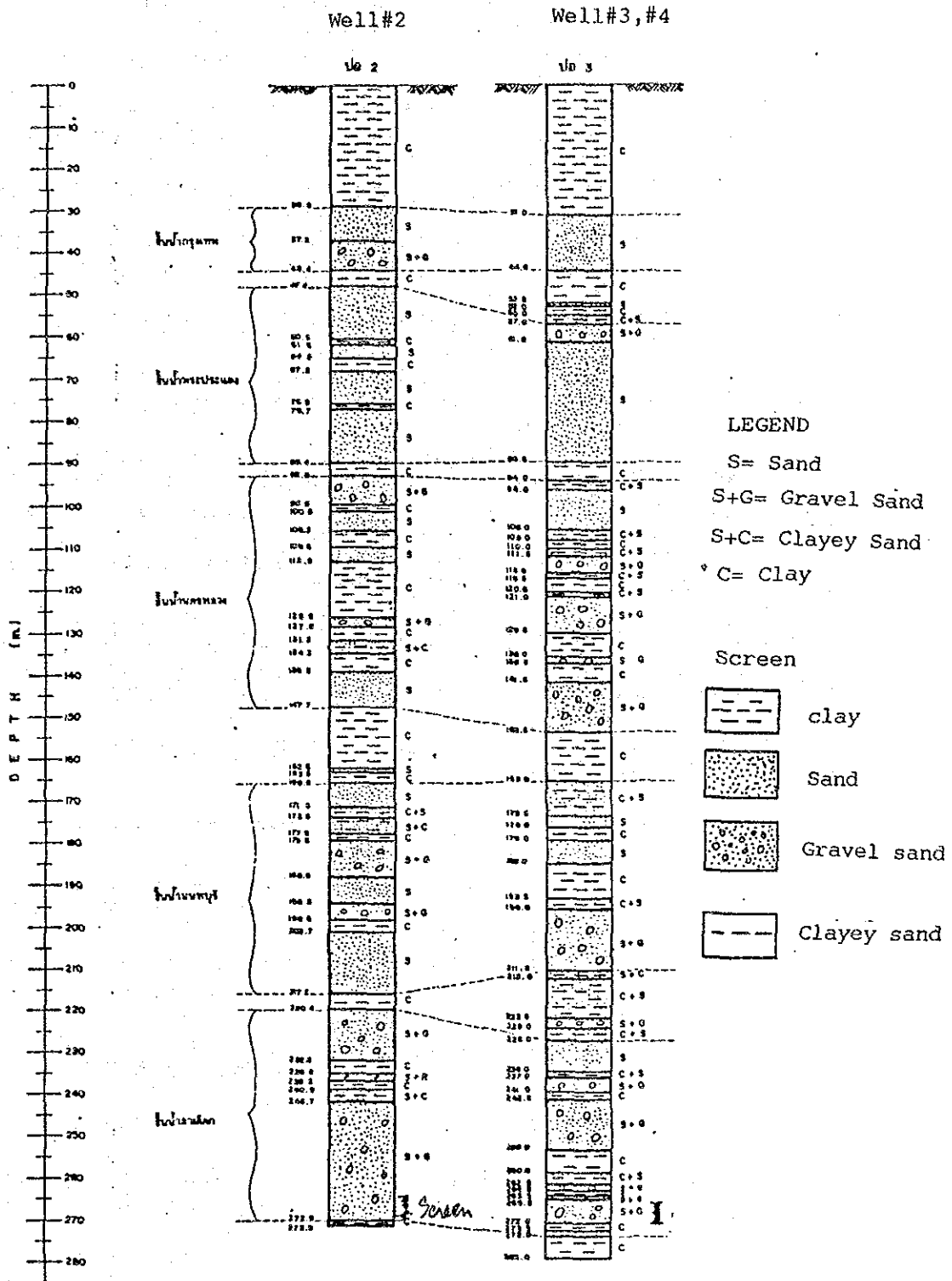


FIGURE A2-1-1
 Profile of Deep Well
 (Prachatipat)

Table A2-1-1 Ground Water Quality

Smple Year : 1986

Item	Patum Thani Waterworks	Prachatipat Waterworks
1. Color	2	None
2. Odor	None	None
3. Taste	None	None
4. Turbidity	0.7	1.2
5. pH	7.37	7.54
6. Electric Coductivity	-	-
7. Chemical Analysis		
- Total solid	427	532
- Total hardness as CaCO ₃	66	110
- Carbonate Hardness	66	110
- Non Carbonate Hardness	0	0
- Alkalinity PP as CaCO ₃	Nil	Nil
- Alkalinity Mo as CaCO ₃	236	234
- NO ₃	-	-
- NO ₂	-	-
- Ca	11	30
- Cl	46	54
- Fe	0.15	0.14
- Mn	Nil	Nil
- Mn and Mn	0.15	0.14
- Cu	-	-
- Zn	-	-
- Mg	13	19
- SO ₄	47.5	29
- F	-	-



Source : PWA

FIGURE A2-1-2
Profile of Deep Well
(Phatum Thani)

Table A2-1-2 List of Deep Wells
(Nakhon Loung Aquifer - 150 m)

No.	Location	Depth (m)	Quality		
			CI	Fe	Hardness
1	Kaew Nimit Mosque	123-129	7.3	0.15	108
2	South Rangsit Area	100-134	170	0.206	139
3	Sen Pam Ya Rang Sit Sch.	129-135	309	0.95	272
4	White House Apt.	159	930	0.273	682
5	Thai-German Agriculture Training Sch.	125-131 137-143 149-155	973	2.3	7.5
6	Barapa Industry	150	1012	1.34	844
7	Kung Thani Ind.	160	275	0.33	262
8	Tong Saard Temple	150	248	0.31	294

Table A2-1-3 List of Deep Wells
(Nontha Buri Aquifer - 200 m)

No.	Location	Depth (m)	Quality		
			CI	Fe	Hardness
9	Bang Kan Shopping Center	186	44	0.25	89
10	Thammasat Univ.	200	8.8	1.0	109
11	Sivali Village	184-190	217	0.31	184
12	Ban Soi Vicheam Village	185-194	365	0.84	220
13	Ratanakosin Vil	220	62	0.13	118
14	Ratanakosin Vil	220	82	0.05	122
15	Ratanakosin Vil	220	257	0.08	240
16	Ratanakosin Vil	220	402	0.027	332
17	Prachatipat	183-186 190-196	56	0.47	112
18	Prachatipat	183-186 190-196	161	0.25	206
19	Fakko Village	180	31	0.106	116
20	Dumrong Chai Wathna Ltd.	210	--	---	--
21	TEP Pathana Kadat Ltd.	200	824	0.72	648
22	TEP Pathana Kadat Ltd.	180	621	11.17	2850
23	ESSO	186-195	33	0.14	124
24	Thai Lee Yom Pa Ltd.	198-204	9	0.53	106
25	Pathum Thani Paper Ltd.	200	7	0.47	140
26	ESSO				
27	Raysit Vitaya School	214-218	36	0.08	136

No.	Location	Depth (m)	Quality		
			CI	Fe	Hardness
28	Somboom Nam Peam	200	53	0.11	128
29	V.O.A.	183	11	0.23	140
30	Rahang Sanitary District	169-180	532	497	3,330
31	Suwan Chinda Temple	194	--	---	--
32	Pathum Thani School	174-183	--	---	--

Table A2-1-4 List of Deep Wells
(Samkok Aquifer - 300 m)

No.	Location	Depth (m)	Quality		
			CI	Fe	Hardness
33	Rural Dev'ment Center	270-296 351-357	12	0.57	146
34	Pathum Thani Municipality	265-274	70	0.614	114
35	Old People's Home	260-269	5	0.206	114
36	Pathum Thani Water Supply	266-272	18	0.19	104
37	Pathum Thani Water Supply	266-272	38	0.14	126
38	Pathum Thani Water Supply	266-272	7	0.055	126
39	Damrong Char- watthana Ltd.	282	10	0.21	100
40	KADAP Nokon Loung Ltd.	260	440	0.23	316
41	MBK Ltd.	240 270	482	838	3240
42	MBK Ltd.	270	6	0.45	130
43	Siam Batang Ltd.	241-250	409	6.70	3280
44	Krung Thai Ind.	210-230	210	0.05	236
45	Nam Mam Pud Pathum Ltd.	270	190	0.17	198
46	Siam Suk (PEPSI) Ltd.	214-229	6	0.64	24
47	Sura Mae Khong Factory	270	14.2	0.2	79
48	AEG Siam Ltd.	240	277	0.17	240
49	Thai Lie Pim Yon Ltd.	240	48	0.28	122

No.	Location	Depth (m)	CI	Quality	
				Fe	Hardness
50	Ban Nai Sukun	295	6	0.14	256
51	Ron Mai Thai	250	8	0.2	108
52	Ah Man Rang Sit	240-250	149	0.11	210
53	Pilolum Thai Gas	237-240	8	0.12	134
54	Power Plant	294	27	0.24	132
55	TaVon Vatan Ltd	258	10	0.11	128
56	Queen Prod. Ltd	231	250	0.16	200
57	Satan Lay Ltd.	270	27	0.16	132
58	Sata Steel ltd.	270	23	0.03	126
59	Rang Mai Rang Sit	252	21	0.23	158
60	Kana Raj Bam Rung School	270	14	0.13	142
61	Tappat Thani Ltd	250	23	0.03	124
62	Tappat Thani Ltd	250	14	0.33	118
63	Thai Nam Tip	254-260	8	0.03	118
64	Thai Nam Tip	254-260	8	0.01	130
65	Pram Prachakon School	229-235	210	0.05	138

Table A2-1-5 List of Deep Wells
(Payathai Aquifer)

:No.:	Location	Depth (m)	Quality		
			CI	Fe	Hardness
:66	Rural Dev'ment Center	270-276 351-357	12	0.57	146
:67	Kimberli-Glass Ltd.	315-324	5	0.18	106
:68	Sitthinam Ltd.	331-340 352-358	20	0.22	132
:69	Siam Modify Satoch Ltd.	331-340 352-358	11	6.25	170
:70	Pepsi Ltd.	295-303 306-310	12	0.05	--
:71	Siam Brewers	308	6	0.22	114
:72	Shell Petr'm	320	28	0.15	140
:73	Thai-Nishimatsu Construction	298-307	10	0.356	148
:74	Carbat Int'l	285-295	172	0.26	92

APPENDIX A-2-2

Data on the Chao Phraya River

Table A2-2-1 MAXIMUM AND MINIMUM WATER LEVEL AT MWA PUMPING STATION (BAN SAMLAE)

YEAR	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
1978	37.41	34.73	36.33	34.81	36.14	34.79	36.10	34.48	36.34	34.13	36.19	34.37	36.87	34.42	36.72	35.08	36.85	35.17	37.89	36.81	37.72	35.25	36.51	35.24
1979	36.32	34.70	36.32	34.70	36.15	34.67	36.14	34.53	36.15	34.16	36.33	34.53	36.18	34.49	36.10	34.40	36.40	34.69	36.78	34.83	36.30	34.85	36.59	34.86
1980	36.24	34.52	36.21	34.56	36.19	34.60	36.18	34.74	36.20	34.28	36.51	34.33	36.48	34.36	36.53	34.77	36.93	35.26	37.88	36.81	37.88	36.01	36.70	35.41
1981	36.19	34.77	36.16	34.51	36.16	34.85	36.13	34.60	36.27	34.73	36.30	34.72	36.56	34.55	36.59	35.63	36.67	35.66	36.40	35.72	36.89	34.91	36.84	35.30
1982	36.37	34.87	36.21	34.80	36.20	34.70	36.18	34.71	36.28	34.51	36.19	34.25	36.22	34.39	36.08	34.43	36.72	34.60	36.69	35.38	36.56	35.06	36.79	35.11
1983	36.35	34.82	36.20	34.61	36.18	34.71	36.24	34.71	36.17	34.54	35.77	34.23	36.09	34.35	36.56	34.70	36.50	34.87	37.79	35.65	37.83	37.61	37.62	35.85
1984	36.53	35.03	36.27	34.85	36.18	34.60	36.14	34.60	36.27	34.48	36.24	34.48	36.20	34.24	35.99	34.28	36.21	34.54	36.88	34.89	36.80	35.27	36.96	35.68
1985	36.88	35.14	36.75	35.12	36.82	35.03	36.57	35.00	36.64	34.98	36.55	34.65	36.67	34.69	36.88	35.08	37.24	35.20	37.39	35.70	37.42	36.59	37.34	35.95
1986	36.86	35.13	36.65	35.04	36.69	35.69	36.95	35.20	36.99	35.24	36.89	35.25	36.61	34.83	36.76	35.05	36.87	35.38	36.71	35.30	36.74	35.25	37.01	35.37
1987	36.89	35.20	36.60	35.00	36.51	35.02	36.67	35.16	36.52	34.96	36.57	34.74	36.36	34.33	36.57	34.86	37.21	34.65	37.25	35.80	36.82	35.51	36.99	35.72

Source : RWA
Unit : m. (neal)

WATER LEVEL OF CHAOPRAYA RIVER

Figure A2-2-1

AT MWA PUMPING STATION (BAN SAMLAE)

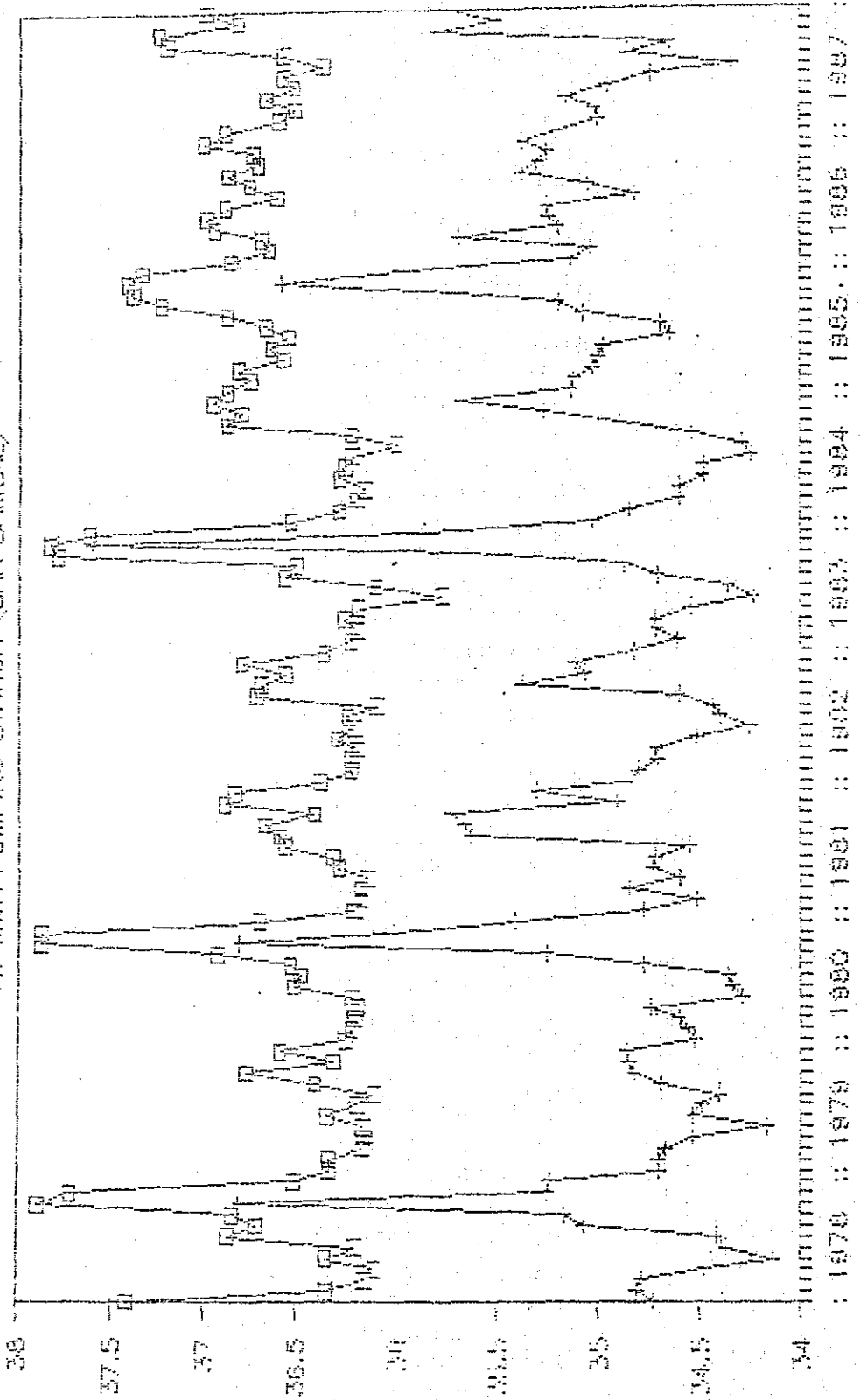


Table A2-2-2 Water Quality of the Chao Praya River

Item	Tested Sept. 26, 1988 Quality
1. Physical Quality	
Color	20
Turbidity	54
pH	7.65
Electrical Conductivity (micromhos/cm)	234
2. Chemical Quality	
Total Solids	123
Total hardness as CaO	94
Carbonate hardness	88
Non-carbonate hardness	6
Alkalinity PP as CaCO ₃	nil
Alkalinity MO as CaCO ₃	88
CA	27
Mg	6.2
Cl	13
Fe	2.08
Mn	0.42
Cu	nil
Zn	nil
SO ₄	22
NO ₄	0.26
NO ₃	nil
F	0.04

APPENDIX A-2-3

Jar Test on Raw Water of the Chao Phraya River

APPENDIX A-2-3 JAR TEST

1 General

Jar Test was conducted to evaluate the treatability for the recommended water source, Chaopraya River, and the required dosage rate of coagulant. The test was conducted on September 1988 for the water sample taken at Tambon Sam Kok.

2 Coagulant Used

Aluminum sulfate was used as a coagulant with a concentration of 1% (10,000 mg/l).

3 Test Procedure

Test procedure followed the PWA's regulation for Jar Test. Sequence and time are shown as follows:

- a) Coagulant dosed
 - b) Rapid Mixing, 100 rpm - 30 sec
 - c) Flocculation 60 rpm - 5 min
 - d) Flocculation, 25 rpm - 5.0 min
 - e) Sedimentation, about 5 min
- Neither Patum Thani nor Prachatipat water-works uses the coagulant since they are taking groundwater as a water source.

4 Condition and Results

Jar Test was conducted at the laboratory at PWA Head Office with a series of six different dosage rates. The condition and results are as shown in Table A5-1.

Table A2-3-1 Jar Test Condition and Result

	1	2	3	4	5	6
1. Coagulant Solution (ml)	1.5	2.0	2.5	3.0	3.5	4.0
2. Dosage Rate (mg/l)	15.0	20.0	25.0	30.0	35.0	40.0
3. Turbidity after settling	43.0	17.0	7.0	5.7	6.0	3.7
4. pH	7.32	7.20	7.09	7.00	6.93	6.85
5. Conductivity (micro ohm/cm)	239	230	232	232	233	235
6. Characteristics of floc	Fine floc	Fine floc	Floc size 2-3 mm	Floc size 2-3 mm	Floc size 2-3 mm	Floc size 2-3mm

From the results above, it is observed that dosage rate of 25.0 mg/l shows the most effective removal of turbidity. This rate is rather high even comparing the Su Ngau Golok which uses the river water. This fact means that cost of coagulant will be high if the river water is used as a water source.

APPENDIX A-3-1

Study on Flow and Pressure Measurement
in Distribution System

APPENDIX A-3-1 STUDY ON FLOW AND PRESSURE MEASUREMENTS IN
DISTRIBUTION SYSTEM

(1) Introduction

To evaluate the characteristics of the distribution system, pressure and flow measurements in Patum Thani were made from 13 to 14 September, 1988. For Prachati-
pat, the same measurements were conducted on September 15, 1988.

(2) Methods and Results

The flow measurements of 24-hours were conducted at the main distribution pipe in the treatment plant using the ultrasonic flow meter with pen recorder. The pressure measurements were made by installing pressure gage at 6 house connections in Patum Thani, and 5 for Prachati-
pat.

