

ATTACHMENT-1 STUDY OF HUAI KONG DAI INTAKE

AT1-1. Objectives

Appendix 7 discussed three alternatives taking water from Laem Chabang Receiving Well, to supplement raw water shortage of the present Pattaya water supply in meeting the increased demand.

Of the three alternatives, Alternative A differs from B and C, in that it transmits raw water from the Receiving Well to the Mab Prachan Reservoir.

The alternative studied herein resembles Alternative A in that, after taking raw water at the Huai Kong Dai Intake, a proposed new source, it transmits and stores water in the Mab Prachan Reservoir, as shown in Fig-7.6. The pipeline of the alternative studied herein and Alternative A are as shown in Fig-7.7.

Technical and economic feasibility of the proposed alternative will be studied to be compared with the three alternatives in Appendix 7.

In this study, cost of Huai Kong Dai system will be compared with that of Alternative A which also uses Mab Prachan Reservoir for storing water, and also with that of Alternative B which is the recommended plan in Appendix 7.

AT1-2. Physical Conditions of Huai Kong Dai Intake

The proposed Huai Kong Dai Intake will be located at the confluence of the Huai Ta Prayam River and Huai Takhian Tia River, to take in the both rivers' flow.

Constructing a dam in the flat area to store a sufficient volume of water will need a huge investment as it involves acquiring a large land area, compensating the people for relocation, moving voluminous earth and water-sealing the soil. A realistic solution will be constructing a small dam (barrage) to facilitate intake of the flow.

Corresponding to the pattern of rainfall, the river flow is high in the rainy season and low in the dry season.

The flow condition, together with the condition of lacking storage, will make the intake flow unsteady.

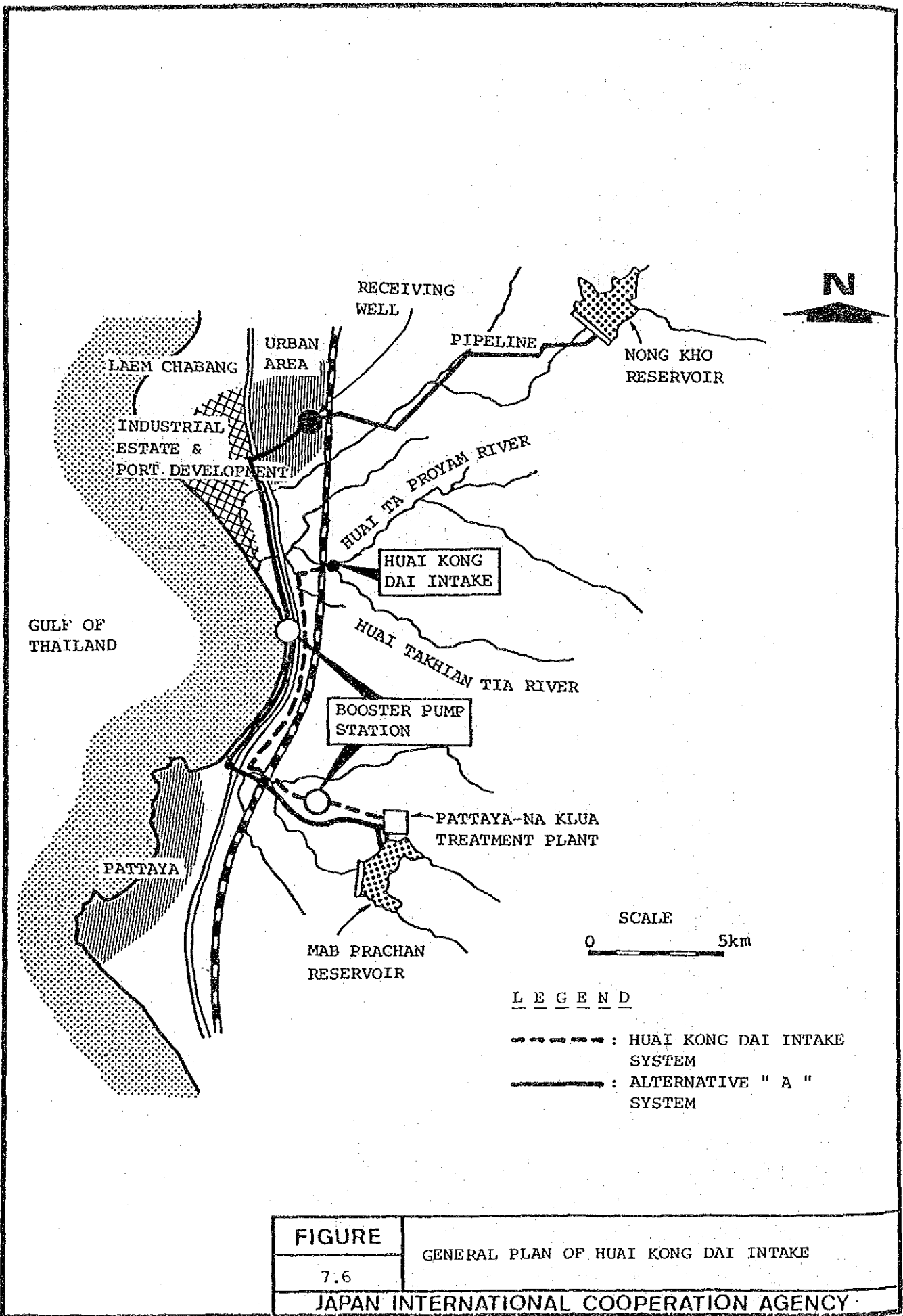
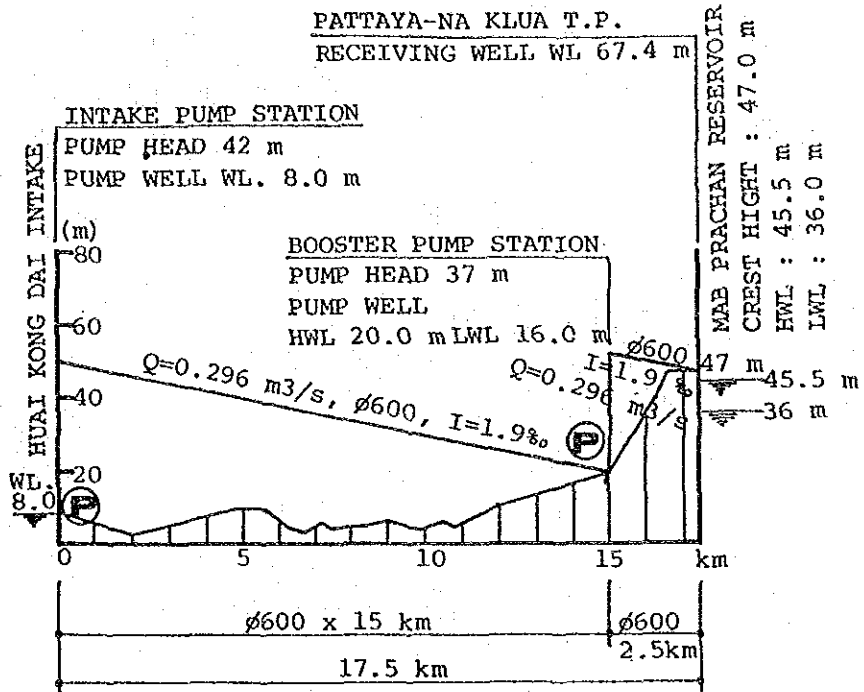
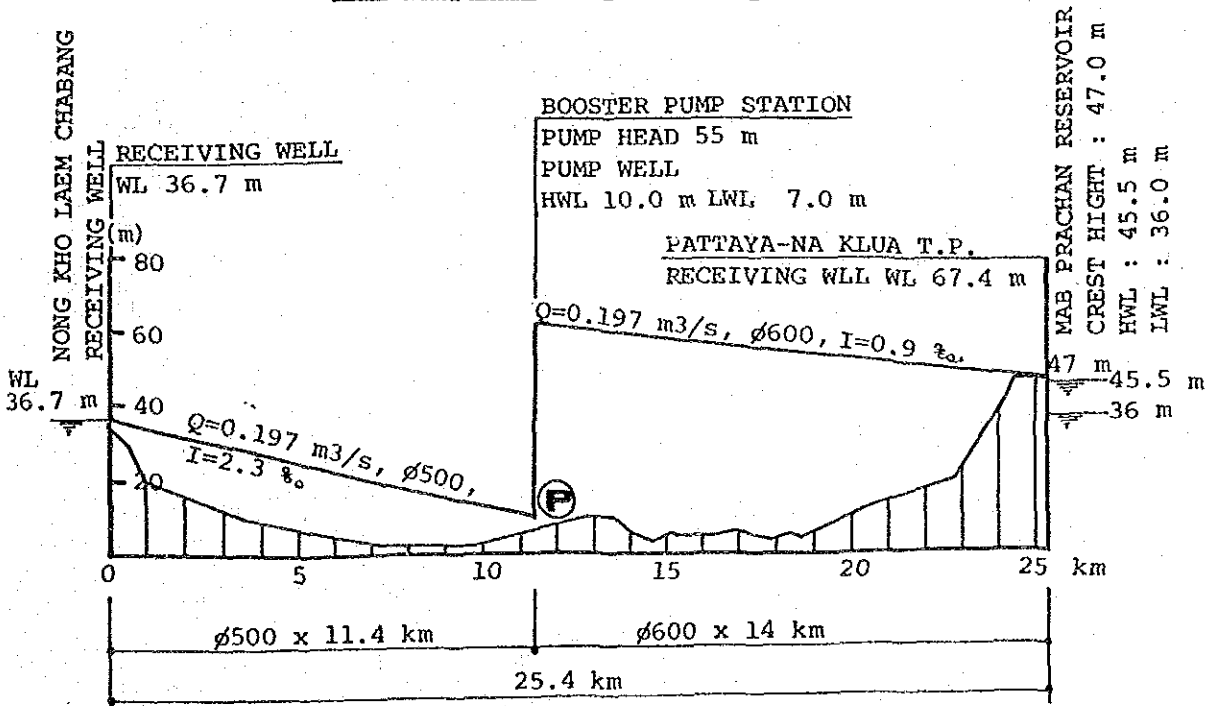


FIGURE	GENERAL PLAN OF HUAI KONG DAI INTAKE
7.6	
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HUAI KONG DAI INTAKE SYSTEM



ALTERNATIVE "A" SYSTEM



FIGURE

PROFILE OF PIPELINES

7.7

JAPAN INTERNATIONAL COOPERATION AGENCY

AT1-3. Demand of Raw Water Flow

As shown in Fig-7.4 previously, the raw water demand to be fed to the Mab Prachan Reservoir is 17,000 cu m/d or 6.2 MCM/year or 0.197 cu m/sec in 2000 on the average.

AT1-4. Runoff and Intake Flow of Huai Kong Dai

Runoff at Huai Kong Dai was estimated by applying the same data used in estimating the runoff of the Mab Prachan reservoir. Details of it are described in Appendix 3.

Of the data from covering the period 1968 to 1984, results of the estimation are shown in Table-7.2.

When the monthly runoff figures listed in Table-7.2 are compared with 0.197 cu m/sec, the average required intake rate to meet the 2000 demand, the runoff is less in some months and more in other months, than the required 0.197 cu m/sec.

Taking surplus water in the water-rich months to balance the water-poor months' deficit shall be the practical solution. However, from the economic angle, the intake of surplus will have to be made evenly in the water-rich months, to avoid oversizing the facility.

Calculation was made to determine the required intake in the water-rich month, using the data in Table-7.2. The simulation results are shown in Attachment-2.

The simulation results demonstrate that if 0.78 MCM/month (0.296 cu m/sec) is transmitted from Huai Kong Dai to Mab Prachan, the storage in Mab Prachan may satisfy not only the 2000 demand but also 2010 demand, the reason being that the simulation was made with the 18 year's climatical cycle (cf. Appendix 3) according to which a period after 2000 is characterized as a water rich part of the cycle where inflow into the Reservoir increases.

Table-7.2 MONTHLY RUN-OFF AT HUAI KONG DAI INTAKE (unit: cu m/s)

	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	*	MEAN	TOTAL (CMCM)
1968	0.74	1.45	1.79	0.56	0.86	3.33	7.38	1.84	0.37	0.59	Δ 0.15	0.46	*	1.61	50.77
1969	0.40	0.99	1.54	0.22	1.51	12.38	5.31	1.42	Δ 0.19	Δ 0.19	0.22	Δ 0.15	*	2.04	84.33
1970	0.59	0.65	1.94	0.74	0.56	1.23	5.99	0.52	2.28	0.31	0.40	Δ 0.15	*	1.28	40.36
1971	0.99	1.98	2.38	1.02	3.77	11.67	9.23	1.57	0.34	Δ 0.03	0.25	Δ 0.15	*	2.78	87.67
1972	0.71	Δ 0.03	Δ 0.15	Δ 0.12	Δ 0.06	5.49	8.12	5.74	1.79	0.34	Δ 0.19	0.40	*	1.93	60.86
1973	0.09	0.46	0.43	0.22	1.33	3.06	5.56	0.56	Δ 0.15	Δ 0.12	Δ 0.15	0.25	*	1.03	32.48
1974	1.33	1.30	0.25	0.22	0.68	2.62	14.05	2.16	Δ 0.15	1.08	0.59	0.52	*	2.12	86.85
1975	0.96	0.49	Δ 0.09	0.43	1.05	3.64	2.84	2.01	0.40	Δ 0.19	0.52	0.25	*	1.08	34.05
1976	0.40	0.37	0.31	0.34	0.96	8.12	4.51	2.65	0.43	0.34	0.31	Δ 0.12	*	1.57	49.51
1977	0.56	0.34	0.46	0.22	0.31	0.40	1.39	Δ 0.15	Δ 0.06	Δ 0.03	0.66	Δ 0.12	*	0.41	12.92
1978	0.43	1.88	2.32	3.89	0.96	3.49	2.16	0.65	Δ 0.03	Δ 0.03	0.52	Δ 0.06	*	1.38	43.52
1979	0.43	Δ 0.19	0.90	0.52	0.68	1.48	0.74	Δ 0.19	Δ 0.03	Δ 0.03	Δ 0.12	Δ 0.09	*	0.45	14.19
1980	0.96	Δ 0.12	1.82	1.45	1.02	3.43	5.31	1.20	0.22	Δ 0.12	0.49	0.45	*	1.38	43.52
1981	3.51	2.93	0.99	0.96	0.74	4.01	2.04	1.79	0.46	0.25	Δ 0.09	0.43	*	1.53	48.25
1982	0.90	0.83	1.45	1.73	0.46	1.39	2.38	2.16	0.71	Δ 0.00	Δ 0.09	1.42	*	1.13	35.63
1983	Δ 0.12	0.62	0.22	1.20	5.16	5.96	13.43	3.80	2.16	1.45	0.74	0.31	*	3.35	105.64
1984	0.65	2.87	1.61	0.34	2.10	2.53	3.61	3.86	Δ 0.00	Δ 0.00	Δ 0.00	Δ 0.00	*	1.46	46.04
MEAN	0.82	1.03	1.10	0.83	1.31	4.37	5.53	2.18	0.60	0.30	0.33	0.31	*	1.56	49.20

Catchment Area 117 sq km

DATA: Based on Bang Phra Run-off Model (1968-1984), RID

Δ : Less than 0.197 cu m/sec needed for 2000

AT1-5. Major Facilities

Major facilities included in this alternative are featured in Fig-7.6.

Close to this intake barrage, a grit chamber and a pump station are constructed at Huai Kong Dai. The raw water transmission pipeline, from the pump station to the receiving well of the Pattaya-Na Klua Treatment Plant is laid and on the way, a booster pump station built at the site shown in Fig-7.6 boosts the pipeline. Similar to Alternative A, a 15,300 cu m/d treatment plant is constructed in the same premises of the existing plant.

Requirements of the facilities are as follows:

- | | | | |
|----|----------------------|----------------|--|
| 1) | Intake Barrage | Site | : Huai Kong Dai |
| | | Intake Flow | : 0.296 cu m/sec |
| | | Auxiliaries | : gates, access bridge |
| 2) | Grit Chamber | Site | : Huai Kong Dai |
| | | Detention Time | : 10 min. |
| | | No. | : 2 |
| | | Effective | |
| | | Volume | : 100 cu m x 2 chambers |
| | | Auxiliaries | : screen, gates, grit
removing device |
| 3) | Intake Pump Station | Site | : Huai Kong Dai |
| | | Pump | : 3 units (incl. 1 standby)
300 mm dia. x 9 cu m/min
x 50 m H x 132 kW |
| | | Auxiliaries | : pump house, staff's quarters |
| 4) | Booster Pump Station | Site | : as indicated in Fig-7.6 |
| | | Pump | : 3 units (incl. 1 standby)
300 mm dia. x 9 cu m/min
x 55 m H x 160 kW |
| | | Auxiliaries | : pump house, staff's quarters |

- 5) Raw Water Pipeline From Huai Kong Dai to Booster Pump station
: 600 mm dia. x 15 km
From Booster Pump Station to Pattaya-Na
Klua Treatment Plant
: 600 mm dia. x 2.5 km
- 6) New Treatment Plant Capacity : 15,300 cu m/d
Intake Pump : 3 units (incl. a standby)
5.5 cu m/min x 37 kw
Pipeline : 400 mm dia. x 0.3 km

AT1-6. Construction Costs

For the purpose of facilitating cost comparison with the three alternatives mentioned above, the cost of the distribution pipeline from the new plant to the connecting point on the Sukumvit Highway, is combined with those of the facilities itemed as Nos.1 to 6 below.

The following are the construction costs of the seven items:

<u>No.</u>	<u>Description</u>	<u>Construction Cost</u> (x 1,000 Baht)	<u>Remarks</u>
1	Intake Barrage	15,500	
2	Grit Chamber	4,600	
3	Intake Pump Station	6,700	
4	Booster Pump Station	7,200	
5	Raw Water Pipeline	81,700	
6	New Treatment Plant	47,800	
7	Distribution Pipeline	31,300	600 mm dia. x 6.7 km
Total		194,800	

AT1-7. Operation and Maintenance Cost

No substantial differences were observed among the personnel and chemical costs of Huai Kong Dai System, and Alternatives A and B. In electricity costs, Huai Kong Dai System ranks the largest, followed by Alternative A and Alternative B.

Only the electricity costs by pumping are compared. They are:

- a) Huai Kong Dai Intake
 - Intake and booster pump : 8.2 months (from the simulation study in Attachment-2)
 - Mab Prachan intake pump : 12 months
- b) Alternative A
 - Booster pump : 12 months
 - Mab Prachan intake pump : 12 months
- c) Alternative B
 - Distribution pump : 12 months

The estimated costs per annum are shown below :

	Huai Kong Dai System	Alternative A	Alternative B
Personnel Cost	15,839	15,839	14,399
Electricity Cost	7,104	4,960	3,590
Chemical Cost	751	751	995
T O T A L	23,694	21,550	18,984

(Unit : x 1,000 Baht/yr)

AT1-8. Summary of Costs

To simplify the estimation, it is assumed that the construction costs are depreciated evenly for 45 years period. From the depreciation and the annual O/M cost, the unit (cubic meter) water cost is counted.

In case of Alternatives A and B, the raw water charge payable to the use of raw water from Nong Kho - Laem Chabang Pipeline is added to the unit cost shown below.

The following table shows construction costs and yearly depreciation allowances, O/M costs and unit water costs of Huai Kong Dai and Alternatives A and B:

Item	Unit	Huai Kong Dai System	Alternative A	Alternative B
Construction Cost	฿1,000	194,800	192,800	146,100
Yearly Depreciation	฿1,000/yr	4,329	4,284	3,247
O/M Cost	฿1,000/yr	23,694	21,550	18,984
Yearly Production	1,000 m ³ /yr	4,307	4,307	5,658
Raw Water Charge	฿/m ³	-	1.50	1.50
Water Cost	฿/m ³	6.51	7.50	5.43

AT1-9. Comparison and Conclusion

Huai Kong Dai System and Alternative A almost equal in construction costs and O/M costs. Alternative B which needs not pump up water to Mab Prachan Reservoir, is less expensive in these costs.

As to the unit cost of water, Alternative A is highest, and the difference between Huai Kong Dai System and Alternative B is not so much.

As already repeated, practically no solid data are available concerning such basic items as climatological, topographical, geological and hydrological features of the Huai Kong Dai area. For determining the viability

of constructing intake facilities in this area, a thorough study is required on these problems to clarify the effects of such construction on the surrounding areas. In view of the length of time required for the study, the problem of developing Huai Kong Dai is considered as an issue to be materialized in the next stage.

Alternative B delineated in Appendix 7 is recommended as a suitable solution for Pattaya System in Stage I of the project.

ATTACHMENT-2

SIMULATION STUDY ON WATER BALANCES
OF
HUAI KONG DAI AND MAB PRACHAN SYSTEM

ATTACHMENT-2 SIMULATION STUDY ON WATER BALANCES OF
HUAI KONG DAI AND MAB PRACHAN SYSTEM

TABLE OF CONTENTS

AT2-1.	Introduction	A7 - 24
AT2-2.	Employed Conditions for Water Balance Simulation	A7 - 24
AT2-3.	Water Balance Simulations	A7 - 25
AT2-4.	Simulation Results	A7 - 25

AT2-1. Introduction

In view of the increasing water demand for Pattaya Waterworks which cannot be met by Mab Prachan Reservoir alone, Appendix 3 of the Report "Study on Water Sources", cited two alternatives to supplement Mab Prachan source, i.e., Nong Kho Reservoir and Huai Kong Dai, and recommended Nong Kho Reservoir as the most reliable source.

Huai Kong Dai, on the other hand, can be an important alternative, subject to further study based on solid data collectable on the features of the source.

The present study simulates future water balances of Mab Prachan Reservoir if supplemented by water pumped from Huai Kong Dai to inquire into whether demand after 2000 could be met by such supplementation.

AT2-2. Employed Conditions for Water Balance Simulation

In view of the mentioned absence of basic data, the water balance simulations of Huai Kong Dai and Mab Prachan System shown in the attached table were made on the assumption that the run-off and flow conditions of Huai Kong Dai be the same as those of Bang Phra.

An 18 year's climatical cycle (cf. Appendix 3) is applied in simulating run-offs. Other main conditions applied in simulation are as follows.

- 1) Water transmission from Huai Kong Dai to Mab Prachan Reservoir:
0.78 MCM/month, provided that the actually taken-in volume will be transmitted, in case the Huai Kong Dai flow becomes below this level.
- 2) Drafts:
 - a) Intake volume of Pattaya-Na Klua T.P.:
(Average day demand) + (Loss in T.P.)
 - b) Industrial water : 0.9 MCM/yr (2,466 m³/day)
 - c) River Maintenance: 0.9 MCM/yr (2,466 m³/day)

AT2-3. Water Balance Simulations

The starting month of water balance simulations was selected to be November 1986, when the Reservoir was filled to capacity. The terms representing the figures of respective columns in the simulations are defined as follows:

- a) Water Level : Water level of Mab Prachan Reservoir
(Mean Sea Level, m)
- b) Storage : Water volume stored in the Reservoir
(MCM)
- c) Inflow (Mab Prachan) : Monthly inflow from the Mab Prachan
river basin (MCM/month)
- d) Inflow (H.K.D) : Monthly water volume pumped up from
Huai Kong Dai (MCM/month)
- e) Draft : (Pattaya-Na Klua T.P. raw water) +
(Industrial water) + (River maintenance
flow), (MCM/month)
- f) Evapolation : Evapolation from the Reservoir surface
based on the past records
- g) Fluctuations : Fluctuations in stored water, (MCM)
Full - Filled to capacity
Positive figures - increases in storage
from the previous months
Negative figures - decreases in storage
from the previous months

AT2-4. Simulation Results

The simulation results shown in the attached table reveal the possibility that the Mab Prachan Reservoir, with an increase in its capacity as scheduled by RID up to 16.5 MCM and with supplemental water pumped up into the Reservoir, will be able to supply enough water to meet demand up to the year 2010.

The volume of transmission from Huai Kong Dai to Mab Prachan to satisfy the 2000 demand is simulated to suffice the demand after 2000 to 2010, as this

period of time coincides with the phase of the mentioned 18 years climatical cycle where Mab Prachan's water balance increases yearly.

As already repeated, a thorough study is yet to be made to determine the technical feasibility of the Huai Kong Dai development.

