Presently the average family size is approximately 4.92. Following the decreasing trend, the figure in 2011 is estimated at 3.51 with the number of families at 12,100. The number of houses in 2011 is estimated at 13,200 as in Table 4-2-2.

4.2.3 Higher and Lower Growth Cases

In order to compare effects of the assumptions adopted in the method of estimation, higher and lower growth cases are shown in Table 4-2-3.

In the higher growth case, annual population growth rates inside and outside the Municipality are 1% higher than the original rates, and in the lower growth case, the growth rates are 1% less.

In the higher growth case, the population of the study area is 25% more than the original case, while in the lower growth case, it is 20% less.

4.2.4 Population Distribution

Population distribution in the study area is presented in Figure 4-2-3.

At present, the north and south centers of the Municipality are the concentrated cores of population distribution.

Future population distribution will be guided by the land use plan of DTCP currently being prepared. However, by setting simple assumptions as follows, population distribution in 2011 can be roughly estimated.

(1) In the Municipality, the northern area and the corridor connecting the both ends of the Municipality will have population growth rate of 0.6% - 0.7% per annum filling vacant plots while the southern area will grow only at 0.07% due to the almost saturated conditions.

(2) Outside the Municipality, all the tambons are assumed to grow at the same rate as the Amphoe.

Table 4-2-2 Projection of Numbers of Families and Houses

Takua Pa Municipality								
Year	1980	1981	1982	1983	1984	1985	1986	1987
Population	9,647	9,569	9,477	9,174	9,222	9,339	9,380	9,303
No. of Houses	1,727	1,789	1,822	1,908	1,942	1,949	1,986	1,901
House Size	5.586	5.349	5.201	4.808	4.749	4.792	4.723	4.894
Nation (Homes Research Report, November 1987)								
Year	1985	1990	1995	2000	2005	2010	2015	
Household Size	4.98	4.62	4.27	3.96	3.7	3.49	3.31	
Year	1987	1991	1996	2001	2006	2011		
Household Size	4.836	4.550	4.208	3.908	3.658	3.454		
Index	1	0.941	0.870	0.808	0.756	0.714		
Takua Pa Study Area								
Year	1987	1991	1996	2001	2006	2011		
Population	28,053	29,979	32,633	35,592	38,891	42,574		
Family Size	4.918	4.627	4.279	3.974	3.720	3.512		
No. of Families	5,704	6,479	7,626	8,956	10,455	12,121		
House Size	4.524	4.256	3.937	3.656	3.422	3.231		
No. of Houses	6,200	7,043	8,289	9,735	11,364	13,176		

Table 4-2-3 Population of Takua Pa Study Area

Year	1987	1991	1996	2001	2006	2011
Original Case	28,462	29,979	32,633	35,592	38,891	42,574
Inside Municipality	9,278	9,434	9,600	9,769	9,941	10,116
Outside Municipality	19,184	20,545	23,033	25,823	28,950	32,458
Higher Growth Case	28,462	30,815	35,232	40,358	46,315	53,245
Inside Municipality	9,278	9,659	10,329	11,045	11,811	12,630
Outside Municipality	19,184	21,156	24,903	29,313	34,504	40,615
Lower Grouwth Case	28,462	29,049	30,104	31,258	32,518	33,891
Inside Municipality	9,278	9,098	8,806	8,523	8,249	7,984
Outside Municipality	19,184	19,951	21,298	22,735	24,269	25,907

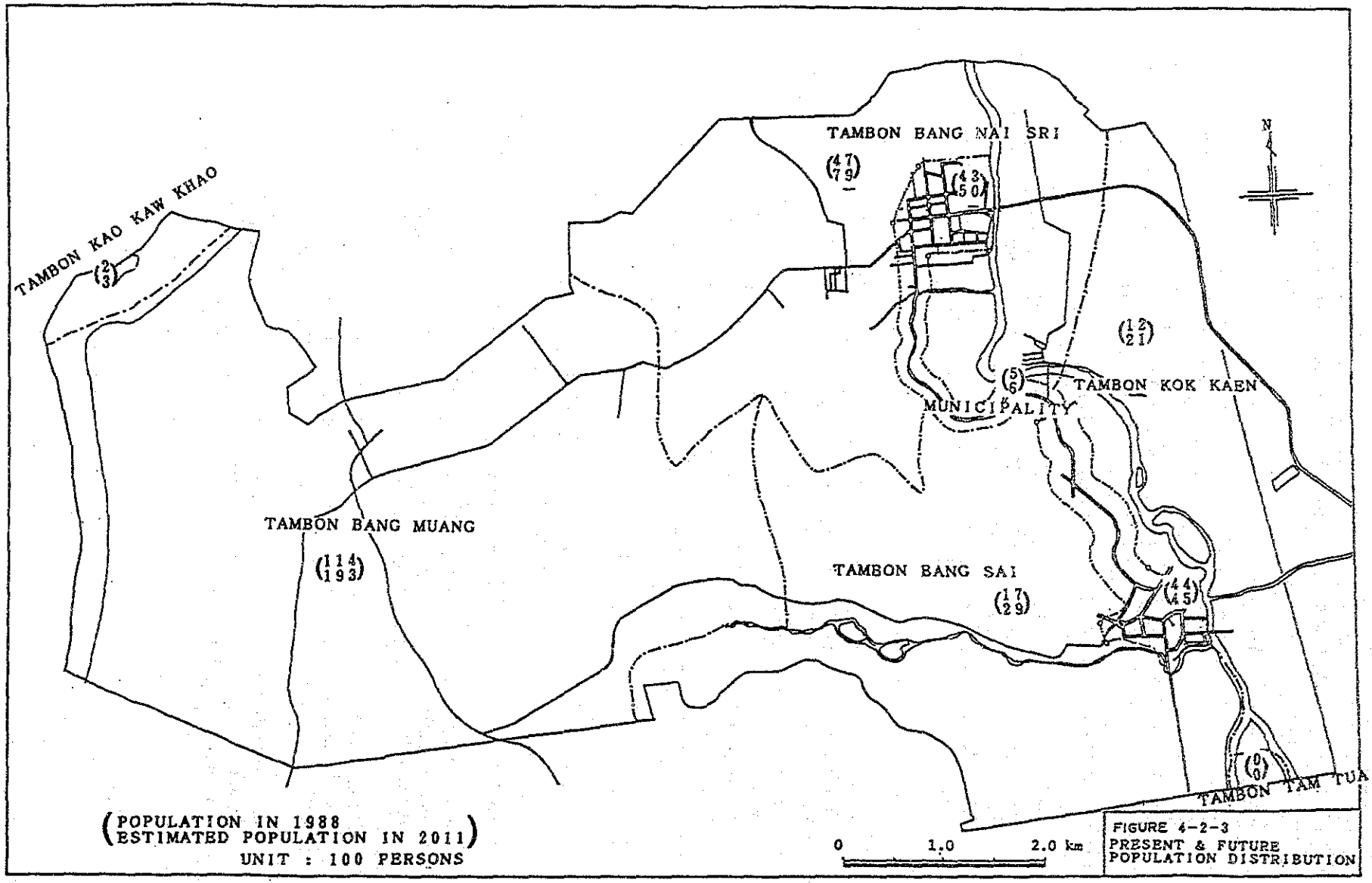


FIGURE 4-2-3
PRESENT & FUTURE
POPULATION DISTRIBUTION

4.3 Service Area and Served Population

4.3.1 Service Area

The present service area of the Takua Pa Waterworks consists of the Municipality of Takua Pa and an eastern part of Tambon Bang Muang.

For the expansion of the service area in the future, taken into account were the DTCP's development plan and the PWA's development strategy. Consideration is made with future land use and population growth.

The service area is classified into two categories: (1) the existing service area, and (2) the future expansion area.

The extent of the service area in years 2001 and 2011 are as shown in Figure 4-3-1.

4.3.2 Served Population

(1) Past and present served population

Past and present served population was estimated from the number of connections and the number of members per household. Prior to this, the number of connections for domestic use was calculated from the number of connections in the past, and the ratio of the connections for residential use against the total connections. As the ratio of residential users is 0.953 (see Table 4-4-3), this ratio is applied to each year's total number of connections to calculate the connections for domestic use.

Table 4-3-1 shows the result of estimation of served population in each year.

Table 4-3-1 Estimation of Served Population

Year	No. of Conn. (a)	No. of Conn. for Domestic Use (b)	Pop./ No. of Houses (c)	Population Served (d)
1980	791	754	5.59	4,215
1981	812	774	5.35	4,141
1982	851	811	5.20	4,217
1983	911	868	4.81	4,175
1984	965	920	4.75	4,370
1985	987	941	4.79	4,507
1986	1,063	1,013	4.72	4,781
1987	1,077	1,026	4.89	5,017

(b) = (a) x 0.953
(c) from Table 4-2-2

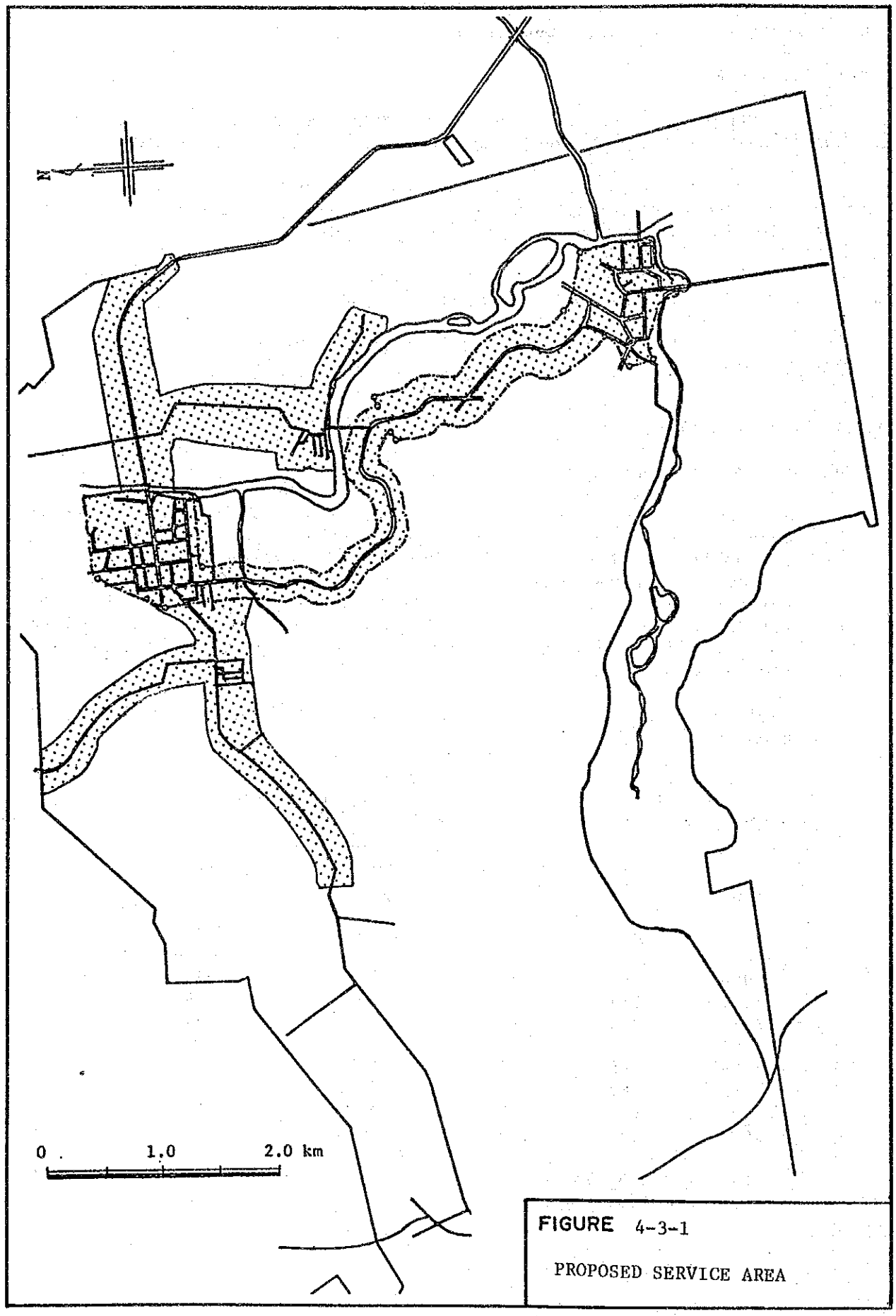


FIGURE 4-3-1

PROPOSED SERVICE AREA

(2) Service ratio

Service ratio is given as shown in Table 4-3-2

Table 4-3-2 Estimation of Service Ratio

Year	Total Population in Service Area (a)	Population served (b)	Service Ratio (%) (c)
1980	9,647	4,215	43.69
1981	9,569	4,141	43.28
1982	9,477	4,217	44.50
1983	9,174	4,175	45.51
1984	9,222	4,370	47.39
1985	9,339	4,507	48.26
1986	9,380	4,781	50.97
1987	9,303	5,017	53.93

(a) from Table 4-2-1
(b) from Table 4-3-1

(3) Future service ratio forecasting

The future service ratio by area are scheduled considering the present service ratio, development strategy for water supply and land use plan, and are summarized as shown in Table 4-3-3.

Table 4-3-3 Future Service Ratio

(Unit : %)

Year	Existing Service Area	Area to be Expanded
1991	60	-
1996	65	15
2001	70	30
2006	75	40
2011	80	50

(4) Future served population

Future served populations are calculated by area using the future service ratios and projected population therein as shown in Table 4-3-4.

Table 4-3-4 Future Served Population

Year	Population in Service Area			Average Service Ratio (%)
	Existing Service Area	Area to be Expanded	Total	
1991	5,660	-	5,660	41.1
	(9,434)	(4,338)	(13,772)	
1996	6,240	729	6,969	48.2
	(9,600)	(4,863)	(14,463)	
2001	6,838	1,636	8,474	55.7
	(9,769)	(5,452)	(15,221)	
2006	7,456	2,444	9,900	61.7
	(9,941)	(6,111)	(16,052)	
2011	8,093	3,427	11,520	67.9
	(10,116)	(6,851)	(16,967)	

Upper : Served population in the service area
Lower : Total population in the service area

4.4 WATER DEMAND

4.4.1 Historical Water Consumption

(1) Water production and water sales

The annual water production and sales from 1980 to 1987 are shown in Figure 4-4-1 and Table 4-4-1

Table 4-4-1 Annual Water Production and Sales

Year	Water Production (cu.m/y)	Water Sales (cu.m/y)	No. of Conn.	Consump. per Conn. (cu.m/d)
1980	230,988	200,460	791	0.692
1981	388,274	254,690	812	0.859
1982	429,356	289,772	851	0.933
1983	421,818	299,975	911	0.902
1984	443,250	304,744	965	0.863
1985	483,900	290,114	987	0.805
1986	496,050	265,973	1,063	0.686
1987	563,505	247,415	1,077	0.629

(2) Classification of consumption

PWA Survey Reports from 1985 to 1987 shows the consumption by categorized major consumer as listed in Table 4-4-2. Table 4-4-3 shows the average of three years after being regrouped into five groups for convenience of estimating future water demand.

4.4.2 Future water consumption

The five categories of consumption listed in Table 4-4-3 will be forecasted separately for the future, as they are different in nature.

(1) Domestic Water Consumption

Table 4-4-3 shows that the average domestic water consumption is accounted to be 72.3% of the total consumption. Assuming that this ratio has been constant from 1980 to 1987, the domestic water consumption is calculated as shown in Table 4-4-4.

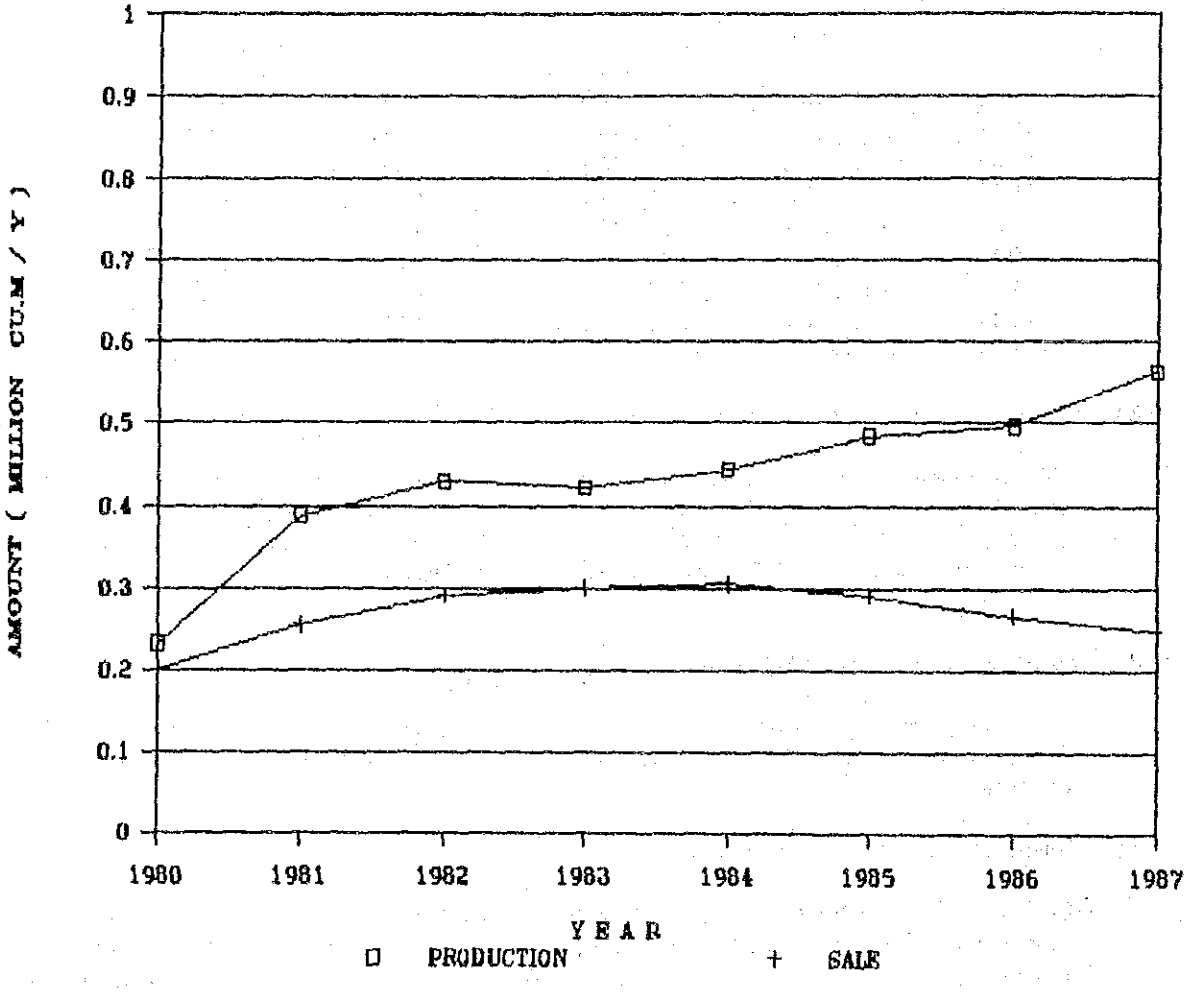


FIGURE 4-4-1
WATER PRODUCTION/SALE
TAKUA PA

Table 4-4-2 Major Consumers by Category

Code	Category	1985		1986		1987		Total		Average		Share	
		No. of Conn.	Consump.	No. of Conn.	Consump.	No. of Conn.	Consump.	No. of Conn.	Consump.	No. of Conn.	Consump.	No. of Conn.	Consump.
1	Residential	50	2095	45	828	46	920	141	3843	47	1281	4.41	6.11
2	Residential(Rental)	0	0	0	0	0	0	0	0	0	0	0	0
3	Commercial	16	784	13	513	13	806	42	2103	14	701	1.31	3.34
4	Restaurant	7	621	4	688	4	712	15	2021	5	674	0.47	3.21
5	Government Agency	11	3451	11	2507	12	2869	34	8827	11.3	2942	1.06	14.02
6	School	9	913	5	606	5	618	19	2137	6.3	712	0.59	3.39
7	Temple	0	0	0	0	0	0	0	0	0	0	0	0
8	Bangalow	0	0	0	0	0	0	0	0	0	0	0	0
9	Industrial	8	473	6	489	6	426	20	1388	6.7	463	0.63	2.21
10	Hotel	3	279	3	66	3	134	9	479	3	160	0.28	0.76
11	Hospital	3	90	3	29	3	91	9	210	3	70	0.28	0.33
12	Service	0	0	0	0	0	0	0	0	0	0	0	0
13	Others	1	119	1	77	1	86	3	282	1	94	0.09	0.45
	Sub-total	108	8825	91	5803	93	6662	292	21290	97.3	7097	9.14	33.82
	Percentage	10.48	38.92	8.38	29.53	8.64	32.31	9.14	33.82				
14	Other than Major Consumer	923	13849	995	13851	984	13956	2902	41656	967.3	13885	90.86	66.18
	Sub-total	923	13849	995	13851	984	13956	2902	41656	967.3	13885	90.86	66.18
	Percentage	89.52	61.08	91.62	70.47	91.36	67.69	90.86	66.18				
	Total	1031	22674	1086	19654	1077	20618	3194	62946	1064.7	20982		
	Percentage	100	100	100	100	100	100	100	100			100	100

Table 4-4-3 Water Consumption by Category (after Re-grouping)

Code	Category	1985		1986		1987		Total		Average		Share	
		No. of Conn.	Consump.	No. of Conn.	Consump.	No. of Conn.	Consump.	No. of Conn.	Consump.	No. of Conn.	Consump.	No. of Conn.	Consump.
	Domestic												
1	Residential	50	2095	45	828	46	920	141	3843	47	1281	4.41	6.11
14	Other than Major Consumer	923	13849	995	13851	984	13956	2902	41656	967.3	13885	90.86	66.18
	Sub-total	973	15944	1040	14679	1030	14876	3043	45499	1014.3	15166	95.27	72.28
	Institutional												
5	Government Agency	11	3451	11	2507	12	2869	34	8827	11.3	2942	1.06	14.02
6	School	9	913	5	606	5	618	19	2137	6.3	712	0.59	3.39
7	Temple	0	0	0	0	0	0	0	0	0	0	0	0
11	Hospital	3	90	3	29	3	91	9	210	3	70	0.28	0.33
	Sub-total	23	4454	19	3142	20	3578	62	11174	20.7	3725	1.94	17.75
	Commercial												
3	Commercial	16	784	13	513	13	806	42	2103	14	701	1.31	3.34
4	Restaurant	7	621	4	688	4	712	15	2021	5	674	0.47	3.21
8	Bangalow	0	0	0	0	0	0	0	0	0	0	0	0
10	Hotel	3	279	3	66	3	134	9	479	3	160	0.28	0.76
	Sub-total	26	1684	20	1267	20	1652	66	4603	22	1534	2.07	7.31
	Industrial												
9	Industrial	8	473	6	489	6	426	20	1388	6.7	463	0.63	2.21
	Sub-total	8	473	6	489	6	426	20	1388	6.7	463	0.63	2.21
	Others												
2	Residential(Rental)	0	0	0	0	0	0	0	0	0	0	0	0
12	Service	0	0	0	0	0	0	0	0	0	0	0	0
13	Others	1	119	1	77	1	86	3	282	1	94	0.09	0.45
	Sub-total	1	119	1	77	1	86	3	282	1	94	0.09	0.45
	Total	1031	22674	1086	19654	1077	20618	3194	62946	1064.7	20982	100	100

Table 4-4-4 Domestic Water Consumption

Year	Water Sales			Pop. Served	Per Capita Consump.
	Total (cu.m/y) (a)	Total (cu.m/d) (b)	Domestic (cu.m/d) (c)	(d)	(lpcd) (e)
1980	200,460	548	396	4,215	94
1981	254,690	698	505	4,141	122
1982	289,772	794	574	4,217	136
1983	299,975	822	594	4,175	142
1984	304,744	833	602	4,370	138
1985	290,114	795	575	4,507	128
1986	265,973	729	527	4,781	110
1987	247,415	678	490	5,017	98

(c) = (b) x 0.723
(d) from Table 4-3-1

The estimated per capita consumption for 2001 is 125 lpcd in the existing service area. Considering the socioeconomic feature of Takua Pa and living standard, an arithmetical progression curve which comes up to 140 lpcd in 2011 is selected.

