9.1.5 Financial Status of Chiangmai Waterworks

All the revenues of waterworks, including Chiangmai, Mae Rim and San Kamphaeng Waterworks, are transferred, through Regional Offices, to PWA Head Office and all the necessary expenses of the waterworks for their administration, operation and maintenance are allocated by PWA Head Office annually. The capital investment procedures for the waterworks, covering all phases of planning, designing and construction, are executed at the responsibility and on account of PWA Head Office.

The waterworks including Chiangmai, Mae Rim and San Kamphaeng Waterworks, thus have no autonomy in financing. Their revenue and expenditure accounts, as shown in the accounts of these three Waterworks illustrated in Table-9.3 do not reflect such items as debt service, depreciation cost and shares of PWA Head Office and Regional Offices to be borne by the waterworks concerned. Their accounts do not present the real financial status of the waterworks concerned. The above revenue and expenditure accounts of Chiangmai Waterworks combined with Mae Rim and San Kamphaeng Waterworks for example registered a net surplus of 42,989 thousand Baht for fiscal 1985, i.e., 66.53 % of gross revenue.

In order to grasp the real picture of the financial status of these waterworks, those activities of PWA Head Office conducted for the waterworks concerned should be taken into consideration, as will be discussed in Chapter 14 "FINANCIAL AND ECONOMIC ANALYSIS in the process of feasibility study.

9.2 Current Project Viewed from the Sixth Sector Five-Year Economic and Social Development Program

PWA is preparing the sector's draft five-year planning which will be integrated into the Sixth National Five-Year Economic and Social Development Program, as summarized in Tables-9.4 to 9.8. The current project for Chiangmai including Mae Rim and San Kamphaeng Waterworks which are planned to be merged into Chiangmai Waterworks (hereinafter the same), together with the three other projects for Pattaya, Ubon-Warin and Suphanburi Waterworks, which are now being studied with a grant by the Japan International Cooperation Agency and constitute a package project named the Provincial

Table-9.3 REVENUE AND EXPENDITURE OF CHIANGMAI, MAE RIM AND SAN KAMPHAENG WATERWORKS (x1,000 BAHT)
- FOR PAST TWO YEARS -

ITEM	CHIANG MAI		MAE RIM		SAN KAMPHAENG	
	1984	1985	1984	1985	1984	1985
Water Production (x1,000 m3)	12,503	12,418	819	806	498	495
Water Sales (x1,000 m3)	8,260	85,000	653	625	340	356
No. of Connections	14,768	15,669	709	774	1,216	1,329
REVENUE:						
Water Sales	32,048	50,249	2,989	3,760	989	1,735
Service Charge	1,814	1,998	109	124	152	163
Connection Fee	4,799	5,491	252	290	207	403
Others	236	265	29.514	127	6.39	10.099
Total	38,896	58,002	3,380	4,301	1,354	2,311
EXPENDITURE:						
Personnel Cost	6,107	6,651	648	664	814	910
Chemicals	1,603	1,961	105	60	32	29
Material & Maintenance	28	664	33	37	35	60
Oil & Fuel	186	223	19	22	20	30
Office Supplies	80	64	6	8	8	8
Hire & Service	161	161	14	8	9	4
Electricity	6,491	6,869	419	435	299	327
Connection Cost	2,169	2,113	114	112	77	125
Others	656	42	18	40	29	1
Total	17,480	18,748	1,375	1,385	1,322	1,494
REVENUE/EXPENDITURE	2.23	3.09	2.46	3.11	1.02	1.55

Table-9.4 SUMMARY OF ECONOMIC TARGETS IN SIXTH ECONOMIC & SOCIAL DEVELOPMENT PROGRAM (PWA)

PLAN	INVESTMENT COSTS (MIL. BAHT)	AVERAGE INVESTMENT COST/ SERVED POPULATION (BAHT/ PERSON)	INCREASED WATER PRODUCTION AT END OF PROJECT PERIOD (MIL. M3/YR)	WATER SOLD AT END OF PROJECT PERIOD			REMARKS
				INCREASED WATER SALES (MIL. M3/ YEAR)	TARIFF RATE (BAHT/ M3)	INCREASED INCOME (MIL. BAHT/ YEAR)	
1. Water Supply Expansion Program	5,988.077	2,181	31.212	23.409	6.79	158.977	- Increased Water Production, Increased Water Sales and Increased Income calculated from the increased amounts for 1987 - 1991 (5 years)
2. Take Over Water Supply Program	243.000	648	4.599	3.449	6.79	23.419	
3. Immediate Improvement Program	165.830	880	2.488	1.866	6.79	12.670	
4. Water Resource Development Program	133.920	137					- No. of Served Population calculated from the figures at the end of project periods (10 years)
5. Rural Water Supply Expansion Construction Program	667.500	890	(1.84)			(5.52)	- Nos. of waterworks in ( ) are those not operated by PWA. The figures in ( ) are therefore do not add up to total.
6. Master Plan and Feasibility Study Program	152.201			(1.38)	(4.0)		
TOTAL	7,350.528	4,736	38.299	28.724	6.79	195.066	

Table-9.5 YEARLY PROJECT TARGETS (SOCIAL) ACCORDING TO 6TH ECONOMIC & SOCIAL DEVELOPMENT PROGRAM (PWA)

PLAN	No. of Communities Alleviated of Water Supply Problems (fiscal year)						No. of People Covered (fiscal year)					
	1987	1988	1989	1990	1991	TOTAL	1987	1988	1989	1990	1991	TOTAL
1. Water Supply Expansion Program	12	7	12	8	10	49	637,400	306,800	936,000	631,100	233,800	2,745,100
2. Take Over Water Supply Program	15	15	15	15	15	75	75,000	75,000	75,000	75,000	75,000	375,000
3. Immediate Improvement Program	16	9	0	0	0	25	117,539	70,891	0	0	0	188,430
4. Water Resource Development Program	8	9	9	9	9	44	198,764	229,802	141,976	162,093	241,351	973,986
5. Rural Water Supply Expansion Construction Program	30	30	30	30	30	150	150,000	150,000	150,000	150,000	150,000	750,000
6. Master Plan and Feasibility Study Program	12	4	8	8	7	39	0	0	0	0	0	0
TOTAL	93	74	74	70	71	382	1,178,703	832,493	1,302,976	1,018,193	700,151	5,032,516

Table-9.6 SUMMARY OF SOCIAL TARGETS
IN
THE 6TH ECONOMIC AND SOCIAL
DEVELOPMENT PLAN
(PWA)

PLAN	NO. OF COMMUNITIES ALLEVIATED OF WATER SUPPLY PROBLEMS	NO. OF POPULATION TO BE COVERED AT THE END OF PROJECT (10 YEARS)	PER YEAR INCREASE IN WATER SALES (MIL. M3)
1. Water Supply Expansion Program	49	2,745,100	23.409
2. Take Over Water Supply Progra	75	375,000	3.449
3. Immediate Improvement Program	25	188,430	1.866
4. Water Resource Development Pr	44	973,986	
5. Rural Water Supply Expansion Construction Program	150	750,000	(1.38)
6. Master Plan and Feasiblity Study Program	39		
T O T A L	382	5,032,516	28.724

Table-9.7 SUMMARY OF EXPENDITURE
IN
THE 6TH ECONOMIC AND SOCIAL
DEVELOPMENT PROGRAM
ON A YEARLY BASIS
(PWA)

TYPE OF PROJECT INVESTMENT	1987	1988	1989	1990	1991	TOTAL
1. Project investment (Mill Baht)						
1.1 Water Supply Expansion Program	862.073	802.915	1,609.999	1,655.836	1,057.254	
1.2 Take Over Water Supply Program	48.600	48.600	48.600	48.600	48.600	
1.3 Immediate Improvement Program	106.130	59.700				
1.4 Water Resource Development Program	20.500	29.200	28.820	31.200	24.200	
1.5 Rural Water Supply Expansion and Construction Program	115.500	124.500	133.500	142.500	151.500	
1.6 Master Plan and Feasiblity Study Program	125.554	24.347	0.800	0.800	0.700	
Sub..total	1,278.357	1,089.262	1,821.719	1,878.936	1,282.254	7,350.528
2. unproject Investment (Mill Baht)						
2.1 Expansion of Service Area						
2.2 Central Durable Articles Procurement						
2.3 Other reserves						
Sub total	111.161	94.718	158.409	163.385	111.500	639.173
TOTAL	1,389.518	1,183.980	1,980.128	2,042.321	1,393.754	7,989.701

Table-3.8 SUMMARY OF INVESTMENT EXPENDITURE
IN
THE 6TH ECONOMIC AND SOCIAL
DEVELOPMENT PROGRAM
CATEGORIZED BY SOURCE OF FUND
(PWA)

TYPE OF PROJECT INVESTMENT	Government Budgets (Mil. Baht)	PWA INCOME (Mil. Baht)	Loans		Grants* (Baht)	Local Budgets (Budget)	Total	Remarks
			Local	Foreign				
1. Project investment (Mil. Baht)								
1.1 Water Supply Expansion Program	2,614.376	87.581		3,286.120			5,988.077	
1.2 Take Over Water Supply Program	119.000			124.000			243.000	-Source of Finance:GTZ
1.3 Immediate Improvement Program	58.050			107.780			165.830	-Worldbank & Local Budget
1.4 Water Resource Development Program		133.920						
1.5 Rural Water Supply Expansion and Construction Program	467.250					200.250	667.500	
1.6 Master Plan and Feasibility Study Program		24.784			127.417		152.201	* Grants (JICA & GTZ)
Sub total	3,258.676	246.285	0.000	3,517.900	127.417	200.250	7,350.528	
2. Unproject Investment (Mil. Baht)								
2.1 Expansion of Service Area								
2.2 Central Durable Article Procurement		639.173					639.173	-8% of Total Investment Cost
2.3 Other reserves								
	3,258.676	885.458	0.000	3,517.900	127.417	200.250	7,989.701	

Water Supply Projects in the Kingdom of Thailand, will form a part of the Five-Year Program.

This chapter tries to evaluate the importance of the aforesaid package of JICA projects from the view point of the draft Sixth Sector Five-Year Economic and Social Development Program, on the top of that for the current project for Chiangmai Waterworks, the reason being that the weight of the former is considered to be more significant than that for the latter.

The projects under the Five-Year Program number 382 and the estimated cost for these projects amounts to 7,350.50 million Baht (1 Baht = 6 Yen as of September 1986). Of these projects, expansion projects such as the current one for Chiangmai amount to 5,988 million Baht, 80 % of the total. The current project for Chiangmai, whose investment cost totals, as shown Table-9.9, 309.5 million Baht, assumes the weight of 5.17 % of the total expansion projects under the Five-Year Program. (The combined total cost of the package project covering Pattaya, Ubon-Warin and Suphanburi as well as Chiangmai shares 16 % of the total cost for the expansion projects under the Program.)

Chiangmai will be one of the 49 communities to be alleviated of water supply problems by the mentioned Five-Year Program. The number of people who will be newly covered by the current project for Chiangmai up to 2000, the target year of Stage 1 of the project, as shown in Table-9.9, is estimated at 52,210 which is about 1.90 % of the number of people to be covered by the expansion projects under the Five-Year Program, i.e., 2,745,100, although both figures are not directly comparable because of differences in the periods of comparison. (The combined total of people newly covered by the JICA package project is estimated to be 150,010, 5.46 % of those covered by the Five-Year Program.)

The per-year increase in water sales to be brought about by the current Project for Chiangmai in the 5 years from 1992 when the current project implementation will be completed, is estimated at 4,033 thousand cu m, whichi is about 17.23 % of the corresponding figure to be achieved by the Five-Year Program. (The combined total of said per-year increase of water sales by the JICA package project for the four cities will be 10,133,000 cu m, i.e., 43.29 % of the corresponding figure for the Five-Year Program.)

Table-9.9 Targets of Five-Year Program
and JICA Projects Compared

	No.of Communities Covered	Investment Cost (Mil. Baht)	Ratio to Five-Year Program	No.of People Covered	Ratio to Five-Year Program	Increase in Annual Water Sales (Mil. M3)	Ratio to Five-Year Program
Water Supply Expansion Projects Under Five-Year Program	49	5988.077	100.00%	2,745,100	100.00%	23.409	100.00%
JICA Provincial Water Supply Projects for Four Cities	4	971.937	16.23%	150,010	5.46%	10.133	43.29%
Chiangmai	1	309.535	5.17%	52,210	1.90%	4.033	17.23%
Pattaya	1	380.830	6.36%	37,400	1.36%	2.300	9.83%
Ubon-Warin	1	219.197	3.66%	52,200	1.90%	3.362	14.36%
Suphanburi	1	62.375	1.04%	8,200	0.30%	0.438	1.87%

The above comparison of the targets of the Five-Year Program and JICA projects reveals that the latter places more weight on sales increases than the number of people to be benefited. This difference may be attributable partly to the fact that the JICA projects cover such large cities as Chiangmai, Ubon and Warin as well as such tourist spots as Pattaya where per-capital consumption of water is expected considerably larger than small communities. In addition it is to be noted that approximately 40 % of water consumption in Pattaya and 10 % in Chiangmai are directed to consumption by tourists whose number is not counted as served population.

Of the four municipalities under the JICA study, Chiangmai together with Pattaya, are believed to have prospective futures to be leading spots of tourism in Thailand on which the Government of Thailand is placing importance as a means of encouraging employment and earning foreign exchange. Ubon and Warin, if combined together, assume the status of the 3rd largest city in Thailand. Suphanburi, which is a municipality important as an ancient cultural resort and a commercial center for its vicinities, is suffering from serious water shortage and troubles caused by the aged facilities.

PWA has achieved a sounder financial position to earn net surplus after depreciation since 1985, having put forward to a second step to self-financing and is now making efforts to be affordable to finance its capital investment with its own internal cash generation. It is regarded in this connection that soft loans from OECF may let PWA achieve its long-cherished desire of self-financing of capital investment without Government subsidies. The above factors doubtless justify the Provincial Water Supply Project under the current JICA study as a top priority project, thus viewed from the Sixth Five-Year Economic and Social Development Program of PWA.

9.3 Financing of the Project

The possible main fund sources for PWA's capital investment are considered to consist of (1) internal generation, (2) government subsidies, and (3) foreign and domestic loans. As for the 2nd category of sources, government subsidies, PWA has recently noticed by NESDB that no Government budget will be allocated to PWA for its capital investment projects as for fiscal year 1986. The Board however indicated a possibility that such budget alloca-

tion may be resumed from 1987 though at a low level if the government budgetary tightness turns to ease. General predictions are however that current financial stringency will not ease so soon.

As a consequence, financing of the current project have to depend upon other two sources, (1) cash generation or net earnings of PWA and foreign and domestic loans. In view of the fact that loans should be repaid with interest in the long run, the bulk of loans available finally depends upon the ability of PWA in internal cash generation. Analysis in this respect will also be furthered in Chapter 14.

In this study, the possibility of financing part of the local portions of capital investment by foreign loans, OECF loans in this case, will be examined in view of the prevailing stringency in the local money market.

CHAPTER 10

CHAPTER 10 SCOPE OF PROJECT FOR FEASIBILITY STUDY

Of the five sanitary districts surrounding Chiangmai City, three of them, i.e., San Sai, Saraphi and Hang Dong will be included in the scope of Stage II implementation but not in that of Stage I implementation, as mentioned in Chapter 7.

Of the three phases of works proposed in Chapter 7, two phases, Stage I Rehabilitation and Modification and Stage I Expansion Works, are planned for Stage I implementation as shown in the Implementation Schedule in Chapter 8.

These two phases of works shall be studied as to their technical, financial and economic feasibility, accordingly.

The outline of the Feasibility Study project is given below:

No.	Item		Description
1.	Service Area	:	73 sq km, as shown in Fig-6.2
2.	Target Year	:	A.D. 2000
3.	Served Population	:	147,900 people (in 2000)
4.	Max-Day Demand	:	86,900 cu m/d (in 2000)
5.	Project Works		
	a) Rehabilitation and Modifications Works		
		:	Intake Facilities
		:	Treatment Plant Facilities
		:	Distribution pipelines
	b) Expansion Works		
	- Chiangmai	:	Ban Tho Intake
		:	Raw Water Transmission Pipeline (Dia. 500 mm x 3.1 km)
		:	Treatment Plant (Capacity 20,000 cu m/d)
		:	Distribution pipeline (Dia. 500 mm - 100 mm x 105 km)

- Mae Rim : Raw Water Transmission Pipeline
  (Dia. 300 mm x 0.9 km)
  : Distribution Pipeline
  (Dia. 300 mm - 100 mm x 21 km)
- San Kamphaeng: Distribution Pipeline
  (Dia. 300 mm - 100 mm x 9.0 km)

PART THREE
FEASIBILITY STUDY

CHAPTER 11 SERVED POPULATION AND WATER DEMAND

CHAPTER 12 PRELIMINARY DESIGN

CHAPTER 13 PROJECT IMPLEMENTATION AND COST ESTIMATES

CHAPTER 14 FINANCIAL AND ECONOMIC ANALYSIS

PART THREE

CHAPTER 11 SERVED POPULATION AND WATER DEMAND

11.1 Introduction

11.2 Served Population

11.3 Water Demand

CHAPTER 11

CHAPTER 11 SERVED POPULATION AND WATER DEMAND

11.1 Introduction

In Chapter 6, the served population and water demand were forecast in every fifth year up to 2010 for the Development Plan. In this chapter, forecast is made yearly up to 2000 for Feasibility Study.

In making yearly forecast, new concepts were introduced as follows:

1) When the supply service is apparently improved after completion of the planned works, accumulated implicit water demand will surface and result in a concentrated increase in application for the service.

2) As the waterworks' resources are limited, meeting such increased application satisfactorily will be difficult.

Though the influence of other factors was considered, the above two factors were thought to be principal.

These factors, however, were found not so influential as to change the Development plan. These factors are considered to bring some bearings on financial forecast in the feasibility study.

11.2 Served Population

In this section, yearly served population was forecasted on the basis of the forecast made in Development Plan, and also, such factors as demand explication mentioned in the former section were taken into consideration.

