stored in the storage house, in sufficient reserve always.

(6) Office

Since the present site of the waterworks office is leased and the space of the office has become narrow, it is recommended that a new office will be settled in the proposed well site.

8.1.5 Distribution Pipeline

Immediate replacement is proposed for obsolete and defective pipes. In addition to the replacement, installation of distribution mains, as listed below, will be required corresponding to the development of the new well.

Table-8.1 REPLACEMENT AND INSTALLATION OF DISTRIBUTION PIPELINE

Diameter (mm)	Replacement (m)	Additional pipe (m)	Total (m)
300 *	500	-	500
250	1,600	1,650	3,250
200	-	2,450	2,450
150	-	2,200	2,200
100	650	300	950
Total	2,750	6,600	9,350

* Clear water transmission pipeline

8.2 Expansion Works

An additional deep well having a 2,100 cu m/d rated capacity will be developed at 1 km away from the Kannasut Deep Well No.1. The specifications of the well are as same as the well to be developed in the rehabilitation and modification works previously described. The groundwater will

be transmitted directly from the well to the distribution reservoir of the Kannasut Deep Well No.1 site, then disinfected and distributed by pumps therefrom.

While, approximately 30 % of the production of the Phophraya plant will be consumed between the plant and the Dab Fafhun distribution pump station. And the rest 70 % will be sent to the distribution reservoir at Dab Fafhun, then, together with groundwater of the Dab Fafhun deep well is distributed by pumps.

The hydraulic analysis of the distribution system incorporating the existing pipelines and proposed ones was carried out by means of computer-aided network analysis. Table-8.2 on the next page presents the results of the analysis. Fig-8.1 shows the land use plan by which the areawise water demands are computed. The routes of distribution pipeline for the target year of 2000 were determined in due consideration of the planned service area and future road planning envisaged in the City Development Plan, and through exchange of views with the officials concerned.

Table-8.3 shows the summary of the proposed distribution pipelines based on the results of hydraulic analysis.

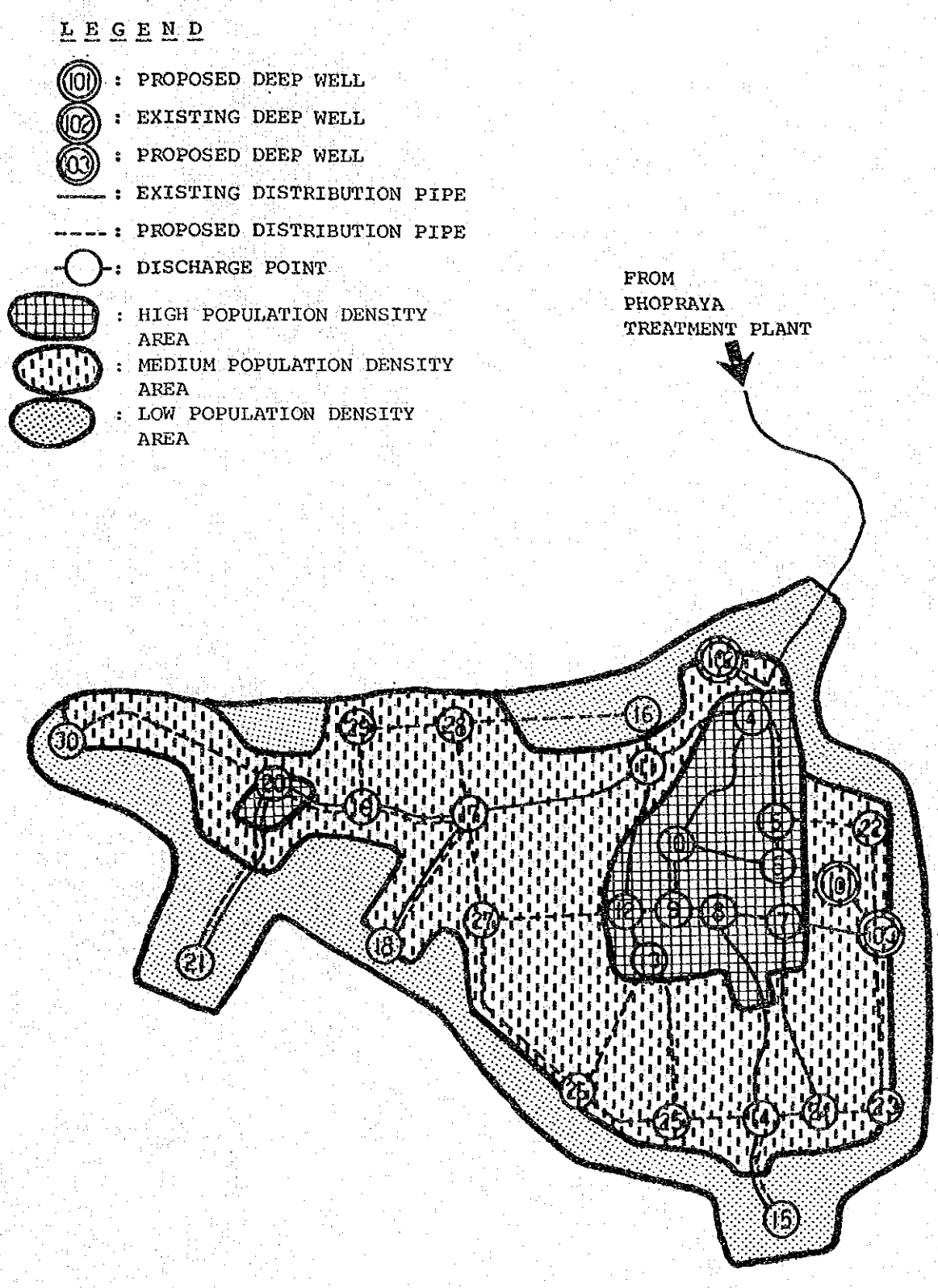
Table-8.3 PROPOSED DISTRIBUTION PIPELINES

DIAMETER (mm)	LENGTH (m)
200	4,150
150	12,100
100	16,950
Total	33,200

According to the result of hydraulic analysis of the distribution network, the area will be served mostly under around 1.0 to 2.5 kg/sq cm service pressure, as shown in Fig-8.2.

Table-8.2 RESULT OF PIPE NETWORK ANALYSIS

Node	- Node	Type	D (mm)	L (m)	C	Q (l/sec)	V (m/sec)	i (o/oo)	dH (m)	Hb/r (m)	H (m)	GL (m)	He (m)
102	- 4	0	325	750	110	87.800	1.058	4.72	3.54	0.00	28.46	2.00	26.46
4	- 5	0	231	950	110	6.157	0.147	0.18	0.17	0.00	28.29	2.00	26.29
5	- 6	0	200	400	110	10.196	0.325	0.94	0.37	0.00	27.91	2.00	25.91
7	- 6	0	200	450	110	3.764	0.120	0.15	0.07	0.00	27.91	2.00	25.91
7	- 8	0	167	650	110	11.985	0.547	3.04	1.97	0.00	26.01	2.00	24.01
8	- 9	0	167	300	110	4.854	0.222	0.57	0.17	0.00	25.83	2.00	23.83
10	- 9	0	231	600	110	23.755	0.567	2.22	1.33	0.00	25.83	2.00	23.83
4	- 10	0	250	1350	110	18.595	0.379	0.96	1.29	0.00	27.16	2.00	25.16
4	- 11	0	296	1150	110	57.648	0.838	3.42	3.93	0.00	24.53	3.00	21.53
11	- 12	0	150	1250	110	2.359	0.133	0.25	0.32	0.00	24.21	2.00	22.21
12	- 13	0	150	400	110	12.029	0.681	5.16	2.06	0.00	22.15	2.00	20.15
8	- 14	0	100	2000	110	2.731	0.348	2.39	4.78	0.00	21.22	2.00	19.22
14	- 15	0	130	1100	110	6.200	0.467	3.04	3.34	0.00	17.88	2.00	15.88
11	- 16	0	130	500	110	8.928	0.673	5.96	2.98	0.00	21.55	4.00	17.55
11	- 17	0	268	1600	110	40.961	0.726	2.95	4.71	0.00	19.82	4.00	15.82
17	- 18	0	130	1150	110	6.200	0.467	3.04	3.49	0.00	16.32	6.00	10.32
17	- 19	0	268	850	110	26.181	0.464	1.29	1.09	0.00	18.72	6.00	12.72
19	- 20	0	241	800	110	16.200	0.355	0.89	0.71	0.00	18.01	6.00	12.01
20	- 21	0	130	1700	110	5.400	0.407	2.35	4.00	0.00	14.01	6.00	8.01
6	- 10	0	200	900	110	9.560	0.304	0.83	0.75	0.00	27.16	2.00	25.16
22	- 5	0	150	800	110	9.439	0.534	3.29	2.63	0.00	28.29	2.00	26.29
103	- 7	0	200	850	110	26.942	0.858	5.65	4.80	0.00	27.98	2.00	25.98
103	- 22	0	200	900	110	15.639	0.498	2.06	1.86	0.00	30.92	2.00	28.92
103	- 23	0	200	1450	110	19.219	0.612	3.02	4.38	0.00	28.40	2.00	26.40
23	- 24	0	150	550	110	13.019	0.737	5.97	3.28	0.00	25.11	2.00	23.11
7	- 24	0	150	1600	110	6.793	0.384	1.79	2.87	0.00	25.11	2.00	23.11
24	- 14	0	150	600	110	13.612	0.770	6.48	3.89	0.00	21.22	2.00	19.22
9	- 12	0	200	350	110	24.209	0.771	4.63	1.62	0.00	24.21	2.00	22.21
13	- 25	0	100	1150	110	3.341	0.425	3.47	3.99	0.00	18.16	2.00	16.16
14	- 25	0	100	650	110	3.943	0.502	4.72	3.07	0.00	18.16	2.00	16.16
25	- 26	0	100	900	110	1.084	0.138	0.43	0.39	0.00	17.77	2.00	15.77
13	- 26	0	100	1300	110	3.288	0.419	3.37	4.38	0.00	17.77	2.00	15.77
12	- 27	0	150	1400	110	9.139	0.517	3.10	4.34	0.00	19.87	3.00	16.87
27	- 26	0	100	1850	110	1.628	0.233	1.14	2.10	0.00	17.77	2.00	15.77
27	- 17	0	150	900	110	1.111	0.063	0.06	0.06	0.00	19.82	4.00	15.82
16	- 28	0	100	1600	110	3.528	0.449	3.84	6.15	0.00	15.40	4.00	11.40
17	- 28	0	100	800	110	4.291	0.546	5.52	4.41	0.00	15.40	4.00	11.40
19	- 29	0	100	650	110	4.581	0.583	6.22	4.05	0.00	14.67	6.00	8.67
28	- 29	0	100	800	110	1.619	0.206	0.91	0.73	0.00	14.67	6.00	8.67
20	- 30	0	150	2400	110	5.400	0.306	1.17	2.81	0.00	15.20	6.00	9.20



NO SCALE

FIGURE	POPULATION DENSITY IN YEAR 2000
8.1	

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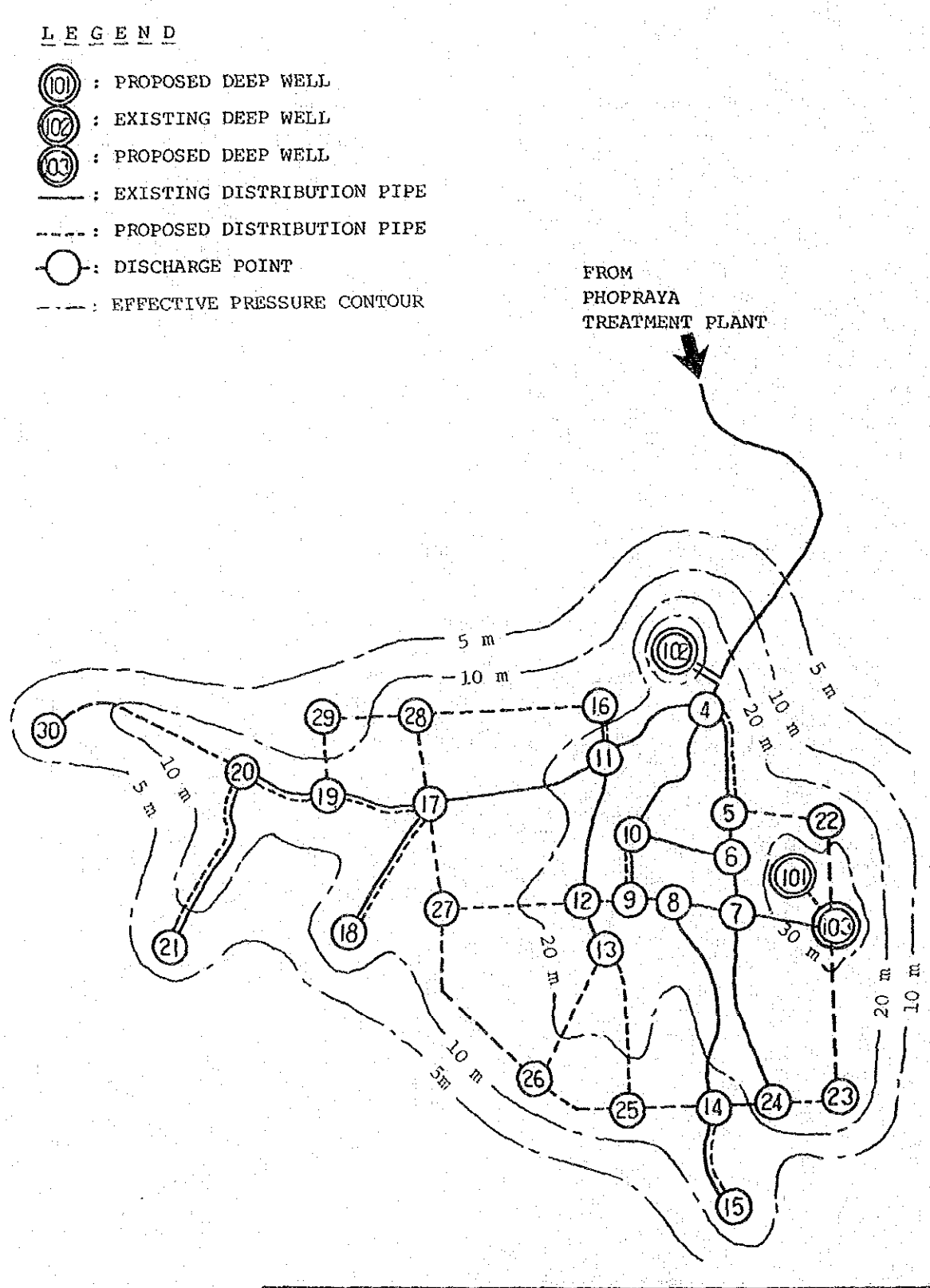

FIGURE	NODE OF PIPE NETWORK AND EFFECTIVE PRESSURE CONTOUR
8.2	

NO SCALE

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APPENDIX 9

COST DATA AND CONSTRUCTION COST

APPENDIX 9

APPENDIX 9 COST DATA AND CONSTRUCTION COST

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APPENDIX 9

9.1 Cost Data

9.1.1 Cost Data Collection

PWA has its own standard price list of materials, products and works. In this estimate, the prices of listed items were quoted directly.

Regarding unlisted items, estimation was made by illation from related prices in the list.

Market prices of the materials and products to be used in the estimation were collected and quoted when found applicable reasonably.

Prices of some products and equipments were quoted by the suppliers and manufacturers were used in the estimation.

9.1.2 Pipelaying Cost

As pipelaying constitutes major part of this project, the cost is detailed in this sub-section.

Three assumptions are made in estimating pipelaying.

The first is that the 20 and 80 % of the total length of a pipeline are allocated to ductile-iron and asbestos-cement pipe respectively.

The second is that 10 % of the estimated cost including pipes, fittings and laying works is counted for railroad crossing, riverbed crossing and pipe bridge additionally.

The third is that 15 % of the estimated cost as above is counted for installation of valves, concrete thrust blocks and other miscellaneous works.

Table-9.1 (a) Unit Cost of Pipelaying (ACP)

(Unit: ฿/m)

Dia.(mm)	Labor	Pipe Material	Sub-Total	Pavement	Total
100	47	140	187	140	327
150	66	230	296	154	450
200	80	398	478	166	644
250	111	551	662	179	841
300	146	780	926	223	1,149
400	181	1,478	1,659	248	1,907
500	261	2,050	2,311	283	2,594
600	338	2,703	3,041	319	3,360

Table-9.1 (b) Unit Cost of Pipelaying (DIP)

(Unit: ฿/m)

Dia.(mm)	Labor	Pipe Material	Sub-Total	Pavement	Total
100	53	504	557	140	697
150	87	723	810	154	964
200	98	972	1,070	166	1,236
250	135	1,224	1,359	179	1,538
300	179	1,596	1,775	223	1,998
350	197	1,917	2,114	236	2,350
400	221	2,346	2,567	248	2,815
450	266	2,839	3,105	266	3,371
500	318	3,362	3,680	283	3,963
600	413	4,505	4,918	319	5,237
700	515	5,897	6,412	341	6,753
800	629	7,414	8,043	378	8,421
900	749	9,122	9,871	402	10,273
1,000	873	11,053	11,926	436	12,362
1,100	1,001	13,086	14,087	470	14,557
1,200	1,125	15,175	16,300	504	16,804

Table-9.1 (a) and (b) show the cost of unit length (meter) of pipelaying for asbestos-cement and ductile-iron pipes including pipes, fittings, labor and pavement restoration.

9.1.3 Treatment Plant, Buildings and Others

In estimating approximately the construction cost of treatment plant and buildings used for administration and others in the plant site, the cost function graphs shown in Fig-9.1 are used.

To prepare the cost function curves, production capacities and construction costs of seven PWA treatment plants plotted and the curves are drawn as most appropriate. Similar data made by other consultants were also referred for comparison.

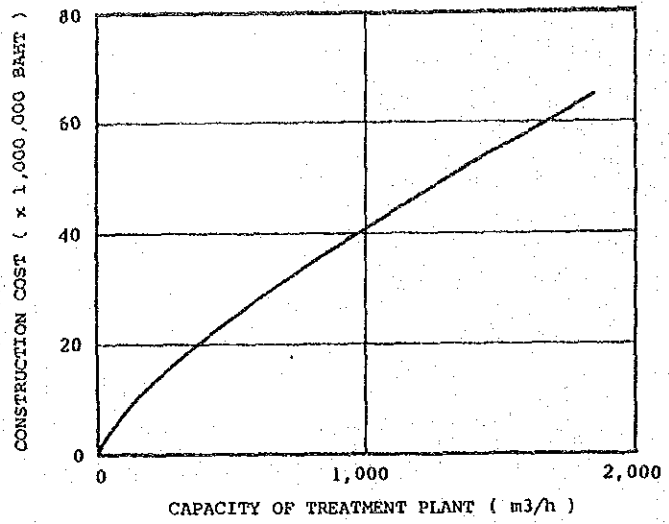
The approximately estimated costs were checked with the costs prepared by calculating, item by item, components of the whole construction work involved in the PWA standard design and the both were found close satisfactorily.

For other construction works like deep well, available data were studied and modification was made by illation from them.

9.1.4 Land Acquisition

Land price of the prospective sites of treatment plants, pump stations and other facilities under this plan were estimated based on the contacts with PWA local officials.

TREATMENT PLANT



BUILDINGS FOR ADMINISTATRATION AND OTHER USES

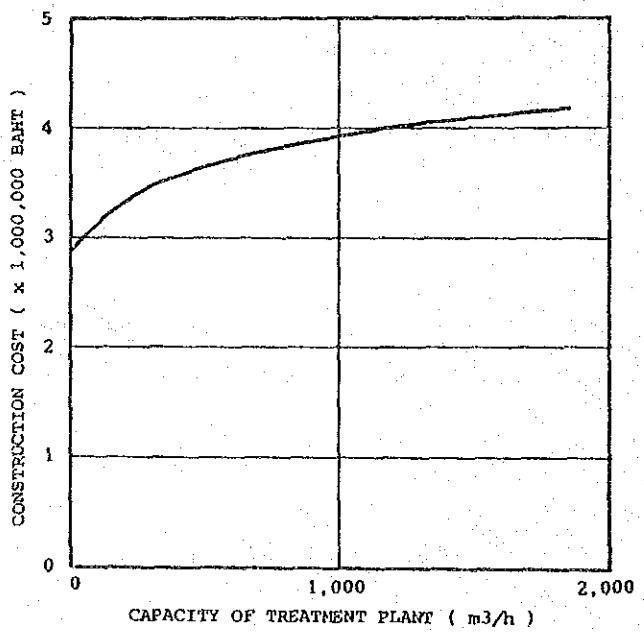


FIGURE	COST FUNCTION OF TREATMENT PALNT AND BUILDINGS FOR ADMINISTRATION AND OTHER USES
9.1	

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9.2 Classification of Works

Every work involved in the project is to be classified into either one of the following six:

1. Pipelaying works : laying pipes above- and under-ground
2. Civil works : construction of barrage, grit chamber, clear water reservoir, intake tower, and earthwork, groundwork
3. Treatment plant construction : inclusive of 1, 2 and 5
4. Pump station construction : inclusive of 1, 2, 5 and architectural works
5. Equipment/machinery installation
6. Purchase of equipment/machinery

This classification is used in making allocation of foreign and local currency portion in the following section and in Table-9.2 listed later.

9.3 Costs allocation of Foreign and Local Currency Portions

All of the estimated costs are allocated to two currency portions, foreign and local, and to each of the six works classified before an appropriate ratio is to be applied.