For the area to be expanded, the per capita consumption is assumed to be 80 and 100 lpcd for 2001 and 2011, respectively.

Table 4-4-5 summarizes the unit consumption per capita.

Table 4-4-5 Unit Consumption for Domestic Use

(Unit : lpcd)

Year	Existing Service Area	Area To Be Expanded
1991	110	-
1996	118	70
2001	125	80
2006	133	90
2011	140	100

Table 4-4-6 shows the domestic water consumption in the every five years to 2011.

Table 4-4-6 Future Domestic Water Consumption

(Unit : cu.m/d)

Year	Existing Service Area	Area To Be Expanded	Total
1991	623	-	623
1996	736	51	787
2001	855	131	986
2006	992	220	1,212
2011	1,133	343	1,476

(2) Governmental/Institutional Water Consumption

The governmental/institutional water consumption includes the consumption of such institutions as governmental offices, hospitals, schools and temples.

Water consumption of each institution is predicted separately as they are different in nature.

(a) Governmental Office

It is assumed that the activities of governmental facilities correlate the population of the service area where these facilities are governing. For example, the staff of the police department will be increased as the population grows up.

Considering this concept, future water consumption of the governmental facilities is predicted from the ratio to the population in the service area of each year. Present data gives the following figures for the water consumption of governmental offices.

Average consumption of governmental office (1985-87)

$Q = 2,942$ cu.m/mo

Population in the service area (1987)

$p = 16,932$

Average daily consumption of governmental office expressed by per population are:

$$q = Q/p = 2,942 / 30 / 16,932 = 5.8 \text{ lpcd}$$

For future unit consumption for governmental use, 10 lpcd is adopted.

(b) School

Prediction of water consumption of schools is made by assuming the number of student from the proportion of that against the total population. The per student consumption calculated from the present data is applied to the future prediction with. In 1987 the per school consumption is given as below:

Average consumption of school (1985 to 1987)

Q = 712 cu.m/mo

Number of students in Amphoe Takua Pa (1987)

n = 10,143

Average daily consumption per student

q = Q/n = 712 / 30 / 10,143 = 2.3 lpcd

Considering that only some part of students are studying in schools in the service area, the per student consumption is higher than this value. Therefore, for future unit consumption, 20 lpcd is adopted.

(c) Hospital

Most of hospitals in the study area are equipped with their own water sources, mainly deep wells, as well as treatment facilities. This fact makes it difficult to identify the unit consumption and the actual total consumption of hospitals.

Regarding the number of beds against population, the "Population and Health" report of TDRI shows the following historical data with the predictions in 1991 and 2006.

Table 4-4-7 Ratio of Population to Hospital Bed

(Unit : pop./bed)

Year	Whole Kingdom	BMA	Provincial Area
1980	805.85	341.48	955.66
1981	801.35	361.22	952.75
1982	793.46	365.63	934.51
1983	761	376	888
1984	749	354	879
1985	748	336	882
1986	744	354	862
1991			(700)
2006			(600)

The ratio of population to bed in the whole of the province was 572.90 in 1985 less than a national target of 600 in 2006, while there is 236 beds in Takua Pa for an amphoe population of 38,134 in 1986. Therefore, the ratio is 161.58 pop./bed in Amphoe Takua Pa where is in good medical condition and no additional bed is considered until 2011.

A water consumption per bed is assumed to be 1.5 cu.m/d through years.

(d) Summary of Governmental/Institutional Consumption

The total of governmental/institutional consumption are summarized as shown in Table 4-4-8.

Table 4-4-8 Summary of Governmental Consumption

	1987	1991	1996	2001	2006	2011
1. Government						
o per pop. consump. (lpcd)	10.5	10	10	10	10	10
o population in service area	9,303	13,772	14,463	15,221	16,052	16,967
o consump. (cu.m/d)	98	138	145	152	161	170
2. School						
o per student consump. (lpcd)	2.3	20	20	20	20	20
o No. of students		4,832	5,075	5,341	5,632	5,953
o consump. (cu.m/d)	24	97	102	107	113	119
3. Hospital						
o per bed consump. (cu.m/d/bed)		1.5	1.5	1.5	1.5	1.5
o No. of beds		236	236	236	236	236
o Consump. (cu.m/d)		354	354	354	354	354
Total consump. (cu.m/d)	201	589	601	613	628	643

(3) Commercial Water Consumption

Commercial water consumption is defined to be the consumption of private businesses such as shops, restaurants, bars, and markets. Consumption derived from the commercial activities in Takua Pa is considered to relate to the population in the service area.

Unit consumption of commercial use is estimated from the 1987 data as follows:

2,929 / 30 / 16,932 = 5.8 lpcd

For future consumption, 10 lpcd is adopted.

Commercial consumption in the future is therefore calculated as shown in Table 4-4-9.

Table 4-4-9 Commercial Consumption

Year	Population in Service Area	Unit Consump. (lpcd)	Commercial Consump. (cu.m/d)
1991	13,772	10	138
1996	14,463	10	145
2001	15,221	10	152
2006	16,052	10	161
2011	16,967	10	170

(4) Industrial and Other Water Consumption

Presently, industrial and other water consumption is 2.5% and 0.5% to the total of domestic and institutional consumptions, respectively. There is no sign for the industry in this region to largely grow up in the future. Therefore, future industrial water consumption is assumed to be stable on the same level as the present.

Table 4-4-9 Industrial and Other Consumption

(Unit : cu.m/d)

Year	Domestic & Instit'l (a)	Industrial (b)	Other (c)
1991	1,212	30	6
1996	1,388	35	7
2001	1,599	40	8
2006	1,840	46	9
2011	2,119	53	11

(b) = (a) x 0.025
(c) = (a) x 0.005

(5) Unaccounted-for Water Ratio

Unaccounted-for water ratio of the Takua Pa Waterworks shows rather high value recently as shown in Table 4-4-11.

This ratio is supposed to be improved as much as possible by investing for the improvement works such as replacement of old pipes, leakage detection, and replacement of water meters with more sensitive and anti-reverse rotation type.

Table 4-4-11 Unaccounted-for Water Ratio

Year	Water Production (cu.m/y)	Water Sales (cu.m/y)	Unaccounted-for Water Ratio (%)
1980	230,988	200,460	13.22
1981	388,274	254,690	34.41
1982	429,356	289,772	32.51
1983	421,818	299,975	28.89
1984	443,250	304,744	31.25
1985	483,900	290,114	40.05
1986	496,050	265,973	46.38
1987	563,505	247,415	56.09

PWA set a target of reducing the unaccounted-for water as one of measures for cost recovery at 25 and 20 percent in 1995 and 2010, respectively. Implementing program of leakage control is presently on going at various waterworks under PWA.

However, it may be difficult for the Takua Pa Waterworks to catch up this PWA's target unless large amount of budget is secured for the improvement of the pipeline. Considering this constraints, future unaccounted-for water ratio is set as shown in Table 4-4-12.

Table 4-4-12 Future Unaccounted-for Water Ratio

(Unit : %)

Year	Unaccounted-for Water Ratio
1991	50
1996	43
2001	35
2006	28
2011	20

4.4.3 Future Water Demand

(1) Peak Factor

The data from January to December 1987 were studied. The results of analysis on the peak factor are summarized in Table 4-3-13.

Table 4-4-13 Summary of Peak Factor

Item	Demand (cu.m/d)	Factor	Date
Daily Maximum	2,054	1.349	May 18 & 25
Monthly Maximum	1,765	1.159	May
Daily Aveerage	1,523	1	
Monthly Minimum	1,384	0.909	Sep.
Daily Minimum	616	0.405	Aug. 18

A value of 1.35 is adopted for the peak factor.

(2) Future Water Demand

Future water demand is calculated from the water consumption, unaccounted-for water ratio and peak factor.

Table 4-4-14 shows the average and maximum daily water demand.

Table 4-4-14 Future Water Demand

(Unit : cu.m/d)

Category	1987	1991	1996	2001	2006	2011
Domestic		623	787	986	1,212	1,476
Gov't/Inst'l		589	601	613	628	643
Commercial		138	145	152	161	170
Industrial		30	35	40	46	53
Others		6	7	8	9	11
Sub-total		**1,386**	**1,575**	**1,799**	**2,056**	**2,353**
Unaccounted-for Water Ratio (%)	56.1	50	43	35	28	20
Unaccounted-for Water		1,386	1,188	969	800	588
Daily Average	1,551	2,772	2,763	2,768	2,856	2,941
Peak Factor		1.35	1.35	1.35	1.35	1.35
Daily Maximum		3,742	3,730	3,737	3,856	3,970

5. DESIGN CRITERIA

5.1 Intake

Intake Capacity = 110 percent of the daily maximum demand

5.2 Treatment and Pipe Design

Design criteria for the design of the treatment system and pipeline was established on the basis of the various design standards having been employed in Thailand or other countries, and with consideration on the conditions of the project site and raw water quality.

The design criteria is summarized in the followings:

(1) Water Loss

Intake Loss : 10 %

Treatment Loss : 8 % of production capacity for filter washing and in-plant use.

(2) Pipeline

Formula for Flow Rate Calculation :

Hazen-William's Formula, C = 110

C-value for pipes are usually defined as 130 for new pipes. For planning purpose, 110 is adopted considering miscellaneous loss in line at valves, bends etc.

Velocity : Maximum 3.0 m/s

Minimum 0.3 m/s

Pipe Material: Material should be decided considering pressure, soil condition, pipe profile, etc. However, material is generally selected in accordance with the principle below:

Steel Pipe:for diameter 400 mm or larger

A/C Pipe: for diameter 300 mm or smaller

(3) Treatment Plant Facilities

a. Receiving Well

Retention Time : 1.5 min

b. Mixing Tank (for Rapid Sand Filter only)

Type of mixing	:	Hydraulic
Mixing time (min)	:	1 - 5
Intensity, G (1/sec)	:	500 - 1,000

c. Flocculation (for Rapid Sand Filter only)

Type of mixing	:	Hydraulic
Stage	:	3 or more
Intensity, G (1/sec)	:	10 - 75
Flocculation time (min)	:	20 - 40

d. Sedimentation Basin (for Rapid Sand Filter only)

Type of sedimentation	:	by Gravity
Type of basin	:	Rectangular Horizontal flow
Flow velocity (cm/min)	:	less than 40
Retention time (hour)	:	3 - 5
Effective depth (m)	:	3 - 4
Length/Width ratio	:	3 - 8
Sludge removal	:	by manual

e. Filter (Alternative : Rapid Sand Filter)

Type of filtration	:	Rapid sand filtration Gravity down flow
Surface loading (m/d)	:	120 - 150
Filter media		
type	:	Single media
depth (cm)	:	60 - 70
effective size (mm)	:	0.45 - 0.70
Underdrain		
gravel layer	:	100- 150 mm x 4 layers
underdrain type	:	Bored pipe
Surface washing		
type	:	fixed nozzle
jet pressure(kg/cm2)	:	1.5 - 2.0
washing time (min)	:	4 - 6
rate (m3/m2/min)	:	0.2
Backwashing		
rate (m3/m2/min)	:	0.6 or larger
washing time (min)	:	5 - 10

f. Filter (Alternative : Slow Sand Filter)

Type of filtration	:	Slow sand filtration Gravity down flow
Surface loading (m/d)	:	4 - 5
Filter media		
type	:	Single media
depth (cm)	:	70 - 90
effective size (mm)	:	0.30 - 0.45
Underdrain		
gravel layer (cm)	:	40 - 60
underdrain type	:	Perforated brick

g. Clear Water Reservoir

Retention time (hour)	:	8.0
Depth (m)	:	3 - 6

h. Chemical feeding (for Rapid Sand Filter only)

Alum

coagulant	:	Solid aluminum sulfate
mixing	:	Batch mixing
dosage rate	:	5 - 10

Lime (as necessarily)

objective	:	pH control for coagulation
chemical type	:	Slaked lime (Ca(OH)2)

i. Chlorination

Chemical type	:	Chlorine gas
Minimum storage	:	1 month
Type of injector	:	Vacuum type injector
Dosage rate (ppm)	:	2.0

j. Instrumentation

General concept

Centralized operation not to be introduced;

Operation to be manual control

Flows to be measured	:	Raw and treated water
Levels to be measured	:	Clear water reservoir
Weights to be measured	:	Chlorine gas cylinder
Head to be measured	:	Filter loss

(4) Distribution Facilities

a. Service pressure

Minimum pressure (kg/cm2): 1.0 (for hourly maximum flow)

6. BASIS OF COST ESTIMATES

6.1 Construction Cost

(1) General

Construction cost of facilities to be built is calculated with prices in 1989 on the basis of the various unit costs.

The construction cost is calculated by different items in the manner as described below:

a. Pipelines : by linear meter for
- o Transmission pipes
- o Distribution pipes

b. Water Treatment Plant : by facilities for
- o Receiving well
- o Sedimentation basin
- o Sand filter
- o Clear water reservoir
- o Elevated tank
- o Pumping house
- o Chemical house
- o Mechanical works
- o Electrical works
- o Miscellaneous

c. Land Acquisition

These costs are separated in Foreign and Local Cost portion with the percentage by item as shown below:

Work Item	Foreign Currency	Local Currency
Pipeline	(%)	(%)
A/C pipes	30	70
Steel pipes	80	20
Structural/Architectural	30	70
Mechanical Works	80	20
Electrical Works	80	20
Land Acquisition	0	100

(2) Pipeline Construction

Pipelines are firstly separated into two major groups: (i) transmission pipeline for either raw water or clear water, but not for distribution, and (ii) distribution pipeline.

Unit costs for construction of transmission pipeline are calculated by linear meter, consisting of the material, transportation (two cases as more than 800 km, or smaller) and installation costs. Cost for fittings are assumed as 10 and 15 percent of pipe material cost for asbestos cement and steel pipes, respectively. These ratios are set smaller compared to that of the distribution pipes because of the simplicity in the pipeline components.

Unit costs of distribution pipeline are calculated in the same manner as that for the transmission pipeline. The ratios for fittings are set as 25 and 35 percent of the pipe material cost for asbestos cement and steel pipes, respectively.

(3) Treatment Plant

Cost for the treatment plant is calculated by the unit cost by facility of plant component of various capacity which has been used by PWA for planning purpose. Each cost is updated to meet the increased construction cost in 1989.

Unit costs for facilities, which are not included in the PWA's unit cost list, are calculated assuming the unit costs for the major items as follows:

- o Concrete works by concrete volume, including related works as reinforcement (assuming 100 kg/cu m of concrete), forming, scaffolding, supporting.
- o Earth works by soil volume for excavation and fill
- o Architectural works by unit area of building
- o Concrete piles by each pile, including material, transportation and driving cost

(4) Mechanical Works

Costs for the plant facilities included in the mechanical works are calculated on the basis of the number of unit of each equipment such as pump, flocculator, sludge remover, or chemical and chlorination dosage equipment. Additional percentage is assumed for the miscellaneous items as pipings and fittings.

(5) Electrical Works

Cost for the electrical works substantially varies depending on the instrumentation system. The records in the construction of the advanced water supply system shows it would share as much as 40 percent of the total construction cost if the sophisticated computer control system is employed. Employing the more simple system could reduce this cost much.

The system to be recommended in this study should be the simple one as described in the Design Criteria so that the cost for the system could be lowered. It is practical and common way to assume that the cost of the electrical works closely related to the cost of the mechanical works. In this study, the cost is therefore, calculated by percentage of the mechanical works.

(6) Land Cost

The unit land cost is assumed to be 1,000,000 Baht per Rai (1,600 sq m).

The details of the unit cost are shown in the Appendix A-6-1.

6.2 Operation and Maintenance Cost

(1) General

Operation and maintenance cost is calculated on the basis of the price and rate in 1989, and consists of the following factors:

- o Energy Cost
- o Chemical Cost
- o Manning Cost
- o Repair Cost
- o Replacement

This cost is calculated in local currency only.

(2) Energy Cost

It is practical that the energy for the operation will be provided in the form of the electricity by Provincial Electricity Authority (PEA).

The Energy cost is calculated separately for the demand charge and energy charge with the PEA rate in 1989 which are:

Demand Charge : Baht 229 /KW/month

Energy Charge : Baht 1.23 /KWH

(3) Chemical Cost

Unit chemical costs are as follows:

Alum : Baht 3.9 /kg

Lime : Baht 1.25 /kg

Chlorine Gas : Baht 15.6 /kg (excluding gas container)

(4) Manning Cost

The unit manning costs of each year are calculated from the average manning cost in 1987, which is Baht 7,510 per person per month. The annual increment of the monthly salary is set to be 5 percent.

(5) Repair Cost

Repair cost should be counted for repairing and maintaining the plant equipment. This cost is calculated as 0.3 percent of the construction cost of the mechanical and electrical works.

(6) Replacement

Each facility to be constructed should have a certain life time. The span for the life time is varying depending on its nature of the facility. The followings are the life time of the facilities to be taken in this study and concept for replacement:

Item	Life time span	To be replaced after life time
Pipeline		
A/C pipes	20 years	50 percent
Steel Pipes	30	50
Concrete Structures		
Treatment Plant	50	100
Reservoir	50	100
Mechanical Equipment	20	100
Electrical System	20	50

(7) Cost of the Head and Regional Office

Cost of the PWA's head office and the regional office are allocated and added, in the financial study in Chapter 17, to the direct operation costs above. The allocation is determined assuming the future increment of their costs in each office, detailes of which is explained in Chapter 13.

Part 2
DEVELOPMENT PLAN

Part 2 DEVELOPMENT PLAN

7. CONSIDERATION FOR DEVELPOMENT PLAN

Expansion of the treatment plant capacity is the main subject in consideration for the development plan.

The treatment plant capacity should be increased to produce the planned amount of water demand in 2011. Expansion of facilities is required although the improvement plan may be considered by PWA in the same manner as implemented at the Thung Song Waterworks in 1987.

Expansion of the distribution network will be planned according to the planned extent of the future service area. Improvement in the existing network is also discussed.

8 DEFINITION AND EVALUATION OF ALTERNATIVES

8.1 Water Source

8.1.1 Comparative Study

As previously mentioned in Chapter 2, several alternatives can be considered. The comparative study was made as shown in Table 8-1-1.

Table 8-1-1 Evaluation of Alternatives

Water Supply Alternative	Constr'n Capacity	Tech'l Difficulty	Constr'n Problem	Social & Cost	Political
(1) Weir Extension	Fair	Poor	Good	Fair	Good
(2) Mining Pit Expansion	Fair	Good	Good	Good	Fair
(3) New Mining Pit	Fair	Fair	Fair	Fair	Poor
(4) Takua Pa River	Good	Fair	Fair	Fair	Fair
(5) Ground Water	Poor	Fair	Fair	Fair	Poor

(1) Extension of the Existing Weir

An access path to the weir is so small and rough that it may be difficult to carry construction materials and equipment. In addition, its catchment area is so small that availability is less than other water sources.

(2) Expansion of the Existing Mining Pit

(a) Improvement of the Existing Mining Pit

The western part of the existing mining pit can be enlarged in capacity by excavating the area over 84.00 m in elevation to expand the capacity to 300,000 cu.m. Therefore, the available amount of water is obtained from the same equation as described in Chapter 2.

$$Q = (300,000-10,000)-0.7x(0.139+0.164+0.155+0.198) \times 32,000-32,000x0.001x120$$

$\fallingdotseq$ 271,600 cu.m in four months

$\fallingdotseq$ 2,200 cu.m/d

(b) Usage of the Mining Pit adjacent to the Existing Mining Pit

A small mining pit is located next to the existing one. The pit is approximately 60,000 cu.m in volume and can be connected to the existing one with a pipe under the path. Therefore, the available amount of water is obtained as follows:

$$Q=(60,000-5,00)-0.7x(0.139+0.164+0.155+0.198) \times 8,000-8,000x0.001x120$$

= 50,440 cu.m in four months
= 400 cu.m/d

(c) Pumping Station

The existing pumping station is frequently flooded in every rainy season so that this pumping station is recommended to be relocated to the southern part of the pit which is the highest part of the bank.

(3) New Mining Pit Development

A few mining pits are located in the flood plain. These pits can be used for water supply.

The water demand in the target year 2011 at the intake level is 4,700 cu.m/d, while the water supply capacities of the existing water sources are 1,600 cu m/d by the existing mining pit, and 300 cu.m/d by the Khlong Bang I, respectively. A balance of 3,000 cu.m/d must be supplemented by other means.

The required storage capacity is estimated by applying the same conditions as the existing pit as follows:

3,000 x 30 x 4 x 1.1 = 396,000 cu.m

(4) Intake from the Takua Pa River

Since the Takua Pa River has a sufficient flow even in the dry season, intake from the river is considered to be the most appropriate if technical problems are solved by constructing a sedimentation basin and intake pumping station in the plain which is not damaged by flood.

(a) Minimum Flow of Takua Pa River

As shown in Table 8-1-2, the minimum flow at the mining pit in the Takua Pa River is estimated at 0.73 cu.m/s against the water demand of 0.053 cu m/s.

Table 8-1-2 Monthly Stream Flow at the Proposed Intake Point
(Unit : cu.m/s)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1972	-	-	-	-	-	-	-	-	60.4	21.9	16.8	7.0
1973	3.3	1.5	1.1	1.8	3.8	31.4	70.9	50.5	47.4	43.8	26.3	11.5
1974	6.6	4.8	3.8	5.5	23.7	49.1	30.4	133.9	50.1	77.2	56.1	10.8
1975	10.2	4.8	3.8	3.1	8.6	95.3	-	63.4	28.7	62.5	29.9	6.5
1976	3.4	2.1	2.2	3.2	38.7	35.9	61.9	43.6	95.3	14.3	13.5	6.5
1977	3.7	2.9	3.8	1.2	8.1	9.6	13.1	79.3	-	25.5	18.3	6.2
1978	3.8	2.7	2.9	2.5	10.8	56.2	73.2	113.4	102.3	51.5	0.4	6.5
1979	3.7	2.4	1.2	9.2	27.6	30.0	106.0	74.6	57.2	71.3	10.4	6.2
1980	4.2	3.2	3.4	4.1	10.5	34.2	83.6	84.9	94.3	56.8	35.1	16.8
1981	9.2	6.2	3.8	5.2	13.9	66.6	32.2	21.3	39.9	24.6	37.0	14.9
1982	8.4	5.4	4.1	8.1	14.1	21.0	95.1	72.8	70.3	32.4	21.2	12.9

Note : (410/312) / (No. of days in a month) / 86,400

The minimum flow is obtained by probability analysis using the yearly minimum flow in the return period of 1/10.

While,

Intake Amount = (4,900-1,900) / 86,400
= 0.034 cu.m s < 0.73 cu.m/s

(b) Capacity Required for Sedimentation

Intake Amount : 0.034 cu.m/s 60 x 60 = 130 cu.m/h
Detention Time : 3 hours
Capacity Required : 130 x 3 x 1.2 = 500 cu.m

(5) Ground Water Development

Ground water development is unreasonable in quality and quantity for public water supply.

Out of the five alternatives above, possible ways are integrated into two plans as shown below:

(1) Expansion of the existing mining pit and new mining pit development
(2) Intake from the Takua Pa River and usage of mining pit

Preliminary design and cost estimates for these plans are described in Table 8-1-3.

Accordingly, from the view point of technical matters, land acquisition and construction cost, intake from the Takua Pa River and usage of the existing mining pit is recommended.