YEAR	MONTH	WATER LEVEL (MSL, m)	RESERVOIR SURFACE (km ²)	STORAGE (MCM)	I N F L O W			EVAPOLATION		FLUCTU- ATION (MCM)
					MAB PRACHAN (MCM)	H. K. D (MCM)	DRAFT (MCM)	UNIT (mm)	TOTAL (MCM)	
1986	NOV	45.5	3.06	16.5	1.39	0.78	0.71	96.2	0.29	FULL
	DEC	45.5	3.06	16.5	0.32	0.77	0.78	100.3	0.31	FULL
	JAN	45.5	3.06	16.5	0.50	0.62	0.87	82.6	0.25	FULL
	FEB	45.5	3.06	15.9	0.13	0.35	0.83	79.0	0.24	-0.59
	MAR	45.3	2.99	15.9	0.39	0.78	0.90	108.3	0.32	-0.05
1987	APR	45.3	2.98	15.8	0.34	0.78	0.75	130.7	0.39	-0.02
	MAY	45.3	2.98	16.3	0.84	0.78	0.75	129.5	0.39	0.48
	JUN	45.4	3.04	16.5	1.31	0.00	0.72	113.5	0.35	FULL
	JUL	45.5	3.06	16.2	0.19	0.51	0.75	93.5	0.29	-0.35
	AUG	45.4	3.02	16.5	1.29	0.08	0.78	82.0	0.25	FULL
	SEP	45.5	3.06	16.5	10.54	0.00	0.72	84.4	0.26	FULL
	OCT	45.5	3.06	16.5	4.52	0.00	0.76	98.3	0.30	FULL
	NOV	45.5	3.06	16.5	1.21	0.00	0.76	87.4	0.27	FULL
	DEC	45.5	3.06	16.0	0.16	0.44	0.84	88.7	0.27	-0.51
	JAN	45.4	3.00	15.3	0.16	0.44	0.93	104.0	0.31	-0.65
	FEB	45.2	2.92	14.9	0.18	0.51	0.89	83.3	0.24	-0.44
	MAR	45.1	2.87	14.1	0.13	0.35	0.97	116.1	0.33	-0.82
1988	APR	44.8	2.75	14.2	0.50	0.78	0.80	113.5	0.31	0.17
	MAY	44.9	2.78	14.4	0.55	0.78	0.81	120.9	0.34	0.19
	JUN	44.9	2.80	15.8	1.66	0.78	0.77	97.4	0.27	1.39
	JUL	45.3	2.98	16.1	0.63	0.78	0.81	105.3	0.31	0.29
	AUG	45.4	3.02	16.3	0.47	0.78	0.83	83.9	0.25	0.17
	SEP	45.4	3.04	16.5	1.05	0.18	0.77	77.2	0.23	FULL
	OCT	45.5	3.06	16.5	5.10	0.00	0.82	74.4	0.23	FULL
	NOV	45.5	3.06	16.5	0.45	0.63	0.82	85.9	0.26	FULL
	DEC	45.5	3.06	16.5	2.37	0.00	0.90	70.1	0.21	FULL
	JAN	45.5	3.06	16.3	0.26	0.72	1.00	58.8	0.18	-0.20
	FEB	45.4	3.04	16.2	0.34	0.78	0.95	73.1	0.22	-0.05
	MAR	45.4	3.03	15.4	0.13	0.35	1.04	93.4	0.28	-0.84
1989	APR	45.2	2.93	15.8	0.84	0.78	0.86	112.6	0.33	0.43
	MAY	45.3	2.98	16.5	1.68	0.14	0.86	101.2	0.30	FULL
	JUN	45.5	3.05	16.5	2.02	0.00	0.83	99.2	0.30	FULL
	JUL	45.5	3.06	16.5	0.87	0.27	0.86	91.0	0.28	FULL
	AUG	45.5	3.06	16.5	3.21	0.00	0.89	90.8	0.28	FULL
	SEP	45.5	3.06	16.5	9.93	0.00	0.83	87.7	0.27	FULL
	OCT	45.5	3.06	16.5	7.86	0.00	0.87	80.7	0.25	FULL
	NOV	45.5	3.06	16.5	1.34	0.00	0.87	76.4	0.23	FULL
	DEC	45.5	3.06	16.3	0.29	0.78	0.96	89.6	0.27	-0.16
	JAN	45.4	3.04	15.2	0.03	0.07	1.07	57.5	0.17	-1.15
	FEB	45.1	2.90	14.7	0.21	0.58	1.02	76.5	0.22	-0.45
	MAR	45.0	2.84	13.8	0.13	0.35	1.11	101.1	0.29	-0.92
1990	APR	44.7	2.72	14.0	0.60	0.78	0.91	101.4	0.28	0.19
	MAY	44.8	2.74	12.8	0.03	0.07	0.92	147.7	0.41	-1.23
	JUN	44.4	2.56	12.1	0.13	0.35	0.88	102.8	0.26	-0.67
	JUL	44.1	2.46	11.3	0.11	0.28	0.92	112.8	0.28	-0.82
	AUG	43.8	2.33	10.3	0.05	0.14	0.95	107.0	0.25	-1.01
	SEP	43.4	2.15	14.7	4.68	0.78	0.88	69.4	0.15	4.42
	OCT	45.0	2.84	16.5	6.91	0.00	0.93	96.7	0.27	FULL
	NOV	45.5	3.06	16.5	4.89	0.00	0.93	81.3	0.25	FULL
	DEC	45.5	3.06	16.5	1.52	0.00	1.03	72.8	0.22	FULL

YEAR	MONTH	WATER LEVEL (MSL, m)	RESERVOIR SURFACE (km ²)	I N F L O W				EVAPOLATION		FLUCTU- ATION (MCM)
				STORAGE (MCM)	HAB PRACHAN (MCM)	H. K. D (MCM)	DRAFT (MCM)	UNIT (mm)	TOTAL (MCM)	
1991	JAN	45.5	3.06	16.2	0.29	0.78	1.13	80.0	0.24	-0.31
	FEB	45.4	3.03	15.5	0.16	0.44	1.08	81.8	0.25	-0.73
	MAR	45.2	2.94	15.1	0.34	0.78	1.18	97.3	0.29	-0.34
	APR	45.1	2.89	14.1	0.08	0.21	0.96	127.9	0.37	-1.05
	MAY	44.8	2.75	14.0	0.39	0.78	0.97	93.0	0.26	-0.05
	JUN	44.8	2.75	14.0	0.37	0.78	0.93	85.3	0.23	-0.02
	JUL	44.8	2.74	13.5	0.18	0.51	0.97	88.8	0.24	-0.52
	AUG	44.6	2.67	14.1	1.13	0.78	1.00	107.6	0.29	0.62
	SEP	44.8	2.76	16.4	2.60	0.78	0.93	72.9	0.20	2.25
	OCT	45.4	3.05	16.5	4.73	0.00	0.98	93.5	0.28	FULL
	NOV	45.5	3.06	16.5	0.47	0.72	0.98	66.6	0.20	FULL
	DEC	45.5	3.06	15.7	0.13	0.35	1.08	64.3	0.20	-0.80
1992	JAN	45.3	2.97	14.7	0.11	0.28	1.19	54.6	0.16	-0.97
	FEB	45.0	2.84	13.9	0.13	0.35	1.14	65.0	0.18	-0.84
	MAR	44.7	2.73	13.2	0.21	0.58	1.24	82.3	0.22	-0.68
	APR	44.5	2.63	13.9	1.13	0.78	1.02	93.8	0.25	0.65
	MAY	44.7	2.72	14.5	1.10	0.78	1.02	88.0	0.24	0.62
	JUN	44.9	2.81	14.0	0.21	0.58	0.98	90.0	0.25	-0.44
	JUL	44.8	2.75	13.4	0.18	0.51	1.02	91.5	0.25	-0.58
	AUG	44.6	2.66	13.5	0.58	0.78	1.06	78.0	0.21	0.09
	SEP	44.6	2.68	15.3	2.23	0.78	0.98	85.6	0.23	1.80
	OCT	45.2	2.92	16.5	11.96	0.00	1.04	83.9	0.25	FULL
	NOV	45.5	3.06	16.5	1.84	0.00	1.04	78.5	0.24	FULL
	DEC	45.5	3.06	16.4	0.53	0.78	1.14	77.1	0.24	-0.07
1993	JAN	45.5	3.05	16.5	0.92	0.61	1.26	63.1	0.19	FULL
	FEB	45.5	3.06	16.3	0.50	0.78	1.20	85.3	0.26	-0.18
	MAR	45.4	3.04	15.9	0.45	0.78	1.31	104.3	0.32	-0.40
	APR	45.3	2.99	16.1	0.81	0.78	1.07	109.3	0.33	0.20
	MAY	45.4	3.02	16.0	0.42	0.78	1.08	92.5	0.28	-0.16
	JUN	45.3	3.00	14.9	0.08	0.21	1.03	89.1	0.27	-1.01
	JUL	45.1	2.87	14.8	0.37	0.78	1.08	88.9	0.26	-0.19
	AUG	45.0	2.85	15.1	0.89	0.78	1.12	83.3	0.24	0.32
	SEP	45.1	2.89	16.5	3.10	0.00	1.03	77.0	0.22	FULL
	OCT	45.5	3.06	16.5	2.42	0.00	1.09	96.8	0.30	FULL
	NOV	45.5	3.06	16.5	1.71	0.00	1.09	107.9	0.33	FULL
	DEC	45.5	3.06	16.2	0.34	0.78	1.21	62.4	0.19	-0.28
1994	JAN	45.4	3.03	15.3	0.16	0.44	1.32	57.3	0.17	-0.89
	FEB	45.2	2.92	15.1	0.45	0.78	1.25	70.8	0.21	-0.23
	MAR	45.1	2.89	14.2	0.21	0.58	1.37	99.1	0.29	-0.87
	APR	44.8	2.78	13.9	0.34	0.78	1.12	111.7	0.31	-0.31
	MAY	44.8	2.73	13.6	0.32	0.78	1.13	95.9	0.26	-0.29
	JUN	44.7	2.69	13.2	0.26	0.72	1.08	119.8	0.32	-0.42
	JUL	44.5	2.63	12.9	0.29	0.78	1.13	112.4	0.30	-0.35
	AUG	44.4	2.58	13.0	0.81	0.78	1.17	95.9	0.25	0.18
	SEP	44.5	2.60	16.5	6.91	0.00	1.08	98.9	0.26	FULL
	OCT	45.5	3.06	16.5	3.84	0.00	1.14	78.3	0.24	FULL
	NOV	45.5	3.06	16.5	2.26	0.00	1.14	50.6	0.15	FULL
	DEC	45.5	3.06	16.1	0.37	0.78	1.26	96.0	0.29	-0.41

YEAR	MONTH	WATER LEVEL (MSL, m)	RESERVOIR SURFACE (km ²)	STORAGE (MCM)	I N F L O W			EVAPOLATION		FLUCTU- ATION (MCM)
					MAB PRACHAN (MCM)	H. K. D (MCM)	DRAFT (MCM)	UNIT (mm)	TOTAL (MCM)	
1995	JAN	45.4	3.01	15.5	0.29	0.78	1.37	101.8	0.31	-0.61
	FEB	45.2	2.94	14.9	0.26	0.72	1.30	75.2	0.22	-0.54
	MAR	45.1	2.87	13.7	0.11	0.28	1.42	86.5	0.25	-1.29
	APR	44.7	2.69	13.5	0.47	0.78	1.16	102.5	0.28	-0.18
	MAY	44.6	2.67	13.1	0.29	0.78	1.17	101.1	0.27	-0.37
	JUN	44.5	2.61	12.9	0.39	0.78	1.12	108.5	0.28	-0.23
	JUL	44.4	2.58	12.2	0.18	0.51	1.17	91.5	0.24	-0.71
	AUG	44.1	2.47	11.7	0.26	0.72	1.21	88.2	0.22	-0.45
	SEP	44.0	2.40	11.5	0.34	0.78	1.12	74.7	0.18	-0.18
	OCT	43.9	2.37	12.1	1.18	0.78	1.19	83.2	0.20	0.58
	NOV	44.1	2.46	11.2	0.13	0.35	1.19	75.9	0.19	-0.89
	DEC	43.8	2.31	9.9	0.05	0.14	1.31	88.3	0.20	-1.32
1996	JAN	43.2	2.08	8.4	0.03	0.07	1.40	78.5	0.16	-1.47
	FEB	42.5	1.80	8.5	0.74	0.78	1.34	55.2	0.10	0.08
	MAR	42.5	1.82	7.3	0.11	0.28	1.46	90.6	0.16	-1.24
	APR	41.8	1.56	7.1	0.42	0.78	1.19	95.8	0.15	-0.14
	MAY	41.7	1.53	8.2	1.60	0.78	1.20	91.6	0.14	1.04
	JUN	42.3	1.75	9.6	1.97	0.78	1.15	89.8	0.16	1.44
	JUL	43.0	2.03	12.3	3.31	0.78	1.20	81.1	0.16	2.73
	AUG	44.2	2.50	12.5	0.81	0.78	1.24	80.6	0.20	0.15
	SEP	44.3	2.52	14.9	2.97	0.78	1.15	73.7	0.19	2.41
	OCT	45.0	2.86	16.0	1.84	0.78	1.22	95.1	0.27	1.13
	NOV	45.4	3.01	15.9	0.55	0.78	1.22	93.4	0.28	-0.17
	DEC	45.3	2.99	14.4	0.03	0.07	1.35	84.9	0.25	-1.50
1997	JAN	44.9	2.79	13.0	0.08	0.21	1.44	75.0	0.21	-1.36
	FEB	44.4	2.60	12.6	0.45	0.78	1.37	80.2	0.21	-0.35
	MAR	44.3	2.54	11.0	0.05	0.14	1.50	115.8	0.29	-1.61
	APR	43.7	2.28	10.7	0.37	0.78	1.22	100.2	0.23	-0.30
	MAY	43.6	2.23	9.8	0.16	0.44	1.23	118.2	0.26	-0.90
	JUN	43.2	2.07	10.0	0.76	0.78	1.18	82.9	0.17	0.19
	JUL	43.2	2.10	9.8	0.45	0.78	1.23	86.7	0.18	-0.19
	AUG	43.2	2.07	9.7	0.58	0.78	1.28	85.5	0.18	-0.09
	SEP	43.1	2.05	10.5	1.26	0.78	1.18	61.7	0.13	0.74
	OCT	43.5	2.19	10.4	0.63	0.78	1.25	102.5	0.22	-0.06
	NOV	43.4	2.17	9.5	0.16	0.44	1.25	99.3	0.22	-0.87
	DEC	43.0	2.02	8.1	0.03	0.07	1.38	76.8	0.15	-1.44
1998	JAN	42.3	1.73	6.6	0.03	0.07	1.47	77.4	0.13	-1.51
	FEB	41.4	1.42	5.5	0.11	0.28	1.40	79.3	0.11	-1.13
	MAR	40.6	1.17	4.1	0.08	0.21	1.53	107.2	0.13	-1.37
	APR	39.6	0.86	4.3	0.81	0.78	1.25	123.2	0.11	0.24
	MAY	39.8	0.92	3.3	0.11	0.28	1.26	133.6	0.12	-1.00
	JUN	39.0	0.69	4.4	1.55	0.78	1.20	98.0	0.07	1.06
	JUL	39.8	0.93	5.1	1.24	0.78	1.26	112.7	0.10	0.65
	AUG	40.3	1.08	5.3	0.87	0.78	1.30	103.4	0.11	0.23
	SEP	40.5	1.13	7.7	2.92	0.78	1.20	96.5	0.11	2.38
	OCT	42.0	1.65	11.5	4.52	0.78	1.27	90.9	0.15	3.88
	NOV	43.9	2.37	11.9	1.02	0.78	1.27	74.0	0.18	0.35
	DEC	44.0	2.43	11.0	0.18	0.51	1.41	77.5	0.19	-0.90

YEAR	MONTH	WATER LEVEL (MSL, m)	RESERVOIR SURFACE (km ²)	STORAGE (MCM)	I N F L O W			EVAPOLATION		FLUCTU- ATION (MCM)
					MAB PRACHAN (MCM)	H. K. D (MCM)	DRAFT (MCM)	UNIT (mm)	TOTAL (MCM)	
1999	JAN	43.7	2.28	9.7	0.11	0.28	1.51	74.2	0.17	-1.29
	FEB	43.1	2.05	9.3	0.42	0.78	1.43	70.3	0.14	-0.38
	MAR	42.9	1.97	8.7	0.39	0.78	1.57	98.6	0.19	-0.59
	APR	42.6	1.86	11.1	3.07	0.78	1.28	113.6	0.21	2.36
	MAY	43.7	2.29	12.8	2.50	0.78	1.29	103.4	0.24	1.75
	JUN	44.4	2.58	13.0	0.84	0.78	1.23	107.5	0.28	0.11
	JUL	44.4	2.59	13.0	0.81	0.78	1.29	108.1	0.28	0.03
	AUG	44.4	2.60	12.8	0.63	0.78	1.33	97.4	0.25	-0.18
	SEP	44.4	2.57	15.5	3.42	0.78	1.23	93.6	0.24	2.72
	OCT	45.2	2.95	16.5	1.73	0.78	1.31	92.0	0.27	0.94
	NOV	45.5	3.06	16.5	1.52	0.02	1.31	68.8	0.21	FULL
	DEC	45.5	3.06	16.0	0.39	0.78	1.44	89.2	0.27	-0.54
2000	JAN	45.3	3.00	14.9	0.21	0.58	1.54	92.2	0.28	-1.03
	FEB	45.1	2.87	13.5	0.08	0.21	1.47	88.5	0.25	-1.43
	MAR	44.6	2.67	12.8	0.37	0.78	1.61	88.5	0.24	-0.70
	APR	44.4	2.57	12.7	0.76	0.78	1.31	118.0	0.30	-0.07
	MAY	44.3	2.56	12.6	0.71	0.78	1.32	113.5	0.29	-0.12
	JUN	44.3	2.54	13.1	1.24	0.78	1.26	102.9	0.26	0.49
	JUL	44.5	2.61	13.8	1.47	0.78	1.32	112.1	0.29	0.64
	AUG	44.7	2.71	13.3	0.39	0.78	1.36	94.5	0.26	-0.44
	SEP	44.5	2.64	13.8	1.18	0.78	1.26	76.0	0.20	0.50
	OCT	44.7	2.72	15.0	2.02	0.78	1.33	85.6	0.23	1.24
	NOV	45.1	2.88	16.1	1.84	0.78	1.33	82.4	0.24	1.05
	DEC	45.4	3.01	15.7	0.60	0.78	1.48	90.5	0.27	-0.36
2001	JAN	45.3	2.97	13.9	0.00	0.00	1.58	95.7	0.28	-1.86
	FEB	44.7	2.72	12.4	0.08	0.21	1.50	93.6	0.25	-1.47
	MAR	44.2	2.51	12.4	1.21	0.78	1.65	120.5	0.30	0.04
	APR	44.2	2.51	11.1	0.11	0.28	1.34	131.5	0.33	-1.29
	MAY	43.7	2.30	10.8	0.53	0.78	1.35	119.6	0.28	-0.32
	JUN	43.6	2.25	10.0	0.18	0.51	1.29	95.7	0.22	-0.81
	JUL	43.2	2.10	10.3	1.02	0.78	1.35	108.3	0.23	0.23
	AUG	43.3	2.15	13.8	4.39	0.78	1.40	104.1	0.22	3.55
	SEP	44.7	2.71	16.5	5.07	0.00	1.29	81.2	0.22	FULL
	OCT	45.5	3.06	16.5	11.43	0.00	1.37	70.6	0.22	FULL
	NOV	45.5	3.06	16.5	7.49	0.00	1.37	73.8	0.23	FULL
	DEC	45.5	3.06	16.5	1.84	0.00	1.51	78.3	0.24	FULL
2002	JAN	45.5	3.06	16.5	1.24	0.65	1.62	87.0	0.27	FULL
	FEB	45.5	3.06	16.1	0.63	0.78	1.54	86.4	0.26	-0.39
	MAR	45.4	3.02	15.1	0.26	0.72	1.69	112.1	0.34	-1.04
	APR	45.1	2.89	14.7	0.55	0.78	1.37	107.4	0.31	-0.35
	MAY	45.0	2.84	16.3	2.44	0.78	1.38	108.3	0.31	1.54
	JUN	45.4	3.03	16.5	1.37	0.50	1.32	93.3	0.30	FULL
	JUL	45.5	3.06	15.9	0.29	0.78	1.38	95.9	0.29	-0.60
	AUG	45.3	2.99	16.5	1.79	0.56	1.43	104.7	0.31	FULL
	SEP	45.5	3.06	16.5	2.15	0.00	1.32	88.8	0.27	FULL
	OCT	45.5	3.06	16.5	3.07	0.00	1.40	89.4	0.27	FULL
	NOV	45.5	3.06	16.5	3.29	0.00	1.40	92.6	0.28	FULL
	DEC	45.5	3.06	14.7	0.00	0.00	1.55	96.2	0.29	-1.84

YEAR	MONTH	WATER LEVEL (MSL, m)	RESERVOIR SURFACE (km ²)	STORAGE (MCM)	I N F L O W			EVAPOLATION		FLUCTU- ATION (MCM)
					MAB (MCM)	FRACHAN (MCM)	H. K. D (MCM)	DRAFT (MCM)	UNIT (mm)		TOTAL (MCM)
2003	JAN	45.0	2.83	12.8	0.00	0.00	1.66	86.3	0.24	-1.90
	FEB	44.4	2.56	11.0	0.00	0.00	1.57	91.0	0.23	-1.81
	MAR	43.7	2.27	9.0	0.00	0.00	1.73	110.5	0.25	-1.98
	APR	42.7	1.91	8.8	0.71	0.78	1.40	112.4	0.21	-0.13
	MAY	42.7	1.88	8.9	0.87	0.78	1.41	111.2	0.21	0.03
	JUN	42.7	1.89	9.1	0.95	0.78	1.35	101.4	0.19	0.18
	JUL	42.8	1.92	8.9	0.71	0.78	1.41	101.2	0.19	-0.12
	AUG	42.7	1.90	9.2	1.10	0.78	1.46	95.4	0.18	0.24
	SEP	42.8	1.95	12.2	3.71	0.78	1.35	81.8	0.16	2.98
	OCT	44.1	2.47	16.0	4.70	0.78	1.43	88.5	0.22	3.83
	NOV	45.4	3.00	16.5	1.87	0.32	1.43	81.8	0.25	FULL
	DEC	45.5	3.06	16.0	0.53	0.78	1.58	82.5	0.25	-0.53
2004	JAN	45.3	3.00	15.0	0.26	0.70	1.69	78.0	0.23	-0.97
	FEB	45.1	2.88	14.2	0.29	0.76	1.61	78.5	0.23	-0.78
	MAR	44.8	2.77	13.2	0.26	0.72	1.77	101.9	0.28	-1.07
	APR	44.5	2.62	12.8	0.63	0.78	1.43	117.7	0.31	-0.33
	MAY	44.4	2.57	13.1	1.24	0.78	1.44	127.5	0.33	0.24
	JUN	44.5	2.61	13.6	1.52	0.78	1.38	141.3	0.37	0.56
	JUL	44.7	2.69	13.1	0.47	0.78	1.44	139.6	0.38	-0.57
	AUG	44.5	2.61	12.7	0.74	0.78	1.50	135.0	0.35	-0.33
	SEP	44.3	2.56	14.7	2.84	0.78	1.38	91.7	0.23	2.00
	OCT	45.0	2.84	16.5	6.28	0.00	1.46	93.4	0.27	FULL
	NOV	45.5	3.06	16.5	1.99	0.37	1.46	96.2	0.29	FULL
	DEC	45.5	3.06	15.7	0.32	0.78	1.62	100.3	0.31	-0.83
2005	JAN	45.3	2.96	15.0	0.50	0.78	1.73	82.6	0.24	-0.70
	FEB	45.1	2.87	13.6	0.13	0.35	1.65	79.0	0.23	-1.39
	MAR	44.6	2.68	12.7	0.39	0.78	1.81	108.3	0.29	-0.92
	APR	44.3	2.55	12.0	0.34	0.78	1.46	130.7	0.33	-0.68
	MAY	44.1	2.44	11.8	0.84	0.78	1.47	129.5	0.32	-0.17
	JUN	44.0	2.41	12.2	1.31	0.78	1.41	113.5	0.27	0.41
	JUL	44.2	2.48	11.2	0.18	0.51	1.47	93.5	0.23	-1.01
	AUG	43.8	2.31	11.6	1.29	0.78	1.53	82.0	0.19	0.35
	SEP	43.9	2.37	16.5	10.54	0.00	1.41	84.4	0.20	FULL
	OCT	45.5	3.06	16.5	4.52	0.00	1.50	98.3	0.30	FULL
	NOV	45.5	3.06	16.5	1.21	0.55	1.50	87.4	0.27	FULL
	DEC	45.5	3.06	15.2	0.16	0.44	1.66	88.7	0.27	-1.33
2006	JAN	45.1	2.90	13.7	0.16	0.44	1.77	104.0	0.30	-1.47
	FEB	44.7	2.70	12.5	0.18	0.51	1.68	83.3	0.22	-1.21
	MAR	44.3	2.52	10.8	0.13	0.35	1.85	116.1	0.29	-1.66
	APR	43.6	2.25	10.4	0.50	0.78	1.50	113.5	0.25	-0.47
	MAY	43.4	2.16	9.9	0.55	0.78	1.51	120.9	0.26	-0.44
	JUN	43.2	2.08	10.7	1.66	0.78	1.44	97.4	0.20	0.79
	JUL	43.6	2.23	10.4	0.63	0.78	1.51	105.3	0.23	-0.33
	AUG	43.4	2.17	9.9	0.47	0.78	1.56	83.9	0.18	-0.49
	SEP	43.2	2.08	10.1	1.05	0.78	1.44	77.2	0.16	0.23
	OCT	43.3	2.12	14.3	5.10	0.78	1.53	74.4	0.16	4.19
	NOV	44.9	2.79	13.8	0.45	0.78	1.53	85.9	0.24	-0.54
	DEC	44.7	2.71	15.0	2.37	0.78	1.69	70.1	0.19	1.26