9.3.1 Basic Conception

Those products which are imported as finished and do not need further processing in Thailand are considered to be of 100 % foreign currency portion.

Labor, both skilled and unskilled, and services locally procured are considered to be 100 % local currency portion.

In between the above two extremes, a certain appropriate ratio is applied upon consideration of the characteristic of item.

Even the majority of domestically made materials and products contain foreign currency portion. Cement and steel are made by consuming imported fuel and electricity, generated by imported fuel. Equipments and machineries producing these materials are imported sometimes. The asbestos-cement pipe, a local product, is made of imported asbestos.

Earthwork and concrete mixing and casting made by laborers in former days are worked by machineries, using foreign currency partly.

9.3.2 Foreign and Local Currency Elements

The foreign currency elements are imported raw and processed materials, equipments and machineries, consumable goods including fuel, etc.

The local currency elements are local raw materials, skilled and unskilled labors used directly or indirectly, for instance, further processing of imported goods, etc.

9.3.3 Combination of Foreign and Local Currency Elements

Of the six classified works, Fig-9.2 (1) to (6) shows how the foreign and local currency elements are combined to construct them.

The six figures are then summarized and shown in Table-9.2.

Seen in the table are:

1) The foreign currency portion increases in the order of the item number.

2) The locally processed portion is largest in treatment plant construction and smallest in equipment/machinery installation, as it involves installation of imported goods finished to higher degree.

3) The skilled labor portion is also highest in treatment plant construction and civil works.

4) The unskilled labor portion decreases in the order of the item number.

5) The sum of labor portions also decreases in the order of the item number, corresponding the labor-intensitiveness of those works.

Table-9.2 ALLOCATION OF FOREIGN AND LOCAL CURRENCY PORTIONS

No.	Works Description	F/C Portion	L/C Portion		
			Locally Processed Portion	Skilled Labor	Unskilled Labor
1.	Pipelaying	60	10	14	16
2.	Civil works	63	11	12	14
3.	Treatment Plant Construction	66	12	12	10
4.	Pump Station Construction	75	10	7	8
5.	Equipments/ Machinery Installation	85	5	7	3
6.	Equipments/ Machinery Purchase	100	0	0	0

9.4 Construction Cost

Using the cost data mentioned in 9.1, estimation was made on Rehabilitation and Modification Works and Expansion Works planned for Stage I.

It is shown in Table-9.3.

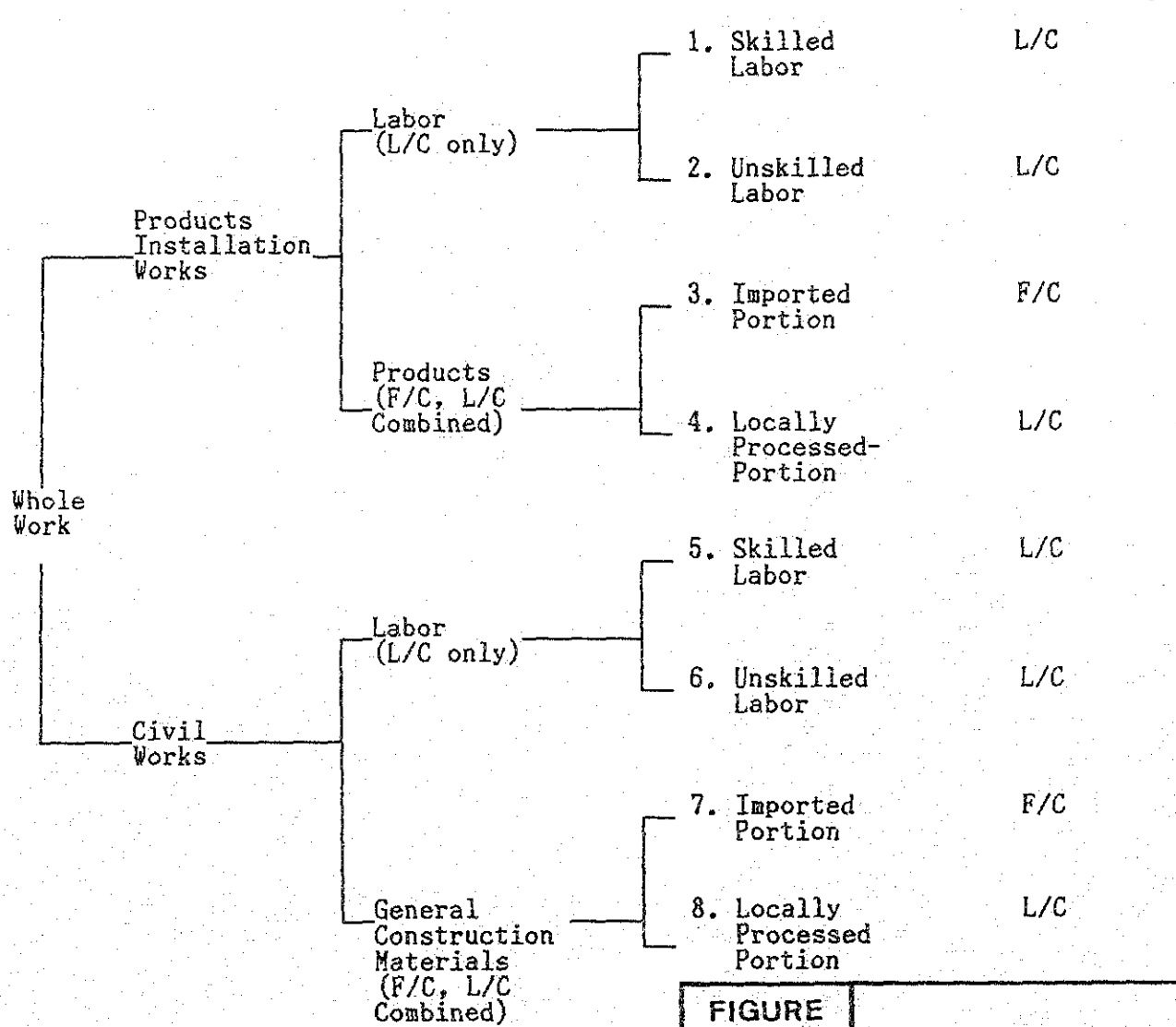
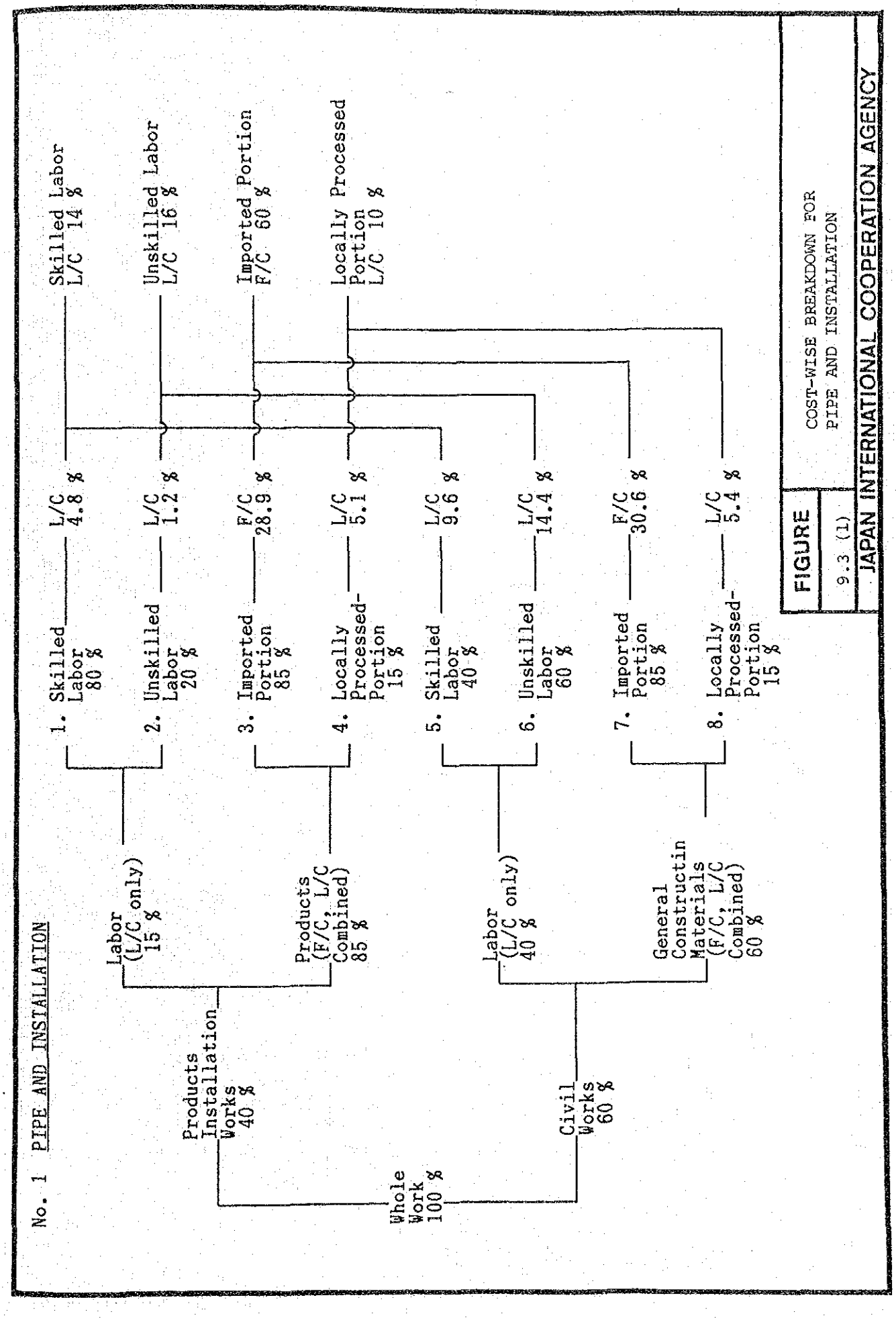


FIGURE 9.2 COST-WISE BREAKDOWN

JAPAN INTERNATIONAL COOPERATION AGENCY


No. 1 PIPE AND INSTALLATION
Whole Work 100 %
Products Installation Works 40 %
Civil Works 60 %
Labor (L/C only) 15 %
Products (F/C, L/C Combined) 85 %
Labor (L/C only) 40 %
General Constructin Materials (F/C, L/C Combined) 60 %
1. Skilled Labor 80 %
2. Unskilled Labor 20 %
3. Imported Portion 85 %
4. Locally Processed-Portion 15 %
5. Skilled Labor 40 %
6. Unskilled Labor 60 %
7. Imported Portion 85 %
8. Locally Processed-Portion 15 %
L/C 4.8 %
L/C 1.2 %
F/C 28.9 %
L/C 5.1 %
L/C 9.6 %
L/C 14.4 %
F/C 30.6 %
L/C 5.4 %
Skilled Labor L/C 14 %
Unskilled Labor L/C 16 %
Imported Portion F/C 60 %
Locally Processed Portion L/C 10 %
FIGURE
9.3 (1)
COST-WISE BREAKDOWN FOR PIPE AND INSTALLATION
JAPAN INTERNATIONAL COOPERATION AGENCY

No. 2 CIVIL WORKS

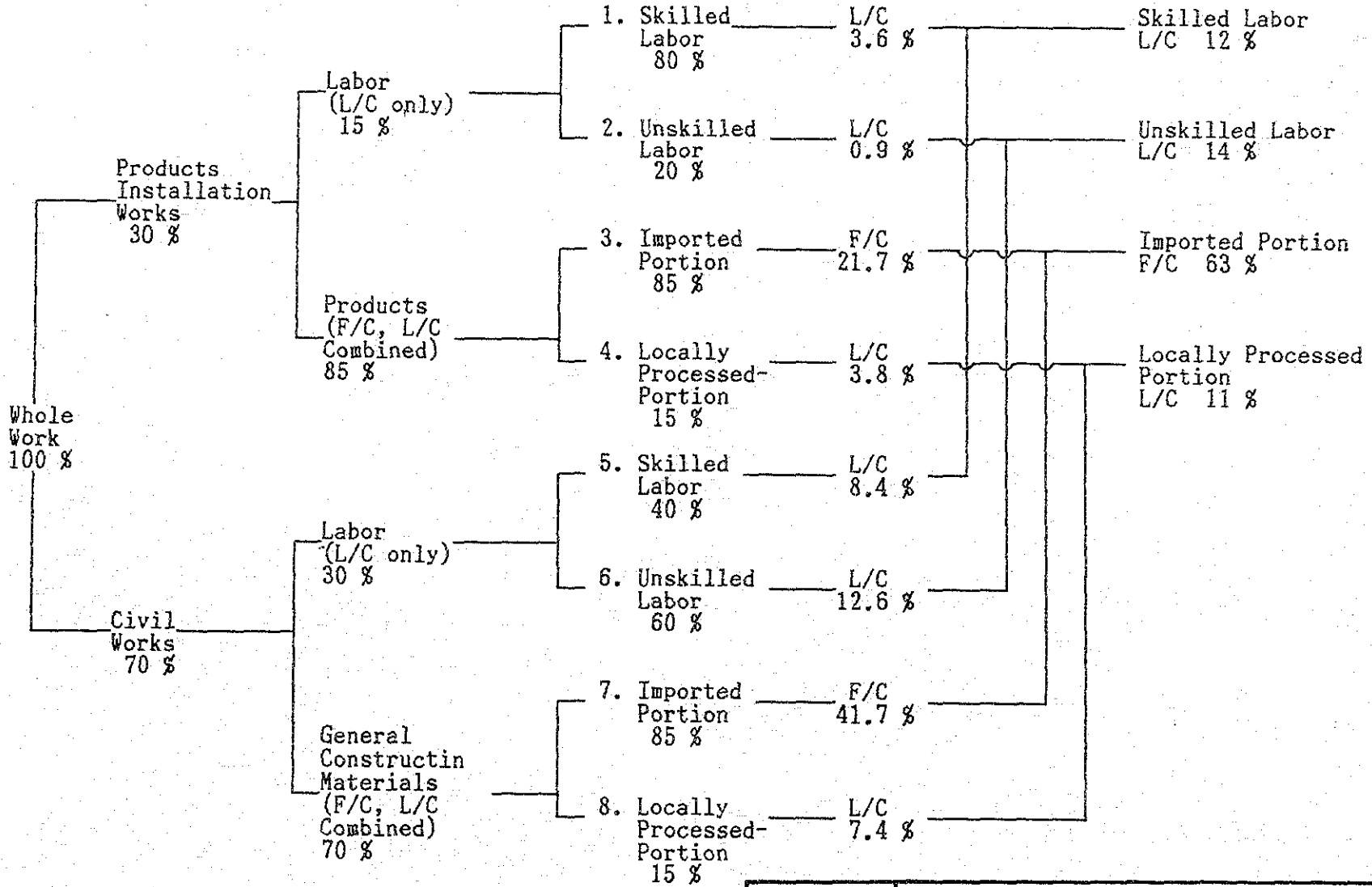


FIGURE 9.3 (2)

COST-WISE BREAKDOWN FOR CIVIL WORKS

JAPAN INTERNATIONAL COOPERATION AGENCY

No. 3 TREATMENT PLANT CONSTRUCTION

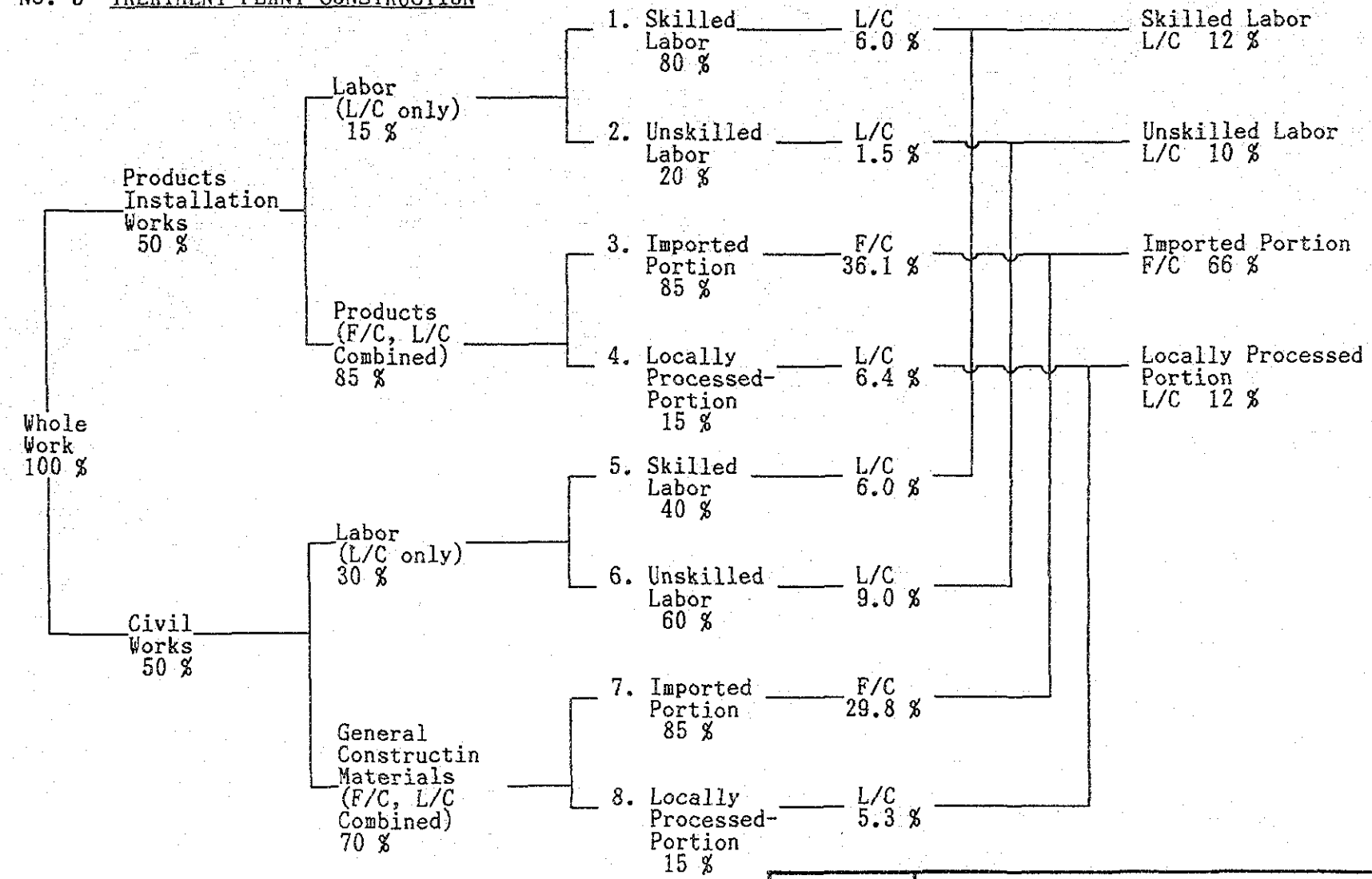


FIGURE 9.3 (3) COST-WISE BREAKDOWN FOR TREATMENT PLANT CONSTRUCTION

JAPAN INTERNATIONAL COOPERATION AGENCY

No. 4 PUMP STATION CONSTRUCTION

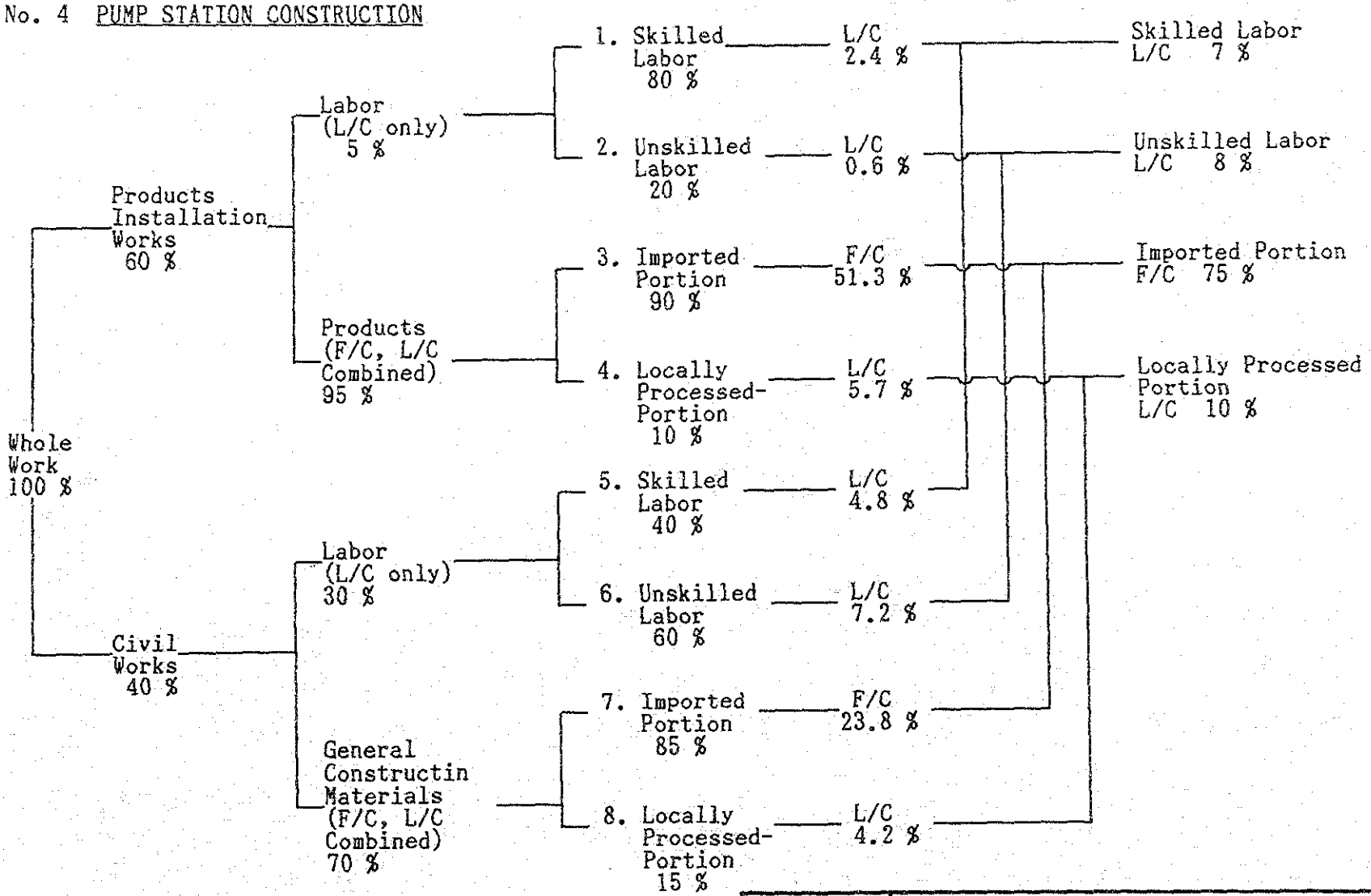


FIGURE	COST-WISE BREAKDOWN FOR PUMP STATION CONSTRUCTION
9.3 (4)	