Table 8-1-3 Preliminary Cost Estimate

(Unit : X 1,000 B)

Facility	Dimensions/Specifications	Cost
(1) Expansion of existing mining pit and new mining pit development		
Purchase of 1 ha mining pit next to the existing pit (10 B/sq.m)		100
Improvement of existing pit	Excavation 80,000 cu.m Embankment 5,000 cu.m	8,000
Pumping Station	150 mm x 1.8 cu.m/min x 20 m x 15 kw x 2 units Housing 25 sq.m	400
Transmission Pipe	AC 200 mm x 1.0 km long	820
* New mining pit development		
Purchase of New Mining Pit	5 ha	500
Pumping Station	125 mm x 1.38 cu.m/min x 30 m x 15 kw x 2 units Housing 25 sq.m	400
Transmission Pipe	AC 200 mm x 2.0 km long	1,640
	Total	11,860
(2) Intake from the Takua Pa River and usage of existing mining pit		
* Purchase of Mining Pit next to the Existing One	1.0 ha (Baht 500,000/rai)	3,120
* Intake and Pumping Station at Takua Pa River		
Intake Tower	Dia.5.0 m Hight approx.10 m	2,000
Pump Station	200 mm x 3.2 cu.m/min x 2 units Housing 36 sq.m	750
Transmission Pipe	AC 300 mm x 1.0 km long	1,490
* Usage of Existing Mining Pit		
Pumping Station	100 mm x 2.1 cu.m/min x 30 m x 11 kw x 2 units	280
Transmission Pipe	AC 250 mm x 2.0 km long	2,180
	Total	6,820

8.1.2 Water Source Development Plan

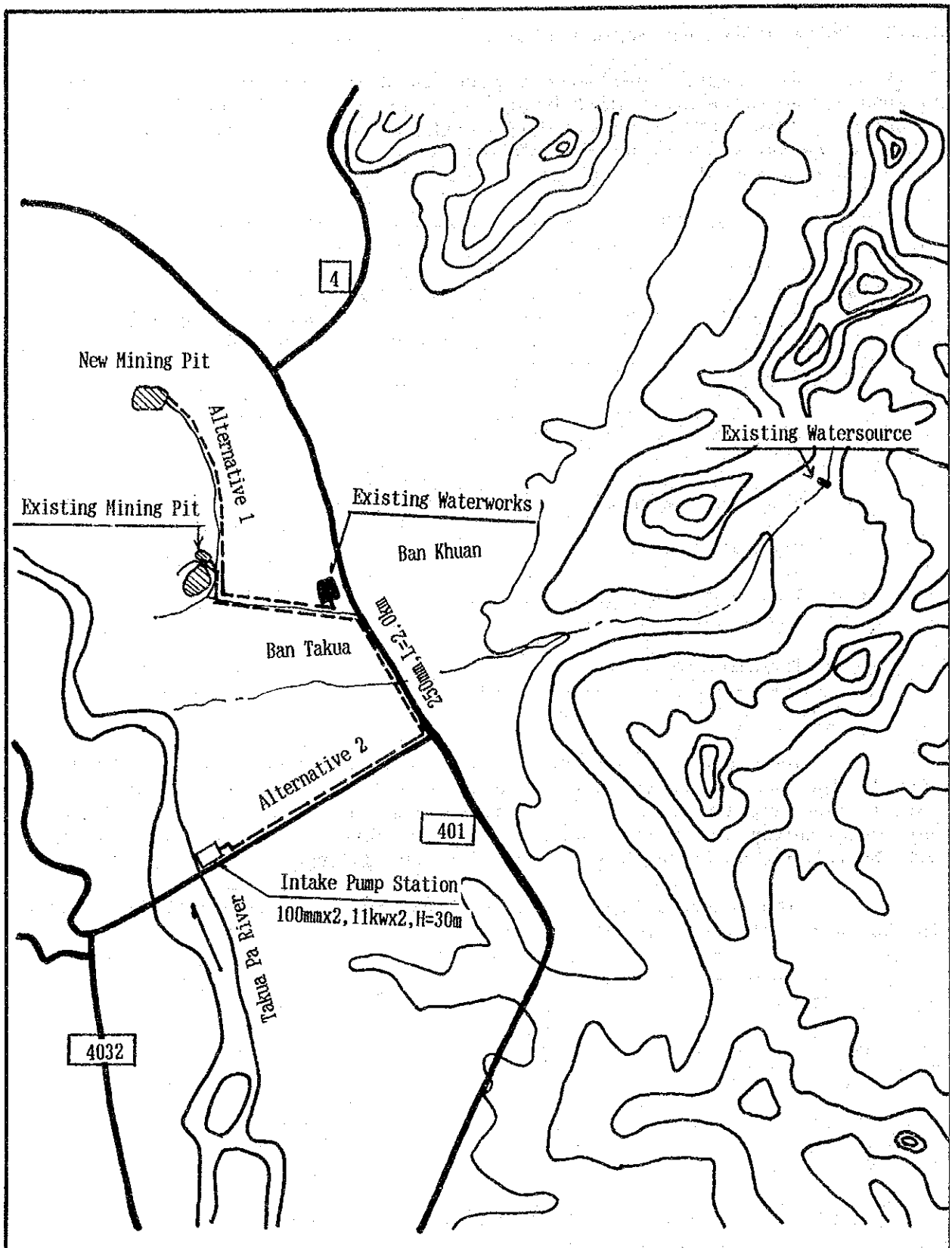
Water source development plan is shown in Figure 8-1-1, in which an intake pumping station will be constructed near the bridge about 2.0 km upstream of the waterworks. Raw water will be transmitted to the new mining pit close to the existing one for sedimentation.

Table 8-1-5 Water source Development Plan

Project	Year	Water Supply Capacity (cu.m/d)	Daily Maximum Water Demand (cu.m/d)
Phase I	1990	4,900	4,630
Purchase of Mining Pit			
Pumping Station			
Transmission Pipe			
Intake Pumping Station			
Transmission Pipe			

As a possible measure to reduce the pump operation cost, an additional pipeline may be considered to be installed from the existing intake weir to the treatment plant. With a provision of the additional pipe, conveyance capacity of raw water will increase so that the larger amount of water will be taken from Khlong Ban I by gravity flow during the rainy season.

The construction cost of this additional pipeline will be included in the cost estimates.



Note ; 1 Enlargement of the existing mining pit and new mining pit development
2 Intake from the Takua Pa river and usage of the mining pit

Figure 8-1-1

Alternative Plans

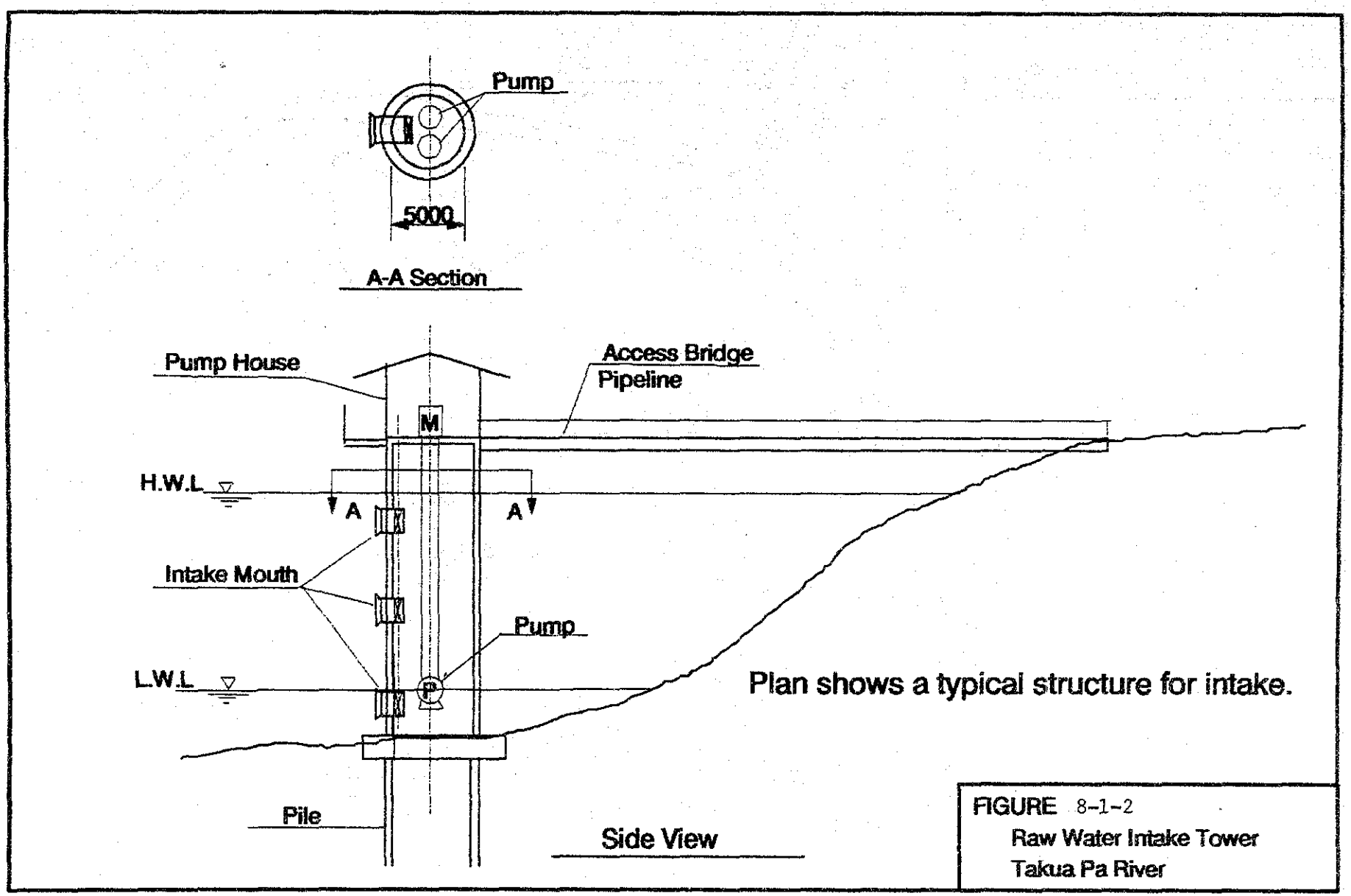


FIGURE 8-1-2
Raw Water Intake Tower
Takua Pa River

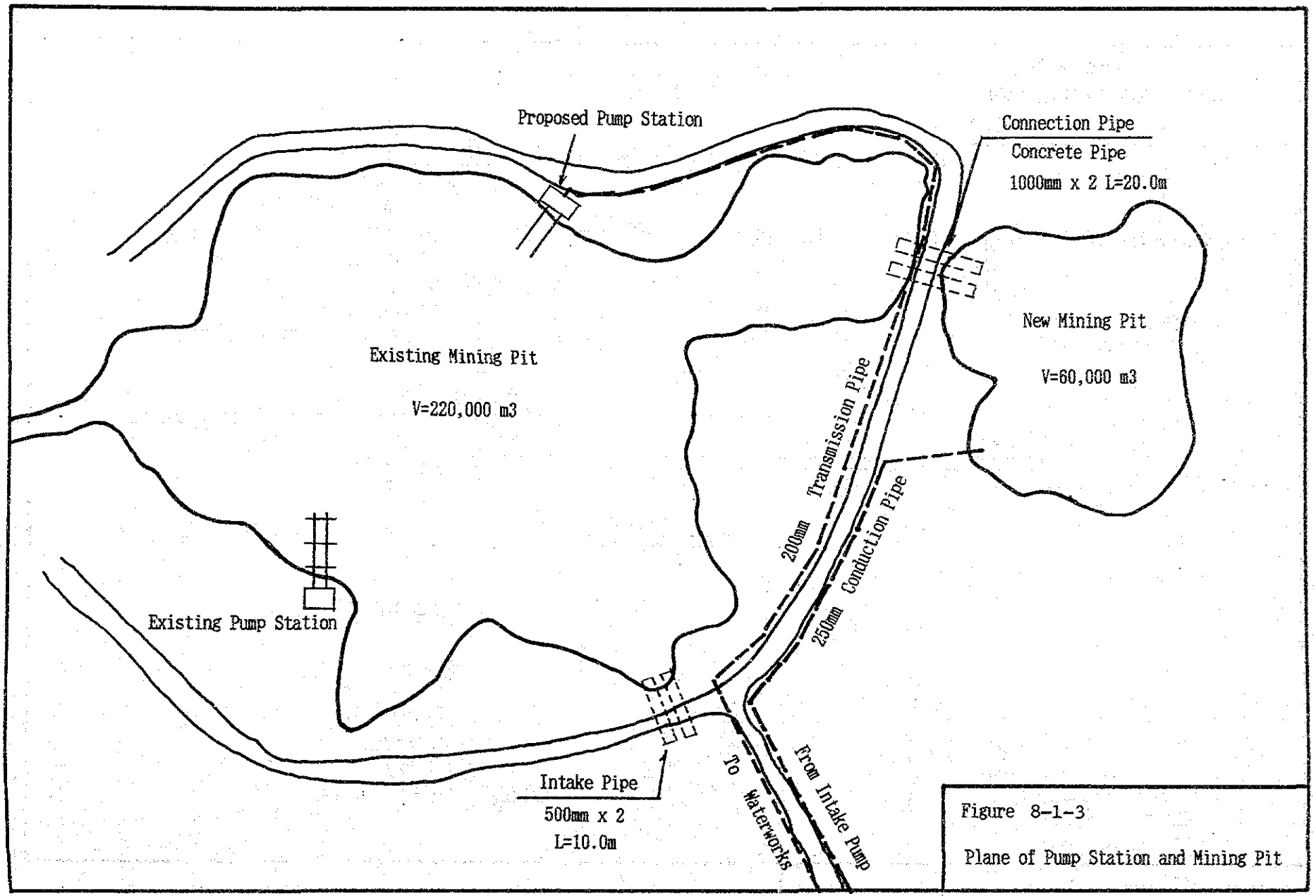


Figure 8-1-3

Plane of Pump Station and Mining Pit

8.2 Water Supply System

8.2.1 Proposed Development for Water Treatment Plant

The existing treatment plant has a treatment capacity of 40 cu m/h (960 cu m/d). The existing capacity of the plant is however lower than the planned daily maximum water demand in 1991 which is 3,738 m/d. Therefore, immediate measures for increasing a treatment capacity should be taken to meet the demand.

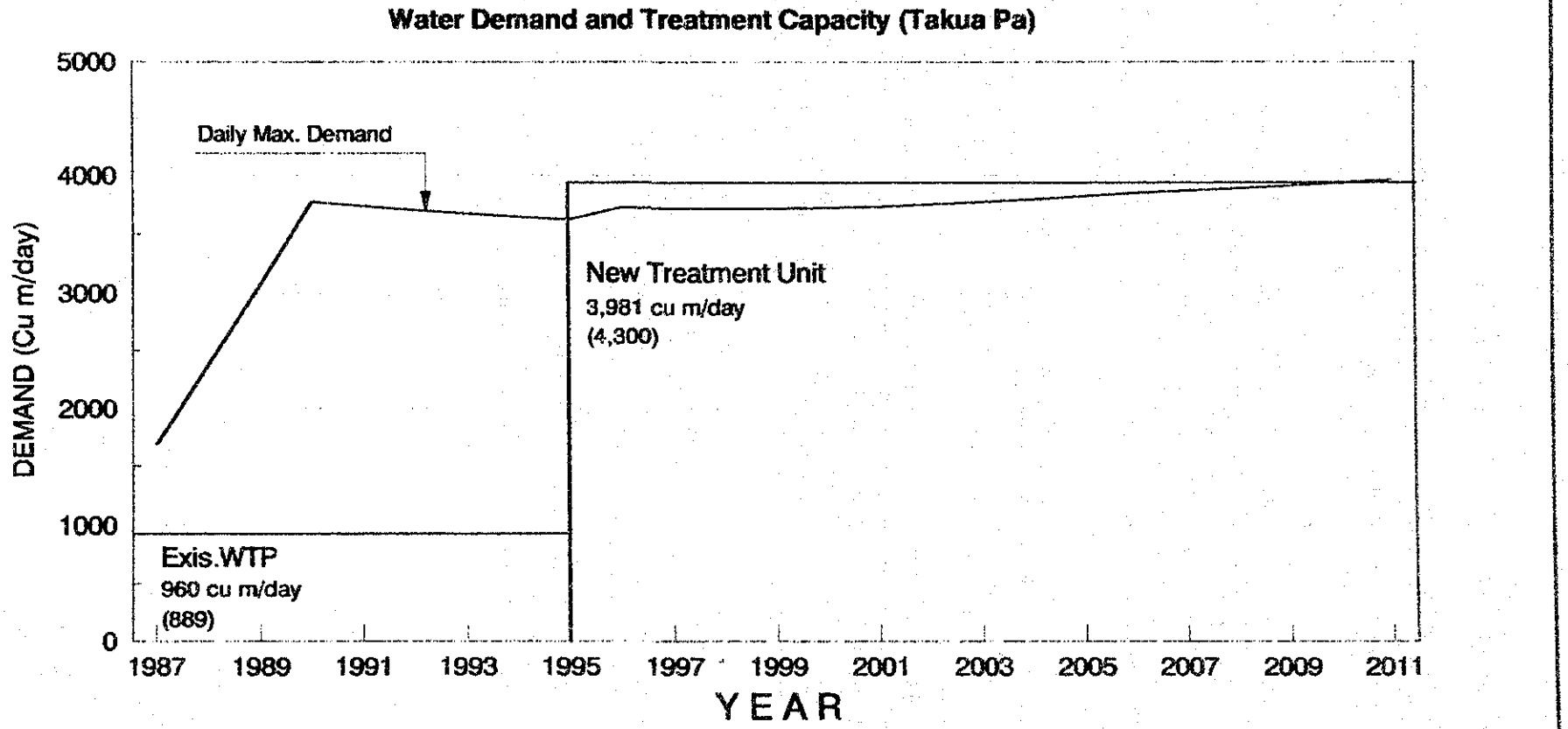
The existing treatment line is however not used constantly through the year because of a good quality of the raw water taken from the water fall. Water taken from the water fall is directly conveyed in the clear water reservoir whenever the raw water is clear enough. Treatment facilities such as sedimentation tanks and sand filters are not well maintained while they are not in use. Therefore, such facilities are time-worn and of poor condition as a treatment facilities.

Therefore, modification of the plant for increasing the treatment capacity, as intended in the other waterworks such as Thung Song and Su Ngai Golok, is not considered since the capacity of the existing plant is very small so that the effect of the modification is not expected to be big enough.

Considering these condition, the required treatment capacity to meet the future demand should be obtained by constructing the new treatment facilities. The planned water demand shows the gentle curve of increasing from 3,738 cu m/d in 1991 to 3,966 cu m/d in 2011. From this feature, the additional treatment facility is recommended to be constructed in one stage. Figure 8.2.1 shows an implementing plan for the treatment plant development.

For the treatment process to be applied for the additional plant unit, chemical sedimentation and rapid sand filtration is recommended considering that raw water will be occasionally taken from the Takua Pa River during the dry season. In this case, turbidity in the raw water will become higher so that chemical coagulation and rapid sand filtration will be needed.

The new treatment plant is recommended to be constructed at the existing plant site since the existing plant site has a enough room for expansion. Figure 8.2.2 shows a proposed expansion plan at the existing plant site.



Water Treatment Plant Capacity

3,981 cu m/day : Net Treatment Capacity

(4,300) : Design Capacity (including Treatment loss)

FIGURE
Water Treatment Plant
Construction Plan

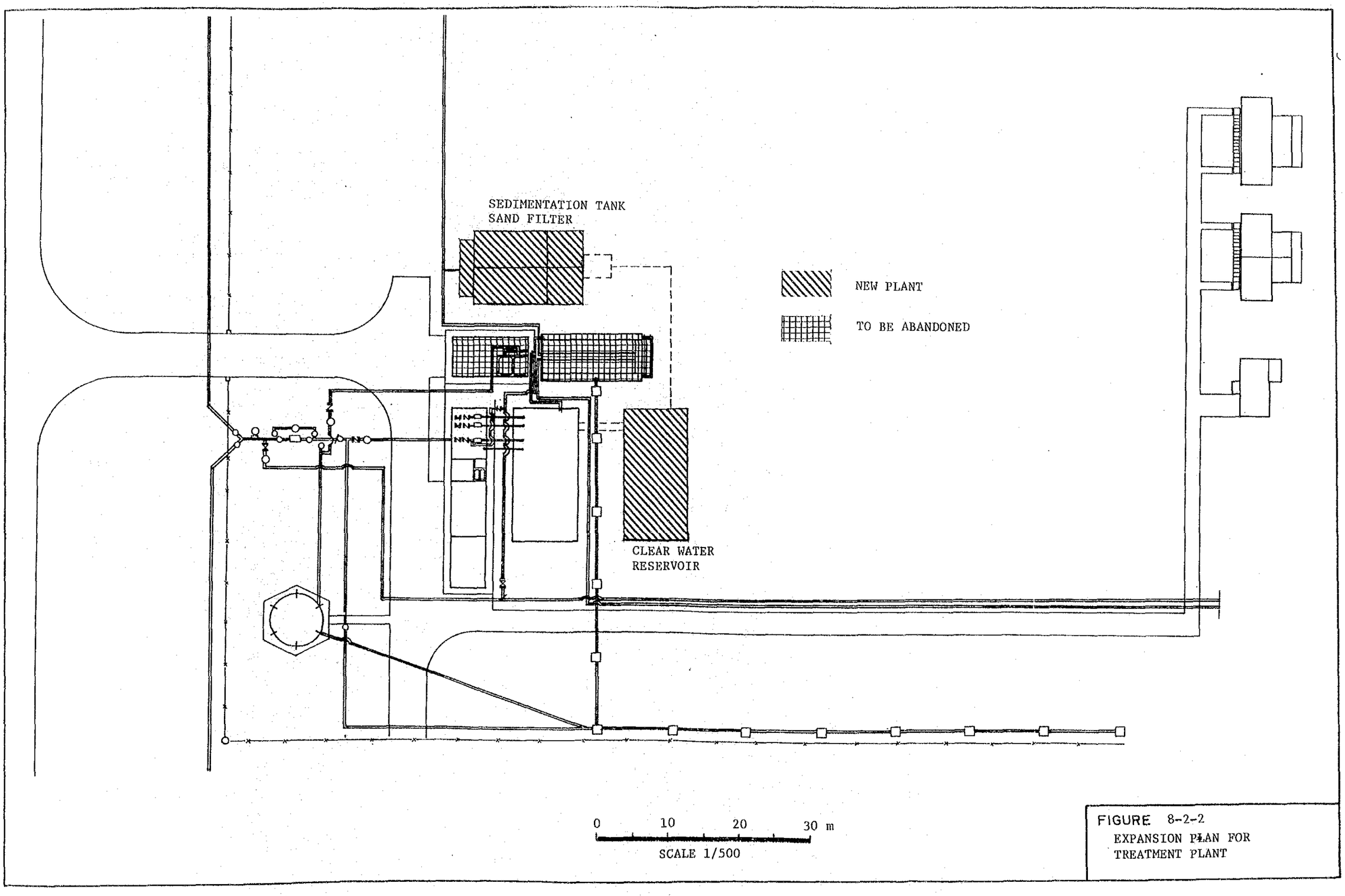


FIGURE 8-2-2
EXPANSION PLAN FOR
TREATMENT PLANT

8.2.2 Proposed Distribution System

The distribution system with a water demand in 2011 was analyzed to optimize the system. The minimum pressure in the maximum hour flow is set at 1.0kg/sq.cm for general application.

Replacement of the existing pipeline is proposed for the aged pipes which have a total length of about 7,000 m.