YEAR	MONTH	WATER LEVEL (MSL, m)	RESERVOIR SURFACE (km ²)	STORAGE (MCM)	I N F L O W			EVAPOLATION		FLUCTU- ATION (MCM)
					MAB	PRACHAN	H. K. D	DRAFT	UNIT (mm)		TOTAL (MCM)
2007	JAN	45.1	2.88	14.0	0.26	0.72	1.81	58.8	0.17	-1.00
	FEB	44.8	2.75	13.2	0.34	0.78	1.72	73.1	0.20	-0.80
	MAR	44.5	2.63	11.6	0.13	0.35	1.89	93.4	0.25	-1.65
	APR	43.9	2.37	11.4	0.84	0.78	1.53	112.6	0.27	-0.17
	MAY	43.8	2.35	12.1	1.68	0.78	1.54	101.2	0.24	0.69
	JUN	44.1	2.46	13.2	2.02	0.78	1.47	99.2	0.24	1.09
	JUL	44.5	2.63	13.0	0.87	0.78	1.54	91.0	0.24	-0.13
	AUG	44.5	2.61	15.2	3.21	0.78	1.60	90.8	0.24	2.15
	SEP	45.1	2.90	16.5	9.93	0.00	1.47	87.7	0.25	FULL
	OCT	45.5	3.06	16.5	7.86	0.00	1.56	80.7	0.25	FULL
	NOV	45.5	3.06	16.5	1.34	0.46	1.56	76.4	0.23	FULL
	DEC	45.5	3.06	15.6	0.29	0.78	1.73	89.6	0.27	-0.94
2008	JAN	45.2	2.95	13.6	0.03	0.07	1.85	57.5	0.17	-1.92
	FEB	44.7	2.69	12.5	0.21	0.58	1.76	76.5	0.21	-1.17
	MAR	44.3	2.52	10.8	0.13	0.35	1.93	101.1	0.25	-1.70
	APR	43.6	2.24	10.4	0.60	0.78	1.56	101.4	0.23	-0.40
	MAY	43.4	2.17	8.6	0.03	0.07	1.57	147.7	0.32	-1.80
	JUN	42.5	1.83	7.4	0.13	0.35	1.50	102.8	0.19	-1.21
	JUL	41.9	1.58	6.0	0.11	0.28	1.57	112.8	0.18	-1.37
	AUG	41.0	1.29	4.4	0.05	0.14	1.63	107.0	0.14	-1.58
	SEP	39.8	0.93	8.3	4.68	0.78	1.59	69.4	0.06	3.89
	OCT	42.4	1.78	14.2	6.91	0.78	1.59	96.7	0.17	5.93
	NOV	44.9	2.78	16.5	4.89	0.00	1.59	81.3	0.23	FULL
	DEC	45.5	3.06	16.5	1.52	0.47	1.77	72.8	0.22	FULL
2009	JAN	45.5	3.06	15.4	0.29	0.78	1.89	80.0	0.24	-1.06
	FEB	45.2	2.93	14.0	0.16	0.44	1.79	81.8	0.24	-1.43
	MAR	44.8	2.74	12.9	0.34	0.78	1.97	97.3	0.27	-1.11
	APR	44.4	2.58	11.3	0.08	0.21	1.59	127.9	0.33	-1.64
	MAY	43.8	2.32	10.6	0.39	0.78	1.60	93.0	0.22	-0.65
	JUN	43.5	2.21	10.0	0.37	0.78	1.53	85.3	0.19	-0.57
	JUL	43.3	2.11	8.9	0.18	0.51	1.60	88.8	0.19	-1.10
	AUG	42.7	1.90	9.0	1.13	0.78	1.66	107.6	0.20	0.04
	SEP	42.7	1.91	10.7	2.60	0.78	1.53	72.9	0.14	1.71
	OCT	43.5	2.22	14.4	4.73	0.78	1.63	93.5	0.21	3.68
	NOV	44.9	2.79	13.8	0.47	0.78	1.63	66.6	0.19	-0.56
	DEC	44.7	2.72	12.3	0.13	0.35	1.80	64.3	0.17	-1.50
2010	JAN	44.2	2.49	10.6	0.11	0.28	1.92	54.6	0.14	-1.68
	FEB	43.5	2.21	9.1	0.13	0.35	1.83	65.0	0.14	-1.49
	MAR	42.8	1.94	7.8	0.21	0.58	2.01	82.3	0.16	-1.38
	APR	42.1	1.66	7.9	1.13	0.78	1.62	93.8	0.16	0.13
	MAY	42.2	1.69	8.0	1.10	0.78	1.64	88.0	0.15	0.10
	JUN	42.2	1.71	7.1	0.21	0.58	1.56	90.0	0.15	-0.93
	JUL	41.7	1.52	6.0	0.18	0.51	1.64	91.5	0.14	-1.08
	AUG	41.0	1.28	5.5	0.58	0.78	1.70	78.0	0.10	-0.44
	SEP	40.7	1.19	6.9	2.23	0.78	1.56	85.6	0.10	1.35
	OCT	43.6	1.48	16.5	11.96	0.00	1.66	83.9	0.12	FULL
	NOV	45.5	3.06	16.5	1.84	0.06	1.66	78.5	0.24	FULL
	DEC	45.5	3.06	15.7	0.53	0.78	1.84	77.1	0.24	-0.77

APPENDIX 8

PRELIMINARY DESIGN

APPENDIX 8 PRELIMINARY DESIGN

TABLE OF CONTENTS

8.1	Rehabilitation and Modification Works	A8 - 1
8.1.1	Intake pump and Raw Water Transmission Pipeline ...	A8 - 1
8.1.2	Treatment Facilities	A8 - 3
8.1.3	Distribution Pipeline	A8 - 5
8.2	Expansion Works	A8 - 7
8.2.1	Condition of the Preliminary Design	A8 - 7
8.2.2	Intake and Raw Water Transmission Pipeline	A8 - 7
8.2.3	Thung Sukla Treatment Plant	A8 - 7
8.2.4	Clear Water Transmission Pipeline	A8 - 11
8.2.5	Rong Po Distribution Pump Station	A8 - 14
8.2.6	Distribution Pipeline	A8 - 14

Appendix 8 PRELIMINARY DESIGN

8.1 Rehabilitation and Modification Works

The objectives for the rehabilitation and modification works, which are 1) to update the present deteriorated equipment and obsolete pipelines and 2) to uprate the present production of the Pattaya-Na Klua Treatment Plant, by some improvements for covering insufficient supply till completion of the expansion works.

The possible increase of production capacity is studied on the Pattaya-Na Klua Treatment Plant. Each of the facilities in Paton system is examined for its capacity whether it meets with the proposed increase as follows:

- Present capacity : 24,000 cu m/d
- Proposed incremental : 9,600 cu m/d
(40 % to the present capacity)
- Proposed production : 33,600 cu m/d
- Proposed treatment capacity : 36,300 cu m/d
(the proposed production plus 8 %
treatment loss)

8.1.1 Intake pump and Raw Water Transmission Pipeline

1) Capacity

All the existing intake pumps are as follows:

- Motor drive, 18.4 cu m/min (26,500 cu m/day) x 41 m H x 2 Nos.
(1 standby)
- Motor drive, 6.7 cu m/min (9,600 cu m/day) x 35 m H x 1 No.
- Engine drive, 18.4 cu m/min (26,500 cu m/day) x 41 m H x 1 No.
(emergency use)

Each of the pump units is found sufficiently operable, and the combined capacity of the 18.4 and 6.7 cu m/min pumps (36,144 cu m/d) nearly equals the proposed treatment capacity of 36,300 cu m/d.

There are 600 mm and 250 mm diameter raw water transmission mains of 600 m each operated. For transmitting water to the treatment plant, these two mains are adequate hydraulically and structurally. Therefore the intake pumping facilities and the raw water transmission mains are considered to meet the proposed treatment capacity up to 1991.

2) Necessary Works

The 6.7 cu m/min pump has been installed recently outdoors, and it shall be relocated to the pump house of the intake tower for long-run use.

For recording daily water amount of intake and determination of chemical dosages, flow meters and recorders should be installed. A flow meter and a recorder should be installed for the 250 mm dia. raw water transmission main. Replacement will be needed for a flow meter and a recorder of the 700 mm raw water transmission main due to malfunctioning. These new flow meters should be of differential pressure type.

8.1.2 Treatment Facilities

1) Major Facilities

a) Capacity

Item	Original Design	Proposed Modification	Design Criteria (Appendix 6)
Production Capacity (cu m/d)	24,000	33,600 (40 % increase)	- -
Treatment Capacity (including treatment loss, cu m/d)	25,920	36,300	- -
Flocculation Basins			
Detention Time (min)	52	37	20 - 40
Sedimentation Basins			
Detention Time (hr),	4.7	3.4	1.5 - 3
Flow Velocity (m/min)	0.19	0.27	0.3 - 1
Filters			
Filtration Rate (m/hr) (of 8 beds, one standby included)	3.2	4.4	7

Except for the detention time of Sedimentation Basins the parameters of the proposed production are almost consistent with the design criteria of the present study, so it is concluded that the production capacity of the Pattaya-Na Klua Treatment Plant can be increased technically to 33,600 cu m/d, within reasonable investment of capital.

b) Necessary Works

As recommended in Chapter 5 EXISTING WATERWORKS, repair/replacement of filter media and underdrain is urgently required to attain efficient filtration.

2) Chemical Feeding Equipment

The existing chemical feeding equipment for alum and lime is housed in a room of the chemical building which is also used for chemical storage. The equipment is composed of solution tanks, stirrers, and feeding pumps but no flow meter is provided. In the next room, chlorine containers and a chlorinator are placed without container scale.

To meet the proposed treatment capacity, the additional chemical feeding equipment will be needed as follows:

Alum feeding pump with flow meter, piping and valves	1 Unit
Lime feeding pump with flow meter, piping and valves	1 Unit
Chlorine gas container scale	1 Unit

In addition to the equipment above, a chemical storage house should be newly constructed, since the existing chemical building will become undersized due to the proposed installation of additional equipment.

3) Instrumentation

As reported in CHAPTER 5, the malfunctioning instrumentation should be replaced by:

- the raw and treated water meters; and
- water level gauges in clear water reservoir and elevated tank.

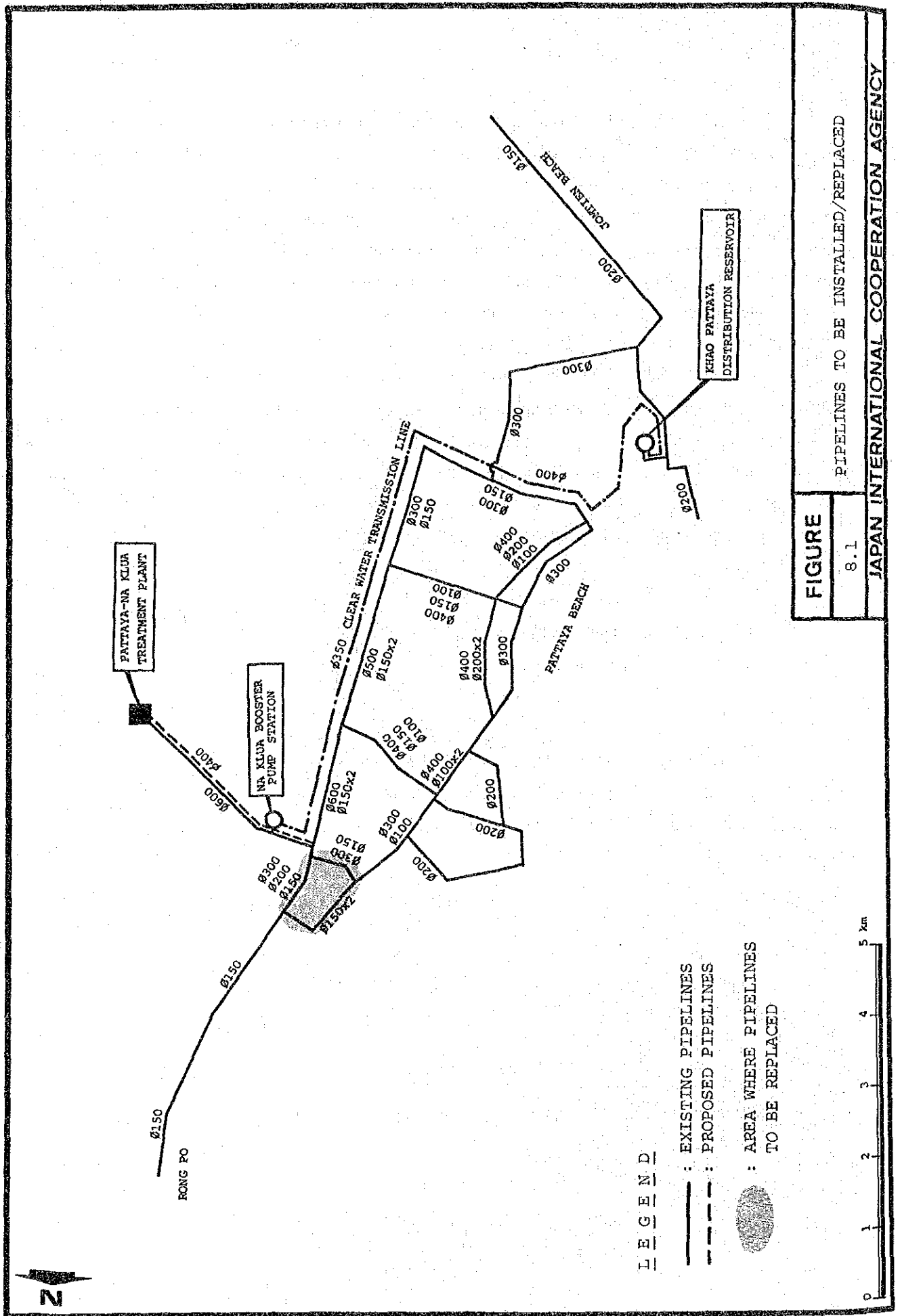
8.1.3 Distribution Pipeline

Immediate replacement is proposed for obsolete and defective pipes. The waterworks also requested the relocation of those pipes installed under rain sewers or in a drive way where heavy traffic is maintained. In addition to the replacement, a 400 mm dia. distribution main is also proposed for installation to convey the incremental production capacity of the Pattaya-Na Klua Treatment Plant and to reinforce the existing 600 mm diameter main as shown in Fig-8.1, and Table-8.1.

Table-8.1 LIST OF PIPELINES TO BE
INSTALLED OR REPLACED

PIPE	LENGTH
Dia. 400 mm	6,700 LM
Dia. 200 mm	380 LM
Dia. 150 mm	3,090 LM
Dia. 100 mm	1,760 LM

(NOTE) LM : Linear Meters



LEGEND

- : EXISTING PIPELINES
- - - : PROPOSED PIPELINES
- : AREA WHERE PIPELINES TO BE REPLACED



FIGURE
8.1

PIPELINES TO BE INSTALLED/REPLACED

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8.2 Expansion Works

8.2.1 Condition of the Preliminary Design

The design flow of each facility in the Stage I Expansion Works is as follows:

- Intake and Raw Water Transmission Pipeline
(Max Day Demand + Treatment Loss) : 21,700 cu m/d
- Thung Sukla Treatment Plant Facilities
(Max Day Demand + Treatment Loss) : 21,700 cu m/d
- Clear Water Transmission Pipeline to Rong Po
Distribution Pump Station (Max Day Demand) : 20,100 cu m/d
- Clear Water Transmission Pipeline to Kao Pattaya
Distribution Reservoir (Max Day Demand) : 4,600 cu m/d
- Distribution Facilities from Pattaya-Na Klua
Treatment Plant (Peak Hour) : 29,000 cu m/d
- Distribution Facilities from Rong Po
Distribution Pump Station (Peak Hour) : 24,100 cu m/d

8.2.2 Intake and Raw Water Transmission Pipeline

The proposed 400 m length raw water transmission pipe of 700 mm diameter will be connected with the 600 mm outlet of the Laem Chabang Receiving Well located in Ban Thung Sukla for diversion to the Pattaya Basin.

The proposed transmission pipe is equipped with a flow meter for measuring the raw water flow and a branch pipe for the Stage II Expansion.

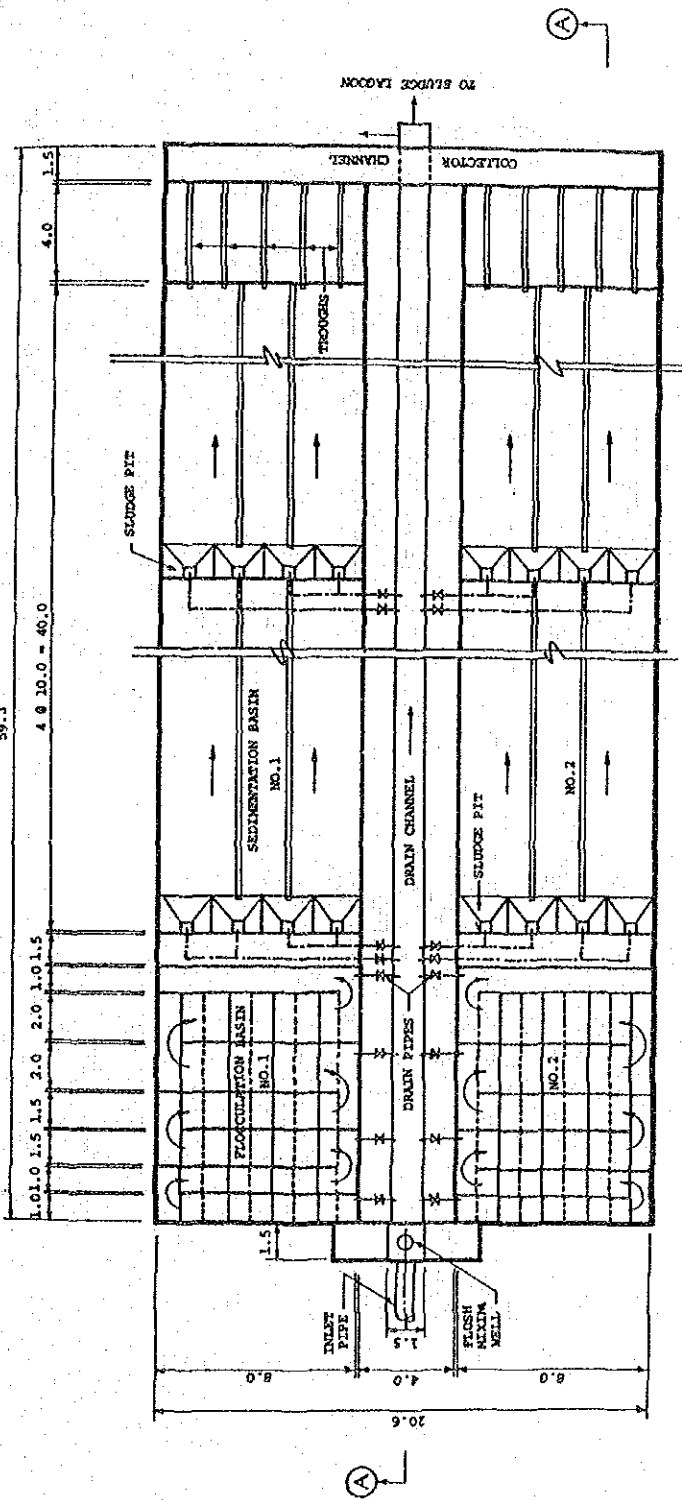
8.2.3 Thung Sukla Treatment Plant

Water quality of Nong Kho Reservoir is found acceptable for water supply except for the probable eutrophication as described in Appendix 4. The proposed treatment plant will incorporate the following processes:

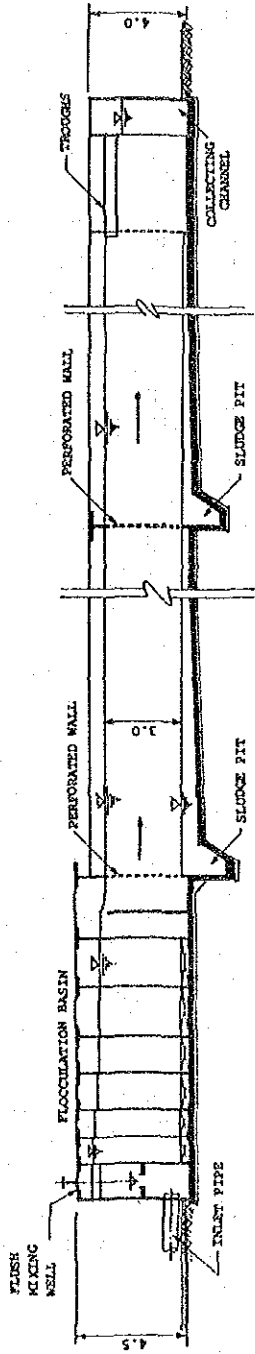
pre-chlorination, coagulation, flocculation and sedimentation, rapid sand filtration, alkali dosage and post-chlorination.