JAPAN INTERNATIONAL COOPERATION AGENCY

No. 5 EQUIPMENT/MACHINERY AND INSTALLATION

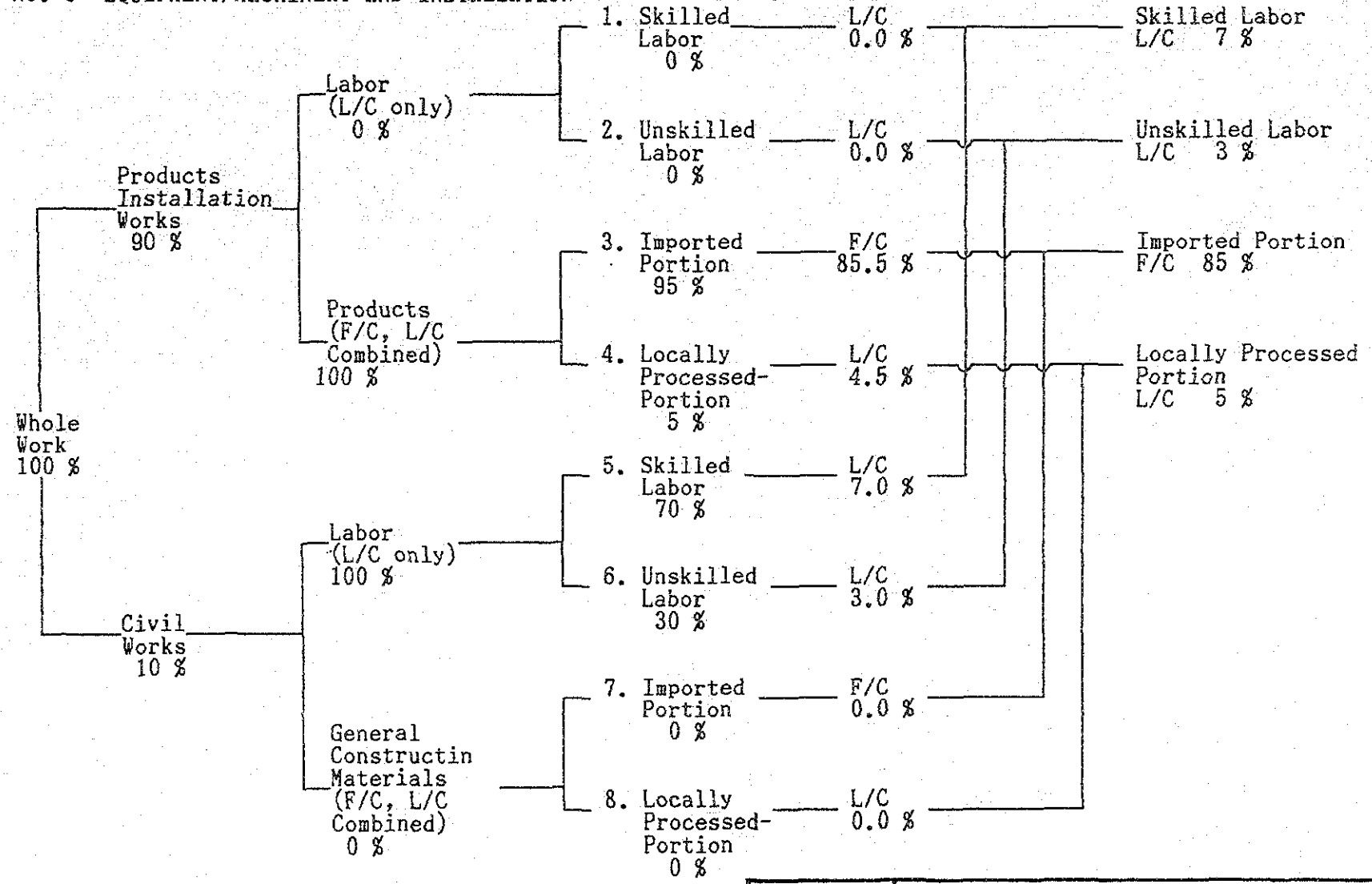


FIGURE	COST-WISE BREAKDOWN FOR EQUIPMENT/MACHINERY AND INSTALLATION
9.3 (5)	

JAPAN INTERNATIONAL COOPERATION AGENCY

No. 6 EQUIPMENT/MACHINERY PURCHASE

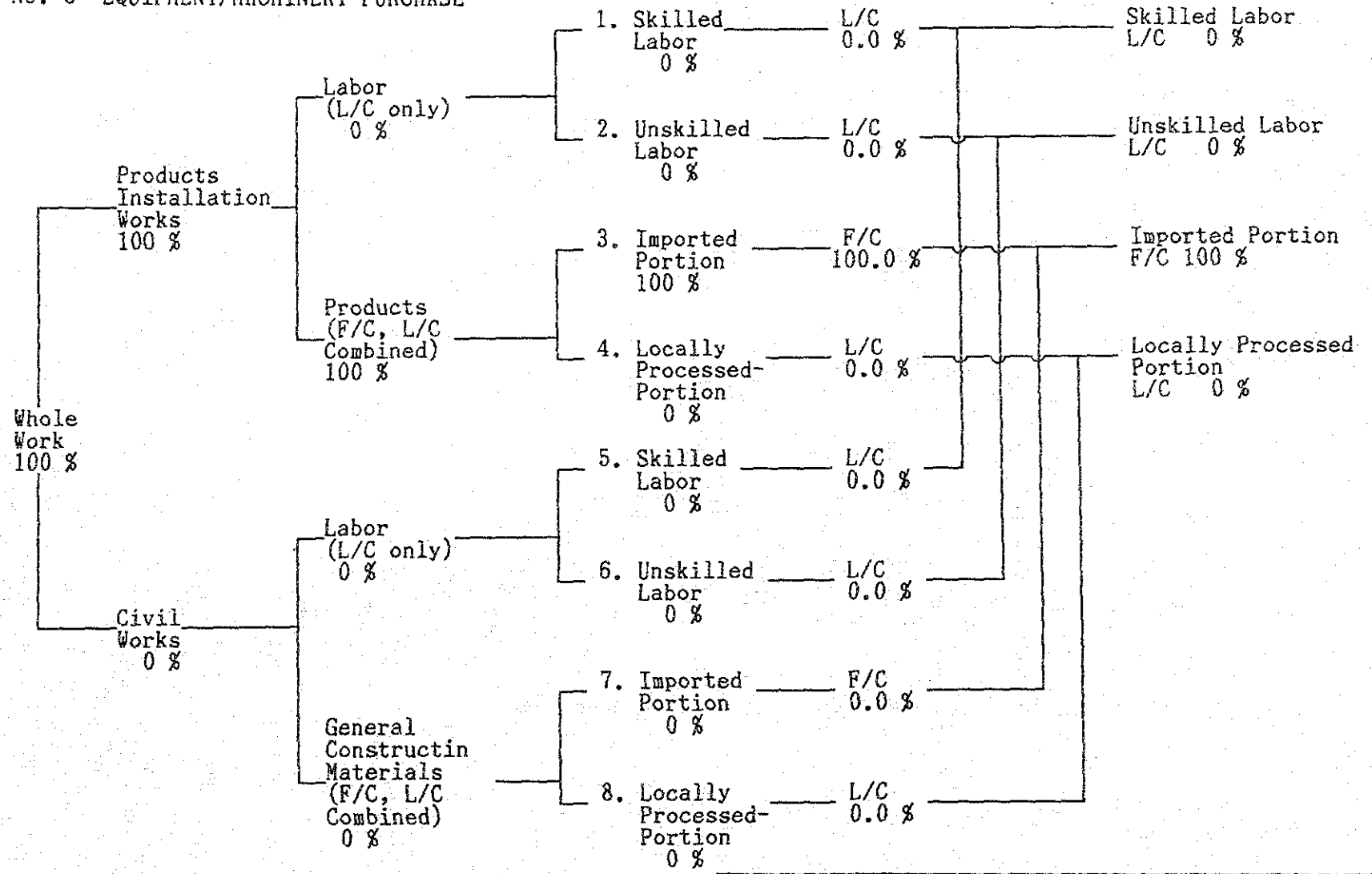


FIGURE	COST-WISE BREAKDOWN FOR EQUIPMENT/MACHINERY PURCHASE
9.3 (6)	

JAPAN INTERNATIONAL COOPERATION AGENCY

Table-9.3 CONSTRUCTION COST

Work Item	Description	Quantity	Unit Cost	Cost
I. Stage I Rehabilitatin/Modification Works				
1. Land Acquisition	Kannasut Deep Well (No.1) 60 m x 65 m = 4,000 m2	4,000	0.5	2,000
	T o t a l 1			2,000
2. Phophraya Treatment Plant				
1) Flow Meter & Indicator	For Raw Water Pipe and Treated Water	2	550	1,100
2) Chlorine Gas Container Scale		1	200	200
3) Level Gauge	Clear Water Reservoir and Elevated Tank	2	200	400
4) Filter Sand Washer		1	650	650
	T o t a l 2			2,350
3. Clear Water Transmission Pipeline				
	Replacement of Pipeline ACP Dia. 300 mm x 500 m	500	1.149	575
	Miscelleneous Works	L.S.		75
	T o t a l 3			650
4. Dab Fafhun Deep Well and Pump Station				
1) Flow Meter & Indicator	For Inlet and Outlet Pipes of Station	2	550	1,100
2) Level Gauge	Clear Water Reservoir and Elevated Tank	2	200	400
3) Chlorination Facilities	Chlorinator 9.0kg/day and Appurtenances	1	400	400
	Chlorine Gas Container Scale	1	200	200
	T o t a l 4			2,100
5. Kannasut Deep Well and Pump Station				
1) Deep Well	Dia. 300 mm x 150 m Depth	1	1200	1,200
2) Intake Pump	Q1.5 m3/min x H35 m x 15 kW Motor & Engine Drive Type	1	250	250
3) Distribution Reservoir	Capacity 1,000 m3	1,000	2.5	2,500
4) Distribution Pump	Q4.1 m3/min x H35 m x 37 kW			
	Motor Drive Type	1	213	213
	Engine Drive Type	1	420	420
	Q2.1 m3/min x H35 m x 22 kW			
	Motor Drive Type	1	157	157
	Engine Drive Type	1	310	310
	Piping and Wiring Works (including intake pump)	L.S.		900
5) Chlorination Facilities	Chlorinator 9.0 kg/day and Appurtenances	1	400	400
	Chlorine Gas Container Scale	1	200	200
6) Building	Office, Pump House and Warehouse (Total floor space : 450 m2)	L.S.		1,800
7) Miscelleneous Works		L.S.		1,650
	T o t a l 5			10.000
6. Distribution Pipeline				
1) Replacement of Pipeline	Dia. 250 mm ACP x 1,600 m	1,600	0.841	1,346
	Dia. 100 mm ACP x 650 m	650	0.327	213
	Miscelleneous Works	L.S.		241
2) Installation of Pipeline	Dia. 250 mm DIP x 330 m	330	1.538	508
	Dia. 250 mm ACP x 1,320 m	1,320	0.841	1,110
	Dia. 200 mm DIP x 490 m	490	1.236	606
	Dia. 200 mm ACP x 1,960 m	1,960	0.644	1,262
	Dia. 150 mm ACP x 2,200 m	2,200	0.45	990
	Dia. 100 mm ACP x 300 m	300	0.327	98
	Pipe Bridge and Road Crossing Works	L.S.		457
	Miscelleneous Works	L.S.		720
3) Leak Detection Equipment	Metal Pipe Detector	1	80	80
	Non-Metal Pipe Detector	1	200	200
	Box Locator	1	20	20
	Leak Detector	2	60	120
	Stethoscopic Bar	2	3	6
	Spare Parts	L.S.		24
	T o t a l 6			8,000
	I. Stage I Rehabilitatin/Modification Works TOTAL			25,100

Cont'ed (x 1,000 Baht)

Work Item		Description	Quantity	Unit Cost	Cost
II. Stage I Expansion Works					
1. Land Acquisition	a)	Kannasut Deep Well (No. 2) 20 m x 20 m = 400 m2	400	0.5	200
		T o t a l 1			200
2. Kannasut Deep Well (No. 2)					
1) Deep Well		Dia. 300 mm x 150 m Depth	1	1200	1,200
2) Intake Pump		Q1.5 m3/min x H35 m x 15 kW Motor & Engine Drive Type	1	250	250
		Piping and Wiring Works	L.S.		150
		Pump House and Others (Total floor space 60 m2)	L.S.		200
		Miscelleneous Works	L.S.		400
		T o t a l 2			2,200
3. Clear Water Transmission Pipeline					
1) Pipeline		Dia. 200 mm DIP x 200 m	200	1.236	247
		Dia. 200 mm ACP x 800 m	800	0.644	515
		Pipe Bridge and Road Crossing Works	L.S.		76
		Miscelleneous Works	L.S.		162
		T o t a l 3			1,000
4. Distribution Facilities					
1) Distribution Pump		Kannasut Deep Well (No. 1) Pump Station Q2.1 m3/min x H35 m x 22 kW			
		Motor Drive Type	1	157	157
		Piping and Wiring Works	L.S.		43
2) Distribution Pipeline		Dia. 200 mm DIP x 830 m	830	1.236	1,026
		Dia. 200 mm ACP x 3,320 m	3,320	0.644	2,138
		Dia. 150 mm ACP x 12,100 m	12,100	0.45	5,445
		Dia. 100 mm ACP x 16,950 m	16,950	0.327	5,543
		Pipe Bridge and Road Crossing Works	L.S.		1,415
		Miscelleneous Works	L.S.		2,233
		T o t a l 4			18,000
		II. Expansion Works TOTAL			21,400
		GROUND TOTAL (I + II)			46,500

APPENDIX 10

FINANCIAL AND ECONOMIC STUDY

APPENDIX 10

APPENDIX 10 FINANCIAL AND ECONOMIC STUDY

LIST OF TABLES RELATED TO FINANCIAL AND ECONOMIC ANALYSIS

Table-10.1 CASH FLOW PROJECTED (x 1,000 Baht) AT 1986 PRICE [SUPHANBURI WATERWORKS]

Description	Text Ref.	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
(A) Water Production (x1000 m3)		1,837	1,968	2,034	2,097	2,157	2,207	2,307	2,403	2,443	2,482	2,566	2,648	2,730	2,859	2,939
(B) Unaccounted for Water (%)		40	39	37	36	34	32	30	29	27	25	25	24	24	23	23
(C) Water Sales (x1000 m3)		1,095	1,205	1,278	1,351	1,424	1,497	1,606	1,716	1,789	1,862	1,935	2,008	2,081	2,190	2,263
(D) No. of Connections		4,689	4,837	5,068	5,233	5,418	5,545	5,819	5,937	6,036	6,141	6,250	6,303	6,399	6,466	6,547
(E) Average Water Tariff (Baht/m3)		6.61	6.61	6.61	6.61	6.61	6.61	6.61	6.61	6.61	6.61	6.61	6.61	6.61	6.61	6.61
1. Operating Revenue:																
1.1 Water Sales		7,238	7,962	8,444	8,927	9,409	9,892	10,616	11,339	11,822	12,305	12,787	13,270	13,752	14,476	14,958
1.2 Connection Fees		730	572	892	637	715	491	1,058	456	362	406	421	205	371	259	313
1.3 Service Charges		624	644	675	697	721	738	775	790	803	817	832	839	852	861	871
1.4 Other Revenue		39	42	46	47	50	51	57	58	60	62	64	66	69	71	74
Total 1.		8,632	9,219	10,057	10,308	10,895	11,171	12,506	12,643	13,067	13,590	14,104	14,379	15,043	15,667	16,217
2. Expenses:																
2.1 Operation & Maintenance																
- Personnel Cost		2,255	2,219	2,219	2,219	2,252	2,970	3,083	3,200	3,200	3,283	3,283	3,283	3,283	3,283	3,283
- Electricity & Fuel Cost		1,738	1,901	1,983	2,024	2,106	2,146	1,722	1,814	1,840	1,866	1,932	2,039	2,121	2,234	2,366
- Chemical Cost		317	342	355	361	374	381	400	419	425	431	444	463	476	495	514
- Connection Cost		210	164	256	183	205	141	304	131	110	116	121	59	106	74	90
- Other Cost		419	429	446	444	457	522	510	516	517	528	536	542	555	564	579
Sub-total 2.1		4,938	5,055	5,259	5,230	5,394	6,160	6,019	6,079	6,091	6,224	6,315	6,386	6,541	6,650	6,832
2.2 Share of Head & Regional Office Overhead Expenses		1,547	1,653	1,803	1,848	1,953	2,003	2,242	2,267	2,343	2,436	2,528	2,578	2,697	2,809	2,907
2.3 Debt Service		0	83	529	1,354	2,782	3,431	4,073	4,767	6,030	5,746	5,463	5,492	5,289	5,086	4,064
Total 2.		6,485	6,790	7,591	8,432	10,129	11,594	12,334	13,113	14,463	14,406	14,306	14,456	14,527	14,544	13,803
3. Net Cash Flow Surplus:																
3.1 Annual		2,146	2,429	2,466	1,876	766	-422	172	-470	-1,396	-817	-202	-77	516	1,123	2,414
3.2 Cumulative		2,146	4,575	7,042	8,918	9,683	9,261	9,433	8,963	7,567	6,751	6,549	6,472	6,988	8,111	10,525
4. Unit Cost of Water after Debt Service (Baht/m3)*		4.97	4.87	4.99	5.41	6.15	6.86	6.52	6.86	7.32	7.01	6.70	6.65	6.38	6.14	5.83

Note: * [(Total 2.) x {(1.1 Water Sales) / (Total 1.)}] / (3.Water Sales m3)

Table-10.2 CASH FLOW PROJECTED (x 1,000 Baht) AT CURRENT PRICE [SUPHANBURI WATERWORKS]

Description	Text Ref.	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
(A) Water Production (x1000 m3)		1,837	1,968	2,034	2,097	2,157	2,207	2,307	2,403	2,443	2,482	2,566	2,648	2,730	2,859	2,939
(B) Unaccounted for Water (%)		40	39	37	36	34	32	30	29	27	25	25	24	24	23	23
(C) Water Sales (x1000 m3)		1,095	1,205	1,278	1,351	1,424	1,497	1,606	1,716	1,789	1,862	1,935	2,008	2,081	2,190	2,263
(D) No. of Connections		4,689	4,837	5,068	5,233	5,418	5,545	5,819	5,937	6,036	6,141	6,250	6,333	6,399	6,466	6,547
(E) Average Water Tariff (Baht/m3)**		6.61	6.83	7.05	7.29	7.53	7.78	8.03	8.30	8.57	8.85	9.15	9.45	9.76	10.08	10.41
1. Operating Revenue:																
1.1 Water Sales		7,238	8,224	9,011	9,840	10,714	11,635	12,899	14,233	15,328	16,480	17,692	18,965	20,304	22,077	23,566
1.2 Connection Fees		730	591	952	703	814	577	1,286	572	496	543	583	293	547	395	493
1.3 Service Charges		624	665	720	768	821	868	941	992	1,042	1,095	1,151	1,199	1,258	1,313	1,373
1.4 Other Revenue		39	43	49	52	57	60	69	72	77	83	89	94	101	109	117
Total 1.		8,632	9,524	10,732	11,362	12,406	13,141	15,195	15,869	16,943	18,201	19,514	20,551	22,210	23,894	25,549
2. Expenses:																
2.1 Operation & Maintenance																
- Personnel Cost		2,255	2,374	2,541	2,718	2,952	4,166	4,627	5,139	5,498	6,036	6,458	6,910	7,394	7,912	8,465
- Electricity & Fuel Cost		1,738	1,964	2,116	2,231	2,398	2,524	2,092	2,277	2,386	2,499	2,673	2,915	3,131	3,407	3,728
- Chemical Cost		317	353	379	398	426	448	486	526	551	577	614	662	703	755	810
- Connection Cost		210	169	273	202	234	166	369	164	142	156	167	84	157	113	141
- Other Cost		419	450	492	514	557	677	702	751	795	859	918	979	1,055	1,129	1,218
Sub-total 2.1		4,938	5,311	5,800	6,063	6,566	7,980	8,276	8,857	9,372	10,126	10,831	11,550	12,440	13,316	14,362
2.2 Share of Head & Regional Office Overhead Expenses		1,547	1,707	1,924	2,037	2,224	2,356	2,724	2,845	3,037	3,263	3,498	3,684	3,982	4,283	4,580
2.3 Debt Service		0	83	529	1,356	2,791	3,439	4,081	4,774	6,041	5,757	5,473	5,499	5,296	5,093	4,070
Total 2.		6,485	7,101	8,253	9,456	11,580	13,775	15,081	16,476	18,451	19,147	19,803	20,734	21,718	22,691	23,012
3. Net Cash Flow Surplus:																
3.1 Annual		2,146	2,422	2,479	1,906	826	-634	114	-607	-1,507	-945	-288	-183	492	1,202	2,536
3.2 Cumulative		2,146	4,568	7,047	8,953	9,779	9,144	9,259	8,652	7,145	6,199	5,911	5,728	6,221	7,423	9,959
4. Unit Cost of Water after Debt Service (Baht/m3)*		4.97	5.09	5.42	6.06	7.03	8.15	7.97	8.61	9.33	9.31	9.28	9.53	9.54	9.57	9.38