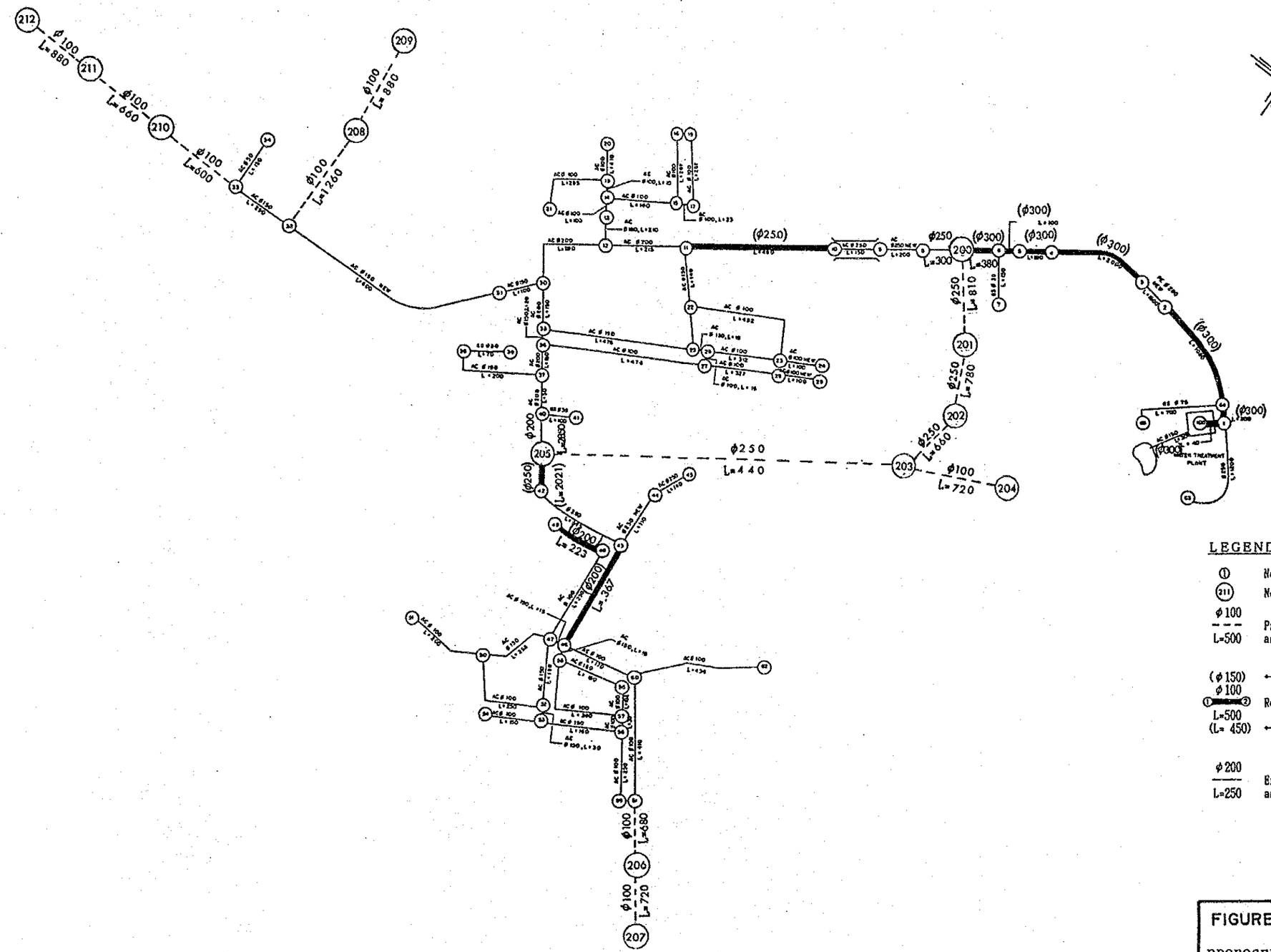
The proposed system includes installation of approximately 9,000 m long mains, with diameters of 100 and 250 mm. Based on the results of the distribution network analysis, distribution pipeline are sized to serve the maximum hourly flows with sufficient service pressure throughout the proposed system.

A schematic plan for the its system are shown in Figure 8.2.3. The results of the distribution network analysis are presented in Appendix 8-2-2.

Breakdown of the proposed distribution pipeline including a replacement of the existing pipeline system are tabulated in Table 8.2.1.

Table 8-2-1 Proposed Distribution pipelines

Dia (mm)	Length (m)	Materials
(Replacement)		
200	590	AC
250	2,480	AC
300	4,050	AC
(New Pipes)		
100	6,400	AC
250	2,690	AC



LEGEND

①	Node Number for Existing Pipeline
(211)	Node Number for Existing Pipeline
φ100 / L=500	Proposed Pipeline and its Diameter & Length (mm) (m)
(φ150)	← Proposed Diameter (mm)
φ100 ①—② L=500 (L= 450)	Replacement of Existing Pipeline ← Proposed Length (m) if necessary, otherwise same as the existing one.
φ200 / L=250	Existing Pipeline and its Diameter & Length (mm) (m)

FIGURE 8-2-3

PROPOSED DISTRIBUTION PIPELINE

9. IMPLEMENTATION PLAN

The implementation plan of the total project is proposed as shown in Figure 9-1. In this program, the facility construction is prepared following the water demand prediction. The construction of the treatment plant will be carried out in one phase. It is assumed that the distribution pipelines will be constructed in two years.

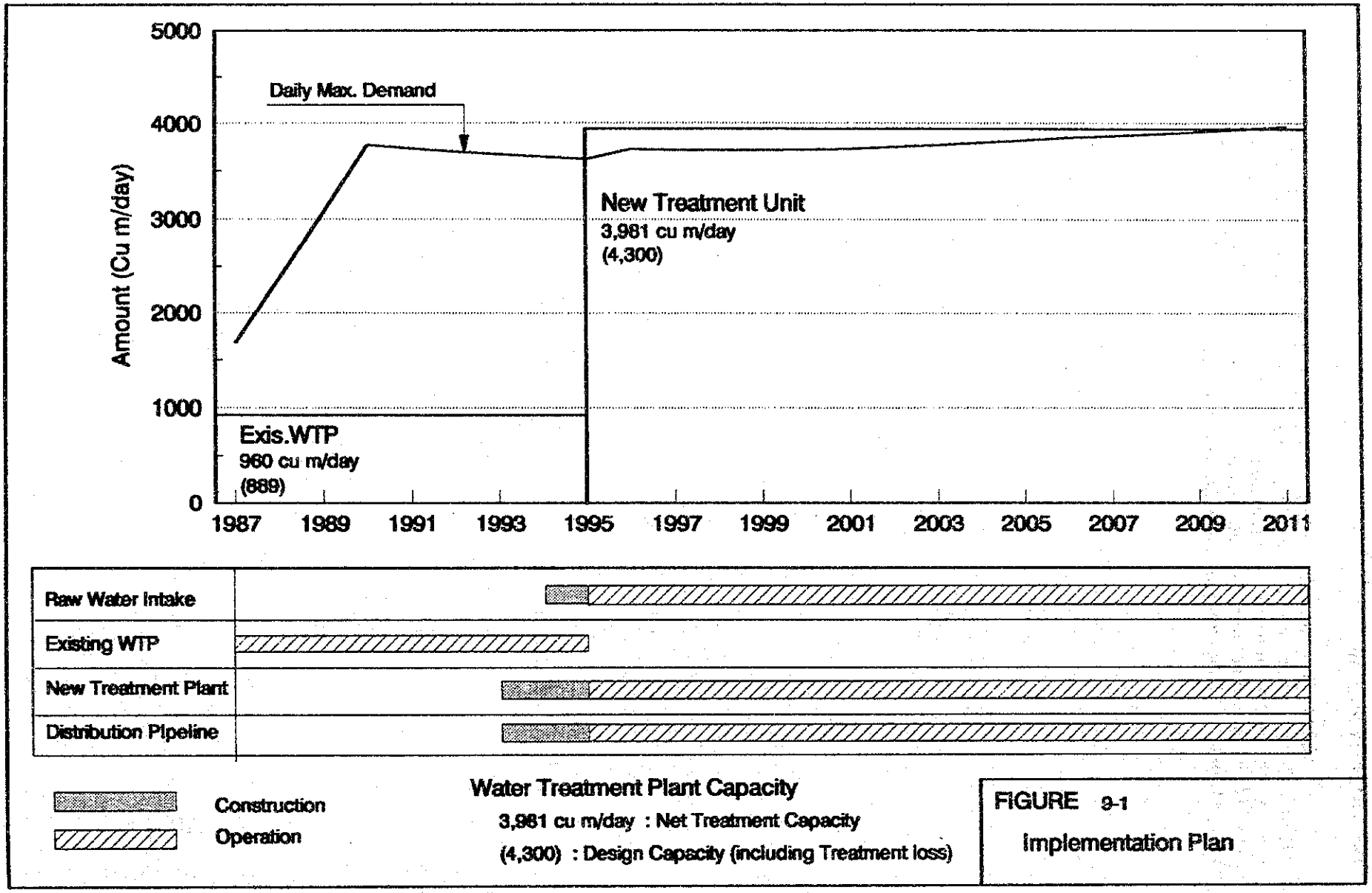


FIGURE 9-1
Implementation Plan

10. ORGANIZATION OF WATERWORKS

The organization of the waterworks is proposed with consideration on the components and size of the proposed water supply system. The construction of sections is based on the existing organization chart of the waterworks. The proposed organization consists of the administration, water production, and service sections as shown in Figure 10-1.

The major tasks of each section are described as follows:

(1) Administration Section

This section will be responsible for the administrative and financial issues of the waterworks. The works to be done will include the preparation of the general administration for the waterworks' staff, meter reading and preparation of bills, collectin of water charge, and management of the documents and records.

(2) Water Production Section

This section will be responsible for the operation and maintenance of the water treatment plants and the raw water intake. Inspection of the transmission pipelines will be performed by this section.

(3) Service Section

This section will be responsible for setting and repair of house connection.

Numbers of staff of each section are decided from the water demand in each year. Ratios of present number of staff and the water demand in 1987 are used in calculating the future number of staff.

Table 10-1 shows numbers of staff.

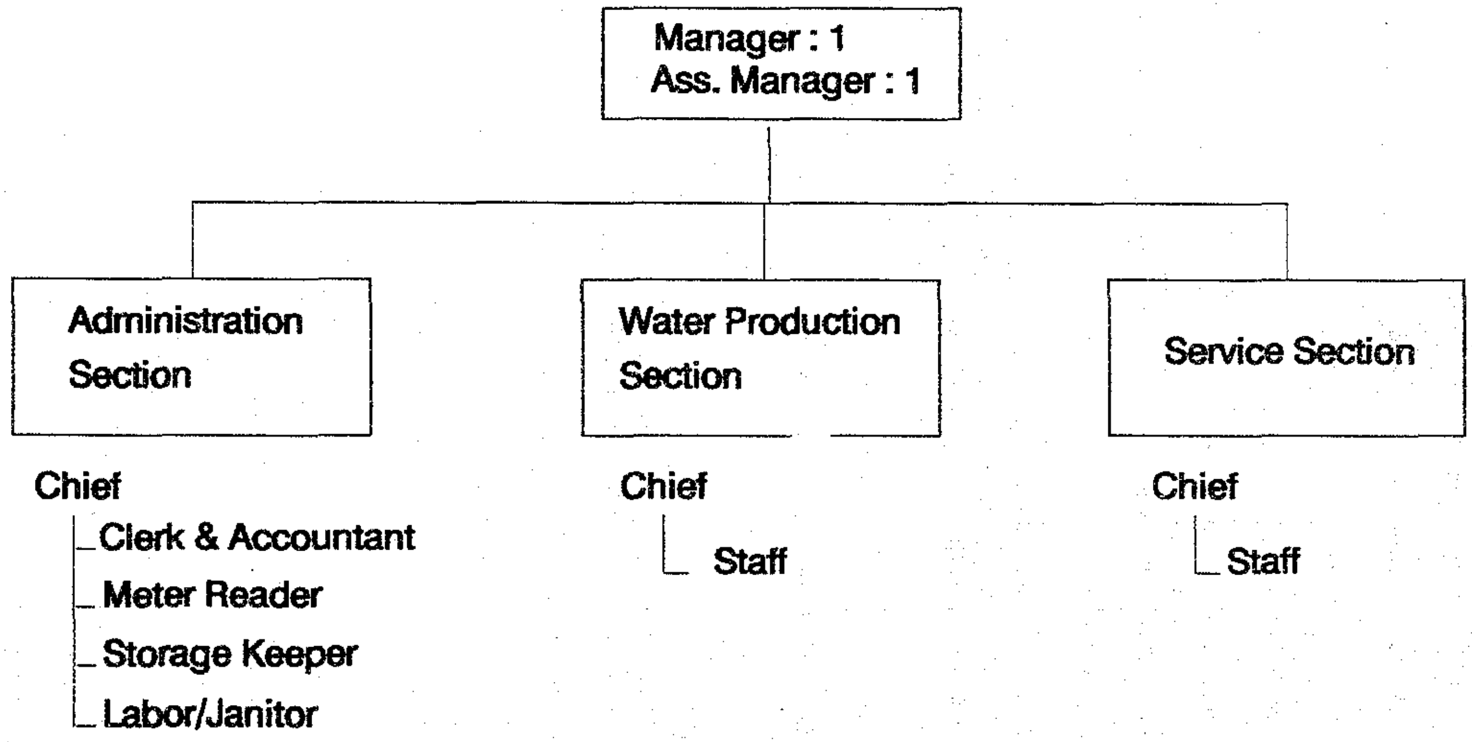


FIGURE 10-1
Proposed Organization

Table 10 - 1 Proposed No. of Staff

Year	No. of Staff	Administrative						Water Production		Service Section	
	Total	Manager	Chief	Clerk Account	Storage Keeper	Meter Reader	Labor etc.	Chief	Staff	Chief	Staff
1990	16	1	1	1	2	1	0	1	5	1	3
1991	16	1	1	1	2	1	0	1	5	1	3
1992	16	1	1	1	2	1	0	1	5	1	3
1993	16	1	1	1	2	1	0	1	5	1	3
1994	16	1	1	1	2	1	0	1	5	1	3
1995	16	1	1	1	2	1	0	1	5	1	3
1996	16	1	1	1	2	1	0	1	5	1	3
1997	16	1	1	1	2	1	0	1	5	1	3
1998	16	1	1	1	2	1	0	1	5	1	3
1999	16	1	1	1	2	1	0	1	5	1	3
2000	16	1	1	1	2	1	0	1	5	1	3
2001	16	1	1	1	2	1	0	1	5	1	3
2002	16	1	1	1	2	1	0	1	5	1	3
2003	16	1	1	1	2	1	0	1	5	1	3
2004	16	1	1	1	2	1	0	1	5	1	3
2005	16	1	1	1	2	1	0	1	5	1	3
2006	16	1	1	1	2	1	0	1	5	1	3
2007	16	1	1	1	2	1	0	1	5	1	3
2008	16	1	1	1	2	1	0	1	5	1	3
2009	16	1	1	1	2	1	0	1	5	1	3
2010	16	1	1	1	2	1	0	1	5	1	3
2011	16	1	1	1	2	1	0	1	5	1	3

11. Project Cost Estimates

11.1 Construction Cost

The construction cost of the water supply system was calculated for each component of facility. Table 11-1 shows a summary of the construction cost based on the 1989 price.

Table 11-1 Summary of the Construction Cost

(unit : Baht 1000)

Item	Total Value	Foreign Currency Portion	Local Currency Portion
1.Raw Water Intake	4,493	1,843	2,650
2.Usage of the Existing Mining Pit	2,675	1,050	1,625
3.Treatment Plant	16,661	6,680	9,980
4.Distribution Pipeline	16,003	4,801	11,202
5.Transmission Pipeline (Intake Weir to WTP SP, Dia.200 mm, 2 km)	3,540	2,832	708
Sub Total	43,372	17,206	26,165
5.Land Cost	100	0	100
Total	43,472	17,206	26,265

The breakdown of the cost estimates are shown in Tables 11-2 to 7.

Table 11-2 Cost Breakdown of the Raw Water Intake Facility

(unit : Baht 1000)

Item	Total Value	Foreign Currency Portion	Local Currency Portion
A. Civil/Architectural Works	2,000	600	1,400
B.Mechanical Works	600	480	120
C.Electrical Works	300	240	60
D.Miscellaneous	103	76	27
E.Transmission Pipe	1,490	447	1,043
Total	4,493	1,843	2,650

Table 11-3 Coat Breakdown of the Existing Mining Pit Usage
(unit : Baht 1000)

Item	Total Value	Foreign Currency Portion	Local Currency Portion
A.Mechanical Works	300	240	60
B.Electrical Works	150	120	30
C.Miscellaneous	45	36	9
D.Transmission Pipe	2,180	654	1,526
Total	2,675	1,050	1,625

Table 11-4 Cost Breakdown of the Treatment Plant
(unit : Baht 1000)

Item	Total Value	Foreign Currency Portion	Local Currency Portion
A. Civil/Architectural Works			
1. Receiving Well	8	2	6
2. Sedimentation Basin	3,759	1,128	2,631
3. Rapid Sand Filter	2,685	806	1,879
4. Clear Water Reservoir	3,168	950	2,218
5. Elevated Tank	1,800	540	1,260
6. Pumping House	288	86	202
7. Chemical House	380	114	266
Sub-total of A.	12,088	3,626	8,462
B. Mechanical Works			
1. Clear Water Pump 200mm, 3 units	600	480	120
2. Chemical Equipment	640	512	128
3. Chlorination Equip	720	576	144
4. Others (20% ofabove)	392	314	78
Sub-total of B.	2,352	1,882	470
C. Electrical Works (30 % of Mechanical)	706	565	141
D. Miscellaneous(10%ofA,B,C)	1,515	607	907
Total	16,661	6,680	9,980

Table 11-5 Cost Breakdown of the Distribution Pipeline

(unit :Baht 1000)

Pipe Dia(mm)	L (m)	Material	Total Value	Foreign Currency Portion	Local Currency Portion
(Replacement)					
200	590	AC	525	158	367
250	2,480	AC	2,926	878	2,048
300	4,050	AC	6,561	1,968	4,593
Sub-Total	2,940		10,012	3,004	7,008
(New Construction)					
100	6,400	AC	2,816	845	1,971
250	2,690	AC	3,174	952	2,222
Sub-Total	24,065		5,990	599	4,193
Total			16,003	4,801	11,202

11.2 Operation and Maintenance Cost

It is assumed that the new treatment unit with a treatment capacity of 3,300 cu m/day will start operation in 1994.

Operation and maintenance cost is calculated from the water demand in each year, and consists of energy, chemical, manning, repair, and replacement costs.

Manning cost is based on the prediction of the staff number of waterworks as proposed in Chapter 10.

Replacement of the mechanical and electrical equipment is considered to be made 20 years after the installation so that they are not included in the period of the development plan.

Total operation and maintenance cost is tabulated in Table 11-6.

Table 11.6 Summary of Operation and Maintenance Cost

(unit : Baht 1000)

Year	OPERATION COST					
	Energy Cost	Chemical Cost	Manning Cost	Repair Cost	Replacement	Total
Total	14,015	1,521	61,212	271	0	77,019
1990	462	69	1,590			2,121
1991	460	68	1,669			2,198
1992	458	68	1,753			2,278
1993	457	67	1,840			2,365
1994	660	67	1,932			2,659
1995	657	66	2,029	16		2,768
1996	669	68	2,130	16		2,883
1997	668	68	2,237	16		2,989
1998	668	68	2,349	16		3,101
1999	668	68	2,466	16		3,218
2000	668	68	2,589	16		3,342
2001	670	68	2,719	16		3,473
2002	672	69	2,855	16		3,612
2003	675	69	2,998	16		3,758
2004	678	70	3,148	16		3,911
2005	681	70	3,305	16		4,072
2006	684	71	3,470	16		4,241
2007	686	71	3,644	16		4,416
2008	689	71	3,826	16		4,602
2009	692	72	4,017	16		4,797
2010	695	72	4,218	16		5,001
2011	698	73	4,429	16		5,215

12. ANNUAL DISBURSEMENT SCHEDULE

The annual disbursement schedule is prepared on the basis of the construction schedule and the cost estimates as shown in the Chapter 9, and 10, respectively.

Table 12-1 shows an annual disbursement by item.

Figure 12-1 Annual Disbursement Schedule

(Unit : Baht 1000)

Year	CONSTRUCTION COST					Sub-Total	Engineering Cost		Sub-Total	Direct Operation Cost	Land Cost	Grand Total
	Intake	WTP	Trans. Pipe	Distrib. Pipe	Contin-gency		Design	Super-vision				
Total	7,168	16,661	3,540	16,003	4,337	47,709	3,617	1,908	5,725	91,324	100	144,858
1990	0	0	0	0	0	0	0	0	0	2,696	100	2,796
1991	0	0	0	0	0	0	0	0	0	2,786	0	2,786
1992	0	0	0	8,002	800	8,802	3,617	0	3,817	2,877	0	15,495
1993	7,168	16,661	3,540	8,002	3,537	38,908	0	1,908	1,908	2,973	0	43,789
1994	0	0	0	0	0	0	0	0	0	3,073	0	3,073
1995	0	0	0	0	0	0	0	0	0	3,189	0	3,189
1996	0	0	0	0	0	0	0	0	0	3,308	0	3,308
1997	0	0	0	0	0	0	0	0	0	3,431	0	3,431
1998	0	0	0	0	0	0	0	0	0	3,560	0	3,560
1999	0	0	0	0	0	0	0	0	0	3,775	0	3,775
2000	0	0	0	0	0	0	0	0	0	3,972	0	3,972
2001	0	0	0	0	0	0	0	0	0	4,121	0	4,121
2002	0	0	0	0	0	0	0	0	0	4,282	0	4,282
2003	0	0	0	0	0	0	0	0	0	4,450	0	4,450
2004	0	0	0	0	0	0	0	0	0	4,627	0	4,627
2005	0	0	0	0	0	0	0	0	0	4,810	0	4,810
2006	0	0	0	0	0	0	0	0	0	5,002	0	5,002
2007	0	0	0	0	0	0	0	0	0	5,205	0	5,205
2008	0	0	0	0	0	0	0	0	0	5,417	0	5,417
2009	0	0	0	0	0	0	0	0	0	5,637	0	5,637
2010	0	0	0	0	0	0	0	0	0	5,945	0	5,945
2011	0	0	0	0	0	0	0	0	0	6,188	0	6,188

Note: 1. Contingency = 10 % of the total of gross construction cost

2. Engineering Cost (Design) = 8 % of the total construction cost

3. Engineering Cost (Supervision) = 4 % of the total construction cost

13. FINANCIAL STUDY

The financial plan for the proposed water supply system is studied to enable the waterworks to take necessary steps for the viable implementation of the project with due consideration on the existing financial practices, potential finding sources to meet the estimated capital costs for the construction and recurrent costs for the operation.

13.1 Funding Arrangements

The funds are required largely in two categories for the construction capital and recurrent costs for yearly operating and maintenance of the systems, including debt service, depreciation and other miscellaneous expenses.

1) Cost Estimates

The required costs break down and the implementation-disbursement schedule into annual disbursement for the construction stage are presented in Table 13-1-1.

2) Funds for Construction Costs

Out of the total capital costs, the foreign currency portion is financed by the international lending agency which the local currency portion is financed by the government subsidies, PWA's own equity or loan.

Such international loans are normally provided to finance the foreign currency portion of the project costs; however, in certain cases, a part of local currency portion is also financed by international loan when such is desirable.

If the funding capability of the executing agency is not sufficient, the subsidy from the central government to the possible extent may be desirable and more soft loans with low interest and longer period of repayment should be sought.

Table 13-1-1 Implementation/Disbursement Schedule

(Unit : Baht x 1000)

Year	Construction Cost			Engineering Cost						Land Cost	Sub-Total			Contingency			Grand Total		
				Design			Supervision												
	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total
Total	17,207	26,166	43,373	1,514	2,303	3,817	757	1,151	1,908	100	19,478	29,720	49,198	1,721	2,616	4,337	21,199	32,336	53,535
1990	0	0	0	0	0	0	0	0	0	100	0	100	100	0	0	0	0	100	100
1991	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1992	2,401	5,601	8,002	1,514	2,303	3,817	0	0	0	0	3,915	7,904	11,819	240	560	800	4,155	8,464	12,619
1993	14,806	20,565	35,371	0	0	0	757	1,151	1,908	0	15,563	21,716	37,279	1,481	2,056	3,537	17,044	23,772	40,816
1994	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1996	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1997	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1998	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2006	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2009	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2011	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

a. Loan from International Lending Agencies

The international loans are broadly grouped in two categories such as multilateral and bilateral loans. The multilateral loans are regarded as loans from the World Bank and Asian Development Bank. The interest of such loans are presently ranging from 6-8 percent per annum and repayment period is normally 20 years with a grace period of 5 years. The bilateral loans are exemplified by the loan from West Germany, U.S.A. or Japan with very concessionaire terms, for example, low interest rates of 2-3 percent per annum and long maturity periods (up to 30 years) including an extended grace period up to 10 years.

b. Government Subsidy

The subsidy from the central government is allocated to the local municipalities in Thailand for the construction project to develop public utilities such as irrigation and drainage system, sewerage system, feeder roads and other infrastructure development projects.

