APPENDIX A-2-2

Runoff Analysis

Runoff Analysis

Rainfall Synthesis

The daily rainfall data for the six gauging stations, collected from the Meteorological Department, RID and NEA within and around the vicinity of the study area, contain many missing data. To generate such missing data, correlation study was done on the basis of monthly rainfall using the overlapping observation periods of the stations.

The coefficients of correlation and equations of linear regression employed to synthesize the missing rainfall data in the object stations were determined statistically by means of the method of least square on a monthly basis among stations.
The highest correlation was taken to complement the missing rainfall data and generation of daily rainfall was done following the procedures shown below;

a) Equation of linear regression obtained through the correlation study is expressed as:

$$Y = aX + b$$

where X: Monthly rainfall at the key station which keeps perfect daily record of rainfall during period under consideration

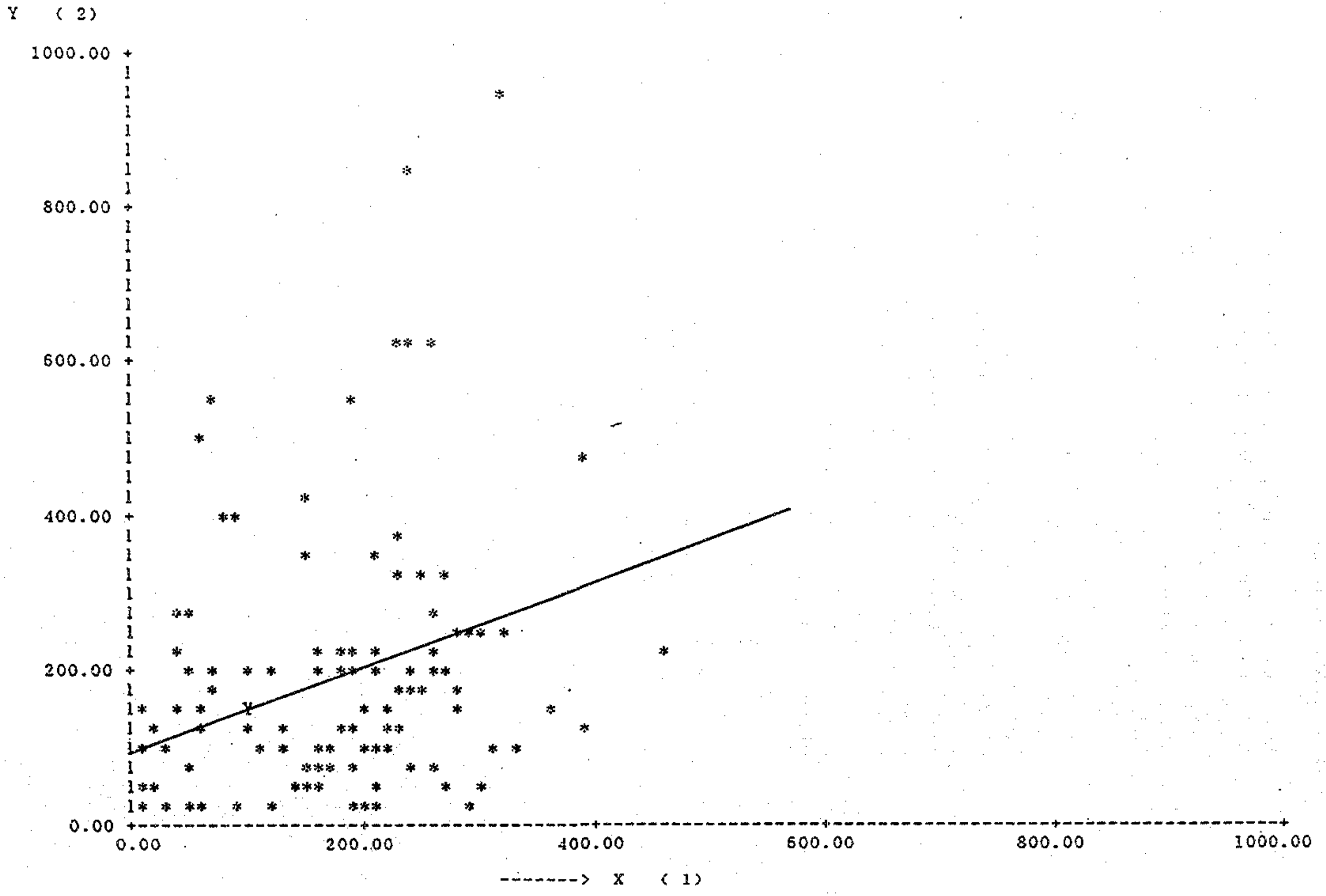
Y: Expected monthly rainfall at the object station which involves missing data