Note: * [(Total 2.) x {(1.1 Water Sales) / (Total 1.)}] / (3. Water Sales m3)

** Based upon the assumption that the water tariff increases every year at the rate of 3.3 %.

Table-10.3 CASH FLOW PROJECTED (x 1,000 Baht) AT CURRENT PRICE [SUPHANBURI WATERWORKS]

Description	Text Ref.	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
(A) Water Production (x1000 m3)		1,837	1,968	2,034	2,097	2,157	2,207	2,307	2,403	2,443	2,482	2,566	2,648	2,730	2,859	2,939
(B) Unaccounted for Water (%)		40	39	37	36	34	32	30	29	27	25	25	24	24	23	23
(C) Water Sales (x1000 m3)		1,095	1,205	1,278	1,351	1,424	1,497	1,606	1,716	1,789	1,862	1,935	2,008	2,081	2,190	2,263
(D) No. of Connections		4,689	4,837	5,068	5,233	5,418	5,545	5,819	5,937	6,036	6,141	6,250	6,303	6,399	6,466	6,547
(E) Average Water Tariff (Baht/m3)**		6.61	6.61	6.61	6.61	6.61	6.61	6.61	6.61	6.61	6.61	6.61	6.61	6.61	6.61	6.61
1. Operating Revenue:																
1.1 Water Sales		7,238	7,962	8,444	8,927	9,409	9,892	10,616	11,339	11,822	12,305	12,787	13,270	13,752	14,476	14,958
1.2 Connection Fees		730	572	892	637	715	491	1,058	456	382	406	421	205	371	259	313
1.3 Service Charges		624	644	675	697	721	738	775	790	803	817	832	839	852	861	871
1.4 Other Revenue		39	42	46	47	50	51	57	58	60	62	64	66	69	71	74
Total 1.		8,632	9,219	10,057	10,308	10,895	11,171	12,506	12,643	13,067	13,590	14,104	14,379	15,043	15,667	16,217
2. Expenses:																
2.1 Operation & Maintenance																
- Personnel Cost		2,255	2,374	2,541	2,718	2,952	4,166	4,627	5,139	5,498	6,036	6,458	6,910	7,394	7,912	8,465
- Electricity & Fuel Cost		1,738	1,964	2,116	2,231	2,398	2,524	2,092	2,277	2,386	2,499	2,673	2,915	3,131	3,407	3,728
- Chemical Cost		317	353	379	398	426	448	486	526	551	577	614	662	703	755	810
- Connection Cost		210	169	273	202	234	166	369	164	142	156	167	84	157	113	141
- Other Cost		419	450	492	514	557	577	702	751	795	859	918	979	1,055	1,129	1,218
Sub-total 2.1		4,938	5,311	5,800	6,063	6,566	7,980	8,276	8,857	9,372	10,126	10,831	11,550	12,440	13,316	14,362
2.2 Share of Head & Regional Office Overhead Expenses		1,547	1,653	1,803	1,848	1,953	2,003	2,242	2,267	2,343	2,436	2,528	2,578	2,697	2,809	2,907
2.3 Debt Service		0	83	529	1,356	2,791	3,439	4,081	4,774	6,041	5,757	5,473	5,499	5,296	5,093	4,070
Total 2.		6,485	7,047	8,132	9,267	11,309	13,422	14,599	15,898	17,756	18,320	18,833	19,627	20,433	21,217	21,339
3. Net Cash Flow Surplus:																
3.1 Annual		2,146	2,172	1,925	1,040	-414	-2,250	-2,093	-3,254	-4,688	-4,730	-4,728	-5,248	-5,390	-5,550	-5,123
3.2 Cumulative		2,146	4,319	6,244	7,284	6,870	4,619	2,526	-728	-5,417	-10,147	-14,875	-20,124	-25,513	-31,063	-36,186
4. Unit Cost of Water after Debt Service (Baht/m3)*		4.97	5.05	5.34	5.94	6.86	7.94	7.72	8.31	8.98	8.91	8.83	9.02	8.98	8.95	8.70

Note: * [(Total 2.) x ((1.1 Water Sales) / (Total 1.))] / (3.Water Sales m3)
** Based upon the assumption that the water tariff remains unchanged up to 2000.

Table-10.4 FORMULA SUGGESTED FOR SHARE ALLOCATION OF HEAD AND REGIONAL OFFICE EXPENSES BASED ON WATERWORKS NET SURPLUSES FOR 1985 (in Million Baht)

I t e m	Chiangmai Waterworks	Pattaya Waterworks	Ubon-Warin Waterworks	Suphanburi Waterworks	Total Revenue of PWA	All Waterworks of PWA
Revenue	64.614	49.106	27.999	7.556	1,307.990	1,307.990
Expenses	21.627	8.205	11.039	4.960	901.730	641.685
Surplus (B)	42.987	40.901	16.960	2.596	406.260	666.305
Share Percentage (A)						
Head Off Expenses	0.239	0.239	0.239	0.239		
Reg Off Expenses	0.012	0.010	0.008	0.012		
Total	0.251	0.249	0.247	0.251		
Share Amount {(B)x(A)}						
Head Off Expenses	10.276	9.777	4.054	0.621		
Reg Off Expenses	0.516	0.427	0.141	0.032		
Total	10.792	10.204	4.195	0.652		

Item	Head Office	Regional Office I	Regional Office II	Regional Office VIII	Regional Office IX
Revenue of w/w under its jurisdiction	1,307.990	196.049	130.639	100.181	168.068
Expense of office	159.273	6.959	8.102	5.545	8.001
Expens/Surplus of all waterworks under jurisdiction =SHARE PERCENTAGE (A)	0.239	0.010	0.012	0.008	0.012

Table-10.5 CASH FLOW PROJECTED (x 1,000 Baht) AT 1986 PRICE [SUPHANBURI WATERWORKS]

Description	Text Ref.	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
(A) Water Production (x1000 m3)		1,837	1,968	2,034	2,097	2,157	2,207	2,307	2,403	2,443	2,482	2,566	2,648	2,730	2,859	2,939
(B) Unaccounted for Water (%)		40	39	37	36	34	32	30	29	27	25	25	24	24	23	23
(C) Water Sales (x1000 m3)		1,095	1,205	1,278	1,351	1,424	1,497	1,606	1,716	1,789	1,862	1,935	2,008	2,081	2,190	2,263
(D) No. of Connections		4,689	4,837	5,068	5,233	5,418	5,545	5,819	5,937	6,036	6,141	6,250	6,303	6,399	6,466	6,547
(E) Average Water Tariff (Baht/m3)		6.61	6.61	6.61	6.61	6.61	6.61	6.61	6.61	6.61	6.61	6.61	6.61	6.61	6.61	6.61
1. Operating Revenue:																
1.1 Water Sales		7,238	7,962	8,444	8,927	9,409	9,892	10,616	11,339	11,822	12,305	12,787	13,270	13,752	14,476	14,958
1.2 Connection Fees		730	572	892	637	715	491	1,058	456	382	406	421	205	371	259	313
1.3 Service Charges		624	644	675	697	721	738	775	790	803	817	832	839	852	861	871
1.4 Other Revenue		39	42	46	47	50	51	57	58	60	62	64	66	69	71	74
Total 1.		8,632	9,219	10,057	10,308	10,895	11,171	12,506	12,643	13,067	13,590	14,104	14,379	15,043	15,667	16,217
2. Expenses:																
2.1 Operation & Maintenance																
- Personnel Cost		2,255	2,219	2,219	2,219	2,252	2,970	3,083	3,200	3,200	3,283	3,283	3,283	3,283	3,283	3,283
- Electricity & Fuel Cost		1,738	1,901	1,983	2,024	2,106	2,146	1,722	1,814	1,840	1,866	1,932	2,039	2,121	2,234	2,366
- Chemical Cost		317	342	355	361	374	381	400	419	425	431	444	463	476	495	514
- Connection Cost		210	164	256	183	205	141	304	131	110	116	121	58	106	74	90
- Other Cost		419	429	446	444	457	522	510	516	517	528	536	542	555	564	579
Sub-total 2.1		4,938	5,055	5,259	5,230	5,394	6,160	6,019	6,079	6,091	6,224	6,315	6,386	6,541	6,650	6,832
2.2 Share of Head & Regional Office Overhead Expenses **		745	796	868	889	940	964	1,079	1,091	1,128	1,173	1,217	1,241	1,298	1,352	1,399
2.3 Debt Service		0	83	529	1,354	2,782	3,431	4,073	4,767	6,030	5,746	5,463	5,492	5,289	5,086	4,064
Total 2.		5,683	5,933	6,656	7,473	9,116	10,555	11,171	11,937	13,248	13,143	12,995	13,119	13,128	13,088	12,295
3. Net Cash Flow Surplus:																
3.1 Annual		2,949	3,286	3,401	2,834	1,779	617	1,334	706	-181	447	1,110	1,260	1,915	2,579	3,921
3.2 Cumulative		2,949	6,235	9,636	12,471	14,250	14,866	16,200	16,906	16,725	17,172	18,282	19,542	21,457	24,036	27,958
4. Unit Cost of Water after Debt Service (Baht/m3)*		4.35	4.25	4.37	4.79	5.53	6.25	5.90	6.24	6.70	6.39	6.09	6.03	5.77	5.52	5.01

Note: * [(Total 2.) x {(1.1 Water Sales) / (Total 1.)}] / (3. Water Sales m3)

** Calculated by a new tentative formula based on waterworks net surplus.

Table-10.6 CASH FLOW PROJECTED (x 1,000 Baht) AT CURRENT PRICE (SUPHANBURI WATERWORKS)

Description	Text Ref.	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
(A) Water Production (x1000 m3)		1,837	1,968	2,034	2,097	2,157	2,207	2,307	2,403	2,443	2,482	2,566	2,648	2,730	2,859	2,939
(B) Unaccounted for Water (%)		40	39	37	36	34	32	30	29	27	25	25	24	24	23	23
(C) Water Sales (x1000 m3)		1,095	1,205	1,278	1,351	1,424	1,497	1,606	1,716	1,789	1,862	1,935	2,008	2,081	2,190	2,263
(D) No. of Connections		4,689	4,837	5,068	5,233	5,418	5,545	5,819	5,937	6,036	6,141	6,250	6,303	6,399	6,466	6,547
(E) Average Water Tariff (Baht/m3)**		6.61	6.83	7.05	7.29	7.53	7.78	8.03	8.30	8.57	8.85	9.15	9.45	9.76	10.08	10.41
1. Operating Revenue:																
1.1 Water Sales		7,238	8,224	9,011	9,840	10,714	11,635	12,899	14,233	15,328	16,480	17,692	18,965	20,304	22,077	23,566
1.2 Connection Fees		730	591	952	703	814	577	1,286	572	496	543	583	293	547	395	493
1.3 Service Charges		624	665	720	768	821	868	941	992	1,042	1,095	1,151	1,199	1,258	1,313	1,373
1.4 Other Revenue		39	43	49	52	57	60	69	72	77	83	89	94	101	109	117
Total 1.		8,632	9,524	10,732	11,362	12,406	13,141	15,195	15,869	16,943	18,201	19,514	20,551	22,210	23,894	25,549
2. Expenses:																
2.1 Operation & Maintenance																
- Personnel Cost		2,255	2,374	2,541	2,718	2,952	4,166	4,627	5,139	5,498	6,036	6,458	6,910	7,394	7,912	8,465
- Electricity & Fuel Cost		1,738	1,964	2,116	2,231	2,398	2,524	2,092	2,277	2,386	2,499	2,673	2,915	3,131	3,407	3,728
- Chemical Cost		317	353	379	398	426	448	486	526	551	577	614	662	703	755	810
- Connection Cost		210	169	273	202	234	166	369	164	142	156	167	84	157	113	141
- Other Cost		419	450	492	514	557	677	702	751	795	859	918	979	1,055	1,129	1,218
Sub-total 2.1		4,938	5,311	5,800	6,063	6,566	7,980	8,276	8,857	9,372	10,126	10,831	11,550	12,440	13,316	14,362
2.2 Share of Head & Regional Office Overhead Expenses***		745	822	926	980	1,070	1,134	1,311	1,359	1,462	1,571	1,684	1,773	1,917	2,062	2,205
2.3 Debt Service		0	83	529	1,354	2,782	3,431	4,073	4,767	6,030	5,746	5,463	5,492	5,289	5,086	4,064
Total 2.		5,683	6,216	7,255	8,397	10,418	12,545	13,660	14,993	16,864	17,443	17,977	18,816	19,646	20,463	20,630
3. Net Cash Flow Surplus:																
3.1 Annual		2,949	3,308	3,476	2,965	1,988	596	1,535	875	80	758	1,537	1,735	2,564	3,431	4,918
3.2 Cumulative		2,949	6,256	9,733	12,698	14,686	15,282	16,816	17,693	17,772	18,531	20,068	21,803	24,367	27,798	32,716
4. Unit Cost of Water after Debt Service (Baht/m3)*		4.35	4.46	4.77	5.38	6.32	7.42	7.22	7.84	8.53	8.48	8.43	8.65	8.63	8.63	8.41

Note: * [(Total 2.) x ((1.1 Water Sales) / (Total 1.))] / (3. Water Sales m3)

** Based upon the assumption that the water tariff increases every year at the rate of 3.3 %.

*** Calculated by a new tentative formula based on waterworks net surplus.

Table-10.7 CASH FLOW PROJECTED (x 1,000 Baht) AT CURRENT PRICE (SUPHANBURI WATERWORKS)

Description	Text Ref.	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
(A) Water Production (x1000 m3)		1,837	1,968	2,034	2,097	2,157	2,207	2,307	2,403	2,443	2,482	2,566	2,648	2,730	2,859	2,939
(B) Unaccounted for Water (%)		40	39	37	36	34	32	30	29	27	25	25	24	24	23	23
(C) Water Sales (x1000 m3)		1,095	1,205	1,278	1,351	1,424	1,497	1,606	1,716	1,789	1,862	1,935	2,008	2,081	2,190	2,263
(D) No. of Connections		4,689	4,837	5,068	5,233	5,418	5,545	5,819	5,937	6,036	6,141	6,250	6,303	6,399	6,466	6,547
(E) Average Water Tariff (Baht/m3)**		6.61	6.61	6.61	7.29	7.29	7.29	8.03	8.03	8.03	8.85	8.85	8.85	9.76	9.76	9.76
1. Operating Revenue:																
1.1 Water Sales		7,238	7,962	8,444	9,840	10,372	10,904	12,899	13,778	14,365	16,480	17,127	17,773	20,304	21,372	22,085
1.2 Connection Fees		730	572	892	703	788	541	1,286	554	465	543	564	274	547	382	462
1.3 Service Charges		624	644	675	768	795	814	941	960	976	1,095	1,114	1,124	1,258	1,271	1,287
1.4 Other Revenue		39	42	46	52	55	56	69	70	72	83	86	88	101	105	109
Total 1.		8,632	9,219	10,057	11,362	12,009	12,314	15,195	15,362	15,878	18,201	18,891	19,259	22,210	23,131	23,942
2. Expenses:																
2.1 Operation & Maintenance																
- Personnel Cost		2,255	2,374	2,541	2,718	2,952	4,166	4,627	5,139	5,498	6,036	6,458	6,910	7,394	7,912	8,465
- Electricity & Fuel Cost		1,738	1,954	2,116	2,231	2,398	2,524	2,092	2,277	2,386	2,499	2,673	2,915	3,131	3,407	3,728
- Chemical Cost		317	353	379	398	426	448	486	526	551	577	614	662	703	755	810
- Connection Cost		210	169	273	202	234	166	369	164	142	156	167	84	157	113	141
- Other Cost		419	450	492	514	557	677	702	751	795	859	918	979	1,055	1,129	1,218
Sub-total 2.1		4,938	5,311	5,800	6,063	6,566	7,980	8,276	8,857	9,372	10,126	10,831	11,550	12,440	13,316	14,362
2.2 Share of Head & Regional Office Overhead Expenses***		745	796	868	980	1,036	1,063	1,311	1,326	1,370	1,571	1,630	1,662	1,917	1,996	2,066
2.3 Debt Service		0	83	529	1,356	2,791	3,439	4,081	4,774	6,041	5,757	5,473	5,499	5,296	5,093	4,070
Total 2.		5,683	6,190	7,197	8,400	10,393	12,482	13,668	14,957	16,783	17,454	17,934	18,711	19,653	20,404	20,498
3. Net Cash Flow Surplus:																
3.1 Annual		2,949	3,030	2,860	2,962	1,617	-167	1,527	406	-905	747	957	547	2,557	2,726	3,444
3.2 Cumulative		2,949	5,978	8,838	11,801	13,418	13,250	14,777	15,183	14,278	15,025	15,981	16,529	19,086	21,812	25,256
4. Unit Cost of Water after Debt Service (Baht/m3)*		4.35	4.44	4.73	5.39	6.31	7.39	7.22	7.82	8.49	8.49	8.40	8.60	8.64	8.51	8.36

Note: * [(Total 2.) x ((1.1 Water Sales) / (Total 1.))] / (3. Water Sales m3)

** Based upon the assumption that the water tariff increases every three years at the rate of 3.3 % per annum.

*** Calculated by a new tentative formula based on waterworks net surplus.

Table-10.8 CASH FLOW PROJECTED (x 1,000 Baht) AT CURRENT PRICE [SUPHANBURI WATERWORKS]

Description	Text Ref.	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
(A) Water Production (x1000 m3)		1,837	1,968	2,034	2,097	2,157	2,207	2,307	2,403	2,443	2,482	2,566	2,648	2,730	2,859	2,939
(B) Unaccounted for Water (%)		40	39	37	36	34	32	30	29	27	25	25	24	24	23	23
(C) Water Sales (x1000 m3)		1,095	1,205	1,278	1,351	1,424	1,497	1,606	1,716	1,789	1,862	1,935	2,008	2,081	2,190	2,263
(D) No. of Connections		4,689	4,837	5,068	5,233	5,418	5,545	5,819	5,937	6,036	6,141	6,250	6,303	6,399	6,466	6,547
(E) Average Water Tariff (Baht/m3)**		6.61	6.61	6.61	6.61	6.61	6.61	6.61	6.61	6.61	6.61	6.61	6.61	6.61	6.61	6.61
1. Operating Revenue:																
1.1 Water Sales		7,238	7,962	8,444	8,927	9,409	9,892	10,616	11,339	11,822	12,305	12,787	13,270	13,752	14,476	14,958
1.2 Connection Fees		730	572	892	637	715	491	1,058	456	382	406	421	205	371	259	313
1.3 Service Charges		624	644	675	697	721	738	775	790	803	817	832	839	852	861	871
1.4 Other Revenue		38	42	46	47	50	51	57	58	60	62	64	66	69	71	74
Total 1.		8,632	9,219	10,057	10,308	10,895	11,171	12,506	12,643	13,067	13,590	14,104	14,379	15,043	15,667	16,217
2. Expenses:																
2.1 Operation & Maintenance																
- Personnel Cost		2,255	2,374	2,541	2,718	2,952	4,166	4,627	5,139	5,498	6,036	6,458	6,910	7,394	7,912	8,465
- Electricity & Fuel Cost		1,738	1,964	2,116	2,231	2,398	2,524	2,692	2,277	2,386	2,499	2,673	2,915	3,131	3,407	3,728
- Chemical Cost		317	353	379	398	426	448	485	526	551	577	614	662	703	755	810
- Connection Cost		210	169	273	202	234	166	369	164	142	156	167	84	157	113	141
- Other Cost		419	450	492	514	557	677	702	751	795	859	918	979	1,055	1,129	1,218
Sub-total 2.1		4,938	5,311	5,800	6,063	6,566	7,980	8,275	8,857	9,372	10,126	10,831	11,550	12,440	13,316	14,362
2.2 Share of Head & Regional Office Overhead Expenses***		745	796	868	889	940	964	1,079	1,091	1,128	1,173	1,217	1,241	1,298	1,352	1,399
2.3 Debt Service		0	83	529	1,356	2,791	3,439	4,081	4,774	6,041	5,757	5,473	5,499	5,296	5,093	4,070
Total 2.		5,683	6,190	7,197	8,309	10,296	12,383	13,436	14,722	16,541	17,056	17,521	18,290	19,034	19,760	19,832
3. Net Cash Flow Surplus:																
3.1 Annual		2,949	3,030	2,860	1,999	598	-1,212	-931	-2,079	-3,473	-3,467	-3,417	-3,911	-3,991	-4,093	-3,615
3.2 Cumulative		2,949	5,978	8,838	10,837	11,436	10,224	9,294	7,215	3,741	274	-3,142	-7,054	-11,045	-15,138	-18,753
4. Unit Cost of Water after Debt Service (Baht/m3)*		4.35	4.44	4.73	5.33	6.25	7.33	7.10	7.70	8.37	8.30	8.21	8.41	8.36	8.34	8.08