The water supply development project as proposed to enhance community benefits such as public health and economic development is necessary to be encouraged by the government initiative with allocation of meaningful amount of subsidy.

c. Loan from Domestic Banks

The local currency portion of the capital costs are normally financed by domestic banks, wholly or partly depending on availability of other sources of capital as subsidy. PWA presently borrows the fund from the Krung Thai Bank. In amortization period, PWA pays only interest part and capital repayments are in charge of the national government.

Table 13-1-2 shows loan conditions of international lending agencies.

Table 13-1-2 Loan Conditions

Agency	Interest Rate	Duration (Grace Period) Year	Charge
IBRD	7.74%	15-20 (3-5)	Front-end Fee: ——— Commitment Charge: 0.75%
IDA	0%	40 (10) or 35 (10)	Service Charge: 0.75% Commitment charge: ———
IDB	8.1%	15-25 (4-6)	Commitment Charge: 0.75% Inspection Fee 1% of loan amount
ADB	6.37%	10-30 (2-7)	Commitment Charge: 0.75%
OECF *	2.74%	28.8 (9.6)	———

* Average condition of 1988.

3) Funds for Recurrent Costs

The funds are normally required after the construction of the system to meet the annual costs including operation and maintenance costs, and debt service payment if any loan is provided. There are established practices in the developed counties that such recurrent costs are met by the users of the system who receive the benefits through the collection of water tariff.

13.2 Financing Plan

The financial plans are developed based on the capital disbursement schedule and funding arrangements. The funding arrangements are considered among others one of the most decisive factor for the financial viability of the project. The funding arrangement which will not impose unbearable burden upon the water works is most desirable subject, however, to the availability of sufficient fund or the loan of lenient condition.

In this study, the following funding plan is assumed as a recommendable funding arrangement.

Financing Plan : The total of foreign currency portion and a part of local currency portion equivalent to 8,348 thousand Baht (approximately 60 percent of the total project cost) is financed by bilateral loan and 21,372 thousand Baht is financed by equal contribution of local loan and PWA's own equity allocation.

In the financing plan, the conditions of the loan are assumed as follows.

IBRD or ADB : 20 year repayment period including 5 year grace period with 7 percent interest per annum.

Bilateral Loan : 30 year repayment period including 10 year grace period with 2.7 percent interest per annum.

Local Loan : 13 year repayment period including 3 year grace period with 11 percent interest per annum and in amortization period, PWA pays only interest part and principal repayments are depended on national government contribution.

Table 13-1-3 to 13-1-5 show the detail debt service for recommended financing plan and Table 13-1-6 shows summarized project cost and funding allocation of financing plan.

Table 13-1-3 Debt Services
for Foreign Portion

(Unit : Baht x 1000)

Year	Capital	Interest	Total Annual Repayment	Balance of Capital
1990	0	0	0	0
1991	0	0	0	0
1992	0	151	151	5,593
1993	0	751	751	27,826
1994	0	751	751	27,826
1995	0	751	751	27,826
1996	0	751	751	27,826
1997	0	751	751	27,826
1998	0	751	751	27,826
1999	0	751	751	27,826
2000	0	751	751	27,826
2001	0	751	751	27,826
2002	1,068	751	1,819	27,826
2003	1,096	722	1,819	26,758
2004	1,126	693	1,819	25,662
2005	1,156	662	1,819	24,536
2006	1,188	631	1,819	23,380
2007	1,220	599	1,819	22,192
2008	1,253	566	1,819	20,972
2009	1,286	532	1,819	19,720
2010	1,321	498	1,819	18,433
2011	1,357	462	1,819	17,112
2012	1,393	425	1,819	15,755
2013	1,431	388	1,819	14,362
2014	1,470	349	1,819	12,931
2015	1,509	309	1,819	11,461
2016	1,550	269	1,819	9,952
2017	1,592	227	1,819	8,402
2018	1,635	184	1,819	6,810
2019	1,679	140	1,819	5,175
2020	1,724	94	1,819	3,496
2021	1,771	48	1,819	1,771
Total	27,826	15,464	43,290	

Table 13-1-4 Debt Services
for Local Portion

(Unit : Baht x 1000)

Year	Capital	Interest	Total Annual Repayment	Balance of Capital
1990	0	6	6	50
1991	0	6	6	50
1992	0	348	348	3,163
1993	189	1,175	1,365	10,686
1994	210	1,155	1,365	10,497
1995	233	1,132	1,365	10,287
1996	709	1,106	1,814	10,054
1997	787	1,028	1,814	9,345
1998	873	941	1,814	8,559
1999	969	845	1,814	7,686
2000	1,076	739	1,814	6,717
2001	1,194	621	1,814	5,641
2002	1,325	489	1,814	4,447
2003	934	343	1,277	3,122
2004	1,037	241	1,277	2,188
2005	1,151	127	1,277	1,151
2006	0	0	0	0
2007	0	0	0	0
2008	0	0	0	0
2009	0	0	0	0
2010	0	0	0	0
2011	0	0	0	0
2012	0	0	0	0
2013	0	0	0	0
Total	10,686	10,301	20,987	

Table 13-1-5 Debt Services

(Unit : Baht x 1000)

Year	Capital	Interest	Total Annual Repayment	Balance of Capital
1990	0	6	6	50
1991	0	6	6	50
1992	0	499	499	8,756
1993	189	1,927	2,116	38,512
1994	210	1,906	2,116	38,323
1995	233	1,883	2,116	38,113
1996	709	1,857	2,566	37,880
1997	787	1,779	2,566	37,171
1998	873	1,693	2,566	36,385
1999	969	1,597	2,566	35,512
2000	1,076	1,490	2,566	34,543
2001	1,194	1,372	2,566	33,467
2002	2,393	1,240	3,633	32,273
2003	2,030	1,066	3,096	29,880
2004	2,163	934	3,096	27,850
2005	2,307	789	3,096	25,687
2006	1,188	631	1,819	23,380
2007	1,220	599	1,819	22,192
2008	1,253	566	1,819	20,972
2009	1,286	532	1,819	19,720
2010	1,321	498	1,819	18,433
2011	1,357	462	1,819	17,112
2012	1,393	425	1,819	15,755
2013	1,431	388	1,819	14,362
2014	1,470	349	1,819	12,931
2015	1,509	309	1,819	11,461
2016	1,550	269	1,819	9,952
2017	1,592	227	1,819	8,402
2018	1,635	184	1,819	6,810
2019	1,679	140	1,819	5,175
2020	1,724	94	1,819	3,496
2021	1,771	48	1,819	1,771
Total	38,512	25,764	64,276	

Table 13-1-6 Project Cost, Disbursement Schedule and Funding Allocation

a. Project Cost and Disbursement Schedule

(Unit : Baht x 1,000)

Year	Foreign Portion	Local Portion	Total
1990	0	100	100
1991	0	0	0
1992	3,915	7,904	11,819
1993	15,563	21,716	37,279
1994	0	0	0
1995	0	0	0
1996	0	0	0
1997	0	0	0
1998	0	0	0
1999	0	0	0
2000	0	0	0
Total	19,478	29,720	49,198

b. Funding allocation

(Unit : Baht x 1,000)

Year	Bilateral Loan	Local Loan	PWA's Equity	Total
1990	0	50	50	100
1991	0	0	0	0
1992	5,593	3,113	3,113	11,819
1993	22,233	7,523	7,523	37,279
1994	0	0	0	0
1995	0	0	0	0
1996	0	0	0	0
1997	0	0	0	0
1998	0	0	0	0
1999	0	0	0	0
2000	0	0	0	0
Total	27,826	10,686	10,686	49,198

13.3 Revenue Plan

1) Water Sales

The revenue is required to be raised by waterworks to meet the annual cash requirement after the construction of the systems. Such annual cash requirements normally include the operation and maintenance costs as well as debt service if a certain loan is made to finance the capital costs.

a. PWA Water Tariff Schedule

Water tariffs are collected by reading water meters with the exception of negligible direct sale fees. PWA has three major sources of tariff revenue: namely, water sales, service charges and connection fees. Revenue from these tariffs contribute 95 percent to the total revenue of PWA. All the waterworks have the same income structure as this. PWA also applies the same water tariff structure to all waterworks. Table 13-1-7 shows the current levels of water tariff structure.

Table 13-1-7 Present Water Tariff Structure

Consumption (cu m / mo)	Tariff (Baht / cu m)
0 - 10	3.75
11 - 20	4.50
21 - 30	6.50
31 - 50	7.50
51 - 80	8.00
81 - 100	8.50
101 - 300	9.00
300 - 1,000	9.25
1,100 - 2,000	9.50
2,001 - 3,000	9.75
3,001 and above	10.00

Connection Fees and Service Charges:

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

Present Connection Fees:

The minimum connection fee is set at 2,050 Baht for 1/2" diameter pipe with a length of 10 meters. The additional fee can be added substantially to the total cost of a connection - for example a new 1/2" connection with a length of 30 meters from the main pipe which 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 charges for the labor and material costs.

Present connection charge and estimated connection fees are shown in Tables 13-1-8 and 13-1-9, respectively.

Table 13-1-8 Present Connection Charge

Size of Connection	Basis Connection Fee (for connection less than 10 meters from main pipe) (Baht / conn.)
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

Note: Basic connection fee is applied to the connection less than 10 m from the main pipe

Table 13-1-9 Connection Fee

Size of Conn. (inch)	0.5	0.75	1	1.5	2	2.5	3	4	6	
Conn. charge (Bath/conn.)	2,050	2,750	3,750	6,690	9,575	13,075	15,495	21,455	30,025	Conn. Charge
Year	No. of Conn.									(Bath x 1000)
1990	0	0	0	0	0	0	0	0	0	0
1991	53	10	1	0	0	0	0	0	0	140
1992	88	1	0	0	0	0	0	0	0	183
1993	88	1	0	0	0	0	0	0	0	183
1994	88	1	0	0	0	0	0	0	0	183
1995	88	1	0	0	0	0	0	0	0	183
1996	88	1	1	0	0	0	1	0	0	202
1997	109	0	0	0	0	0	0	0	0	223
1998	109	0	0	0	0	0	0	0	0	223
1999	109	0	0	0	0	0	0	0	0	223
2000	109	0	0	0	0	0	0	0	0	223
2001	110	1	1	0	0	0	0	0	0	232
2002	116	0	0	0	0	0	0	0	0	238
2003	116	0	0	0	0	0	0	0	0	238
2004	116	0	0	0	0	0	0	0	0	238
2005	116	0	0	0	0	0	0	0	0	238
2006	116	3	1	0	0	0	0	0	0	250
2007	134	2	0	0	0	0	0	0	0	280
2008	134	2	0	0	0	0	0	0	0	280
2009	134	2	0	0	0	0	0	0	0	280
2010	134	2	0	0	0	0	0	0	0	280
2011	136	0	1	0	0	0	0	0	0	283

Note : 0.5 inch ; Domestic & Others
0.75 inch ; Commercial & Industrial
1 inch ; Government & School
3 inch ; Hospital

Service charges are levied on consumers according to the size of their connection,and increase rapidly for larger connections. The service charge is levied monthly and is fixed, regardless of the level of water consumption during a given month. Present service charges are shown in Table 13-1-10 below.

Table 13-1-10 Present Service Charge

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

Service charges are estimated by multiplying the number of connections by the service charge per connection as shown in Table 13-1-11.

Table 13-1-11 Service Charge

Size of Conn. (inch)	0.5	0.75	1	1.5	2	2.5	3	4 & above	
Conn. charge (Bath/month.)	10	15	30	60	100	120	160	200	Total Service Charge
Year	No. of Conn.								(Bath x 1000)
1990	1,277	59	17	0	0	0	2	0	174
1991	1,330	69	18	0	0	0	2	0	182
1992	1,418	70	18	0	0	0	2	0	193
1993	1,506	71	18	0	0	0	2	0	204
1994	1,594	72	18	0	0	0	2	0	215
1995	1,682	73	18	0	0	0	2	0	225
1996	1,770	74	19	0	0	0	3	0	238
1997	1,879	74	19	0	0	0	3	0	251
1998	1,988	74	19	0	0	0	3	0	264
1999	2,097	74	19	0	0	0	3	0	278
2000	2,206	74	19	0	0	0	3	0	291
2001	2,316	75	20	0	0	0	3	0	304
2002	2,432	75	20	0	0	0	3	0	318
2003	2,548	75	20	0	0	0	3	0	332
2004	2,664	75	20	0	0	0	3	0	346
2005	2,780	75	20	0	0	0	3	0	360
2006	2,896	78	21	0	0	0	3	0	375
2007	3,030	80	21	0	0	0	3	0	391
2008	3,164	82	21	0	0	0	3	0	408
2009	3,298	84	21	0	0	0	3	0	424
2010	3,432	86	21	0	0	0	3	0	441
2011	3,568	86	22	0	0	0	3	0	457

Note : 0.5 inch ; Domestic & Others
0.75 inch ; Commercial & Industrial
1 inch ; Government & School
3 inch ; Hospital

b. Project Water Sales Revenue

Water Sales of the waterworks are estimated as tabulated in Table 13-1-12 with the following conditions adopted in the forecasting.

i) Water tariffs will remain unchanged until 2020.

ii) Water sales are estimated by use for domestic, commercial, institutional, industrial and other use as predicted in each year.

iii) Water sales are calculated from the monthly average.
water consumption multiplied by water tariff.

In the PWA's water tariff system, water charge is levied on consumers according to metered water consumption after every month. Charging method is to levy a progressive method for the amount metered. Prior to the increases, charges were levied on a sliding scale. Thus, for example, a consumer using 25 cu m of water in a month would pay 3.75 Baht per cu m for

Table 13 - 12 Water Sales

(1)Domestic

Item/Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Water Sales (cu.m/d)	601	623	644	667	690	713	787	824	862	901	943	986
(cu.m/month)	18,030	18,690	19,320	20,010	20,700	21,390	23,610	24,720	25,860	27,030	28,290	29,580
No.of Connections	1,276	1,329	1,417	1,505	1,593	1,681	1,769	1,878	1,987	2,096	2,205	2,315
Water Cons./Conn.	14.13	14.06	13.63	13.30	12.98	12.72	13.35	13.16	13.01	12.90	12.83	12.78
Water Sales(*1,000Baht)	72	74	76	79	81	84	93	97	100	106	111	116

(2)Governmental/Institutional

Item/Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Water Sales (cu.m/d)	586	589	591	593	596	598	600	603	606	608	611	613
(cu.m/month)	17,580	17,670	17,730	17,790	17,880	17,940	18,000	18,090	18,180	18,240	18,330	18,390
No.of Connections	27	29	29	29	29	29	30	30	30	30	30	32
Water Cons./Conn.												
Water Sales(*1,000Baht)	161	161	161	163	163	164	162	163	164	164	166	166

(3)Commercial

Item/Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Water Sales (cu.m/d)	136	138	139	140	142	143	145	146	148	149	151	152
(cu.m/month)	4,080	4,140	4,170	4,200	4,260	4,290	4,350	4,380	4,440	4,470	4,530	4,560
No.of Connections	51	60	61	62	63	64	63	63	63	63	63	63
Water Cons./Conn.	80.00	69.00	68.36	67.74	67.62	67.03	69.05	69.52	70.48	70.95	71.90	72.38
Water Sales(*1,000Baht)	27	27	27	27	27	27	28	28	29	29	30	30

(4)Industrial

Item/Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Water Sales (cu.m/d)	29	30	30	31	31	32	34	35	36	37	38	39
(cu.m/month)	870	900	900	930	930	960	1,020	1,050	1,080	1,110	1,140	1,170
No.of Connections	8	9	9	9	9	9	11	11	11	11	11	12
Water Cons./Conn.	108.75	100.00	100.00	103.33	103.33	106.67	92.73	95.45	98.18	100.91	103.64	97.50
Water Sales(*1,000Baht)	6	6	6	7	7	7	7	7	8	8	8	8

(5)Others

Item/Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Water Sales (cu.m/d)	6	6	6	6	6	7	7	7	7	8	8	8
(cu.m/month)	180	180	180	180	180	210	210	210	210	240	240	240
No.of Connections	6	7	7	7	7	7	8	8	8	8	8	10
Water Cons./Conn.	30.00	25.71	25.71	25.71	25.71	30.00	26.25	26.25	26.25	30.00	30.00	24.00
Water Sales(*1,000Baht)	1	1	1	1	1	1	1	1	1	1	1	1

Total	267	269	271	277	279	283	291	296	302	308	316	321

Table 13 - 12 Water Sales (Cont'd)

(1)Domestic

Item/Year	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Water Sales (cu.m/d)	1,028	1,071	1,116	1,163	1,212	1,261	1,312	1,365	1,419	1,476
(cu.m/month)	30,840	32,130	33,480	34,890	36,360	37,830	39,360	40,950	42,570	44,280
No.of Connections	2,431	2,547	2,663	2,779	2,895	3,029	3,163	3,297	3,431	3,567
Water Cons./Conn.	12.69	12.61	12.57	12.55	12.56	12.49	12.44	12.42	12.41	12.41
Water Sales(*1,000Baht)	121	125	131	136	142	148	153	160	166	172

(2)Governmental/Institu

Item/Year	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Water Sales (cu.m/d)	616	619	621	624	628	630	633	636	640	643
(cu.m/month)	18,480	18,570	18,630	18,720	18,840	18,900	18,990	19,080	19,200	19,290
No.of Connections	32	32	32	32	33	33	33	33	33	35
Water Cons./Conn.										
Water Sales(*1,000Baht)	166	167	167	169	169	169	171	171	173	173

(3)Commercial

Item/Year	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Water Sales (cu.m/d)	154	156	157	159	161	162	164	166	168	170
(cu.m/month)	4,620	4,680	4,710	4,770	4,830	4,860	4,920	4,980	5,040	5,100
No.of Connections	63	63	63	63	64	65	66	67	68	68
Water Cons./Conn.	73.33	74.29	74.76	75.71	75.47	74.77	74.55	74.33	74.12	75.00
Water Sales(*1,000Baht)	30	31	31	32	32	32	32	33	33	34

(4)Industrial

Item/Year	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Water Sales (cu.m/d)	40	41	43	44	45	46	48	49	50	52
(cu.m/month)	1,200	1,230	1,290	1,320	1,350	1,380	1,440	1,470	1,500	1,560
No.of Connections	12	12	12	12	14	15	16	17	18	17
Water Cons./Conn.	100.00	102.50	107.50	110.00	96.43	92.00	90.00	86.47	83.33	91.76
Water Sales(*1,000Baht)	8	9	9	10	9	10	10	10	10	11

(5)Others

Item/Year	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Water Sales (cu.m/d)	8	8	9	9	9	9	10	10	10	11
(cu.m/month)	240	240	270	270	270	270	300	300	300	330
No.of Connections	10	10	10	10	12	12	12	12	12	14
Water Cons./Conn.	24.00	24.00	27.00	27.00	22.50	22.50	25.00	25.00	25.00	23.57
Water Sales(*1,000Baht)	1	1	1	1	1	1	1	1	1	1

Total	326	333	339	348	353	360	367	375	383	391

the first 10 cu m, 4.50 Baht per cu m for the next 10 cu m and 6.50 Baht per cu m only for the last 5 cu m above 20 cu m, so that a total payment will be 115 Baht.

13.4 Cash Flow Statement

1) Cash Flow

Table 13-1-13 shows the projected cash flow from 1990 to 2020. Estimate condition of each items to be counted in cash flow are as follows.

a. Cash Inflow

- Government contribution

  capital contribution for interest payment of domestic loan.

- Loan

  Local and foreign loan disbursement is estimated based on the recommended financing plan.

- Water sales, connection charge and service charge.

  Detailed estimation is shown in Table 13-1-9, 13-1-11 and 13-1-12.

- Other income

  This income is including sales of materials, fine penalties and other, and estimated 2 percent of total water sales of each year.

b. Cash Outflow

- Project expenditure

  It is according to capital disbursement schedule for Implementation plan.

- Amortization

  Recommended financing plan is adopted in the debt service calculation.

- Operation & maintenance

  Details are shown in chapter 11.

- Connnection expenses

  50 percent of Connection Fee.

- Share of Head Office

Table 13-1-13 Projected Cash Flow at 1989 Price

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Cash Inflow																
Government contribution																
Capital contribution	0	0	0	189	210	233	709	787	873	969	1,076	1,194	1,325	934	1,037	1,151
Laon	50	0	8,706	29,756												
Local loan	0	0	5,593	22,233												
Foreign loan	50	0	3,113	7,523												
Operating Revenue	3,442	3,615	3,693	3,777	3,813	3,872	4,002	4,097	4,183	4,271	4,382	4,465	4,546	4,646	4,733	4,858
Water Sales	3,204	3,228	3,252	3,324	3,348	3,396	3,492	3,552	3,624	3,696	3,792	3,852	3,912	3,996	4,068	4,176
Connection Fee	0	140	183	183	183	183	202	223	223	223	223	232	238	238	238	238
Service Charge	174	182	193	204	215	225	238	251	264	278	291	304	318	332	346	360
Ohter Income	64	65	65	66	67	68	70	71	72	74	76	77	78	80	81	84
Total Inflow	3,492	3,615	12,399	33,722	4,023	4,105	4,711	4,884	5,056	5,240	5,458	5,659	5,871	5,580	5,770	6,009
Cash Outflow																
Project expenditures																
Local portion	100	0	7,904	21,716												
Foreign portion	0	0	3,915	15,563												
Amortization																
Principal	0	0	0	189	210	233	709	787	873	969	1,076	1,194	2,393	2,030	2,163	2,307
Interest	6	6	499	1,927	1,906	1,883	1,857	1,779	1,693	1,597	1,490	1,372	1,240	1,066	934	789
Operating Expenses	3,669	3,822	3,930	4,033	4,333	4,453	4,600	4,731	4,860	4,994	5,140	5,289	5,445	5,611	5,781	5,967
O & M Cost	2,121	2,198	2,278	2,365	2,659	2,768	2,883	2,989	3,101	3,218	3,342	3,473	3,612	3,758	3,911	4,072
Connection Expenses	0	70	92	92	92	92	101	112	112	112	112	116	119	119	119	119
Share of Head Office	1,548	1,554	1,560	1,576	1,582	1,593	1,616	1,630	1,647	1,664	1,686	1,700	1,714	1,734	1,751	1,776
Total Outflow	3,775	3,828	16,248	43,428	6,449	6,569	7,166	7,297	7,426	7,560	7,706	7,855	9,078	8,707	8,878	9,063
Net Cash flow	-283	-213	-3,848	-9,705	-2,426	-2,464	-2,455	-2,412	-2,369	-2,320	-2,248	-2,196	-3,207	-3,127	-3,108	-3,054
Accumulated	-283	-496	-4,345	-14,050	-16,475	-18,939	-21,394	-23,807	-26,176	-28,495	-30,743	-32,939	-36,146	-39,273	-42,380	-45,435

Table 13-1-13 Projected Cash Flow at 1989 Price (Cont'd)

(Unit: Baht x 1000)

Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Cash Inflow															
Government contribution															
Capital contribution															
Laon															
Local loan															
Foreign loan															
Operating Revenue	4,946	5,077	5,180	5,294	5,409	5,526	5,526	5,526	5,526	5,526	5,526	5,526	5,526	5,526	5,526
Water Sales	4,236	4,320	4,404	4,500	4,596	4,692	4,692	4,692	4,692	4,692	4,692	4,692	4,692	4,692	4,692
Connection Fee	250	280	280	280	280	283	283	283	283	283	283	283	283	283	283
Service Charge	375	391	408	424	441	457	457	457	457	457	457	457	457	457	457
Ohter Income	85	86	88	90	92	94	94	94	94	94	94	94	94	94	94
Total Inflow	4,946	5,077	5,180	5,294	5,409	5,526	5,526	5,526	5,526	5,526	5,526	5,526	5,526	5,526	5,526
Cash Outflow															
Project expenditures															
Local portion															
Foreign portion															
Amortization															
Principal	1,188	1,220	1,253	1,286	1,321	1,357	1,393	1,431	1,470	1,509	1,550	1,592	1,635	1,679	1,724
Interest	631	599	566	532	498	462	425	388	349	309	269	227	184	140	94
Operating Expenses	6,156	6,366	6,572	6,789	7,016	7,254	7,254	7,254	7,254	7,254	7,254	7,254	7,254	7,254	7,254
O & M Cost	4,241	4,416	4,602	4,797	5,001	5,215	5,215	5,215	5,215	5,215	5,215	5,215	5,215	5,215	5,215
Connection Expenses	125	140	140	140	140	142	142	142	142	142	142	142	142	142	142
Share of Head Office	1,790	1,810	1,830	1,852	1,875	1,897	1,897	1,897	1,897	1,897	1,897	1,897	1,897	1,897	1,897
Total Outflow	7,975	8,185	8,391	8,607	8,835	9,073	9,072	9,073	9,073	9,072	9,073	9,073	9,073	9,073	9,072
Net Cash flow	-3,029	-3,108	-3,211	-3,313	-3,426	-3,547	-3,546	-3,547	-3,547	-3,546	-3,547	-3,547	-3,547	-3,547	-3,546
Accumulated	-48,464	-51,572	-54,783	-58,096	-61,522	-65,068	-68,614	-72,161	-75,707	-79,253	-82,800	-86,346	-89,893	-93,440	-96,985

As clearly shown in this table, net annual revenue surpluses are forecasted not enough cover throughout construction period and operation and expenditures in the maintenance period, amortization cost and operating expenses.