The results of flow measurement at the Patum Thani Water-works, location of pressure measurement points and the results of pressure measurement are shown in Figures A3-1 to A3-3, A3-4 and A3-5 to A3-10, respectively. Also, the results in the service area of the Prachati-
pat Water-works are shown in Figures A3-11, A3-12 and A3-13 to A3-17, respectively.

The results of pressure measurements in the distribution system show similar pressure conditions with distribu-
tion network analysis (refer to section 3.1.3).

FLOW RATE MEASUREMENT TEST

PATUM THANI

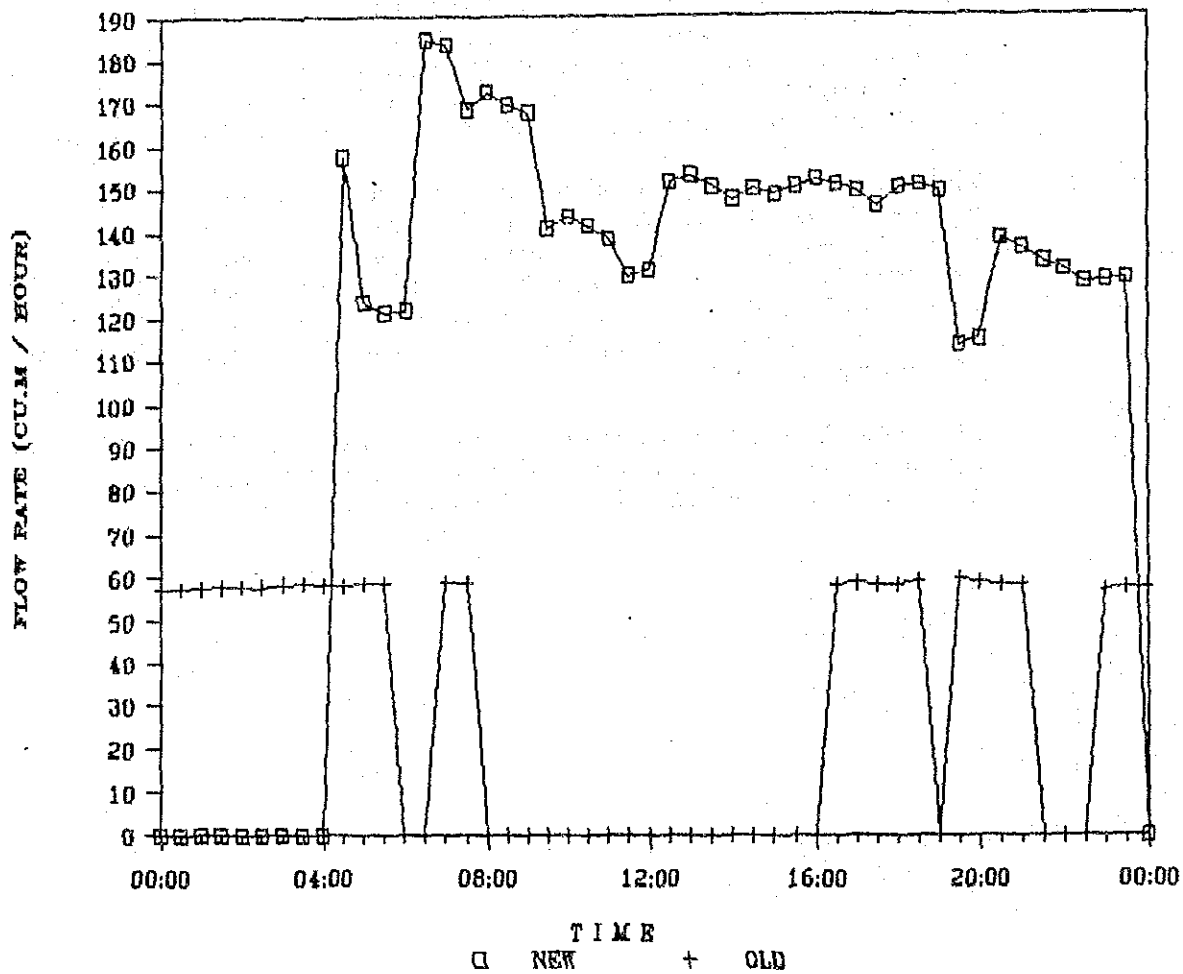


FIGURE A3-1
FLOW RATE MEASUREMENT TEST
PATUM THANI

FLOW RATE MEASUREMENT TEST

PATUM THANI (NEW PLANT)

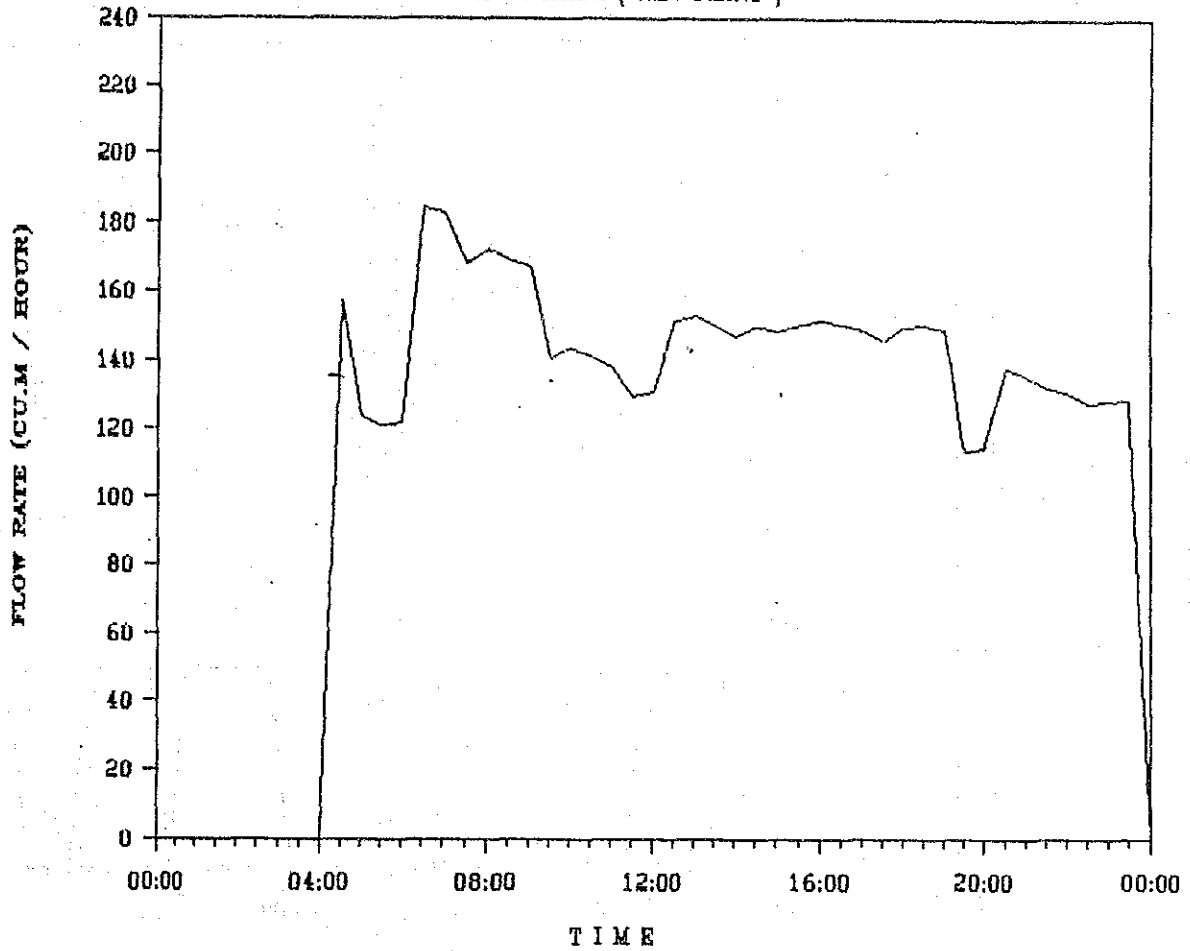


FIGURE A3-2
FLOW RATE MEASUREMENT TEST
PATUM THANI (NEW PLANT)

FLOW RATE MEASUREMENT TEST PATUM THANI (OLD PLANT)

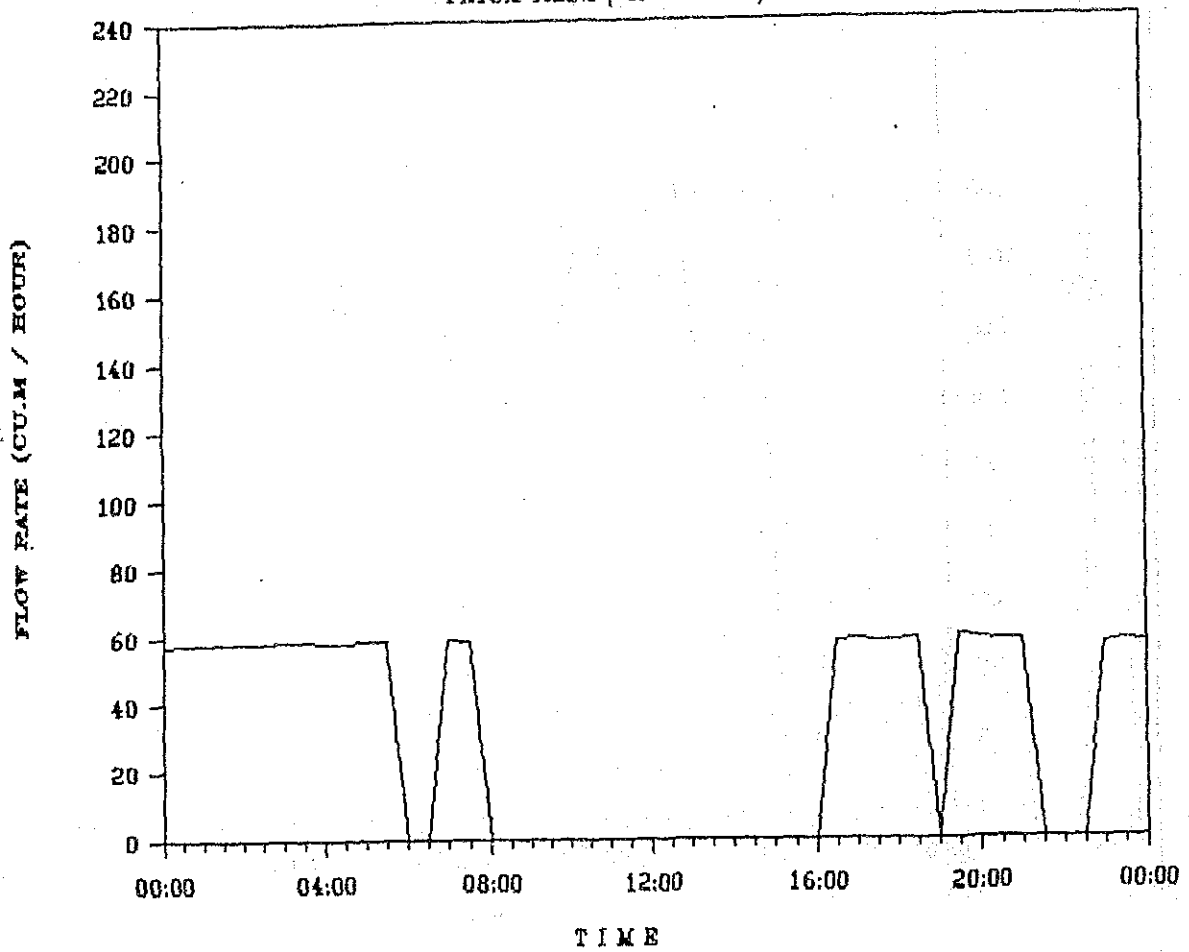


FIGURE A3-3
FLOW RATE MEASUREMENT TEST
PATUM THANI (OLD PLANT)

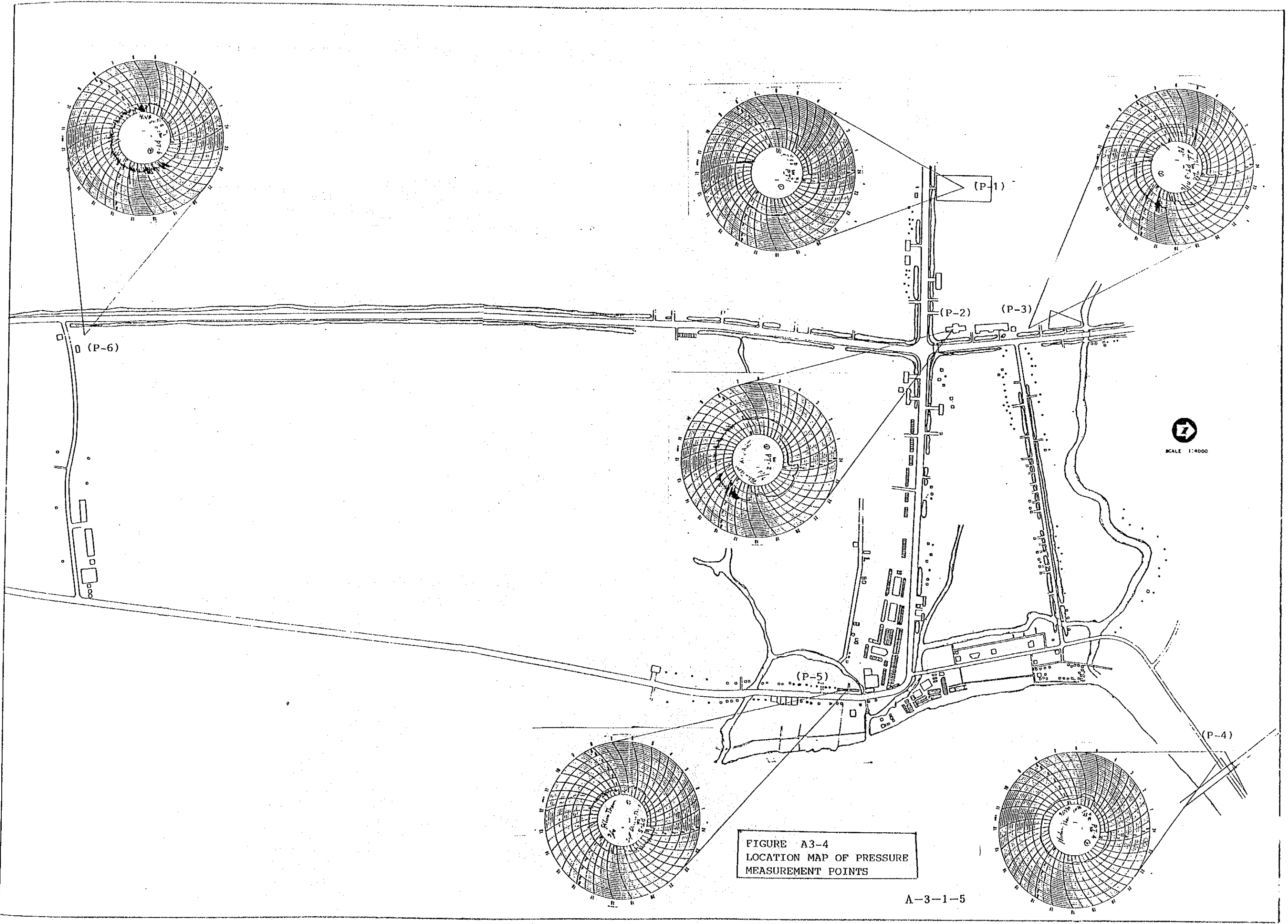


FIGURE A3-4
 LOCATION MAP OF PRESSURE
 MEASUREMENT POINTS

PRESSURE MEASUREMENT TEST

PATUN THANI Point 1

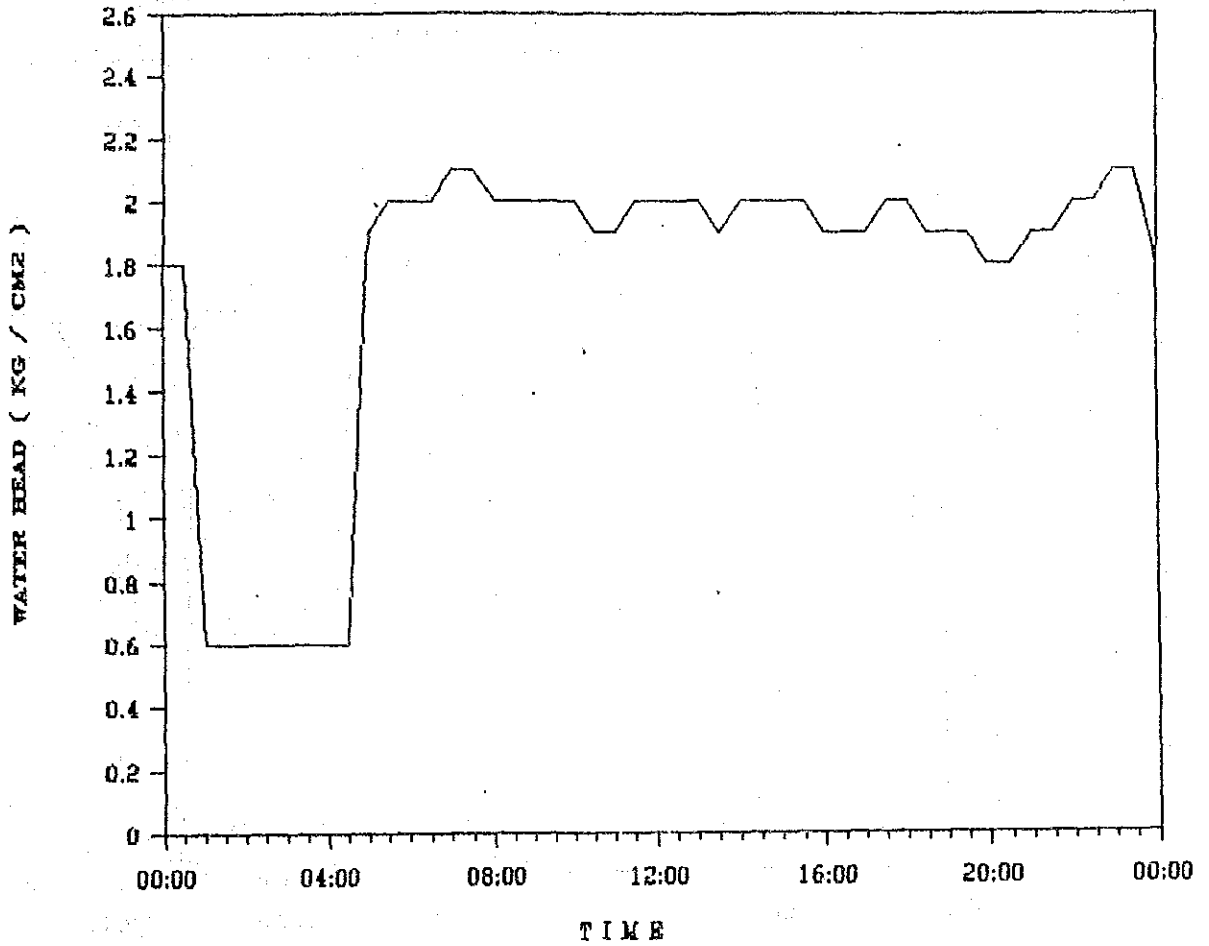


FIGURE A3-5

PRESSURE MEASUREMENT TEST
PATUN THANI (Point 1)