Note: * [(Total 2.) x {(1.1 Water Sales) / (Total 1.)}] / (3. Water Sales m3)

** Based upon the assumption that the water tariff remains unchanged up to 2000.

*** Calculated by a new tentative formula based on waterworks net surplus.

Table-10.9 DEBT SERVICE PROJECTED [SUPHANBURI WATERWORKS]

Year	FOREIGN CURRENCY PORTION (in 1,000 Baht) Interest : 8.5% per annum*									LOCAL CURRENCY PORTION (in 1,000 Baht) Interest : 13.0 % per annum									TOTAL DEBT SERVICE
	Rehabil. and Modif.	Stage I Expan.	Loans Outstanding Beginning	Loans Outstanding Ending	Interest Payments 1st year	Interest Payments Later year	Principal Repayment Rehab. & Mod.	Principal Repayment Expnasion	Debt Service Sub-total	Rehabil. and Modif.	Stage I Expan.	Loans Outstanding Beginning	Loans Outstanding Ending	Interest Payments 1st year	Interest Payments Later year	Principal Repayment Rehab. & Mod.	Principal Repayment Expnasion	Debt Service Sub-total	
1987	2,465	0	0	2,465	105	0	0	0	105	616	0	0	616	40	0	0	0	40	145
1988	10,753	0	2,465	13,218	457	210	0	0	667	2,688	0	616	3,304	175	80	0	0	255	921
1989	13,757	0	13,218	26,975	585	1,124	0	0	1,708	3,439	0	3,304	6,743	224	430	0	0	653	2,361
1990		197	26,975	27,172	8	2,293	0	0	2,301		49	6,743	5,829	3	877	963	0	1,843	4,144
1991		22,729	27,172	49,901	966	2,310	0	0	3,276		5,682	5,829	10,547	369	758	963	0	2,090	5,366
1992			49,901	49,901		4,242	0	0	4,242			10,547	9,584		1,371	963	0	2,334	6,576
1993			49,901	49,901		4,242	0	0	4,242			9,584	7,802		1,246	963	819	3,028	7,270
1994			49,901	48,402		4,242	1,499	0	5,740			7,802	6,020		1,014	963	819	2,796	8,536
1995			48,402	46,904		4,114	1,499	0	5,613			6,020	4,238		783	963	819	2,565	8,177
1996			46,904	45,405		3,987	1,499	0	5,485			4,238	2,456		551	963	819	2,333	7,818
1997			45,405	42,633		3,859	1,499	1,274	6,632			2,456	1,637		319		819	1,138	7,770
1998			42,633	39,861		3,624	1,499	1,274	6,396			1,637	819		213		819	1,032	7,428
1999			39,861	37,088		3,388	1,499	1,274	6,160			819	0		106		819	925	7,086
2000			37,088	34,316		3,153	1,499	1,274	5,925										5,925
2001			34,316	31,544		2,917	1,499	1,274	5,689										5,689
2002			31,544	28,772		2,681	1,499	1,274	5,453										5,453
2003			28,772	25,999		2,446	1,499	1,274	5,218										5,218
2004			25,999	23,227		2,210	1,499	1,274	4,982										4,982
2005			23,227	20,455		1,974	1,499	1,274	4,747										4,747
2006			20,455	17,682		1,739	1,499	1,274	4,511										4,511
2007			17,682	14,910		1,503	1,499	1,274	4,275										4,275
2008			14,910	12,138		1,267	1,499	1,274	4,040										4,040
2009			12,138	9,366		1,032	1,499	1,274	3,804										3,804
2010			9,366	6,593		796	1,499	1,274	3,568										3,568
2011			6,593	3,821		560	1,499	1,274	3,333										3,333
2012			3,821	2,547		325		1,274	1,598										1,598
2013			2,547	1,274		217		1,274	1,490										1,490
2014			1,274	0		108		1,274	1,382										1,382

Note: * Based upon the assumption that the foreign currency portion is financed by a foreign financial institution whose lending rate is 8.5 % per annum.

Table-10.10 CASH FLOW PROJECTED (x 1,000 Baht) AT CURRENT PRICE (SUPHANBURI WATERWORKS)

Description	Text Ref.	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
(A) Water Production (x1000 m3)		1,837	1,968	2,034	2,097	2,157	2,207	2,307	2,403	2,443	2,482	2,566	2,648	2,730	2,859	2,939
(B) Unaccounted for Water (%)		40	39	37	36	34	32	30	29	27	25	25	24	24	23	23
(C) Water Sales (x1000 m3)		1,095	1,205	1,278	1,351	1,424	1,497	1,606	1,716	1,789	1,862	1,935	2,008	2,081	2,190	2,263
(D) No. of Connections		4,689	4,837	5,068	5,233	5,418	5,545	5,819	5,937	6,036	6,141	6,250	6,303	6,399	6,456	6,547
(E) Average Water Tariff (Baht/m3)##		6.61	6.61	6.61	7.29	7.29	7.29	8.03	8.03	8.03	8.85	8.85	8.85	9.76	9.76	9.76
1. Operating Revenue:																
1.1 Water Sales		7,238	7,962	8,444	9,840	10,372	10,904	12,899	13,778	14,365	16,480	17,127	17,773	20,304	21,372	22,085
1.2 Connection Fees		730	572	892	703	788	541	1,286	554	465	543	564	274	547	382	462
1.3 Service Charges		624	644	675	768	795	814	941	960	976	1,035	1,114	1,124	1,258	1,271	1,287
1.4 Other Revenue		39	42	46	52	55	56	69	70	72	83	86	88	101	105	109
Total 1.		8,632	9,219	10,057	11,362	12,009	12,314	15,195	15,362	15,878	18,201	18,891	19,259	22,210	23,131	23,942
2. Expenses:																
2.1 Operation & Maintenance																
- Personnel Cost		2,255	2,374	2,541	2,718	2,952	4,166	4,627	5,139	5,498	6,036	6,458	6,910	7,394	7,912	8,465
- Electricity & Fuel Cost		1,738	1,954	2,116	2,231	2,398	2,524	2,092	2,277	2,386	2,499	2,573	2,915	3,131	3,407	3,728
- Chemical Cost		317	353	379	398	426	448	486	526	551	577	614	662	703	755	810
- Connection Cost		210	169	273	202	234	166	369	164	142	156	167	84	157	113	141
- Other Cost		419	450	492	514	557	577	702	751	795	859	918	979	1,055	1,129	1,218
Sub-total 2.1		4,938	5,311	5,800	6,063	6,566	7,980	8,276	8,857	9,372	10,126	10,831	11,550	12,440	13,316	14,362
2.2 Share of Head & Regional Office Overhead Expenses		1,547	1,653	1,803	2,037	2,153	2,208	2,724	2,754	2,846	3,263	3,387	3,452	3,982	4,147	4,292
2.3 Debt Service###		0	145	921	2,361	4,144	5,366	6,576	7,270	8,536	8,177	7,818	7,770	7,428	7,086	5,925
Total 2.		6,485	7,109	8,524	10,461	12,863	15,554	17,576	18,880	20,755	21,567	22,036	22,772	23,849	24,548	24,579
3. Net Cash Flow Surplus:																
3.1 Annual		2,146	2,111	1,533	901	-853	-3,239	-2,381	-3,518	-4,877	-3,365	-3,145	-3,514	-1,639	-1,417	-636
3.2 Cumulative		2,146	4,257	5,790	6,691	5,838	2,599	218	-3,300	-8,177	-11,542	-14,687	-18,201	-19,840	-21,257	-21,894
4. Unit Cost of Water after Debt Service (Baht/m3)*		4.97	5.10	5.60	6.71	7.80	9.20	9.29	9.87	10.50	10.49	10.33	10.47	10.48	10.36	10.02

Note: * [(Total 2.) x ((1.1 Water Sales) / (Total 1.))] / (3.Water Sales m3)

Based upon the assumption that the water tariff increases every three years at the rate of 3.3 % per annum.

Based upon the assumption that the foreign currency portion is financed by a foreign financial institution whose lending rate is 8.5 % per annum.

Table-10.11 FIXED ASSETS, UNIT COST AFTER DEPRECIATION AND RATE OF RETURN

[SUPHANBURI WATERWORKS] x 1,000 BAHT

YEAR	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Fixed Assets														
Accumulative Fixed Assets	14,687	15,171	18,747	32,751	50,922	52,847	82,723	85,453	88,273	91,186	94,195	97,303	100,514	103,831
Less Accumulative Depreciation	6,252	6,964	7,819	9,169	11,169	13,299	16,495	19,888	23,486	27,301	31,342	35,619	40,145	44,931
Net Fixed Assets in Operation	8,435	8,207	10,928	23,582	39,754	39,548	66,228	65,565	64,786	63,885	62,853	61,684	60,369	58,900
Work in Progress	3,075	16,460	30,476	17,335	28,376	28,132	0	0	0	0	0	0	0	0
TOTAL	11,510	24,667	41,404	40,917	68,130	67,680	66,228	65,565	64,786	63,885	62,853	61,684	60,369	58,900
Total Cost before Depreciation and Interest ##	6,133	6,726	7,043	7,636	9,114	9,587	10,226	10,834	11,697	12,515	13,323	14,357	15,377	16,567
Total Cost after Depreciation but before Interest		7,438	7,898	8,986	11,114	11,717	13,422	14,227	15,296	16,329	17,364	18,634	19,903	21,352
Total Cost after Depreciation and Interest		7,967	9,255	10,813	13,590	14,835	16,415	16,987	17,772	18,522	19,273	20,339	21,405	22,551
Unit Cost of Water (Baht/cm3) after Depreciation and Interest*		6.23	6.85	7.59	9.08	9.24	9.57	9.50	9.54	9.57	9.60	9.77	9.77	10.01
Average Rate Base		8,321	9,568	17,255	31,668	39,651	52,388	65,896	65,176	64,335	63,369	62,258	61,026	59,634
Surplus after Depreciation and Interest		2,764	2,108	1,593	-449	360	-545	-44	429	992	1,278	1,870	2,489	2,898
Rate of Return after Completion of Construction						1%	-1%	0%	1%	2%	2%	3%	4%	5%

Note: * [{(Total Cost after Depreciation and Debt Service) of this Table} x {(1.1 Water Sales)/(1. Operating Revenue) of Cash Flow Table}]/[{(C) Water Sales (x 1000 m3)} of Cash Flow Table]

Includes Share of Head & Regional Office Overhead Expenses calculated by a new tentative formula based on waterworks net surplus.

Table-10.12 FINANCIAL INTERNAL RATE OF RETURN (FIRR) TABLE 6-14

(SUPHANBURI WATERWORKS)x 1,000 BAHT 0.03 0.04

YEAR	TOTAL WATER REVENUE	CAPITAL INVESTMENT COST	OPERATING COSTS & H.R.O.*	1986 PRICE NET REVENUE	NET BENEFITS DISCOUNTED AT 6 %	NET BENEFITS DISCOUNTED AT 7 %
1987	0	2,983	0	-2,983	-2,896	-2,868
1988	0	12,596	0	-12,596	-11,873	-11,645
1989	1,676	15,600	437	-14,361	-13,142	-12,767
1990	2,263	216	652	1,396	1,240	1,193
1991	2,540	24,154	1,441	-23,055	-19,888	-18,950
1992	3,874		1,416	2,458	2,059	1,943
1993	4,012		1,488	2,524	2,052	1,918
1994	4,436		1,536	2,900	2,289	2,119
1995	4,958		1,714	3,244	2,486	2,279
1996	5,473		1,850	3,623	2,696	2,448
1997	5,747		1,944	3,804	2,748	2,471
1998	6,412		2,157	4,255	2,984	2,658
1999	7,035		2,319	4,716	3,211	2,832
2000	7,585		2,549	5,036	3,330	2,908
2001	7,585		2,549	5,036	3,233	2,796
2002	7,585		2,549	5,036	3,138	2,689
2003	7,585		2,549	5,036	3,047	2,586
2004	7,585		2,549	5,036	2,958	2,486
2005	7,585		2,549	5,036	2,872	2,390
2006	7,585		2,549	5,036	2,788	2,299
Salvage		-25,070		25,070	13,880	7,685
TOTALS	101,523	30,478	34,795	36,249	9,215	-530

Note: * Share Allocation of Head and Regional Office Overhead Expenses calculated by a new tentative formula based on waterworks net surplus.

FIRR= 3+(4-3)x9,215/(9,215+530)
= 3.95%

Table-10.13 AVERAGE INCREMENTAL COSTS (AIC)

(SUPHANBURI WATERWORKS) x 1,000 BAHT

YEAR	CAPITAL INVESTMENT					ECONOMIC VALUE OF CAPITAL INVESTMENT					DISCOUNTED AT 10%	SALES VOLUMES (INCREMENTS) 1,000 cm	DISCOUNTED AT 10%	OPERATION AND MAINTENANCE	DISCOUNTED AT 10%
	FORIGN PORTION	LOCAL PORTION			TOTAL INVESTMENT	FORIGN PORTION	LOCAL PORTION			TOTAL INVESTMENT					
		PROCUR.	SKILLED LABOR	UNSKILLED LABOR			PROCUR.	SKILLED LABOR	UNSKILLED LABOR						
1987	493	2,161	329	0	2,983	493	1,710	240	0	2,442	2,220	0	0	0	0
1988	8,403	1,019	2,055	1,118	12,596	8,403	806	1,501	425	11,134	9,202	0	0	0	0
1989	10,628	1,528	1,766	1,677	15,600	10,628	1,209	1,289	637	13,764	10,341	256	192	474	356
1990	0	216	0	0	216	0	171	0	0	171	117	329	224	690	471
1991	14,881	2,291	3,523	3,458	24,154	14,881	1,812	2,572	1,314	20,579	12,778	402	249	1,342	833
1992												511	288	1,421	802
1993												621	318	1,489	764
1994												694	324	1,559	727
1995												767	325	1,740	738
1996												840	324	1,887	727
1997												913	320	1,983	695
1998												986	314	2,202	702
1999												1,095	317	2,379	689
2000												1,168	308	2,603	686
2001												1,168	280	2,603	623
2002												1,168	254	2,603	567
2003												1,168	231	2,603	515
2004												1,168	210	2,603	468
2005												1,168	191	2,603	426
2006												1,168	174	2,603	387
Salvage					-25,070					-21,683	-3,223				
TOTAL					30,478					26,408	31,435		4,843		11,176

TOTAL INVEST. DISCNTED 31,435

Table-10.14 AVERAGE INCREMENTAL COSTS (AIC)

[SUPHANBURI WATERWORKS] x 1,000 BAHT

YEAR	CAPITAL INVESTMENT: FORIGN PORTION	CAPITAL INVESTMENT: LOCAL PORTION: PROCUR.	CAPITAL INVESTMENT: LOCAL PORTION: SKILLED LABOR	CAPITAL INVESTMENT: LOCAL PORTION: UNSKILLED LABOR	CAPITAL INVESTMENT: TOTAL INVESTMENT	ECONOMIC VALUE OF CAPITAL INVESTMENT: FORIGN PORTION	ECONOMIC VALUE OF CAPITAL INVESTMENT: LOCAL PORTION: PROCUR.	ECONOMIC VALUE OF CAPITAL INVESTMENT: LOCAL PORTION: SKILLED LABOR	ECONOMIC VALUE OF CAPITAL INVESTMENT: LOCAL PORTION: UNSKILLED LABOR	ECONOMIC VALUE OF CAPITAL INVESTMENT: TOTAL INVESTMENT	DISCOUNTED AT 10%	SALES VOLUMES (INCREMENTS) 1,000 cm	DISCOUNTED AT 10%	OPERATION AND MAINTENANCE	DISCOUNTED AT 10%
1987	493	2,161	329	0	2,983	493	1,710	240	0	2,442	2,220	0	0	0	0
1988	8,403	1,019	2,055	1,118	12,596	8,403	806	1,501	425	11,134	9,202	0	0	0	0
1989	10,628	1,528	1,766	1,677	15,600	10,628	1,209	1,289	637	13,764	10,341	256	192	350	263
1990	0	216	0	0	216	0	171	0	0	171	117	329	224	521	356
1991	14,881	2,291	3,523	3,458	24,154	14,881	1,812	2,572	1,314	20,579	12,778	402	249	1,153	716
1992												511	288	1,133	639
1993												621	318	1,190	611
1994												894	324	1,229	573
1995												767	325	1,371	582
1996												840	324	1,480	571
1997												913	320	1,555	545
1998												986	314	1,725	550
1999												1,095	317	1,855	537
2000												1,168	308	2,039	537
2001												1,168	280	2,039	488
2002												1,168	254	2,039	444
2003												1,168	231	2,039	403
2004												1,168	210	2,039	367
2005												1,168	191	2,039	333
2006												1,168	174	2,039	303
Salvage					-25,070					-21,683	-3,223				
TOTAL					30,478					26,408	31,435		4,843		8,818

Note: * Share of Head & Regional Office Overhead Expenses calculated by a new tentative formula based on waterworks net surplus.

TOTAL INVEST. DISCNTED	31,435
O&M COST DISCOUNTED +	8,818

Table-10.15 ECONOMIC BENEFITS VS COSTS (INCREMENTAL)

(SUPHANBURI WATERWORKS) x 1,000 BAHT

YEAR	AT 1986 PRICE		DISCOUNTED AT 10% PER ANNUM	
	BENEFITS	COSTS	BENEFITS	COSTS
1987	0	2,442	0	2,220
1988	0	11,134	0	9,202
1989	1,676	14,043	1,259	10,551
1990	2,263	588	1,546	402
1991	2,540	21,502	1,577	13,351
1992	3,874	906	2,187	511
1993	4,012	952	2,059	489
1994	4,436	983	2,069	459
1995	4,958	1,097	2,103	465
1996	5,473	1,184	2,110	456
1997	5,747	1,244	2,014	436
1998	6,412	1,380	2,043	440
1999	7,035	1,484	2,038	430
2000	7,585	1,631	1,997	430
2001	7,585	1,631	1,816	391
2002	7,585	1,631	1,651	355
2003	7,585	1,631	1,501	323
2004	7,585	1,631	1,364	293
2005	7,585	1,631	1,240	267
2006	7,585	1,631	1,127	242
Salvage		-21,683		-3,223
TOTAL	101,523	48,677	31,702	38,489
	BENEFITS/COS = 2.086		BENEFITS/COS = 0.824	

Note: * Share of Head & Regional Office Overhead Expenses calculated by a new tentative formula based on waterworks net surplus.

Table-10.16 ECONOMIC INTERNAL RATE OF RETURN (EIRR)

[SUPHANBURI WATERWORKS] x 1,000 BAHT

YEAR	TOTAL ECONOMIC BENEFITS * AT 1986 PRICE	TOTAL CAPITAL INVESTMENT AT 1986 PRICE	OPERATING COSTS & H.R.O.** AT 1986 PRICE	NET BENEFITS AT 1986 PRICE	CONVERTED ECONOMIC VALUE				NET BENEFITS	
					TOTAL ECONOMIC BENEFITS	TOTAL CAPITAL INVESTMENT	OPERATING COSTS & H.R.O.*	NET BENEFITS	DISCOUNTED AT 9%	DISCOUNTED AT 10%
1987	0	2,983	0	-2,983	0	2,442	0	-2,442	-2,241	-2,220
1988	0	12,596	0	-12,596	0	11,134	0	-11,134	-9,371	-9,202
1989	2,040	15,600	350	-13,910	2,040	13,764	280	-12,004	-9,269	-9,019
1990	2,622	216	521	1,885	2,622	171	417	2,034	1,441	1,390
1991	3,205	24,154	1,153	-22,102	3,205	20,579	922	-18,297	-11,892	-11,361
1992	4,079		1,133	2,947	4,079		906	3,173	1,892	1,791
1993	4,954		1,190	3,763	4,954		952	4,001	2,189	2,053
1994	5,536		1,229	4,307	5,536		983	4,553	2,285	2,124
1995	6,119		1,371	4,748	6,119		1,097	5,022	2,312	2,130
1996	6,702		1,480	5,222	6,702		1,184	5,518	2,331	2,127
1997	7,285		1,555	5,730	7,285		1,244	6,041	2,341	2,117
1998	7,867		1,725	6,142	7,867		1,380	6,487	2,306	2,067
1999	8,741		1,855	6,886	8,741		1,484	7,257	2,367	2,102
2000	9,324		2,039	7,285	9,324		1,631	7,693	2,302	2,026
2001	9,324		2,039	7,285	9,324		1,631	7,693	2,112	1,842
2002	9,324		2,039	7,285	9,324		1,631	7,693	1,938	1,674
2003	9,324		2,039	7,285	9,324		1,631	7,693	1,778	1,522
2004	9,324		2,039	7,285	9,324		1,631	7,693	1,631	1,384
2005	9,324		2,039	7,285	9,324		1,631	7,693	1,496	1,258
2006	9,324		2,039	7,285	9,324		1,631	7,693	1,373	1,144
Salvage		-25,070		25,070		-21,683		21,683	3,869	3,223
TOTAL				66,106				75,744	3,190	172

Note : * Average water tariff in 1986 used as benefits. (6.61 Baht)

** Share Allocation of Head and Regional Office Overhead Expenses calculated by a new tentative formula based on waterworks net surplus.