a,b: Coefficient and constant

***** THE REGRESSION LINE OF CO-RELATION OF RAINFALL BETWEEN NAKORN SI THAMMARAT AND CHA*****

1973--1987

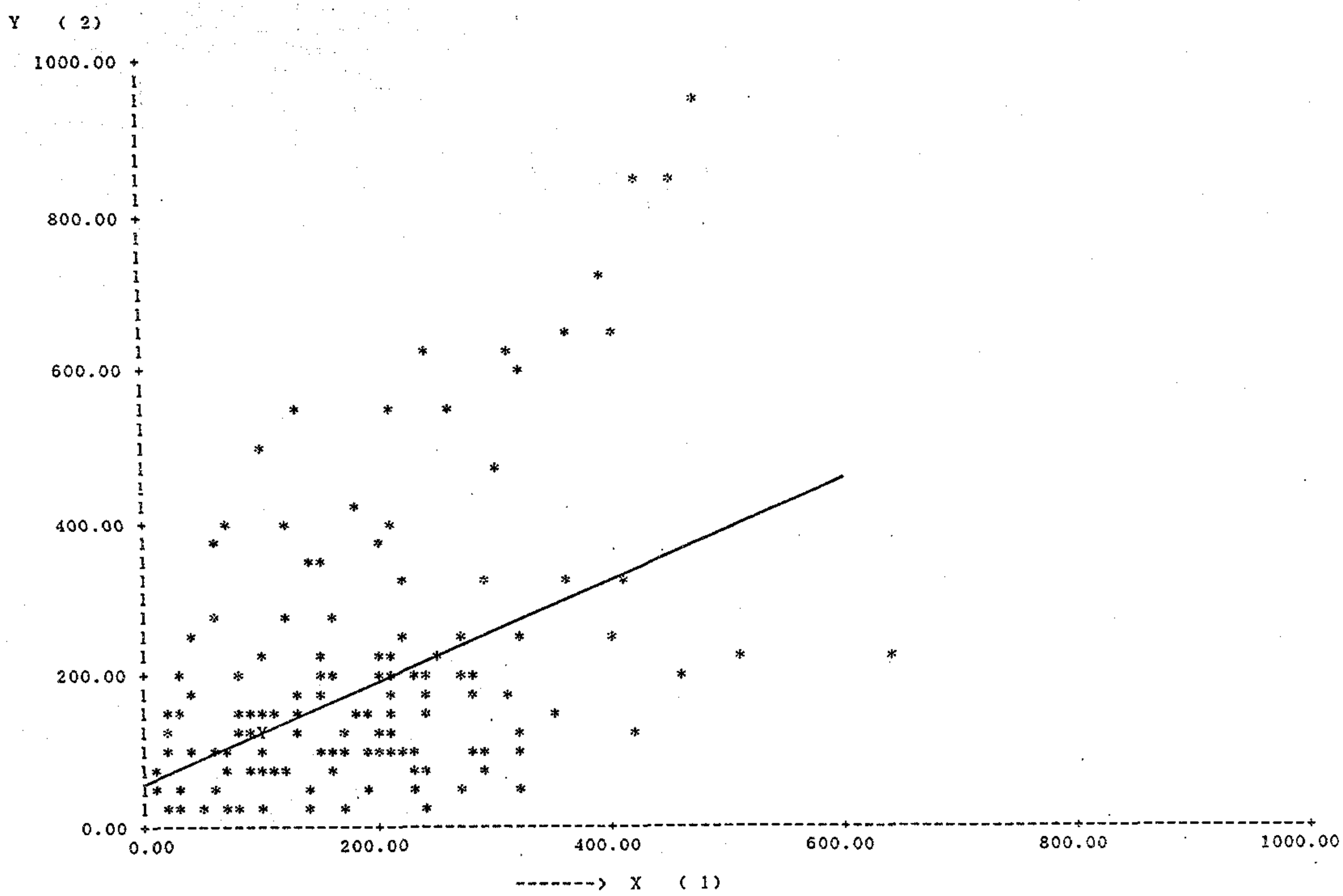
```
Y =     0.508 X +    92.061  (      MM          )  R = 0.316
X =     0.196 Y +   128.649  (      MM          )
```