PRESSURE MEASUREMENT TEST

PATUM THANI Point 2

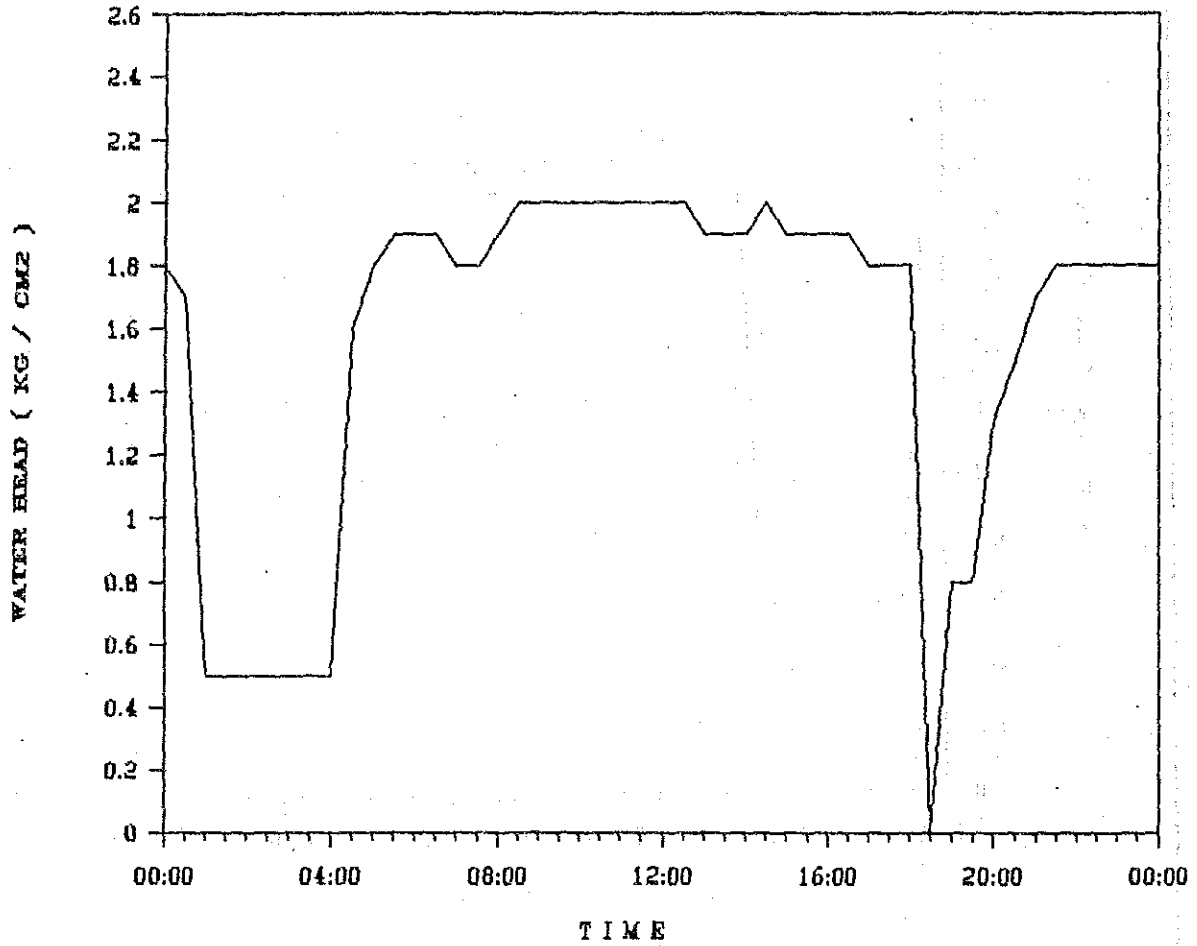


FIGURE A3-6
PRESSURE MEASUREMENT TEST
PATUM THANI (Point 2)

PRESSURE MEASUREMENT TEST

PATUM THANI Point 3

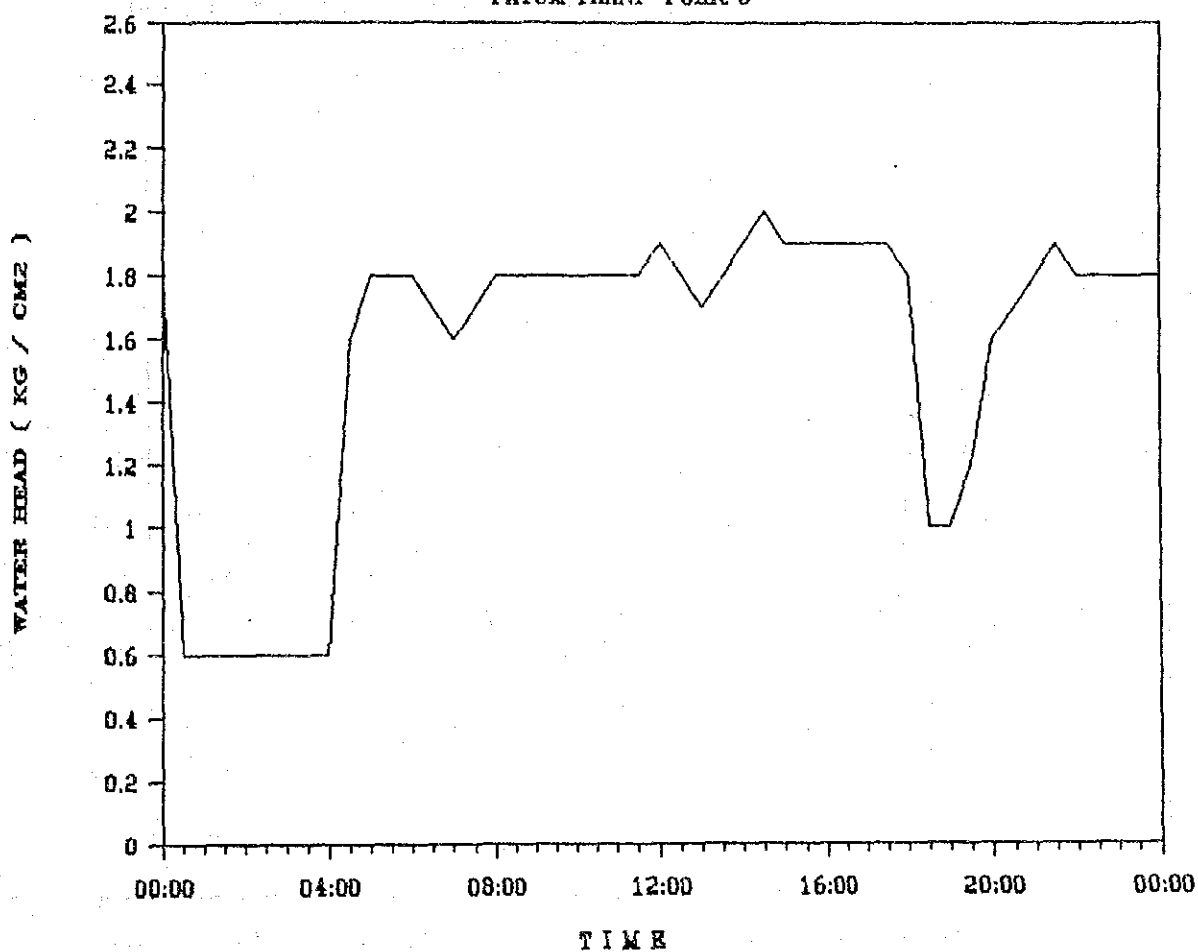


FIGURE A3-7
PRESSURE MEASUREMENT TEST
PATUM THANI (Point 3)

PRESSURE MEASUREMENT TEST

PATUM THANI Point 4

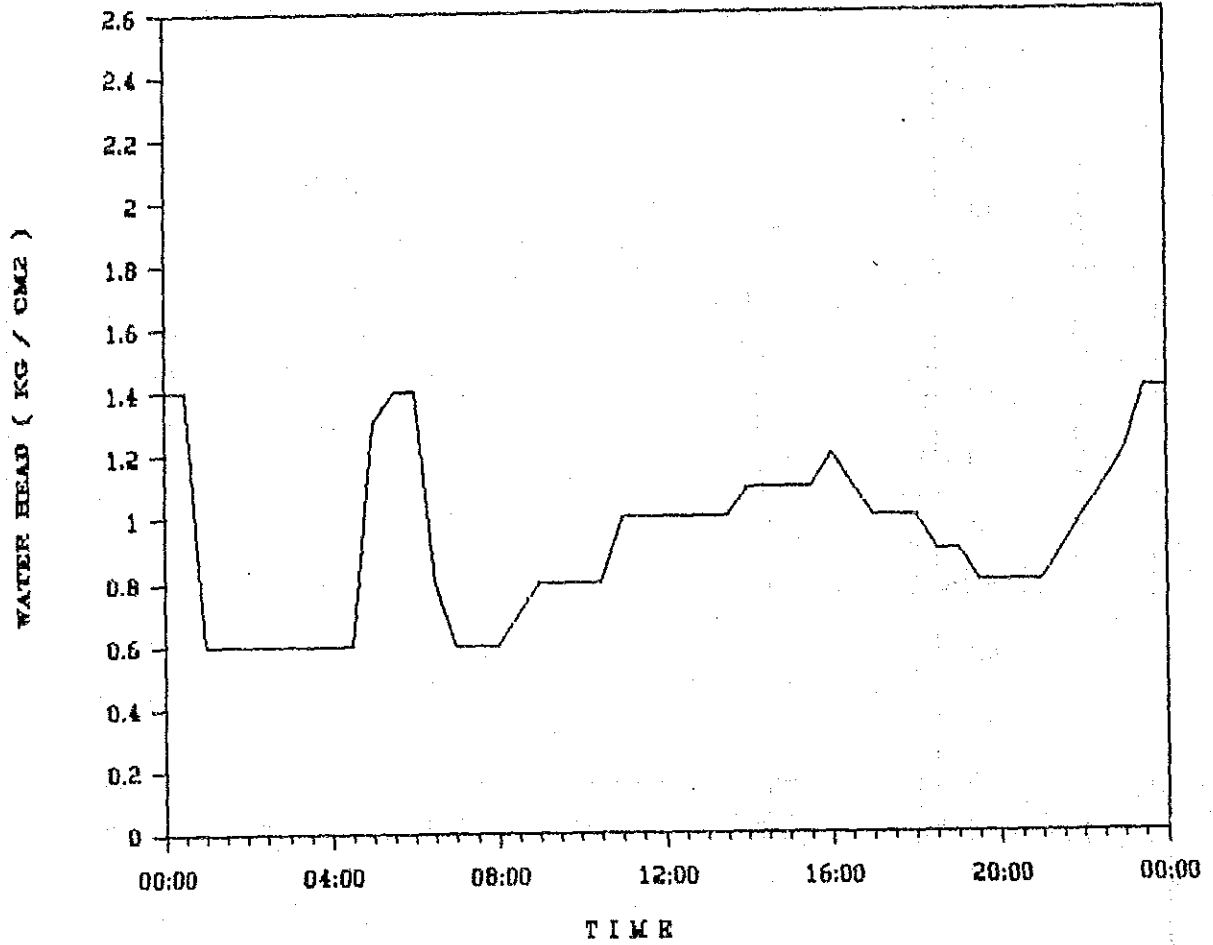


FIGURE A3-8

PRESSURE MEASUREMENT TEST
PATUM THANI (Point 4)

PRESSURE MEASUREMENT TEST

PATUM THANI Point 5

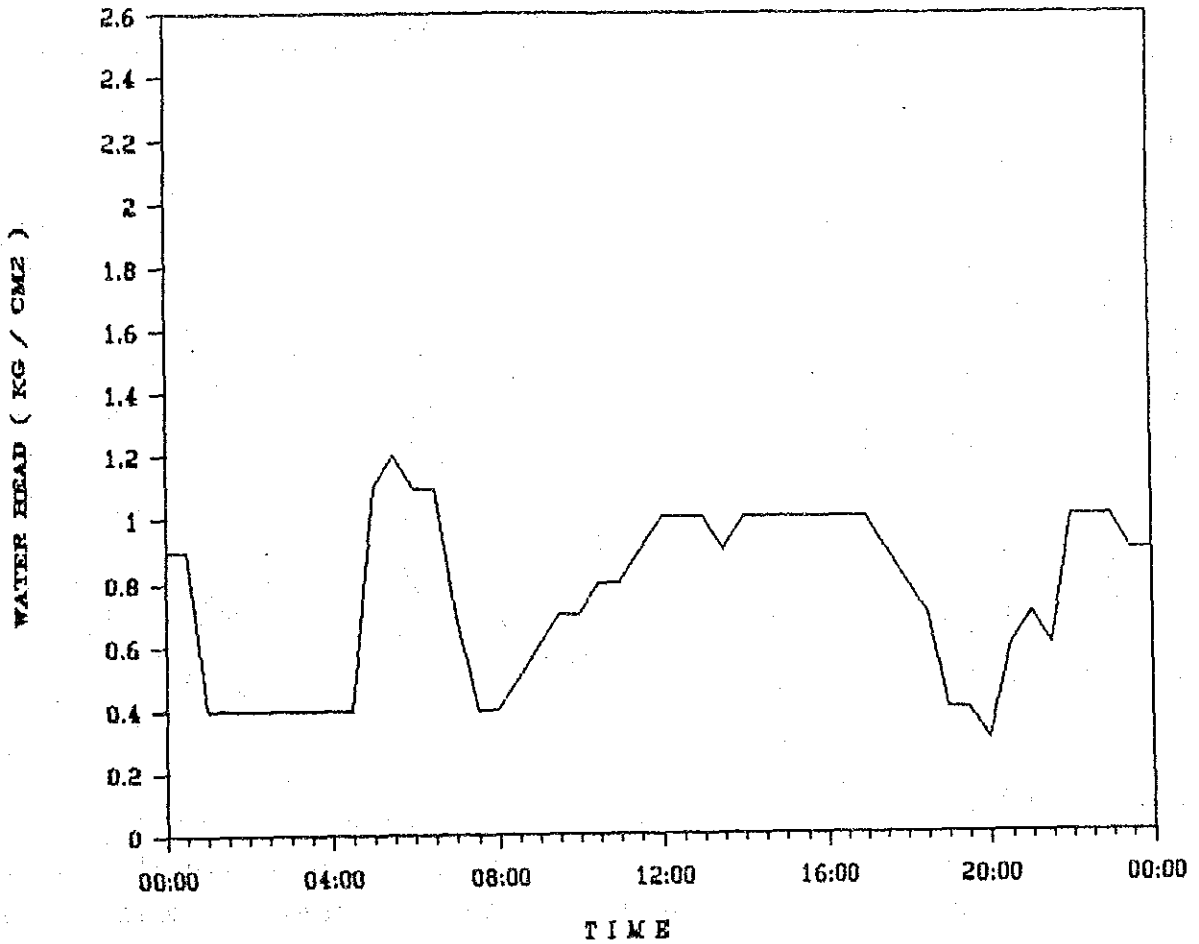


FIGURE A3-9
PRESSURE MEASUREMENT TEST
PATUM THANI (Point 5)

PRESSURE MEASUREMENT TEST

PATUM THANI Point 6

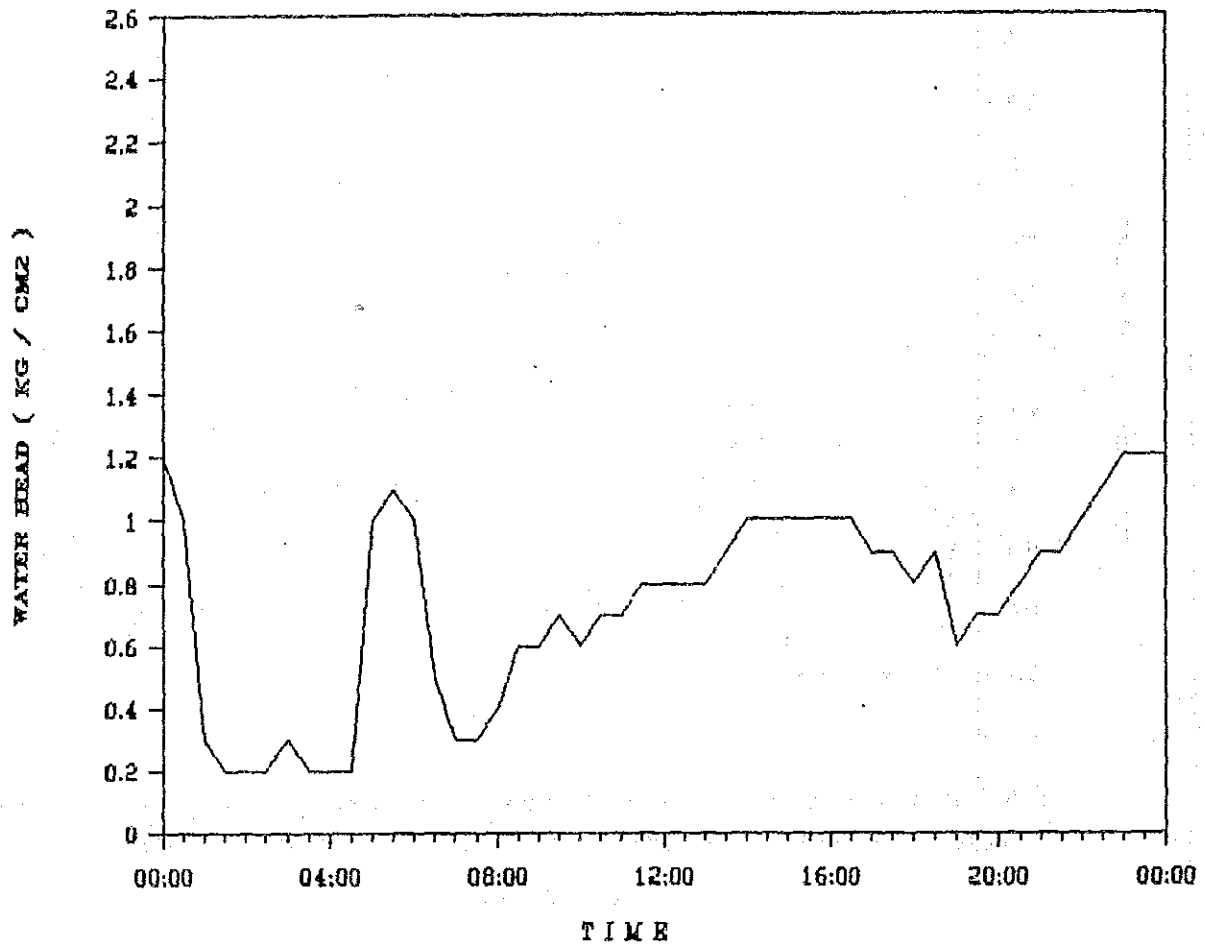


FIGURE A3-10

PRESSURE MEASUREMENT TEST
PATUM THANI (Point 6)