The capacity, dimensions and features of the facilities proposed for the plant's unit processes and operations are described below:

- 1) Flash Mixing Well (Fig-8.2)
hydraulic mixing by adjustable cone type for instance,
W 1.3 m x L 1.3 m x D 2.0 m, 1 well
G Value : 650 sec^{-1} (average in well)
Mixing Time : 1 - 3 sec, Detention time : 16 sec (V/Q)
- 2) Flocculation Basin (Fig-8.2)
hydraulic flocculation by baffled channels, 3 stages,
Volume : 260 cu m/basin, Detention Time : 34 min, 2 basins,
G Value : 25 - 70 sec^{-1}
- 3) Sedimentation Basin (Fig-8.2)
rectangular, one direction horizontal flow,
Volume : 960 cu m/basin, 2 basins, W 8.0 m x L 40.0 m x D 3.0 m,
Detention Time : 2.1 h, hydraulic loading : 1.4 $\text{m}^3/\text{m}^2/\text{h}$,
flow velocity : 0.3 m/min, manual desludging
- 4) Rapid Sand Filter (fig-8.3)
declining rate filtration,
filtration rate : 130 cu m/sq m/d in average,
6 filter beds including 1 stand-by, 33 sq m/bed,
backwashing together with surface washing
- 5) Clear Water Reservoir
for in-plant water consumption including backwashing, and
transmission
Volume : 450 cu m/reservoir, 2 reservoirs
- 6) Elevated Tank
for backwashing of filter bed,
Volume : 250 cu m/tank, 1 tank
- 7) Wastewater Basin
for wastewater from filters,
Volume : 250 cu m/basin, 2 basins

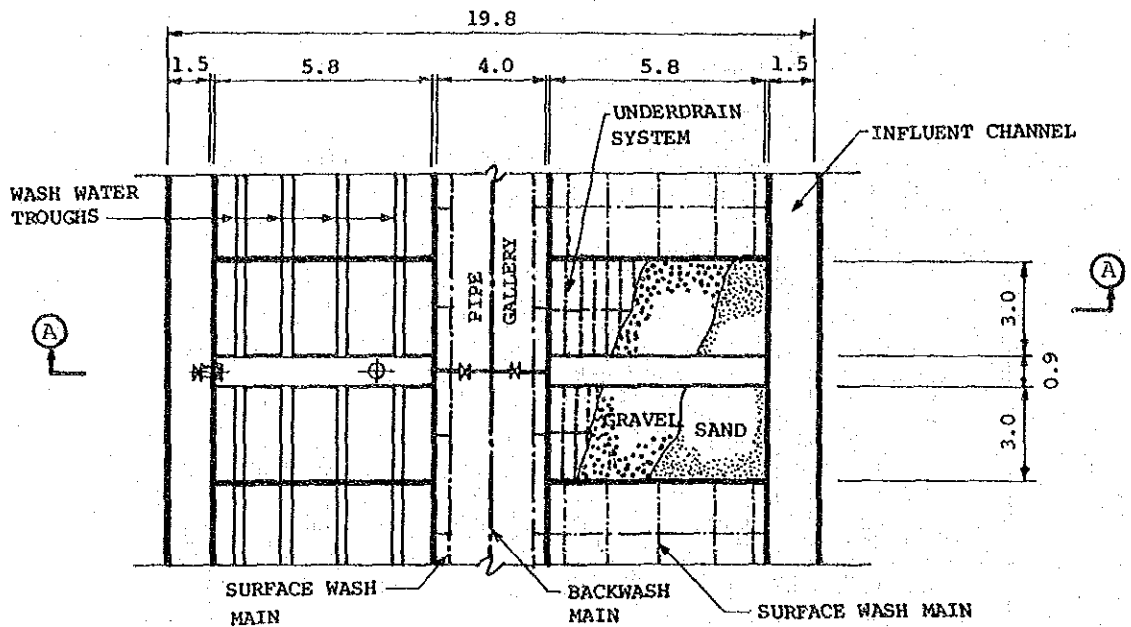


PLAN

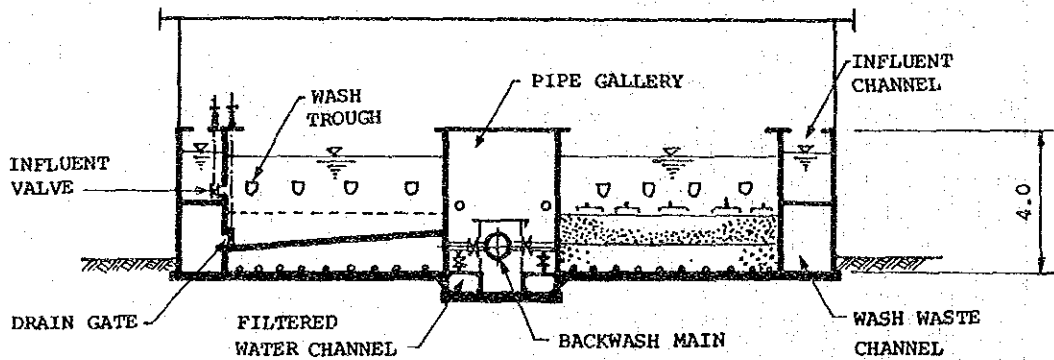


SECTION A-A

FLUSH MIXING, FLOCCULATION AND SEDIMENTATION BASINS	
FIGURE	8.2
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P L A N



S E C T I O N A - A

FIGURE	R A P I D S A N D F I L T E R
8.3	
J A P A N I N T E R N A T I O N A L C O O P E R A T I O N A G E N C Y	

- 8) Sludge Lagoon
for settling sludge dewatering
Surface area : 2,000 sq m

- 9) Chemical Feeding Equipment
 - Alum
solution tanks with mixers, feeding pumps, elevated header tanks, and appurtenances
 - Lime
hopper, solution tanks with mixers, feeding pumps, header tank, saturation tanks and appurtenances
 - Pre and Post Chlorination
container scale, evaporator, chlorinator and appurtenances

- 10) Instrumentation
 - flow meter and controller
 - flow and level indicator and recorder

- 11) Power Substation

- 12) Buildings
 - administration building
 - chemical building
 - staff houses
 - warehouse

8.2.4 Clear Water Transmission Pipeline

A new clear water transmission pipeline comprising 600 mm and 500 mm diameter of 6,000 m and 5,000 m lengths respectively will be constructed during the Stage I to deliver treated water to Rong Po Distribution Pump Station.

The general plan and topographic profile of the transmission route from the Thung Sukla Treatment Plant to the Rong Po Distribution Pump Station are shown in Fig-8.4 and Fig-8.5.

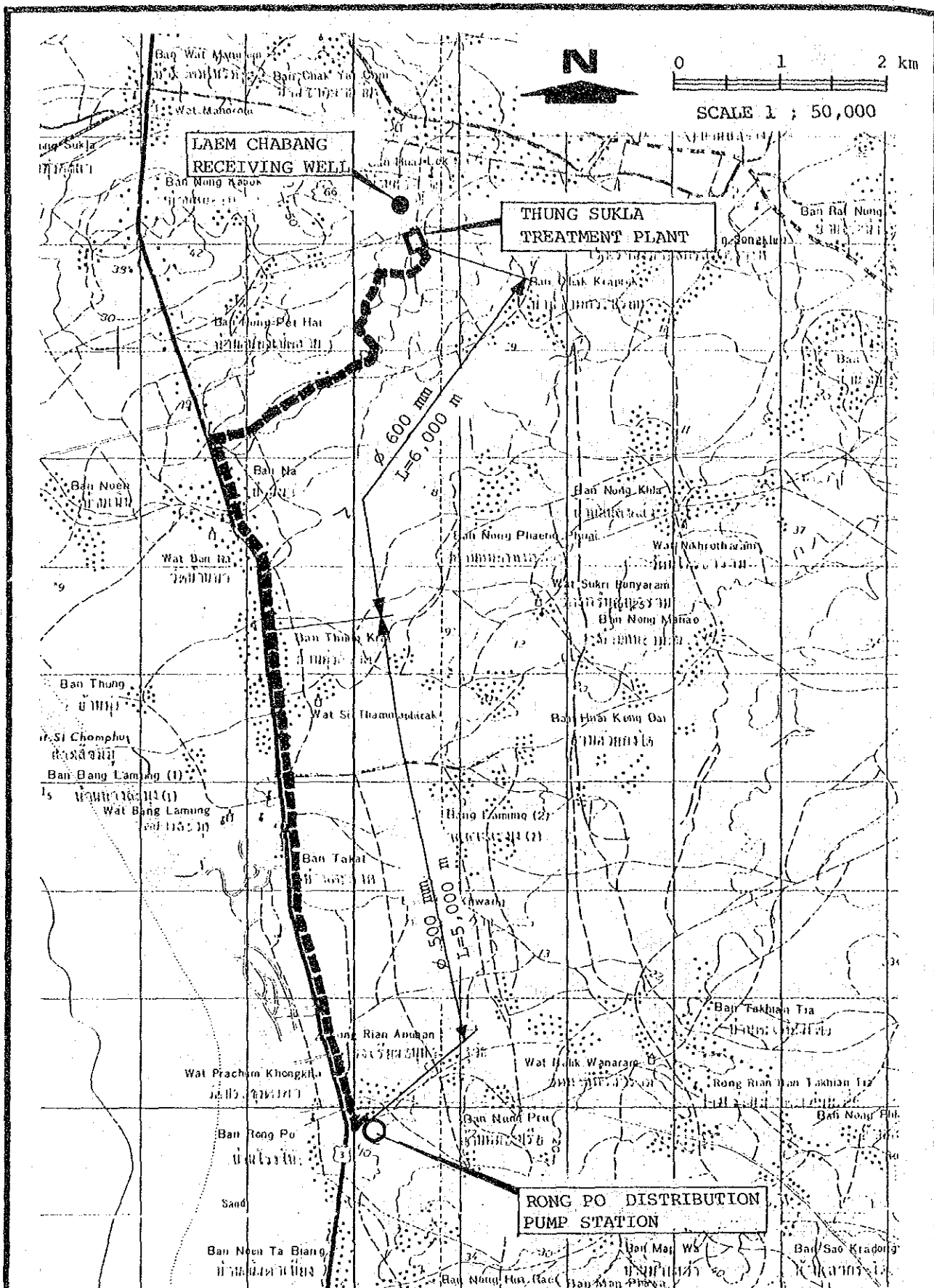


FIGURE	CLEAR WATER TRANSMISSION PIPELINE ROUTE
8.4	
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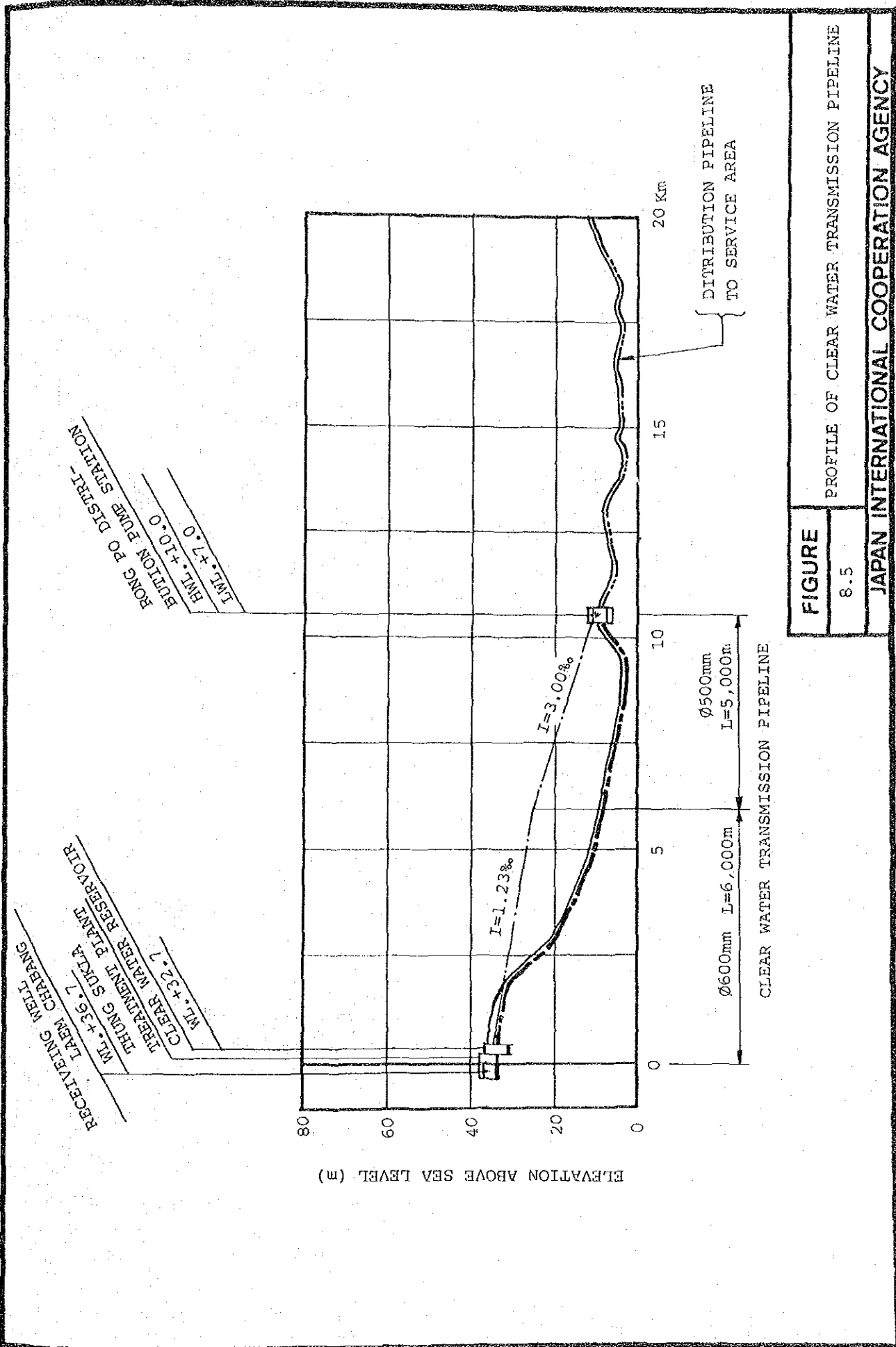


FIGURE
8.5

PROFILE OF CLEAR WATER TRANSMISSION PIPELINE

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For augmentation of services to the high elevation area around Kao Pattaya Distribution Reservoir, an additional 400 mm diameter clear water transmission pipe will be installed for 13,000 m from Na Klua Booster Pump Station to the Distribution Reservoir.

8.2.5 Rong Po Distribution Pump Station

The proposed Rong Po Distribution Pump Station is composed of two reservoirs with a total capacity of 5,000 cu m, pumps, a pump house, chlorination equipment, a power substation and staff houses. Features of the facilities are summarized below:

1) Distribution Reservoirs (Fig-8.6)

2 reservoirs

Volume: 2,500 cu m each

Detention Time: 6.0 h storage of the maximum day demand

2) Distribution Pump and Pump House (Fig-8.6)

large pumps : 2 units (one standby) 11.2 cu m/min x H 45 m

small pumps : 2 units (one standby) 5.6 cu m/min x H 45 m

The pumps are systematicable operated to immediately respond the daily fluctuation of demand.

3) Chlorination Equipment

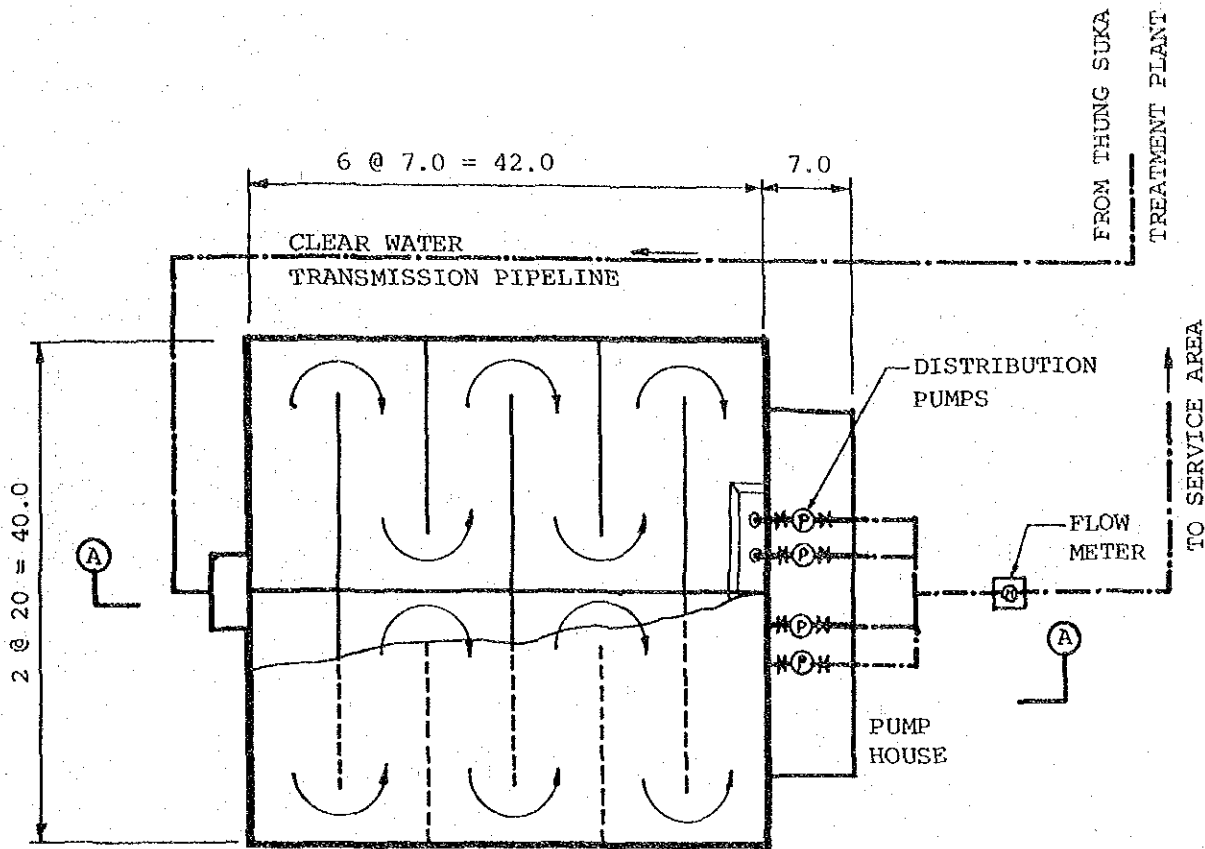
container scale, evaporator, chlorinator and appurtenances

4) Power Substation

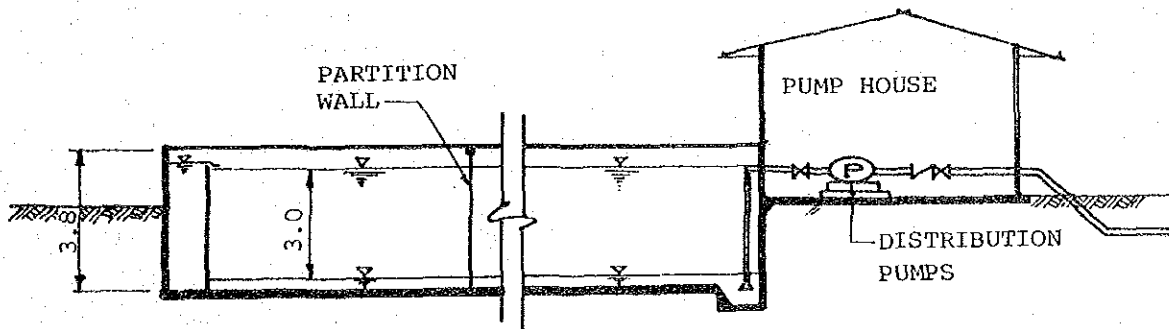
5) Staff Houses

8.2.6 Distribution Pipeline

The distribution system will be divided into two separate pressure zones allowing similar pressure ranges at different elevations of the service area. (See Fig-8.8 for division of zones)



P L A N



S E C T I O N A - A

FIGURE

RONG PO DISTRIBUTION PUMP STATION

8.6

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The hydraulic analysis of the distribution system incorporating proposed pipelines and the existing ones was carried out by means of computer-aided network analysis. Table-8.2 presents results of the analysis. Fig-8.7 shows the land use plan on which 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 proposed distribution pipelines based on the results of hydraulic analysis.

Table- 8.3 PROPOSED DISTRIBUTION
PIPELINES

DIAMETER (mm)	LENGTH (m)
600	4,200
500	1,800
400	7,400
300	15,750
200	1,000
150	11,000
100	37,200
Total	78,350

As a result of hydraulic analysis of the distribution network, the area will be served with 1 to 3 kg/sq cm service pressure except the node 29 where during the peak hour, the service pressure is expected to decrease to 0.75 kg/sq cm as shown in Fig-8.8. This is considered due to hydraulic disadvantages of the locality: the node 29 is 5 m higher than nodes 26 and 28 in ground elevation and the node 29 located at the end of the distribution networks. A particular measure will not be provided to increase the service pressure at the node 29 since the pressure drop is considered not critical.

Table-8.2 RESULT OF PIPE NETWORK ANALYSIS

Node	Node	Type	D (mm)	L (m)	C	Q (l/sec)	V (m/sec)	f (o/co)	dH (m)	Hb/r (m)	H (m)	GL (m)	He (m)	
100	-	1	0	671	2500	110	401.350	1.135	2.30	5.75	0.00	52.25	20.00	32.25
1	-	35	0	671	3000	110	371.850	1.052	2.00	5.99	0.00	46.26	5.00	41.26
35	-	2	0	671	1200	110	307.500	0.870	1.41	1.69	0.00	44.57	5.00	39.57
2	-	3	0	401	750	110	94.835	0.751	1.96	1.47	0.00	43.10	3.00	40.10
4	-	3	0	421	1400	110	89.532	0.643	1.39	1.94	0.00	43.10	3.00	40.10
4	-	2	0	566	1000	110	109.368	0.435	0.48	0.48	0.00	44.57	5.00	39.57
2	-	5	0	611	1800	110	316.633	1.080	2.34	4.21	0.00	40.36	10.00	30.36
5	-	6	0	411	1000	110	85.683	0.646	1.44	1.44	0.00	38.92	20.00	18.92
6	-	7	0	411	700	110	77.034	0.581	1.18	0.83	0.00	38.09	20.00	18.09
8	-	7	0	400	1000	110	94.188	0.750	1.96	1.96	0.00	38.09	20.00	18.09
3	-	8	0	390	800	110	126.548	1.059	3.82	3.06	0.00	40.05	10.00	30.05
3	-	6	0	300	1700	110	50.019	0.708	2.46	4.19	0.00	38.92	20.00	18.92
5	-	33	0	515	400	110	227.549	1.092	2.92	1.17	0.00	39.19	20.00	19.19
33	-	34	0	300	1000	110	56.724	0.802	3.11	3.11	0.00	36.08	25.00	11.08
6	-	34	0	300	900	110	57.168	0.809	3.15	2.84	0.00	36.08	25.00	11.08
34	-	12	0	300	1100	110	43.515	0.616	1.90	2.09	0.00	33.99	15.00	18.99
13	-	12	0	400	650	110	108.932	0.867	2.56	1.67	0.00	33.99	15.00	18.99
7	-	13	0	400	700	110	128.660	1.024	3.48	2.44	0.00	35.65	25.00	10.65
8	-	15	0	200	550	110	19.260	0.613	3.03	1.67	0.00	38.38	20.00	18.38
15	-	14	0	200	1300	110	10.060	0.320	0.91	1.19	0.00	37.19	15.00	22.19
7	-	14	0	200	950	110	10.262	0.327	0.95	0.90	0.00	37.19	15.00	22.19
14	-	13	0	200	1400	110	11.123	0.354	1.10	1.54	0.00	35.65	25.00	10.65
33	-	9	0	515	2000	110	168.925	0.811	1.68	3.37	0.00	35.82	20.00	15.82
9	-	10	0	411	1000	110	113.391	0.855	2.42	2.42	0.00	33.41	5.00	28.41
34	-	10	0	300	1800	110	38.077	0.539	1.49	2.68	0.00	33.41	5.00	28.41
10	-	11	0	411	850	110	52.175	0.393	0.57	0.49	0.00	32.92	4.00	28.92
9	-	16	0	317	1700	110	53.634	0.680	2.14	3.64	0.00	32.18	15.00	17.18
16	-	17	0	317	1000	110	51.634	0.654	2.00	2.00	0.00	30.18	5.00	25.18
18	-	17	0	317	700	110	52.366	0.664	2.05	1.43	0.00	30.18	5.00	25.18
10	-	18	0	400	1800	110	65.294	0.520	0.99	1.79	0.00	31.62	4.00	27.62
19	-	18	0	317	950	110	19.873	0.252	0.34	0.32	0.00	31.62	4.00	27.62
11	-	19	0	481	1600	110	81.473	0.448	0.61	0.97	0.00	31.94	3.00	28.94
17	-	21	0	390	1600	110	102.000	0.854	2.56	4.10	0.00	26.08	15.00	11.08
25	-	26	0	150	1300	110	6.951	0.393	1.87	2.43	0.00	16.54	5.00	11.54
28	-	26	0	200	500	110	21.649	0.689	3.77	1.88	0.00	16.54	5.00	11.54
27	-	28	0	400	1400	110	71.749	0.571	1.18	1.65	0.00	18.42	5.00	13.42
28	-	29	0	300	1900	110	20.400	0.289	0.47	0.89	0.00	17.53	10.00	7.53
32	-	4	0	566	800	110	208.300	0.828	1.57	1.25	0.00	45.05	5.00	40.05
30	-	32	0	605	800	110	213.800	0.744	1.19	0.95	0.00	46.30	5.00	41.30
31	-	30	0	605	3400	110	219.400	0.763	1.25	4.24	0.00	47.25	5.00	42.25
12	-	11	0	498	1700	110	90.898	0.467	0.63	1.07	0.00	32.92	4.00	28.92
27	-	25	0	200	500	110	16.251	0.517	2.22	1.11	0.00	18.97	5.00	13.97
21	-	27	0	400	2800	110	99.000	0.788	2.14	6.00	0.00	20.08	5.00	15.08
101	-	36	0	300	400	110	64.350	0.910	3.92	1.57	0.00	48.43	35.00	13.43
36	-	24	0	200	1200	110	22.000	0.700	3.88	4.66	0.00	43.77	20.00	23.77
36	-	23	0	300	800	110	42.350	0.599	1.81	1.45	0.00	46.98	35.00	11.98
23	-	22	0	200	900	110	37.350	1.189	10.33	9.30	0.00	37.69	20.00	17.69
22	-	21	0	300	1800	110	2.950	0.042	0.01	0.02	0.00	37.66	15.00	22.66
22	-	25	0	200	2500	110	9.250	0.294	0.78	1.95	0.00	35.73	5.00	30.73
22	-	27	0	300	2200	110	10.950	0.155	0.15	0.33	0.00	37.36	5.00	32.36