The result of this cash flow statement reveals that the annual net cash flow will not continuously raise profit surpluses and the cumulative deficits will be 65,068 thousand Baht in 2011.

These deficits shall be covered with PWA'S own fund or water tariff rate shall be increased to achieve a financial self-standing of waterworks management.

2) Share of Head and Regional Office Overhead Expenses

PWA is administratively, technically, economically and financially independent from the central government. Therefore, in order that total financial independence can be achieved by PWA in the future, administrative expenses and consignment fee shall be charged to the revenue of each waterworks.

In view of the above, it is recommended that share allocation of administrative expenses shall be calculated based on number of waterworks and gross revenue of waterworks.

3) Unit cost of water

As shown in Table 13-1-14, the unit cost after debt service which will register 8.46 Baht per cu m in 2011 or equal to 77 percent of the average unit water cost from year 1990 to 2011 and almost sixth level of present water tariff structure of PWA. And average unit water cost from 1990 to 2020 is projected to stand at 10.44 Baht or maximum level of present water tariff.

4) Average Water Rate

In view of revenue aspect, average water tariff is calculated based on water sales and it is shown in Table 13-1-15.

Table 13-1-14 Unit Cost of Water

(Unit :Baht x 1000)

year	Water Consum. (cu.m/day)	Capital Investement	Operating Expenses	Total Expenses	Unit Water Cost (Baht/cu.m)
1990	1,359	100	3,669	3,769	7.60
1991	1,384	0	3,822	3,822	7.57
1992	1,411	11,819	3,930	15,749	30.58
1993	1,437	37,279	4,033	41,312	78.76
1994	1,465	0	4,333	4,333	8.10
1995	1,492	0	4,453	4,453	8.18
1996	1,573	0	4,600	4,600	8.01
1997	1,615	0	4,731	4,731	8.03
1998	1,658	0	4,860	4,860	8.03
1999	1,703	0	4,994	4,994	8.03
2000	1,750	0	5,140	5,140	8.05
2001	1,798	0	5,289	5,289	8.06
2002	1,864	0	5,455	5,455	8.02
2003	1,895	0	5,611	5,611	8.11
2004	1,946	0	5,781	5,781	8.14
2005	1,999	0	5,967	5,967	8.18
2006	2,054	0	6,156	6,156	8.21
2007	2,109	0	6,366	6,366	8.27
2008	2,167	0	6,572	6,572	8.31
2009	2,226	0	6,789	6,789	8.36
2010	2,287	0	7,016	7,016	8.40
2011	2,350	0	7,614	7,254	8.46
2012	2,350	0	7,614	7,254	8.46
2013	2,350	0	7,614	7,254	8.46
2014	2,350	0	7,614	7,254	8.46
2015	2,350	0	7,614	7,254	8.46
2016	2,350	0	7,614	7,254	8.46
2017	2,350	0	7,614	7,254	8.46
2018	2,350	0	7,614	7,254	8.46
2019	2,350	0	7,614	7,254	8.46
2020	2,350	0	7,614	7,254	8.46
Average Unit Water Cost (1990-2020) :					10.44

Table 13-1-15 Average Water Tariff

Year	Water Consumption (cu.m/d)	Water Sales (1000 Baht /year)	Average Water Tariff (Baht/cu.m)
1990	1,359	3,204	6.46
1991	1,384	3,228	6.39
1992	1,411	3,252	6.31
1993	1,437	3,324	6.34
1994	1,465	3,348	6.26
1995	1,492	3,396	6.24
1996	1,573	3,492	6.08
1997	1,615	3,552	6.03
1998	1,658	3,624	5.99
1999	1,703	3,696	5.95
2000	1,750	3,792	5.94
2001	1,798	3,852	5.87
2002	1,846	3,912	5.81
2003	1,895	3,996	5.78
2004	1,946	4,068	5.73
2005	1,999	4,176	5.72
2006	2,054	4,236	5.65
2007	2,109	4,320	5.61
2008	2,167	4,404	5.57
2009	2,226	4,500	5.54
2010	2,287	4,596	5.51
2011	2,350	4,692	5.47
2012	2,350	4,692	5.47
2013	2,350	4,692	5.47
2014	2,350	4,692	5.47
2015	2,350	4,692	5.47
2016	2,350	4,692	5.47
2017	2,350	4,692	5.47
2018	2,350	4,692	5.47
2019	2,350	4,692	5.47
2020	2,350	4,692	5.47

APPENDICES

APPENDIX A-1-1

Meteorological Data

1 Meteorological Data

Table A1-1-1: Monthly Rainfall at Takua Pa

Code; RM 3705
Station; Amphur Takua Pa, Phang Nga

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1956	28.2	0.6	112.9	255.5	643.1	832.3	407.1	1044.9	810.0	687.6	145.9	36.6	5004.7
1957	0.0	0.0	139.9	142.5	617.6	588.6	760.3	944.3	710.3	444.1	117.4	8.7	4473.7
1958	0.0	0.0	35.7	87.4	540.5	656.3	607.7	544.8	841.1	776.0	140.1	0.0	4229.6
1959	0.0	9.6	220.0	264.0	320.3	492.4	869.7	781.4	729.5	483.2	210.4	60.0	4440.5
1960	72.0	80.7	0.0	266.3	1068.2	379.6	780.7	657.1	978.3	289.8	392.4	95.1	5060.2
1961	54.6	99.2	101.5	288.7	688.1	648.1	429.5	548.0	873.8	442.8	190.1	79.1	4443.5
1962	104.4	0.0	170.2	231.9	485.9	406.6	546.3	449.0	707.6	567.4	31.4	10.4	3711.1
1963	62.9	7.4	58.9	8.4	350.9	506.6	280.2	714.8	1074.7	660.7	304.4	85.8	4118.7
1964	79.4	48.9	0.0	151.1	1092.3	487.0	222.4	708.5	679.7	378.0	348.2	81.9	4277.4
1965	11.3	70.3	113.8	134.6	444.3	565.7	743.7	829.3	858.3	193.3	114.4	113.4	4192.4
1966	8.0	51.0	16.7	324.8	716.7	467.1	656.3	438.5	244.4	424.0	86.2	126.7	3560.4
1967	9.1	17.9	91.0	206.5	326.9	604.7	646.9	809.7	615.4	581.2	83.1	6.8	3999.2
1968	1.3	0.0	4.8	426.4	424.5	674.8	732.2	860.5	779.3	245.2	56.1	56.6	4261.7
1969	62.5	13.7	62.2	66.8	132.6	880.3	231.9	282.3	1362.8	785.3	155.1	10.2	4045.7
1970	0.0	0.0	246.7	307.6	553.5	840.7	579.6	387.5	870.2	321.5	213.9	126.9	4448.1
1971	12.9	152.7	223.3	220.5	730.1	1003.5	550.2	763.5	670.6	856.1	143.2	70.4	5397.0
1972	2.3	60.2	163.1	402.5	356.3	689.4	440.7	553.1	749.1	294.7	203.2	39.5	3954.1
1973	0.0	0.0	228.3	143.0	248.7	1044.4	1030.7	491.1	867.8	577.5	181.1	75.3	4887.9
1974	16.8	51.7	145.2	473.9	461.2	412.2	621.2	-	696.9	927.5	547.1	-	-
1975	110.8	37.0	160.0	145.5	356.7	1165.7	359.9	437.4	638.0	429.3	250.5	112.3	4203.1
1976	8.0	3.5	139.6	209.6	863.0	475.8	657.8	537.2	733.9	317.6	203.0	4.3	4153.3
1977	46.2	53.6	0.0	62.7	695.4	513.7	461.3	820.0	669.0	774.8	161.7	10.6	4269.0
1978	37.3	0.0	90.8	278.8	551.6	1069.9	727.5	686.7	506.1	206.2	122.7	0.0	4277.6
1979	0.0	0.0	0.0	67.6	375.3	323.4	624.3	153.0	532.7	151.8	75.0	0.0	2303.1
1980	0.0	108.0	48.0	113.7	321.2	471.4	593.2	644.9	467.0	261.1	363.5	47.5	3439.5
1981	0.0	0.0	0.0	193.2	480.3	521.0	467.8	160.3	405.4	157.3	483.4	39.3	2908.0
1982	0.0	0.0	0.0	371.5	234.9	180.0	973.9	708.7	377.2	218.0	122.8	24.7	3231.7
1983	0.0	0.0	10.4	155.0	617.1	577.6	699.2	762.8	872.8	552.1	317.4	51.9	4616.3
1984	59.3	24.0	50.6	372.5	572.8	782.6	451.0	564.6	556.4	404.6	164.5	95.6	4074.5
1985	21.7	57.1	146.3	253.2	360.1	510.9	259.3	515.8	793.1	1049.1	157.6	77.9	4202.1
1986	7.0	28.2	23.6	159.4	756.1	444.4	672.0	447.7	1216.8	536.9	470.2	8.5	4770.8
1987	10.6	0.0	76.5	133.2	322.3	289.6	104.0	700.1	101.5	480.1	311.4	63.8	2593.1

Source : Meteorological Department

Table A1-1-2: Monthly Rainfall at Kura Buri

Code; RM
Station; Amphur Kura Buri

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1966													
1967	58.0	0.0	0.0	100.8	360.5	742.7	937.1	1284.0	401.3	452.8	541.7	6.8	4885.7
1968	-	-	-	-	-	-	-	-	-	-	-	-	-
1969	27.9	29.0	100.9	74.7	438.5	977.7	579.7	419.3	1068.7	438.8	98.6	0.0	4253.8
1970	48.5	0.0	59.6	286.1	299.7	504.0	730.0	843.6	523.8	49.5	86.8	10.9	3442.5
1971	0.0	0.0	0.0	0.0	0.0	512.4	809.8	540.9	349.5	887.3	0.0	0.0	3099.9
1972	0.0	90.5	24.5	249.6	127.5	1109.9	458.0	397.0	328.5	161.5	106.5	0.0	3053.5
1973	0.0	0.0	35.0	220.1	239.0	743.2	507.7	339.1	283.7	60.5	0.0	0.0	2428.3
1974	0.0	-	-	419.9	160.3	766.0	933.6	954.6	-	1336.0	1146.3	0.0	5716.7
1975	-	-	45.5	241.6	467.0	1101.0	738.6	753.8	468.3	474.4	63.7	-	4353.9
1976	0.0	0.0	0.0	76.4	121.6	132.9	397.2	392.4	919.0	371.4	284.0	55.1	2750.0
1977	0.0	0.0	0.0	20.9	124.1	170.4	74.7	303.7	211.2	166.5	36.0	0.0	1107.5
1978	0.0	0.0	25.9	130.8	364.2	2067.9	1340.7	1011.3	1026.6	21.5	19.0	2.3	6010.2
1979	0.0	10.8	20.6	49.8	241.8	247.0	903.6	697.2	941.5	492.7	69.0	0.0	3674.0
1980	0.0	0.0	133.2	123.9	531.5	291.1	1490.0	1306.7	1587.1	449.2	332.4	181.1	6426.2
1981	0.0	10.1	0.0	156.1	387.7	780.9	599.7	394.9	457.1	271.3	374.5	19.7	3452.0
1982	0.0	0.0	22.5	491.7	425.9	293.6	1177.0	737.0	440.3	147.0	138.0	21.3	3894.3
1983	0.0	0.0	0.0	35.5	519.0	739.6	721.0	1364.3	900.2	474.1	401.0	0.0	5154.7
1984	14.5	0.0	48.3	371.9	572.2	576.2	480.0	818.0	507.0	353.1	29.6	52.8	3823.6
1985	1.0	14.9	94.4	229.4	483.7	715.0	306.4	616.5	713.0	596.0	99.5	14.2	3884.0
1986	0.9	3.6	0.7	175.1	640.0	340.6	435.3	1060.0	1048.9	468.6	193.2	0.0	4366.9
1987	2.6	0.0	0.0	61.9	177.6	557.4	109.6	646.3	252.5	298.3	266.7	266.7	2639.6

Source : Meteorological Department

Table A1-1-3: Monthly Rainfall at Phanom

Code; RH
Station; Amphur Phanom, Surat Thani

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1956	41.2	28.3	39.8	207.2	220.7	199.0	102.0	224.1	189.6	460.5	137.0	73.0	1922.4
1957	0.0	89.2	106.6	183.7	183.7	70.4	156.0	104.8	225.8	124.1	170.7	102.2	1517.2
1958	7.5	31.7	56.6	110.8	255.8	205.6	148.6	234.1	241.5	282.8	291.2	19.1	1885.3
1959	20.2	12.4	152.3	22.8	88.6	238.1	131.7	172.8	194.2	343.1	310.5	79.0	1765.7
1960	53.3	76.8	79.8	45.6	164.3	48.7	202.3	181.7	182.9	268.3	233.8	22.1	1559.6
1961	6.1	93.7	126.4	195.2	221.4	243.2	37.6	133.6	177.5	181.3	95.0	140.4	1651.4
1962	13.7	38.4	71.0	205.9	313.9	153.2	278.4	200.6	221.5	479.0	69.5	32.4	2077.5
1963	18.8	0.0	66.5	43.0	137.9	9.7	142.1	55.5	261.0	332.1	162.5	37.3	1266.4
1964	66.1	31.6	22.0	244.7	198.7	147.1	185.0	244.9	175.0	131.1	273.6	124.0	1843.8
1965	22.4	61.2	92.8	84.0	216.6	116.2	241.0	214.3	168.0	196.6	236.0	218.8	1867.9
1966	34.5	34.9	130.0	173.0	237.7	122.7	71.2	268.4	90.6	219.7	253.4	170.9	1807.0
1967	95.4	76.1	46.4	301.9	363.6	176.5	326.1	159.7	126.3	241.5	123.0	4.8	2041.3
1968	10.4	0.0	8.2	273.6	142.0	122.0	172.0	208.3	158.0	216.5	89.6	98.3	1498.9
1969	108.3	33.7	360.8	121.7	302.2	68.2	119.5	330.6	256.2	192.5	176.2	58.7	2128.6
1970	172.8	18.6	99.4	136.4	133.6	201.0	127.3	143.7	125.5	135.8	167.7	129.7	1591.5
1971	0.0	129.4	58.2	99.5	180.3	222.4	38.5	81.6	238.6	226.2		58.7	1333.4
1972	6.0	120.5	68.5	125.1	7.5	81.6	103.2	110.8	116.8	181.8	109.4	202.0	1233.2
1973	20.6	0.0	50.7	119.5	166.7	158.7	194.8	218.0	163.9	416.2	235.7	133.9	1878.7
1974	10.2	27.3	68.8	40.2	285.8	87.1	122.9	162.1	138.5	-			942.9
1975	214.2	37.8	43.1	242.8	160.5	238.9	120.1	158.4	135.7	176.2	165.2	80.9	1773.8
1976	0.0	0.0	146.1	102.2	221.8	207.6	233.1	101.0	219.6	176.2	287.6	0.0	1695.2
1977	-	-	-	-	-	-	-	-	-	-	-	-	-
1978	26.8	38.0	93.2	125.3	174.3	110.8	162.4	78.5	111.2	46.7	37.9	20.6	1025.7
1979	32.8	0.0	12.5	187.6	88.5	55.5	128.7	93.1	323.9	161.0	143.5	7.9	1235.0
1980	0.0	9.9	97.8	162.5	178.7	204.3	227.4	188.9	151.3	279.0	196.5	125.0	1821.3
1981	4.1	85.8	70.8	158.4	311.8	224.7	30.0	45.1	168.5	279.9	291.4	83.3	1753.8
1982	0.0	8.3	139.8	128.4	183.9	77.8	200.9	113.4	111.6	-	-	40.4	1004.5
1983	3.1	0.0	28.5	3.4	99.8	53.1	9.1	71.2	68.9	78.3	40.2	18.9	474.5
1984	17.5	16.2	4.9	10.1	56.2	102.0	112.4	167.6	31.8	208.9	32.3	35.7	795.6
1985	0.0	180.2	38.1	119.8	32.7	127.3	17.4	103.1	103.5	135.0	138.5		995.6
1986	----	----	----	M	I	S	S	I	N	G	----	----	----
1987	42.3	13.1	46.6	105.1	328.8	22.5	0.0	0.0	0.0	0.0	0.0	0.0	558.4

Source : Meteorological Department

Table A1-1-4: Monthly Rainfall at Takua Pa

Code; RM 3719
Station; Amphur Takua Pa (MD Station), Phang Nga

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1975	-	-	-	-	-	-	350.1	293.4	664.0	509.0	195.7	55.0	2067.2
1976	30.9	1.6	124.4	150.3	574.6	316.8	539.2	490.9	656.0	375.1	110.5	26.4	3396.7
1977	49.2	51.9	0.5	64.6	547.0	338.0	227.3	549.4	707.7	443.5	75.0	21.6	3075.7
1978	103.2	21.2	96.4	190.5	543.1	899.6	745.2	448.5	638.8	276.4	95.1	15.4	4073.4
1979	18.3	63.4	40.4	453.4	320.1	595.7	722.0	353.8	809.3	268.6	93.1	0.3	3738.4
1980	4.6	13.5	79.2	207.7	438.9	712.7	754.2	779.7	637.9	410.3	344.4	98.4	4481.5
1981	18.0	61.2	24.8	221.8	442.5	501.5	399.4	265.7	388.7	354.6	377.9	107.2	3163.3
1982	0.0	8.5	37.6	221.7	402.3	208.9	670.1	528.4	326.1	383.5	274.7	20.9	3082.7
1983	62.2	0.0	57.0	23.9	527.0	451.2	755.5	696.0	677.3	501.9	409.8	65.7	4227.5
1984	49.5	69.4	116.0	367.6	561.2	632.8	503.0	192.8	456.0	289.9	164.9	35.7	3438.8
1985	52.6	11.7	134.6	200.7	559.5	496.9	265.9	457.4	548.1	647.4	196.7	62.3	3633.8
1986	18.8	8.9	24.2	167.3	560.2	399.4	506.2	825.3	1028.3	715.5	181.4	5.8	4441.3
1987	15.7	77.3	55.8	158.0	461.1	302.0	142.4	712.2	427.1	359.5	281.0	47.4	3039.5

Source : Meteorological Department

Table A1-1-5 Meteorological Data at Takua Pa

Station : Phuket Airport
Latituds : 08 07' N.
Longtitude : 98 19 E.
Elevation of station above MSL 6 meters

Items	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Temperature (C.degree)													
Mean	26.7	27.5	28.2	28.6	28.0	27.9	27.5	27.6	26.9	26.7	26.6	26.5	27.4
Mean Max.	31.4	32.6	33.2	33.0	31.5	30.8	30.5	30.4	29.9	30.1	30.5	30.8	31.2
Mean Min.	21.9	22.3	23.0	23.9	24.4	24.7	24.4	24.7	23.9	23.5	23.0	22.5	23.5
Ext. Max.	34.5	36.2	37.0	36.8	36.0	35.0	34.0	34.5	33.3	33.3	33.0	33.3	37.0
Ext. Min.	13.9	15.8	18.3	21.1	21.4	21.2	21.0	20.7	21.2	21.0	17.9	18.4	13.9
Relative Humidity (%)													
Mean	76.1	74.3	75.9	79.7	83.8	82.8	83.0	82.1	85.2	86.3	84.1	79.4	81.1
Mean Max.	92.5	92.4	93.9	95.4	95.4	92.7	93.0	91.8	94.6	96.3	95.5	92.7	93.9
Mean Min.	56.1	53.3	55.2	61.6	69.9	71.8	72.2	72.1	74.5	73.1	68.1	62.5	65.9
Ext. Min.	33.0	32.0	32.0	29.0	34.0	42.0	51.0	43.0	54.0	52.0	46.0	40.0	29.0
Evaporation (mm.)													
Mean - Pan	151.0	146.0	172.0	151.0	134.0	135.0	128.0	144.0	127.0	127.0	115.0	122.0	1651.0
Sunshine Duration (hr.)													
Mean	289.6	272.0	280.2	250.8	194.0	163.7	170.6	177.1	152.0	181.3	200.2	246.6	2578.1
Wind (knots)													
Prevailing Wind	E	E	E	NW	W	W	W	W	W	W	E	E	-
Mean Wind Speed	4.6	5.2	4.2	3.6	4.3	6.3	6.0	6.8	5.9	3.6	3.0	4.2	-
Max. Wind Speed	30 ENE, E, ESE	30 E,ENE	33 N	37 E	48 WNW	46 W	52 W	52 N	48 WNW	50 WSW	56 WSW	32 ENE	56 WSW
Rainfall (mm.)													
Mean	43.6	26.3	68.0	195.9	458.9	471.4	484.5	505.8	604.3	396.1	258.9	47.7	3561.4
Mean Rainy Days	6.0	4.2	6.3	11.8	21.9	21.0	20.8	19.8	22.8	23.1	16.1	9.3	183.6
Greatest in 24 hr.	65.6	59.0	72.3	156.3	209.4	113.4	151.1	132.0	142.1	197.6	121.5	63.2	209.4
Day / Year	22/66	26/71	23/73	29/83	23/63	23/63	14/66	13/83	24/56	5/71	2/58	16/73	23/64

Source : Meteorological Department
Remark : Sunshine Duration 1957-1985
: Evaporation 1981-1985

APPENDIX A-2-1

Hydrological Data

2 Hydrological Data

Table A2-1-1 : Monthly Flow Records at Huai Chong Lom

River : Huai Chong Lom Location : Phang Nga Station : X-57 Drainage Area : 8 sq m

Year	Streamflow in (MCM)												Annual
	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	
1972	-	-	-	-	-	-	0.535	0.752	0.268	0.107	0.005	-	1.667
1973	0.236	0.054	1.322	4.413	3.321	1.777	2.277	2.074	0.348	0.067	0.031	0.029	15.949
1974	0.104	0.991	2.566	0.402	9.696	2.229	3.669	2.877	0.482	0.911	0.097	0.104	24.128
1975	0.544	1.045	7.672	0.509	4.500	1.555	4.098	1.763	0.295	0.163	0.104	0.083	22.331
1976	0.073	3.000	2.696	4.446	2.786	7.750	0.509	1.115	0.348	0.115	0.093	0.083	23.014
1977	0.052	0.589	0.363	-	-	-	2.116	2.022	0.375	0.214	0.194	0.187	6.112
1978	0.259	0.509	1.840	4.714	9.600	7.206	1.634	0.933	0.536	0.321	0.218	0.241	28.011
1979	0.492	1.634	1.296	11.196	7.687	7.024	8.196	1.452	0.696	0.589	0.460	0.562	41.284
1980	0.544	0.643	1.633	6.535	5.866	7.361	2.143	1.555	-	0.643	0.476	0.562	27.961