FLOW RATE MEASUREMENT TEST

PRACHATIPAT

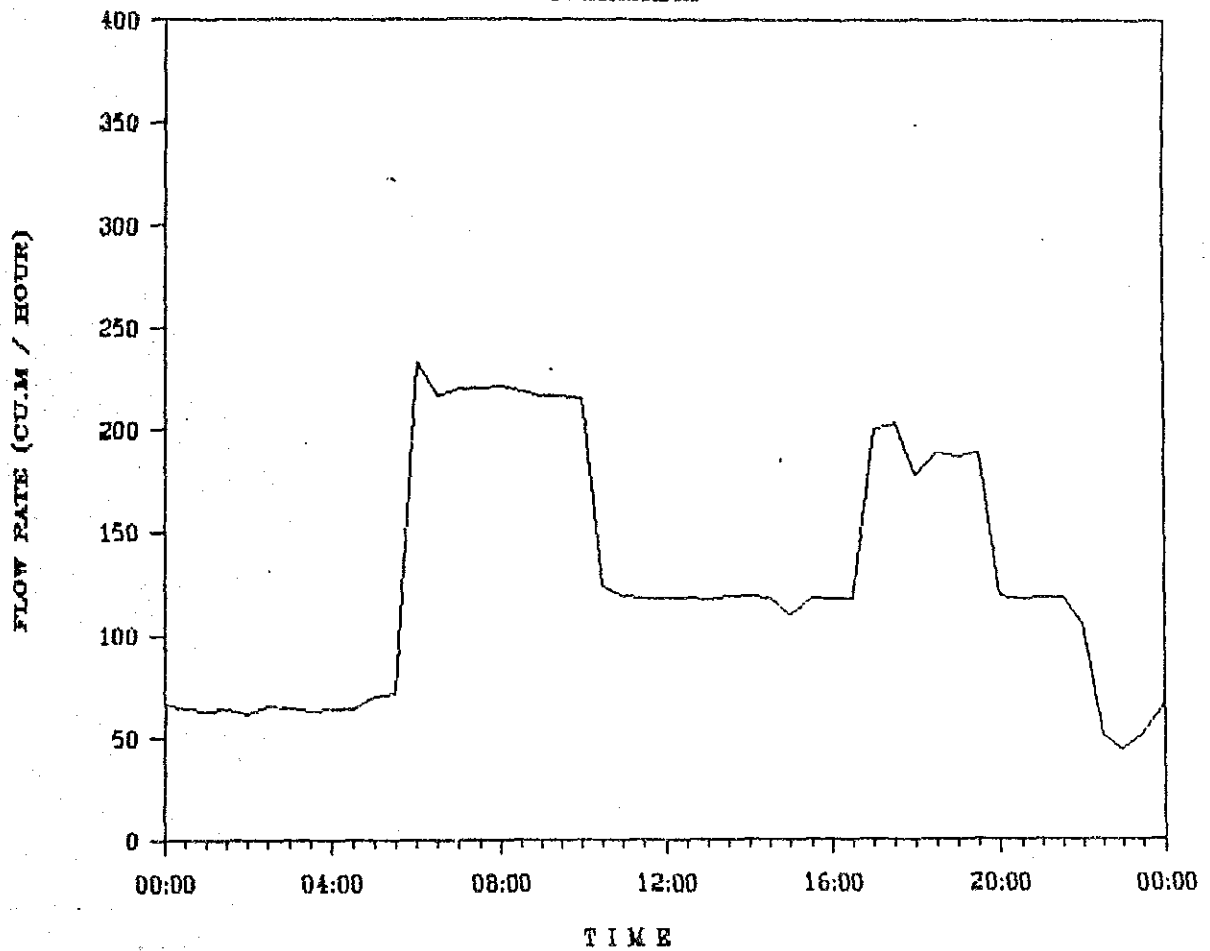


FIGURE A3-11
FLOW RATE MEASUREMENT TEST
PRACHATIPAT



A-3-1-14

FIGURE A3-12
 LOCATION MAP OF PRESSURE
 MEASUREMENT POINTS

PRESSURE MEASUREMENT TEST

PRACHATIPAT Point 1

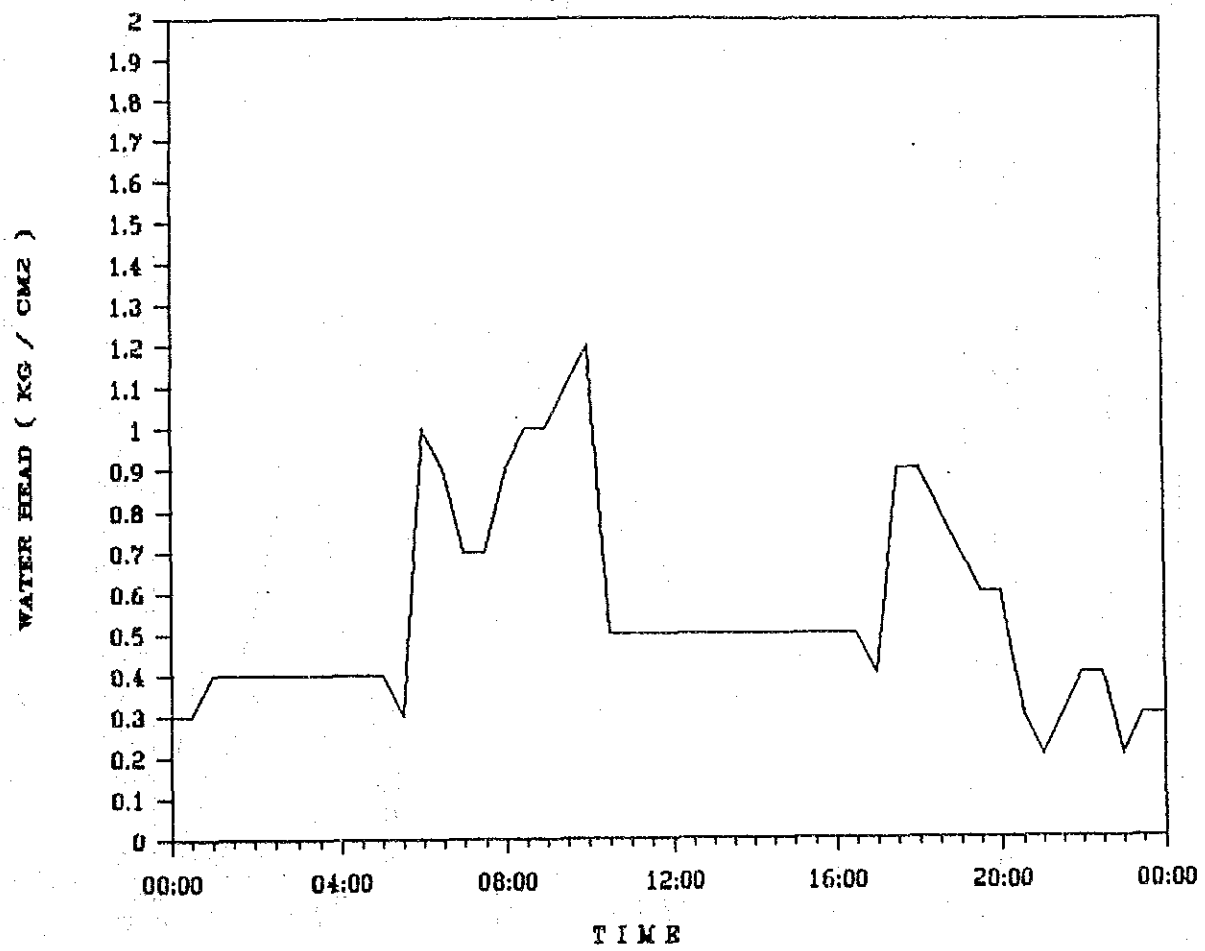


FIGURE A3-13
PRESSURE MEASUREMENT TEST
PRACHATIPAT (Point 1)

PRESSURE MEASUREMENT TEST

PRACHATIPAT Point 2

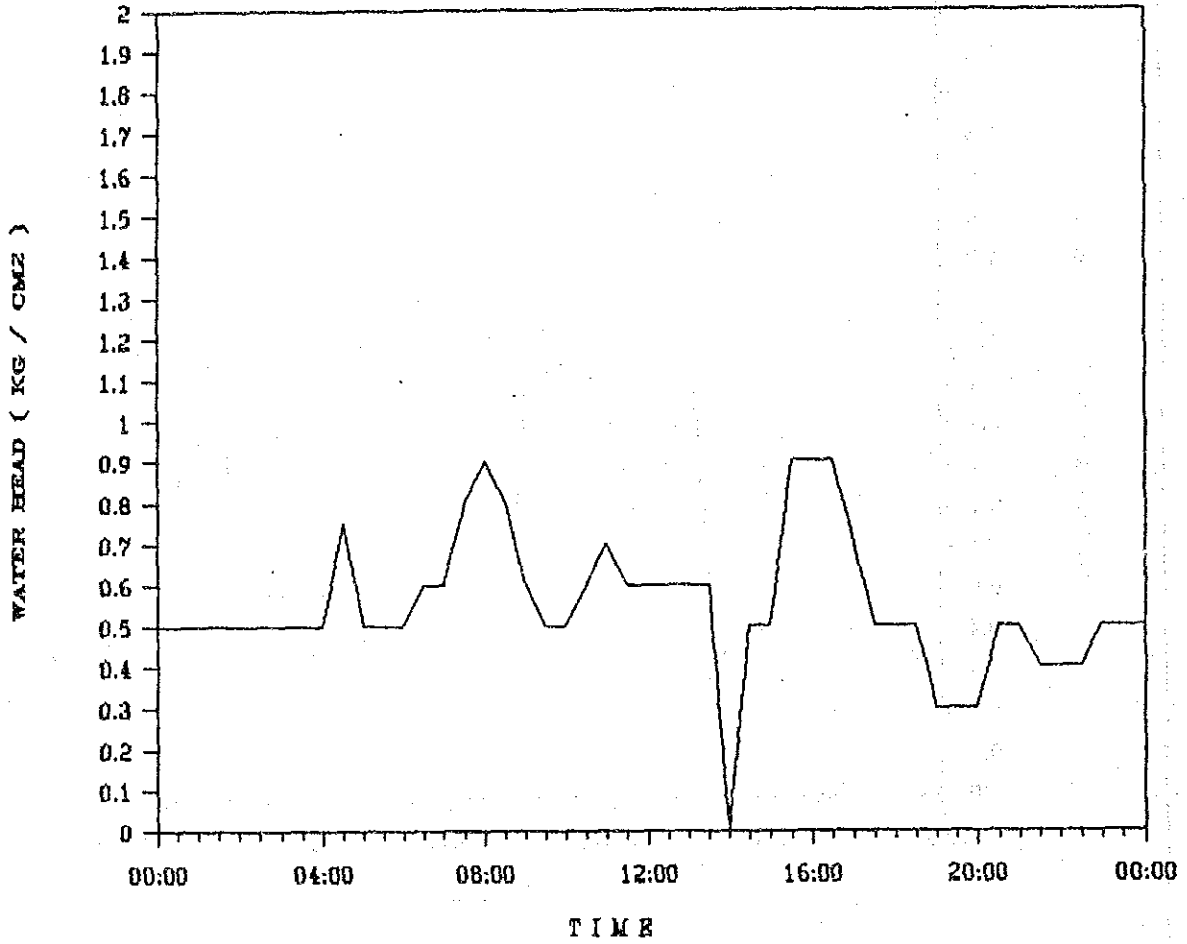


FIGURE A3-14
PRESSURE MEASUREMENT TEST
PRACHATIPAT (Point 2)

PRESSURE MEASUREMENT TEST

PRACHATIPAT Point 3

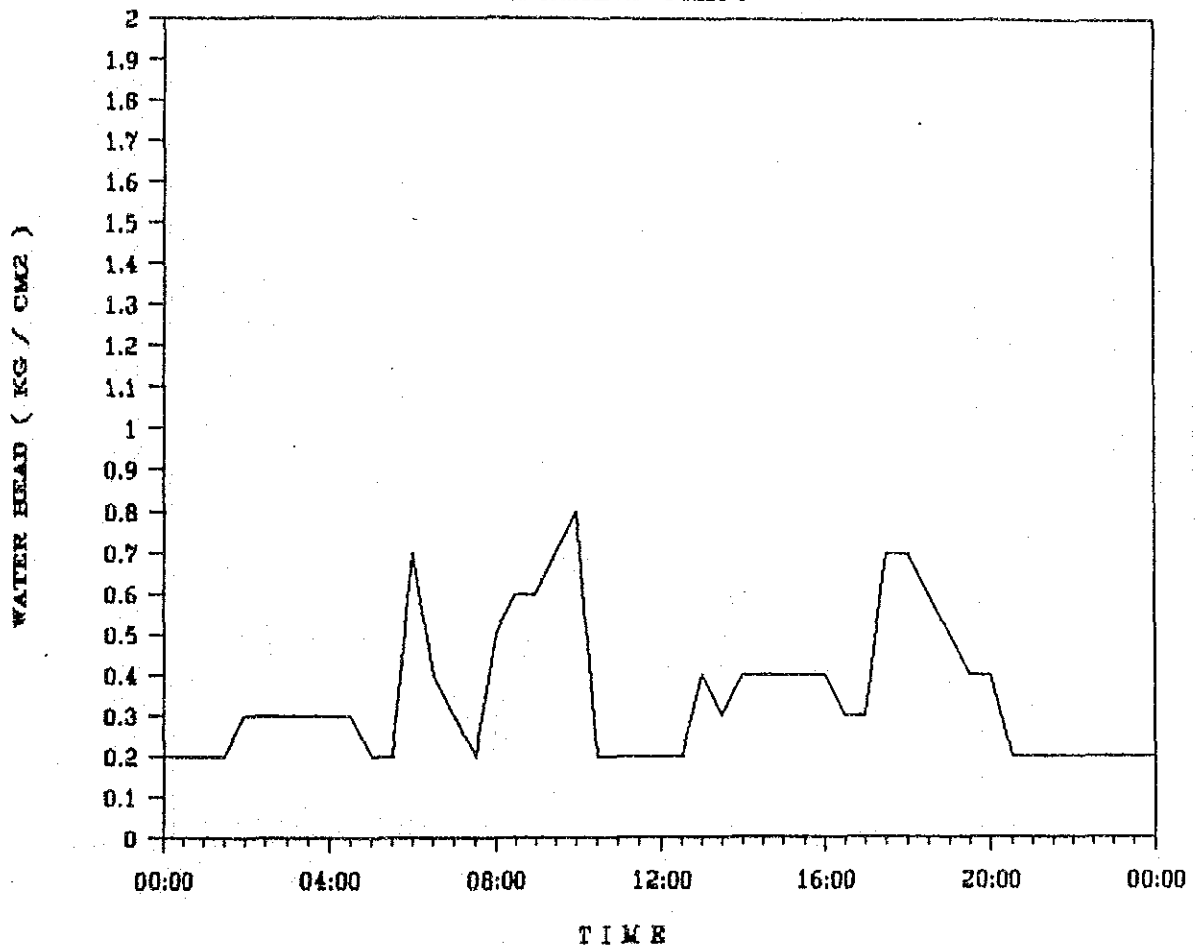


FIGURE A3-15
PRESSURE MEASUREMENT TEST
PRACHATIPAT (Point 3)

PRESSURE MEASUREMENT TEST

PRACHATIPAT Point 4

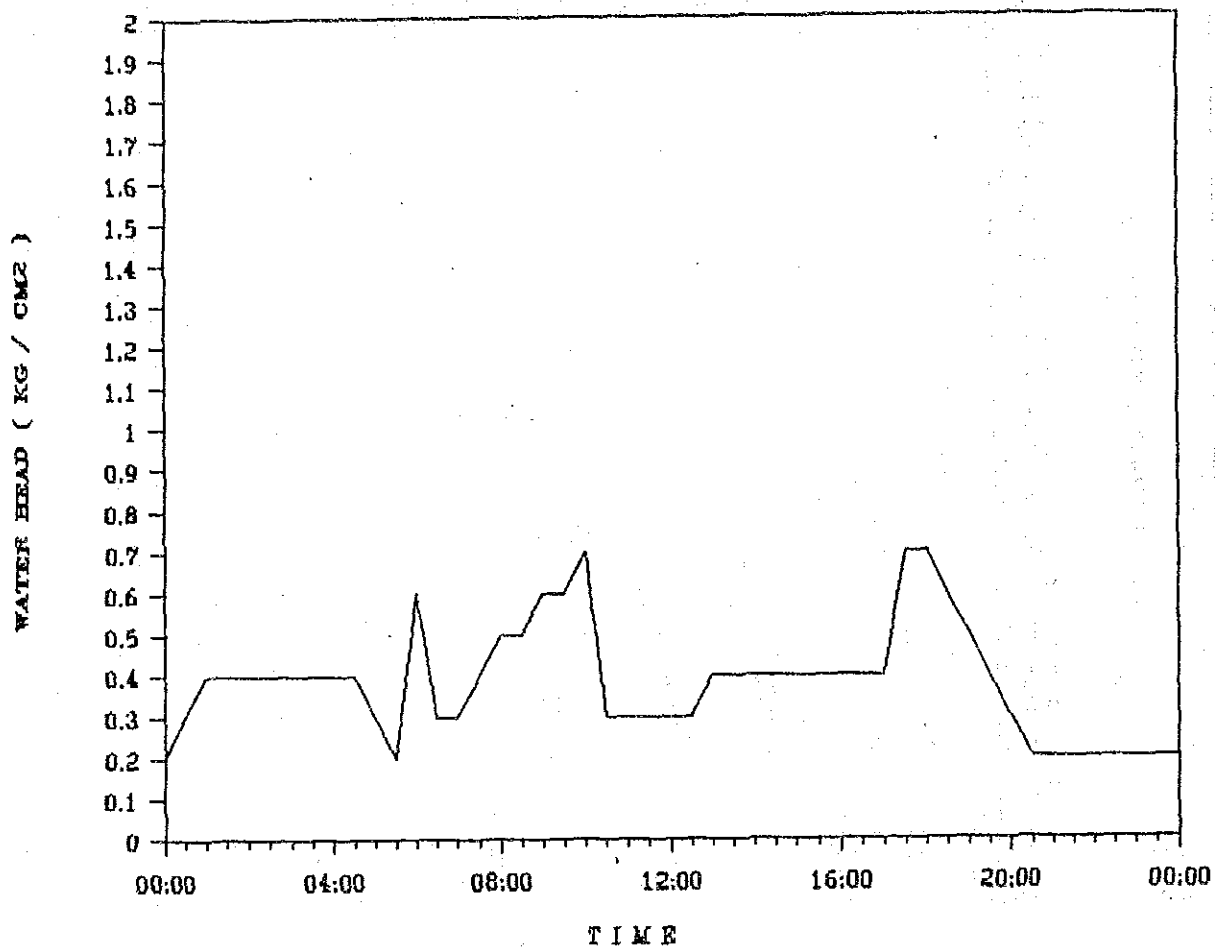


FIGURE A3-16

PRESSURE MEASUREMENT TEST
PRACHATIPAT (Point 4)

PRESSURE MEASUREMENT TEST

PRACHATIPAT Point 5

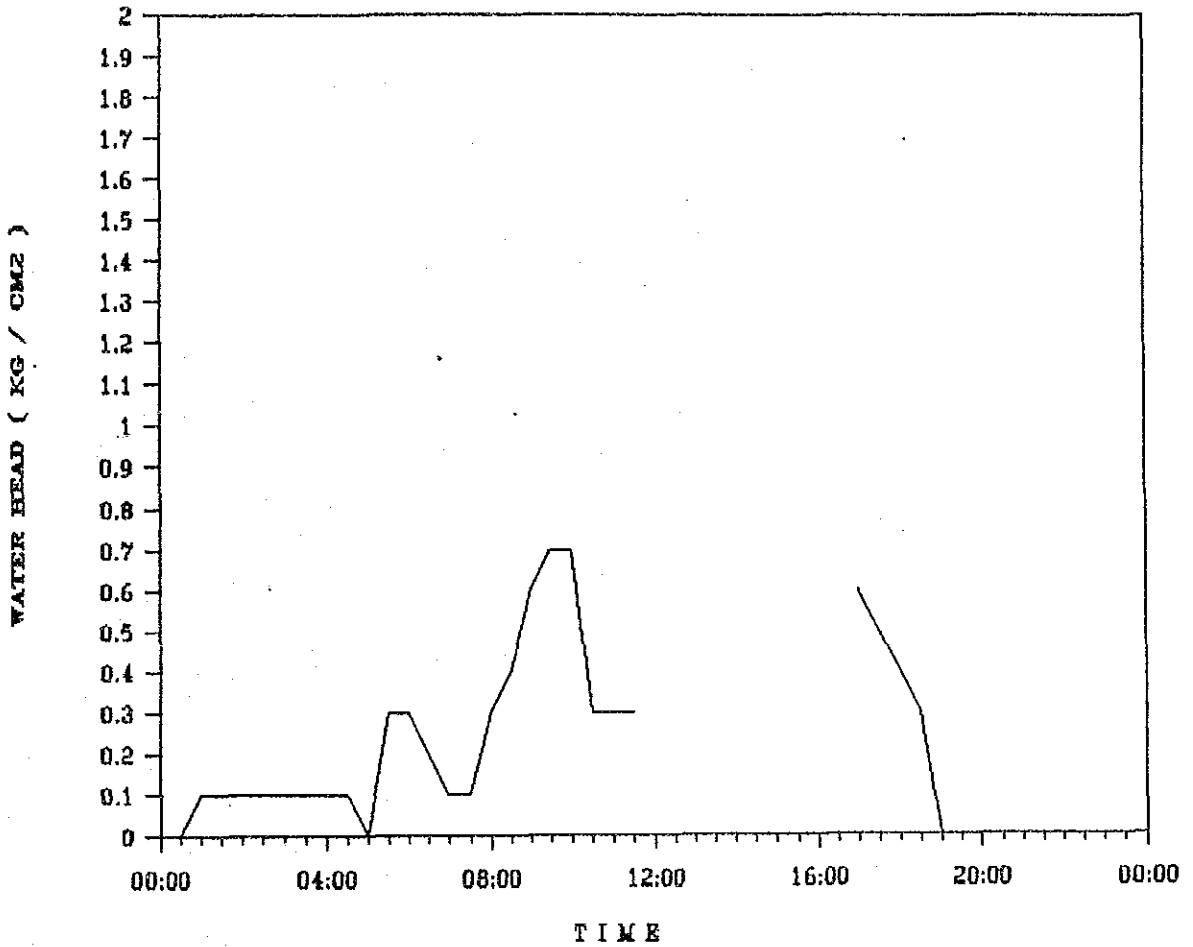


FIGURE A3-17
PRESSURE MEASUREMENT TEST
PRACHATIPAT (Point 5)

APPENDIX A-3-2

Study on Water Quality on Distribution Network

APPENDIX A-3-2 WATER QUALITY ON DISTRIBUTION NETWORK

Water quality analysis was conducted along the existing main distribution pipelines with a potable water quality analyzer. Parameters of the analysis are pH, temperature and conductivity.