Table-11.1 shows future yearly served population together with total population, which was utilized as an imputation factor for projecting yearly water demand.

11.3 Water Demand

Total water consumption, and average and maximum water demand are shown in Table-11.2.

Total water consumption was forecast from such factors as served population, per capita water consumption, consumption by each category, and tourism water consumption, as described in Chapter 6. This water consumption is used for financial analysis as basic data on water quantity.

For the calculation of average day water demand, the unaccounted-for water ratio was set on the decrease to 23 % in 2000.

Maximum day water demand was calculated, with a peak factor of 1.25 for Chiangmai and 1.3 for Mae Rim and San Kamphaeng.

Table-11.1 TOTAL AND SERVED POPULATION

YEAR	Chiangmai			Mae Rim			San Kamphaeng			TOTAL		
	Total	Service Ratio (%)	Served Population	Total	Service Ratio (%)	Served Population	Total	Service Ratio (%)	Served Population	Total	Service Ratio (%)	Served Pop.
1985	155,300	52.0	80,800	11,100	42.0	4,700	17,000	34.0	5,800	183,400	49.8	91,300
1986	157,000	53.8	84,500	11,200	44.0	4,900	17,400	36.0	6,300	185,600	51.6	95,700
1987	158,700	55.7	88,400	11,300	46.0	5,200	17,700	38.0	6,700	187,700	53.4	100,300
1988	160,500	57.6	92,400	11,400	49.0	5,600	18,100	39.7	7,200	190,000	55.4	105,200
1989	162,200	59.4	96,300	11,500	51.0	5,900	18,400	41.3	7,600	192,100	57.2	109,800
1990	163,900	61.3	100,500	11,600	53.0	6,100	18,800	43.0	8,100	194,300	59.0	114,700
1991	165,700	63.0	104,400	11,700	54.5	6,400	19,200	44.6	8,600	196,600	60.7	119,400
1992	167,400	65.3	109,300	11,700	56.5	6,600	19,500	46.2	9,000	198,600	62.9	124,900
1993	169,100	66.8	113,000	11,800	58.0	6,800	19,900	47.4	9,400	200,800	64.3	129,200
1994	170,100	68.2	116,000	11,900	59.5	7,100	20,200	49.0	9,900	202,200	65.8	133,000
1995	172,100	68.6	118,100	12,000	61.0	7,300	20,600	50.4	10,400	204,700	66.3	135,800
1996	174,300	69.0	120,300	12,100	62.0	7,500	21,000	51.5	10,800	207,400	66.8	138,600
1997	176,100	69.4	122,200	12,200	63.0	7,700	21,300	53.1	11,300	209,600	67.4	141,200
1998	177,800	69.6	123,700	12,300	63.8	7,800	21,700	54.3	11,800	211,800	67.7	143,300
1999	179,500	69.9	125,500	12,500	64.2	8,000	22,000	56.0	12,300	214,000	68.1	145,800
2000	181,300	70.0	126,900	12,600	65.0	8,200	22,400	57.0	12,800	216,300	68.4	147,900

Table-11.2 TOTAL WATER CONSUMPTION AND AVERAGE AND MAXIMUM DAY DEMAND

YEAR	Chiangmai			Mae Rim			San Kamphaeng			TOTAL		
	TOTAL WATER CONSUMPTION (cu m/day)	AVERAGE-DAY DEMND (cu m/day)	MAXIMUM-DAY DEMND (cu m/day)	TOTAL WATER CONSUMPTION (cu m/day)	AVERAGE-DAY DEMND (cu m/day)	MAXIMUM-DAY DEMND (cu m/day)	TOTAL WATER CONSUMPTION (cu m/day)	AVERAGE-DAY DEMND (cu m/day)	MAXIMUM-DAY DEMND (cu m/day)	TOTAL WATER CONSUMPTION (cu m/day)	AVERAGE-DAY DEMND (cu m/day)	MAXIMUM-DAY DEMND (cu m/day)
1985	23,500	34,600	43,300	1,960	2,900	3,900	750	1,120	1,500	26,210	38,620	48,700
1986	24,900	36,100	45,100	2,090	3,100	4,200	820	1,200	1,600	27,810	40,400	50,900
1987	26,600	38,000	47,500	2,200	3,200	4,300	950	1,370	1,800	29,750	42,570	53,600
1988	28,200	39,700	49,600	2,410	3,400	4,600	980	1,390	1,900	31,590	44,490	56,100
1989	29,800	41,400	51,800	2,520	3,500	4,700	1,110	1,550	2,100	33,430	46,450	58,600
1990	31,500	43,200	54,000	2,630	3,600	4,900	1,140	1,560	2,100	35,270	48,360	61,000
1991	33,200	45,200	56,500	2,820	3,800	5,100	1,270	1,730	2,300	37,290	50,730	63,900
1992	35,200	47,700	59,600	2,910	3,900	5,300	1,310	1,780	2,400	39,420	53,380	67,300
1993	36,900	49,700	62,100	3,010	4,100	5,500	1,440	1,940	2,600	41,350	55,740	70,200
1994	38,700	51,900	64,900	3,200	4,300	5,800	1,480	1,980	2,700	43,380	58,180	73,400
1995	40,200	53,600	67,000	3,290	4,400	5,900	1,610	2,150	2,900	45,100	60,150	75,800
1996	41,600	55,200	69,000	3,360	4,500	6,100	1,650	2,190	3,000	46,610	61,890	78,100
1997	43,000	56,700	70,900	3,540	4,700	6,300	1,800	2,370	3,200	48,340	63,770	80,400
1998	44,500	58,400	73,000	3,610	4,700	6,300	1,940	2,550	3,400	50,050	65,650	82,700
1999	45,800	59,800	74,800	3,690	4,800	6,500	1,990	2,600	3,500	51,480	67,200	84,800
2000	47,200	61,300	76,600	3,760	4,900	6,600	2,130	2,770	3,700	53,090	68,970	86,900

CHAPTER 12 PRELIMINARY DESIGN

12.1 Design Criteria

12.1.1 Peak Factors

12.1.2 Water Loss in Production

12.1.3 Treatment Plant

12.1.4 Service Pressure

12.1.5 Pipelines

12.2 Rehabilitation and Modification Works

12.2.1 Chiangmai

12.2.2 Mae Rim and San Kamphaeng

12.3 Expansion Works

12.3.1 General

12.3.2 Outline of Proposed Water Supply Facilities

12.4 Operation and Management Plan

CHAPTER 12

CHAPTER 12 PRELIMINARY DESIGN

In Chapter 7, the water supply system proposed for the Stage I, including rehabilitation and modification of the existing system and the expansion works, was described. This chapter intends to make the preliminary design of the involved works. The criteria is discussed in 12.1, in 12.2 and 12.3 the applications of the criteria to the rehabilitation and modification works and the expansion works are described. In 12.4, fundamental requirements of operation and maintenance of the completed facilities are described.

12.1 Design Criteria

The design criteria mentioned herein were concluded after discussion with PWA and studying the PWA design criteria and the concepts widely accepted in waterworks field. They are applied to the preliminary design of the project, and detailed in Appendix 6.

12.1.1 Peak Factors

No peak factors have been established as criteria, and the table below shows the peak factors planned for Chiangmai and 5 Sanitary Districts.

	Peak Factor by Day (Max Day/Ave Day)	Peak Factor by Hour (Max Hour/Ave Hour)
Chiangmai	1.25	1.30
5 S.D.	1.35	1.50

(Note) Ave Hour = 1/24 Max Day

Using the peak factors, the average day demand, maximum day demand and maximum hour demand were calculated.

Each type of the demands is for different use as described below:

Average Day Demand :	financial and economic study
Maximum Day Demand :	production facility design
Maximum Hour Demand:	distribution facility design

12.1.2 Water Loss in Production

Water loss is counted in designing production facilities. They are assumed to be:

Treatment Plant	:	8 % of production capacity including filter washing and other in-plant consumption
Intake, Transmission	:	2 % of production capacity.

12.1.3 Treatment Plant

The treatment plant must be equipped with such facilities as necessary to produce treated water enough in quantity and quality.

The design criteria applied to the expansion of the existing plant will basically follow the original design concept for the convenience of layout of the treatment plant process units and to facilitate ease of operation and maintenance.

Treated water must conform to the Drinking Water Quality Standards of PWA. Details of the design criteria for treatment plant and the Drinking Water Quality Standards of PWA are stipulated in Appendix 6.

12.1.4 Service Pressure

The minimum service pressure in the maximum hour flow is set at 1.0 kg/sq cm for general application, except for rural areas where 0.7 - 0.8 kg/sq cm can be tolerated.

12.1.5 Pipelines

1) Pipe Material

In selecting pipe material, conditions such as strength against internal and external loads, suitability to ground conditions, workability in existing conditions and influence on water quality must be considered.

Asbestos cement pipes, corrosion coated when necessary, are to be used preferably for economic reasons. For cases requiring pipe strength such as road crossing works and the like, ductile cast iron pipes are to be employed.

2) Pipe Size

Pipe size is to be selected pursuant to flow requirements. In this preliminary design, the maximum hour flow is employed for the pipe size selection.

3) Appurtenances

Necessary appurtenances such as valves, drain valves, air release valves, hydrants are installed at necessary and appropriate places.

12.2 Rehabilitation and Modification Works

The rehabilitation and modification works are intended to provide needed improvements of the existing facilities as previously described in Chapter 5, and to increase potential capacity of the Paton Treatment Plant which could be accomplished with minimal engineering and capital investment. (For details, refer to Appendix 8.)

The Paton Treatment Plant is originally designed with 16,000 cu m/d (667 cu m/h) capacity. The plant was investigated for its potential capacity, whether the existing facilities could be upgraded with minimum capital investment. As the result of the study, it was found that approximately 25 % increase of the production capacity was reasonable, or the total capacity was reasonably increased to 20,000 cu m/d, considering both the design

criteria and the hydraulic conditions.

The planned works are described in the following sections:

12.2.1 Chiangmai

1) Ban Tho Intake

Two intake pumps inclusive of one standby will be newly installed for the increase of production capacity of the Paton Treatment Plant.

- Q 3.1 cu m/min x H 46 m x 2 nos.

Replacement should be needed for a flow meter and a recorder of the 500 and 300 mm diameter raw water transmission main due to malfunctioning. These new flow meters will be of differential pressure type.

2) Water Treatment Plant

The Rehabilitation and Modification Works are shown in Table-12.1 for the three treatment plants of Wang Sing Kam, Umong and Paton, and the details are attached in Appendix 8.

3) Distribution Pipeline

a) Replacement

Obsolete pipes and defective ones are proposed for replacement.

Following pipes are also requested by the Waterworks for replacement:

- Pipes installed under rain sewers and found hindering smooth maintenance service; and
- Pipes buried in a driveway which is subjected to heavy traffic.

Table-12.1 REHABILITATION/MODIFICATION WORKS FOR THREE TREATMENT PLANTS

Items	WANG SING KAM	UMONG	PATON
1. Replacement and installation of chemical feeding equipment	- Alum solution tank, feeding pump and other apputenances : 2 units - Lime solution tank, feeding pump and other appurtenances : 2 units	- Alum feeding pump and other appurtenances : 2 units - Lime solution tank, feeding pump and other appurtenances : 2 units	- Alum feeding pump and other appurtenances : 2 units - Alum solution tank : 1 - Lime solution tank, feeding pump and other appurtenances : 2 units
2. Replacement of level gauge and water flow meter	- 2 level gauges - 2 water flow meters and recorders	- 2 level gauges - 1 water flow meter and recorder	- 2 water flow meters
3. Provision of chlorine gas container scale	- 1 set	- 1 set	- not required
4. Replacement or washing of filter media and repair of underdrain	- 6 beds (72 m2)	- 8 beds (390 m2)	- 6 beds (200 m2)
5. Installation of distribution pump	- Q 7.2 m3/min x H 20 m x 1 no. - Q 3.6 m3/min x H 20 m x 1 no.	- not required	- Q 13.9 m3/min x H 30 m x 2 nos
6. Replacement of broken drain pipes of sedimentation basin	- not required	- 100 mm dia. x 20 pipes	- not required
7. Installation of hanging nets in sedimentation basin	- not required	- not required	- W 3.5 m x D 3.0 m x 10 nets
8. Replacement of head stocks for filter washing valves	- not required	- not required	- 18 sets
9. Purchase of filter sand washer	1 unit for Chiangmai Waterworks		

Such replacement is summarized below:

Diameter (mm)	Length (m)
150	2,900
100	1,850
Total	4,750

b) Purchase of leak detection equipment and implementation of leakage control program

Following equipments will be purchased for the program:

- Leak detector
- Electric sound detector, and
- Pipe locator

A leakage control program as described in Appendix 11 is proposed for implementation.

12.2.2 Mae Rim and San Kamphaeng

A set of chlorine gas container scale will be provided the both Mae Rim and San Kamphaeng Treatment Plants.

Replacement of the distribution pipelines is not required, as it was confirmed in the field investigations and by the information given by the waterworks.

12.3 Expansion Works

12.3.1 General

1) Chiangmai

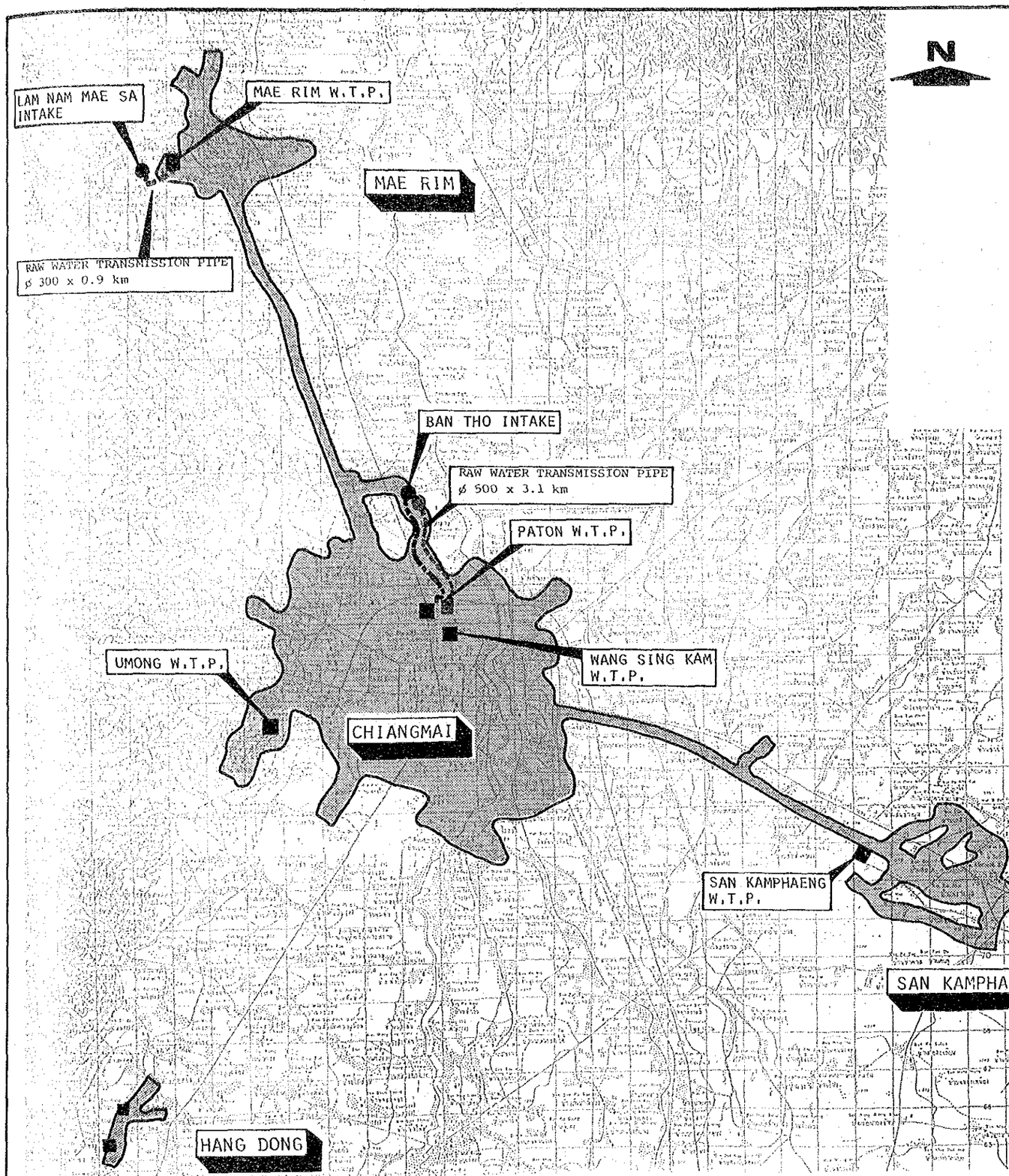
The proposed major facilities for the Stage I Expansion Works are summarized in this section. The planned water supply system for 2000 is shown in the general plan of Fig-12.1 and schematically presented in Fig-12.2(1). The major facilities proposed for the Stage I are tabulated in Table-12.2, and the details are referred to Appendix 8.

The projected year 2000 water demand of 76,600 cu m/d will be satisfied by productions of the following treatment plants:

Wang Sing Kam Treatment Plant	7,900 cu m/d
Umong Treatment Plant	30,000 cu m/d
Paton Treatment Plant	20,000 cu m/d
Proposed (Paton) Treatment Plant	20,000 cu m/d
T o t a l	77,900 cu m/d

2) Mae Rim and San Kamphaeng

The present production capacities of the Mae Rim and the San Kamphaeng Treatment Plants will be able to cover the projected water demand in 2000 very nearly. Therefore, the main works are to install distribution pipelines, corresponding with the increase of served population and the expansion of service area. The outline of water supply system in 2000 is illustrated in Fig-12.2.(2).