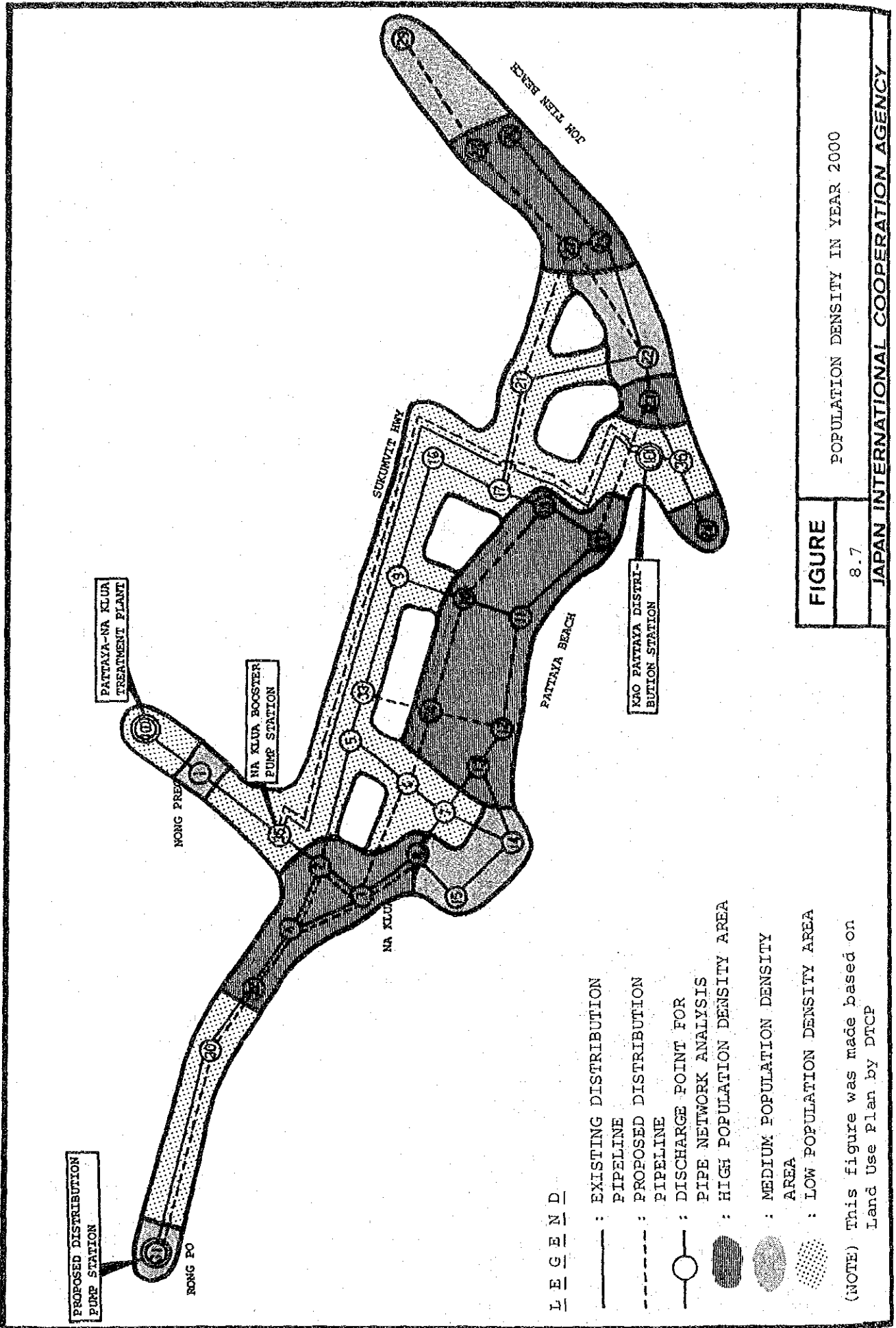
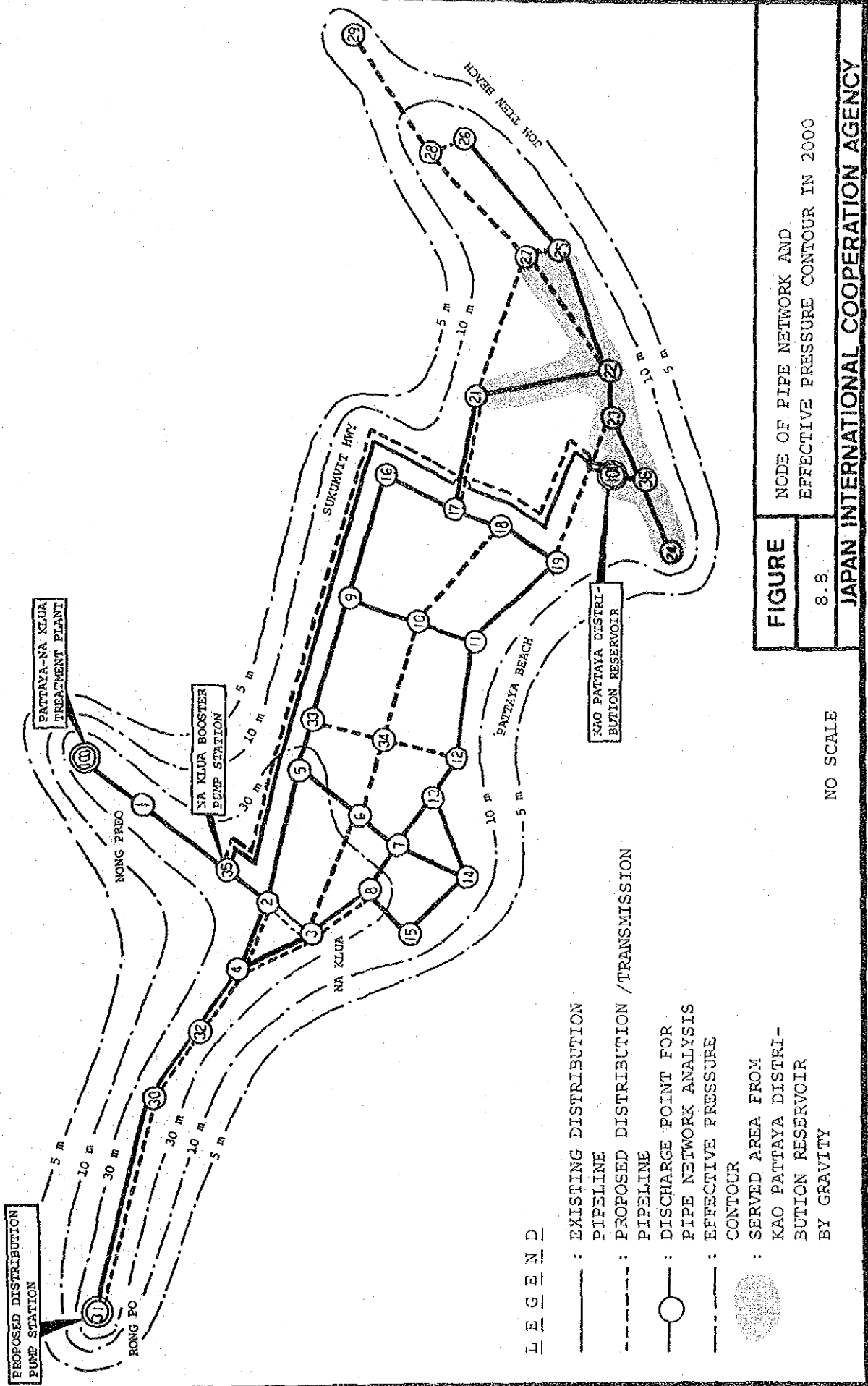


FIGURE	POPULATION DENSITY IN YEAR 2000
	8.7
JAPAN INTERNATIONAL COOPERATION AGENCY	



APPENDIX 9

COST DATA AND CONSTRUCTION COST

APPENDIX 9 COST DATA AND CONSTRUCTION COST

TABLE OF CONTENTS

9.1	Cost Data	A9 - 1
9.1.1	Cost Data Collection	A9 - 1
9.1.2	Pipelaying Cost	A9 - 1
9.1.3	Treatment Plant, Buildings and Others	A9 - 3
9.1.4	Land Acquisition	A9 - 3
9.2	Classification of Works	A9 - 5
9.3	Cost Allocation of Foreign and Local Currency Portions .	A9 - 5
9.3.1	Basic Conception	A9 - 5
9.3.2	Foreign and Local Currency Elements	A9 - 6
9.3.3	Combination of Foreign and Local Currency Elements	A9 - 6
9.4	Construction Cost	A9 - 9

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.

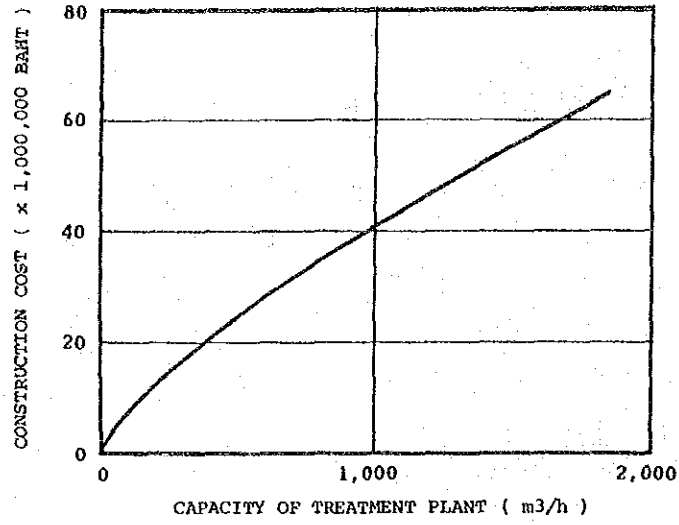
The approximately estimated costs were checked with the costs prepared by calculating, item by item, components of the whole construction work involved in the PWA standard design and the both were found close satisfactorily.

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 ADMINISTRATION AND OTHER USES

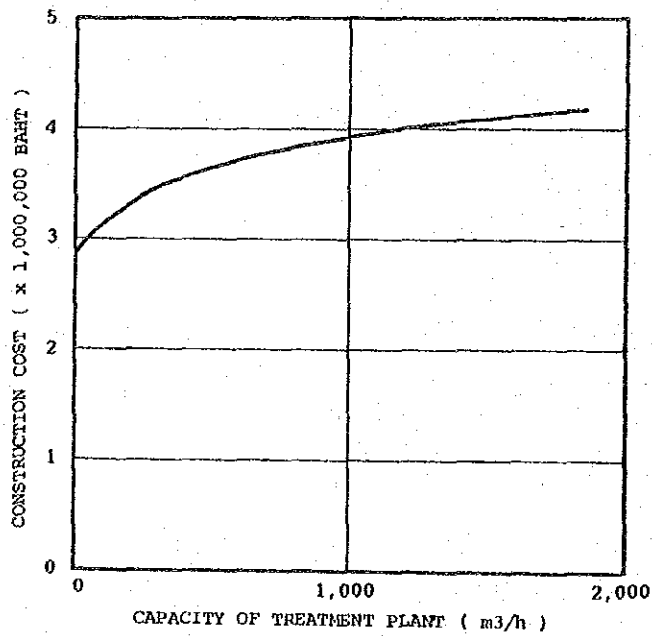


FIGURE	COST FUNCTION OF TREATMENT PALNT AND BUILDINGS FOR ADMINISTRATION AND OTHER USES
9.1	
JAPAN INTERNATIONAL COOPERATION AGENCY	

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 Cost 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

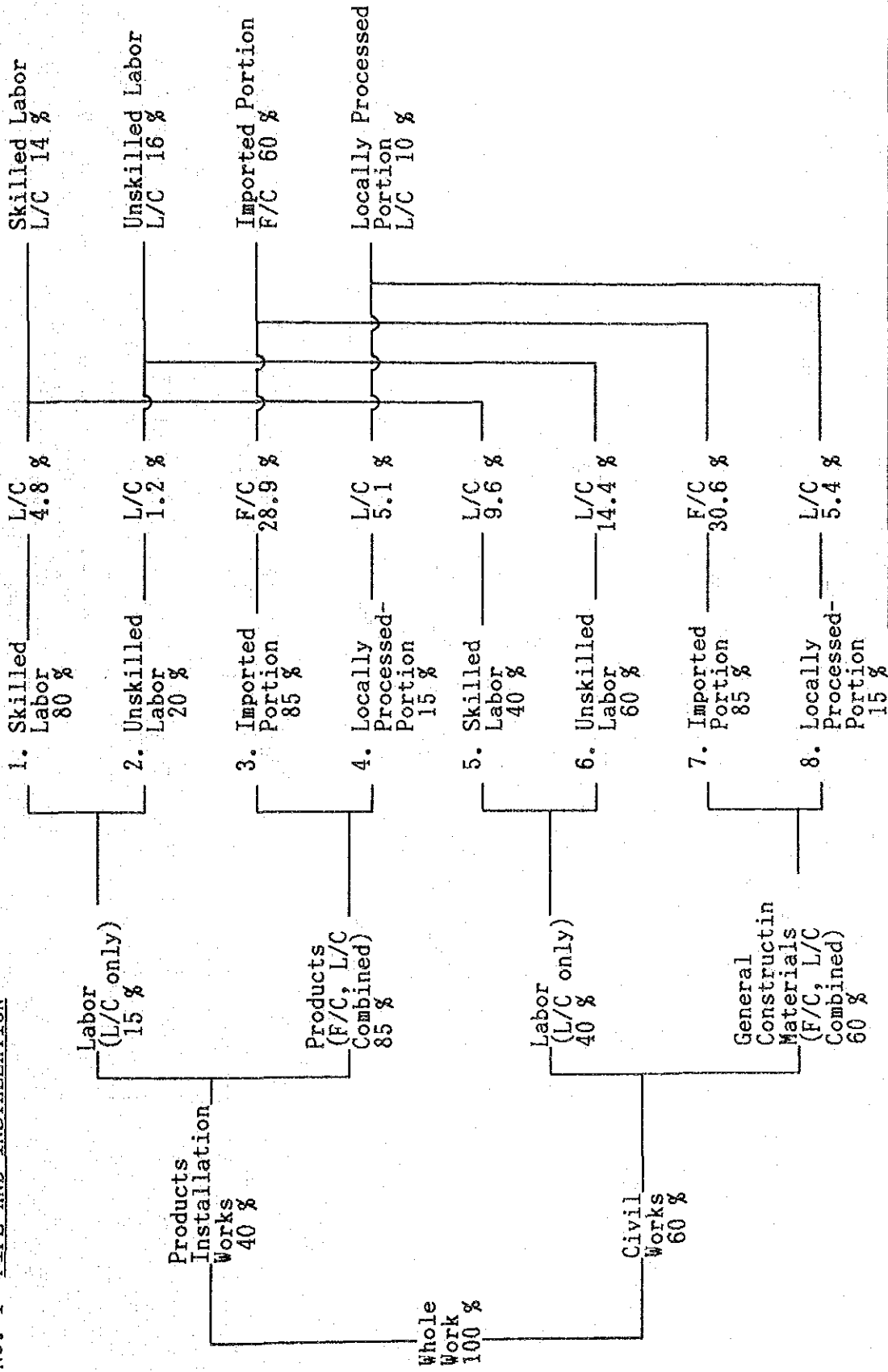
No.	Works Description	F/C Portion	L/C Portion		
			Locally Processed Portion	Skilled Labor	Unskilled Labor
1.	Pipelaying	60	10	14	16
2.	Civil works	63	11	12	14
3.	Treatment Plant Construction	66	12	12	10
4.	Pump Station Construction	75	10	7	8
5.	Equipments/ Machinery Installation	85	5	7	3
6.	Equipments/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

No. 1 PIPE AND INSTALLATION



FIGURE

9.3 (1)

COST-WISE BREAKDOWN FOR
PIPE AND INSTALLATION

JAPAN INTERNATIONAL COOPERATION AGENCY

No. 2 CIVIL WORKS

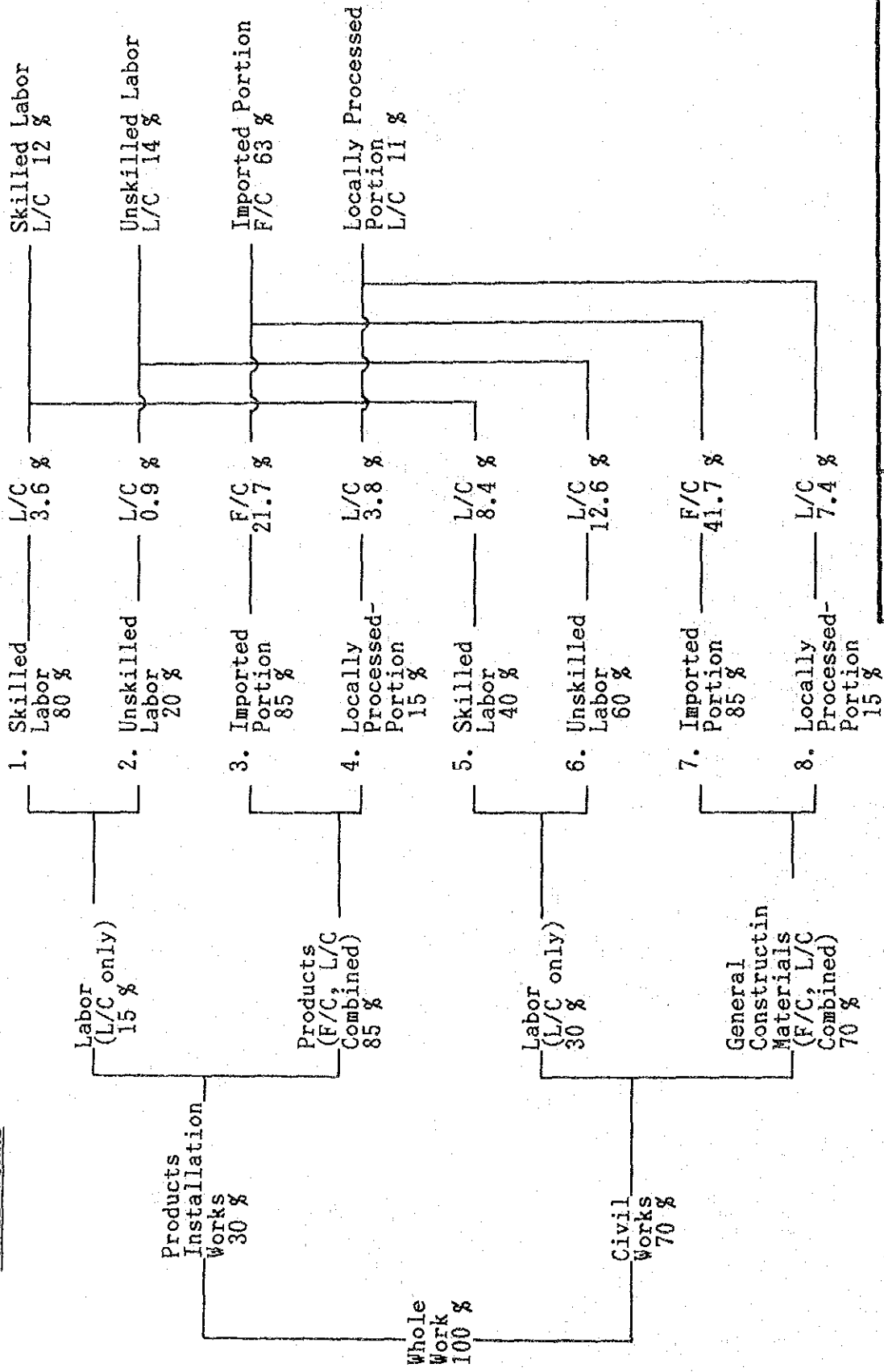
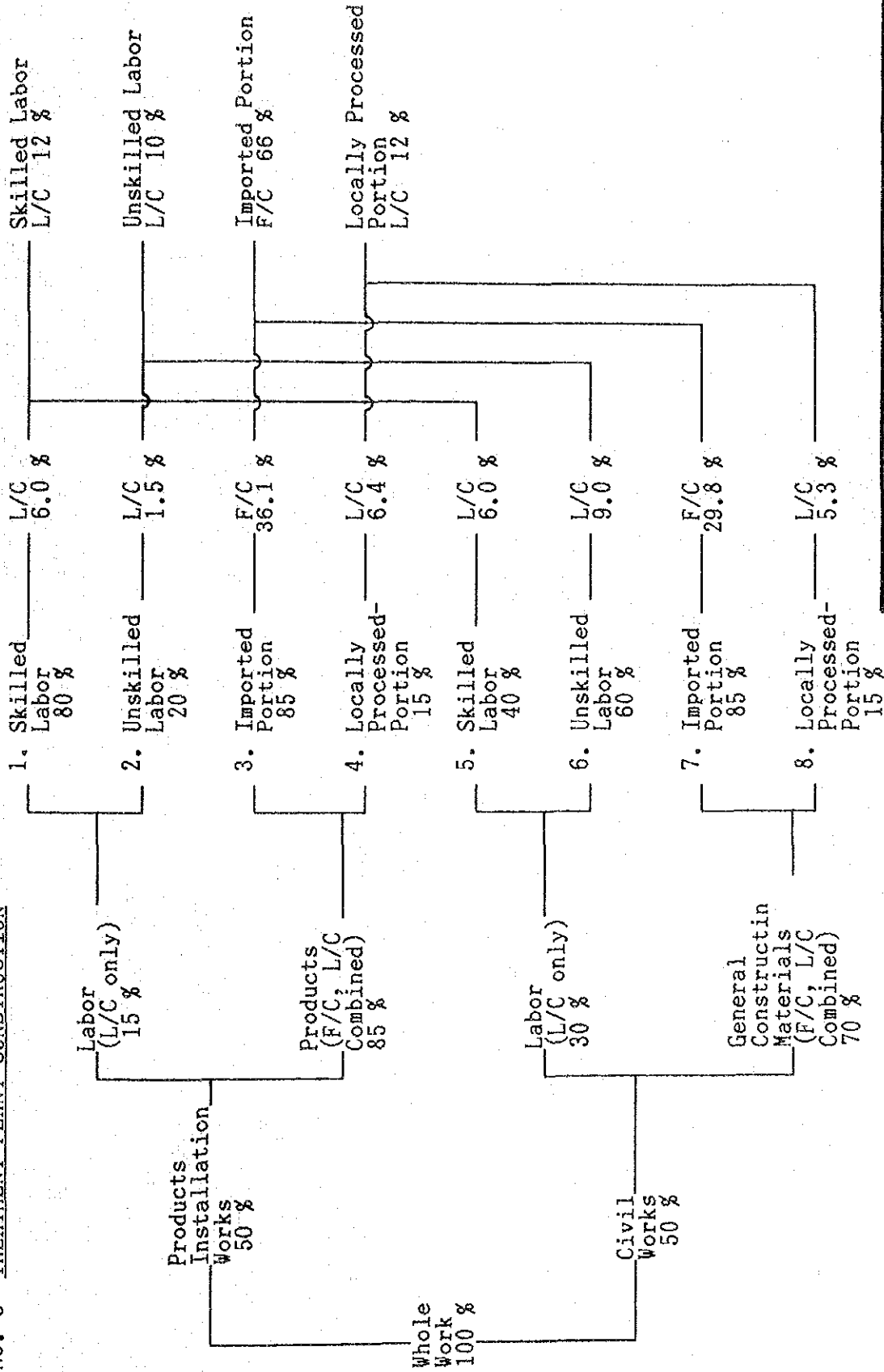


FIGURE
9.3 (2)