The results of the analysis are shown in Tables A4-1 and A4-2. Sampling points are indicated in Figure A4-1 and A4-2.

As listed in Table A4-1 and A4-2, there is no problem regarding the high pH value in both Patum Thani and Prachati-pat distribution networks.

Table A3-2-1 Results of Water Quality Analysis (Patum Thani)

Items	*1										*2
	1	2	3	4	5	6	7	8	9	10	
pH	7.56	7.75	7.86	7.90	7.92	7.55	7.60	7.52	7.75	7.81	
Temp. (°C)	35.0	37.2	33.4	32.9	33.6	36.4	36.9	34.5	33.2	32.4	
Conductivity (5x10 ³ µm)	8.2	7.4	7.4	7.9	7.0	7.8	7.8	8.1	7.9	6.7	

Note : *1 Treated Water at New Water Treatment Plant
 *2 Treated Water at Old Water Treatment Plant

Table A3-2-2 Results of Water Quality Analysis (Prachathipat)

Items	*1					
	1	2	3	4	5	6
pH	7.5	7.5	7.5	7.52	7.50	7.50
Temp. (°C)	31.8	32.5	30.7	31.3	31.3	29.3
Conductivity (5x10 ³ µm)	10.8	7.3	7.2	7.0	7.0	11.6

Note: *1 Treated Water at Water Treatment Plant

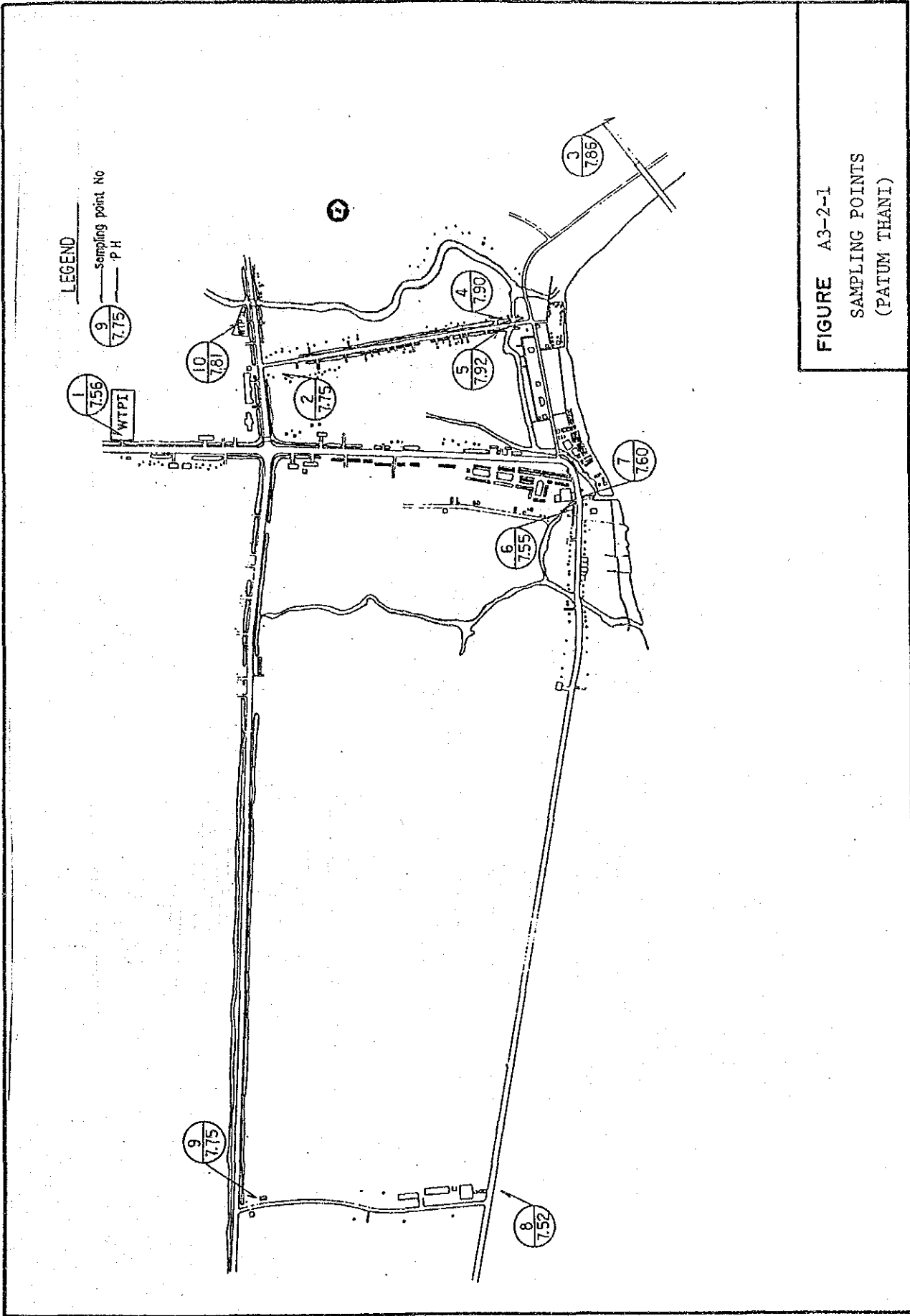


FIGURE A3-2-1
 SAMPLING POINTS
 (PATUM THANI)

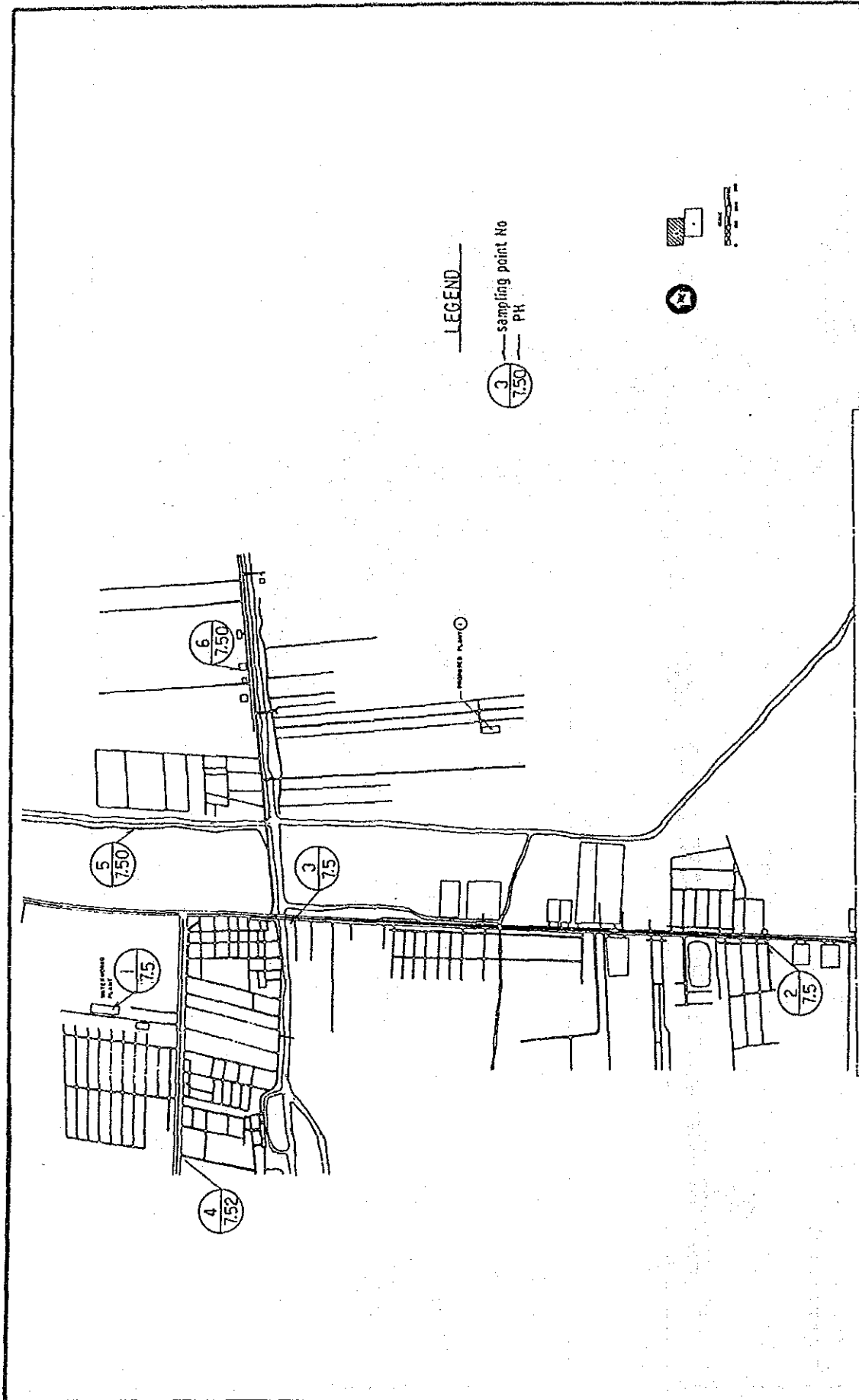


FIGURE A3-2-2
 SAMPLING POINTS
 (PRACHATIPAT)

APPENDIX A-4-1

Study on Water Consumption

APPENDIX A4-1 STUDY ON WATER CONSUMPTION

1 Data Collection

Present water consumption data was collected from the waterworks' meter reading records for the study of water demand and distribution network analysis. Meter reading records at the waterworks office consist of volumes of cards in PWA's format for each connection. Monthly consumptions from September 1987 to August 1988 of each connection are recorded on this card.

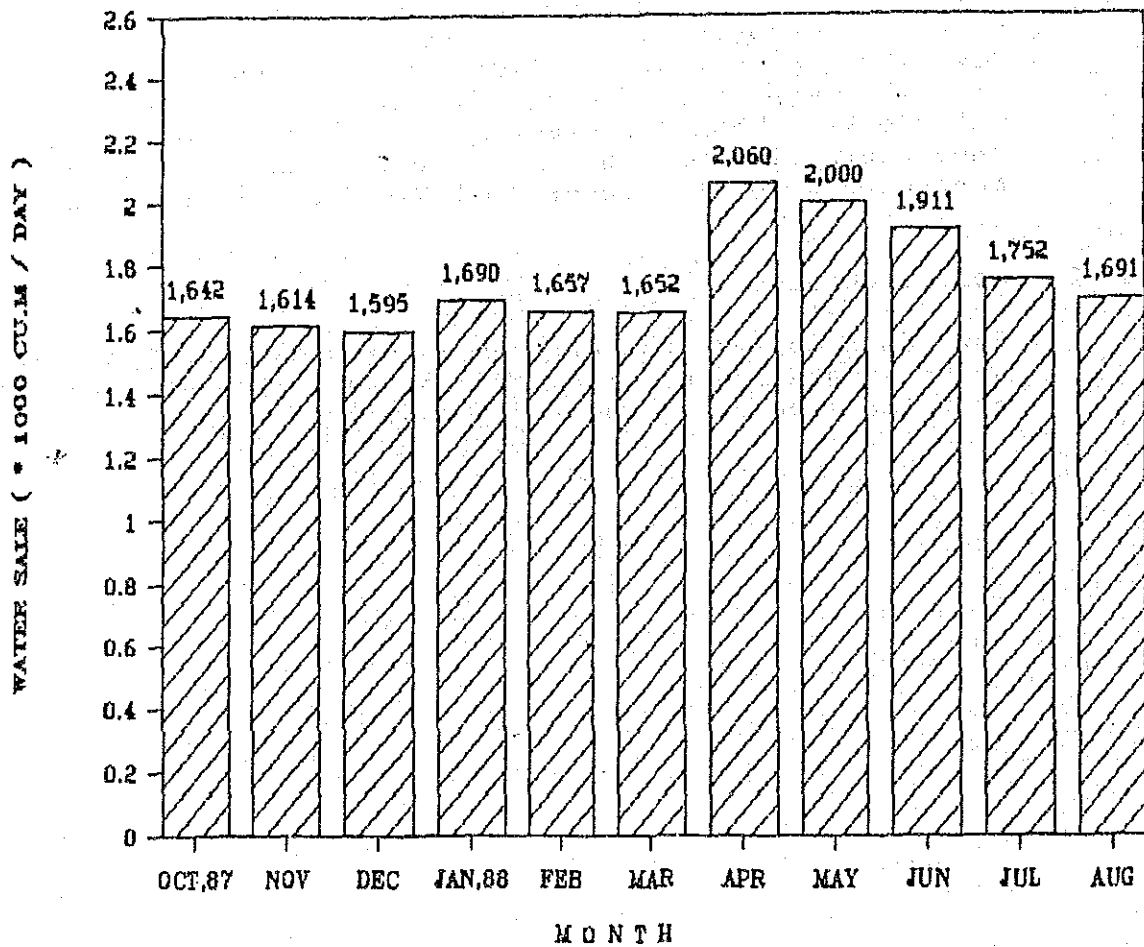
Data collection was made in a manner of copying figures water consumption of each consumer for every month. For distribution network analysis, each consumer was located on the map by interviewing meter readers of the waterworks. When the exact locations were not identified, they were located in some extent of the pipeline. Big consumers were also identified for further analysis.

2 Collected Data

Raw data copied from meter reading books was then summed up by month and by area. The attached sheets hereafter show the summary of water consumption.

WATER SALE OF PATUM THANI W.W

DAILY AVG BY MONTH

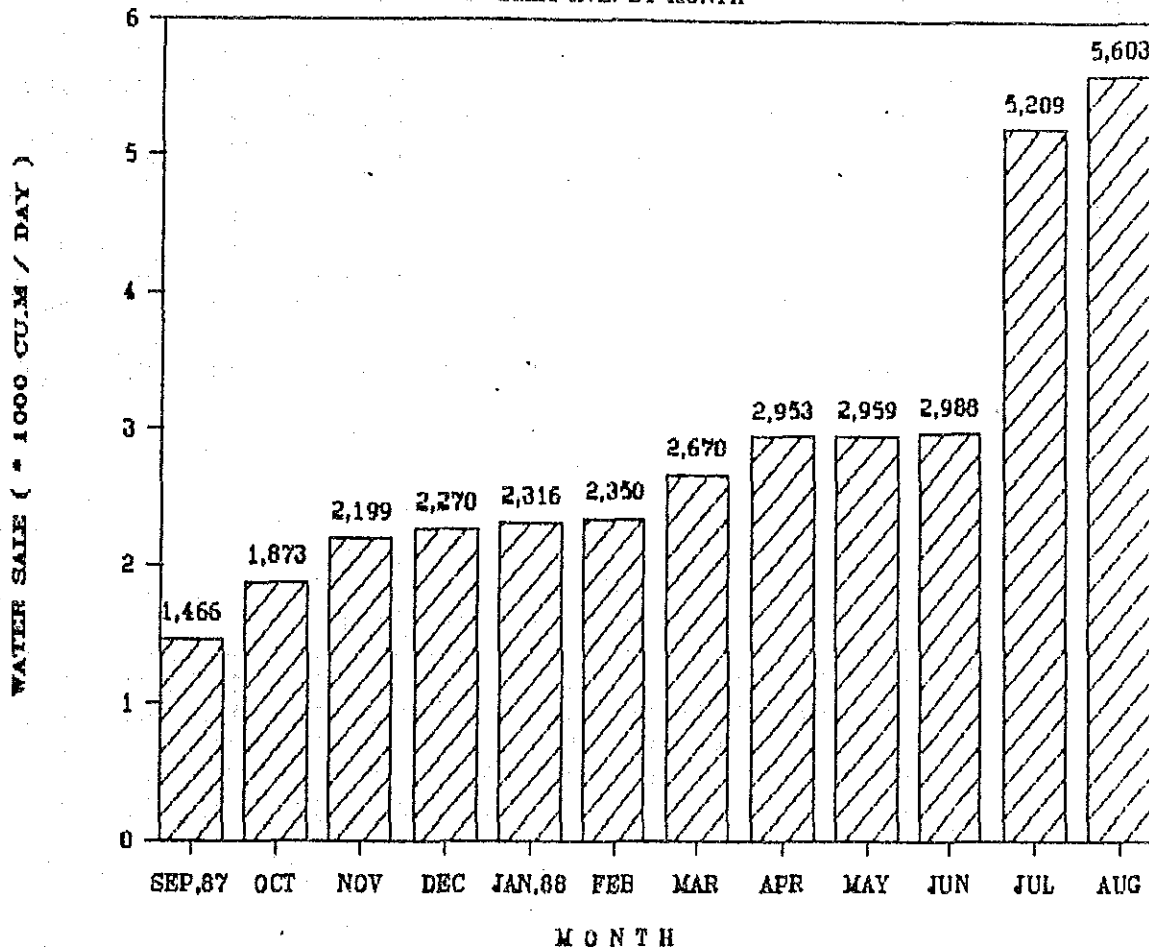


FIGURE

A4 - 1 - 1

WATER SALE OF PRACHATIPAT W.W

DAILY AVE. BY MONTH



FIGURE

A4 - 1 - 2

Table A4-1-1

SUMMARY OF PATUM THANI WATER SALE

BOOK NO.	OCT, 87	NOV	DEC	JAN, 88	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL	DAY AVG.
1	13,778	13,163	13,431	13,335	12,685	13,852	14,894	14,969	14,756	14,930	13,733	15,178	168,704	481.63
2	28,461	26,587	28,549	30,122	27,467	28,345	33,879	32,694	30,328	31,495	30,821	14,901	343,649	1047.06
3	8,671	8,665	7,465	8,936	7,888	9,002	13,022	14,329	12,254	7,890	7,859	6,787	112,768	308.95
TOTAL (CU.W/MO)	50,910	48,415	49,445	52,393	48,040	51,199	61,795	61,992	57,338	54,315	52,413	36,866	625,121	1837.65
TOTAL (CU.W/DAY)	1,642	1,614	1,595	1,690	1,657	1,652	2,060	2,000	1,911	1,752	1,691	1,229		

Table A4-1-2

SUMMARY OF PRACHATIPAT

FILE NO.	BOOK NO.	SEP,87	OCT	NOV	DEC	JAN,88	FEB	MAR	APR	MAY	JUN	JUL	AUG	TOTAL	DAY AVE.
1	1	7,117	9,207	8,613	9,022	9,728	8,385	10,071	10,188	11,588	11,723	8,338	10,230	114,210	312.90
2	2-1	9,872	12,961	13,458	13,490	11,348	10,608	13,564	9,738	12,766	13,281	13,097	11,662	145,845	399.58
3	2-2	12,045	14,985	15,201	14,732	14,129	12,027	14,986	13,542	16,220	14,804	14,815	13,866	171,352	469.46
4	2-3	9,749	12,615	12,580	12,437	11,791	10,004	11,811	11,131	11,615	10,946	9,863	10,889	135,431	371.04
5	2-4	6,152	8,688	8,683	7,981	8,717	8,693	9,413	9,158	10,840	10,111	10,321	11,372	110,129	301.72
6	3	4,626	7,614	14,677	17,482	16,631	16,777	18,234	21,465	21,661	22,308	24,529	21,638	207,642	568.88
7	3-1,-2	0	0	0	0	0	0	0	0	0	0	35,990	25,376	61,366	168.13
7	4	634	871	699	653	627	749	629	624	1,214	975	1,192	936	9,803	26.86
8	5-1	3,662	4,078	5,508	7,361	7,887	8,063	9,576	11,757	9,456	9,034	8,379	8,203	92,878	254.46
9	5-2	0	0	0	699	2,279	3,446	8,044	10,716	9,139	9,725	10,111	9,347	63,506	173.99
10	6-1	0	0	0	0	0	0	0	0	0	0	10,352	15,202	25,554	70.01
11	6-2	0	0	0	0	0	0	0	0	0	0	8,503	14,534	23,037	63.12
12	6-3	0	0	0	0	0	0	0	0	0	0	7,840	14,258	22,098	60.54
13	6-4	0	0	0	0	0	0	0	0	0	0	11,235	17,851	29,086	79.63
TOTAL		53,857	71,019	79,419	83,857	83,137	78,752	96,328	98,319	104,499	102,907	174,565	185,364	1,211,937	3,320
(CU.M/MO)															
DAY AVE		1,795	2,291	2,647	2,795	2,682	2,716	3,107	3,277	3,371	3,430	5,631	5,979		
(CU.M/DAY)															

DAYLY AVE. BY AREA (CU.M/DAY)

LINE (Book) No.	SEP,87	OCT	NOV	DEC	JAN,88	FEB	MAR	APR	MAY	JUN	JUL	AUG
1	237	297	287	291	314	289	325	340	374	391	269	330
2	1,261	1,589	1,664	1,569	1,483	1,425	1,606	1,452	1,659	1,638	1,551	1,542
3	154	246	489	564	536	579	588	716	699	744	1,952	1,517
4	21	28	23	21	20	26	20	21	39	33	38	30
5	122	132	184	260	328	397	558	749	600	625	596	566
6	0	0	0	0	0	0	0	0	0	0	1,224	1,995

APPENDIX A-4-2

Questionnaire Survey for Residents in Patum Thani

APPENDIX A-4-2 QUESTIONNAIRE SURVEY IN PATUM THANI (RESIDENTIAL)

1 Objective

The door-to-door questionnaire survey was conducted to obtain the basic information on the resident's living conditions, water use patterns, responses to the municipal system and/or their own water sources and willingness for house-connection supply, and covered the area served or unserved by the municipal water supply system.