W.T.P.	PRESENT	INCREASED CAPACITY IN REHA/MODI WORKS	INCREASED CAPACITY IN EXPANSION WORKS	TOTAL
PATON	16,000 m3/d (666 m3/h)	4,000 m3/d (167 m3/h)	20,000 m3/d (833 m3/h)	40,000 m3/d (1,666 m3/h)
UMONG	30,000 m3/d (1,250 m3/h)	-	-	30,000 m3/d (1,250 m3/h)
WANG SING KAM	7,920 m3/d (330 m3/h)	-	-	7,920 m3/d (330 m3/h)
TOTAL	53,920 m3/d (2,246 m3/h)	4,000 m3/d (167 m3/h)	20,000 m3/d (833 m3/h)	77,920 m3/d (3,246 m3/h)
MAE RIM	7,920 m3/d (330 m3/h)	-	-	7,920 m3/d (330 m3/h)
SAN KAMPHAENG	3,600 m3/d (150 m3/h)	-	-	3,600 m3/d (150 m3/h)

Note: Hang Dong Sanitary District has its own water supply system not belonging to PWA.

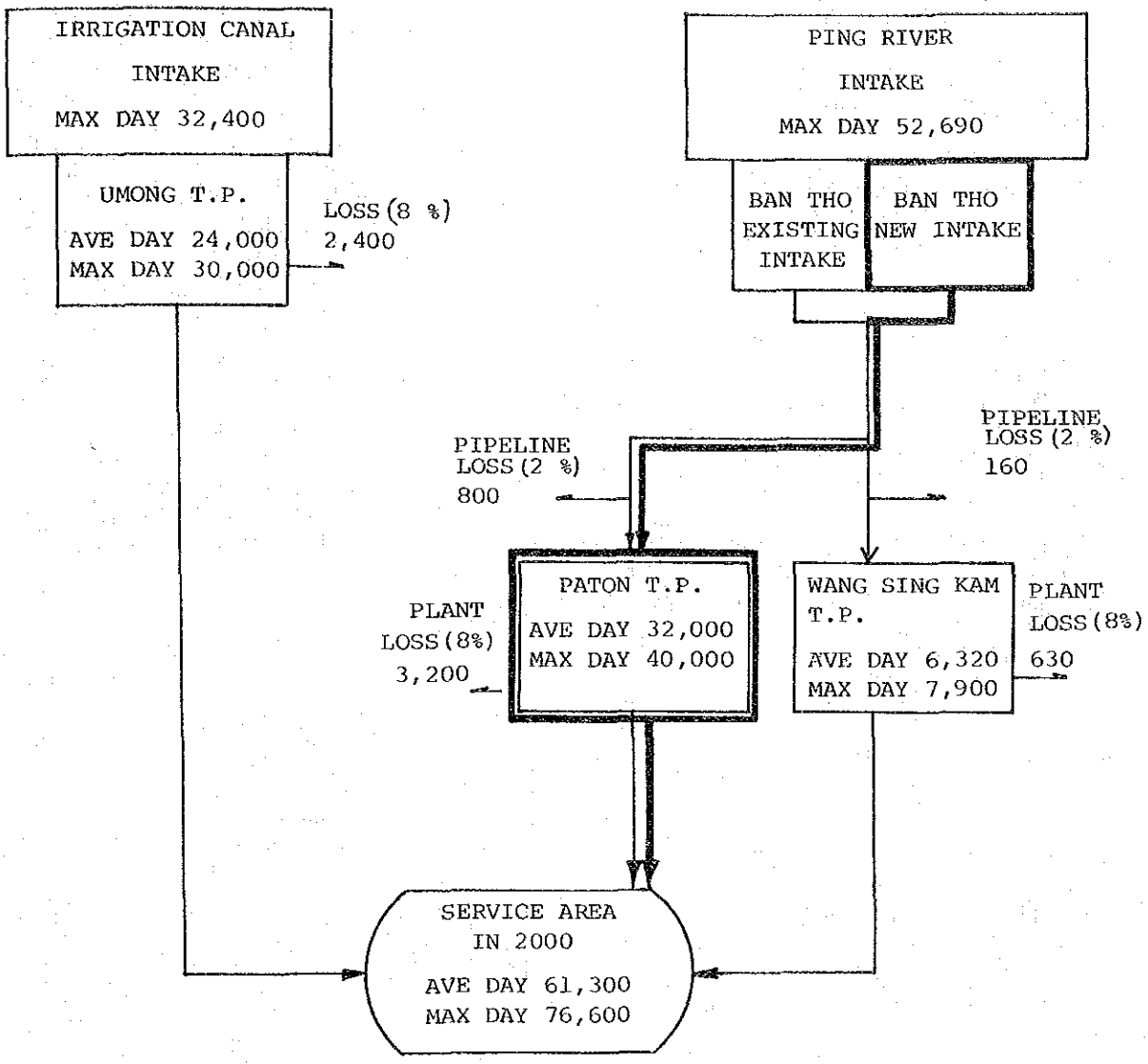
L E G E N D

: EXISTING PIPELINE
: PROPOSED PIPELINE
: EXISTING FACILITY
: PROPOSED FACILITY
: SERVICE AREA IN 2000

0 2 4 6 km

FIGURE 12.1 WATER SUPPLY SYSTEM IN 2000

JAPAN INTERNATIONAL COOPERATION AGENCY



PATON T.P.

	(cu m/hr)	(cu m/day)
Existing	666	16,000
Upgrading	167	4,000
Expansion	833	20,000
Total	1,666	40,000

LEGEND

: PROPOSED FACILITIES

: EXISTING FACILITIES

Unit : cu m/day

FIGURE 12.2.(1)

SCHEMATIC DIAGRAM OF WATER SUPPLY SYSTEM IN 2000 (CHIANGMAI)

JAPAN INTERNATIONAL COOPERATION AGENCY

Table-12.2 MAJOR FACILITIES IN EXPANSION WORKS OF CHIANGMAI, MAE RIM AND SAN KAMPHAENG

Category	Item	No.	Unit	Description
1. CHIANGMAI				
1) Ban Tho Intake	Barrage H = 1.5 m	1	L.S.	Gates and access bridge
	Grit Chamber	2	chambers	V = 22,000 cu m
	Raw water pump statiaon	1	L.S.	
	Raw water pump	2	pumps	Q 15.3 cu m/min. x H 47 m
2) Raw Water Transmission Pipeline	Ban Tho Intake to Paton Dia. 500 mm	3,100	L.M.	ACP and DIP
3) Proposed (Paton) Treatment Plant (20,000 cu m/day)	Flash mixing well	2	wells	mixing by flash mixer
	Flocculation basin	4	basins	mixing by flocculators
	Sedimentation basin	2	basins	one direction horizontal flow
	Rapid sand filter	6	beds	constant rate filtration
	Clear water reservoir	2	reservoirs	V = 5,000 cu m (D.T. 6hrs)
	Chemical feeding facility	1	L.S.	
	- Alum			
	- Lime			
	- Post chlorination			
	Instrumentation	1	L.S.	
	Distribution pumps	2	pumps	Q 13.9 cu m/min. x H 30 m
4) Wang Sing Kaw T.P.	Distribution pumps	1	pump	Q 3.6 cu m/min. x H 20 m
5) Umong T.P.	Distribution pumps	2	pumps	Q 10.7 cu m/min. x H 20 m
4) Distribution Pipeline	Dia. 500 mm	350	L.M.	
	Dia. 400 mm	4,450	L.M.	
	Dia. 300 mm	13,400	L.M.	
	Dia. 250 mm	3,300	L.M.	
	Dia. 200 mm	7,520	L.M.	
	Dia. 150 mm	24,700	L.M.	
	Dia. 100 mm	51,500	L.M.	
5) Land Acquisition	Ban Tho Intake	2,300	sq m	
2 MAE RIM				
1) Raw Water Transmission Pipeline	Intake to plant Dia. 300 mm	900	L.M.	
2) Distribution Pipeline	Dia. 300 mm	1,300	L.M.	
	Dia. 200 mm	11,100	L.M.	
	Dia. 150 mm	3,400	L.M.	
	Dia. 100 mm	5,200	L.M.	
3 SAN KAMPHAENG				
1) Distribution Pipeline	Dia. 300 mm	500	L.M.	
	Dia. 250 mm	1,100	L.M.	
	Dia. 200 mm	1,200	L.M.	
	Dia. 150 mm	2,900	L.M.	
	Dia. 100 mm	3,400	L.M.	

12.3.2 Outline of Proposed Water Supply Facilities

1) Chiangmai

a) The proposed water source for the Stage I project is the Ping River, from which 22,000 cu m/d water is taken at the Ban Tho Intake. An intake barrage will be constructed at a downstream point of the proposed intake, to take in the required quantity. The proposed plan of the barrage and grit chamber is shown in Fig-12.3.

The proposed raw water transmission pipeline is routed along the same road as the existing one is shown in Fig-12.4. The distance from the Ban Tho Intake to the proposed treatment plant at Paton to be covered by the 500 mm dia. pipeline is about 3.1 km.

b) Treatment Plant

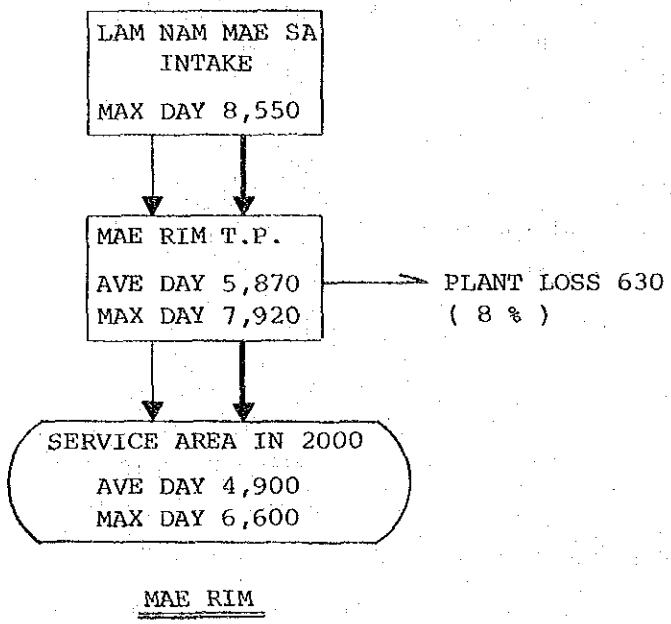
The proposed treatment plant is located in the Paton Treatment Plant site. The treatment plant will use a series of unit processes and operations, as shown in Fig-12.5. Layout of the proposed plant is presented in Fig-12.6.

c) Distribution Pipelines

The distribution system in the proposed Stage I Expansion Works includes installation of 95 km distribution mains in total, as shown in Fig-12.7. And a 150 mm diameter, 10 km long pipeline will be installed along the main road linking Chiangmai to San Kamphaeng, considering possible advantage of interconnecting the two water supply services.

Based on the computer-aided distribution network analysis, distribution pipelines are sized to serve the peak hour flows with sufficient service pressures.

Service connections will be installed by the Waterworks personnel



LEGEND

: PROPOSED FACILITIES

: EXISTING FACILITIES

Unit : cu m/day

FIGURE	SCHEMATIC DIAGRAM OF WATER SUPPLY SYSTEM IN 2000 (MAE RIM AND SAN KAMPHAENG)
12.2 (2)	

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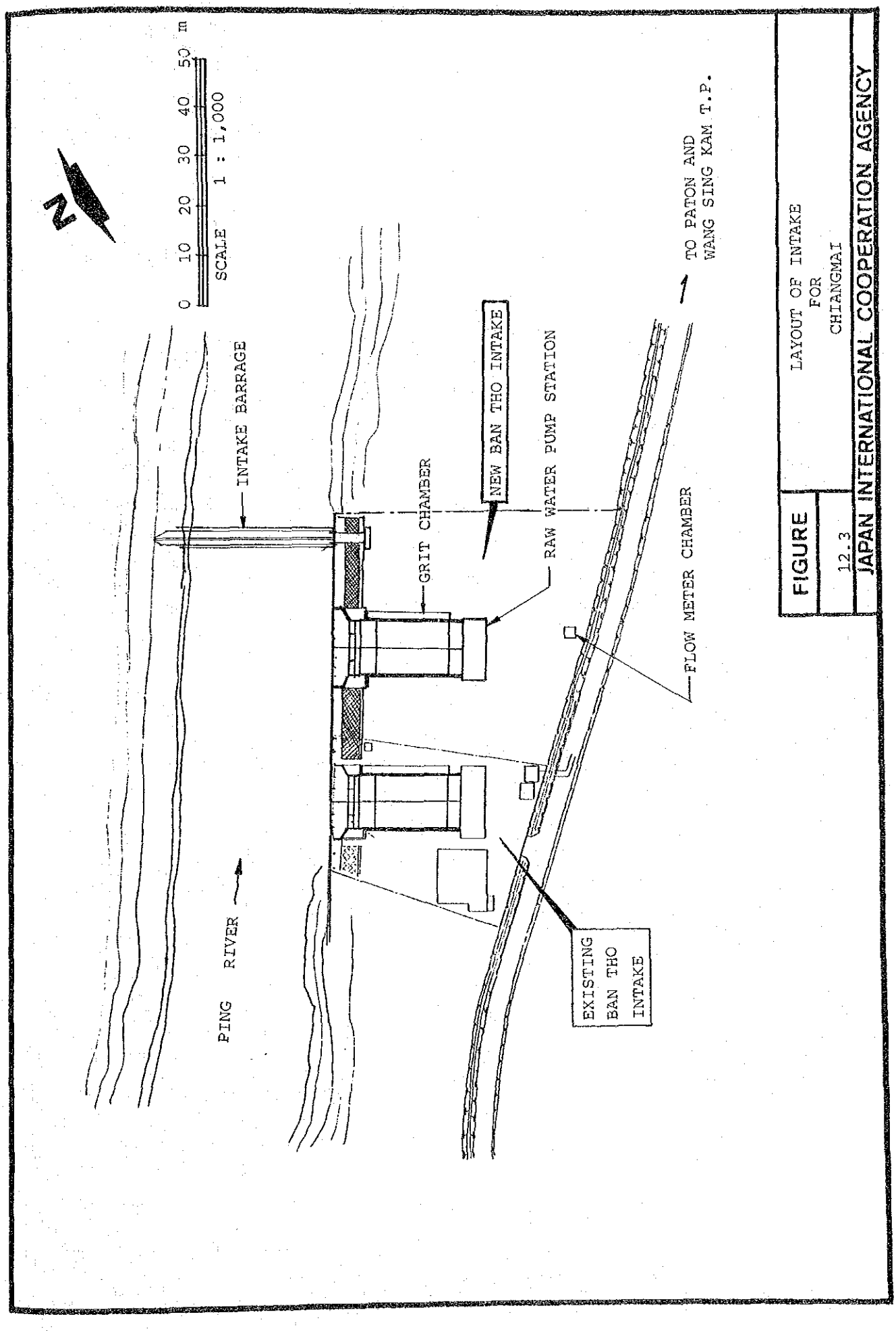

N
SCALE 1 : 1,000
0 10 20 30 40 50 m
INTAKE BARRAGE
GRIT CHAMBER
NEW BAN THO INTAKE
RAW WATER PUMP STATION
FLOW METER CHAMBER
TO PATON AND
WANG SING KAM T.P.
PING RIVER
EXISTING
BAN THO
INTAKE
FIGURE
12.3
LAYOUT OF INTAKE
FOR
CHIANGMAI
JAPAN INTERNATIONAL COOPERATION AGENCY

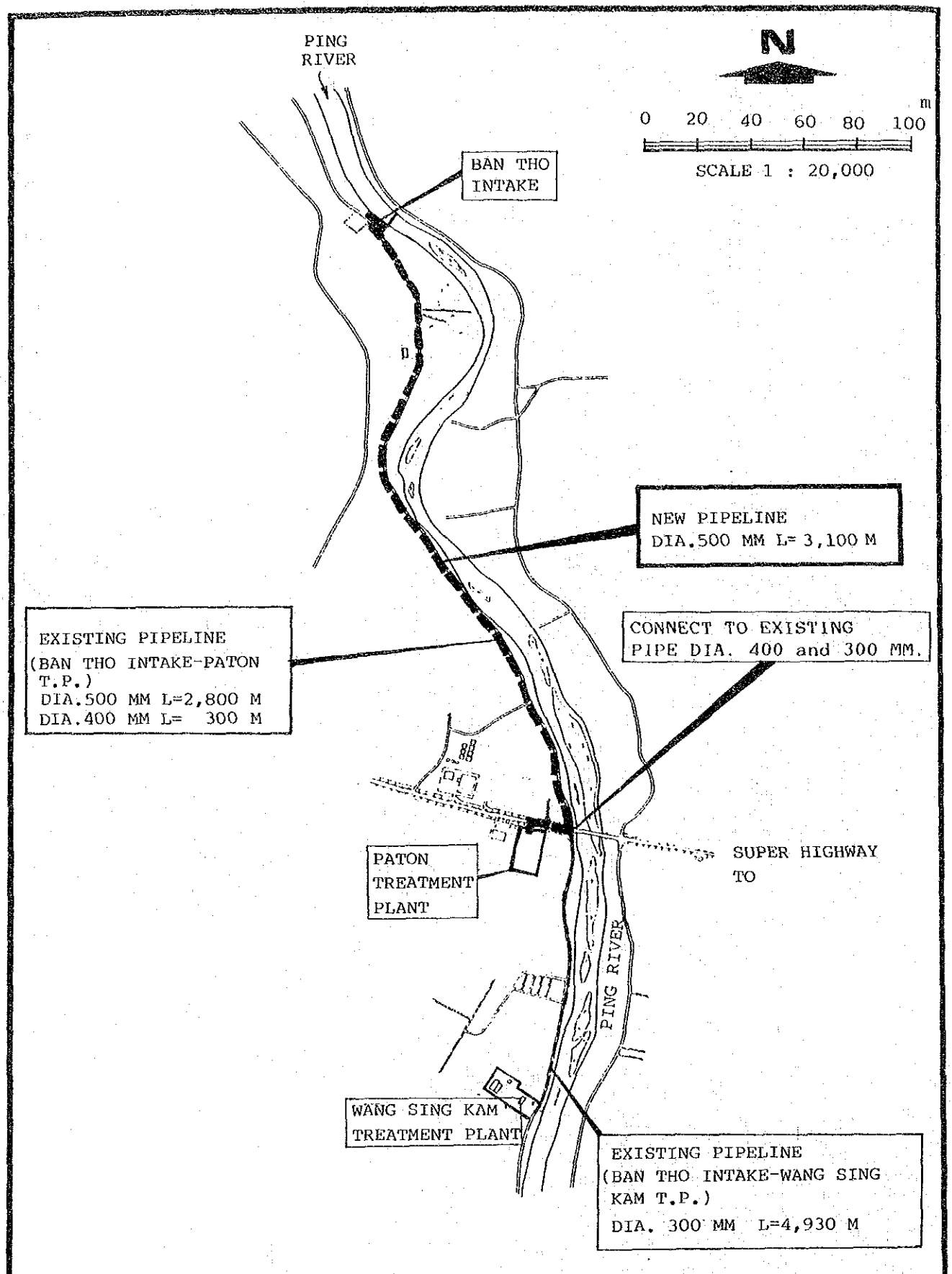


FIGURE	RAW WATER TRANSMISSION PIPELINE ROUTE
12.4	

JAPAN INTERNATIONAL COOPERATION AGENCY

as a part of routine task, when new applications are filed. More than 4,900 connections are planned to be installed by 2000.