EIRR = 9+(10-9)x3,190/(3,190+172)

= 10.057%

Table-10.17 ECONOMIC INTERNAL RATE OF RETURN (EIRR)

[SUPHANBURI WATERWORKS] x 1,000 BAHT

YEAR	TOTAL ECONOMIC BENEFITS * AT 1986 PRICE	TOTAL CAPITAL INVESTMENT AT 1986 PRICE	OPERATING COSTS & H.R.O.** AT 1986 PRICE	NET BENEFITS AT 1986 PRICE	CONVERTED ECONOMIC VALUE				NET BENEFITS	
					TOTAL ECONOMIC BENEFITS	TOTAL CAPITAL INVESTMENT	OPERATING COSTS & H.R.O.*	NET BENEFITS	DISCOUNTED AT 10%	DISCOUNTED AT 11%
1987	0	2,983	0	-2,983	0	2,442	0	-2,442	-2,220	-2,200
1988	0	12,596	0	-12,596	0	11,134	0	-11,134	-9,202	-9,037
1989	2,248	15,600	474	-13,826	2,248	13,764	380	-11,895	-8,937	-8,698
1990	2,890	216	690	1,985	2,890	171	552	2,168	1,481	1,428
1991	3,533	24,154	1,342	-21,963	3,533	20,579	1,074	-18,120	-11,251	-10,754
1992	4,496		1,421	3,075	4,496		1,137	3,360	1,896	1,796
1993	5,460		1,489	3,971	5,460		1,191	4,269	2,191	2,056
1994	6,102		1,559	4,543	6,102		1,247	4,855	2,265	2,107
1995	6,744		1,740	5,004	6,744		1,392	5,352	2,270	2,092
1996	7,386		1,887	5,500	7,386		1,509	5,877	2,266	2,070
1997	8,029		1,983	6,046	8,029		1,586	6,443	2,258	2,044
1998	8,671		2,202	6,469	8,671		1,762	6,909	2,202	1,975
1999	9,635		2,379	7,256	9,635		1,903	7,732	2,240	1,991
2000	10,277		2,603	7,674	10,277		2,083	8,194	2,158	1,901
2001	10,277		2,603	7,674	10,277		2,083	8,194	1,962	1,713
2002	10,277		2,603	7,674	10,277		2,083	8,194	1,783	1,543
2003	10,277		2,603	7,674	10,277		2,083	8,194	1,621	1,390
2004	10,277		2,603	7,674	10,277		2,083	8,194	1,474	1,252
2005	10,277		2,603	7,674	10,277		2,083	8,194	1,340	1,128
2006	10,277		2,603	7,674	10,277		2,083	8,194	1,218	1,016
Salvage		-25,070		25,070		-21,683		21,683	3,223	2,689
TOTAL				71,265				82,414	2,235	-497

Note : * AIC used as benefits. (8.799 Baht)

** Share Allocation of Head and Regional Office Overhead Expenses.

EIRR = 10+(11-10)x2,235/(2,235+497)

= 10.818%

Table-10.18 ECONOMIC INTERNAL RATE OF RETURN (EIRR)

(SUPHANBURI WATERWORKS) x 1,000 BAHT

YEAR	TOTAL ECONOMIC BENEFITS * AT 1986 PRICE	TOTAL CAPITAL INVESTMENT AT 1986 PRICE	OPERATING COSTS & H.R.O.** AT 1986 PRICE	NET BENEFITS AT 1986 PRICE	CONVERTED ECONOMIC VALUE				NET BENEFITS	
					TOTAL ECONOMIC BENEFITS	TOTAL CAPITAL INVESTMENT	OPERATING COSTS & H.R.O.*	NET BENEFITS	DISCOUNTED AT 10%	DISCOUNTED AT 11%
1987	0	2,983	0	-2,983	0	2,442	0	-2,442	-2,220	-2,200
1988	0	12,596	0	-12,596	0	11,134	0	-11,134	-9,202	-9,037
1989	2,124	15,600	350	-13,826	2,124	13,764	280	-11,920	-8,956	-8,716
1990	2,730	216	521	1,993	2,730	171	417	2,142	1,463	1,411
1991	3,337	24,154	1,153	-21,970	3,337	20,579	922	-18,165	-11,279	-10,780
1992	4,247		1,133	3,115	4,247		906	3,341	1,886	1,786
1993	5,157		1,190	3,967	5,157		952	4,205	2,158	2,026
1994	5,764		1,229	4,535	5,764		983	4,781	2,230	2,075
1995	6,371		1,371	5,000	6,371		1,097	5,274	2,237	2,062
1996	6,978		1,480	5,498	6,978		1,184	5,794	2,234	2,041
1997	7,584		1,555	6,029	7,584		1,244	6,340	2,222	2,012
1998	8,191		1,725	6,466	8,191		1,380	6,811	2,170	1,947
1999	9,101		1,855	7,246	9,101		1,484	7,617	2,206	1,962
2000	9,708		2,039	7,669	9,708		1,631	8,077	2,127	1,874
2001	9,708		2,039	7,669	9,708		1,631	8,077	1,934	1,688
2002	9,708		2,039	7,669	9,708		1,631	8,077	1,758	1,521
2003	9,708		2,039	7,669	9,708		1,631	8,077	1,598	1,370
2004	9,708		2,039	7,669	9,708		1,631	8,077	1,453	1,234
2005	9,708		2,039	7,669	9,708		1,631	8,077	1,321	1,112
2006	9,708		2,039	7,669	9,708		1,631	8,077	1,201	1,002
Salvage		-25,070		25,070		-21,683		21,683	3,223	2,689
TOTAL				71,228				80,866	1,764	-922

Note : * AIC used as benefits. (8.312 Baht)

** Share Allocation of Head and Regional Office Overhead Expenses calculated by a new tentative formula based on waterworks net surplus.

EIRR = 10+(11-10)x1,764/(1,764+922)

= 10.657%

APPENDIX 11

UNACCOUNTED-FOR WATER STUDY

APPENDIX 11

APPENDIX 11 UNACCOUNTED-FOR WATER STUDY

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APPENDIX 11 UNACCOUNTED-FOR WATER STUDY

11.1 Introduction

Unaccounted-for water is defined as the difference between the volume of produced water (water production) and that of sold water (water sales). The water production is measured as the outflow of treatment plant, while the water sales is calculated as the sum of customer meters' reading.

Included in the water sales are discount rate consumption, bad debt, public use and others.

Discount rate is applied to the consumption by veterans, waterworks staff and hospitals. As the consumption is very small in size, the impact on the whole revenue is almost negligible.

Bad debt is the uncollected credit which should be written off. Although some consumers delay regular payment because of handy money's shortage or unwillingness by reason of their dissatisfaction with the service, payment is made eventually in most cases. Bad debt is also negligibly small.

Regarding the public use, most of the public institutions are paying the normal rate duly, excepting those applied with discount rates.

All of the water sales can be considered revenue-bearing or accounted-for water practically in Thailand.

This study aims for setting up the framework to reduce unaccounted-for water in the future. During the field leakage survey undertaken as a part of the study, some useful and important findings were made, as reported in the Attachment herewith. Some of the essential findings are quoted in the main report.

In the following sections, classification of the unaccounted-for water, existing conditions related to the issue, framework for reduction are discussed.

11.2 Classification of the unaccounted-for water

For the present study, "Unaccounted-for Water" is classified into four categories, as shown below;

1) Illegal Connection
2) Meter Reading Error
3) Metering Loss (Under-sensitivity of Consumer's Meter)
4) Leakage

1) Illegal Connection

Illegal connections are defined as intentional mismanagement of water meters and pipeworks conspired to steal the public supply water. They include breaking or bypassing water meters and making a connection unlawfully. The water consumed through such connection is stolen partly or wholly.

2) Meter Reading Error

Meter reading error occurs in such cases as 1) the meter reader fails to read the meter because of very difficult accessibility, and 2) the meter reader mistakes reading. The part of water guessed for consumption and under-estimated by mistaken reading becomes unaccounted-for water.

3) Metering Loss

Undersensitive or malfunctioning water meters under-register the actual flow. The under-registered part of water becomes the unaccounted-for.

4) Leakage

Water loss caused by leakage from cracks, holes and loose joints of pipes and fittings before flowing into consumers' meter belongs this classification. However, the water loss from the plumbing on the down-stream side of water meter is not classified herein.

11.3 Approach of the Study

The four categories of unaccounted-for water itemized in the previous section are sorted out into two groups by the way of approach, namely;

Group 1 : Reducible by Institutional Management
- Illegal Connection
- Meter Reading Error

Group 2 : Reducible by Technical Management
- Metering Loss
- Leakage

The following steps will be taken in narrowing down the leakage:

- estimation of the total unaccounted-for water, firstly
- estimation of the metering loss, secondly
- estimation of the illegal connections' loss and meter reading error, thirdly
- deducting the sum of the second and third from the first

The balance calculated by the deduction is designated as the leakage.

11.4 Existing Condition

In this section, to understand the existing conditions concerning unaccounted-for water, information of the itemized categories provided by the PWA Headquarters, Regional Office and Waterworks will be examined.

11.4.1 Total Unaccounted-for Water

The data of water production, water sales and unaccounted-for ratio from 1975 to 1984 are shown in Table-11.1 and plotted in Fig-11.1.

Similar monthly data from June 1985 to June 1986 are shown in Table-11.2 and plotted in Fig-11.2.

The yearly data ending in 1984 and the monthly data, starting in the middle of 1985 and covering 13 months, show continuity. Comparing the 1984 data and 1985-1986 data, June 1985 to May 1986, the production increased by 5.4 % and the sales 2.8 %. The 44 % unaccounted-for ratio in 1984 continued to fluctuate between 40 % to 50 % in 1985-1986.

The unaccounted-for ratio which had stayed at more or less than 20 % from 1975 to 1982 started to increase sharply after 1982. While the sales increased slightly, the production increase was steep, as seen in Fig-11.1.

Concerning the worsened situation of unaccounted-for ratio, since 1982 to the present days, no convincing reason has been found.

To estimate the existing unaccouted-for ratio, the last three months' data of Table-11.2, from April to June 1986, were averaged. It was calculated as 48 %.

Table-11.1 PAST UNACCOUNTED-FOR WATER RATIO

YEAR	TOTAL WATER PRODUCTION (cu m/year)	TOTAL WATER SALES (cu m/year)	UNACCOUNTED-FOR WATER RATIO (%)
1975	691,550	579,606	16.2
1976	684,359	657,993	3.9
1977	805,565	724,645	10.0
1978	920,964	729,470	20.8
1979	1,189,187	942,270	20.8
1980	1,372,200	1,080,100	21.3
1981	1,487,800	1,138,046	23.5
1982	1,391,915	1,187,212	14.7
1983	1,622,970	1,211,156	25.4
1984	2,168,555	1,211,786	44.1

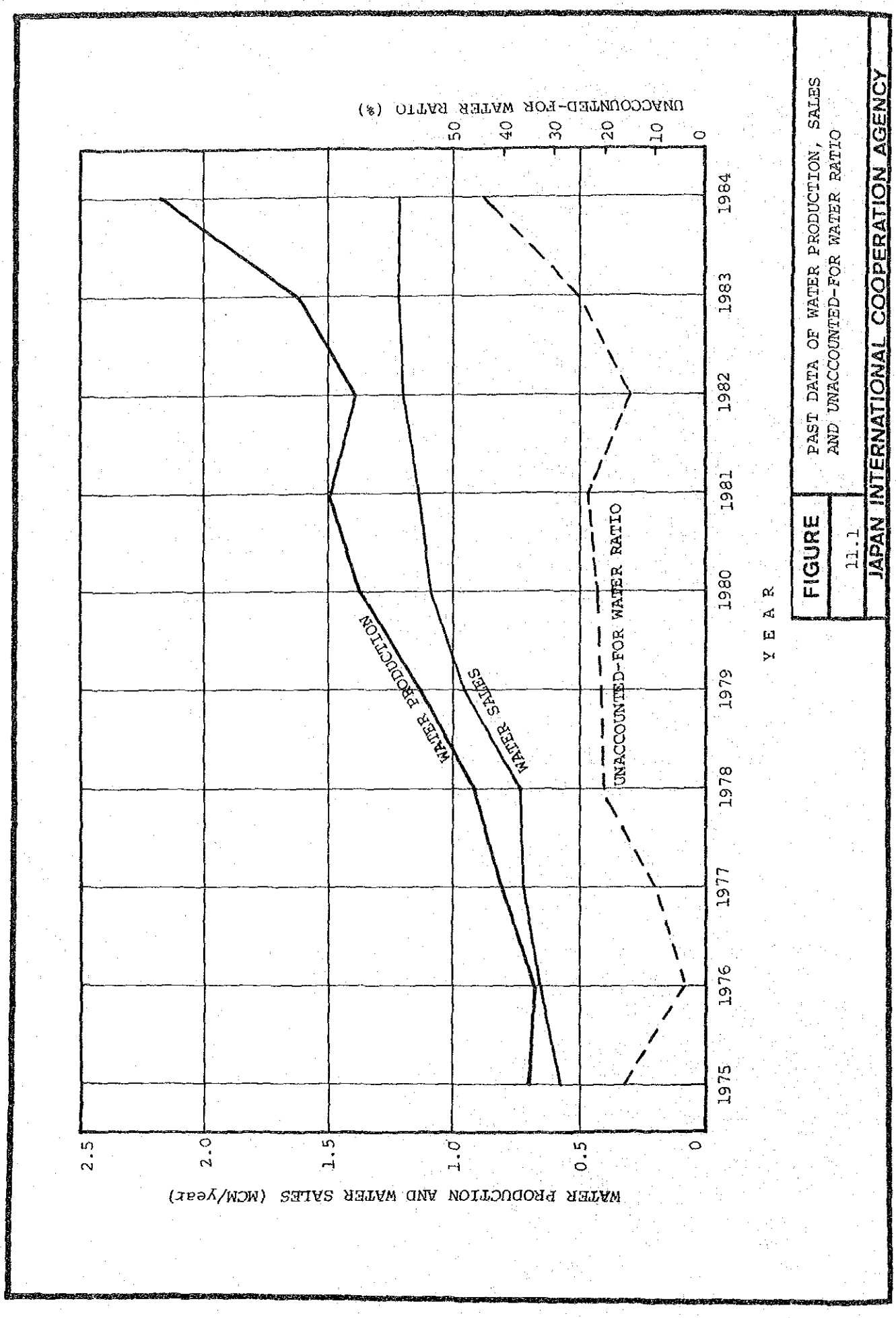

FIGURE 11.1

PAST DATA OF WATER PRODUCTION, SALES AND UNACCOUNTED-FOR WATER RATIO

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Table-11.2 RECENT DATA OF WATER PRODUCTION AND WATER SALES IN SUPHANBURI

	(A) WATER PRODUCTION (cu m/month)	(B) WATER SALES (cu m/month)	(C) UNACCOUNTED -FOR WATER (cu m/month)	D=(C/A)x100 UNACCOUNTED -FOR WATER RATIO (%)
JUN. 1985	191,950	108,898	83,052	43.3
JUL.	177,170	96,322	80,848	45.6
AUG.	179,560	107,544	72,016	40.1
SEP.	183,520	103,777	79,743	43.5
OCT.	191,255	97,208	94,047	49.2
NOV.	178,417	105,970	72,447	40.6
DEC.	189,930	101,248	88,682	46.7
JAN. 1986	191,380	92,974	98,406	51.4
FEB.	180,900	100,187	80,713	44.6
MAR.	196,945	96,159	100,786	51.2
APR.	203,237	116,877	86,360	42.5
MAY	222,057	118,647	103,410	46.6
JUN.	226,505	101,637	124,868	55.1
TOTAL	2,512,826	1,347,448	1,165,378	AVE, 46.4

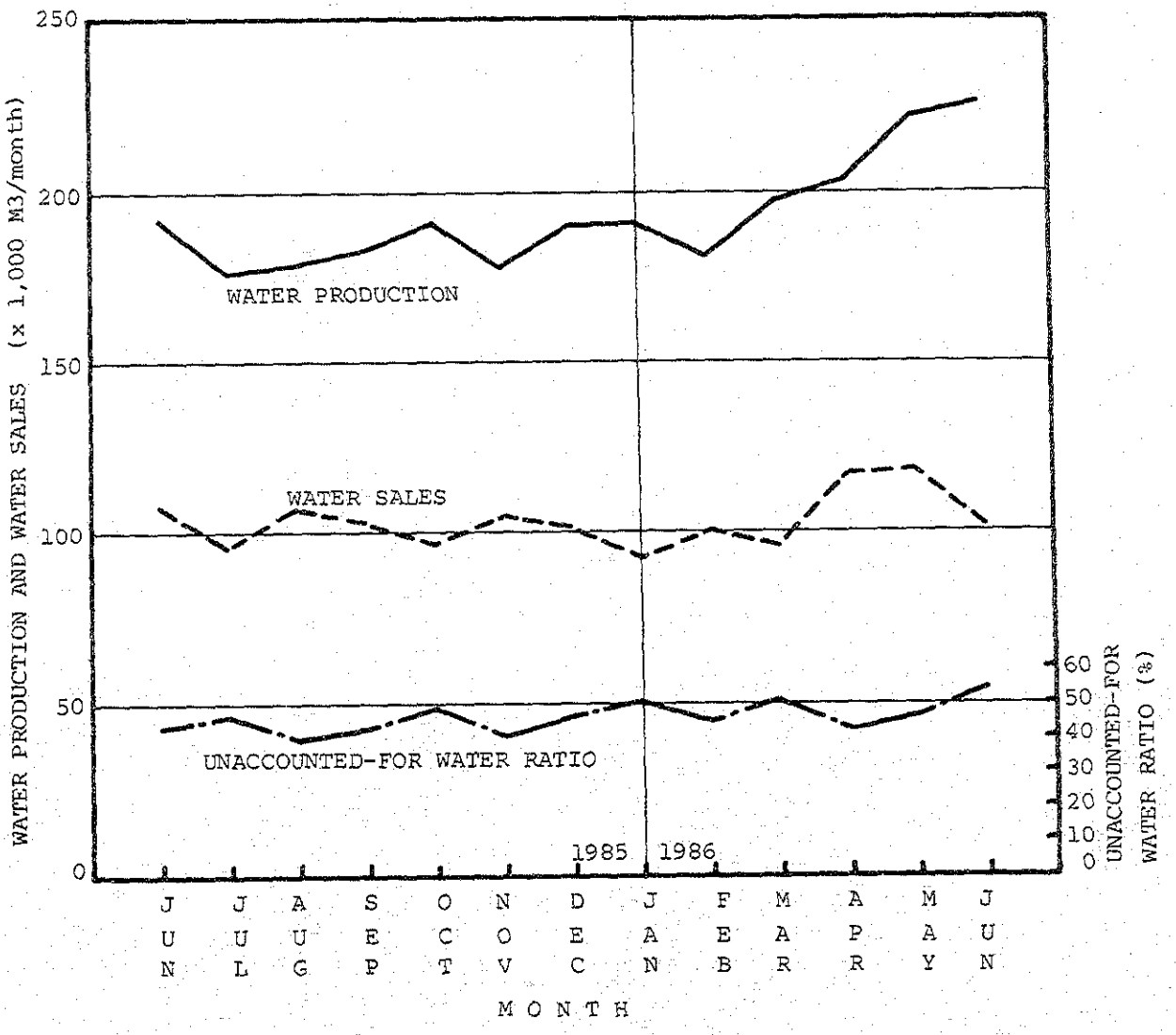


FIGURE	RECENT DATA OF WATER PRODUCTION, SALES, AND UNACCOUNTED-FOR WATER RATIO
11.2	

JAPAN INTERNATIONAL COOPERATION AGENCY

11.4.2 Illegal Connection

Illegal connections are usually uncovered by information from neighboring consumers.

When an illegal connection is uncovered, the consumer must pay, in addition to the penalty fixed under the PWA regulation, the tariff for the stolen water on the estimation by PWA. The penalty for a 1/2 in. illegal connection is ฿5,000.

The informer is awarded with 20 % of the penalty and 50 % of the water tariff paid to PWA by the illegal consumer.

As the Suphanburi Waterworks reported to the Study Team, no illegal connection had been uncovered. The illegal connections found in 1985 were 4 in Pattaya, 12 in Chiangmai and 13 in Ubon/Warin. Very likely illegal connections will be existing in Suphanburi, but they have not been uncovered.

Regarding the water loss due to illegal connections however, the ratio will be very low. For the above mentioned three cities, the loss was estimated 1 % at most.

In the case of Suphanburi also, 1 % is assumed for safety.

11.4.3 Meter Reading Error

During the field leakage survey, it was found that some water meters were installed at inaccessible spots. In Suphanburi, some inhabitants are using private wells, and the neighboring users have own water meters. It was found that the consumers' meters of the waterworks and the meters of private well users were installed very confusedly in some places, though the meter reader identified them correctly.

As no maps of showing the exact location of water meters has been prepared, spotting them shall depend fully on the meter readers' memory or the consumers' guidance.

Presently practiced is that a meter reader, once allocated to an area, is not transferred to other areas. Periodical change of the allocated area together with improvement of preparation of the maps will help decrease the error of meter reading.

So far no check system of preventing or decreasing the meter reading error has been tried and the unaccounted-for volume of water or ratio due to the error has not been made known.

The loss due to meter reading error is not counted herein.

11.4.4 Metering Loss

According to the manufacturers' information, - 5 % error is tolerated for the least flow rate at about 30 l/h in a 1/2 inch meter. The error becomes larger when the flow rate falls lower.