Table A2-1-2 : Monthly Flow Records at Khlong Sole

River : Khlong Sole Location : Bang Longthan Phanom Station : X-58 Drainage Area: 312 sq m

Year	Streamflow in (MCM)												Annual
	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	
1972	-	-	-	-	-	119.232	44.725	33.178	14.383	6.850	2.781	2.330	223.479
1973	3.603	7.660	61.949	144.901	103.386	94.349	86.780	52.176	23.490	13.767	9.193	7.660	608.914
1974	11.197	48.747	97.200	60.264	273.197	99.274	152.665	110.678	22.204	20.892	9.072	7.714	913.104
1975	6.273	17.811	188.179	-	129.635	56.765	127.760	56.246	13.312	6.750	4.016	4.607	611.354
1976	6.558	78.852	70.761	122.296	89.057	188.101	29.382	26.931	13.526	7.526	5.738	7.017	645.745
1977	2.600	16.579	18.896	26.730	161.775	-	52.229	36.288	12.910	7.660	5.032	6.160	346.859
1978	4.977	22.124	111.015	149.455	231.521	201.761	105.154	0.989	13.365	7.446	4.306	2.518	854.631
1979	18.377	56.541	59.227	216.067	152.321	130.761	145.625	20.658	12.910	8.812	5.879	6.937	834.115
1980	8.217	21.374	67.288	170.721	173.051	186.313	97.387	69.595	34.364	18.990	11.526	7.901	866.727
1981	10.420	28.364	131.544	65.970	43.578	78.745	50.354	73.120	30.694	17.169	10.040	8.544	548.542
1982	15.993	27.748	41.679	193.970	148.410	138.698	66.103	41.835	26.409	18.668	12.580	11.678	743.771
1983	8.217	38.917	81.596	102.904	157.570	128.123	130.920	70.762	28.177	19.258	13.983	11.517	791.944

APPENDIX A-2-2

Mining Pit Operation

Table A2-2-1 Mining Pit Operation (CASE 1) Takua Pa
(Inflow is 50% of the Total Runoff)

********** INPUT DATA **********

* FULL WATER CAPACITY = .195 (MCM)
* DEAD WATER CAPACITY = .039 (MCM)
* CATCHMENT AREA = 11.7 (KM2)

********** THE OUTCOME OF RESERVOIR OPERATION **********

PLACE : MINING PIT.TAKUA PA DURATION : FROM 1968 TO 1987

YEAR	MON	VOL (MCM)	INFLOW (MCM)	WATER SUPPLY (MCM)	IRRI (MCM)	EVAPO (MCM)	LOSS (MCM)	SPILL (MCM)	SHORTAG (MCM)
	1	0.195	0.000	0.040	0.000	0.000	0.000	0.000	0.000
	2	0.155	0.000	0.040	0.000	0.000	0.000	0.000	0.000
	3	0.115	0.002	0.044	0.000	0.000	0.000	0.000	0.000
	4	0.073	1.507	0.048	0.000	0.000	0.000	1.337	0.000
	5	0.195	1.495	0.048	0.000	0.000	0.000	1.447	0.000
1968	6	0.195	3.660	0.040	0.000	0.000	0.000	3.620	0.000
	7	0.195	4.291	0.040	0.000	0.000	0.000	4.251	0.000
	8	0.195	5.883	0.040	0.000	0.000	0.000	5.843	0.000
	9	0.195	4.847	0.036	0.000	0.000	0.000	4.811	0.000
	10	0.195	0.529	0.036	0.000	0.000	0.000	0.493	0.000
	11	0.195	0.040	0.036	0.000	0.000	0.000	0.004	0.000
	12	0.195	0.041	0.040	0.000	0.000	0.000	0.001	0.000
ANNUAL TOTAL			22.295	0.488	0.000	0.000	0.000	21.807	0.000
	1	0.195	0.048	0.040	0.000	0.000	0.000	0.008	0.000
	2	0.195	0.005	0.040	0.000	0.000	0.000	0.000	0.000
	3	0.160	0.048	0.044	0.000	0.000	0.000	0.000	0.000
	4	0.164	0.053	0.048	0.000	0.000	0.000	0.000	0.000
	5	0.170	0.173	0.048	0.000	0.000	0.000	0.099	0.000
1969	6	0.195	6.151	0.040	0.000	0.000	0.000	6.111	0.000
	7	0.195	0.477	0.040	0.000	0.000	0.000	0.437	0.000
	8	0.195	0.689	0.040	0.000	0.000	0.000	0.649	0.000
	9	0.195	1.107	0.036	0.000	0.000	0.000	1.071	0.000
	10	0.195	4.920	0.036	0.000	0.000	0.000	4.884	0.000
	11	0.195	0.228	0.036	0.000	0.000	0.000	0.192	0.000
	12	0.195	0.004	0.040	0.000	0.000	0.000	0.000	0.000
ANNUAL TOTAL			13.902	0.488	0.000	0.000	0.000	13.450	0.000
	1	0.159	0.000	0.040	0.000	0.000	0.000	0.000	0.000
	2	0.119	0.000	0.040	0.000	0.000	0.000	0.000	0.000
	3	0.079	0.535	0.044	0.000	0.000	0.000	0.375	0.000
	4	0.195	0.819	0.048	0.000	0.000	0.000	0.762	0.000
	5	0.195	2.492	0.048	0.000	0.000	0.000	2.444	0.000
1970	6	0.195	5.621	0.040	0.000	0.000	0.000	5.581	0.000
	7	0.195	2.724	0.040	0.000	0.000	0.000	2.684	0.000
	8	0.195	1.255	0.040	0.000	0.000	0.000	1.215	0.000
	9	0.195	6.013	0.036	0.000	0.000	0.000	5.977	0.000
	10	0.195	0.880	0.036	0.000	0.000	0.000	0.844	0.000
	11	0.195	0.411	0.036	0.000	0.000	0.000	0.375	0.000
	12	0.195	0.160	0.040	0.000	0.000	0.000	0.120	0.000
ANNUAL TOTAL			20.901	0.488	0.000	0.000	0.000	20.376	0.000
	1	0.195	0.005	0.040	0.000	0.000	0.000	0.000	0.000
	2	0.160	0.222	0.040	0.000	0.000	0.000	0.147	0.000
	3	0.195	0.445	0.044	0.000	0.000	0.000	0.401	0.000
	4	0.195	0.434	0.048	0.000	0.000	0.000	0.386	0.000
	5	0.195	4.267	0.048	0.000	0.000	0.000	4.219	0.000
1971	6	0.195	7.952	0.040	0.000	0.000	0.000	7.912	0.000
	7	0.195	2.463	0.040	0.000	0.000	0.000	2.423	0.000
	8	0.195	4.657	0.040	0.000	0.000	0.000	4.617	0.000
	9	0.195	3.616	0.036	0.000	0.000	0.000	3.580	0.000
	10	0.195	5.823	0.036	0.000	0.000	0.000	5.787	0.000
	11	0.195	0.198	0.036	0.000	0.000	0.000	0.162	0.000
	12	0.195	0.058	0.040	0.000	0.000	0.000	0.018	0.000
ANNUAL TOTAL			30.140	0.488	0.000	0.000	0.000	29.652	0.000
	1	0.195	0.001	0.040	0.000	0.000	0.000	0.000	0.000
	2	0.156	0.045	0.040	0.000	0.000	0.000	0.000	0.000
	3	0.161	0.250	0.044	0.000	0.000	0.000	0.172	0.000
	4	0.195	1.350	0.048	0.000	0.000	0.000	1.302	0.000
	5	0.195	1.070	0.048	0.000	0.000	0.000	1.022	0.000
1972	6	0.195	3.816	0.040	0.000	0.000	0.000	3.776	0.000
	7	0.195	1.606	0.040	0.000	0.000	0.000	1.566	0.000
	8	0.195	2.488	0.040	0.000	0.000	0.000	2.448	0.000
	9	0.195	4.487	0.036	0.000	0.000	0.000	4.451	0.000
	10	0.195	0.747	0.036	0.000	0.000	0.000	0.711	0.000
	11	0.195	0.373	0.036	0.000	0.000	0.000	0.337	0.000
	12	0.195	0.023	0.040	0.000	0.000	0.000	0.000	0.000
ANNUAL TOTAL			16.256	0.488	0.000	0.000	0.000	15.785	0.000

	1	0.178	0.000	0.040	0.000	0.000	0.000	0.000	0.000
	2	0.138	0.000	0.040	0.000	0.000	0.000	0.000	0.000
	3	0.098	0.463	0.044	0.000	0.000	0.000	0.323	0.000
	4	0.195	0.197	0.048	0.000	0.000	0.000	0.149	0.000
	5	0.195	0.543	0.048	0.000	0.000	0.000	0.495	0.000
1973	6	0.195	8.601	0.040	0.000	0.000	0.000	8.561	0.000
	7	0.195	8.381	0.040	0.000	0.000	0.000	8.341	0.000
	8	0.195	1.978	0.040	0.000	0.000	0.000	1.938	0.000
	9	0.195	5.981	0.036	0.000	0.000	0.000	5.945	0.000
	10	0.195	2.705	0.036	0.000	0.000	0.000	2.669	0.000
	11	0.195	0.302	0.036	0.000	0.000	0.000	0.266	0.000
	12	0.195	0.065	0.040	0.000	0.000	0.000	0.025	0.000
ANNUAL TOTAL			29.217	0.488	0.000	0.000	0.000	28.712	0.000
	1	0.195	0.007	0.040	0.000	0.000	0.000	0.000	0.000
	2	0.162	0.035	0.040	0.000	0.000	0.000	0.000	0.000
	3	0.158	0.203	0.044	0.000	0.000	0.000	0.121	0.000
	4	0.195	1.847	0.048	0.000	0.000	0.000	1.799	0.000
	5	0.195	1.753	0.048	0.000	0.000	0.000	1.705	0.000
1974	6	0.195	1.413	0.040	0.000	0.000	0.000	1.373	0.000
	7	0.195	3.116	0.040	0.000	0.000	0.000	3.076	0.000
	8	0.195	0.000	0.040	0.000	0.000	0.000	0.000	0.000
	9	0.155	3.897	0.036	0.000	0.000	0.000	3.821	0.000
	10	0.195	6.814	0.036	0.000	0.000	0.000	6.778	0.000
	11	0.195	2.436	0.036	0.000	0.000	0.000	2.400	0.000
	12	0.195	0.000	0.040	0.000	0.000	0.000	0.000	0.000
ANNUAL TOTAL			21.521	0.488	0.000	0.000	0.000	21.073	0.000
	1	0.155	0.126	0.040	0.000	0.000	0.000	0.046	0.000
	2	0.195	0.021	0.040	0.000	0.000	0.000	0.000	0.000
	3	0.176	0.241	0.044	0.000	0.000	0.000	0.179	0.000
	4	0.195	0.204	0.048	0.000	0.000	0.000	0.156	0.000
	5	0.195	1.072	0.048	0.000	0.000	0.000	1.024	0.000
1975	6	0.195	10.675	0.040	0.000	0.000	0.000	10.635	0.000
	7	0.195	1.090	0.040	0.000	0.000	0.000	1.050	0.000
	8	0.195	1.583	0.040	0.000	0.000	0.000	1.543	0.000
	9	0.195	3.282	0.036	0.000	0.000	0.000	3.246	0.000
	10	0.195	1.527	0.036	0.000	0.000	0.000	1.491	0.000
	11	0.195	0.550	0.036	0.000	0.000	0.000	0.514	0.000
	12	0.195	0.129	0.040	0.000	0.000	0.000	0.089	0.000
ANNUAL TOTAL			20.501	0.488	0.000	0.000	0.000	19.973	0.000
	1	0.195	0.003	0.040	0.000	0.000	0.000	0.000	0.000
	2	0.158	0.001	0.040	0.000	0.000	0.000	0.000	0.000
	3	0.119	0.189	0.044	0.000	0.000	0.000	0.069	0.000
	4	0.195	0.395	0.048	0.000	0.000	0.000	0.347	0.000
	5	0.195	5.916	0.048	0.000	0.000	0.000	5.868	0.000
1976	6	0.195	1.861	0.040	0.000	0.000	0.000	1.821	0.000
	7	0.195	3.483	0.040	0.000	0.000	0.000	3.443	0.000
	8	0.195	2.352	0.040	0.000	0.000	0.000	2.312	0.000
	9	0.195	4.311	0.036	0.000	0.000	0.000	4.275	0.000
	10	0.195	0.860	0.036	0.000	0.000	0.000	0.824	0.000
	11	0.195	0.373	0.036	0.000	0.000	0.000	0.337	0.000
	12	0.195	0.001	0.040	0.000	0.000	0.000	0.000	0.000
ANNUAL TOTAL			19.746	0.488	0.000	0.000	0.000	19.296	0.000
	1	0.156	0.030	0.040	0.000	0.000	0.000	0.000	0.000
	2	0.146	0.038	0.040	0.000	0.000	0.000	0.000	0.000
	3	0.144	0.000	0.044	0.000	0.000	0.000	0.000	0.000
	4	0.100	0.048	0.048	0.000	0.000	0.000	0.000	0.000
	5	0.100	3.881	0.048	0.000	0.000	0.000	3.738	0.000
1977	6	0.195	2.157	0.040	0.000	0.000	0.000	2.117	0.000
	7	0.195	1.753	0.040	0.000	0.000	0.000	1.713	0.000
	8	0.195	5.353	0.040	0.000	0.000	0.000	5.313	0.000
	9	0.195	3.599	0.036	0.000	0.000	0.000	3.563	0.000
	10	0.195	4.792	0.036	0.000	0.000	0.000	4.756	0.000
	11	0.195	0.246	0.036	0.000	0.000	0.000	0.210	0.000
	12	0.195	0.004	0.040	0.000	0.000	0.000	0.000	0.000
ANNUAL TOTAL			21.902	0.488	0.000	0.000	0.000	21.411	0.000

	1	0.159	0.021	0.040	0.000	0.000	0.000	0.000	0.000
	2	0.140	0.000	0.040	0.000	0.000	0.000	0.000	0.000
	3	0.100	0.089	0.044	0.000	0.000	0.000	0.000	0.000
	4	0.146	0.673	0.048	0.000	0.000	0.000	0.575	0.000
	5	0.195	2.475	0.048	0.000	0.000	0.000	2.427	0.000
1978	6	0.195	9.018	0.040	0.000	0.000	0.000	8.978	0.000
	7	0.195	4.238	0.040	0.000	0.000	0.000	4.198	0.000
	8	0.195	3.787	0.040	0.000	0.000	0.000	3.747	0.000
	9	0.195	2.096	0.036	0.000	0.000	0.000	2.060	0.000
	10	0.195	0.384	0.036	0.000	0.000	0.000	0.348	0.000
	11	0.195	0.150	0.036	0.000	0.000	0.000	0.114	0.000
	12	0.195	0.000	0.040	0.000	0.000	0.000	0.000	0.000
ANNUAL TOTAL			22.932	0.488	0.000	0.000	0.000	22.448	0.000
	1	0.155	0.000	0.040	0.000	0.000	0.000	0.000	0.000
	2	0.115	0.000	0.040	0.000	0.000	0.000	0.000	0.000
	3	0.075	0.000	0.044	0.000	0.000	0.000	0.000	-0.008
	4	0.039	0.055	0.048	0.000	0.000	0.000	0.000	0.000
	5	0.046	1.181	0.048	0.000	0.000	0.000	0.983	0.000
1979	6	0.195	0.890	0.040	0.000	0.000	0.000	0.850	0.000
	7	0.195	3.147	0.040	0.000	0.000	0.000	3.107	0.000
	8	0.195	0.223	0.040	0.000	0.000	0.000	0.183	0.000
	9	0.195	2.314	0.036	0.000	0.000	0.000	2.278	0.000
	10	0.195	0.220	0.036	0.000	0.000	0.000	0.184	0.000
	11	0.195	0.065	0.036	0.000	0.000	0.000	0.029	0.000
	12	0.195	0.000	0.040	0.000	0.000	0.000	0.000	0.000
ANNUAL TOTAL			8.093	0.488	0.000	0.000	0.000	7.613	-0.008
	1	0.155	0.000	0.040	0.000	0.000	0.000	0.000	0.000
	2	0.115	0.120	0.040	0.000	0.000	0.000	0.000	0.000
	3	0.195	0.032	0.044	0.000	0.000	0.000	0.000	0.000
	4	0.183	0.132	0.048	0.000	0.000	0.000	0.071	0.000
	5	0.195	0.879	0.048	0.000	0.000	0.000	0.831	0.000
1980	6	0.195	1.828	0.040	0.000	0.000	0.000	1.788	0.000
	7	0.195	2.850	0.040	0.000	0.000	0.000	2.810	0.000
	8	0.195	3.352	0.040	0.000	0.000	0.000	3.312	0.000
	9	0.195	1.795	0.036	0.000	0.000	0.000	1.759	0.000
	10	0.195	0.595	0.036	0.000	0.000	0.000	0.559	0.000
	11	0.195	1.111	0.036	0.000	0.000	0.000	1.075	0.000
	12	0.195	0.031	0.040	0.000	0.000	0.000	0.000	0.000
ANNUAL TOTAL			12.723	0.488	0.000	0.000	0.000	12.204	0.000
	1	0.186	0.000	0.040	0.000	0.000	0.000	0.000	0.000
	2	0.146	0.000	0.040	0.000	0.000	0.000	0.000	0.000
	3	0.106	0.000	0.044	0.000	0.000	0.000	0.000	0.000
	4	0.062	0.340	0.048	0.000	0.000	0.000	0.159	0.000
	5	0.195	1.895	0.048	0.000	0.000	0.000	1.847	0.000
1981	6	0.195	2.217	0.040	0.000	0.000	0.000	2.177	0.000
	7	0.195	1.801	0.040	0.000	0.000	0.000	1.761	0.000
	8	0.195	0.242	0.040	0.000	0.000	0.000	0.202	0.000
	9	0.195	1.366	0.036	0.000	0.000	0.000	1.330	0.000
	10	0.195	0.234	0.036	0.000	0.000	0.000	0.198	0.000
	11	0.195	1.919	0.036	0.000	0.000	0.000	1.883	0.000
	12	0.195	0.023	0.040	0.000	0.000	0.000	0.000	0.000
ANNUAL TOTAL			10.037	0.488	0.000	0.000	0.000	9.557	0.000
	1	0.178	0.000	0.040	0.000	0.000	0.000	0.000	0.000
	2	0.138	0.000	0.040	0.000	0.000	0.000	0.000	0.000
	3	0.098	0.000	0.044	0.000	0.000	0.000	0.000	0.000
	4	0.054	1.158	0.048	0.000	0.000	0.000	0.969	0.000
	5	0.195	0.569	0.048	0.000	0.000	0.000	0.521	0.000
1982	6	0.195	0.299	0.040	0.000	0.000	0.000	0.259	0.000
	7	0.195	7.498	0.040	0.000	0.000	0.000	7.458	0.000
	8	0.195	4.027	0.040	0.000	0.000	0.000	3.987	0.000
	9	0.195	1.192	0.036	0.000	0.000	0.000	1.156	0.000
	10	0.195	0.425	0.036	0.000	0.000	0.000	0.389	0.000
	11	0.195	0.151	0.036	0.000	0.000	0.000	0.115	0.000
	12	0.195	0.012	0.040	0.000	0.000	0.000	0.000	0.000
ANNUAL TOTAL			15.331	0.488	0.000	0.000	0.000	14.854	0.000

	1	0.167	0.000	0.040	0.000	0.000	0.000	0.000	0.000
	2	0.127	0.000	0.040	0.000	0.000	0.000	0.000	0.000
	3	0.087	0.004	0.044	0.000	0.000	0.000	0.000	0.000
	4	0.047	0.228	0.048	0.000	0.000	0.000	0.032	0.000
	5	0.195	3.077	0.048	0.000	0.000	0.000	3.029	0.000
1983	6	0.195	2.706	0.040	0.000	0.000	0.000	2.666	0.000
	7	0.195	3.922	0.040	0.000	0.000	0.000	3.882	0.000
	8	0.195	4.648	0.040	0.000	0.000	0.000	4.608	0.000
	9	0.195	6.049	0.036	0.000	0.000	0.000	6.013	0.000
	10	0.195	2.480	0.036	0.000	0.000	0.000	2.444	0.000
	11	0.195	0.859	0.036	0.000	0.000	0.000	0.823	0.000
	12	0.195	0.036	0.040	0.000	0.000	0.000	0.000	0.000
ANNUAL TOTAL			24.008	0.488	0.000	0.000	0.000	23.496	0.000
	1	0.191	0.044	0.040	0.000	0.000	0.000	0.000	0.000
	2	0.195	0.000	0.040	0.000	0.000	0.000	0.000	0.000
	3	0.155	0.034	0.044	0.000	0.000	0.000	0.000	0.000
	4	0.145	1.164	0.048	0.000	0.000	0.000	1.066	0.000
	5	0.195	2.663	0.048	0.000	0.000	0.000	2.615	0.000
1984	6	0.195	4.887	0.040	0.000	0.000	0.000	4.847	0.000
	7	0.195	1.679	0.040	0.000	0.000	0.000	1.639	0.000
	8	0.195	2.589	0.040	0.000	0.000	0.000	2.549	0.000
	9	0.195	2.517	0.036	0.000	0.000	0.000	2.481	0.000
	10	0.195	1.363	0.036	0.000	0.000	0.000	1.327	0.000
	11	0.195	0.254	0.036	0.000	0.000	0.000	0.218	0.000
	12	0.195	0.097	0.040	0.000	0.000	0.000	0.057	0.000
ANNUAL TOTAL			17.292	0.488	0.000	0.000	0.000	16.800	0.000
	1	0.195	0.010	0.040	0.000	0.000	0.000	0.000	0.000
	2	0.165	0.041	0.040	0.000	0.000	0.000	0.000	0.000
	3	0.166	0.206	0.044	0.000	0.000	0.000	0.133	0.000
	4	0.195	0.562	0.048	0.000	0.000	0.000	0.514	0.000
	5	0.195	1.091	0.048	0.000	0.000	0.000	1.043	0.000
1985	6	0.195	2.134	0.040	0.000	0.000	0.000	2.094	0.000
	7	0.195	0.587	0.040	0.000	0.000	0.000	0.547	0.000
	8	0.195	2.174	0.040	0.000	0.000	0.000	2.134	0.000
	9	0.195	5.016	0.036	0.000	0.000	0.000	4.980	0.000
	10	0.195	8.677	0.036	0.000	0.000	0.000	8.641	0.000
	11	0.195	0.235	0.036	0.000	0.000	0.000	0.199	0.000
	12	0.195	0.069	0.040	0.000	0.000	0.000	0.029	0.000
ANNUAL TOTAL			20.803	0.488	0.000	0.000	0.000	20.315	0.000
	1	0.195	0.002	0.040	0.000	0.000	0.000	0.000	0.000
	2	0.157	0.014	0.040	0.000	0.000	0.000	0.000	0.000
	3	0.132	0.011	0.044	0.000	0.000	0.000	0.000	0.000
	4	0.099	0.240	0.048	0.000	0.000	0.000	0.096	0.000
	5	0.195	4.569	0.048	0.000	0.000	0.000	4.521	0.000
1986	6	0.195	1.632	0.040	0.000	0.000	0.000	1.592	0.000
	7	0.195	3.631	0.040	0.000	0.000	0.000	3.591	0.000
	8	0.195	1.655	0.040	0.000	0.000	0.000	1.615	0.000
	9	0.195	11.616	0.036	0.000	0.000	0.000	11.580	0.000
	10	0.195	2.349	0.036	0.000	0.000	0.000	2.313	0.000
	11	0.195	1.819	0.036	0.000	0.000	0.000	1.783	0.000
	12	0.195	0.003	0.040	0.000	0.000	0.000	0.000	0.000
ANNUAL TOTAL			27.542	0.488	0.000	0.000	0.000	27.091	0.000
	1	0.158	0.004	0.040	0.000	0.000	0.000	0.000	0.000
	2	0.122	0.000	0.040	0.000	0.000	0.000	0.000	0.000
	3	0.082	0.067	0.044	0.000	0.000	0.000	0.000	0.000
	4	0.105	0.174	0.048	0.000	0.000	0.000	0.036	0.000
	5	0.195	0.884	0.048	0.000	0.000	0.000	0.836	0.000
1987	6	0.195	0.723	0.040	0.000	0.000	0.000	0.683	0.000
	7	0.195	0.113	0.040	0.000	0.000	0.000	0.073	0.000
	8	0.195	3.932	0.040	0.000	0.000	0.000	3.892	0.000
	9	0.195	0.108	0.036	0.000	0.000	0.000	0.072	0.000
	10	0.195	1.893	0.036	0.000	0.000	0.000	1.857	0.000
	11	0.195	0.829	0.036	0.000	0.000	0.000	0.793	0.000
	12	0.195	0.050	0.040	0.000	0.000	0.000	0.010	0.000
ANNUAL TOTAL			8.776	0.488	0.000	0.000	0.000	8.251	0.000