2) Mae Rim and San Kamphaeng

a) Mae Rim

An additional raw water transmission pipe with dia. 300 mm of 900 m length will be installed from the intake to the Mae Rim Treatment Plant and a flow meter will be equipped.

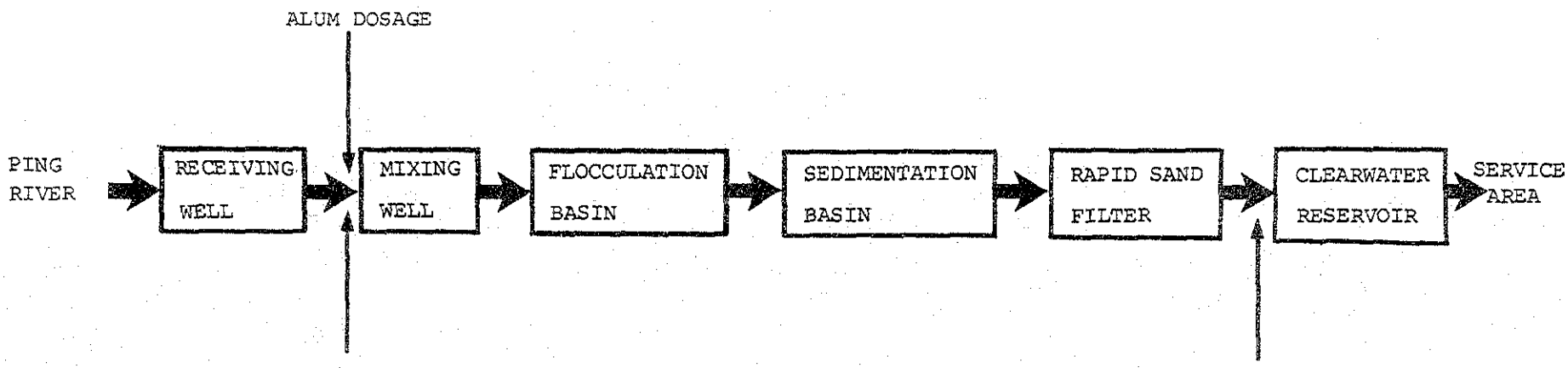
Presently, distribution pipelines are extended to all directions from the central part of the service area. As the waterworks plans extension of the service area to the east and west, the distribution pipelines will be laid in line with the plan in the Stage I, as shown in Fig-12.8. Another pipeline, dia. 200 mm and about 10 km long, will be laid to service large consumers located along the road to Chiangmai. Including it, the total pipeline length will be about 21 km.

Additional service connections estimated at 310 will be installed to serve about 1,800 incremental population.

b) San Kamphaeng

The service area will expand to the east and north of the present service area which now extends east- and west-ward. Distribution mains for the expanded service area totaling about 9 km in length, will be laid in the existing and planned roads, as shown in Fig-12.9.

Additional service connection estimated at about 1,000 will be installed, under the Stage I, to serve about 4,200 incremental population.



CHEMICAL DOSAGE (mg/l)

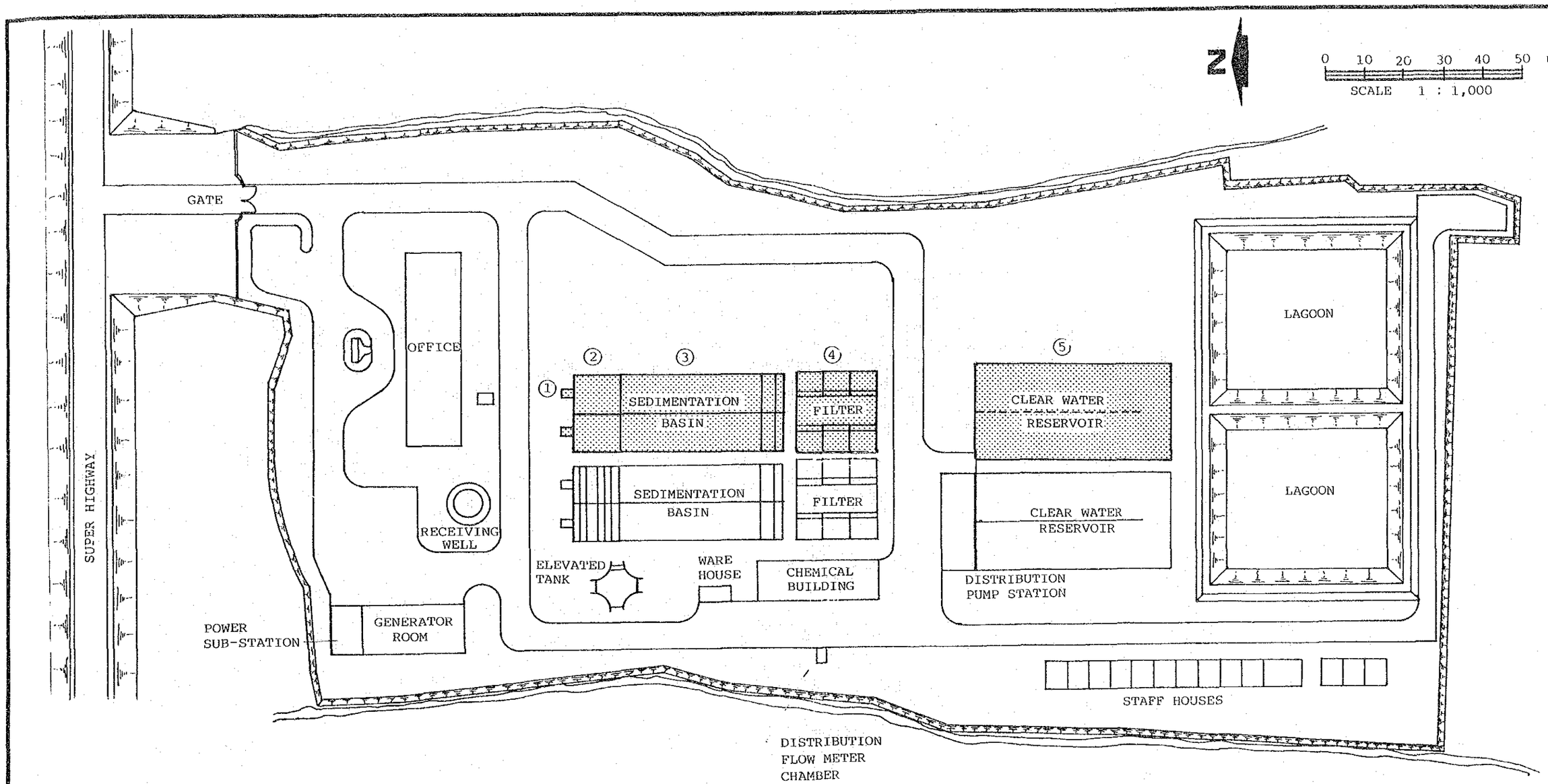
Alum	Ave.	35
	Max.	100
Lime	Ave.	-
	Max.	25
Chlorine	Ave.	1.5
	Max.	3.0

Note) Alkali dosage (0 - 25 mg/l) is employed to regulate pH when turbidity becomes high.

Maximum Alum and Alkali dosage rate are estimated from 200 NTU turbidity.

FIGURE	TREATMENT PROCESS OF PATON TREATMENT PLANT
12.5	

JAPAN INTERNATIONAL COOPERATION AGENCY



LEGEND

: FACILITIES TO BE CONSTRUCTED IN EXPANSION WORKS

PROPOSED FACILITIES (20,000 CU M/DAY)

① MIXING WELL
- 2 WELLS
- V=7.6 CU M/WELL
- D.T.=1.0 MIN

② FLOCCULATION BASIN
- 4 BASINS
- V=103 CU M/BASIN
- D.T.=27 MIN

③ SEDIMENTATION BASIN
- 2 BASINS
- V=1,080 CU M/BASIN
- D.T.=2.4 HR

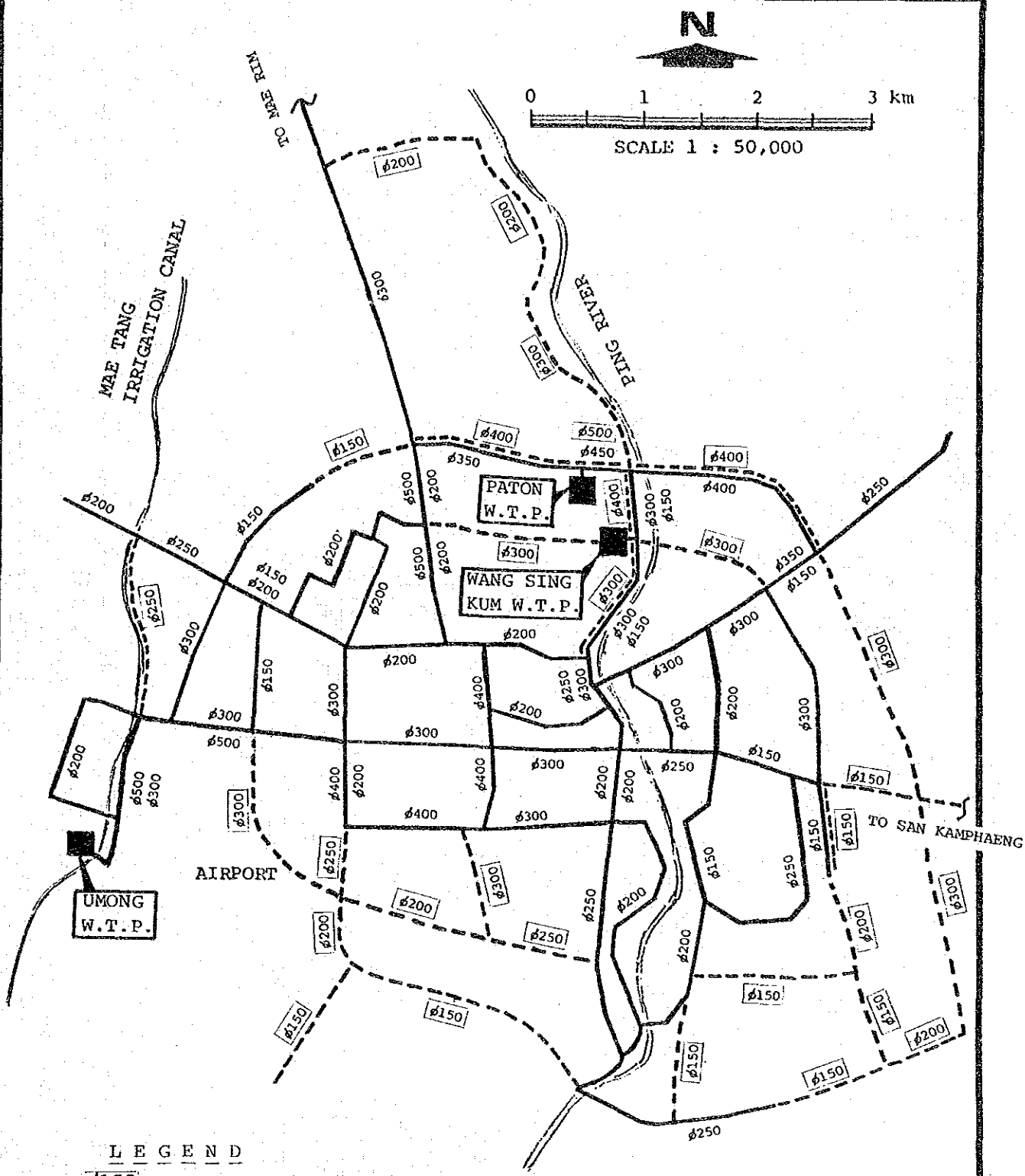
④ FILTER
- 6 BEDS
- A=32 SQ M/BED
- F.R.=5.6 M/HR

⑤ CLEAR WATER RESERVOIR
- 1 RESERVOIR
- V=5,000 CU M
- D.T.=6 HR

NOTE: D.T.=DETENTION TIME
F.R.=FILTRATION RATE

FIGURE	GENERAL LAYOUT OF PATON TREATMENT PLANT
12.6	

JAPAN INTERNATIONAL COOPERATION AGENCY



L E G E N D

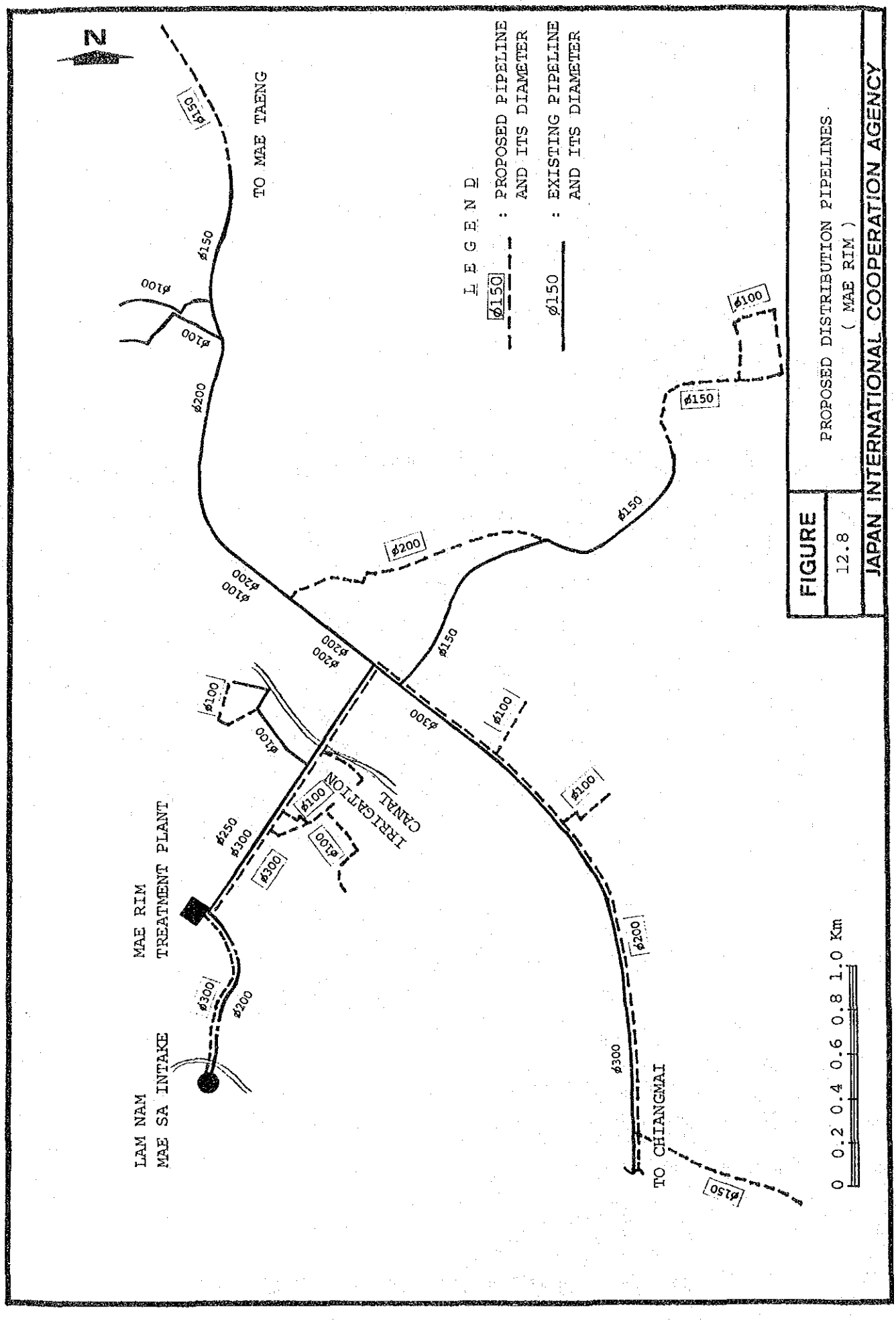
ø150 : PROPOSED PIPELINE AND ITS DIAMETER

ø150 : EXISTING PIPELINE AND ITS DIAMETER

W.T.P. : WATER TREATMENT PLANT

FIGURE	PROPOSED DISTRIBUTION PIPELINES (CHIANGMAI)
12.7	

JAPAN INTERNATIONAL COOPERATION AGENCY


N
TO MAE TAENG
LEGEND
ø150 : PROPOSED PIPELINE AND ITS DIAMETER
ø150 : EXISTING PIPELINE AND ITS DIAMETER
LAM NAM
MAE SA INTAKE
MAE RIM
TREATMENT PLANT
IRRIGATION CANAL
TO CHIANGMAI
0 0.2 0.4 0.6 0.8 1.0 Km
FIGURE
12.8
PROPOSED DISTRIBUTION PIPELINES
(MAE RIM)
JAPAN INTERNATIONAL COOPERATION AGENCY