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

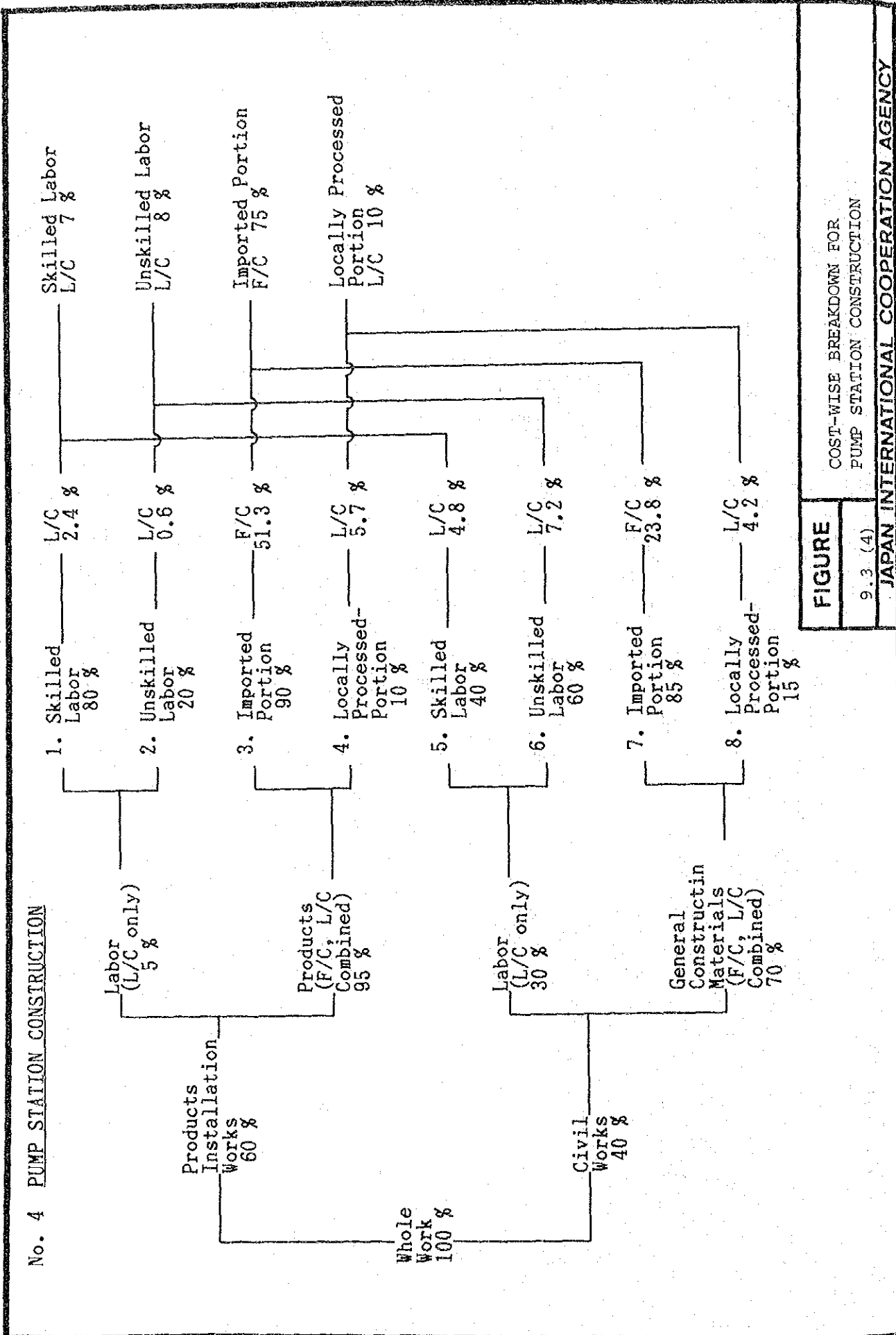


FIGURE
9.3 (4)
JAPAN INTERNATIONAL COOPERATION AGENCY

COST-WISE BREAKDOWN FOR
PUMP STATION CONSTRUCTION

No. 5 EQUIPMENT/MACHINERY AND INSTALLATION

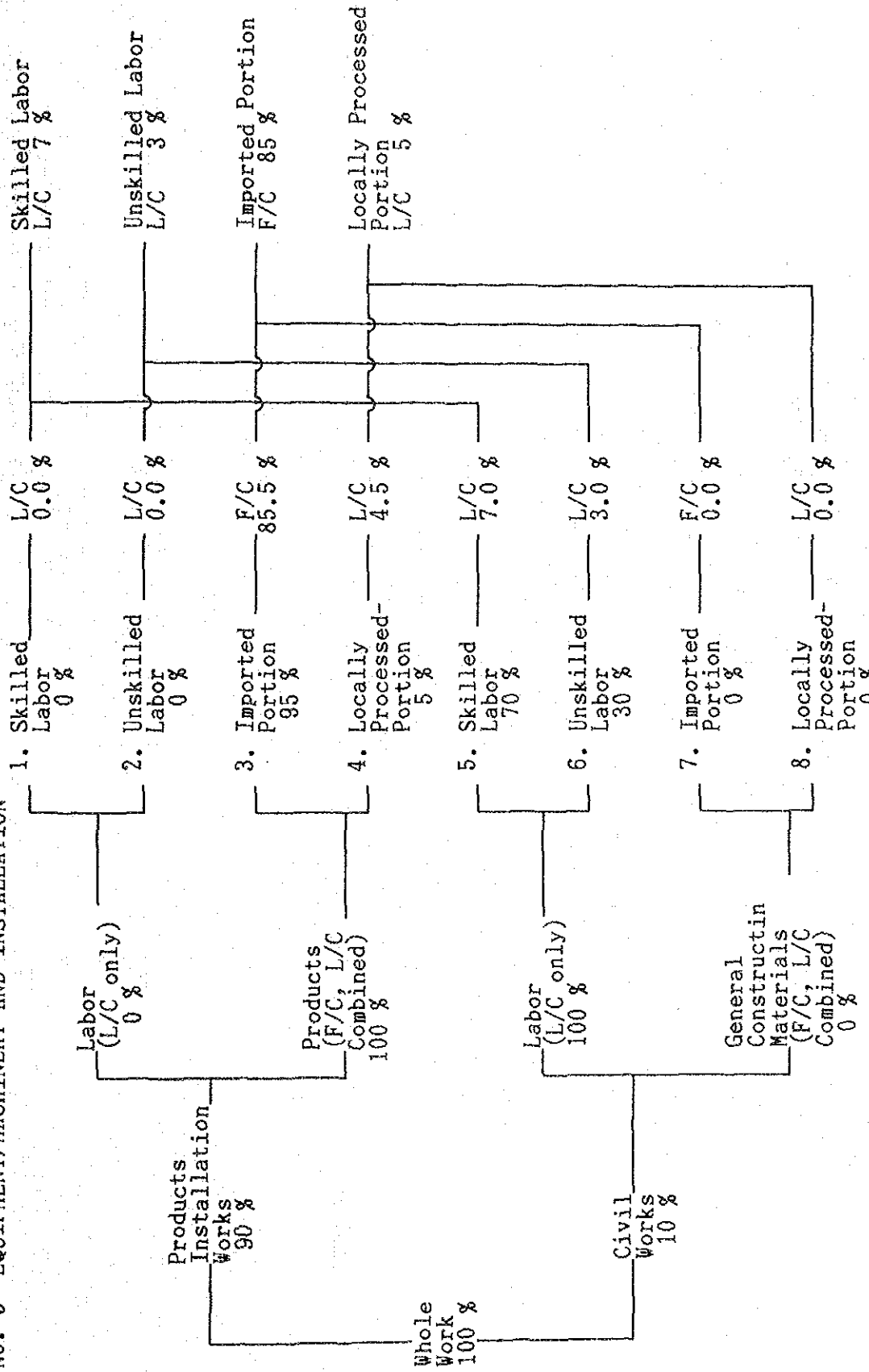


FIGURE
9.3 (5)
COST-WISE BREAKDOWN FOR
EQUIPMENT/MACHINERY AND INSTALLATION
JAPAN INTERNATIONAL COOPERATION AGENCY

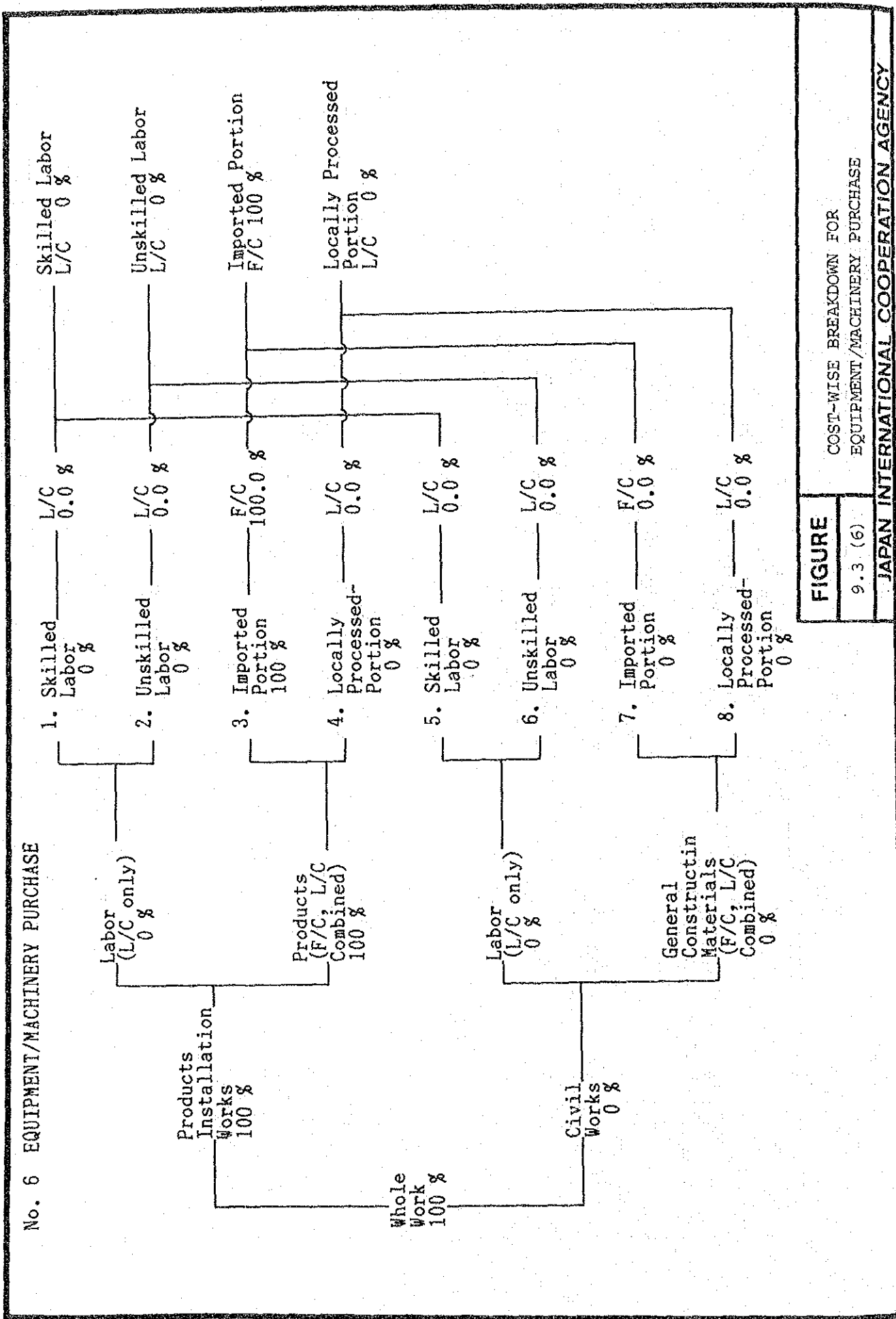


FIGURE
9.3 (6)
COST-WISE BREAKDOWN FOR
EQUIPMENT/MACHINERY PURCHASE
JAPAN INTERNATIONAL COOPERATION AGENCY

Table-9.3 CONSTRUCTION COST

(x 1,000 Baht)

Work Item	Description	Quantity	Unit Cost	Cost
I. Stage I Rehabilitatin/Modification Works				
1) Intake and Raw Water Transmission Pipeline	(1) Relocation of Intake Pump	L. S		300
	(2) Flow Meters and Recorders (Dia. 700 and 250 mm)	2	150	300
	T o t a l 1)			600
2) Pattaya-Na Klua Treatment Plant	(1) Chemical Feeding Equipment			
	- Alum	1	110	110
	- Lime	1	147	147
	- Chemical Storage House 7 m x 12 m	1	343	343
	Sub total (1)			600
	(2) Instrumentation			
	- Flow Meter and Recorder (Dia. 600 mm)	1	300	300
	- Water Level Gauges	2	200	400
	- Chlorine Container Scale	1	300	300
	Sub total (2)			1,000
	(3) Ripar of Filters			
	- Filter Media 390 m ²	390	0.62	240
	- Filter Underdrain	390	5.85	2,280
	- Miscellaneous	L. S		180
Sub total (3)			2,700	
(4) Procurement of Sand Washer	1	650	650	
	T o t a l 2)			4,950
3) Distribution Pipeline	(1) Additional Installation (Dia. 400 mm x 6,700 m)			
	- DIP	1,340	2.815	3,772
	- ACP	5,360	1.907	10,222
	- Pipe Bridge and Road Crossing	L. S		1,399
	- Miscellaneous	L. S		1,807
	Sub total (1)			17,200
	(2) Replacement			
	- ACP Dia. 200 mm	380	0.644	245
	- ACP Dia. 150 mm	3,090	0.450	1,391
	- ACP Dia. 100 mm	1,760	0.327	576
	- Miscellaneous	L. S		288
	Sub total (2)			2,500
	(3) Procurement of Leakage Detection Equipment			
	- Metal Pipe Detector	1	80	80
	- Non-Metal Pipe Detector	1	200	200
	- Box Locator	1	20	20
	- Leakage Detector	2	60	120
- Stethoscopic Bar	2	3	6	
- Spare Parts	L. S		24	
Sub total (3)			450	
	T o t a l 3)			20,150
Stage I Rehabilitatin/Modification Works	TOTAL			25,700

(Cont'd)

Work Item	Description	Quantity	Unit Cost	Cost
II. Stage I Expansion Works				
1) Land Acquisition	(1) Thung Sukla Treatment Plant 200 m x 150 m = 30,000 m ²	30,000	0.06	1,800
	(2) Rong Po Distribution Pump Station 70 m x 70 m = 4,900 m ²	4,900	0.063	300
	T o t a l 1)			2,100
2) Raw Water Transmission Pipeline	(1) PCP Dia. 700 mm x 400 m	400	1.6	640
	(2) Fittings	L.S		640
	(3) Valves and Flow Meter	L.S		900
	(4) Miscellaneous	L.S		320
T o t a l 2)				2,500
3) Thung Sukla Treatment Plant (Production Capacity : 20,100 m ³ /d)	(1) Civil Work	20,100	1.791	36,000
	(2) Building and Other Houses	20,100	0.194	3,900
	(3) Elevated Tank 250 m ³	250	10.4	2,600
	(4) Instrumentation	L.S		3,600
	(5) Miscellaneous	L.S		6,800
T o t a l 3)				52,900
4) Clear Water Transmission Pipeline	(1) Thung Sukla T.P. to Rong Po Pump Station			
	- DIP Dia. 500 mm x 1,000 m	1,000	3.963	3,963
	- ACP Dia. 500 mm x 4,000 m	4,000	2.594	10,376
	- DIP Dia. 600 mm x 1,200 m	1,200	5.237	6,284
	- ACP Dia. 600 mm x 4,800 m	4,800	3.360	16,128
	- Pipe Bridge and Road Crossing	L.S		3,675
	- Miscellaneous	L.S		5,374
	Sub total (1)			45,800
	(2) Na Klua Pump Station to Khao Pattaya Reservoir			
	- DIP Dia. 400 mm x 2,600 m	2,600	2.815	7,319
	- ACP Dia. 400 mm x 10,400 m	10,400	1.907	19,833
	- Pipe Bridge and Road Crossing	L.S		2,715
	- Booster Pump 1 unit	1		513
- Miscellaneous	L.S		4,320	
Sub total (2)			34,700	
T o t a l 4)				80,500
5) Rong Po Distribution Pump Station (Capacity : 5,000 m ³)	(1) Reservoir 5,000 m ³	5,000	2	10,000
	(2) Pump Station			
	- Pump House and Office 250 m ²	250	4	1,000
	- Large Pump 2 units	2	1022	2,044
	- Small Pump 2 units	2	438	876
	- Instrumentation	L.S		3,526
	- Miscellaneous	L.S		1,354
Sub total (2)			8,800	
T o t a l 5)				18,800
6) Distribution Pipeline	- DIP Dia. 600 mm x 840 m	840	5.237	4,399
	- ACP Dia. 600 mm x 3,360 m	3,360	3.360	11,290
	- DIP Dia. 500 mm x 360 m	360	3.963	1,427
	- ACP Dia. 500 mm x 1,440 m	1,440	2.594	3,735
	- DIP Dia. 400 mm x 1,480 m	1,480	2.815	4,166
	- ACP Dia. 400 mm x 5,920 m	5,920	1.907	11,289
	- DIP Dia. 300 mm x 3,150 m	3,150	1.998	6,294
	- ACP Dia. 300 mm x 12,600 m	12,600	1.149	14,477
	- DIP Dia. 200 mm x 200 m	200	1.236	247
	- ACP Dia. 200 mm x 800 m	800	0.644	515
	- ACP Dia. 150 mm x 11,000 m	11,000	0.450	4,950
	- ACP Dia. 100 mm x 37,200 m	37,200	0.327	12,164
	- Pipe Bridge and Road Crossing	L.S		7,495
	- Miscellaneous	L.S		11,451
T o t a l 6)				93,900
Stage I Expansion Works TOTAL				250,700
GRAND TOTAL (I+II)				276,400

APPENDIX 10

FINANCIAL AND ECONOMIC STUDY

APPENDIX 10 FINANCIAL AND ECONOMIC STUDY

LIST OF TABLES RELATED TO FINANCIAL AND ECONOMIC ANALYSIS

Table-10.1	Cash Flow Projected At 1986 Price	A10 - 1
Table-10.2	Cash Flow Projected At Current Price (With Every Year Increases In Water Tariffs)	A10 - 2
Table-10.3	Cash Flow Projected At Current Price (With No Changes In Water Tariffs)	A10 - 3
Table-10.4	Formula Suggested For Share Allocation Of Head And Regional Office Expenses Based On Waterworks Net Surpluses For 1985	A10 - 4
Table-10.5	Cash Flow Projected At 1986 Price (With Share Allocation Of Head And Regional Office Expenses Based On New Formula)	A10 - 5
Table-10.6	Cash Flow Projected At Current Price (With Every Year Increases In Water Tariffs, Based On New Share Allocation Formula)	A10 - 6
Table-10.7	Cash Flow Projected At Current Price (With Every 3 Year Increases In Water Tariffs, Based On New Share Allocation Formula)	A10 - 7
Table-10.8	Cash Flow Projected At Current Price (With No Changes In Water Tariffs, Based On New Share Allocation Formula)	A10 - 8
Table-10.9	Debt Service Projected (Based On Assumption Finance Given By A Foreign Loan With 8.5 % Interest Rate)	A10 - 9
Table-10.10	Cash Flow Projected At Current Price (With Every 3 Year Increases In Water Tariffs, Based On Assumption Finance Given by A Foreign Loan With 8.5 % Interest Rate)	A10 - 10
Table-10.11	Fixed Assets, Unit Cost After Depreciation And Rate Of Return (Based On New Share Allocation Formula)	A10 - 11
Table-10.12	Financial Internal Rate Of Return (Based On New Share Allocation Formula)	A10 - 12
Table-10.13	Average Incremental Costs (AIC)	A10 - 13

Table-10.14	Average Incremental Costs (AIC) (Based On New Share Allocation Formula)	.....	A10 - 14
Table-10.15	Economic Benefits VS Costs, Incremental (Based On New Share Allocation Formula)	.....	A10 - 15
Table-10.16	Economic Internal Rate Of Return (EIRR) Using Average Water Tariff As Economic Benefits (Based On New Share Allocation Formula)	.....	A10 - 16
Table-10.17	Economic Internal Rate Of Return (EIRR) Using AIC As Economic Benefits	.....	A10 - 17
Table-10.18	Economic Internal Rate Of Return (EIRR) Using AIC As Economic Benefits (Based On New Share Allocation Formula)	.....	A10 - 18

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

Description	Text Ref.	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
(A) Water Production (x1000 m ³)		6,484	7,085	7,686	8,374	9,061	9,619	10,263	10,907	11,465	11,981	12,524	12,711	13,011	13,355	13,698
(B) Unaccounted for Water (x)		15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
(C) Water Sales (x1000 m ³)		5,512	6,023	6,534	7,118	7,702	8,176	8,724	9,271	9,746	10,184	10,476	10,804	11,060	11,352	11,644
(D) No. of Connections		5,930	6,640	7,414	8,203	9,084	9,895	10,941	11,856	12,694	13,342	13,825	14,498	15,038	15,542	16,038
(E) Average Water Tariff (Baht/m ³)		8.36	8.36	8.36	8.36	8.36	8.36	8.36	8.36	8.36	8.36	8.36	8.36	8.36	8.36	8.36
1. Operating Revenue:																
1.1 Water Sales		46,076	50,348	54,620	59,502	64,385	68,351	72,928	77,506	81,472	85,134	87,575	90,321	92,457	94,899	97,340
1.2 Connection Fees		2,657	2,854	3,112	3,172	3,542	3,260	4,205	3,679	3,369	2,605	2,344	2,304	2,171	2,026	2,016
1.3 Service Charge		756	847	945	1,045	1,158	1,262	1,395	1,512	1,618	1,701	1,775	1,848	1,917	1,982	2,045
1.4 Other Revenue		227	248	269	292	316	334	360	379	396	410	420	433	442	453	465
Total 1.		49,716	54,297	58,946	64,012	69,401	73,207	78,888	83,074	86,856	89,850	92,114	94,906	96,988	99,359	101,865
2. Expenses:																
2.1 Operation & Maintenance																
- Personnel Cost		2,782	2,891	3,157	3,241	3,556	4,237	4,555	4,711	4,858	5,039	5,123	5,185	5,438	5,500	5,584
- Electricity & Fuel Cost		2,983	3,252	3,637	3,838	4,157	4,354	4,695	4,983	5,225	5,450	5,511	5,772	5,901	6,082	6,206
- Chemical Cost		897	977	1,063	1,153	1,249	1,330	1,415	1,506	1,582	1,652	1,703	1,753	1,793	1,844	1,889
- Connection Cost		1,074	1,154	1,258	1,282	1,431	1,318	1,700	1,487	1,362	1,053	947	931	877	819	806
- Raw Water Cost		0	0	0	0	0	0	3,499	4,543	5,447	6,282	6,838	7,464	7,951	8,508	9,054
- Other Cost		406	405	474	501	548	593	653	671	689	699	710	724	744	756	771
Sub-total 2.1		8,142	8,708	9,488	10,015	10,941	11,832	15,527	17,900	19,163	20,175	20,932	21,829	22,705	23,489	24,320
2.2 Share of Head & Regional Office Overhead Expenses		6,404	6,994	7,593	8,246	8,940	9,438	10,162	10,701	11,189	11,574	11,856	12,226	12,494	12,799	13,122
2.3 Debt Service		0	104	996	2,329	6,218	13,987	21,691	30,852	31,804	30,307	28,810	40,350	38,541	36,792	25,563
Total 2.		14,546	15,806	18,077	20,590	26,099	35,249	48,380	59,454	62,156	62,056	61,608	74,405	73,739	73,020	63,005
3. Net Cash Flow Surplus:																
3.1 Annual		35,170	38,490	40,868	43,422	43,302	37,958	30,509	23,621	24,700	27,794	30,506	20,501	23,249	26,340	38,860
3.2 Cumulative		35,170	73,660	114,528	157,950	201,252	239,210	269,719	293,340	318,040	345,834	376,340	396,841	420,090	446,430	485,289
4. Unit Cost of Water after Debt Service (Baht/m ³)*		2.45	2.43	2.56	2.69	3.14	4.03	5.13	5.98	5.98	5.77	5.59	6.55	6.36	6.14	5.17

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. (PATTAYA WATERWORKS)