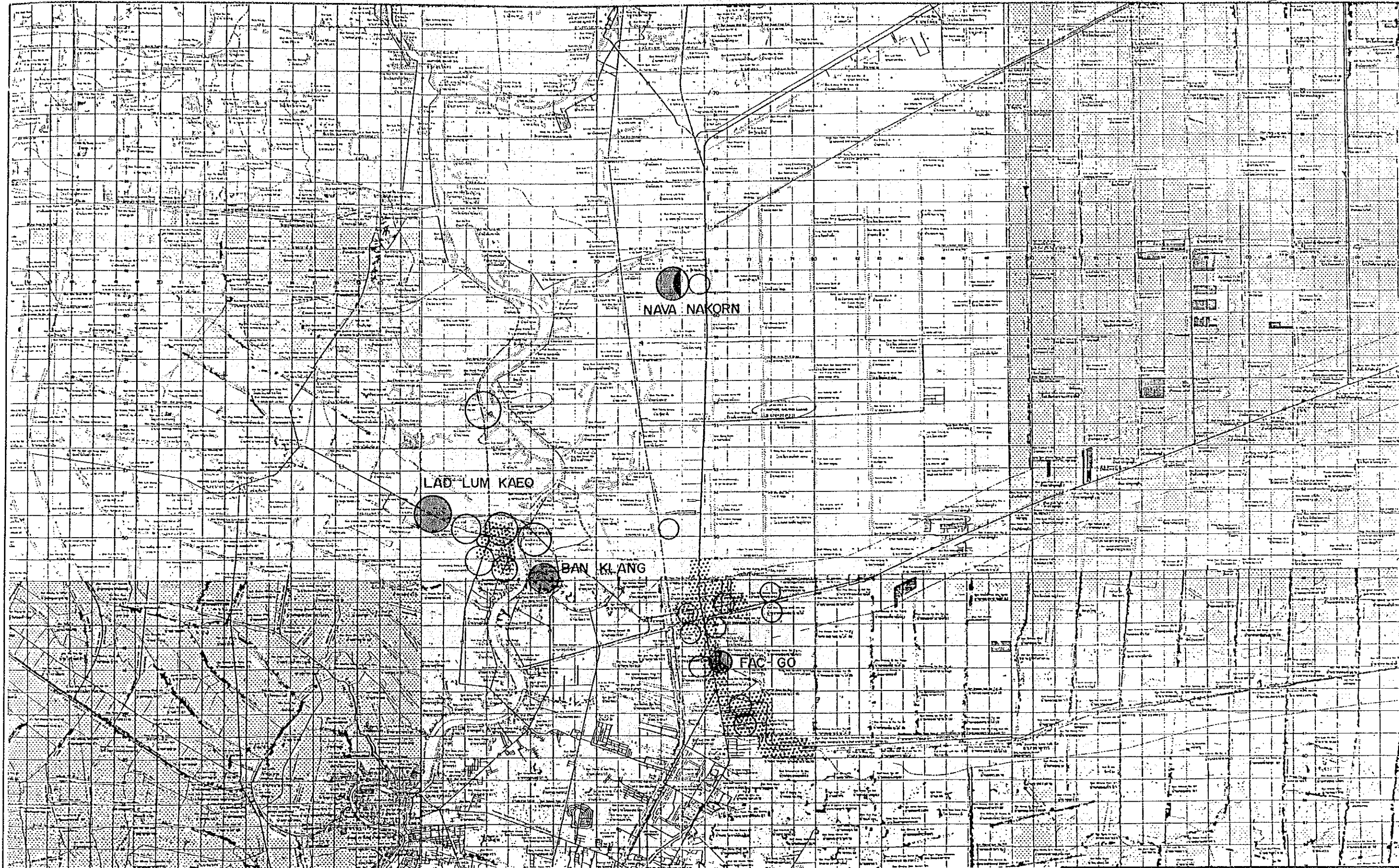
2 Survey Area

The survey area was divided into 7 blocks taking into account the urbanized situation as shown in Figure A1-2-1. Blocks 1, 2 and 3 were presently being served by the municipal system and other blocks were unserved by the municipal system.

3 Survey Item

The form used for the questionnaire survey was originally written by Thai and included the following items.

1. General
 - 1.1 Address
 - 1.2 Type of House
 - 1.3 No. of Persons in Family
 - 1.4 No. of Employees
 - 1.5 Average Monthly Income
 - 1.6 Average Monthly Medical Expense
2. Type of Water Supply
3. Conditions in case of Municipal System
 - 3.1 Pressure
 - 3.2 Quantity
4. Other Sources than Municipal System
 - 4.1 Type of Source
 - 4.2 Conditions in case of Groundwater
5. Potability
6. Water Quality in case of Municipal System
 - 6.1 Color
 - 6.2 Smell
 - 6.3 Turbidity
7. Average Monthly Water Consumption



- RESIDENTIAL
- INDUSTRIAL

FIGURE A4-2-1
QUESTIONNAIRE SURVEY IN
PATUM THANI & PRACHATIPAT

8. Average Monthly Water Charge
9. Willingness to Pay for Water Charge
10. Water Quality in case of Other Source
 - 10.1 Color
 - 10.2 Smell
 - 10.3 Turbidity
11. Willingness to Connect to the Municipal System
12. Willingness to Pay for Connection Fee
13. Willingness to Pay for Water Charge

4 Survey Method

College students were employed as interviewers and were engaged in the questionnaire survey with the guidance of the PWA Head Office staff. The survey was conducted to 182 residents on September 14, 1988.

5 Survey Results

The results of the questionnaire survey are summarized in Table A1-5-1.

1) General

57.1% of the respondents lived in residential houses while 42.9% in commercial buildings.

The total numbers of persons in families and employees were 902 and 367 respectively. Accordingly one household is composed of 4.96 family members and 2.02 employees on an average with a total of 6.98 persons.

Regarding the average monthly income, 70.8% of the respondents was in the up-to-6,000 Baht bracket, or 5.5% in the up-to-2,000 Baht, 17.0% in 2,001-3,000 Baht, 30.2% in the 3,001-4,500 Baht and 18.1% in the 4,501-6,000 Baht brackets, respectively. The average in respondents weighted by the number of persons and the median in each income bracket was approximately 4,630 Baht, but the number of persons was biggest in the 3,001-4,500 Baht bracket.

As to the average monthly medical expense, 23.6% was in the up-to-50 Baht bracket and 20.9%, and 15.4% were in the 51-100, 101-200 and 201-500 Baht brackets, respectively, while 32.4% was unknown. The average in respondents calculated by the same method as the above is 140 Baht, but the number of persons was biggest in the up-to-50 Baht bracket.

2) Type of Water Supply

44.5% of the respondents used the municipal system only and 52.% the other source than the municipal system and 2.7% the combined system of the municipal system and other source(s).

81.2% or 82 out of 101 other sources was rain or surface water, in which the main source seemed to be surface water from the canal or river.

```

=====
Block No.           1  2  3  4  5  6  7  Total
=====
Municipal System Only    55  5 20  -  -  1  -   81
  plus Rain/River        2  -  1  -  -  -  -    3
  plus Water Vender      1  -  -  -  -  -  -    1
  plus Well              -  1  -  -  -  -  -    1

Well Only                -  -  1  -  1  9  1   12
  plus Rain/River        -  -  -  -  2  4  -    6

Rain/River Only          1  -  -  21 21 15 15   73

Water Vendor Only        -  1  -  -  2  -  -    3

Unknown                  -  -  -  -  -  1  1    2
-----
Total                    59  7 22 21 26 30 17  182
=====

```

3) Response to Municipal System

The reputation of the PWA waterworks among 86 respondents using the municipal system was not so good, that is to say, 26.7% complained of low pressure, 18.6% of insufficient water, 51.2% of color, 40.7% of smell and 67.9% for turbidity. Such complaints took place in all served blocks, or Blocks 1, 2 and 3.

4) Potability

This question was originally intended to know the potability of tap water, but the answer seemed to be made not only for the tap water but also for other source water, since the question followed that on other sources.

Accordingly, the evaluation was made extracting the data from respondents using tap water or Rain/River water only.

	Tap Water	Rain/River Water
Drinking	23 (28.4%)	32 (43.8%)
Not Drinking	57 (70.4%)	26 (35.6%)
Both	1 (1.2%)	11 (15.1%)
Unknown	---	4 (5.5%)
Total	81 (100%)	73 (100%)

28.4% of the respondents used tap water for drinking and 1.2% for both drinking and not-drinking in spite of much complaints of its water quality, while 43.8% used rain/river water for drinking and 15.1% for both drinking and not-drinking. The majority used tap water for not-drinking.

5.5% of the respondents used unknown water source for drinking purposes. Assumptions was made that they maybe using water vendor, thought this is not clearly stated in the survey.

5) Water Quality of Other Sources

As above-mentioned, rain/rive water is the main water source of the respondents. 34.7% complained of color, 31.7% of smell, 68.5% of turbidity. Such complaints took place in all unserved blocks, or Blocks 4, 5, 6 and 7. As compared with the tap water source, the complaints regarding color and smell were less in other sources.

6) Conditions of Wells

18.8% or 19 out of 101 other sources including the combination with the other used groundwater. The wells were mainly located in Blocks 5 and 6 but, respondents had no knowledge about their conditions.

7) Average Monthly Water Consumption, Water Charge and Willingness-to-Pay

82.6% of the respondents had no knowledge regarding the average monthly water consumption, and remaining 17.4% answered to be in the up-to-50 cu m brackets. The respondents' average monthly water charge are widely distributed in the range of up to 300 Baht. The respondents belonging to the up-to-50 Baht bracket was rather less and the number of respondents was biggest in the 101-150 Baht bracket. According to the result on the willingness-to-pay for water charge, 24.4% wanted that the water charge would be in the up-to-50 Baht bracket, 32.6% in the 51-100 Baht bracket and 12.8% in the 101-200 Baht bracket. The remaining 30.2% didn't give clear answer.

8) Willingness-to-Connect

Out of 182 respondents, 96 didn't use the municipal system at present. However, 91.7% was willing to connect to the municipal system. They wanted that the connection fee would be less than 2,500 Baht (90.9%) and the water charge less than 100 Baht (87.5%). The response to the water charge of the possible consumers was severer than that of the existing consumers.

Table A1-5-1 : SUMMARY OF QUESTIONNAIRE SURVEY (RESIDENTIAL)

Block No.	1	2	3	4	5	6	7	Total	Rate (%)
No. of Samples	59	7	22	21	26	30	17	182	
1. General									
1.1 Address									
1.2 Type of House									
Residential	31	5	16	3	15	21	13	104	57.1
Commercial	28	2	6	18	11	9	4	78	42.9
Residential/Commercial	-	-	-	-	-	-	-	-	-
Unknown	-	-	-	-	-	-	-	-	-
1.3 No. of Persons in Family	276	34	78	92	175	149	98	902	
Unknown (No. of Samples)	-	-	-	-	-	-	-	-	-
1.4 No. of Employees	105	17	39	33	75	63	35	367	
Unknown (No. of Samples)	-	-	-	-	-	-	-	-	-
1.5 Ave. Monthly Income									
Baht									
up to 2,000	2	1	1	-	2	1	3	10	5.5
2,001-3,000	10	3	1	4	6	5	2	31	17.0
3,001-4,500	11	3	8	8	8	11	6	55	30.2
4,501-6,000	15	-	2	3	5	5	3	33	18.1
6,001-7,500	4	-	3	2	2	5	2	18	9.9
7,501-10,000	7	-	3	-	1	-	-	11	6.1
10,001-15,000	5	-	1	-	-	-	-	6	3.3
15,001-50,000	-	-	-	-	-	-	-	-	-
Over 50,000	-	-	-	-	-	-	-	-	-
Unknown	5	-	3	4	2	3	1	18	9.9
1.6 Ave. Monthly Medical Expense									
Baht									
up to 50	15	3	5	3	5	8	4	43	23.6
51-100	12	-	6	4	8	7	1	38	20.9
101-200	11	-	5	1	3	5	3	28	15.4
201-500	3	-	1	2	1	1	2	10	5.5
501-1,000	-	-	-	1	-	-	-	1	0.6
1,001-2,000	-	-	-	1	1	1	-	3	1.6
2,001-5,000	-	-	-	-	-	-	-	-	-
Over 5,000	-	-	-	-	-	-	-	-	-
Unknown	18	4	5	9	8	8	7	59	32.4
2. Type of Water Supply									
Municipal System	55	5	20	-	-	1	-	81	44.5
Combined	3	1	1	-	-	-	-	5	2.7
Other Sources	1	1	1	21	26	29	17	96	52.8
Unknown	-	-	-	-	-	-	-	-	-
3. Municipal System									
3.1 Pressure									
Low	13	2	8	-	-	-	-	23	26.7
High	43	4	12	-	-	-	-	59	68.6
Unknown	2	1	1	-	-	-	-	4	4.7
3.2 Quantity									
Sufficient	46	6	13	-	-	-	-	65	75.6
Not Sufficient	9	-	7	-	-	-	-	16	18.6
Unknown	3	1	1	-	-	-	-	5	5.8

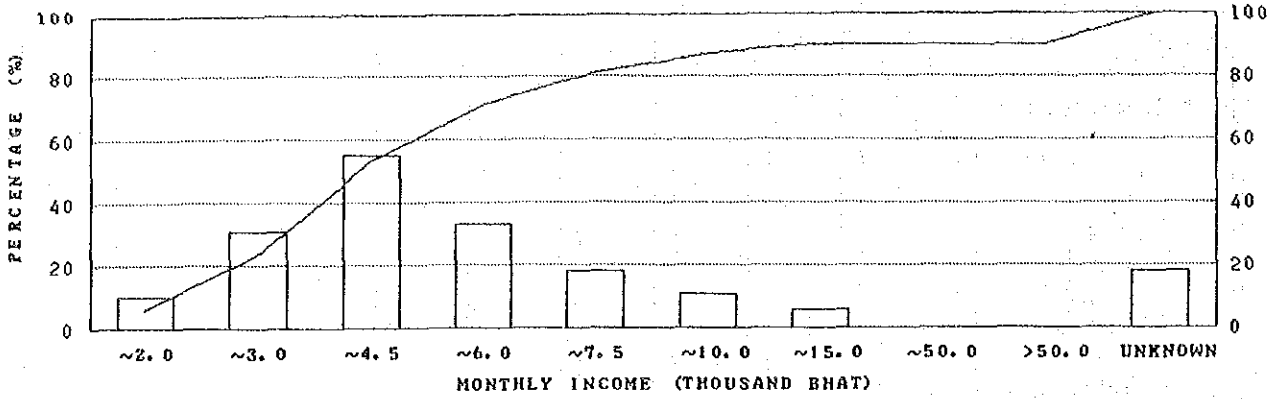
Table A1-5-1 : SUMMARY OF QUESTIONNAIRE SURVEY (RESIDENTIAL) (CONT'D)

Block No.	1	2	3	4	5	6	7	Total	Rate (%)
4. Other Sources									
Rain/River	3	-	1	21	23	19	15	82	
Pond/Reservoir	-	-	-	-	-	-	-	-	
Water Vendor	1	1	-	-	2	-	-	4	
Groundwater-Shallow Well	-	1	1	-	3	12	1	18	
-Deep Well	-	-	-	-	-	1	-	1	
Unknown	-	-	-	-	-	1	1	2	
5. Potability									
Drinking	19	3	2	9	15	10	2	60	33.0
Not Drinking	39	4	20	6	5	20	9	103	56.6
Both	1	-	-	2	5	-	5	13	7.1
Unknown	-	-	-	4	1	-	1	6	3.3
6. Water Quality (Municipal System)									
6.1 Color									
Yes	27	2	14	-	-	1	-	44	51.2
No	21	2	6	-	-	-	-	29	33.7
Unknown	10	2	1	-	-	-	-	13	15.1
6.2 Smell									
Yes	21	-	13	-	-	1	-	35	40.7
No	24	2	7	-	-	-	-	33	38.4
Unknown	13	4	1	-	-	-	-	18	20.9
6.3 Turbidity									
Yes	40	5	12	-	-	1	-	58	67.4
No	15	1	7	-	-	-	-	23	26.8
Unknown	3	-	2	-	-	-	-	5	5.8
7. Ave. Monthly Water Consumption									
Up to 15 cu m	1	-	1	-	-	-	-	2	2.3
16-30 cu m	3	-	3	-	-	1	-	7	8.1
31-50 cu m	5	-	1	-	-	-	-	6	7.0
51-75 cu m	-	-	-	-	-	-	-	-	-
76-100 cu m	-	-	-	-	-	-	-	-	-
101-150 cu m	-	-	-	-	-	-	-	-	-
151-200 cu m	-	-	-	-	-	-	-	-	-
201-300 cu m	-	-	-	-	-	-	-	-	-
Over 300 cu m	-	-	-	-	-	-	-	-	-
Unknown	49	6	16	-	-	-	-	71	82.6
8. Ave. Monthly Water Charge									
Baht									
Up to 50	3	2	2	-	-	-	-	7	8.1
51-100	16	1	7	-	-	1	-	25	29.1
101-150	22	1	3	-	-	-	-	26	30.2
151-200	10	1	3	-	-	-	-	14	16.3
201-300	6	-	3	-	-	-	-	9	10.5
301-500	-	-	1	-	-	-	-	1	1.2
501-1,000	-	-	-	-	-	-	-	-	-
Over 1,000	-	-	-	-	-	-	-	-	-
Unknown	1	1	2	-	-	-	-	4	4.6