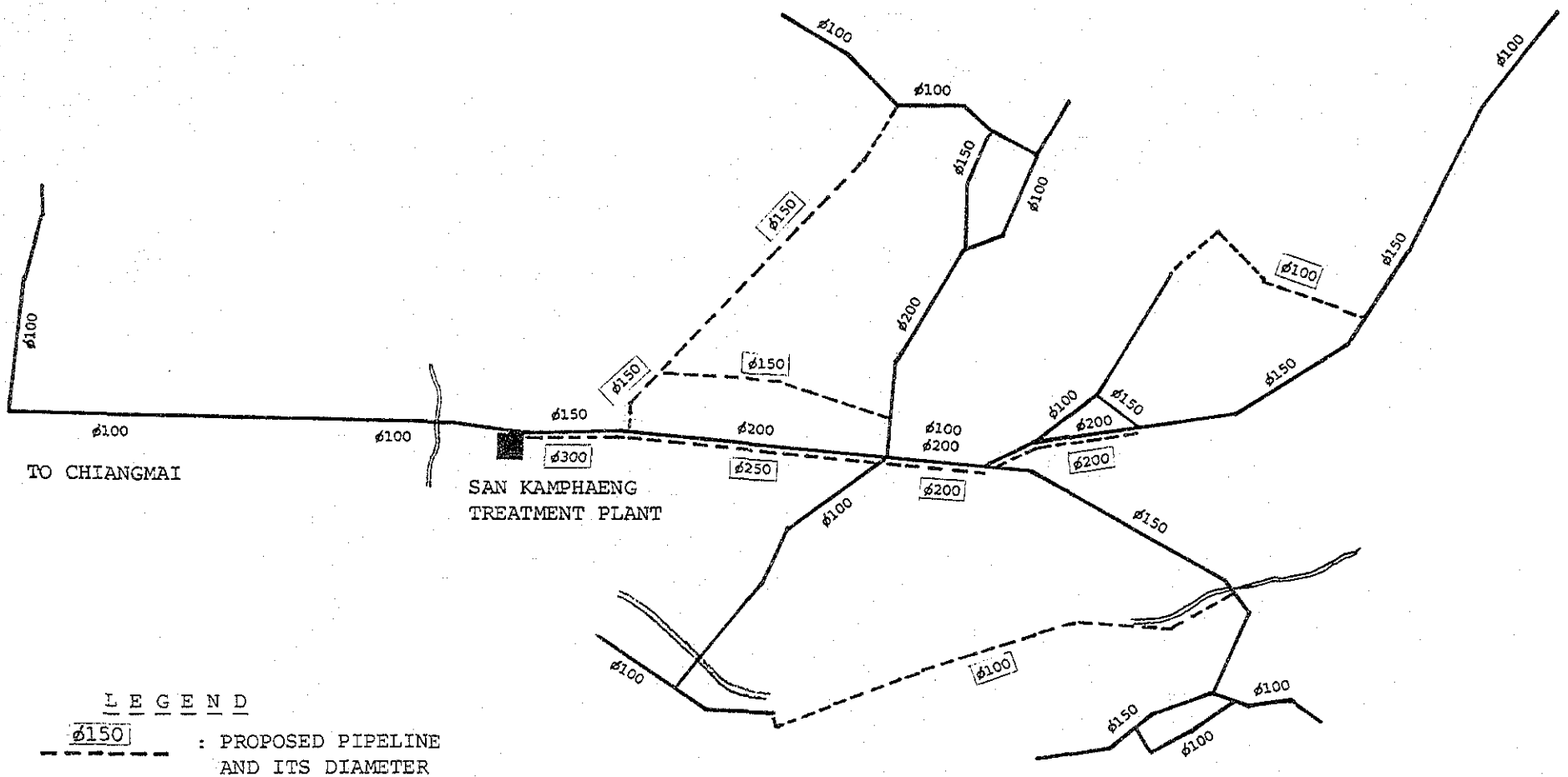


FIGURE	PROPOSED DISTRIBUTION PIPELINES (SAN KAMPHAENG)
12.9	

JAPAN INTERNATIONAL COOPERATION AGENCY

12.4 Operations and Management Plan

To secure supply of sufficient amount of safe water to customers, the following procedures should be practiced by the Chiangmai Waterworks Office and the treatment plants.

- Treatment Plants

  (1) To gauge and control water flow in the system for required volume of water to meet demand,

  (2) To control water quality by testing water and by dosing and stockpiling chemicals,

  (3) To maintain the treatment plant in proper conditions,

- Waterworks Office

  (4) To control and manage the whole system in accordance with the information obtained from the operation room at each respective treatment plant, and

  (5) To organize a leakage survey team in the Waterworks for the purpose of reducing water leakage,

  (6) To economize the operation cost by controlling the production of treatment plants and the distribution therefrom.

In realizing the above mentioned matters and to prepare for the increasing water demand, the number of personnel shall be increased, as shown in Table-12.3. The effect on the operation and maintenance cost is given in Chapter 13.

Regarding (6) of the above, the raw water taken in to the Umong Treatment Plant may be charged 0.5 Baht per cubic meter in future and it will make the production cost of the plant substantially higher than the other plants. It will have to be taken into consideration in the future operation of the system.

Table-12.3 STAFF REQUIREMENT FOR CHIANGMAI WATERWORKS

Description	Grade	1986	1990	1995	2000
1) Manager	9	1	1	1	1
2) Assistant Manager	8	3	3	3	3
3) Water Production Section					
- Chief	7	1	1	1	1
- Mechanic	5	5	5	7	7
- Production Staff	4	19	20	22	22
- Janitor	3	2	2	2	2
- Electrician	2	1	1	2	2
4) Service Section					
- Chief	7	1	1	1	1
- Technician	6	3	4	4	5
- Servicing Staff	5	7	9	10	11
- Skilled Labor	6	2	2	3	3
- Labor	3	3	4	4	5
- Driver	3	1	1	2	2
5) Administration Section					
- Chief	8	1	1	1	1
- Clerk	6	2	2	2	2
- Finance & A/C	6	17	20	24	26
- Storage Keeper	4	2	2	2	2
- Labor	3	2	2	2	2
- Bill Collector	5	8	10	12	12
- Meter Reader	4	6	7	9	9
- Security Staff	4	1	1	2	2
T O T A L		88	99	116	121

(Note) Chiangmai, Mae Rim and San Kamphaeng Waterworks are to be merged in 1990.

CHAPTER 13 PROJECT IMPLEMENTATION AND COST ESTIMATES

13.1 Labor, Material, Equipment and Machinery
13.1.1 Labor
13.1.2 Materials
13.1.3 Equipment and Machinery

13.2 Procurement and Financing
13.2.1 Procurement Procedures of PWA
13.2.2 Project Financing

13.3 Implementation Schedule

13.4 Cost Estimates and Disbursement Schedule
13.4.1 Cost Estimates for Rehabilitation and Modification Works
13.4.2 Cost Estimates for Expansion Works
13.4.3 Cost Estimates for Operation and Maintenance
13.4.4 Disbursement Schedule

CHAPTER 13 PROJECT IMPLEMENTATION AND COST ESTIMATES

In this chapter, availability of labor, material, equipment and machinery necessitated for construction is studied.

Related to it, the procurement procedures of PWA is reviewed and the principal matters of financing the project is discussed.

Following the above, the implementation schedule is proposed and the cost estimation is presented.

13.1 Labor, Material, Equipment and Machinery

13.1.1 Labor

A good number of qualified workers can be mobilized in the project area, enough to meet the civil and architectural needs for the implementation of the project. The mobilization may be facilitated by the climate of the labor market of the project area where supply generally exceeds demand.

The qualification of levels of skill in various trades has not been institutionalized and each laborer differs in skill. General contractors are trying to maintain the level of workmanship, by employing skilled workers on a permanent basis and/or sub-contracting the part of work to contractors which are specialized in particular fields.

13.1.2 Materials

1) Standards of Construction Materials

The following two standards are adopted and practiced by PWA:

General Construction Standard
Pipe and Fitting Standard

The pipe and fitting standards have been based mainly on the standards of the American Water Works Association (AWWA). Regarding matters unspecified

therein and/or un-specified details, PWA makes its own specifications.

On the part of manufacturers, materials based on their own standards, as well as on AWWA, JWWA, B.S. (British Standards) and DIN (German Standards) have been prepared and supplied to PWA.

2) Construction Materials

Materials used in construction by waterworks are roughly divided into a) general construction materials and b) waterworks related construction materials.

a) General Construction Materials

Natural products like natural gravel, sand, clay and timber are available in the area, although crush/sieved stone is gradually taking the place of natural gravel for concrete aggregate.

Such local products as steel bars, cement, bricks, concrete precast products, ready mixed concrete, window sashes, doors and furniture are easily available.

As for scaffolding and staging, steel materials have taken the place of wooden ones since the beginning of 1980s. Staging of bamboo and wooden plates is still popular in the countryside.

Wooden forms are popular in the construction field.

b) Waterworks Related Construction Materials

Machines specifically used in water treatment, like chemicals dosing pumps, chlorinator and others are mostly imported.

Asbestos cement pipes up to 600 mm in diameter are available. Cast iron valves and pipe fittings are made by a few local factories. One of the largest is capable of making

1,500 mm sized valves.

A few makers are manufacturing service meters by importing major components and assembling them in domestically made casings.

Two to three firms are producing alum, and PWA is now being supplied by a national enterprise. Chlorine gas is produced by an unknown number of companies which have sufficient supply capacity.

13.1.3 Equipment and Machinery

Small construction machinery like concrete pushcarts, concrete mixers, drainage pumps for civil works, etc., and motors and engines for them have been manufactured locally. Large construction machinery for general and special uses are imported. Both of the local and foreign made, after-sale service is taken care by the local agents.

Lease service of construction machinery has been undertaken by about ten firms. Almost all kinds of construction machinery can be available on a rental base. Rental conditions are flexible.

Machinery for general uses are owned by large contractors and some of them have their own repair workshops and motor pools.

13.2 Procurement and Financing

13.2.1 Procurement Procedures of PWA

Procurement of goods and construction works is generally made on a contract basis. Except for small scale and urgently necessary goods or works, PWA depends on open tendering rather than direct appointment.

The following criteria have been set on the level of order agencies:

Individual Waterworks	: less than 50,000 Baht
PWA Regional Office	: from 50,000 to 500,000 Baht
PWA Head Office	: more than 500,000 Baht

The below procedures are taken from planning to tendering and awarding contracts:

Planning is made by Planning Division of Corporate Planning Department. On the basis of the plan, Project Preparation Division of Engineering Department prepares detail designs and plans of goods procurement.

Costs of goods procurement and construction works are estimated jointly by Project Preparation Division and Cost Estimation Division and tendering is made based on such estimated costs.

Tendering is managed by two committees of PWA. One committee is responsible for checking the consistency with the specified conditions and opening the proposed tender prices. Tendering Committee is responsible, then, for evaluating the proposed tenders and finalizing them.

Both committees are formed by the PWA directors and higher ranked senior staff. After decision making, the contract is officially finalized between PWA and the contractor/supplier.

Generally adopted is open tendering. In case of big projects, prequalification is applied prior to open tendering. Tendering by the specified bidders and awarding by direct-appointment is seldom practiced except special cases.

Announcement of open tenders is made public in Bidding News, weekly editions of the Thai Construction Association publication, Construction Business News (monthly publication), Other Thai papers, and English ones in case of international tendering.

When the method of announcement is conditioned with the loan/grant

agreement, the terms and conditions of the loan will be followed.

The present procedures of procurement of PWA are well routinized and applying them to the project will be reasonable and justifiable.

13.2.2 Project Financing

Implementation of the project assumes that the fund will be made available from foreign financial sources such as the OECF Loans. Therefore, if the fund is provided by other types of leading agencies on the terms and conditions different from said loans, the schedule may be adjusted so as to meet these terms and conditions.

The Stage I Works consist of two components, the Rehabilitation and Modification Works to be undertaken at the early phase of the Stage, and to be followed by the Expansion Works which constitute major component of the Stage I Works.

The Stage I Works are planned to be financed by the following two kinds of loans. The First loan which consists of the following components:

a) Engineering service loan for detailed design for the whole Stage I Works

b) Project loan for the Rehabilitation and Modification Works

c) Engineering service loan for the construction supervision services for the above Rehabilitation and Modification Works

The Second loan which consists of the followings:

a) Project loan for the construction of Stage I Expansion Works

b) Engineering service loan for construction supervision services for the above works

Implementation delineates the time schedule for the above loan procedure, together with detailed design and construction to be followed.

The following is the schedule covering (1) the Rehabilitation and Modification and (2) Stage I Expansion:

Rehabilitation and Modification Works	: July 1988 - June 1989 (1 year)
Expansion Works	: January 1990 - December 1991 (2 years)

13.3 Implementation Schedule

As the construction of the water supply system is one of the important public works, it is imperative that a reliable construction work be ensured within the shortest period practical. In view of these, the construction works under the Stage I should adopt the common construction methods widely practiced in Thailand, so that the steady construction works are easily undertaken and the period can be shortened.

The timing of the implementation of Stage I Works which are composed of Rehabilitation and Modification Works and Expansion Works for Chiangmai, Mae Rim and San Kamphaeng are set as follows:

The timing of executing the rehabilitation/modification is flexible, although earlier execution is preferable. The works are planned to be completed in 1989 prior to the commencement of the expansion works.

The expansion works to meet the demand in 2000 are scheduled to be completed at end of 1991.

The design period for the rehabilitation/modification works is estimated at about 4 month, judging from the work volume.

As the facilities included in the expansion works are diversified in nature, the design period of 15 months is planned.

Loan application for the project will be made in two steps presumably.

The first step loan is planned to cover the engineering service, design of both of the rehabilitation/modification and expansion works and supervision of the former, and the implementation of rehabilitation/modification.

The second step loan is for the implementation of the expansion works, inclusive of supervision by consultants.

The construction period planned for the rehabilitation/modification works is estimated on 1 year, including safety margin.

As for the expansion works, the planned 2 years are rather tight, when the involved works are considered. A detailed execution plan will be needed in the later stage.

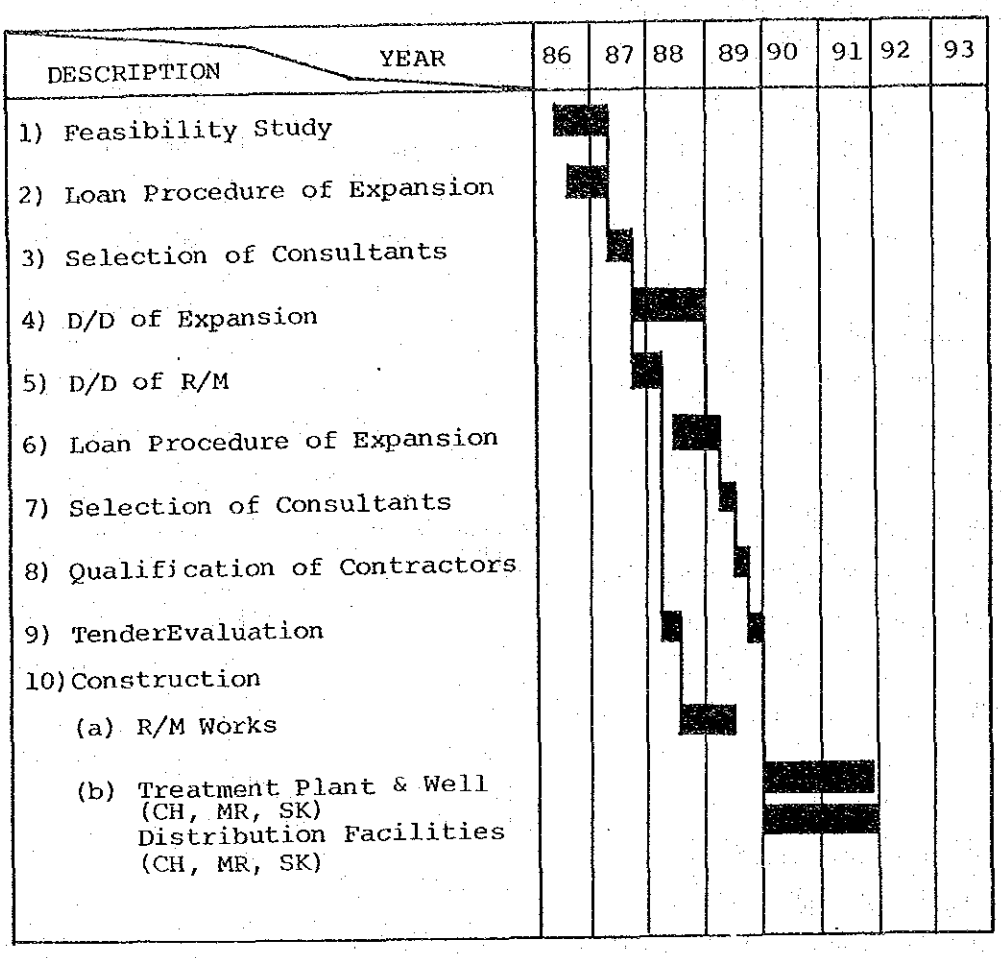
The above mentioned conditions were taken into account in preparing the implementation schedule, shown in Fig-13.1.

13.4 Cost Estimates and Disbursement Schedule

13.4.1 Cost Estimates for Rehabilitation and Modification Works

The methods of cost estimation and cost-allocation of foreign/local currency, described in detail in Appendix 9 was applied herewith.

Table-13.1 shows the summary of the estimated cost of rehabilitation and modification works resulted by the estimation and allocation.



NOTE : D/D Detailed Design
R/M Rehabilitation and Modification
CH Chiangmai
MR Mae Rim
SK San Kamphaeng

FIGURE	IMPLEMENTATATION SCHEDULE OF CHIANGMAI, MAE RIM AND SAN KAMPHAENG
13.1	
JAPAN INTERNATIONAL COOPERATION AGENCY	

Table-13.1 ESTIMATED COST OF REHABILITATION AND MODIFICATION WORKS

(Unit : 1,000 ฿)

	F/C	L/C	Total
1. Land Acquisition	-	-	-
2. Intake and Treatment Plant			
1) Chiangmai			
(1) Ban Tho Intake	1,386	814	2,200
(2) Treatment Plant	11,286	5,814	17,100
Sub-Total	12,672	6,628	19,300
2) Mae Rim & San Kamphaeng			
(1) Treatment Plant	264	136	400
Sub-Total	264	136	400
3. Distribution Pipeline			
1) Chiangmai			
(1) Pipe Replacement	1,350	900	2,250
(2) Leak Detection Equipment	450	-	450
Sub-total	1,800	900	2,700
Total	14,736	7,664	22,400

13.4.2 Cost Estimates for Expansion Works

Table-13.2 shows the summary of the estimated cost of expansion works resulted by the estimation and allocation, and the details are reffered to Appendix 9.