When water is discharged from a tap opened ordinarily under normal pressure, the flow is larger than the said 30 l/h and under-registration is not brought about.

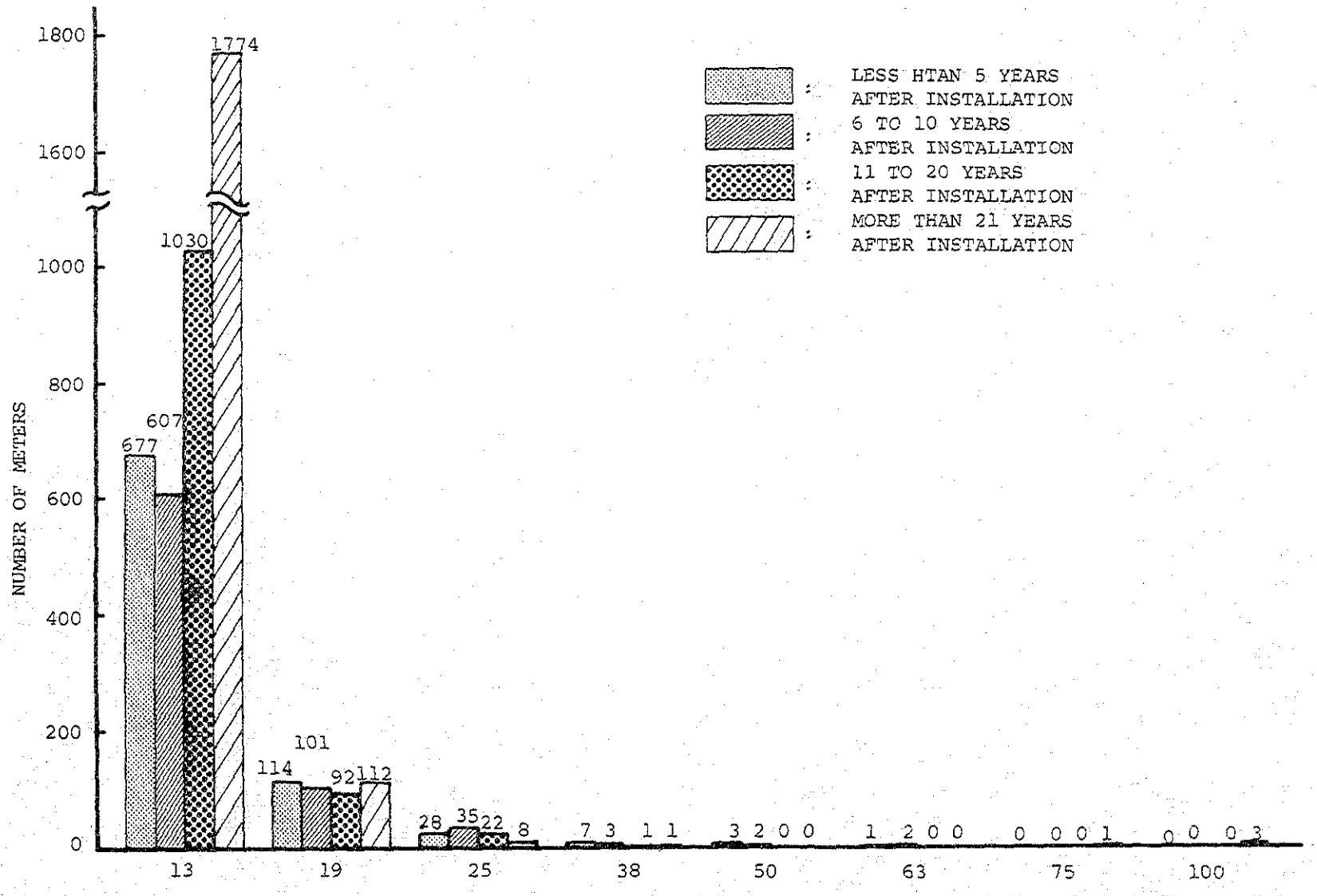
However in Suphanburi, the field survey disclosed that many consumers' taps, slightly opened, were dripping to fill vessels in kitchen and bathroom. The practice might have come from unsteady and unreliable supply condition in the past. The flow rate, apparently less than 30 l/h, results in under-registering the actual consumption, another cause of the unaccounted-for water.

From the result of meter accuracy test which was carried out for 10 consumers' meters in Pattaya (See Appendix 11 of Pattaya Report), it was learned that the difference between the master meter and the sum of tested consumers' meters was 4 %. The average age of tested meters was 5 years after installation.

Fig-11.3 shows the result, classified by the size and age, of water meters surveyed in Suphanburi.

65 % of all the meters is used in the service for more than 11 years and nearly 60 % of it for more than 20 years, without being replaced and checked of accuracy of measurement. The meter condition in Suphanburi seems to be fairly bad, compared with Pattaya, Ubon/Warin and Chiangmai Waterworks. It surely affects the under-registration of meters.

Upon the consideration of the above, the unaccounted for ratio in Suphanburi was assumed as 5 %.



NOTE: The above numbers were collected by the Suphanburi Waterworks.

FIGURE	CONSUMER METER CLASSIFICATION BY METER SIZE AND YEARS AFTER INSTALLATION
11.3	

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11.4.5 Leakage

In the foregoing subsections estimated were: 48 % for the total unaccounted-for ratio, 1 % for illegal connections, nil for meter reading error and 5 % for meter loss (under-registration).

The leakage ratio, deducting the sum of 1 % and 5 % from 48 %, is calculated as 42 % therefore.

Detection of leakage in Suphanburi is mostly made accidentally by the consumers, passers-by and waterworks staff. Receiving information from them, the waterworks send personnel to repair the leaking spots.

Fig-11.4 shows the number of repair works made in 1985, the number seems low for the estimated leakage ratio, 42 %. Presumably undetected and/or uninformed leakage is taking place, because the detection of leakage has been done in passive way as described above.

The leakage ratio resulted from the field leakage survey (See Attachment) of a big block of 230 connections and a small block of 85 connections, was 41.5 % for the big and 16.6 % for the small. The Big Block Survey covered 5.2 % of the whole distribution pipes in the system.

41.5 % of the big block was very close to 42 %, the estimated leakage ratio. These figures will be indicative of the existing conditions, if not representative of them.

11.4.6 Conclusions

In Suphanburi, the leakage loss is the largest of the several factors affecting unaccounted-for ratio, and there is much hope to reduce the ratio.

But the efforts to lower not only leakage but also each factor of the unaccounted-for ratio are worth making, as described in the following sections.

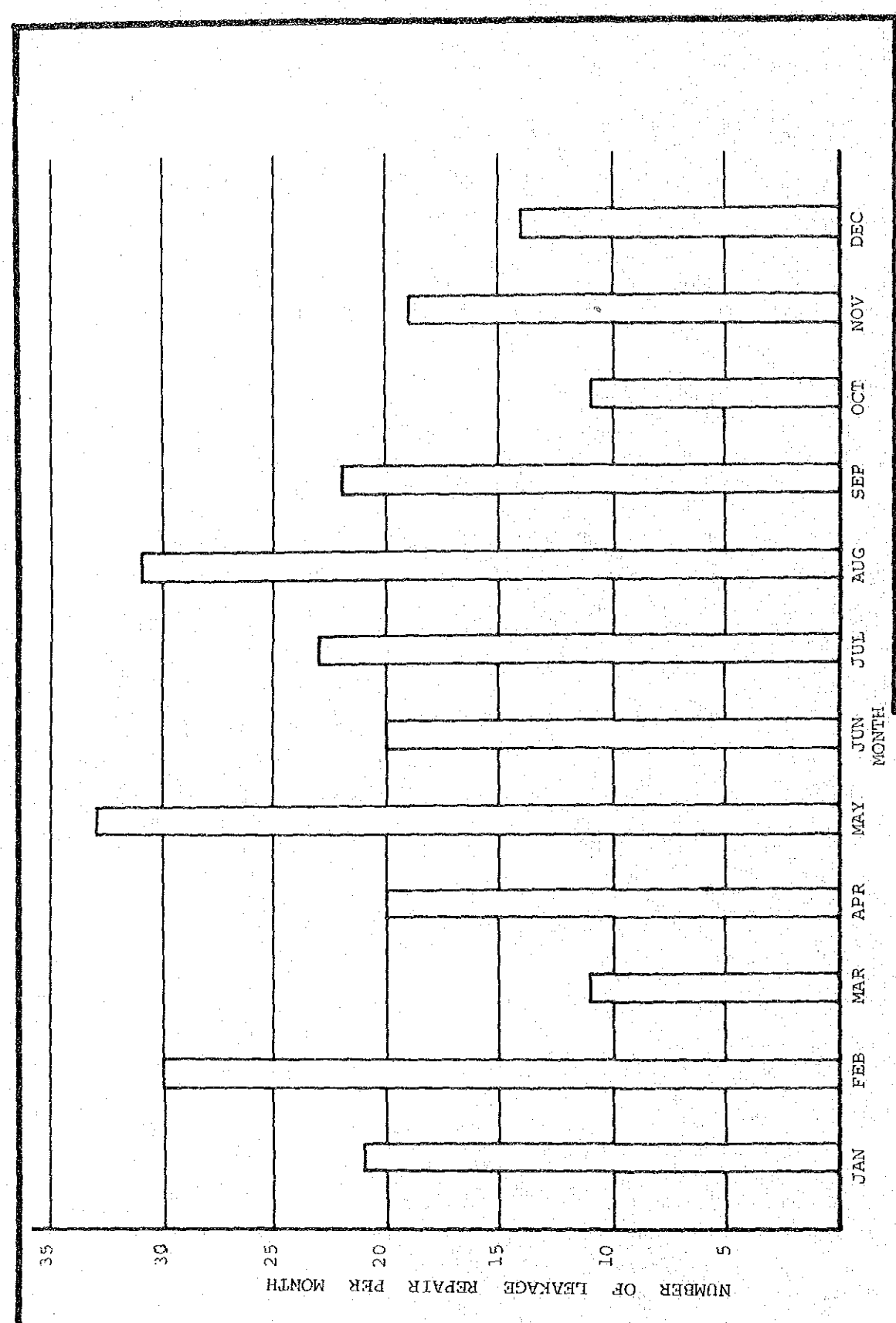

FIGURE 11.4 NUMBER OF LEAKAGE REPAIRE PER MONTH IN 1985

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11.5 Reduction of Unaccounted-for water

11.5.1 Illegal Connections

The present situation of illegal connection, estimated at 1 % of the total unaccounted-for water, is very satisfactory. The PWA regulation which imposes penalty upon the unlawful consumers and awarding the informers seems to be effective.

In fact however, no assurance is given whether all illegal connections have been uncovered and such connections will not be made any more in future.

Desirable approaches will be promoting public relations to stimulate the public-mindedness of people against such illegality and encourage meter readers and bill collectors to find illegal connections.

11.5.2 Meter Reading Error

Estimating the error made in reading water meters is most difficult and it was counted out of the unaccounted-for water estimation.

However, some ways of preventing and decreasing can be discussed herein.

It is necessary to make a guideline or manual for installing meters in rightful ways. Basic considerations will be that the meters are safe from accidental damage, inundation and suchlike and easy for connection, disconnection and reading. The existing meters installed wrongly shall be relocated.

Also necessitated is that the ledgers and maps of recording every house connection in the distribution system shall be prepared and filed, so that they are made available to any waterworks official.

As suggested previously in 11.4.3, rotating the allocated areas of meter readers are worth trying.

11.5.3 Metering Loss

Metering loss, or the loss due to under-registration of meters, in Suphanburi was assumed as 5 % in the ratio.

The figure was established partly on the manufacturers' information and the observation of the manner of water consumption, backed up by the result of field leakage test.

The following measures are recommended for reducing the loss:

1) Maintaining Accuracy

Overhaul at regular intervals, say 6 years, changing parts and checking accuracy, is to be practiced and records of the overhaul be kept in file.

2) Checking Meter Size

Over- or under-sized meters register inaccurate consumption. A meter size shall be checked periodically of its suitableness for consumption especially for large consumers.

11.5.4 Leakage

To prevent future occurrence of leakage, much consideration is to be given in selecting pipe material and class, pipeline route and alignment, burying and joining methods of new pipelines. When rehabilitation and repair works are made on existing pipelines, unreliable parts of pipeline shall be thoroughly replaced, abandoned parts be cut off from living parts completely.

Of distribution pipelines, maps recording exact alignment, depth, location of valves, fittings, service connections shall be prepared and filed. In case any change is made on existing conditions, like by road improvement and urban renewal, the maps shall be updated immediately.

Of every service connection, a ledger and map shall be made and filed. In them, length, size, material of service pipes, location of service connection, stop valve, meter shall be recorded. They are subject to updating when necessary, too.

Availability of those maps and ledgers is indispensable for successful execution of leakage control.

Fig-11.6 shows a case of leakage control program drawn schematically.

PREPARATORY WORKS

Preparatory works are the works to be done in preparation of execution of the leakage control program.

Training of staff in detection and repair of leakage control is to be given at all the levels of PWA, Head Office, Regional Office and waterworks.

In Regional Office and waterworks organization, a team assigned to leakage control is formed by the trained staff.

The team selects areas for the leakage survey plan, upon consideration of various factors like the past occurrence of leakage, consumption in the area, etc.

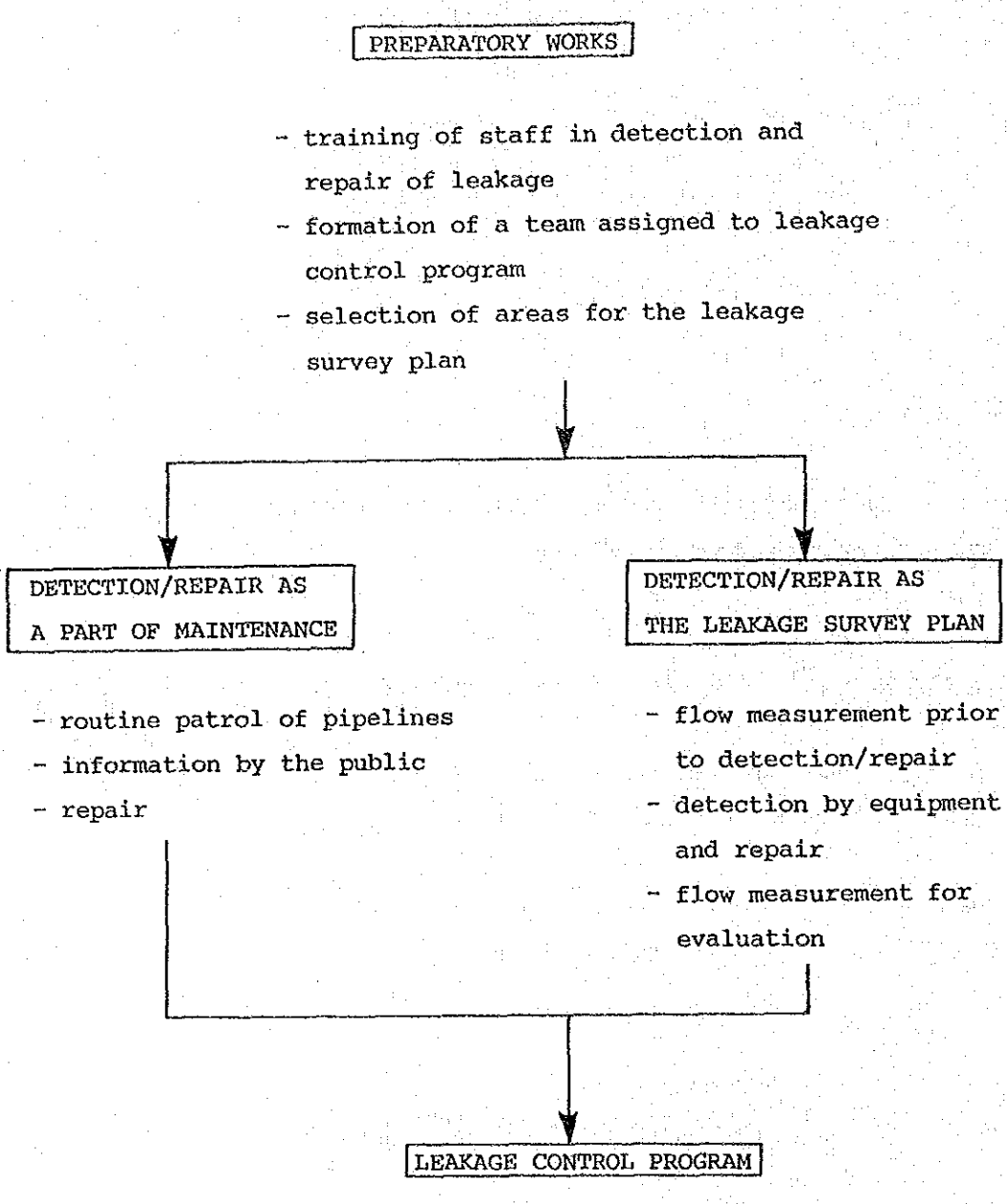

FIGURE 11.5	LEAKAGE CONTROL PROGRAM

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DETECTION/REPAIR AS A PART OF MAINTENANCE

Patrol of pipelines to detect leakage, under a plan, is practiced as a routine work of the maintenance.

Information given by the public of leakage is responded with gratitude.

Leakage detected by the patrol and reported by the public is repaired by the maintenance staff, as a routine work also.

DETECTION/REPAIR AS THE LEAKAGE SURVEY PLAN

The inflow to the selected area is measured before and after the detection and repair works. The pre-measurement is to gain informations of existing pressure/flow conditions affected by the consumption and leakage. The post-measurement is to evaluate the detection/repair works' effectiveness.

The leakage survey plan carried out for the Suphanburi waterworks is reported in the attached paper.

LEAKAGE CONTROL PROGRAM

Informations of the distribution pipework and service connections gained in the leakage survey plan's implementation shall be used for updating the existing maps and ledgers.

The result of the leakage survey plan is to be used for controlling the pressure in the surveyed area, as overpressurization is found to affect adversely on leakage sometimes.

Overall evaluation of leakage reduction works shall be made under the coordination of engineers, administrative and financial managers. The effectiveness of implementation of the leakage control program shall be studied from the angles like cost performance, working conditions of personnel, organization re-structuring as well as technical improvement.

The leakage control program shall be executed at regular intervals. Because the leakage ratio of Suphanburi estimated at 42 % presently shall be lowered to realize the planned 15 % unaccounted for ratio in 2010, 20 %.

ATTACHMENT

FIELD LEAKAGE SURVEY

ATTACHMENT

FIELD LEAKAGE SURVEY

TABLE OF CONTENTS

1. Introduction

The field leakage survey in Suphanburi was carried out from July 23 to August 1 in 1986, and covered 5.2 % of the distribution pipes of whole length of the network as shown in Fig-11.6. The field leakage survey aimed the following goals.

1) to identify the preparatory works necessitated for effective execution of a leakage abatement program in future

2) to transfer practical know-hows of handling the instruments used for leakage survey and to introduce the methodology of leakage survey to the counterparts

3) to study major causes of leakage

4) to recommend a leakage abatement program prepared based on all findings of the leakage survey

2. Method of Leakage Survey

In this leakage survey, a certain area was isolated from the rest of distribution areas by closing appropriate valves, and then measurement of the inflow to the area was made for 24 hours continuously and sound detection of leakage within the area was carried out at midnight when the background noise was lowest. The advantage of 24 hours' measurement was that it could study about the minimum flow at midnight as well as the flow pattern in the area.

A flow meter of the portable ultra-sonic type, made by Tokyo Keiki in Japan, was installed on an inflow pipe to the area, a closed system without connection to other distribution areas.

Two ways of the midnight measurement were carried out. One was named the direct measurement and another the indirect measurement.