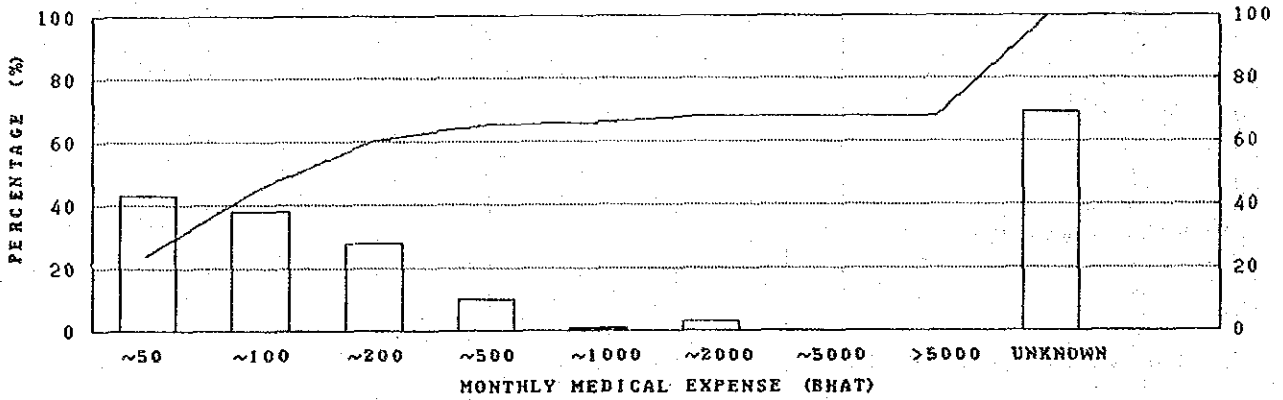
Table A1-5-1 : SUMMARY OF QUESTIONNAIRE SURVEY (RESIDENTIAL) (CONT'D)

Block No.	1	2	3	4	5	6	7	Total	Rate (%)
9. Willingness to Pay									
Baht									
Up to 50	13	1	7	-	-	-	-	21	24.4
51-100	22	1	4	-	-	1	-	28	32.6
101-200	9	-	2	-	-	-	-	11	12.8
201-500	-	-	-	-	-	-	-	-	-
501-1,000	-	-	-	-	-	-	-	-	-
Over 1,000	-	-	-	-	-	-	-	-	-
Unknown	14	4	8	-	-	-	-	26	30.2
10. Water Quality (Other Source)									
10.1 Color									
Yes	-	-	-	4	14	11	6	35	34.7
No	-	1	-	13	6	17	9	46	45.5
Unknown	4	1	2	4	6	1	2	20	19.8
10.2 Swell									
Yes	-	-	-	4	9	11	8	32	31.7
No	-	1	-	15	9	17	7	49	48.5
Unknown	4	1	2	2	8	1	2	20	19.8
10.3 Turbidity									
Yes	-	-	-	15	18	20	16	69	68.3
No	-	1	-	5	6	8	-	20	19.8
Unknown	4	1	2	1	2	1	1	12	11.9
11. Willingness to Connect									
Yes	1	1	1	19	23	26	17	88	91.7
No	-	-	-	1	1	1	-	3	3.1
Unknown	-	-	-	1	2	2	-	5	5.2
12. Willingness to Pay for Connection Fee									
Baht									
Up to 1,000	-	1	-	5	10	7	7	30	34.1
1,001-2,000	-	-	1	7	9	9	6	32	36.4
2,001-2,500	-	-	-	4	4	7	3	18	20.4
2,501-3,000	-	-	-	1	-	-	1	2	2.3
3,001-4,000	-	-	-	-	-	-	-	-	-
4,001-5,000	-	-	-	-	-	-	-	-	-
5,001-6,000	-	-	-	-	-	-	-	-	-
Over 6,000	-	-	-	-	-	-	-	-	-
Unknown	1	-	-	2	-	3	-	6	6.8
13. Willingness to Pay for Water Charge									
Baht									
Up to 50	-	-	-	2	7	6	6	21	23.9
51-100	-	1	1	11	8	13	4	38	43.2
101-200	-	-	-	3	6	4	5	18	20.4
201-500	-	-	-	-	2	-	-	2	2.3
501-1,000	-	-	-	-	-	-	1	1	1.1
Over 1,000	-	-	-	-	-	-	-	-	-
Unknown	1	-	-	3	-	3	1	8	9.1

MONTHLY INCOME DISTRIBUTION



MONTHLY MEDICAL EXPENSE DISTRIBUTION



TYPE OF WATER SOURCE & WILLINGNESS-TO-CONNECT

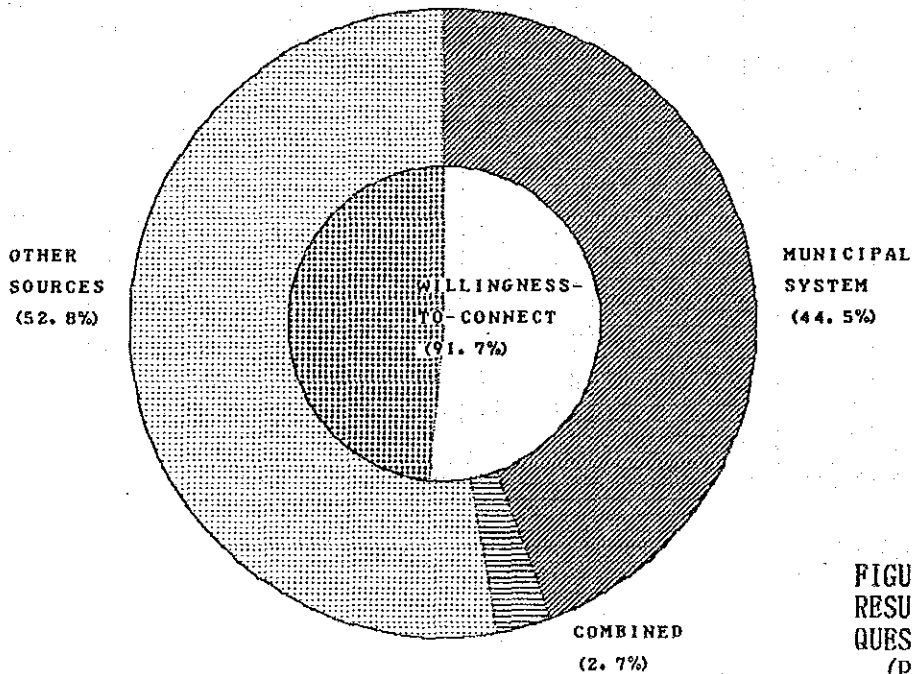
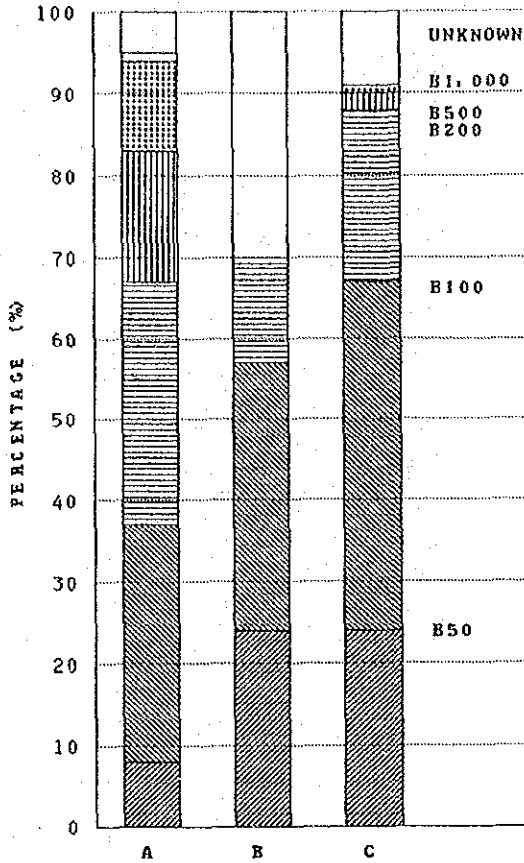


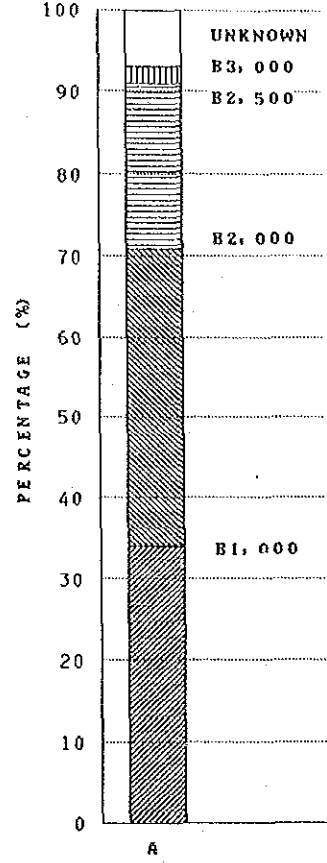
FIGURE A1-5-2
RESULTS OF
QUESTIONNAIRE SURVEY (1)
(PATUM THANI)

WILLINGNESS-TO-PAY

WATER CHARGE



CONNECTION FEE



A : ACTUAL PAYMENT BY EXISTING USERS
 B : EXPECTANT PAYMENT BY EXISTING USERS
 C : EXPECTANT PAYMENT BY POSSIBLE USERS

COMPLAINTS OF RESPONDENTS

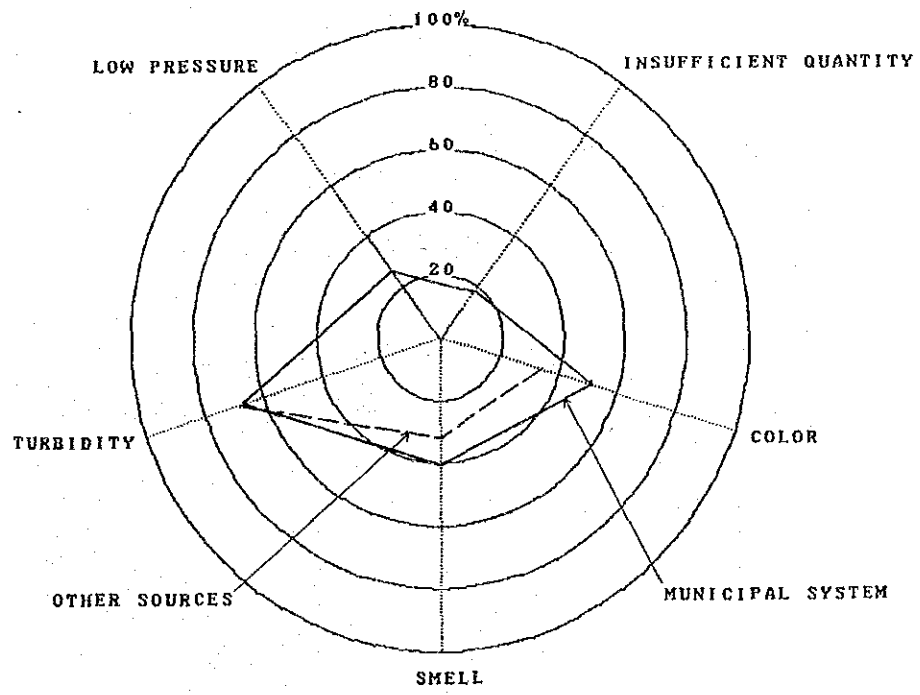


FIGURE A1-5-2
 RESULTS OF
 QUESTIONNAIRE SURVEY (2)
 (PATUM THANI)

APPENDIX A-4-3

Questionnaire Survey for Residents in Prachatipat

APPENDIX A-4-3 QUESTIONNAIRE SURVEY IN PRACHATIPAT (RESIDENTIAL)

1 Objective

The door-to-door questionnaire survey was conducted to obtain the basic information on the resident's living conditions, water use patterns, responses to the municipal system and/or their own water sources and willingness for house-connection supply, and covered the area served or unserved by the municipal water supply system.

2 Survey Area

The survey area was divided into 11 blocks taking into account the urbanized situation as shown in Figure A1-2-2. All blocks others than Block 11 were at present fully or partially served by the municipal system.

3 Survey Item

The form used for the questionnaire survey was originally written by Thai and included the following items.

1. General

- 1.1 Address
- 1.2 Type of House
- 1.3 No. of Persons in Family
- 1.4 No. of Employees
- 1.5 Average Monthly Income
- 1.6 Average Monthly Medical Expense

2. Type of Water Supply

3. Conditions in case of Municipal System

- 3.1 Pressure
- 3.2 Quantity

4. Other Sources than Municipal System

- 4.1 Type of Source
- 4.2 Conditions in case of Groundwater

5. Potability

6. Water Quality in case of Municipal System

- 6.1 Color
- 6.2 Smell
- 6.3 Turbidity

7. Average Monthly Water Consumption

8. Average Monthly Water Charge
9. Willingness to Pay for Water Charge
10. Water Quality in case of Other Source
 - 10.1 Color
 - 10.2 Smell
 - 10.3 Turbidity
11. Willingness to Connect to the Municipal System
12. Willingness to Pay for Connection Fee
13. Willingness to Pay for Water Charge

4 Survey Method

College students were employed as interviewers and were engaged in the questionnaire survey with the guidance of the PWA Head Office staff. The survey was conducted to 240 residents on September 13 and 17, 1988.

5 Survey Results

The results of the questionnaire survey are summarized in Table A1-5-2.

1) General

60.0% of the respondents lived in residential houses while 38.3% in commercial buildings and the remaining 1.7 % was unknown due to the omission of confirmation by the interviewers.

The total numbers of persons in families and employees were 1,131 and 455 respectively. Accordingly, one household is composed of 4.73 family members and 1.90 employees on an average or a total of 6.03 persons in all.

The respondents' average monthly income is widely scattered in the range of up to 50,000 Baht. 70.8% of the respondents were in the up-to-7,500 Baht bracket, or 5.8% in the up-to-2,000 Baht, 15.0% in the 2,001-3,000 Baht and 17.5% in the 3,001-4,500 Baht 17.1% 4,501-6,000 Baht and 15.4% in the 6,001-7,500 Baht brackets, respectively. The average in respondents weighted by the number of persons and the median in each income bracket was approximately 6,060 Baht, but the number of persons was biggest in the 3,001-4,500 Baht bracket.

As to the average monthly medical expense, 17.1% was in the up-to-50 Baht bracket and 21.3%, 10.6% and 7.9% were in the 51-100, 101-200 and 201-500 Baht brackets, respectively. However, it should be noted that 37.1% was unknown. The

average in respondents calculated by the same method as the above is 200 Baht, but the number of persons was biggest in the 51-100 Baht brackets.

2) Type of Water Supply

58.3% used the municipal system only and 32.9% used source(s) other than the municipal system and 8.8% the combined system of the municipal and other source(s).

62.0% or 62 out of 100 other sources was groundwater as shown below.

Block No.	1	2	3	4	5	6	7	8	9	10	11	Total
Municipal System Only	24	24	25	16	8	24	2	2	6	9	-	140
plus Rain/River	3	2	1	-	-	3	-	-	-	-	-	9
plus Water Vendor	4	-	2	-	-	-	-	-	1	1	-	8
plus Unknown	-	-	1	-	-	-	-	-	-	-	-	1
plus Well	-	-	1	-	-	-	-	1	1	-	-	3
Well Only	2	-	-	-	-	-	10	7	11	7	19	56
plus Rain	-	-	-	-	-	-	-	-	-	-	1	1
plus Water Vendor	-	-	-	-	-	-	1	-	-	-	-	1
plus Other	-	-	-	-	-	-	-	-	-	-	1*	1
Rain/River Only	-	-	-	-	1	-	6	-	-	-	-	7
plus Water Vendor	-	-	-	-	-	-	1	-	-	-	-	1
Pond/Reservoir Only	-	-	-	-	-	-	1	-	-	4	-	5
Water Vendor Only	-	-	-	-	-	-	1	-	-	1	2	4
Unknown	-	-	-	-	-	-	-	-	-	2	1	3
Total	33	26	36	16	9	27	22	10	19	24	24	240

* Rain/River and Well

3) Response to Municipal System

The reputation of the PWA waterworks among 161 respondents using the municipal system was not so good, that is to say, 42.2% complained of low pressure, 16.2% of insufficient water, 30.5% of color, 38.5% of smell and 36.0% for turbidity. However there were big gaps in response by the block. The low pressure took place in Blocks 2, 3, 4 and 5

blocks, and the respondents in Block 3 encountered insufficient water. The complaints of color, smell and turbidity occurred in all blocks except for Blocks 7, 8 and 10.

4) Potability

This question was originally intended to know the potability of tap water, but the answer seemed to be made not only for the tap water but for other source water as well, since the question followed that on other sources.

Accordingly, the evaluation was made extracting the data from respondents using tap water or well water only.

	Tap Water	Well Water
Drinking	27 (19.4%)	2 (3.6%)
Not Drinking	103 (74.1%)	45 (80.3%)
Both	6 (4.3%)	3 (5.4%)
Unknown	3 (2.2%)	6 (10.7%)
Total	139 (100%)	56 (100%)

19.4% used tap water for drinking and 4.3% for drinking and not-drinking in spite of their complaints of its water quality, while 3.6% used well water for drinking and 5.4% for drinking and not-drinking. The majority used tap or well water for not-drinking.

The doubt as to the kind of water the respondents (who answered that they didn't use only one source for drinking) used for drinking is remained. They may use the water vendor, although this is not expressed clearly in the survey.

5) Water Quality of Other Sources

As mentioned above, groundwater is the main water source. 23.0% complained of color, 41.0% of smell and 35.0% of turbidity. Scrutinizing the data block by block, such complaints mostly took place in Blocks 7, 9 and 11, while Blocks 1 and 7 were blessed with water quality. Compared with those in tap water, the complaint of water quality was almost same in well water.

6) Conditions of Wells

Though the wells were located in Blocks 7, 8, 9, 10 and 11, their owner had no knowledge on the depth, water depth, etc. of the wells.

7) Average Monthly Water Consumption, Water Charge and Willingness-to-Pay

Regarding the average monthly water consumption, 70.2% didn't know the rough figure and remaining 29.8% scattered in the range of up to 150 cu m. Respondents' average monthly water charges are widely scattered in all brackets. 59.6% belonged to the up-to-200 Baht bracket and 28.0% in the 201-500 brackets, while according to the result on the willingness-to-pay for water charge 60.2% wanted that the water charge would be in the up-to-200 Baht bracket and 13.7% in the 201-500 Baht bracket.

8) Willingness-to-Connect

Out of 240 respondents, 79 didn't use the municipal system at present. However, 96.2% was willing to connect to the municipal system. They wanted that the connection fee would be less than 2,500 Baht (75.0%) and the water charge less than 200 Baht (86.8%). The response to the water charge of the possible consumers were severer than that of the existing consumers.