Table-13.2 ESTIMATED COST OF EXPANSION WORKS

(Unit : 1,000 ฿)

	F/C	L/C	Total
1. Land Acquisition	-	1,800	1,800
Sub-Total	-	1,800	1,800
2. Chiangmai Facilities			
1) Ban Tho Intake	13,863	7,037	20,900
2) Raw Water Transmission Pipeline	6,120	4,080	10,200
3) Paton Treatment Plant	40,524	20,876	61,400
4) Wang Sing Kam T.P.	462	238	700
5) Umong Treatment Plant	1,188	612	1,800
6) Distribution Pipeline	48,660	32,440	81,100
Sub-Total	110,817	65,283	176,100
3. Mae Rim Facilities			
1) Raw Water Transmission Pipeline	840	560	1,400
2) Distribution Pipeline	10,080	6,720	16,800
Sub-Total	10,920	7,280	18,200
4. San Kamphaeng Facilities			
1) Distribution Facilities	3,780	2,520	6,300
Sub-Total	3,780	2,520	6,300
Total	125,517	76,883	202,400

13.4.3 Cost Estimates for Operation and Maintenance

Operation and maintenance cost is classified as stated below, the items are:

1) Personnel Cost

The personnel cost is estimated as follows:

Organization and staff arrangement will continue to keep the present form, even if managerial practice and efficiency in functioning may need improvement in future.

Corresponding to increased supply of water resulting from the rehabilitation/modification and expansion works, work volume of operation/ maintenance/service will increase accordingly.

Every section in the waterworks, to meet increased work volume, will have to be staffed by additional personnel gradually. The number of personnel from 1986 to 2000 was assumed considering the work volume.

Personnel cost are calculated on the basis of the number of personnel classified by position and function multiplied by the salary grades of the PWA, according to their functions and positions as shown in Table-12.3. In case one grade is divided into several salary levels, the medium level is used as a base of calculation. The basic level of personnel expenses is assumed to increase at 7 % per annum, inclusive of price escalations, following the pattern in recent years.

2) Electricity and Fuel Cost

The electricity rate is divided into two portions. The first one, fixed on the basis of the total electric equipments' rated capacity (@ ฿95/kW), is paid monthly. The second one is charged on the basis of actual consumption measured by periodical meter readings (@ ฿1.36/kW).

In this report, estimation is made by a simplified method, on the following assumptions:

Electricity:

(a) The present electricity cost consisting of the both portions mentioned above and fuel cost of each waterworks is converted to unit cost (per cubic meter of produced water).
(b) Unit cost will be subject to price escalation of 3.3 % per annum
(c) Annual electricity cost is calculated from the planned yearly water production volume multiplied by unit cost.
(d) In case the two treatment plants in the area are not in full operation, the priority of operation is given to the plant with cheaper unit electricity cost, so that the combined total electricity cost may be minimized.

Fuel:

Fuel cost is assumed to increase in the same proportion with electricity charges.

3) Chemical Cost

Considering the future water quality and planned treatment process, chemical dosage was forecast in the previous chapter, on an average basis.

Unit cost of chemicals per cubic meter of produced water is calculated on the basis of the present average price and the quoted chemical dosage. The unit prices employed herein are as follows:

Alum	: ฿ 3.8/kg
Lime	: ฿ 1.5/kg
Chlorine	: ฿12.0/kg

The unit cost is assumed to increase at 3.3 % per annum from 1986 to 2000.

Chemicals cost in a particular year is calculated based on the planned water volume and unit cost for the year.

4) Connection Work Cost

Connection cost is an expense to connect service pipe to consumers' service meters from the distribution pipe.

The number of connections is estimated from the served population and average number of household members per family in a respective year.

Average unit connection cost is estimated on the basis of the accounting records of the actual expenses spent for connection works, with escalation at 3.3 % per annum from 1986 to 2000.

Connection cost in a respective year is calculated on the basis of yearly increase in the connection number and the above average unit cost per connection work.

5) Raw Water Cost

As to the raw water the Umong Treatment Plant is taking in from the irrigation canal, PWA is presently charged with no raw water fees. In this study, however, operation and maintenance cost is forecast on the assumption that such fees are charged by RID at the rate of 0.5 Baht per cu m. With the raw water fees thus charged, the unit water production cost of the Umong Plant is projected to be the highest among those of other two plants. As referred to in Chapter 12, Section 12.4, the other two plants, Paton and Wang Sing Kam, should be operated prior to Umong Plant, when all these are not required to be operated.

The raw water cost is also forecast with annual price escalation of 3.3 %.

6) Other Cost

This item includes costs for repair works, office expenses and other miscellaneous costs. Data in 1985 show that these costs amount to about 5 % of total expenditure including personnel, power and other costs stated in the preceding sections.

For better maintenance of the facilities, particularly to keep the unaccounted ratio at a lowest possible level, repair costs and material costs are expected to increase. The ratio of other expenses to the total cost is, therefore, projected to increase gradually. Estimation of this item was therefore made along this line.

7) Operation and Maintenance Summarized

All of the operation and maintenance costs estimated in the preceding sections are summarized and tabulated as shown below in Table-13.3.

Table-13.3 OPERATION AND MAINTENANCE COST

(Unit : 1,000 ฿)

Item	1986	1990	1995	2000
Personnel Cost	8,956	13,388	21,584	30,272
Electricity & Fuel Cost	8,844	12,365	18,914	25,651
Chemical Cost	2,246	3,054	4,455	5,984
Connection Cost	2,350	2,708	1,958	1,719
Raw Water Cost	3,095	4,339	3,753	6,601
Other	3,563	4,803	7,008	8,953
Total	29,054	40,657	57,652	79,180

13.4.4 Disbursement Schedule

The project will be commenced in 1987 and completed in 1991. Disbursement by each year will be made as stated in Table-13. , which is based on the Implementation Schedule.

The cost described in the Table of the Schedule is denoted in 1986 price.

The employed exchange rate is : US $1.00 = ฿26.12

Table-13.4 PROJECT COST AND DISBURSEMENT SCHEDULE

Note: 1) Figures of Items A to E are expressed at 1986 prices.
2) Figures of Items F and G are expressed at current prices.

Unit : x 1,000 Baht

ITEM	Total Cost	BREAK DOWN				1987				1988				1989				1990				1991			
		FC	LC			FC	LC			FC	LC			FC	LC			FC	LC			FC	LC		
			Material Cost	Labor Cost			Material Cost	Labor Cost			Material Cost	Labor Cost			Material Cost	Labor Cost			Material Cost	Labor Cost			Material Cost	Labor Cost	
				Skilled	Unskilled			Skilled	Unskilled			Skilled	Unskilled			Skilled	Unskilled			Skilled	Unskilled			Skilled	Unskilled
A. Rehab. & Modification																									
1. Land Acquisition	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2. Intake & T. Plant	19,700	12,936	2,342	2,364	2,058	0	0	0	0	5,174	937	946	823	7,762	1,405	1,418	1,235	0	0	0	0	0	0	0	0
1) Chiangmai	19,300	12,672	2,294	2,316	2,018	0	0	0	0	5,069	918	926	807	7,603	1,376	1,390	1,211	0	0	0	0	0	0	0	0
a. Ban Tho Intake	2,200	1,386	242	264	308	0	0	0	0	554	97	106	123	832	145	158	185	0	0	0	0	0	0	0	0
b. Treatment Plant	17,100	11,286	2,052	2,052	1,710	0	0	0	0	4,514	821	821	684	6,772	1,231	1,231	1,026	0	0	0	0	0	0	0	0
2) Mae Rim & San Kam.	400	264	48	48	40	0	0	0	0	106	19	19	16	158	29	29	24	0	0	0	0	0	0	0	0
a. Treatment Plant	400	264	48	48	40	0	0	0	0	106	19	19	16	158	29	29	24	0	0	0	0	0	0	0	0
3. Distribution Pipe	2,700	1,800	225	315	360	0	0	0	0	990	90	126	144	810	135	189	216	0	0	0	0	0	0	0	0
1) Chiangmai	2,700	1,800	225	315	360	0	0	0	0	990	90	126	144	810	135	189	216	0	0	0	0	0	0	0	0
a. Pipe Replacement	2,250	1,350	225	315	360	0	0	0	0	540	90	126	144	810	135	189	216	0	0	0	0	0	0	0	0
b. Leak Detect. Equip.	450	450	0	0	0	0	0	0	0	450	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
- Total of A -	22,400	14,736	2,567	2,679	2,418	0	0	0	0	6,164	1,027	1,072	967	8,572	1,540	1,607	1,451	0	0	0	0	0	0	0	0
B. Expansion																									
1. Land Acquisition	1,800	0	1,800	0	0	0	0	0	0	0	0	0	0	0	1,800	0	0	0	0	0	0	0	0	0	0
2. Chiangmai Facilities	176,100	110,817	19,039	22,668	23,576	0	0	0	0	0	0	0	0	0	0	0	0	44,327	7,616	9,067	9,430	66,490	11,423	13,601	14,146
1) Ban Tho Intake	20,900	13,863	2,241	2,218	2,578	0	0	0	0	0	0	0	0	0	0	0	0	5,545	896	887	1,031	8,318	1,345	1,331	1,547
a. Barrage	11,000	6,930	1,210	1,320	1,540	0	0	0	0	0	0	0	0	0	0	0	0	2,772	484	528	616	4,158	726	792	924
b. Grit Chamber	4,100	2,583	451	492	574	0	0	0	0	0	0	0	0	0	0	0	0	1,033	180	197	230	1,550	271	295	344
c. Raw Water Pump Station	5,800	4,350	580	406	464	0	0	0	0	0	0	0	0	0	0	0	0	1,740	232	162	186	2,610	348	244	278
2) R. W. Transmission Pipeline	10,200	6,120	1,020	1,428	1,632	0	0	0	0	0	0	0	0	0	0	0	0	2,448	408	571	653	3,672	612	857	979
3) Paton Treat. Plant	61,400	40,524	7,368	7,368	6,140	0	0	0	0	0	0	0	0	0	0	0	0	16,210	2,947	2,947	2,456	24,314	4,421	4,421	3,684
4) Wang Sing Kam T.P.	700	462	84	84	70	0	0	0	0	0	0	0	0	0	0	0	0	185	34	34	28	277	50	50	42
5) Umon T.P.	1,800	1,188	216	216	180	0	0	0	0	0	0	0	0	0	0	0	0	475	86	86	72	713	130	130	108
6) Dist. Pipeline	81,100	48,660	8,110	11,354	12,976	0	0	0	0	0	0	0	0	0	0	0	0	19,464	3,244	4,542	5,190	29,196	4,866	6,812	7,786
3. Mae Rim Facilities	18,200	10,920	1,820	2,548	2,912	0	0	0	0	0	0	0	0	0	0	0	0	4,368	728	1,019	1,165	6,552	1,092	1,529	1,747
a. R.W.Trans.Pipeline	1,400	840	140	196	224	0	0	0	0	0	0	0	0	0	0	0	0	336	56	78	90	504	84	118	134
b. Dist. Pipeline	16,800	10,080	1,680	2,352	2,688	0	0	0	0	0	0	0	0	0	0	0	0	4,032	672	941	1,075	6,048	1,008	1,411	1,613
4. San Kam. Facilities	6,300	3,780	630	882	1,008	0	0	0	0	0	0	0	0	0	0	0	0	1,512	252	353	403	2,268	378	529	605
a. Dist. Pipeline	6,300	3,780	630	882	1,008	0	0	0	0	0	0	0	0	0	0	0	0	1,512	252	353	403	2,268	378	529	605
- Total of B -	202,400	125,517	23,289	26,098	27,496	0	0	0	0	0	0	0	0	0	1,800	0	0	50,207	8,596	10,439	10,998	75,310	12,893	15,659	16,498
- Total of A+B -	224,800	140,253	25,856	28,777	29,914	0	0	0	0	6,164	1,027	1,072	967	8,572	3,340	1,607	1,451	50,207	8,596	10,439	10,998	75,310	12,893	15,659	16,498
C. Engineering Services																									
1. Detail Design	11,600	6,960	0	4,640	0	1,392	0	928	0	5,568	0	3,712	0	0	0	0	0	0	0	0	0	0	0	0	0
2. Field Survey and Soil Investigation	1,300	780	0	520	0	780	0	520	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3. Supervision	11,800	7,080	0	4,720	0	0	0	0	0	708	0	472	0	708	0	472	0	2,832	0	1,888	0	2,832	0	1,888	0
- Total of C -	24,700	14,820	0	9,880	0	2,172	0	1,448	0	6,276	0	4,184	0	708	0	472	0	2,832	0	1,888	0	2,832	0	1,888	0
- Total of A+B+C -	249,500	155,073	25,856	38,657	29,914	2,172	0	1,448	0	12,440	1,027	5,256	967	9,280	3,340	2,079	1,451	53,039	8,596	12,327	10,998	78,142	12,893	17,547	16,498
D. Administration Cost,1%	2,495	1,551	259	387	299	22	0	14	0	124	10	53	10	93	33	21	15	530	86	123	110	781	129	175	165
- Total of A+B+C+D -	251,995	156,624	26,115	39,044	30,213	2,194	0	1,462	0	12,565	1,037	5,308	977	9,372	3,374	2,100	1,465	53,569	8,682	12,450	11,108	78,924	13,022	17,722	16,663
E. Physical Contingencies,7%	17,640	10,964	1,828	2,733	2,115	154	0	102	0	880	73	372	68	656	236	147	103	3,750	608	872	778	5,525	912	1,241	1,166
- Total of A+B+C+D+E - (Project Cost at 1986 Price)	269,635	167,587	27,943	41,777	32,328	2,347	0	1,565	0	13,444	1,110	5,680	1,045	10,028	3,610	2,247	1,568	57,319	9,289	13,322	11,886	84,448	13,934	18,963	17,829
F. Price Contingencies, 3.3% per annum	39,900	24,839	4,188	5,852	5,021	77	0	52	0	902	74	381	70	1,026	369	230	160	7,949	1,288	1,847	1,648	14,884	2,456	3,342	3,142
- Total of A+B+C+D+E+F - (Total Project Cost)	309,535	192,426	32,130	47,629	37,349	2,425	0	1,616	0	14,346	1,184	6,061	1,115	11,054	3,979	2,477	1,728	65,268	10,577	15,169	13,534	99,333	16,390	22,305	20,971
G. Total of Year						4,041				22,707				19,239				104,549				158,999			

CHAPTER 14 FINANCIAL AND ECONOMIC ANALYSIS

14.1 Financial Analysis

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CHAPTER 14 FINANCIAL AND ECONOMIC ANALYSIS

14.1 FINANCIAL ANALYSIS

14.1.1 Financing For Proposed Project

This chapter verifies the financial feasibility of the proposed project for Chiangmai Waterworks combined with Mae Rim and San Kamphaeng Waterworks, on the assumptions that capital investment will be disbursed and financed as shown in Table-14.1.

1) The above disbursements will be grouped into two phases, (1) rehabilitation and modification and (2) expansion.

2) The foreign portions and part of local portions will be financed by a foreign financial institution such as OECF (Overseas Economic Cooperation Fund of Japan) and the terms and conditions of loans will be the same as the prevailing ones, i.e.,

a.	Interest Rate	:	3.5% per annum
b.	Maturity	:	25 years, with a grace period of 7 years

3) The part of local portions which will be financed with foreign loans is calculated to meet the recent practices of the foreign loans.

4) The rest of local portions, i.e., 20% of the total project cost, will be financed by the Krung Thai Bank Ltd. The terms and conditions of loans will be the same as the prevailing ones, i.e.,

a.	Interest Rate	:	13.0% per annum
b.	Maturity	:	10 years, with a grace period of 3 years

5) Analysis is made to verify that debt service and the increase in operation and maintenance expenses resulting from the implementation of the proposed project, as forecast in Section 14.1.4 following, can be absorbed by an increase in revenue, mainly due to the recent revisions in the water tariff schedule.

Table-14.1 PROJECT COSTS, DISBURSEMENT SCHEDULE AND AND SOURCES OF FUND (CHIANGMAI WATERWORKS)

a. PROJECT COSTS AND DISBURSEMENT SCHEDULE (x 1,000 BAHT)

YEAR	FOREIGN PORTION	LOCAL PORTION	TOTAL
1987	2,425	1,616	4,041
1988	14,346	8,361	22,707
1989	11,054	8,185	19,239
1990	65,268	39,281	104,549
1991	99,333	59,666	158,999
TOTAL	192,426	117,109	309,535

b. SOURCES OF FUND (x 1,000 BAHT)

YEAR	OECF LOAN	LOCAL LOAN	TOTAL
1987	3,233	808	4,041
1988	18,166	4,541	22,707
1989	15,391	3,848	19,239
1990	83,639	20,910	104,549
1991	127,199	31,800	158,999
TOTAL	247,628	61,907	309,535

Note: Disbursement amounts are forecast at current prices.

14.1.2 Approach to Financial Analysis

Like other waterworks of PWA, the Chiangmai Waterworks combined with Mae Rim and San Kamphaeng Waterworks will be wholly under the control of PWA Head Office in budgetary and financial aspects. All the revenues of these waterworks are, as a rule, transferred to PWA Head Office and all the necessary expenses of the waterworks inclusive of those for their administration, operation and maintenance are allocated by the PWA Head Office annually. The financing of their capital investment, if any, including the implementation of the project under this study, is also planned and executed at the responsibility and on the accounts of PWA Head Office.

In view of the above, this report verifies the financial feasibility by the following methods, instead of the analysis of income statements and balance sheets, which is only meaningful for entities that have full or semi-autonomy in their financial management.