Description	Text Ref.	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
(A) Water Production (x1000 m ³)		5,484	7,081	7,702	8,359	9,052	9,636	10,257	10,914	11,461	11,972	12,337	12,702	12,994	13,359	13,688
(B) Unaccounted for Water (%)		15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
(C) Water Sales (x1000 m ³)		5,512	6,023	6,534	7,118	7,702	8,176	8,724	9,271	9,746	10,184	10,475	10,804	11,060	11,352	11,544
(D) No. of Connections		5,930	6,640	7,414	8,203	9,084	9,895	10,941	11,856	12,694	13,542	13,925	14,498	15,038	15,542	16,038
(E) Average Water Tariff (Baht/m ³)**		8.36	8.64	8.92	9.22	9.52	9.83	10.16	10.49	10.84	11.20	11.57	11.95	12.34	12.75	13.17
1. Operating Revenue:																
1.1 Water Sales		46,076	52,010	58,284	65,590	73,313	80,399	88,613	97,283	105,636	114,027	121,167	129,091	136,504	144,732	152,354
1.2 Connection Fees		2,657	2,949	3,320	3,486	4,033	3,835	5,110	4,617	4,368	3,489	3,243	3,292	3,205	3,090	3,141
1.3 Service Charges		756	874	1,009	1,153	1,319	1,484	1,635	1,897	2,098	2,278	2,456	2,642	2,831	3,022	3,221
1.4 Other Revenue		227	256	287	322	360	393	437	475	514	549	581	619	653	691	732
Total 1.		49,716	58,088	62,900	70,561	79,025	86,110	95,855	104,272	112,616	120,343	127,447	135,643	143,193	151,535	160,448
2. Expenses:																
2.1 Operation & Maintenance		2,782	3,093	3,514	3,970	4,661	5,943	6,851	7,565	8,347	9,264	10,078	10,914	12,247	13,254	14,399
- Personnel Cost		2,983	3,359	3,774	4,231	4,783	5,122	5,705	6,255	6,775	7,300	7,764	8,250	8,712	9,245	9,771
- Electricity & Fuel Cost		897	1,008	1,134	1,271	1,422	1,564	1,719	1,890	2,051	2,213	2,356	2,505	2,647	2,812	2,976
- Chemical Cost		1,074	1,192	1,342	1,413	1,630	1,550	2,065	1,866	1,765	1,410	1,311	1,331	1,295	1,249	1,270
- Connection Cost		0	0	0	0	0	0	4,239	5,715	7,053	8,395	9,490	10,648	11,698	12,986	14,253
- Raw Water Cost		406	455	519	573	656	748	863	929	1,002	1,089	1,140	1,221	1,323	1,412	1,513
- Other Cost		8,142	9,108	10,383	11,459	13,103	14,927	21,442	24,220	26,994	29,651	32,138	34,868	37,923	40,958	44,187
Sub-total 2.1		5,404	7,225	8,103	9,089	10,180	11,093	12,348	13,432	14,507	15,502	16,417	17,473	18,446	19,520	20,669
2.2 Share of Head & Regional Office Overhead Expenses		0	104	996	2,329	5,218	13,987	21,691	30,852	31,804	30,307	28,810	40,350	38,541	36,732	25,563
2.3 Debt Service		14,546	16,437	19,462	22,877	29,530	40,006	55,460	68,504	73,305	75,460	77,366	92,691	94,909	97,210	90,419
Total 2.		35,170	39,651	43,419	47,683	49,525	46,104	40,375	35,768	39,311	44,883	50,082	42,952	48,283	54,325	70,030
3. Net Cash Flow Surplus:																
3.1 Annual		35,170	74,821	118,240	165,923	215,448	261,552	361,927	337,696	377,007	421,890	471,971	514,923	563,207	617,531	687,561
3.2 Cumulative		2.45	2.53	2.76	2.99	3.55	4.57	5.88	6.89	7.06	7.02	7.02	8.16	8.18	8.18	7.42
4. Unit Cost of Water after Debt Service (Baht/m ³)*																

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. (PATTAYA WATERWORKS)

Description	Text Ref.	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
(A) Water Production (x1000 m ³)		6,484	7,085	7,586	8,374	9,061	9,619	10,263	10,907	11,465	11,981	12,324	12,711	13,011	13,355	13,658
(B) Unaccounted for Water (x)		15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
(C) Water Sales (x1000 m ³)		5,512	6,023	6,534	7,118	7,702	8,176	8,724	9,271	9,746	10,184	10,476	10,804	11,060	11,352	11,644
(D) No. of Connections		5,930	6,640	7,414	8,203	9,084	9,895	10,941	11,856	12,694	13,342	13,925	14,498	15,038	15,542	16,098
(E) Average Water Tariff (Baht/m ³)**		8.36	8.36	8.36	8.36	8.36	8.36	8.36	8.36	8.36	8.36	8.36	8.36	8.36	8.36	8.36
1. Operating Revenue:																
1.1 Water Sales		46,076	50,348	54,620	59,592	64,395	68,351	72,928	77,536	81,472	85,134	87,575	90,321	92,457	94,899	97,340
1.2 Connection Fees		2,657	2,854	3,112	3,172	3,542	3,260	4,205	3,679	3,369	2,605	2,344	2,304	2,171	2,026	1,994
1.3 Service Charges		756	847	945	1,046	1,158	1,262	1,395	1,512	1,618	1,701	1,775	1,848	1,917	1,982	2,045
1.4 Other Revenue		227	248	263	292	316	334	360	379	396	410	420	433	442	453	464
Total 1.		49,716	54,297	58,946	64,012	69,401	73,207	78,868	83,074	86,856	89,850	92,114	94,906	96,988	99,359	101,843
2. Expenses:																
2.1 Operation & Maintenance																
- Personnel Cost		2,782	3,093	3,614	3,970	4,661	5,943	6,851	7,565	8,347	9,264	10,078	10,914	12,247	13,254	14,399
- Electricity & Fuel Cost		2,983	3,359	3,774	4,231	4,733	5,122	5,705	6,255	6,775	7,300	7,764	8,250	8,712	9,245	9,777
- Chemical Cost		897	1,009	1,134	1,271	1,422	1,584	1,719	1,830	2,051	2,213	2,356	2,505	2,647	2,812	2,975
- Connection Cost		1,074	1,192	1,342	1,413	1,630	1,550	2,065	1,866	1,765	1,410	1,311	1,331	1,295	1,249	1,270
- Raw Water Cost		0	0	0	0	0	0	4,252	5,702	7,062	8,414	9,461	10,568	11,739	12,975	14,280
- Other Cost		406	455	519	573	656	748	863	929	1,002	1,069	1,140	1,221	1,323	1,412	1,513
Sub-total 2.1		8,142	9,108	10,383	11,459	13,103	14,927	21,454	24,297	27,003	29,670	32,109	34,888	37,964	40,948	44,214
2.2 Share of Head & Regional Office Overhead Expenses		6,404	6,994	7,583	8,246	8,940	9,430	10,162	10,701	11,189	11,574	11,866	12,226	12,494	12,799	13,119
2.3 Debt Service		0	104	996	2,329	6,218	13,987	21,591	30,852	31,804	30,307	28,810	40,350	38,541	35,732	25,563
Total 2.		14,546	16,206	18,972	22,034	28,260	38,344	53,307	65,760	69,996	71,551	72,785	87,464	88,998	99,479	82,897
3. Net Cash Flow Surplus:																
3.1 Annual		35,170	38,090	39,973	41,978	41,141	34,863	25,581	17,314	16,860	18,299	19,329	7,443	7,989	8,881	18,946
3.2 Cumulative		35,170	73,260	113,233	155,212	196,362	231,216	256,797	274,111	290,971	309,270	328,599	336,042	344,031	352,912	371,858
4. Unit Cost of Water after Debt Service (Baht/m ³)*		2.45	2.50	2.69	2.88	3.40	4.38	5.55	6.62	6.74	6.65	6.61	7.70	7.67	7.61	6.80

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)

Item	Chiangmai Waterworks	Pattaya Waterworks	Ubon-Rathin Waterworks	Suphanburi Waterworks	Total Revenue of PWA	All Waterworks of PWA	Item	Head Office	Regional Office I	Regional Office II	Regional Office VIII	Regional Office IX
Revenue	64.614	49.106	27.999	7.556	1,307.990	1,307.990	Revenue of w/w under its jurisdiction	1,307.990	196.049	130.639	100.181	168.068
Expenses	21.627	8.205	11.039	4.960	901.730	641.685	Expense of office	159.275	6.959	8.102	5.545	8.001
Surplus (B)	42.987	40.901	16.960	2.596	406.260	666.305	Expens/Surplus of all waterworks under jurisdiction	0.239	0.010	0.012	0.008	0.012
Share Percentage (A)							=SHARE PERCENTAGE (A)					
Head Off Expenses	0.239	0.239	0.239	0.239	0.239	0.239						
Reg Off Expenses	0.012	0.010	0.008	0.012	0.012	0.012						
Total	0.251	0.249	0.247	0.251	0.251	0.251						
Share Amount -(B)x(A)												
Head Off Expenses	10.276	9.777	4.054	0.621	0.621	0.621						
Reg Off Expenses	0.516	0.427	0.141	0.032	0.032	0.032						
Total	10.792	10.204	4.195	0.652	0.652	0.652						

Table-10.5 CASH FLOW PROJECTED (x 1,000 Baht) AT 1986 PRICE. (PATTAYA WATERWORKS)

Description	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
(A) Water Production (x1000 m ³)	6,484	7,085	7,686	8,374	9,061	9,619	10,263	10,907	11,465	11,981	12,524	12,711	13,011	13,355	13,698
(B) Unaccounted for Water (C)	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
(C) Water Sales (x1000 m ³)	5,512	6,923	6,534	7,118	7,702	8,176	8,724	9,271	9,746	10,184	10,476	10,804	11,063	11,352	11,644
(D) No. of Connections	5,930	6,640	7,414	8,203	9,084	9,895	10,941	11,866	12,694	13,342	13,925	14,498	15,038	15,542	16,038
(E) Average Water Tariff (Baht/m ³)	8.36	8.36	8.36	8.36	8.36	8.36	8.36	8.36	8.36	8.36	8.36	8.36	8.36	8.36	8.36
1. Operating Revenue:															
1.1 Water Sales	46,076	50,348	54,620	59,502	64,385	68,351	72,928	77,506	81,472	85,134	87,575	90,321	92,457	94,899	97,340
1.2 Connection Fees	2,657	2,854	3,112	3,172	3,542	3,260	4,205	3,579	3,369	2,695	2,944	2,304	2,171	2,025	2,016
1.3 Service Charge	756	847	945	1,046	1,158	1,262	1,385	1,512	1,618	1,701	1,775	1,848	1,917	1,982	2,045
1.4 Other Revenue	227	248	269	292	316	334	350	379	396	410	420	433	442	453	465
Total 1.	49,716	54,297	58,946	64,012	69,401	73,207	78,888	83,074	86,856	89,850	92,114	94,906	96,988	99,369	101,865
2. Expenses:															
2.1 Operation & Maintenance															
- Personnel Cost	2,782	2,891	3,157	3,241	3,556	4,237	4,585	4,711	4,858	5,009	5,123	5,185	5,408	5,500	5,584
- Electricity & Fuel Cost	2,983	3,252	3,537	3,838	4,157	4,354	4,695	4,983	5,225	5,450	5,611	5,772	5,901	6,062	6,206
- Chemical Cost	897	977	1,063	1,153	1,249	1,330	1,415	1,506	1,582	1,652	1,703	1,753	1,793	1,844	1,889
- Connection Cost	1,074	1,154	1,258	1,282	1,431	1,318	1,700	1,487	1,362	1,053	947	931	877	819	806
- Raw Water Cost	0	0	0	0	0	0	3,499	4,543	5,447	6,282	6,838	7,464	7,951	8,508	9,064
- Other Cost	406	435	474	501	548	593	653	671	689	699	710	724	744	756	771
Sub-total 2.1	8,142	8,708	9,468	10,015	10,941	11,832	16,527	17,900	19,163	20,175	20,932	21,829	22,705	23,469	24,320
2.2 Share of Head & Regional Office Overhead Expenses	10,331	11,263	12,249	13,301	14,421	15,212	16,393	17,263	18,048	18,670	19,141	19,721	20,154	20,646	21,157
2.3 Debt Service	0	104	996	2,329	6,218	13,987	21,691	30,852	31,884	30,307	28,810	40,350	38,541	36,732	25,563
Total 2.	18,473	20,095	22,733	25,646	31,580	41,031	54,610	66,015	69,016	69,152	68,883	81,900	81,399	80,867	71,051
3. Net Cash Flow Surplus:															
3.1 Annual	31,243	34,202	36,213	38,366	37,821	32,176	24,278	17,050	17,640	20,698	23,231	13,006	15,589	16,492	30,615
3.2 Cumulative	31,243	65,445	101,658	140,024	177,845	210,022	234,300	251,359	269,199	289,897	313,128	326,134	341,723	360,215	391,030
4. Unit Cost of Water after Debt Service (Baht/m ³)*	3.11	3.09	3.22	3.35	3.80	4.69	5.79	6.64	6.64	6.43	6.25	7.21	7.02	6.80	5.83

Note: * [(Total 2.) x (1.1 Water Sales) / (Total 1.)] / (C. 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. (PATTAYA WATERWORKS)

Description	Text Ref.	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
(A) Water Production (x1000 m ³)		6,484	7,081	7,702	8,359	9,052	9,836	10,257	10,914	11,461	11,972	12,337	12,702	12,984	13,359	13,688
(B) Unaccounted for Water (x)		15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
(C) Water Sales (x1000 m ³)		5,512	6,023	6,584	7,118	7,702	8,176	8,724	9,271	9,745	10,184	10,476	10,804	11,060	11,352	11,644
(D) No. of Connections		5,930	6,640	7,414	8,203	9,084	9,885	10,941	11,856	12,694	13,342	13,925	14,498	15,038	15,542	16,038
(E) Average Water Tariff (Baht/m ³)**		8.36	8.64	8.92	9.22	9.52	9.83	10.16	10.49	10.84	11.20	11.57	11.95	12.34	12.75	13.17
1. Operating Revenue:																
1.1 Water Sales		46,076	52,010	58,284	65,590	73,313	80,399	88,613	97,283	105,636	114,027	121,167	129,091	136,504	144,732	153,354
1.2 Connection Fees		2,657	2,949	3,320	3,496	4,003	3,835	5,110	4,617	4,368	3,468	3,243	3,292	3,205	3,090	3,141
1.3 Service Charges		756	874	1,009	1,153	1,319	1,484	1,685	1,897	2,098	2,278	2,456	2,642	2,831	3,022	3,221
1.4 Other Revenue		227	256	287	322	360	393	437	475	514	549	581	619	653	691	732
Total 1.		49,716	56,088	62,900	70,561	79,025	86,110	95,855	104,272	112,516	120,343	127,447	135,643	143,193	151,535	160,448
2. Expenses:																
2.1 Operation & Maintenance																
- Personnel Cost		2,782	3,093	3,614	3,970	4,661	5,943	6,851	7,565	8,347	9,264	10,078	10,914	12,247	13,254	14,399
- Electricity & Fuel Cost		2,983	3,359	3,774	4,231	4,733	5,122	5,705	6,255	6,775	7,300	7,764	8,250	8,712	9,245	9,777
- Chemical Cost		897	1,009	1,134	1,271	1,422	1,564	1,719	1,890	2,051	2,213	2,366	2,505	2,647	2,812	2,976
- Connection Cost		1,074	1,192	1,342	1,413	1,636	1,550	2,065	1,866	1,765	1,410	1,311	1,331	1,295	1,249	1,270
- Raw Water Cost		0	0	0	0	0	0	4,239	5,715	7,053	8,395	9,490	10,648	11,698	12,986	14,253
- Other Cost		406	455	519	573	656	748	863	929	1,002	1,069	1,140	1,221	1,323	1,412	1,513
Sub-total 2.1		8,142	9,108	10,388	11,459	13,103	14,927	21,442	24,220	26,994	29,651	32,138	34,868	37,923	40,958	44,187
2.2 Share of Head & Regional Office Overhead Expenses ***		10,331	11,655	13,070	14,662	16,421	17,893	19,918	21,667	23,401	25,007	26,483	28,186	29,755	31,488	33,341
2.3 Debt Service		0	104	996	2,329	6,218	13,987	21,691	30,852	31,804	30,307	28,810	40,350	38,541	36,732	25,563
Total 2.		18,473	20,867	24,450	28,450	35,741	46,807	63,050	76,739	82,200	84,965	87,431	103,404	106,219	109,178	103,091
3. Net Cash Flow Surplus:																
3.1 Annual		31,243	35,221	38,451	42,111	43,284	39,303	32,804	27,533	30,417	35,378	40,016	32,239	36,974	42,356	57,368
3.2 Cumulative		31,243	66,465	104,915	147,026	190,310	229,613	262,418	289,951	320,368	355,746	395,762	428,001	454,975	507,331	554,699
4. Unit Cost of Water after Debt Service (Baht/m ³)*		3.11	3.21	3.47	3.72	4.31	5.35	6.68	7.72	7.91	7.91	7.93	9.11	9.16	9.19	8.45

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. (PATTAYA WATERWORKS)

Description	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
(A) Water Production (x1000 m ³)	6,484	7,085	7,686	8,374	9,061	9,619	10,263	10,907	11,455	11,981	12,524	12,711	13,011	13,355	13,698
(B) Unaccounted for Water (B)	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
(C) Water Sales (x1000 m ³)	5,512	6,023	6,554	7,118	7,702	8,176	8,724	9,271	9,745	10,184	10,476	10,804	11,060	11,352	11,644
(D) No. of Connections	5,930	6,540	7,414	8,203	9,084	9,895	10,941	11,856	12,694	13,342	13,925	14,498	15,038	15,542	16,038
(E) Average Water Tariff (Baht/m ³)**	8.36	8.36	8.36	9.22	9.22	9.22	10.16	10.16	10.16	11.20	11.20	11.20	12.34	12.34	12.34
1. Operating Revenue:															
1.1 Water Sales	46,076	50,368	54,620	65,530	70,971	75,344	88,513	94,175	98,985	114,027	117,266	120,974	136,504	140,108	143,712
1.2 Connection Fees	2,657	2,854	3,112	3,496	3,904	3,594	5,110	4,470	4,694	3,489	3,139	3,085	3,205	2,991	2,944
1.3 Service Charges	756	847	945	1,153	1,277	1,391	1,695	1,837	1,966	2,278	2,378	2,476	2,631	2,925	3,019
1.4 Other Revenue	227	248	289	322	349	368	437	460	481	549	563	580	653	669	686
Total 1.	49,716	54,297	58,946	70,561	76,501	80,696	95,855	100,941	105,536	120,343	123,376	127,115	143,193	146,694	150,361
2. Expenses:															
2.1 Operation & Maintenance															
- Personnel Cost	2,782	3,093	3,614	3,970	4,661	5,943	6,851	7,565	8,347	9,264	10,078	10,914	12,247	13,254	14,399
- Electricity & Fuel Cost	2,983	3,359	3,774	4,231	4,733	5,122	5,705	6,255	6,775	7,300	7,764	8,250	8,712	9,245	9,777
- Chemical Cost	897	1,009	1,104	1,271	1,422	1,564	1,719	1,890	2,051	2,213	2,356	2,505	2,647	2,812	2,976
- Connection Cost	1,074	1,192	1,342	1,413	1,630	1,550	2,065	1,866	1,765	1,410	1,311	1,331	1,295	1,249	1,270
- Raw Water Cost	0	0	0	0	0	0	4,252	5,702	7,052	8,414	9,461	10,668	11,739	12,975	14,280
- Other Cost	406	455	519	573	656	748	863	929	1,002	1,069	1,140	1,221	1,323	1,412	1,513
Sub-total 2.1	8,142	9,108	10,393	11,458	13,103	14,927	21,454	24,207	27,003	29,670	32,109	34,888	37,954	40,948	44,214
2.2 Share of Head & Regional Office Overhead Expenses ***	10,331	11,283	12,249	14,662	15,897	16,768	19,918	20,975	21,930	25,007	25,637	26,414	29,755	30,462	31,244
2.3 Debt Service	0	104	996	2,329	6,218	13,987	21,691	30,852	31,804	30,307	29,810	40,350	38,541	36,732	25,563
Total 2.	18,473	20,495	23,628	28,450	35,217	45,682	63,063	76,084	80,737	84,984	86,556	101,652	106,260	108,162	101,022
3. Net Cash Flow Surplus:															
3.1 Annual	31,243	33,802	35,318	42,111	41,284	35,014	32,792	24,907	24,793	35,359	36,820	25,463	36,933	38,532	49,339
3.2 Cumulative	31,243	65,045	100,363	142,474	183,758	218,772	251,564	276,471	301,270	336,629	373,449	398,912	435,845	474,377	523,716
4. Unit Cost of Water after Debt Service (Baht/m ³)*	3.11	3.15	3.35	3.72	4.24	5.22	6.68	7.65	7.77	7.91	7.86	8.95	9.16	9.10	8.29

Note: * [(Total 2.) x (C1.1 Water Sales) / (Total 1.)] / (C. Water Sales m³)
 ** Based upon the assumption that the water tariff increases every 3 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. (PRITAYA WATERWORKS)

Description	Text Ref.	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1. Operating Revenue:																
1.1 Water Sales		46,076	50,348	54,620	59,502	64,385	68,351	72,928	77,506	81,472	85,134	87,575	90,321	92,457	94,899	97,340
1.2 Connection Fees		2,557	2,854	3,112	3,172	3,542	3,260	4,205	3,679	3,369	2,605	2,344	2,304	2,171	2,026	1,994
1.3 Service Charges		756	847	945	1,046	1,158	1,262	1,395	1,512	1,618	1,701	1,775	1,848	1,917	1,982	2,045
1.4 Other Revenue		227	248	269	292	316	334	360	379	396	410	420	433	442	453	464
Total 1.		49,716	54,297	58,946	64,012	69,401	73,297	78,888	83,074	86,856	89,850	92,114	94,906	96,988	99,359	101,843
2. Expenses:																
2.1 Operation & Maintenance																
- Personnel Cost		2,782	3,093	3,614	3,970	4,661	5,943	6,851	7,565	8,347	9,254	10,078	10,914	12,247	13,254	14,389
- Electricity & Fuel Cost		2,983	3,359	3,774	4,231	4,733	5,122	5,705	6,255	6,775	7,300	7,764	8,250	8,712	9,245	9,777
- Chemical Cost		897	1,009	1,134	1,271	1,422	1,584	1,719	1,890	2,051	2,213	2,356	2,505	2,647	2,812	2,976
- Connection Cost		1,074	1,192	1,342	1,413	1,630	1,550	2,055	1,866	1,765	1,410	1,311	1,331	1,295	1,249	1,270
- Raw Water Cost		0	0	0	0	0	0	4,252	5,702	7,062	8,414	9,461	10,668	11,739	12,975	14,290
- Other Cost		406	455	519	573	656	748	863	929	1,002	1,069	1,140	1,221	1,323	1,412	1,513
Sub-total 2.1		8,142	9,108	10,383	11,459	13,103	14,927	21,454	24,207	27,003	29,670	32,109	34,888	37,954	40,948	44,214
2.2 Share of Head & Regional Office Overhead Expenses ***		10,331	11,283	12,249	13,301	14,421	15,212	16,393	17,263	18,048	18,670	19,141	19,721	20,154	20,646	21,163
2.3 Debt Service		0	104	996	2,329	6,218	13,987	21,691	30,652	31,604	30,307	28,810	40,350	38,541	36,722	25,563
Total 2.		18,473	20,495	23,628	27,089	33,741	44,126	59,538	72,321	76,856	79,647	80,060	94,959	96,653	98,326	90,940
3. Net Cash Flow Surplus:																
3.1 Annual		31,243	33,802	35,318	36,923	35,660	29,081	19,351	10,753	10,000	11,293	12,054	-53	329	1,063	10,903
3.2 Cumulative		31,243	65,045	100,363	137,286	172,945	202,027	221,377	232,131	242,131	253,333	265,388	265,334	265,664	266,597	271,600
4. Unit Cost of Water after Debt Service Baht/m ³ *		3.11	3.16	3.35	3.54	4.06	5.04	6.31	7.28	7.40	7.32	7.27	8.36	8.33	8.27	7.47

Note: * [(Total 2.) x (U.1 Water Sales) / (Total 1.)] / (U. 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.