Table A1-5-2 SUMMARY QUESTIONNAIRE SURVEY IN PRACHATIPAT (RESIDENCE)

Block No.	1	2	3	4	5	6	7	8	9	10	11	Total	Rate (%)
No. of Samples	33	26	30	16	9	27	22	10	19	24	24	240	
1. General													
1.1 Address													
1.2 Type of House													
Residential	20	23	11	1	1	22	16	5	13	14	18	144	60.0
Commercial	12	1	19	14	8	5	6	5	6	10	6	92	38.3
Residential/Commercial	-	-	-	-	-	-	-	-	-	-	-	-	-
Unknown	1	2	-	1	-	-	-	-	-	-	-	4	1.7
1.3 No. of Persons in Family	139	115	149	81	57	142	127	45	75	101	100	1131	
Unknown (No. of Samples)	-	-	1	-	-	-	-	-	-	-	-	1	
1.4 No. of Employees	58	48	53	47	11	50	59	19	29	49	32	455	
Unknown (No. of Samples)	-	-	1	-	-	-	-	-	-	-	-	1	
1.5 Ave. Monthly Income													
Baht													
up to 2,000	-	1	4	1	-	1	4	-	1	2	-	14	5.8
2,001-3,000	4	-	2	1	2	9	3	2	2	4	7	36	15.0
3,001-4,500	4	-	7	3	-	9	4	-	5	6	4	42	17.5
4,501-6,000	5	7	8	3	3	1	3	2	2	3	4	41	17.1
6,001-7,500	7	7	1	2	1	3	5	2	2	3	4	37	15.4
7,501-10,000	3	8	1	-	1	2	-	2	3	2	1	23	9.6
10,001-15,000	3	1	3	-	1	-	-	1	3	1	-	13	5.4
15,001-50,000	1	2	-	2	-	-	-	-	-	1	-	6	2.5
Over 50,000	-	-	-	-	-	-	-	-	-	-	-	-	-
Unknown	6	-	4	4	1	2	3	1	1	2	4	28	11.7
1.6 Ave. Monthly Medical Expense													
Baht													
up to 50	5	3	5	2	3	6	1	-	7	3	6	41	17.1
51-100	4	7	3	7	1	8	2	2	2	7	8	51	21.3
101-200	1	3	7	2	1	2	1	-	-	4	3	24	10.0
201-500	1	5	3	1	1	2	-	1	-	4	1	19	7.9
501-1,000	2	1	2	-	1	-	1	-	1	1	-	9	3.7
1,001-2,000	-	-	1	2	1	-	1	-	1	-	1	7	2.9
2,001-5,000	-	-	-	-	-	-	-	-	-	-	-	-	-
Over 5,000	-	-	-	-	-	-	-	-	-	-	-	-	-
Unknown	20	7	9	2	1	9	16	7	8	5	5	89	37.1
2. Type of Water Supply													
Municipal System	24	24	25	16	8	24	2	2	6	9	-	140	58.3
Combined	7	2	5	-	-	3	-	1	2	1	-	21	8.8
Other Sources	2	-	-	-	1	-	20	7	11	14	24	79	32.9
Unknown	-	-	-	-	-	-	-	-	-	-	-	-	-
3. Municipal System													
3.1 Pressure													
Low	4	10	24	11	7	5	1	-	3	3	-	68	42.2
High	25	16	5	4	1	22	1	3	3	5	-	85	52.8
Unknown	2	-	1	1	-	-	-	-	2	2	-	8	3.0
3.2 Quantity													
Sufficient	28	24	16	12	4	25	1	3	6	10	-	129	80.1
Not Sufficient	2	2	13	3	4	-	1	-	1	-	-	26	16.2
Unknown	1	-	1	1	-	2	-	-	1	-	-	6	3.7

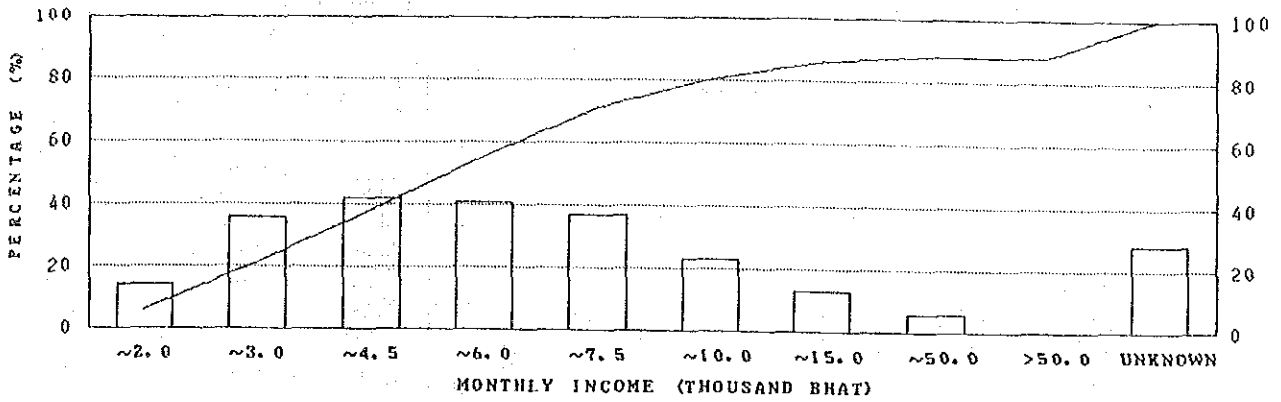
Table A1-5-2 SUMMARY QUESTIONNAIRE SURVEY IN PRACHATIPAT (RESIDENCE) (CONT'D)

Block No.	1	2	3	4	5	6	7	8	9	10	11	Total	Rate (%)
4. Other sources													
Rain/River	3	2	1	-	1	3	7	-	-	-	2	19	
Pond/Reservoir	-	-	-	-	-	-	1	-	-	4	-	5	
Water Vendor	4	-	2	-	-	-	3	-	1	2	3	15	
Groundwater-Shallow Well	2	-	1	-	-	-	11	8	12	7	21	62	
-Deep Well	-	-	-	-	-	-	-	-	-	-	-	-	
Unknown	-	-	1	-	-	-	-	-	-	2	1	4	
5. Potability													
Drinking	7	-	7	3	3	6	4	-	1	3	2	36	15.0
Not Drinking	24	26	23	12	5	16	12	9	15	18	18	178	74.2
Both	-	-	-	1	1	5	2	1	-	2	-	12	5.0
Unknown	2	-	-	-	-	-	4	-	3	1	4	14	5.8
6. Water Quality (Municipal System)													
6.1 Color													
Yes	13	9	7	7	6	3	-	1	3	-	-	49	30.5
No	14	12	14	6	2	18	2	2	4	8	-	82	50.9
Unknown	4	5	9	3	-	6	-	-	1	2	-	30	18.6
6.2 Smell													
Yes	16	20	7	7	3	5	-	1	3	-	-	62	38.5
No	10	5	12	6	2	16	2	2	3	7	-	65	40.4
Unknown	5	1	11	3	3	6	-	-	2	3	-	34	21.1
6.3 Turbidity													
Yes	17	12	11	7	-	5	-	1	4	1	-	58	36.0
No	12	13	10	5	4	17	2	2	4	7	-	76	47.2
Unknown	2	1	9	4	4	5	-	-	-	2	-	27	16.8
7. Ave. Monthly Water Consumption													
Up to 15 cu m	2	2	2	-	-	-	-	-	1	-	-	7	4.4
16-30 cu m	3	-	1	2	-	2	-	-	1	1	-	10	6.2
31-50 cu m	-	5	6	2	-	3	-	-	-	-	-	16	9.9
51-75 cu m	2	1	1	3	-	1	-	-	-	-	-	8	5.0
76-100 cu m	1	-	2	-	-	1	1	-	-	1	-	6	3.7
101-150 cu m	-	-	-	-	1	-	-	-	-	-	-	1	0.6
151-200 cu m	-	-	-	-	-	-	-	-	-	-	-	-	-
201-300 cu m	-	-	-	-	-	-	-	-	-	-	-	-	-
Over 300 cu m	-	-	-	-	-	-	-	-	-	-	-	-	-
Unknown	23	18	18	9	7	20	1	3	6	8	-	113	70.2
8. Ave. Monthly Water Charge													
Baht													
Up to 50	2	1	-	1	-	1	-	-	-	1	-	6	3.7
51-100	13	3	4	4	-	6	-	-	3	2	-	35	21.7
101-150	3	7	6	3	1	4	1	2	1	3	-	31	19.3
151-200	7	3	3	1	1	7	-	1	1	-	-	24	14.9
201-300	-	6	6	2	1	7	1	-	-	1	-	24	14.9
301-500	2	4	7	4	3	1	-	-	-	-	-	21	13.1
501-1,000	3	2	1	-	2	1	-	-	-	1	-	10	6.2
Over 1,000	-	-	3	1	-	-	-	-	1	-	-	5	3.1
Unknown	1	-	-	-	-	-	-	-	2	2	-	5	3.1

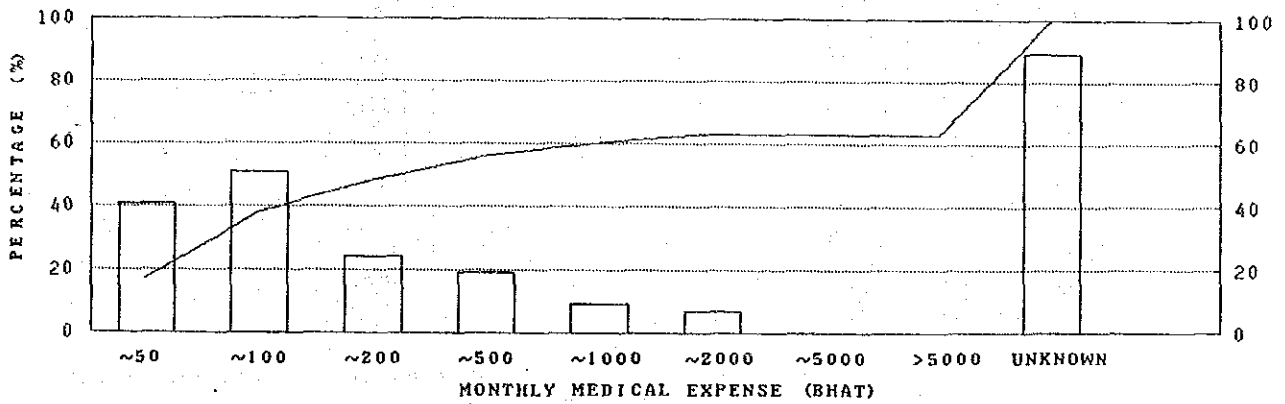
Table A1-5-2 SUMMARY QUESTIONNAIRE SURVEY IN PRACHATIPAT (RESIDENCE) (CONT'D)

Block No.	1	2	3	4	5	6	7	8	9	10	11	Total	Rate (%)
9. Willingness to Pay Baht													
Up to 50	6	1	3	3	-	2	-	1	2	2	-	20	12.4
51-100	9	6	5	4	2	8	2	1	3	3	-	43	26.7
101-200	2	7	11	3	3	7	-	-	-	1	-	34	21.1
201-500	3	6	5	3	-	4	-	-	-	1	-	22	13.7
501-1,000	-	-	1	-	2	-	-	-	-	-	-	3	1.9
Over 1,000	-	-	2	-	-	-	-	-	-	-	-	2	1.2
Unknown	11	6	3	3	1	6	-	1	3	3	-	37	23.0
10. Water Quality (Other Source)													
10.1 Color													
Yes	-	-	-	-	-	-	2	-	6	2	13	23	23.0
No	9	-	2	-	-	-	17	7	5	10	3	53	53.0
Unknown	-	2	3	-	1	3	1	1	2	3	8	24	24.0
10.2 Smell													
Yes	-	-	-	-	1	-	5	3	11	3	18	41	41.0
No	9	-	1	-	-	-	15	4	2	10	4	45	45.0
Unknown	-	2	4	-	-	3	-	1	-	2	2	14	14.0
10.3 Turbidity													
Yes	1	-	1	-	1	-	5	-	7	4	16	35	35.0
No	8	-	2	-	-	-	15	7	4	9	2	47	47.0
Unknown	-	2	2	-	-	3	-	1	2	2	6	18	18.0
11. Willingness to Connect													
Yes	-	-	-	-	1	-	20	7	11	13	24	76	96.2
No	2	-	-	-	-	-	-	-	-	-	-	2	2.5
Unknown	-	-	-	-	-	-	-	-	-	1	-	1	1.3
12. Willingness to Pay for Connection Fee Baht													
Up to 1,000	-	-	-	-	-	-	9	1	6	1	4	21	27.6
1,001-2,000	-	-	-	-	-	-	6	6	4	4	6	26	34.2
2,001-2,500	-	-	-	-	1	-	1	-	-	7	1	10	13.2
2,501-3,000	-	-	-	-	-	-	1	-	-	-	9	10	13.2
3,001-4,000	-	-	-	-	-	-	-	-	-	-	-	-	-
4,001-5,000	-	-	-	-	-	-	-	-	-	-	-	-	-
5,001-6,000	-	-	-	-	-	-	-	-	-	-	-	-	-
Over 6,000	-	-	-	-	-	-	-	-	-	-	-	-	-
Unknown	-	-	-	-	-	-	3	-	1	1	4	9	11.8
13. Willingness to Pay for Water Charge Baht													
Up to 50	-	-	-	-	-	-	6	-	2	3	2	13	17.1
51-100	-	-	-	-	-	-	7	4	5	4	13	33	43.4
101-200	-	-	-	-	-	-	3	3	2	6	6	20	26.3
201-500	-	-	-	-	1	-	1	-	-	-	1	3	4.0
501-1,000	-	-	-	-	-	-	-	-	-	-	-	-	-
Over 1,000	-	-	-	-	-	-	-	-	-	-	-	-	-
Unknown	-	-	-	-	-	-	3	-	2	-	2	7	9.2

MONTHLY INCOME DISTRIBUTION



MONTHLY MEDICAL EXPENSE DISTRIBUTION



TYPE OF WATER SOURCE & WILLINGNESS-TO-CONNECT

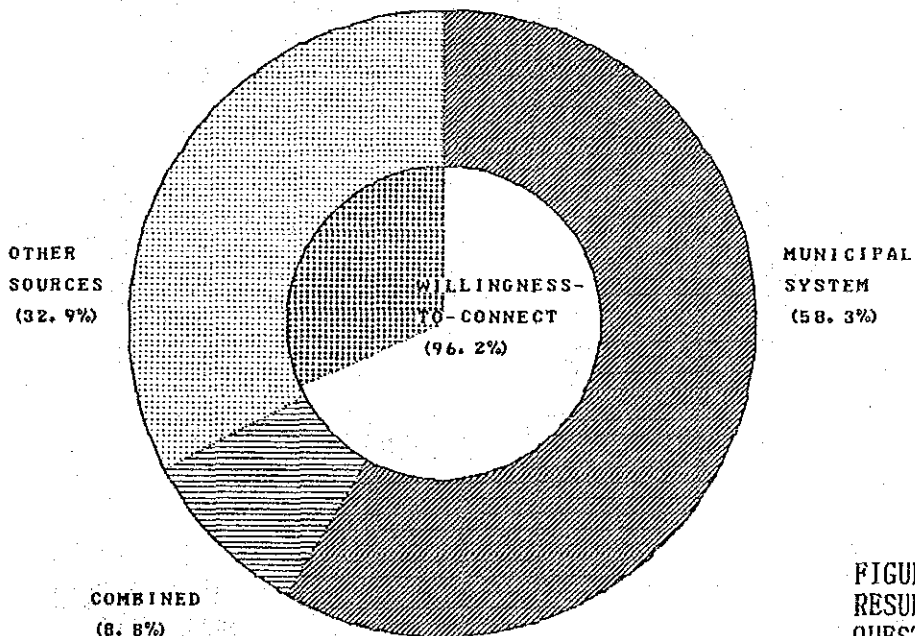
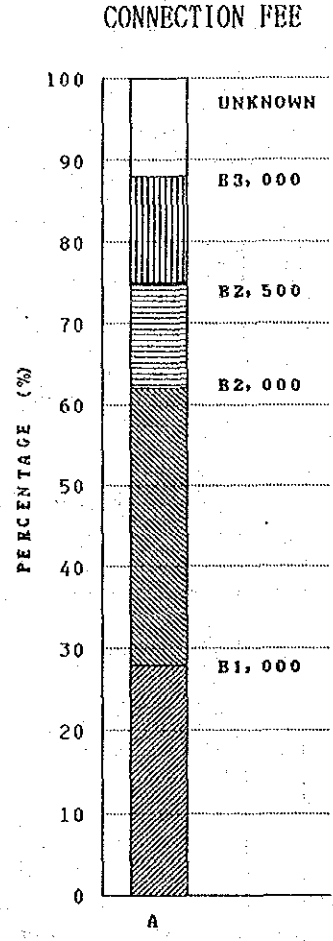
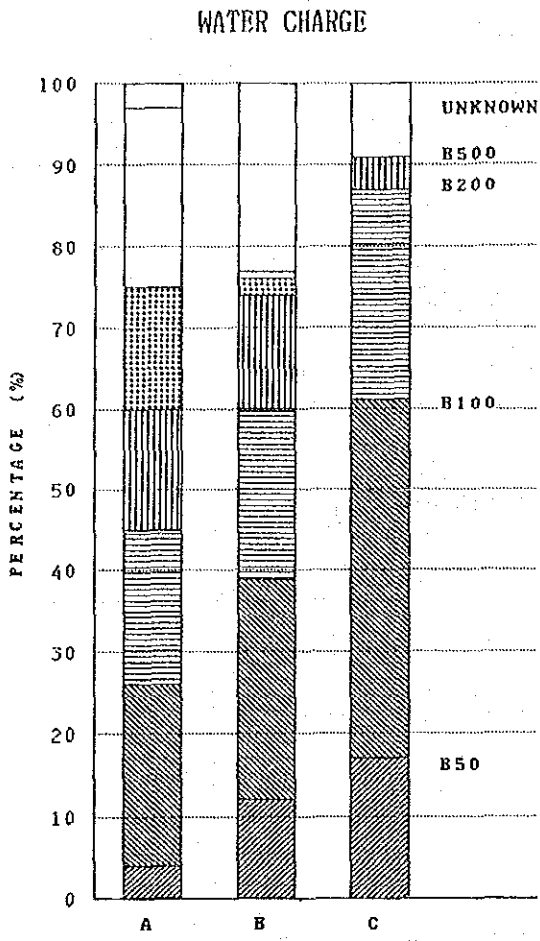


FIGURE A1-5-2
RESULTS OF
QUESTIONNAIRE SURVEY (1)
(PRACHATIPAT)

WILLINGNESS-TO-PAY



A : ACTUAL PAYMENT BY EXISTING USERS
 B : EXPECTANT PAYMENT BY EXISTING USERS
 C : EXPECTANT PAYMENT BY POSSIBLE USERS

COMPLAINTS OF RESPONDENTS

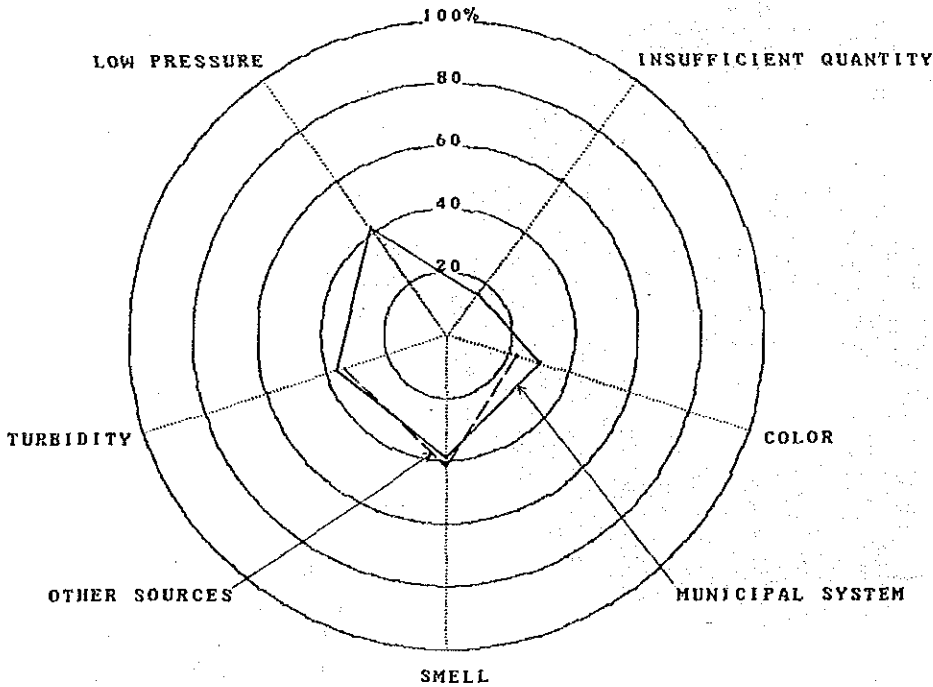


FIGURE A1-5-2
RESULTS OF
QUESTIONNAIRE SURVEY (2)
(PRACHATIPAT)