Method I : Cash Flow Analysis

In this analysis, the following are projected:

(a) Revenue collection from the waterworks.
(b) Operation and Maintenance expenses allocation to the waterworks from PWA Head Office.
(c) Share of Head and Regional Office Overhead Expenses.
(d) Debt service relating to the waterworks.
(e) Net cash flow surplus
(f) Unit cost of water after debt service but before depreciation

and check if the amount of item I.(a) above can cover the necessary amounts for items I.(b), I.(c) and I.(d).

Method II : Fixed Assets and Rate of Return Analysis

The following items are projected:

(a) Fixed assets in operation.
(b) Depreciation of fixed assets.
(c) Total Cost after Depreciation and Interest.

(d) Unit Cost of Water after Depreciation and Interest.

(e) Rate of Return = Surplus after Depreciation and Interest / Fixed Assets in Operation

and with these figures, the rate of return from the operation of the waterworks is projected. This rate of return will provide one of the criteria for the financial feasibility of the project and also give an assessment of the suitability of the proposed water tariff schedule.

Method III : Financial Internal Rate of Return analysis (FIRR)

A discount rate at which the net present worth revenue of the project equals zero will be calculated as a factor to verify the financial feasibility of the project.

14.1.3 Financial Performance of the Waterworks

Table-14.2 following shows the combined annual revenues and expenditures of Chiangmai, Mae Rim and San Kamphaeng Waterworks on a cash-flow basis for 1984 and 1985. Reflecting the recent up-ward revision of the water tariff schedule executed from 1984 to 1985, the revenues of the waterworks mainly consisting of water sales increased remarkably to improve the revenue-expenditure ratio, from 2.16 in 1984 to 2.99. For reference, the separate revenue-expenditure accounts of Chiangmai, Mae Rim and San Kamphaeng Waterworks respectively are shown in Appendix 10, Table-10.19.

14.1.4 Cash-Flow Analysis

The Cash-Flow Analysis is summarized in Table-14.3 following. The items comprised in the table and assumptions used for forecasting their future estimates are given below.

Table-14.2 COMBINED REVENUE AND EXPENDITURE OF CHIANGMAI, MAE RIM AND SAN KAMPHAENG WATERWORKS (x1000 Baht)
- FOR PAST TWO YEARS -

	1984	1985
Water Production (x1,000	13,820	13,719
Water Sales (x1,000 m3)	9,253	85,981
No. of Connections	16,693	17,772
REVENUE:		
Water Sales	36,026	55,744
Service Charge	2,075	2,285
Connection Fee	5,257	6,185
Others	272	401
Total	43,630	64,615
EXPENDITURE:		
Personnel Cost	7,570	8,225
Chemicals	1,741	2,051
Material & Maintenance	96	760
Oil & Fuel	224	275
Office Supplies	94	80
Hire & Service	183	173
Electricity	7,208	7,631
Connection Cost	2,360	2,350
Others	702	83
Total	20,177	21,626
REVENUE/EXPENDITURE	2.16	2.99

Table-14.3 CASH FLOW PROJECTED (x 1,000 Baht) AT CURRENT PRICE. (CHIANGMAI WATERWORKS)

Description	Text Ref.	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
(A) Water Production (x1000 m3)		14,754	15,557	16,240	16,947	17,659	18,493	19,496	20,341	21,253	21,949	22,593	23,277	23,943	24,530	25,199
(B) Unaccounted for Water (%)		31	30	29	28	27	26	26	26	26	25	25	24	24	23	23
(C) Water Sales (x1000 m3)		10,151	10,859	11,530	12,202	12,874	13,611	14,388	15,093	15,834	16,462	17,013	17,644	18,268	18,790	19,378
(D) No. of Connections		18,700	19,750	20,810	21,860	22,950	23,900	25,050	25,970	26,770	27,440	28,000	28,550	29,090	29,610	30,110
(E) Average Water Tariff (Baht/m3)**		7.11	7.11	7.11	7.84	7.84	7.84	8.64	8.64	8.64	9.52	9.52	9.52	10.50	10.50	10.50
1. Operating Revenue:																
1.1 Water Sales		72,171	77,206	81,981	95,631	100,895	106,673	124,303	130,389	136,790	156,762	162,011	168,024	191,765	197,244	203,413
1.2 Connection Fees		5,340	6,030	6,087	6,646	6,900	6,013	8,024	6,419	5,582	5,153	4,307	4,230	4,578	4,409	4,239
1.3 Service Charges		2,404	2,539	2,676	3,098	3,253	3,387	3,914	4,057	4,182	4,725	4,822	4,917	5,522	5,621	5,716
1.4 Other Revenue		366	393	416	483	509	532	624	645	671	763	784	812	925	949	977
Total 1.		80,282	86,168	91,159	105,859	111,556	116,606	136,865	141,511	147,225	167,404	171,924	177,983	202,791	208,223	214,345
2. Expenses:																
2.1 Operation & Maintenance																
- Personnel Cost		8,956	9,722	10,843	12,041	13,388	15,162	17,324	18,633	20,068	21,584	23,094	24,711	26,441	28,292	30,272
- Electricity & Fuel Cost		8,844	9,691	10,485	11,439	12,365	13,415	15,307	16,465	17,743	18,914	20,139	21,455	22,816	24,155	25,651
- Chemical Cost		2,246	2,439	2,635	2,836	3,054	3,303	3,593	3,871	4,178	4,455	4,735	5,032	5,343	5,652	5,984
- Connection Cost		2,350	2,367	2,468	2,526	2,708	2,438	3,049	2,520	2,263	1,958	1,691	1,715	1,740	1,731	1,719
- Raw Water Cost		3,095	3,559	4,004	3,846	4,339	4,912	5,624	2,602	3,218	3,735	4,262	4,799	5,410	5,990	6,601
- Other Cost		3,563	3,811	4,120	4,439	4,803	5,173	5,827	6,214	6,587	7,008	7,374	7,811	8,265	8,667	8,953
Sub-total 2.1		29,054	31,589	34,555	37,127	40,658	44,403	50,725	50,306	54,057	57,653	61,295	65,524	70,015	74,487	79,180
2.2 Share of Head & Regional Office Overhead Expenses		10,953	11,717	12,442	13,167	13,891	14,687	15,526	16,286	17,086	17,763	18,358	19,039	19,713	20,276	20,910
2.3 Debt Service		12,050	11,696	12,187	13,088	17,513	24,226	28,117	35,244	35,907	34,454	33,002	41,948	40,256	38,564	29,342
Total 2.		52,057	55,002	59,184	63,382	72,062	83,316	94,367	101,836	107,050	109,870	112,655	126,511	129,984	133,327	129,433
3. Net Cash Flow Surplus:																
3.1 Annual		28,225	31,165	31,975	42,477	39,494	33,290	42,497	39,674	40,176	57,534	59,270	51,472	72,807	74,897	84,913
3.2 Cumulative		28,225	59,390	91,365	133,842	173,336	206,626	249,123	288,798	328,973	386,507	445,777	497,248	570,055	644,952	729,865
4. Unit Cost of Water after Debt Service (Baht/m3)*		4.61	4.54	4.62	4.69	5.06	5.60	5.96	6.22	6.28	6.25	6.24	6.77	6.73	6.72	6.34

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.

1) Operating Revenue

The Operating Revenue is classified as follows :

Water Sales

Water Sales are estimated in the table as:
products of Projected Water Sales Volumes (shown as item (C) in the table) multiplied by the Average Water Tariff (shown as item (E)).

a. Average Water Tariff

The average water tariff for 1986 shown in the table is calculated as the average of the water tariffs collected by the three waterworks during the six months ending March 1986.

In view of the past performance and the political and social climate of Thailand where frequent revision of public charges is difficult, this report forecasts cash flow on the assumption that the water tariffs will be increased every three years at the rate of 3.3% per annum. As shown in Appendix 10, Tables-10.2 and -10.3 sensitivity studies were made in this report to forecast cash flows on the assumptions that (1) water tariffs will be increased every year at the rate of 3.3 % (Table-10.2) and (2) water tariffs will remain unchanged up to the target year 2000 (Table-10.3). Also for the purpose of constant price analysis such as FIRR, EIRR and AIC calculations, a cash flow table at 1986 constant price is shown in Appendix 10, Table-10.1.

b. PWA Water Tariff Schedule

Water tariffs are collected by water meters, with the exception of negligible direct sale fees. Shown below is the existing water tariff schedule, compared with the one which was in force prior to the revision in 1984.

Table-14.4 WATER TARIFF SCHEDULE

Consumption (cubic meters/ month)	Existing Tariff (B/cubic meter)	Previous Tariff (B/cubic meter)
1-10	3.75	2.00
11-20	4.50	2.50
21-50	6.00	3.00
51-80	7.00	4.00
81-100	7.50	4.50
101-300	8.00	5.00
301 and above	8.50	5.50

Connection Fees and Service Charges

These fees and charges are of the nature which cover actual expenses to be borne by the users for connection work. PWA accounts these fees and charges as revenue sources and they actually form a significant part of its revenue.

In this study, these fees and charges are forecast on the basis of future demand projection with charge rates to be revised every three years at the rate of 3.3 % per annum as in the case of water tariffs. As a sensitivity study, forecasts are made on the assumptions of (1) every year upward revision of 3.3 % and (2) no changes in charge rates, as given in Appendix 10, Tables-10.2 and -10.3.

Connection fees

Connection fees are estimated in the table as:
products of annual increases in the number of connections multiplied by the 1985 average fee per connection work, with price adjustments.

Existing PWA Connection Fees:

The minimum connection fee is set at 2,050 Baht for 1/2" ϕ pipe with a length of 10 meters. Based on the records for the past three years, average connection fees for households are assumed at 3,566 Baht and for those for industrial and other large scale consumers at 6,985 Baht. The additional fee can add substantially to the total cost of a connection - for example a new 1/2" connection 30 meters from the main pipe could cost over double that for an equivalent connection 10 meters from the main. The additional fees are not charged according to a fixed scale, but instead are levied by PWA on an ad hoc basis, using standard unit costs for the labor and material required.

Table-14.5 Existing Connection Fees

Size of Connection	Basic Connection Fee (for connections less than 10 meters from main pipe) - Baht/connection -
1/2"	2,050
3/4"	2,750
1"	3,750
1 1/2"	6,690
2"	9,575
2 1/2"	13,075
3"	15,495
4"	21,455
6"	30,025

Service Charges

Service charges are estimated in the table as:
a product of the number of connections multiplied by the 1985 average charge per connection, with price adjustments.

Existing PWA Service Charges:

Service charges are levied on consumers according to the size of their connection, as shown Table-14.6 below.

Table-14.6 Service Charges

Size of Connection	Monthly Service Charge (Baht)
1/2"	10
3/4"	15
1"	30
1 1/2"	60
2"	100
2 1/2"	120
3"	160
4" and above	200

Other Revenue

This item is estimated in the table as:
a portion equal to the ratio of the other revenue to the 1985 combined total of water sales, connection fees and service charges, with price adjustments.

2) Expenses

With the expansion of water supply facilities, water production is planned under the current project to be increased approximately 2 times more than the present level. With production expanded, the scale of operation and maintenance and other expenses are expected to increase. This report forecasts expenses in the following manner.

Operation & Maintenance

This item is shown in the table classified as follows:

a. Personnel Cost
b. Electricity & Fuel Cost
c. Chemical Cost
d. Connection Cost
e. Raw water Cost
f. Other Cost

The method of estimation employed in forecasting operation and maintenance expenses are delineated in Chapter 13.

As shown in table-14.2, the combined Revenue and Expenditure Account of Chiangmai, Mae Rim and San Kamphaeng Waterworks lists only operation and maintenance expenses as expenditure items and does not reflect the following items which are important in financial feasibility analysis:

(1) the overhead expenses of the Head Office and Regional Office No. 9 which controls Chiangmai, Mae Rim and San Kamphaeng Waterworks.
(2) depreciation of the fixed assets of the waterworks,
(3) debt service expenses payable by Head Office, if any, in relation to the capital investment in the waterworks.

The cash flow table of this study lists them as follows:

Share of Head & Regional Office Overhead Expenses

The formula shown in Table-14.7 is the existing accounting method applied to the allocation of Head and Regional Office overhead expenses to be shared by Chiangmai Waterworks, if combined with Mae Rim and San Kamphaeng Waterworks.

As discussed in Section 14.3, this formula is considered unfair to small sized waterworks or those waterworks whose earning position is not favorable.

Table-14.7 SHARE ALLOCATION OF HEAD AND REGIONAL OFFICE EXPENSES
(ON ASSUMPTION THAT CHIANGMAI WATERWORKS MERGED
WITH MAE RIM AND SAN KAMPHAENG WATERWORKS)
- 1985 Cost Share Allocation -

1. Head Office Expenses

a) Per Waterworks Portion (1/3)

Baht 159,272,735 x (1/3) / (No. of Waterworks in PWA) = Baht 288,538

b) WW/PWA-Total Consumption Portion (2/3)

Baht 159,272,735 x (2/3) x (WW% of PWA Total) = Baht 7,094,027

2. Regional Office Expenses

a) Per Waterworks Portion (1/3)

Baht 8,951,080 x (1/3) / (No. of Waterworks in Region)= Baht 135,622

b) WW/Region-Total Consumption Portion (2/3)

Baht 8,951,080 x (2/3) x (WW% of Regional Total) = Baht 2,607,905

TOTAL SHARE OF HEAD AND REGIONAL OFFICE
OVERHEAD EXPENSES = Baht 10,322,989

The formula is, as you see in Table-14.7, divided into two portions:

(1) The portion applicable to one-third of Head and Regional Office overhead expenses. The share of this portion is allocated to each waterworks equal in amount regardless of their sizes of water sales and earning positions. The amount of this portion allocated to each waterworks in Region No. 9 in 1985 was 424,160 Baht which was equal to 2.3 % of the operation and maintenance expenses of Chiangmai waterworks alone, but the corresponding percentages were so large as 30.6 % for Mae Rim Waterworks and 28.4 % for San Kamphaeng waterworks.

(2) The portion applicable to the rest two-thirds. The share of this portion is calculated by sales scales of waterworks, regardless of their earning positions. This makes the share practically uncollectable when respective waterworks make deficits or fail to make surpluses enough to pay share amounts.

In view of the above, it is recommended that the allocation of shares be made in one lot without portioning it into two portions and the calculation of shares be based on net surpluses rather than on sales scales, as illustrated by a trial formula suggested in Appendix 10, Table-10.4.

The recommended formula may support cross-subsidies among waterworks, with those earning more to pay more and those earning less or making losses to pay less or nothing. Under the new formula, therefore, waterworks with large earnings would have to be allocated larger shares than under the existing PWA formula. Chiangmai Waterworks if combined with Mae Rim and San Kamphaeng Waterworks for example would have to pay 10.79 million Baht in 1985, 4.6 % larger than the share calculated by the existing formula.

This report tries to forecast future share allocations by the existing formula, but also tries to make forecasts, as a

sensitivity study, by the new formula suggested above.

Debt Service

Debt service payment as forecast in Table-14.8 is considered as a factor which usually restricts the cash flow of an entity which has gone through a large scale capital investment. With such foreign assistance as OECF loans to finance the total foreign currency portion and part of the local currency portion, as referred to in Section 14.1.1, financing of the project will be substantially improved.

3) Net Cash Flow Surplus

Annual

As shown in Table-14.3, net annual revenue surpluses are forecast large enough to cover throughout the project period (1) operation and maintenance expenses, (2) the waterworks' share of Head and Regional Office overhead expenses calculated either by the existing PWA formula or by a new formula suggested above, and (3) PWA's debt service arising from the proposed project. This will be true even in case the water tariff is kept unchanged up to the year 2000, as shown in Tables-10.3 and 10.8 of Appendix 10.

Cumulative

As the annual revenue-expenditure balance continues to produce surpluses throughout project period, the cumulative cash flow surpluses are forecast to show spiral increases.