CAPIVANA WATERWORKS

Table-10.9 DEBT SERVICE PROJECTED

FOREIGN CURRENCY PORTION (in 1,000 Baht)
Interest : 8.5% per annum

LOCAL CURRENCY PORTION (in 1,000 Baht)
Interest : 13.0% per annum

Year	Rehabil. and Modif.	Stage 1 Expan.	Loans		Interest Payments		Principal Repayment		Debt Service Sub-total	Year	Rehabil. and Modif.	Stage 1 Expan.	Loans		Interest Payments		Principal Repayment		Debt Service Sub-total	TOTAL DEBT SERVICE
			Beginning	Ending	1st year	Later year	1st year	Later year					1st year	Later year	1st year	Later year	1st year	Later year		
1987	3,089		0	3,089	131	0	0	0	131	1987	772		0	772	50	0	0	0	50	181
1988	23,325		3,089	26,414	991	263	0	0	1,254	1988	5,831		772	6,603	379	100	0	0	479	1,733
1989	16,190		26,414	42,604	888	2,245	0	0	2,933	1989	4,047		6,603	10,650	263	858	0	0	1,121	4,055
1990		104,033	42,604	146,637	0	3,621	0	0	3,621	1990		26,008	10,650	35,137	0	1,385	1,521	0	2,906	6,527
1991		188,028	146,637	304,665	0	12,464	0	0	12,464	1991		39,507	35,137	73,122	0	4,568	1,521	0	6,089	16,553
1992			304,665	304,665	0	25,897	0	0	25,897	1992			73,122	71,601	0	9,506	1,521	0	11,027	36,324
1993			304,665	304,665	0	25,897	0	0	25,897	1993			71,601	60,720	0	9,308	1,521	9,359	23,189	46,085
1994			304,665	302,298	0	25,897	2,367	0	28,260	1994			60,720	49,839	0	7,894	1,521	9,359	16,774	47,088
1995			302,298	298,931	0	25,695	2,367	0	28,062	1995			49,839	38,959	0	6,479	1,521	9,359	17,360	45,422
1996			298,931	297,564	0	25,494	2,367	0	27,861	1996			38,959	28,078	0	5,065	1,521	9,359	15,945	43,806
1997			297,564	280,539	0	25,293	2,367	14,559	42,219	1997			28,078	18,719	0	3,650	0	9,359	13,009	55,228
1998			280,539	263,713	0	23,854	2,367	14,559	40,760	1998			18,719	9,359	0	2,433	0	9,359	11,793	52,573
1999			263,713	246,787	0	22,415	2,367	14,559	39,341	1999			9,359	0	0	1,217	0	9,359	10,576	48,917
2000			246,787	229,861	0	20,977	2,367	14,559	37,903	2000										37,903
2001			229,861	212,935	0	19,538	2,367	14,559	36,464	2001										36,464
2002			212,935	196,009	0	18,099	2,367	14,559	35,025	2002										35,025
2003			196,009	179,084	0	16,661	2,367	14,559	33,587	2003										33,587
2004			179,084	162,158	0	15,222	2,367	14,559	32,148	2004										32,148
2005			162,158	145,232	0	13,783	2,367	14,559	30,709	2005										30,709
2006			145,232	128,306	0	12,345	2,367	14,559	29,271	2006										29,271
2007			128,306	111,380	0	10,906	2,367	14,559	27,832	2007										27,832
2008			111,380	94,454	0	9,467	2,367	14,559	26,393	2008										26,393
2009			94,454	77,528	0	8,029	2,367	14,559	24,954	2009										24,954
2010			77,528	60,603	0	6,590	2,367	14,559	23,516	2010										23,516
2011			60,603	43,677	0	5,151	2,367	14,559	22,077	2011										22,077
2012			43,677	28,118	0	3,713	0	0	14,559	2012										18,271
2013			28,118	14,559	0	2,275	0	0	14,559	2013										17,034
2014			14,559	0	0	1,238	0	0	14,559	2014										15,796

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

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

Description	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
(A) Water Production (x1000 m ³)	5,484	7,085	7,685	8,374	9,061	9,619	10,283	10,907	11,465	11,981	12,324	12,711	13,011	13,355	13,698
(B) Unaccounted for Water (x)	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
(C) Water Sales (x1000 m ³)	5,512	6,023	6,504	7,118	7,702	8,176	8,724	9,271	9,745	10,184	10,476	10,804	11,060	11,352	11,644
(D) No. of Connections	5,930	6,640	7,414	8,203	9,084	9,895	10,941	11,856	12,694	13,342	13,925	14,498	15,038	15,542	16,038
(E) Average Water Tariff (Baht/m ³)**	8.36	8.36	8.36	9.22	9.22	9.22	10.16	10.16	10.16	11.20	11.20	11.20	12.34	12.34	12.34
1. Operating Revenue:															
1.1 Water Sales	46,076	50,348	54,620	65,590	70,971	75,344	88,613	94,175	98,995	114,027	117,296	120,974	136,504	140,108	143,712
1.2 Connection Fees	2,657	2,854	3,112	3,496	3,904	3,594	5,110	4,470	4,094	3,489	3,139	3,085	3,205	2,991	2,944
1.3 Service Charges	756	847	945	1,153	1,277	1,391	1,695	1,837	1,956	2,278	2,378	2,476	2,831	2,925	3,019
1.4 Other Revenue	227	248	269	322	349	368	437	460	481	549	563	580	653	669	686
Total 1.	49,716	54,297	58,946	70,561	76,501	80,696	95,855	100,941	105,536	120,343	123,376	127,115	143,193	146,694	150,361
2. Expenses:															
2.1 Operation & Maintenance															
- Personnel Cost	2,782	3,093	3,614	3,970	4,661	5,943	6,851	7,555	8,347	9,264	10,078	10,914	12,247	13,254	14,399
- Electricity & Fuel Cost	2,983	3,359	3,774	4,231	4,783	5,122	5,705	6,255	6,775	7,300	7,764	8,250	8,712	9,245	9,777
- Chemical Cost	897	1,009	1,134	1,271	1,422	1,564	1,719	1,890	2,051	2,213	2,356	2,505	2,647	2,812	2,976
- Connection Cost	1,074	1,192	1,342	1,413	1,630	1,550	2,055	1,866	1,755	1,410	1,311	1,331	1,295	1,249	1,270
- Raw Water Cost	0	0	0	0	0	0	4,252	5,702	7,052	8,414	9,451	10,668	11,739	12,975	14,280
- Other Cost	408	455	519	573	656	748	863	929	1,002	1,069	1,140	1,221	1,323	1,412	1,513
Sub-total 2.1	8,142	9,108	10,383	11,459	13,103	14,327	21,454	24,207	27,003	29,570	32,109	34,888	37,964	40,948	44,214
2.2 Share of Head & Regional Office Overhead Expenses	6,404	6,994	7,593	9,089	9,855	10,395	12,348	13,003	13,595	15,502	15,893	16,375	18,446	18,897	19,369
2.3 Debt Service ***	0	181	1,793	4,055	6,527	18,553	36,924	46,085	47,038	45,422	43,806	55,228	52,573	49,917	37,903
Total 2.	14,546	16,284	19,710	24,603	29,484	43,875	70,726	83,295	87,635	90,594	91,809	106,491	108,982	109,762	101,486
3. Net Cash Flow Surplus:															
3.1 Annual	35,170	38,013	39,236	45,958	47,016	36,821	25,129	17,646	17,901	29,749	31,567	20,624	34,210	36,932	48,875
3.2 Cumulative	35,170	73,183	112,419	158,376	205,393	242,214	267,343	284,990	302,890	332,639	364,206	384,831	419,041	455,973	504,848
4. Unit Cost of Water after Debt Service (Baht/m ³)*	2.45	2.51	2.80	3.21	3.55	5.01	7.50	8.38	8.44	8.43	8.33	9.38	9.39	9.24	8.33

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

** Based upon the assumption that the water tariff increases every 3 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

IPATTAYA WATERWORKS) x 1,000 BAHT

ITEM	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Fixed Assets														
Accumulative Fixed Assets	117,584	121,455	129,326	162,631	188,112	323,323	529,591	547,068	555,121	583,770	603,034	622,934	643,491	664,725
Less Accumulative Depreciation	29,076	33,125	37,436	42,857	49,127	59,904	77,558	95,793	114,630	134,089	154,191	174,955	196,405	218,562
Net Fixed Assets in Operation	88,509	88,340	91,890	119,774	138,985	263,419	452,034	451,274	450,490	449,680	448,844	447,979	447,086	446,164
Work in Progress	3,853	32,890	49,151	149,118	324,602	195,598	0	0	0	0	0	0	0	0
TOTAL	92,362	121,230	141,041	268,892	463,587	459,017	452,034	451,274	450,490	449,680	448,844	447,979	447,086	446,164
Total Cost before Depreciation and Interest**	20,763	23,454	26,121	29,524	32,820	41,360	45,887	50,395	54,658	58,621	63,054	67,678	72,447	77,527
Total Cost after Depreciation but before Interest	27,503	30,402	34,945	39,090	39,090	52,137	63,540	68,601	73,495	78,080	83,155	88,442	93,896	99,685
Total Cost after Depreciation and Interest	28,498	32,761	39,641	51,556	72,306	72,306	83,512	87,188	90,555	93,843	97,220	100,698	104,343	108,322
Unit Cost of Water (Baht/m ³) after depreciation and Interest*	4.36	4.60	5.15	6.31	8.29	8.29	9.01	8.95	8.89	8.94	9.00	9.10	9.19	9.30
Average Rate Base	88,424	90,115	105,832	129,379	201,202	357,726	451,654	450,882	450,095	449,262	448,411	447,533	446,625	
Surplus after Depreciation and Interest	34,402	37,800	39,384	34,554	23,548	20,761	25,429	29,788	33,805	38,423	42,495	47,192	52,125	
Rate of Return after Completion of Construction						12%	6%	6%	7%	8%	9%	9%	11%	12%

Note: * $\frac{[(\text{Total Cost after Depreciation and Debt Service}) \times (\text{1.1 Water Sales}) / (\text{1. Operating Revenue}) \text{ of Cash Flow Table}] / [(\text{10 Water Sales} \times 1000 \text{ m}^3) \text{ of Cash Flow Table}]$

** 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)

(PATTAYA WATERWORKS) x 1,000 BAHT

YEAR	TOTAL WATER REVENUE	CAPITAL INVESTMENT COST	OPERATING COSTS & H. R. O. *	1986 PRICE NET REVENUE	NET BENEFITS	
					DISCOUNTED AT 3 %	DISCOUNTED AT 4 %
1987	0	3,738	0	-3,738	-3,629	-3,594
1988	0	27,323	0	-27,323	-25,755	-25,262
1989	14,296	18,359	4,844	-8,907	-8,151	-7,918
1990	19,685	114,203	6,889	-101,407	-90,099	-86,684
1991	23,491	167,935	8,571	-153,016	-131,993	-125,768
1992	29,172		14,447	14,725	12,332	11,638
1993	33,358		16,690	16,668	13,553	12,667
1994	37,140		18,738	18,401	14,526	13,446
1995	40,134		20,372	19,761	15,146	13,884
1996	42,398		21,600	20,798	15,476	14,050
1997	45,190		23,077	22,113	15,975	14,364
1998	47,272		24,385	22,886	16,052	14,295
1999	49,643		25,662	23,981	16,330	14,402
2000	52,149		27,014	25,135	16,617	14,515
2001	52,149		27,014	25,135	16,133	13,956
2002	52,149		27,014	25,135	15,663	13,420
2003	52,149		27,014	25,135	15,207	12,903
2004	52,149		27,014	25,135	14,764	12,407
2005	52,149		27,014	25,135	14,334	11,930
2006	52,149		27,014	25,135	13,916	11,471
Salvage		-157,518		157,518	87,214	48,288
TOTALS	746,819	174,041	374,375	198,403	53,610	-1,590

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

$$\text{FIRR} = 3 + (4 - 3) \times 53,610 / (53,610 + 1,590) = 3.97\%$$

Table-10.14 AVERAGE INCREMENTAL COSTS (AIC)

(PATTAYA WATERWORKS) x 1,000 BAHT

YEAR	CAPITAL INVESTMENT			ECONOMIC VALUE OF CAPITAL INVESTMENT			DISCOUNTED AT 10%	SALES VOLUMES (INCREMENTS) 1,000 cu	DISCOUNTED AT 10%	OPERATION* AND MAINTENANCE	DISCOUNTED AT 10%
	FORIGN PORTION	LOCAL PORTION SKILLED LABOR	LOCAL PORTION UNSKILLED LABOR	FORIGN PORTION	LOCAL PORTION SKILLED LABOR	LOCAL PORTION UNSKILLED LABOR						TOTAL INVESTMENT
1987	2,243	0	1,495	0	0	0	3,031	0	0	0	0
1988	17,558	1,317	5,711	1,737	1,092	660	19,986	0	0	0	0
1989	9,654	3,566	3,064	2,075	4,899	788	11,645	1,606	1,207	3,875	2,911
1990	70,652	11,247	15,903	15,400	2,821	5,852	66,758	2,190	1,496	5,511	3,764
1991	103,957	16,871	24,007	23,101	8,896	8,778	89,168	2,664	1,654	5,857	4,258
1992					13,345	17,525	143,605	3,212	1,813	11,557	6,524
1993								3,759	1,929	13,362	6,852
1994								4,234	1,975	14,991	6,993
1995								4,672	1,981	16,298	6,912
1996								4,964	1,914	17,280	6,662
1997								5,292	1,855	18,462	5,471
1998								5,548	1,768	19,508	5,216
1999								5,840	1,592	20,530	5,947
2000								6,132	1,615	21,511	5,691
2001								6,132	1,458	21,511	5,174
2002								6,132	1,335	21,511	4,703
2003								6,132	1,213	21,511	4,276
2004								6,132	1,103	21,511	3,887
2005								6,132	1,003	21,511	3,534
2006								6,132	911	21,511	3,212
Salvage							-157,518		-20,070		
TOTAL							174,041		149,321		93,986

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

TOTAL INVEST. DISCOUNTED 170,489
 O&M COST DISCOUNTED + 93,986

AVERAGE INCREMENTAL COST = 264,485 / 27,931 = 9.469
 (SALES #3 DISCOUNTED)

Table-10.15 ECONOMIC BENEFITS VS COSTS (INCREMENTAL)

(PATTAYA WATERWORKS) x 1,000 BAHT

YEAR	AT 1986 PRICE		DISCOUNTED AT 10% PER ANNUM	
	BENEFITS	COSTS	BENEFITS	COSTS
1987	0	3,334	0	3,031
1988	0	24,159	0	19,966
1989	14,487	18,600	10,884	13,974
1990	19,755	102,149	13,493	69,769
1991	24,030	149,091	14,921	92,574
1992	28,974	9,246	16,355	5,219
1993	33,908	10,681	17,400	5,481
1994	38,193	11,992	17,817	5,595
1995	42,143	13,038	17,873	5,529
1996	44,777	13,824	17,264	5,330
1997	47,736	14,770	16,731	5,177
1998	50,045	15,607	15,946	4,973
1999	52,679	16,424	15,259	4,757
2000	55,313	17,289	14,566	4,553
2001	55,313	17,289	13,242	4,139
2002	55,313	17,289	12,038	3,763
2003	55,313	17,289	10,943	3,421
2004	55,313	17,289	9,949	3,110
2005	55,313	17,289	9,044	2,827
2006	55,313	17,289	8,222	2,570
Salvage		-135,018		-20,070
TOTAL	783,921	388,921	251,946	245,687
	BENEFITS/COS = 2.016		BENEFITS/COS = 1.025	

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

Table-10.16 ECONOMIC INTERNAL RATE OF RETURN (EIRR)

(PATTAYA 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		
	1986 PRICE	AT 1986 PRICE	1986 PRICE	AT 1986 PRICE	H.R.O.** AT 1986 PRICE	AT 1986 PRICE	AT 1986 PRICE	AT 1986 PRICE	TOTAL ECONOMIC BENEFITS	TOTAL CAPITAL INVESTMENT	OPERATING COSTS & H.R.O.*	NET BENEFITS	DISCOUNTED AT 10%	DISCOUNTED AT 11%
1987	0	3,738	0	3,738	0	0	-3,738	0	3,334	0	0	-3,334	-3,031	-3,004
1988	0	27,323	0	27,323	0	0	-27,323	0	24,159	0	0	-24,159	-19,966	-19,608
1989	14,487	18,359	3,875	-7,747	3,875	14,487	-7,747	14,487	15,500	3,100	3,100	-4,113	-3,090	-3,007
1990	19,755	114,203	5,511	-99,960	5,511	19,755	-99,960	19,755	97,740	4,409	4,409	-82,395	-56,277	-54,276
1991	24,030	167,935	6,857	-150,762	6,857	24,030	-150,762	24,030	143,605	5,485	5,485	-125,060	-77,653	-74,217
1992	28,974		11,557	17,416	11,557	28,974	17,416	28,974		9,246	9,246	19,728	11,136	10,547
1993	33,908		13,352	20,556	13,352	33,908	20,556	33,908		10,681	10,681	23,226	11,919	11,187
1994	38,193		14,991	23,282	14,991	38,193	23,282	38,193		11,992	11,992	26,200	12,223	11,369
1995	42,143		16,298	25,846	16,298	42,143	25,846	42,143		13,038	13,038	29,105	12,343	11,378
1996	44,777		17,280	27,497	17,280	44,777	27,497	44,777		13,824	13,824	30,953	11,934	10,901
1997	47,736		18,462	29,274	18,462	47,736	29,274	47,736		14,770	14,770	32,967	11,555	10,460
1998	50,045		19,508	30,537	19,508	50,045	30,537	50,045		15,607	15,607	34,439	10,973	9,844
1999	52,679		20,530	32,150	20,530	52,679	32,150	52,679		16,424	16,424	36,256	10,502	9,336
2000	55,313		21,611	33,702	21,611	55,313	33,702	55,313		17,289	17,289	38,024	10,013	8,821
2001	55,313		21,611	33,702	21,611	55,313	33,702	55,313		17,289	17,289	38,024	9,103	7,947
2002	55,313		21,611	33,702	21,611	55,313	33,702	55,313		17,289	17,289	38,024	8,275	7,160
2003	55,313		21,611	33,702	21,611	55,313	33,702	55,313		17,289	17,289	38,024	7,523	6,450
2004	55,313		21,611	33,702	21,611	55,313	33,702	55,313		17,289	17,289	38,024	6,839	5,811
2005	55,313		21,611	33,702	21,611	55,313	33,702	55,313		17,289	17,289	38,024	6,217	5,235
2006	55,313		21,611	33,702	21,611	55,313	33,702	55,313		17,289	17,289	38,024	5,652	4,716
Salvage		-157,518		157,518					-135,018			135,018	20,070	16,747
TOTAL				310,381								395,000	6,259	-6,202

Note : * Average water tariff in 1986 used as benefits. (8.36 Baht)

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

$$\begin{aligned} \text{EIRR} &= 10 + (11 - 10) \times 6,259 / (6,259 + 6,202) \\ &= 10.502\% \end{aligned}$$

Table-10.17 ECONOMIC INTERNAL RATE OF RETURN (EIRR)

IPRITAYA WATERWORKS) x 1,000 BAHT

YEAR	TOTAL ECONOMIC BENEFITS *		TOTAL CAPITAL INVESTMENT		OPERATING COSTS & H.R.O. **		NET BENEFITS AT 1986 PRICE		CONVERTED ECONOMIC VALUE			NET BENEFITS		
	AT 1986 PRICE	1986 PRICE	AT 1986 PRICE	1986 PRICE	AT 1986 PRICE	1986 PRICE	AT 1986 PRICE	1986 PRICE	TOTAL ECONOMIC BENEFITS	TOTAL CAPITAL INVESTMENT	OPERATING COSTS & H.R.O. *	NET BENEFITS	DISCOUNTED AT 11%	DISCOUNTED AT 12%
1987	0	0	3,788	0	0	0	-3,788	0	0	3,334	0	-3,334	-3,004	-2,977
1988	0	0	27,323	0	0	0	-27,323	0	0	24,159	0	-24,159	-19,608	-19,260
1989	14,329	18,359	18,359	2,972	14,329	2,972	-7,002	14,329	14,329	15,500	2,377	-3,548	-2,594	-2,526
1990	19,540	114,203	114,203	4,268	19,540	4,268	-98,931	19,540	19,540	97,740	3,414	-81,615	-53,762	-51,868
1991	23,769	167,935	167,935	5,373	23,769	5,373	-149,539	23,769	23,769	143,605	4,298	-124,135	-73,688	-70,437
1992	28,558			9,714	28,558	9,714	18,944	28,558	28,558		7,771	20,887	11,167	10,582
1993	33,539			11,244	33,539	11,244	22,294	33,539	33,539		8,995	24,543	11,821	11,162
1994	37,777			12,644	37,777	12,644	25,133	37,777	37,777		10,115	27,661	12,003	11,172
1995	41,684			13,762	41,684	13,762	27,923	41,684	41,684		11,010	30,675	11,992	11,062
1996	44,290			14,601	44,290	14,601	29,688	44,290	44,290		11,581	32,609	11,484	10,498
1997	47,216			15,607	47,216	15,607	31,610	47,216	47,216		12,485	34,731	11,020	9,984
1998	49,500			16,521	49,500	16,521	32,979	49,500	49,500		13,217	36,283	10,371	9,313
1999	52,106			17,393	52,106	17,393	34,713	52,106	52,106		13,914	38,191	9,835	8,752
2000	54,711			18,316	54,711	18,316	36,394	54,711	54,711		14,653	40,058	9,293	8,197
2001	54,711			18,316	54,711	18,316	36,394	54,711	54,711		14,653	40,058	8,372	7,318
2002	54,711			18,316	54,711	18,316	36,394	54,711	54,711		14,653	40,058	7,543	6,534
2003	54,711			18,316	54,711	18,316	36,394	54,711	54,711		14,653	40,058	6,795	5,834
2004	54,711			18,316	54,711	18,316	36,394	54,711	54,711		14,653	40,058	6,122	5,209
2005	54,711			18,316	54,711	18,316	36,394	54,711	54,711		14,653	40,058	5,515	4,651
2006	54,711			18,316	54,711	18,316	36,394	54,711	54,711		14,653	40,058	4,969	4,153
Salvage			-157,518				157,518			-105,018		135,018	16,747	13,997
TOTAL							349,029					424,211	2,411	-8,708

Note : * AIC used as benefits. (8.922 Baht)

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

EIRR = $11 + (12 - 11) \times 2,411 / (2,411 + 8,708)$
 = 11.217%

Table-10.18 ECONOMIC INTERNAL RATE OF RETURN (EIRR)

EPATAVA WATERWORKS] x 1,000 BAHT

YEAR	TOTAL ECONOMIC BENEFITS *		TOTAL CAPITAL INVESTMENT		OPERATING COSTS & H.R.O. **		NET BENEFITS AT 1986 PRICE		CONVERTED ECONOMIC VALUE			NET BENEFITS		
	AT 1986 PRICE	1986 PRICE	AT 1986 PRICE	1986 PRICE	AT 1986 PRICE	1986 PRICE	AT 1986 PRICE	1986 PRICE	TOTAL ECONOMIC BENEFITS	TOTAL CAPITAL INVESTMENT	OPERATING COSTS & H.R.O. *	NET BENEFITS	DISCOUNTED AT 11%	DISCOUNTED AT 12%
1987	0	3,738	0	3,738	0	-3,738	0	0	0	3,334	0	-3,334	-3,004	-2,977
1988	0	27,323	0	27,323	0	-27,323	0	0	0	24,159	0	-24,159	-19,608	-19,260
1989	15,208	18,359	3,875	18,359	3,875	-7,026	15,208	15,208	3,100	15,500	3,100	-3,392	-2,480	-2,414
1990	20,738	114,203	5,511	114,203	5,511	-98,977	20,738	20,738	4,409	97,740	4,409	-81,412	-53,628	-51,738
1991	25,226	167,935	6,857	167,935	6,857	-148,566	25,226	25,226	5,485	143,605	5,485	-123,864	-73,507	-70,284
1992	30,415		11,557		11,557	-18,858	30,415	30,415	9,246		9,246	21,170	11,318	10,725
1993	35,595		13,352		13,352	-22,243	35,595	35,595	10,661		10,661	24,914	12,000	11,270
1994	40,093		14,991		14,991	-25,103	40,093	40,093	11,992		11,992	28,101	12,194	11,349
1995	44,241		16,298		16,298	-27,943	44,241	44,241	13,038		13,038	31,203	12,198	11,252
1996	47,006		17,280		17,280	-29,726	47,006	47,006	13,824		13,824	33,182	11,686	10,684
1997	50,112		18,462		18,462	-31,550	50,112	50,112	14,770		14,770	35,342	11,213	10,160
1998	52,536		19,508		19,508	-33,028	52,536	52,536	15,607		15,607	36,929	10,555	9,479
1999	55,301		20,530		20,530	-34,771	55,301	55,301	16,424		16,424	38,877	10,011	8,910
2000	58,066		21,511		21,511	-36,455	58,066	58,066	17,289		17,289	40,777	9,460	8,344
2001	58,066		21,511		21,511	-36,455	58,066	58,066	17,289		17,289	40,777	8,523	7,450
2002	58,066		21,511		21,511	-36,455	58,066	58,066	17,289		17,289	40,777	7,678	6,652
2003	58,066		21,511		21,511	-36,455	58,066	58,066	17,289		17,289	40,777	6,917	5,939
2004	58,066		21,511		21,511	-36,455	58,066	58,066	17,289		17,289	40,777	6,292	5,303
2005	58,066		21,511		21,511	-36,455	58,066	58,066	17,289		17,289	40,777	5,614	4,734
2006	58,066		21,511		21,511	-36,455	58,066	58,066	17,289		17,289	40,777	5,058	4,227
Salvage		-157,518				157,518				-135,018		135,018	16,747	13,997
TOTAL						349,392						494,012	5,176	-6,200

EIRR = $11 + (12 - 11) \times \frac{5,176 / (5,176 + 6,200)}{11.455\%}$
 = 11.455%

Note : * AIC used as benefits. (9,469 Baht)
 ** Share Allocation of Head and Regional Office Overhead Expenses calculated by a new tentative formula based on waterworks surplus.