The direct measurement was measuring the inflow, after all consumers' taps were ensured to have been closed. The reading indicated the leakage loss

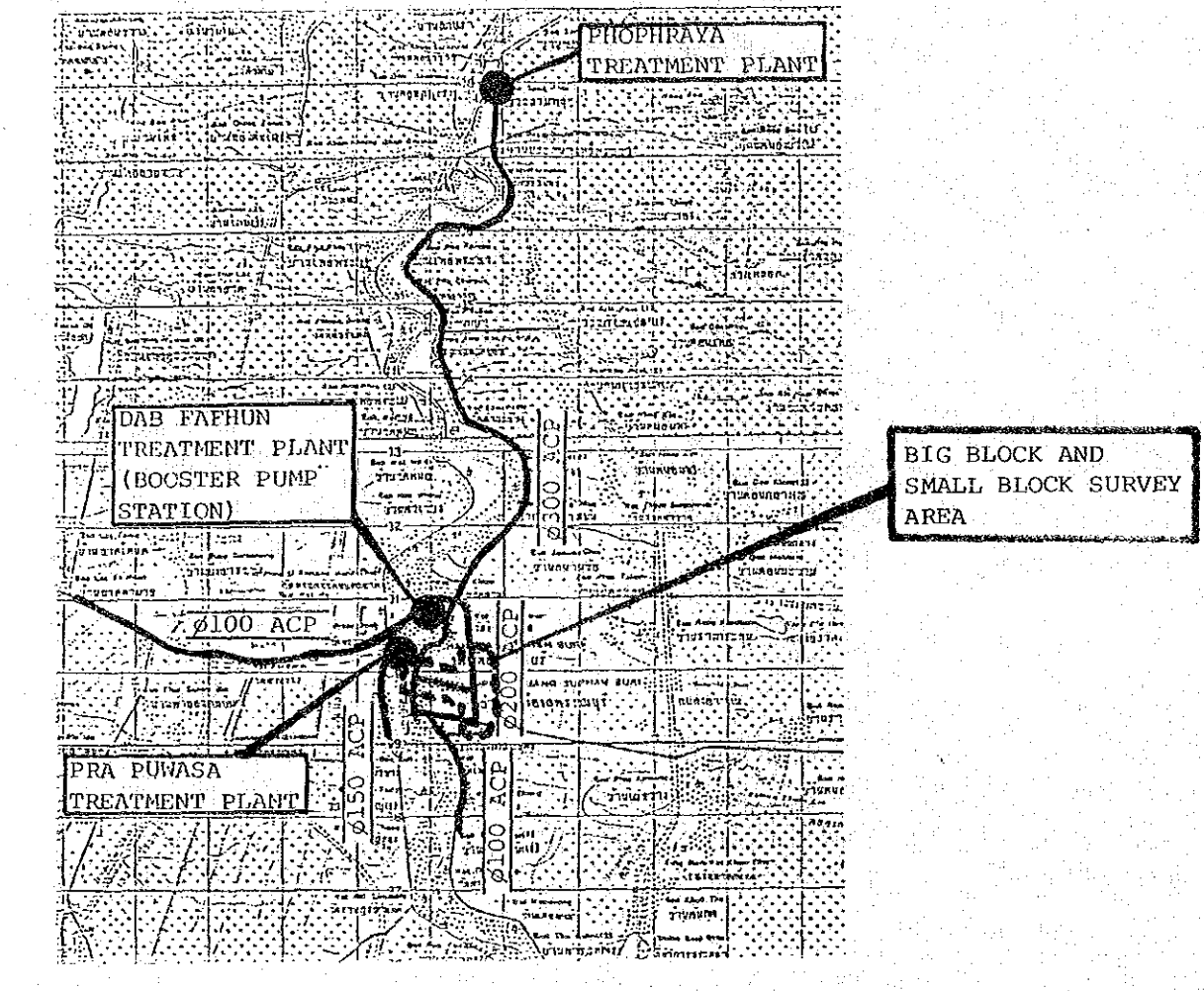

FIGURE	LOCATION OF LEAKAGE SURVEY AREA
11.6	
JAPAN INTERNATIONAL COOPERATION AGENCY	

presumably.

The indirect measurement was measuring the inflow without any assurance of the consumers' tap condition. The reading can be approximate to the leakage loss, as the consumption at midnight would be small negligibly.

To train the PWA counterparts on the methodology and technology described above, two areas, named "Big Block" and "Small Block" because of their size, were selected as the pilot area of survey. The direct measurement was made on the Small Block and the indirect measurement on the Big Block.

In selecting the survey area (block), the following matters were considered:

(1) the survey block is not a newly developed one
(2) leakage in the block seems to be highly probable, according to the waterworks' experience
(3) pipelines in the block are made of the so-called Class 15 Asbestos Cement Pipe manufactured years ago for low pressure service
(4) service pressure in the block is relatively high
(5) the block is entirely of residential use and does not contain any consumers like factories, hotels, hospitals and facilities which use water for 24 hours continuously
(6) the inflow pipe is conveniently conditioned for installation of the flow meter

Details of the steps taken in the leakage survey is shown in Figs-11.7 and 11.8 schematically.

To ask the consumers' cooperation for closing their taps during the midnight survey, from 1:00 to 4:00 a.m. on the appointed date, announcement was made by distributing handbills to every consumer in the area, prior to "Measurement Procedure" shown in Fig-11.8 for the survey of the Small Block.

PREPARATION PROCEDURE

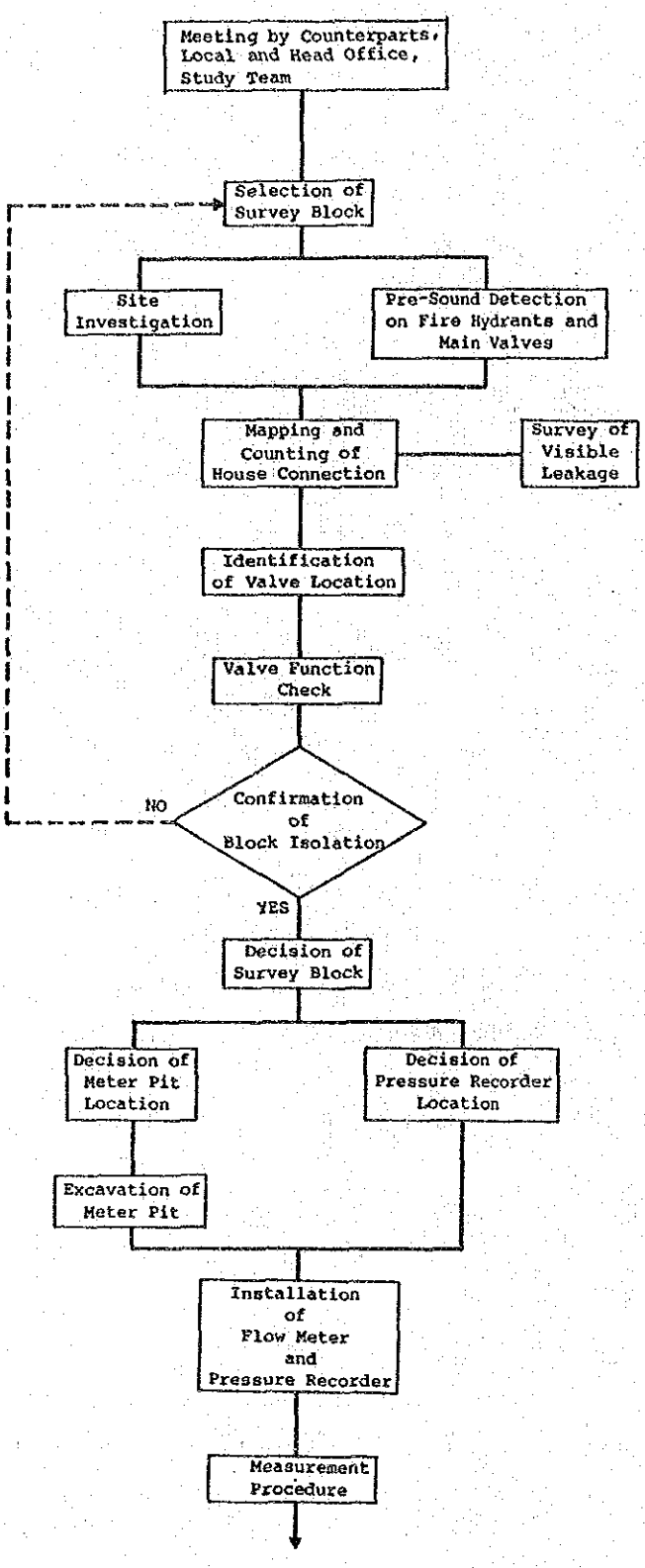

FIGURE	PREPARATION PROCEDURE FOR LEAKAGE SURVEY
11.7	

JAPAN INTERNATIONAL COOPERATION AGENCY

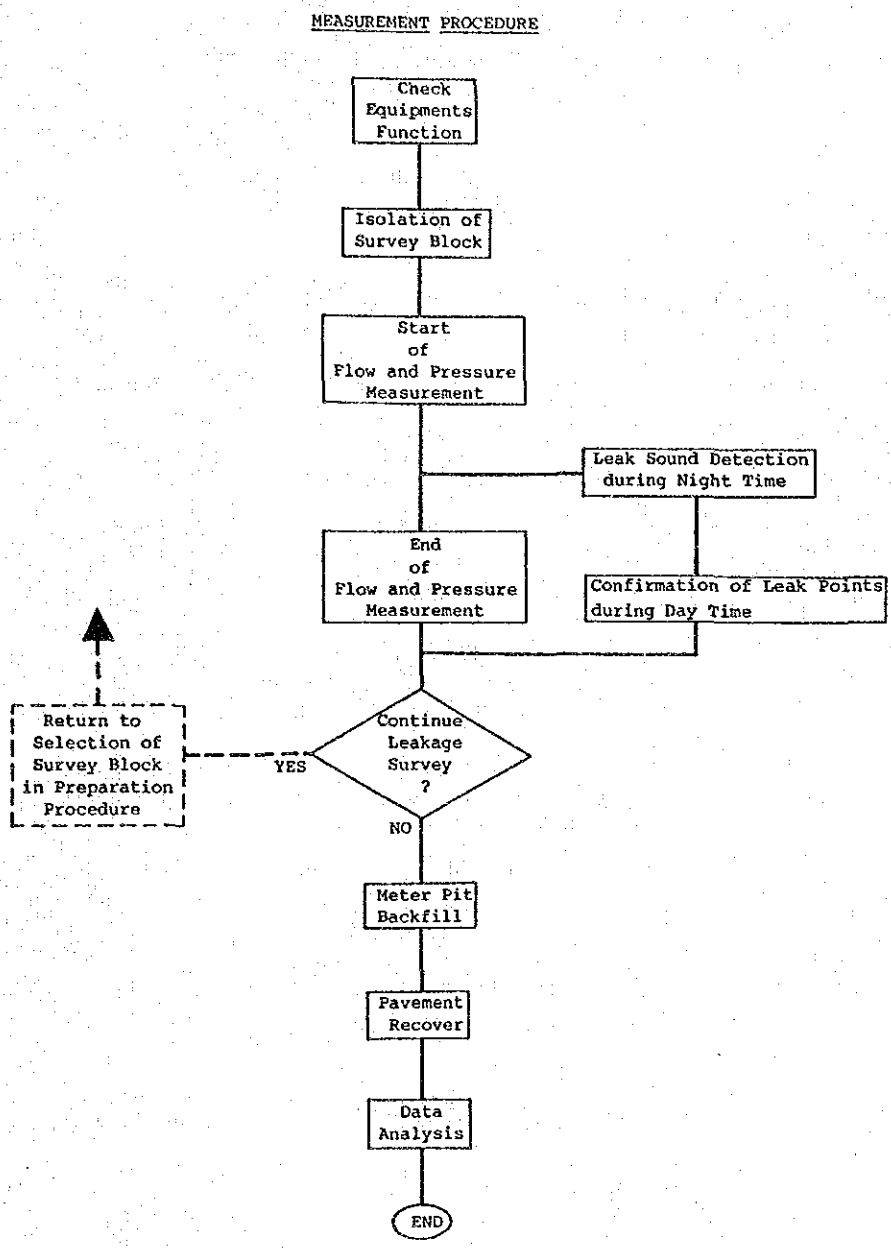

FIGURE 11.8 MEASUREMENT PROCEDURE FOR LEAKAGE SURVEY

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3. Activities of Leakage Survey Team

Nine counterparts from the PWA Head Quarters, Saraburi Regional Office and Suphanburi Waterworks worked willingly with the Study Team. The activities of the Study Team and the counterparts are summarized below.

3.1 Big Block Survey

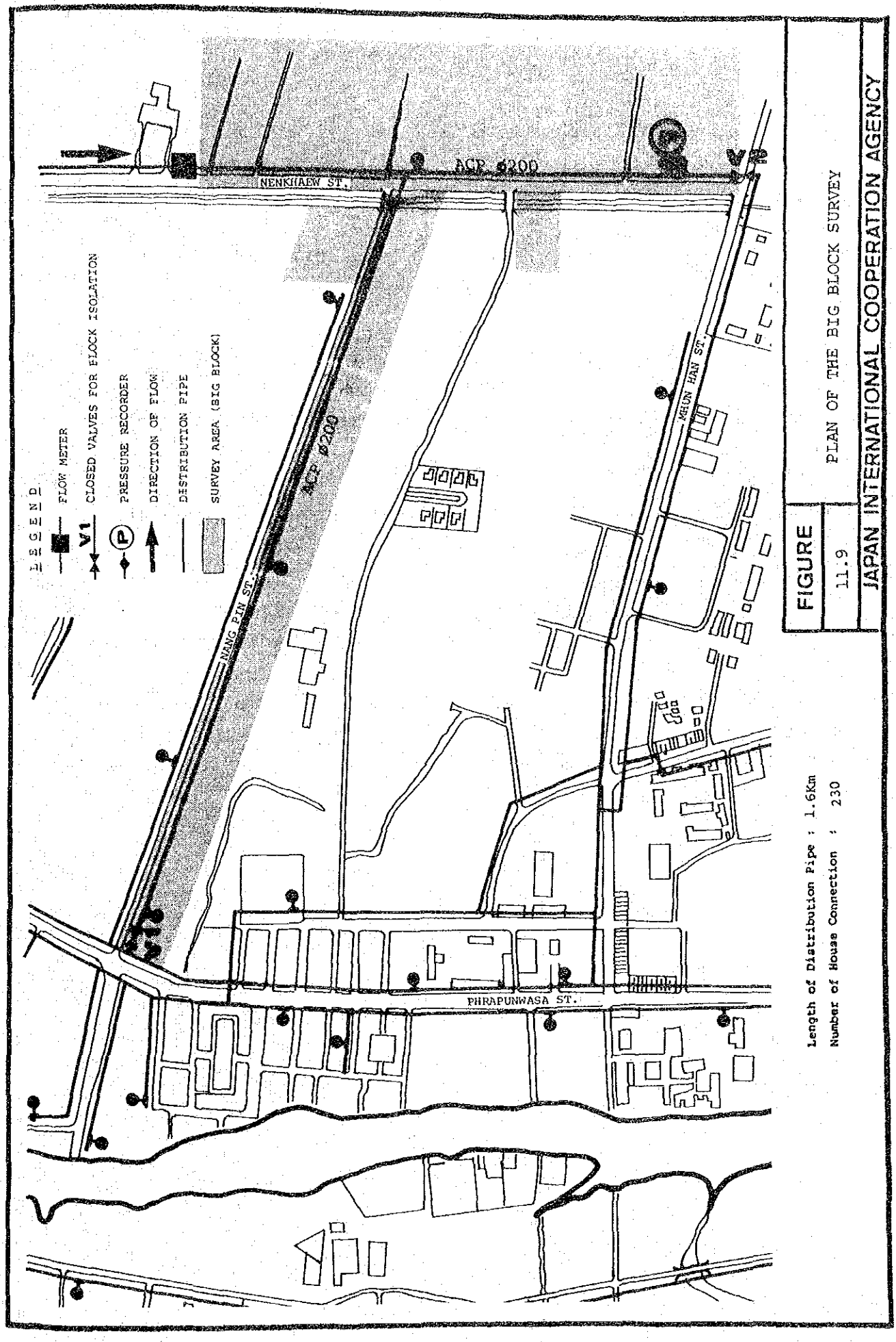
The area, of which the total length of distribution pipes is 1.6 km and the number of house connections 230, was selected as a Big Block. Material of the distribution pipes in the survey block was ACP Class 15. Most of the service pipes were of SP. It has been reported that plenty of leakage cases were found on ACP Class 15.

In selecting the survey area, consideration was given to the areas of frequent leakage occurrence. As there was only one outdated drawing (1:10,000) made available, advice by the experienced workers of the Suphanburi Waterworks were of great help in the selection. From the works, the Study Team could collect indispensable information of the location of pipes and valves and operability of valves, before finalizing the selection.

All the valves used on isolating the survey block were confirmed of their operability and the pipes in the block were plotted in the available drawing. The survey block was confirmed of isolation.

The flow meter was installed on a 200 mm dia. ACP pipe, buried at more than 1.5 m depth, leading to the survey block. Although the depth was unfavorable, no other choice was possible for convenience of installing the sensor. Excavation work was hard for the workers hired temporarily, because convenient tools were not prepared well. The flow meter and pressure recorder, fixed on a fire hydrant, are shown in Fig-11.9.

24 hours' measurement of the flow and pressure was carried out from July 28 to July 29, 1986. During the 24 hours' measurement, locating leaking spots was tried by detecting sound with stethoscopic bars and sound detectors. Several spots of leakage, invisible but detectable by sound, were located and confirmed of leakage on the next day, after digging the ground.


LEGEND
FLOW METER
CLOSED VALVES FOR BLOCK ISOLATION
PRESSURE RECORDER
DIRECTION OF FLOW
DISTRIBUTION PIPE
SURVEY AREA (BIG BLOCK)
NENKHAEW ST.
ACP ø200
NANG PIN ST.
MEUN HAN ST.
PHRAPUNWASA ST.
V1
V2
Length of Distribution Pipe : 1.6Km
Number of House Connection : 230
FIGURE 11.9
PLAN OF THE BIG BLOCK SURVEY
JAPAN INTERNATIONAL COOPERATION AGENCY

3.2 Small Block Survey

A section of the Big Block was selected as the Small Block. The total length of distribution pipes was 0.7 km and the number of house connections was 85 in the block. The location and plan are shown in Fig-11.10.

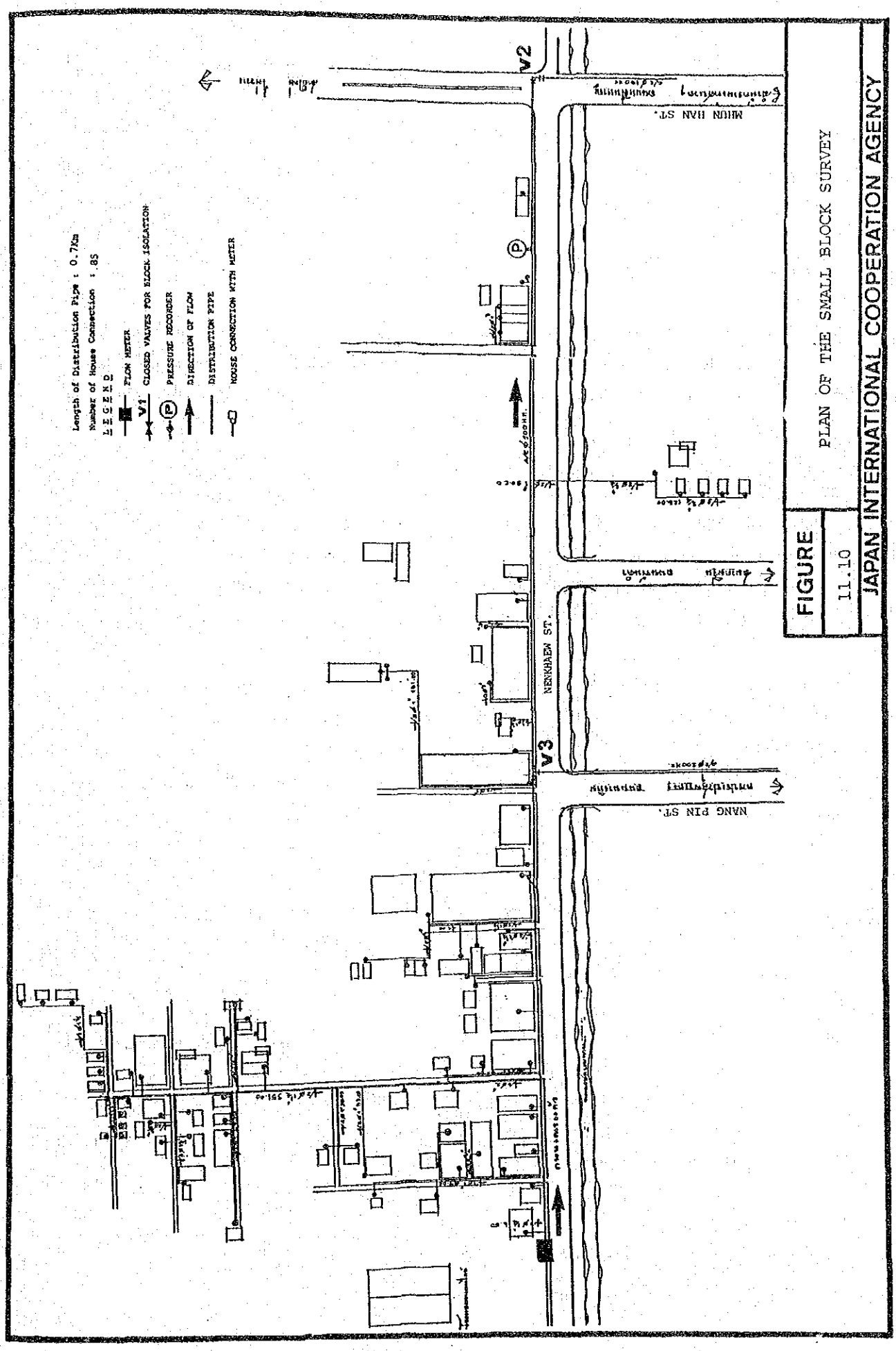
As the Small Block was an upstream section of the Big Block, the same point of flow measurement and pressure recording as in the case of the Big Block was used.

The distribution pipes surveyed were ACP Class 15, and SP was used for all the service connections. Many of the service pipes were found laid above ground.

24 hours' measurement of the flow and pressure was carried out on July 29 to July 30, 1986.

Concurrently with the measurement, sound detection of leakage on the distribution pipes was made, using stethoscopic bars and sound detectors.

To see whether the consumers' taps were closed as requested by PWA, every service pipe was sound-detected at midnight. Where the result was positive in a few cases, the service pipe was inspected the next day and the leakage was found on the service pipes in the private premises.


JAPAN INTERNATIONAL COOPERATION AGENCY
PLAN OF THE SMALL BLOCK SURVEY
FIGURE
11.10
MUEN BAN ST.
NANG PIN ST.
NEKNAEW ST.
V1
V2
V3
LEGEND
FLOW METER
CLOSED VALVES FOR BLOCK ISOLATION
PRESSURE RECORDER
DIRECTION OF FLOW
DISTRIBUTION PIPE
HOUSE CONNECTION WITH METER
Length of Distribution Pipe : 0.7Km
Number of House Connection : 85