As a sensitivity analysis, cash flow forecasts are also made on the assumption that, instead of the OECF loan, a foreign loan whose lending rate is 8.5 % per annum is applied to finance 80 % of the total project investment. The result of this study reveals, as shown in Appendix 10, Tables-10.9 and -10.10, that the annual revenue-expenditure balance will continuously register positive surpluses throughout the project period, with the cumu-

[CHIANGMAI WATERWORKS]

Table-14.8 DEBT SERVICE PROJECTED

FOREIGN CURRENCY PORTION (in 1,000 Baht)
Interest : 3.5% per annum

Year	Rehabil. and Modifi.	Stage 1 Expansion	Loans Outstanding Beginning	Loans Outstanding Ending	Interest Payments 1st year	Interest Payments Later year	Principal Repayment Rehab.& Mod.	Principal Repayment Expansion	Debt Service Sub-total	1977 OECF LOAN Sub-total
1987	3,233		0	3,233	57	0	0	0	57	11,587
1988	18,166		3,233	21,399	318	113	0	0	431	11,356
1989	15,391		21,399	36,790	269	749	0	0	1,018	11,124
1990		83,639	36,790	120,429	1,464	1,288	0	0	2,751	10,893
1991		127,199	120,429	247,628	2,226	4,215	0	0	6,441	10,661
1992			247,628	247,628	0	8,667	0	0	8,667	10,430
1993			247,628	247,628	0	8,667	0	0	8,667	10,198
1994			247,628	245,584	0	8,667	2,044	0	10,711	9,966
1995			245,584	243,540	0	8,595	2,044	0	10,639	9,735
1996			243,540	241,496	0	8,524	2,044	0	10,568	9,503
1997			241,496	227,739	0	8,452	2,044	11,713	22,209	9,272
1998			227,739	213,982	0	7,971	2,044	11,713	21,728	9,040
1999			213,982	200,225	0	7,489	2,044	11,713	21,246	8,809
2000			200,225	186,468	0	7,008	2,044	11,713	20,765	8,577
2001			186,468	172,711	0	6,526	2,044	11,713	20,283	
2002			172,711	158,954	0	6,045	2,044	11,713	19,802	
2003			158,954	145,197	0	5,563	2,044	11,713	19,320	
2004			145,197	131,439	0	5,082	2,044	11,713	18,839	
2005			131,439	117,682	0	4,600	2,044	11,713	18,357	
2006			117,682	103,925	0	4,119	2,044	11,713	17,876	
2007			103,925	90,168	0	3,637	2,044	11,713	17,394	
2008			90,168	76,411	0	3,156	2,044	11,713	16,913	
2009			76,411	62,654	0	2,674	2,044	11,713	16,431	
2010			62,654	48,897	0	2,193	2,044	11,713	15,950	
2011			48,897	35,140	0	1,711	2,044	11,713	15,468	
2012			35,140	23,426	0	1,230	0	11,713	12,943	
2013			23,426	11,713	0	820	0	11,713	12,533	
2014			11,713	0	0	410	0	11,713	12,123	

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

Year	Rehabil. and Modifi.	Stage 1 Expansion	Loans Outstanding Beginning	Loans Outstanding Ending	Interest Payments 1st year	Interest Payments Later year	Principal Repayment Rehab.& Mod.	Principal Repayment Expansion	Debt Service Sub-total	TOTAL DEBT SERVICE
1987	808		0	808	53	0	0	0	53	11,696
1988	4,541		808	5,349	295	105	0	0	400	12,187
1989	3,848		5,349	9,197	250	695	0	0	945	13,086
1990		20,910	9,197	28,793	1,359	1,196	1,314	0	3,869	17,513
1991		31,800	28,793	59,279	2,067	3,743	1,314	0	7,124	24,226
1992			59,279	57,965	0	7,706	1,314	0	9,020	28,117
1993			57,965	49,122	0	7,536	1,314	7,530	16,379	35,244
1994			49,122	40,278	0	6,386	1,314	7,530	15,230	35,907
1995			40,278	31,434	0	5,236	1,314	7,530	14,080	34,454
1996			31,434	22,590	0	4,086	1,314	7,530	12,930	33,002
1997			22,590	15,060	0	2,937	0	7,530	10,467	41,948
1998			15,060	7,530	0	1,958	0	7,530	9,488	40,256
1999			7,530	0	0	979	0	7,530	8,509	38,564
2000										29,342
2001										20,283
2002										19,802
2003										19,320
2004										18,839
2005										18,357
2006										17,876
2007										17,394
2008										16,913
2009										16,431
2010										15,950
2011										15,468
2012										12,943
2013										12,533
2014										12,123

lative surplus increasing to 643 million Baht in 2000, or more than three times as large as the gross revenue of the year. This result may demonstrates the financial feasibility of the project, in either case the project be financed by OECF loans or by such foreign loans. This study result is also supported by the FIRR of 10.8 % (see 14.1.6 below) which is well above an assumed composite lending rate of 9.4 % per annum (Foreign loans 8.5 % x 0.8 + Local loans 13 % x 0.2), not speaking of the composite rate of OECF and Local loans (OECF loans 3.5 % x 0.8 + Local loans 13 % x 0.2 = 5.4 %).

4) Unit Cost of Water after Debt Service

This Unit Cost does not reflect cost for depreciation of fixed assets and may be compared with the unit cost after depreciation shown in Table-14.9. As shown in Table-14.3, the unit cost after debt service which will register 4.61 Baht/m3 in 1986 or equal to 64.8 % of the then prevailing average water tariff, is projected to stand at 6.34 Baht in 2000 or 60.4 % of the comparable water tariff.

For reference, separate Cash Flow Tables for Chiangmai, Mae Rim and San Kamphaeng Waterworks respectively are shown in Appendix 10, Tables-10.20 to -10.22.

14.1.5 Fixed Assets, Unit Cost after Depreciation and Rate of Return Analysis

1) Fixed Assets

Fixed Assets (excluding land) in this analysis are expressed in the following terms:

(a) Accumulative Fixed Assets = Accumulative Fixed Assets of previous year + completion amount of construction work, transferred from "Work in Progress".

(b) Accumulative Depreciation = Accumulative Depreciation of previous year + depreciation of current year. Depreciation is applied by a straight line method, with durability of fixed assets assumed to be 30 years.

(c) Net Fixed Assets = (a) - (b) above.

(d) Work in Progress = Accumulative capital investment - accumulative capital construction completed (No price escalation applied during construction).

(e) TOTAL (Total fixed assets excluding land) = (c) + (d) above.

(f) Total Cost before Depreciation and Interest = Operation and Maintenance Cost (see Table-10.2 of Appendix 10) + Share of Head & Regional Office Overhead Expenses (see same Table).

As shown in Table-14.9, Net Fixed Assets in Operation which is projected to stand at 108,764 thousand Baht in 1987, or 136 % of then Total Revenue (80,282 thousand Baht, see Table-10.2 of Appendix 10) will register 527,917 thousand Baht in 1993 the year after completion of construction, or 3.6 times as large as then Total Revenue (146,180 thousand Baht, see the same Table), but will decrease to 304,010 thousand Baht in 2000, or 1.3 times of then Total Revenue (228,726 thousand Baht, see the same Table), in reflection of both accumulative depreciation and increases in revenue resulting from the expansion of production facilities. The improvement of the above revenue - fixed assets ratio is reflected in the rate of return mentioned below.

2) Cost after Depreciation and Interest

This analysis show production cost in the following terms:

(g) Total Cost after Depreciation but before Interest = (f) + depreciation for current year (accumulative depreciation for current year - that for previous year).

Table-14.9 FIXED ASSETS, UNIT COST AFTER DEPRECIATION AND RATE OF RETURN

[CHIANGMAI 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	201,300	207,943	218,838	248,673	276,001	379,757	549,729	567,870	586,609	605,968	625,965	646,621	667,960	690,003
Less Accumulative Depreciation	92,536	102,521	113,199	125,224	138,556	155,787	179,252	204,096	230,385	258,187	287,573	318,617	351,396	385,992
Net Fixed Assets in Operation	108,764	105,422	109,672	146,062	156,567	318,618	527,917	363,773	356,224	347,781	338,392	328,005	316,564	304,010
Work in Progress	4,033	26,646	41,735	113,770	252,088	157,440	0	0	0	0	0	0	0	0
TOTAL	112,797	132,068	151,407	259,832	408,655	476,058	527,917	363,773	356,224	347,781	338,392	328,005	316,564	304,010
Total Cost before Depreciation and Interest	45,810	50,096	54,039	59,068	64,282	72,590	73,660	79,156	84,398	89,669	95,866	102,413	108,851	115,722
Total Cost after Depreciation but before Interest		60,081	64,717	71,093	77,614	89,821	97,125	104,001	110,687	117,470	125,252	133,457	141,630	150,318
Total Cost After Depreciation and Interest		60,913	66,681	76,399	89,865	106,194	113,327	119,053	124,518	130,081	136,641	143,386	150,098	157,326
Unit Cost of Water (Baht/cm3) after depreciation and Interest*		5.28	5.46	5.93	6.60	7.38	7.51	7.52	7.56	7.65	7.74	7.85	7.99	8.12
Average Rate Base		107,093	107,547	127,867	151,314	237,592	423,267	445,845	359,999	352,002	343,086	333,198	322,284	310,287
Surplus after Depreciation and Interest		36,362	39,178	38,838	34,563	30,670	32,853	38,049	42,886	47,517	53,282	59,405	64,996	71,400
Rate of Return after Completion of Construction						13%	8%	9%	12%	13%	16%	18%	20%	23%

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

(h) Total Cost after Depreciation and Interest = (g) + interest payable for current year (see Table-14.8).

(i) Unit Cost of Water after Depreciation and Interest = (h) / Water Sales (x 1,000 m3) (see (C) of Table-10.2 of Appendix 10).

The figures of Total Cost after Depreciation and Interest shown in Table-14.9 are found almost equal to those of Total Cost after Debt Service shown in Table-10.2 of Appendix 10.

	1993	1998
Total Cost after Depreciation and Interest (Table-14.9, x 1,000 Baht)	113,327	143,386
Total Cost after Debt Service (Table-10.2 of Appendix 10, x 1,000 Baht)	108,904	142,669

This is due partly to the low interest rate (3.5 % per annum) of the foreign loan applicable to this project.

The figures of Unit Cost after Depreciation and Interest are compared with those of Unit Cost after Debt Service as follows:

		1993	1998
i)	After Depreciation and Interest	7.51 Baht	7.85 Baht
ii)	After Debt Service	6.65 Baht	7.39 Baht

This comparison shows that depreciation decreases yearly as fixed assets balance decreases by yearly depreciation, while annual debt service amount reaches its peak in 1997 and 1998 (see Table-14.8).

3) Rate of Return after Completion of Construction

This item is calculated in this analysis as follows:

(j) Average Rate Base = (Fixed Assets in Operation for current year + Fixed Assets in Operation for previous year) / 2.

(k) Surplus after Depreciation and Interest = Total Revenue (see Table-10.2 of Appendix 10) - (h).

(l) Rate of Return after Completion of Construction = (k) / (j).

The Rate of Return is projected to increase to 23 % in 2000 after dropping to 8 % in 1993, the year following the completion of project implementation.

14.1.6 Financial Internal Rate of Return

Table-14.10 represents the tabulation and calculation of the Financial Internal Rate of Return for Chiangmai Waterworks combined with Mae Rim and San Kamphaeng Waterworks on an incremental basis resulting from investment in the expansion project of the waterworks, utilizing a discount rate that equates costs with benefits which produces a figure of 10.8 %.

14.1.7 Financial Feasibility

The results of the analysis mentioned above throughout Section 14.1, demonstrate the financial feasibility of the project, particularly in view of the terms and conditions of loans considered available for the project.

14.1.8 Summary of Sensitivity Study Results

The results of sensitivity studies are summarized, for your reference, as follows:

1) Cashflow analysis (in terms of accumulative surplus in 2000)

Unit: 1,000 Baht

a. Main Report (see Table-14.3) 729,865
   Tariff change: every three years
   Share allocation PWA method
   Foreign loan: interest rate at 3.5 % p.a.

Table-14.10 FINANCIAL INTERNAL RATE OF RETURN (FIRR)

[CHIANGMAI WATERWORKS] x 1,000 BAHT

YEAR	TOTAL REVENUE	CAPITAL INVESTMENT COST	OPERATING COSTS & H.R.O.*	1986 PRICE NET REVENUE	NET BENEFITS DISCOUNTED AT 10%	NET BENEFITS DISCOUNTED AT 11%
1987	0	3,912	0	-3,912	-3,556	-3,524
1988	0	9,179	0	-9,179	-7,586	-7,450
1989	15,752	17,453	6,049	-7,750	-5,823	-5,667
1990	20,920	91,816	8,450	-79,346	-54,194	-52,268
1991	25,502	135,174	10,690	-120,362	-74,735	-71,429
1992	32,357		15,147	17,210	9,714	9,201
1993	36,181		13,563	22,617	11,606	10,894
1994	40,884		15,372	25,512	11,902	11,071
1995	44,705		16,758	27,947	11,852	10,925
1996	48,079		17,977	30,102	11,606	10,601
1997	52,603		19,645	32,957	11,551	10,457
1998	57,073		21,318	35,755	11,393	10,220
1999	60,753		22,681	38,071	11,028	9,804
2000	64,056		23,964	40,093	10,558	9,301
2001	64,056		23,964	40,093	9,598	8,380
2002	64,056		23,964	40,093	8,725	7,549
2003	64,056		23,964	40,093	7,932	6,801
2004	64,056		23,964	40,093	7,211	6,127
2005	64,056		23,964	40,093	6,556	5,520
2006	64,056		23,964	40,093	5,960	4,973
Salvage		-123,103		123,103	18,299	2,720
TOTALS	883,203	134,431	335,396	413,376	19,595	-5,794

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

FIRR =10+(11-10)x19,595/(19,595+5,794)
= 10.772%

b. Sensitivity Study A (Share allocation: PWA formula)

a) Tariff change: every year (Appendix 10, Table-10.2) 688,682

b) Tariff change: no change (Appendix 10, Table-10.3) 217,878

c. Sensitivity Study B (Share allocation: new formula)

a) Tariff change: every year (Appendix 10, Table-10.6) 672,796

b) Tariff Change: every 3 years (App. 10, Table-10.7) 630,586

c) Tariff change: no change (App. 10, Table-10.8) 220,934

d. Sensitivity Study C (Foreign loan: at 8.5 % p.a., and tariff change: every 3 years) (App.10, Table-10.10) 642,853

2) Fixed Assets, Unit Cost after Depreciation and Rate of Return Analysis

a. Main Report (see Table-14.9)

Unit cost of water in 2000	8.12 Baht
Annual surplus in 2000	71,400 thousand Baht
Rate of return in 2000	23 %

b. Sensitivity Study (share allocation: new formula, see Table-10.11 of APP.10)

Unit cost of water in 2000	8.10 Baht
Annual surplus in 2000	310,287 thousand Baht
Rate of return in 2000	23 %

3) Financial Internal Rate of Return

a. Main Report (share allocation: PWA formula, see Table-14.10) 10.8 %

b. Sensitivity Study (share allocation: new formula, see Table-10.12 of App.10) 10.7 %

14.2 ECONOMIC ANALYSIS

This analysis purports the economic justification of the project by comparing the net creation of benefits to the net increase in costs.

In this analysis, benefits and costs are considered from the national interest standpoint. Costs are converted to economic costs to reflect alternative uses of resources by the nation, and benefits include effects of the projects upon water users and upon the community in which the improvement occurs.

Benefits and costs in this analysis are valued in the present national value of money, currently at approximately 10%, for the purpose of discounting benefits and costs.

In this analysis, economic justification is considered to be proved if benefits exceed costs at the present national value.

14.2.1 Economic Benefits

The main socio-economic benefits which will be brought about by the implementation of the Chiangmai Water Supply Expansion Project as proposed in the current feasibility study are summarized as follows.

1) Water Volume Benefits

The increases to be brought about by the project in total water production, served population and per capita and total water consumption are summarized in Chapter 2. Also water pressures will be substantially increased and the existing chronic water shortages will be eliminated.

2) Water Quality Effects

The questionnaire market survey which the study team conducted in January, 1986 revealed that the majority of Chiangmai residents are not satisfied with the present quality of water supplied, as shown in Appendix 5.

3) Fire Loss Reduction

Tables-14.11 and -14.12 show that the damages in Chiangmai and the five Sanitary districts caused by fire losses in the past three years amounted to considerable amounts.

As the water supply service will dramatically improve and expand the fire fighting capabilities of the area, this will protect property values especially in the central business districts where a major conflagration has the greatest potential. With reduced fire loss, personal injury and loss of human lives will be markedly reduced.

4) Effects on Health, Sanitation and Aesthetics

Table-14.13 following shows that Chiangmai and its neighboring sanitary districts are still not free from water-borne diseases such as Typhoid, Dysentery, Diarrhea, Cholera and Food Poisoning.

The current project upon implementation will be a positive step in reducing such water-borne diseases. Improvement of sanitation and beautification will also contribute to further development of these areas.

5) Increase in Property Values

With the improvement of the sanitary environment and fire protection, property values throughout the city, particularly in the areas where water supply will be improved or extended by the project, will show an increase.

6) Direct and Indirect Impacts on Local and National Economies

Direct employment of people and procurement of materials during the planning, construction and operational periods of the project will produce excellent economic repercussions on the regional economies, which will in turn impact the national economy as a whole.

Table-14.11 FIRE LOSSES
IN
CHIANG MAI

* YEAR ITEM *	1981	1982	1983	1984	1985
HOUSE	27	36	60	55	48
FOREST	109	120	303	150	278
FACTORY	3	6	5	2	1
SHOP	2	6	0	0	2
OTHERS	53	57	76	71	78
TOTAL	194	225	444	278	407
INSIDE	86	95	202	175	356
OUTSIDE OF MUNI.	108	130	242	103	51
DAMAGE (BAHT)	6,547,800	29,290,250	72,863,300	14,596,100	2,537,150

SOURCE: FIRE STATION OF CHIANG MAI MUNICIPALITY, 25 JUNE 1986

Table-14.12 FIRE LOSSES
IN
FIVE SANITARY DISTRICTS
SURROUNDING
CHIANGMAI

YEAR	BURNT FOREST NUMBER	BURNT FOREST DAMAGE (BAHT)	BURNT HOUSE NUMBER	BURNT HOUSE DAMAGE (BAHT)
1) HANG DONG				
1983	4	-	6	203,500
1984	0	0	4	99,000
1985	0	0	0	0
1986-JUNE	0	0	1	4,500
2) SAN KAMPHENG				
1981-1985	0	0	2	-
1986-JUNE	9	-	1	3,500,000
3) MAERIM				
1985	6	-	3	1,200
1986-JUNE	4	-	2	8,000
4) SAN SAI				
1985				
1986-JUNE	No fire losses in the municipal area.			
5) SARAPHI				
1985				
1986-JUNE	No fire losses in the municipal area.			

SOURCE: SARAPHI BAN FIRE STATION, 28 JUNE 1986

Table-14.13 MORBIDITIES
BY
WATERBORNE DISEASES
IN
CHIANGMAI AND SANITARY DISTRICTS

1984 - 1985

	Diarrhoea		Dysentery		Food Poisoning		Typhoid		Cholera	
	1984	1985	1984	1985	1984	1985	1984	1985	1984	1985
Municipality	981	774	131	147	325	333	17	17	0	0
Mae Rim	918	948	239	263	62	98	5	19	0	0
Saraphi	539	891	160	124	30	44	8	5	1	0
San Sai	457	637	110	169	33	104	9	11	0	0
Hang Dong	588	920	83	159	90	107	2	5	0	0
San Kamphaeng	608	941	129	191	29	57	16	8	0	0

Note : 1984 figures are for January - October

1986

	Diarrhoea	Dysentery	Food Poisoning	Typhoid	Cholera
Municipality	275	42	77	1	0
Mae Rim	433	120	17	1	0
Saraphi	466	84	13	1	0
San Sai	260	72	37	0	0
Hang Dong	321	114	46	0	0
San Kamphaeng	358	98	14	0	0

Note : 1986 figures are for January - April

Sources : Public Health Offices of Chiangmai Municipality
and Other Respective Sanitary Districts, June 1986.