Table A2-2-2 Mining Pit Operation (CASE 2) Takua Pa
(Inflow is 30% of the Total Runoff)

********** INPUT DATA **********

* FULL WATER CAPACITY = .195 (MCM)
* DEAD WATER CAPACITY = .039 (MCM)
* CATCHMENT AREA = 11.7 (KM2)

********** THE OUTCOME OF RESERVOIR OPERATION **********

PLACE : MINING PIT,TAKUA PA DURATION : FROM 1968 TO 1987

YEAR	MON	VOL (MCM)	INFLOW (MCM)	WATER SUPPLY (MCM)	IRRI (MCM)	EVAPO (MCM)	LOSS (MCM)	SPILL (MCM)	SHORTAG (MCM)
	1	0.195	0.000	0.040	0.000	0.000	0.000	0.000	0.000
	2	0.155	0.000	0.040	0.000	0.000	0.000	0.000	0.000
	3	0.115	0.001	0.044	0.000	0.000	0.000	0.000	0.000
	4	0.072	0.904	0.048	0.000	0.000	0.000	0.734	0.000
	5	0.195	0.897	0.048	0.000	0.000	0.000	0.849	0.000
1968	6	0.195	2.196	0.040	0.000	0.000	0.000	2.156	0.000
	7	0.195	2.575	0.040	0.000	0.000	0.000	2.535	0.000
	8	0.195	3.530	0.040	0.000	0.000	0.000	3.490	0.000
	9	0.195	2.908	0.036	0.000	0.000	0.000	2.872	0.000
	10	0.195	0.317	0.036	0.000	0.000	0.000	0.281	0.000
	11	0.195	0.024	0.036	0.000	0.000	0.000	0.000	0.000
	12	0.183	0.025	0.040	0.000	0.000	0.000	0.000	0.000
ANNUAL TOTAL			13.377	0.488	0.000	0.000	0.000	12.916	0.000
	1	0.168	0.029	0.040	0.000	0.000	0.000	0.000	0.000
	2	0.157	0.003	0.040	0.000	0.000	0.000	0.000	0.000
	3	0.120	0.029	0.044	0.000	0.000	0.000	0.000	0.000
	4	0.104	0.032	0.048	0.000	0.000	0.000	0.000	0.000
	5	0.088	0.104	0.048	0.000	0.000	0.000	0.000	0.000
1969	6	0.144	3.690	0.040	0.000	0.000	0.000	3.599	0.000
	7	0.195	0.286	0.040	0.000	0.000	0.000	0.246	0.000
	8	0.195	0.419	0.040	0.000	0.000	0.000	0.373	0.000
	9	0.195	0.664	0.036	0.000	0.000	0.000	0.628	0.000
	10	0.195	2.952	0.036	0.000	0.000	0.000	2.916	0.000
	11	0.195	0.137	0.036	0.000	0.000	0.000	0.101	0.000
	12	0.195	0.002	0.040	0.000	0.000	0.000	0.000	0.000
ANNUAL TOTAL			8.341	0.488	0.000	0.000	0.000	7.864	0.000
	1	0.157	0.000	0.040	0.000	0.000	0.000	0.000	0.000
	2	0.117	0.000	0.040	0.000	0.000	0.000	0.000	0.000
	3	0.077	0.321	0.044	0.000	0.000	0.000	0.159	0.000
	4	0.195	0.486	0.048	0.000	0.000	0.000	0.438	0.000
	5	0.195	1.495	0.048	0.000	0.000	0.000	1.447	0.000
1970	6	0.195	3.373	0.040	0.000	0.000	0.000	3.333	0.000
	7	0.195	1.635	0.040	0.000	0.000	0.000	1.595	0.000
	8	0.195	0.753	0.040	0.000	0.000	0.000	0.713	0.000
	9	0.195	3.608	0.036	0.000	0.000	0.000	3.572	0.000
	10	0.195	0.528	0.036	0.000	0.000	0.000	0.492	0.000
	11	0.195	0.246	0.036	0.000	0.000	0.000	0.210	0.000
	12	0.195	0.096	0.040	0.000	0.000	0.000	0.056	0.000
ANNUAL TOTAL			12.540	0.488	0.000	0.000	0.000	12.015	0.000
	1	0.195	0.003	0.040	0.000	0.000	0.000	0.000	0.000
	2	0.158	0.133	0.040	0.000	0.000	0.000	0.056	0.000
	3	0.195	0.287	0.044	0.000	0.000	0.000	0.223	0.000
	4	0.195	0.261	0.048	0.000	0.000	0.000	0.213	0.000
	5	0.195	2.560	0.048	0.000	0.000	0.000	2.512	0.000
1971	6	0.195	4.771	0.040	0.000	0.000	0.000	4.731	0.000
	7	0.195	1.478	0.040	0.000	0.000	0.000	1.438	0.000
	8	0.195	2.794	0.040	0.000	0.000	0.000	2.754	0.000
	9	0.195	2.170	0.036	0.000	0.000	0.000	2.134	0.000
	10	0.195	3.494	0.036	0.000	0.000	0.000	3.458	0.000
	11	0.195	0.119	0.036	0.000	0.000	0.000	0.083	0.000
	12	0.195	0.035	0.040	0.000	0.000	0.000	0.000	0.000
ANNUAL TOTAL			18.084	0.488	0.000	0.000	0.000	17.601	0.000
	1	0.190	0.000	0.040	0.000	0.000	0.000	0.000	0.000
	2	0.150	0.027	0.040	0.000	0.000	0.000	0.000	0.000
	3	0.138	0.150	0.044	0.000	0.000	0.000	0.049	0.000
	4	0.195	0.810	0.048	0.000	0.000	0.000	0.762	0.000
	5	0.195	0.642	0.048	0.000	0.000	0.000	0.594	0.000
1972	6	0.195	2.290	0.040	0.000	0.000	0.000	2.250	0.000
	7	0.195	0.964	0.040	0.000	0.000	0.000	0.924	0.000
	8	0.195	1.493	0.040	0.000	0.000	0.000	1.453	0.000
	9	0.195	2.692	0.036	0.000	0.000	0.000	2.656	0.000
	10	0.195	0.448	0.036	0.000	0.000	0.000	0.412	0.000
	11	0.195	0.224	0.036	0.000	0.000	0.000	0.188	0.000
	12	0.195	0.014	0.040	0.000	0.000	0.000	0.000	0.000
ANNUAL TOTAL			9.754	0.488	0.000	0.000	0.000	9.286	0.000

	1	0.169	0.000	0.040	0.000	0.000	0.000	0.000	0.000
	2	0.129	0.000	0.040	0.000	0.000	0.000	0.000	0.000
	3	0.089	0.278	0.044	0.000	0.000	0.000	0.128	0.000
	4	0.195	0.118	0.048	0.000	0.000	0.000	0.070	0.000
	5	0.195	0.326	0.048	0.000	0.000	0.000	0.278	0.000
1973	6	0.195	5.160	0.040	0.000	0.000	0.000	5.120	0.000
	7	0.195	5.028	0.040	0.000	0.000	0.000	4.988	0.000
	8	0.195	1.187	0.040	0.000	0.000	0.000	1.147	0.000
	9	0.195	3.589	0.036	0.000	0.000	0.000	3.553	0.000
	10	0.195	1.623	0.036	0.000	0.000	0.000	1.587	0.000
	11	0.195	0.181	0.036	0.000	0.000	0.000	0.145	0.000
	12	0.195	0.039	0.040	0.000	0.000	0.000	0.000	0.000
ANNUAL TOTAL			17.530	0.488	0.000	0.000	0.000	17.017	0.000
	1	0.194	0.004	0.040	0.000	0.000	0.000	0.000	0.000
	2	0.158	0.021	0.040	0.000	0.000	0.000	0.000	0.000
	3	0.140	0.122	0.044	0.000	0.000	0.000	0.022	0.000
	4	0.195	1.108	0.048	0.000	0.000	0.000	1.060	0.000
	5	0.195	1.052	0.048	0.000	0.000	0.000	1.004	0.000
1974	6	0.195	0.848	0.040	0.000	0.000	0.000	0.808	0.000
	7	0.195	1.870	0.040	0.000	0.000	0.000	1.830	0.000
	8	0.195	0.000	0.040	0.000	0.000	0.000	0.000	0.000
	9	0.155	2.338	0.036	0.000	0.000	0.000	2.262	0.000
	10	0.195	4.088	0.036	0.000	0.000	0.000	4.052	0.000
	11	0.195	1.462	0.036	0.000	0.000	0.000	1.426	0.000
	12	0.195	0.000	0.040	0.000	0.000	0.000	0.000	0.000
ANNUAL TOTAL			12.913	0.488	0.000	0.000	0.000	12.464	0.000
	1	0.155	0.075	0.040	0.000	0.000	0.000	0.000	0.000
	2	0.190	0.013	0.040	0.000	0.000	0.000	0.000	0.000
	3	0.163	0.145	0.044	0.000	0.000	0.000	0.069	0.000
	4	0.195	0.122	0.048	0.000	0.000	0.000	0.074	0.000
	5	0.195	0.643	0.048	0.000	0.000	0.000	0.595	0.000
1975	6	0.195	6.405	0.040	0.000	0.000	0.000	6.365	0.000
	7	0.195	0.654	0.040	0.000	0.000	0.000	0.614	0.000
	8	0.195	0.950	0.040	0.000	0.000	0.000	0.910	0.000
	9	0.195	1.969	0.036	0.000	0.000	0.000	1.933	0.000
	10	0.195	0.916	0.036	0.000	0.000	0.000	0.880	0.000
	11	0.195	0.330	0.036	0.000	0.000	0.000	0.294	0.000
	12	0.195	0.077	0.040	0.000	0.000	0.000	0.037	0.000
ANNUAL TOTAL			12.301	0.488	0.000	0.000	0.000	11.773	0.000
	1	0.195	0.002	0.040	0.000	0.000	0.000	0.000	0.000
	2	0.157	0.001	0.040	0.000	0.000	0.000	0.000	0.000
	3	0.117	0.113	0.044	0.000	0.000	0.000	0.000	0.000
	4	0.187	0.237	0.048	0.000	0.000	0.000	0.181	0.000
	5	0.195	3.550	0.048	0.000	0.000	0.000	3.502	0.000
1976	6	0.195	1.117	0.040	0.000	0.000	0.000	1.077	0.000
	7	0.195	2.090	0.040	0.000	0.000	0.000	2.050	0.000
	8	0.195	1.411	0.040	0.000	0.000	0.000	1.371	0.000
	9	0.195	2.586	0.036	0.000	0.000	0.000	2.550	0.000
	10	0.195	0.516	0.036	0.000	0.000	0.000	0.480	0.000
	11	0.195	0.224	0.036	0.000	0.000	0.000	0.188	0.000
	12	0.195	0.001	0.040	0.000	0.000	0.000	0.000	0.000
ANNUAL TOTAL			11.847	0.488	0.000	0.000	0.000	11.399	0.000
	1	0.156	0.018	0.040	0.000	0.000	0.000	0.000	0.000
	2	0.134	0.023	0.040	0.000	0.000	0.000	0.000	0.000
	3	0.116	0.000	0.044	0.000	0.000	0.000	0.000	0.000
	4	0.072	0.029	0.048	0.000	0.000	0.000	0.000	0.000
	5	0.053	2.329	0.048	0.000	0.000	0.000	2.139	0.000
1977	6	0.195	1.294	0.040	0.000	0.000	0.000	1.254	0.000
	7	0.195	1.052	0.040	0.000	0.000	0.000	1.012	0.000
	8	0.195	3.212	0.040	0.000	0.000	0.000	3.172	0.000
	9	0.195	2.160	0.036	0.000	0.000	0.000	2.124	0.000
	10	0.195	2.875	0.036	0.000	0.000	0.000	2.839	0.000
	11	0.195	0.148	0.036	0.000	0.000	0.000	0.112	0.000
	12	0.195	0.002	0.040	0.000	0.000	0.000	0.000	0.000
ANNUAL TOTAL			13.141	0.488	0.000	0.000	0.000	12.652	0.000

	1	0.157	0.013	0.040	0.000	0.000	0.000	0.000	0.000
	2	0.130	0.000	0.040	0.000	0.000	0.000	0.000	0.000
	3	0.090	0.054	0.044	0.000	0.000	0.000	0.000	0.000
	4	0.100	0.404	0.048	0.000	0.000	0.000	0.260	0.000
	5	0.195	1.485	0.048	0.000	0.000	0.000	1.437	0.000
1978	6	0.195	5.411	0.040	0.000	0.000	0.000	5.371	0.000
	7	0.195	2.543	0.040	0.000	0.000	0.000	2.503	0.000
	8	0.195	2.272	0.040	0.000	0.000	0.000	2.232	0.000
	9	0.195	1.258	0.036	0.000	0.000	0.000	1.222	0.000
	10	0.195	0.230	0.036	0.000	0.000	0.000	0.194	0.000
	11	0.195	0.090	0.036	0.000	0.000	0.000	0.054	0.000
	12	0.195	0.000	0.040	0.000	0.000	0.000	0.000	0.000
ANNUAL TOTAL			13.759	0.488	0.000	0.000	0.000	13.274	0.000
	1	0.155	0.000	0.040	0.000	0.000	0.000	0.000	0.000
	2	0.115	0.000	0.040	0.000	0.000	0.000	0.000	0.000
	3	0.075	0.000	0.044	0.000	0.000	0.000	0.000	-0.008
	4	0.039	0.033	0.048	0.000	0.000	0.000	0.000	-0.015
	5	0.039	0.709	0.048	0.000	0.000	0.000	0.505	0.000
1979	6	0.195	0.534	0.040	0.000	0.000	0.000	0.494	0.000
	7	0.195	1.888	0.040	0.000	0.000	0.000	1.848	0.000
	8	0.195	0.134	0.040	0.000	0.000	0.000	0.094	0.000
	9	0.195	1.388	0.036	0.000	0.000	0.000	1.352	0.000
	10	0.195	0.132	0.036	0.000	0.000	0.000	0.096	0.000
	11	0.195	0.039	0.036	0.000	0.000	0.000	0.003	0.000
	12	0.195	0.000	0.040	0.000	0.000	0.000	0.000	0.000
ANNUAL TOTAL			4.856	0.488	0.000	0.000	0.000	4.391	-0.023
	1	0.155	0.000	0.040	0.000	0.000	0.000	0.000	0.000
	2	0.115	0.072	0.040	0.000	0.000	0.000	0.000	0.000
	3	0.147	0.019	0.044	0.000	0.000	0.000	0.000	0.000
	4	0.122	0.079	0.048	0.000	0.000	0.000	0.000	0.000
	5	0.153	0.527	0.048	0.000	0.000	0.000	0.437	0.000
1980	6	0.195	1.097	0.040	0.000	0.000	0.000	1.057	0.000
	7	0.195	1.710	0.040	0.000	0.000	0.000	1.670	0.000
	8	0.195	2.011	0.040	0.000	0.000	0.000	1.971	0.000
	9	0.195	1.077	0.036	0.000	0.000	0.000	1.041	0.000
	10	0.195	0.357	0.036	0.000	0.000	0.000	0.321	0.000
	11	0.195	0.667	0.036	0.000	0.000	0.000	0.631	0.000
	12	0.195	0.019	0.040	0.000	0.000	0.000	0.000	0.000
ANNUAL TOTAL			7.634	0.488	0.000	0.000	0.000	7.127	0.000
	1	0.174	0.000	0.040	0.000	0.000	0.000	0.000	0.000
	2	0.134	0.000	0.040	0.000	0.000	0.000	0.000	0.000
	3	0.094	0.000	0.044	0.000	0.000	0.000	0.000	0.000
	4	0.050	0.204	0.048	0.000	0.000	0.000	0.011	0.000
	5	0.195	1.137	0.048	0.000	0.000	0.000	1.089	0.000
1981	6	0.195	1.330	0.040	0.000	0.000	0.000	1.290	0.000
	7	0.195	1.081	0.040	0.000	0.000	0.000	1.041	0.000
	8	0.195	0.145	0.040	0.000	0.000	0.000	0.105	0.000
	9	0.195	0.820	0.036	0.000	0.000	0.000	0.784	0.000
	10	0.195	0.141	0.036	0.000	0.000	0.000	0.105	0.000
	11	0.195	1.151	0.036	0.000	0.000	0.000	1.115	0.000
	12	0.195	0.014	0.040	0.000	0.000	0.000	0.000	0.000
ANNUAL TOTAL			6.022	0.488	0.000	0.000	0.000	5.539	0.000
	1	0.169	0.000	0.040	0.000	0.000	0.000	0.000	0.000
	2	0.129	0.000	0.040	0.000	0.000	0.000	0.000	0.000
	3	0.089	0.000	0.044	0.000	0.000	0.000	0.000	0.000
	4	0.045	0.695	0.048	0.000	0.000	0.000	0.497	0.000
	5	0.195	0.341	0.048	0.000	0.000	0.000	0.293	0.000
1982	6	0.195	0.179	0.040	0.000	0.000	0.000	0.139	0.000
	7	0.195	4.499	0.040	0.000	0.000	0.000	4.459	0.000
	8	0.195	2.416	0.040	0.000	0.000	0.000	2.376	0.000
	9	0.195	0.715	0.036	0.000	0.000	0.000	0.679	0.000
	10	0.195	0.255	0.036	0.000	0.000	0.000	0.219	0.000
	11	0.195	0.090	0.036	0.000	0.000	0.000	0.054	0.000
	12	0.195	0.007	0.040	0.000	0.000	0.000	0.000	0.000
ANNUAL TOTAL			9.199	0.488	0.000	0.000	0.000	8.717	0.000

	1	0.162	0.000	0.040	0.000	0.000	0.000	0.000	0.000
	2	0.122	0.000	0.040	0.000	0.000	0.000	0.000	0.000
	3	0.082	0.002	0.044	0.000	0.000	0.000	0.000	0.000
	4	0.040	0.137	0.048	0.000	0.000	0.000	0.000	0.000
	5	0.129	1.846	0.048	0.000	0.000	0.000	1.732	0.000
1983	6	0.195	1.624	0.040	0.000	0.000	0.000	1.584	0.000
	7	0.195	2.353	0.040	0.000	0.000	0.000	2.313	0.000
	8	0.195	2.789	0.040	0.000	0.000	0.000	2.749	0.000
	9	0.195	3.629	0.036	0.000	0.000	0.000	3.593	0.000
	10	0.195	1.488	0.036	0.000	0.000	0.000	1.452	0.000
	11	0.195	0.515	0.036	0.000	0.000	0.000	0.479	0.000
	12	0.195	0.021	0.040	0.000	0.000	0.000	0.000	0.000
ANNUAL TOTAL			14.405	0.488	0.000	0.000	0.000	13.903	0.000
	1	0.176	0.026	0.040	0.000	0.000	0.000	0.000	0.000
	2	0.163	0.000	0.040	0.000	0.000	0.000	0.000	0.000
	3	0.123	0.021	0.044	0.000	0.000	0.000	0.000	0.000
	4	0.099	0.699	0.048	0.000	0.000	0.000	0.555	0.000
	5	0.195	1.598	0.048	0.000	0.000	0.000	1.550	0.000
1984	6	0.195	2.932	0.040	0.000	0.000	0.000	2.892	0.000
	7	0.195	1.007	0.040	0.000	0.000	0.000	0.967	0.000
	8	0.195	1.554	0.040	0.000	0.000	0.000	1.514	0.000
	9	0.195	1.510	0.036	0.000	0.000	0.000	1.474	0.000
	10	0.195	0.818	0.036	0.000	0.000	0.000	0.782	0.000
	11	0.195	0.152	0.036	0.000	0.000	0.000	0.116	0.000
	12	0.195	0.058	0.040	0.000	0.000	0.000	0.018	0.000
ANNUAL TOTAL			10.375	0.488	0.000	0.000	0.000	9.869	0.000
	1	0.195	0.006	0.040	0.000	0.000	0.000	0.000	0.000
	2	0.161	0.025	0.040	0.000	0.000	0.000	0.000	0.000
	3	0.146	0.123	0.044	0.000	0.000	0.000	0.030	0.000
	4	0.195	0.337	0.048	0.000	0.000	0.000	0.289	0.000
	5	0.195	0.655	0.048	0.000	0.000	0.000	0.607	0.000
1985	6	0.195	1.281	0.040	0.000	0.000	0.000	1.241	0.000
	7	0.195	0.352	0.040	0.000	0.000	0.000	0.312	0.000
	8	0.195	1.305	0.040	0.000	0.000	0.000	1.265	0.000
	9	0.195	3.009	0.036	0.000	0.000	0.000	2.973	0.000
	10	0.195	5.206	0.036	0.000	0.000	0.000	5.170	0.000
	11	0.195	0.141	0.036	0.000	0.000	0.000	0.105	0.000
	12	0.195	0.041	0.040	0.000	0.000	0.000	0.001	0.000
ANNUAL TOTAL			12.482	0.488	0.000	0.000	0.000	11.994	0.000
	1	0.195	0.001	0.040	0.000	0.000	0.000	0.000	0.000
	2	0.156	0.009	0.040	0.000	0.000	0.000	0.000	0.000
	3	0.125	0.007	0.044	0.000	0.000	0.000	0.000	0.000
	4	0.088	0.144	0.048	0.000	0.000	0.000	0.000	0.000
	5	0.184	2.741	0.048	0.000	0.000	0.000	2.682	0.000
1986	6	0.195	0.979	0.040	0.000	0.000	0.000	0.939	0.000
	7	0.195	2.179	0.040	0.000	0.000	0.000	2.139	0.000
	8	0.195	0.993	0.040	0.000	0.000	0.000	0.953	0.000
	9	0.195	6.970	0.036	0.000	0.000	0.000	6.934	0.000
	10	0.195	1.410	0.036	0.000	0.000	0.000	1.374	0.000
	11	0.195	1.091	0.036	0.000	0.000	0.000	1.055	0.000
	12	0.195	0.002	0.040	0.000	0.000	0.000	0.000	0.000
ANNUAL TOTAL			16.525	0.488	0.000	0.000	0.000	16.075	0.000
	1	0.157	0.002	0.040	0.000	0.000	0.000	0.000	0.000
	2	0.119	0.000	0.040	0.000	0.000	0.000	0.000	0.000
	3	0.079	0.040	0.044	0.000	0.000	0.000	0.000	0.000
	4	0.075	0.104	0.048	0.000	0.000	0.000	0.000	0.000
	5	0.132	0.531	0.048	0.000	0.000	0.000	0.419	0.000
1987	6	0.195	0.434	0.040	0.000	0.000	0.000	0.394	0.000
	7	0.195	0.068	0.040	0.000	0.000	0.000	0.028	0.000
	8	0.195	2.359	0.040	0.000	0.000	0.000	2.319	0.000
	9	0.195	0.065	0.036	0.000	0.000	0.000	0.029	0.000
	10	0.195	1.136	0.036	0.000	0.000	0.000	1.100	0.000
	11	0.195	0.497	0.036	0.000	0.000	0.000	0.461	0.000
	12	0.195	0.030	0.040	0.000	0.000	0.000	0.000	0.000
ANNUAL TOTAL			5.266	0.488	0.000	0.000	0.000	4.750	0.000