***** THE REGRESSION LINE OF CO-RELATION OF RAINFALL BETWEEN THUNG SONG AND NAKORN SI TH*****

1973--1987

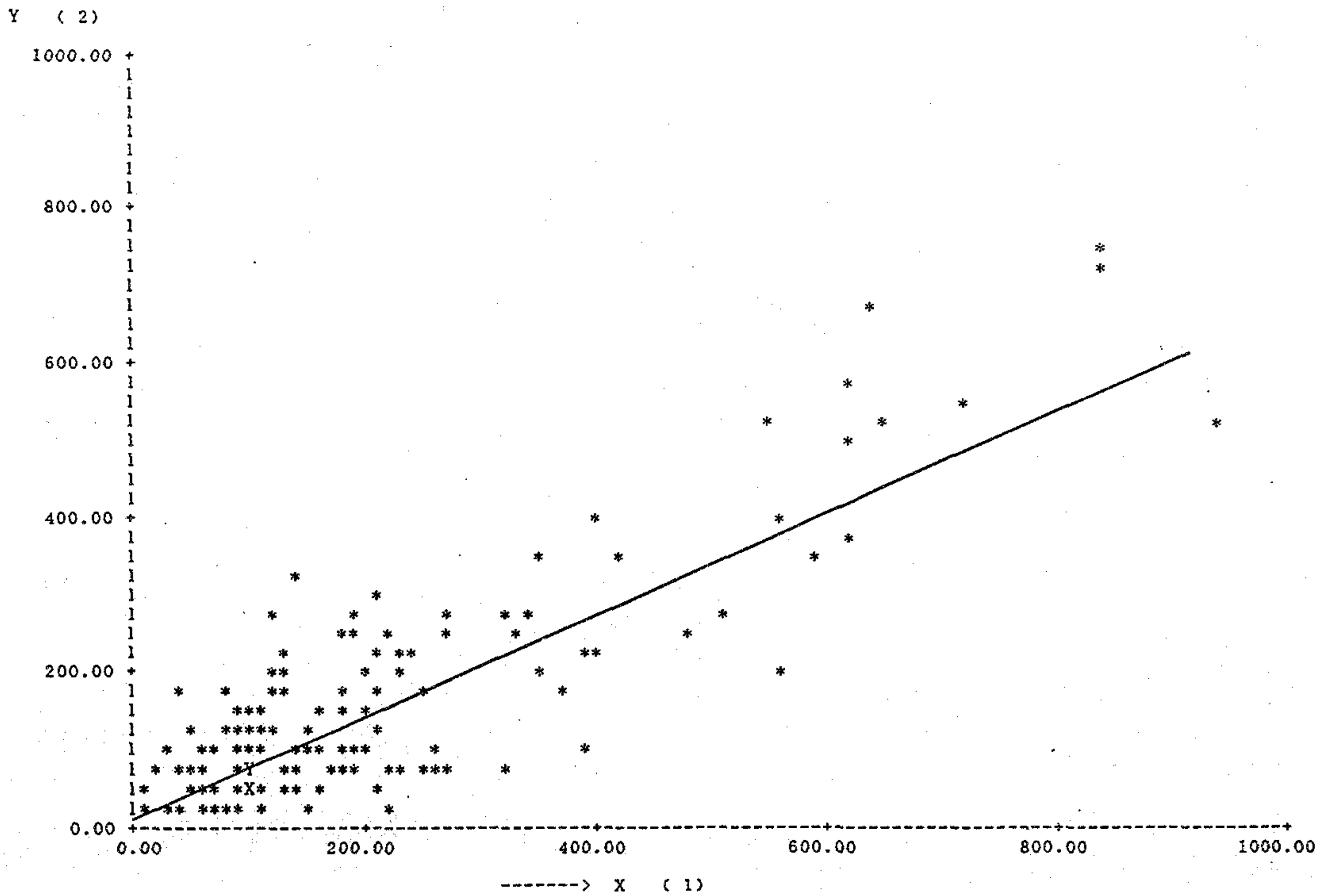
```
Y =     0.753 X +    60.346  (      MM          )  R = 0.498
X =     0.329 Y +   113.446  (      MM          )
```



***** THE REGRESSION LINE OF CO-RELATION OF RAINFALL BETWEEN NAKORN SI THAMMARAT AND RON*****

1973--1987

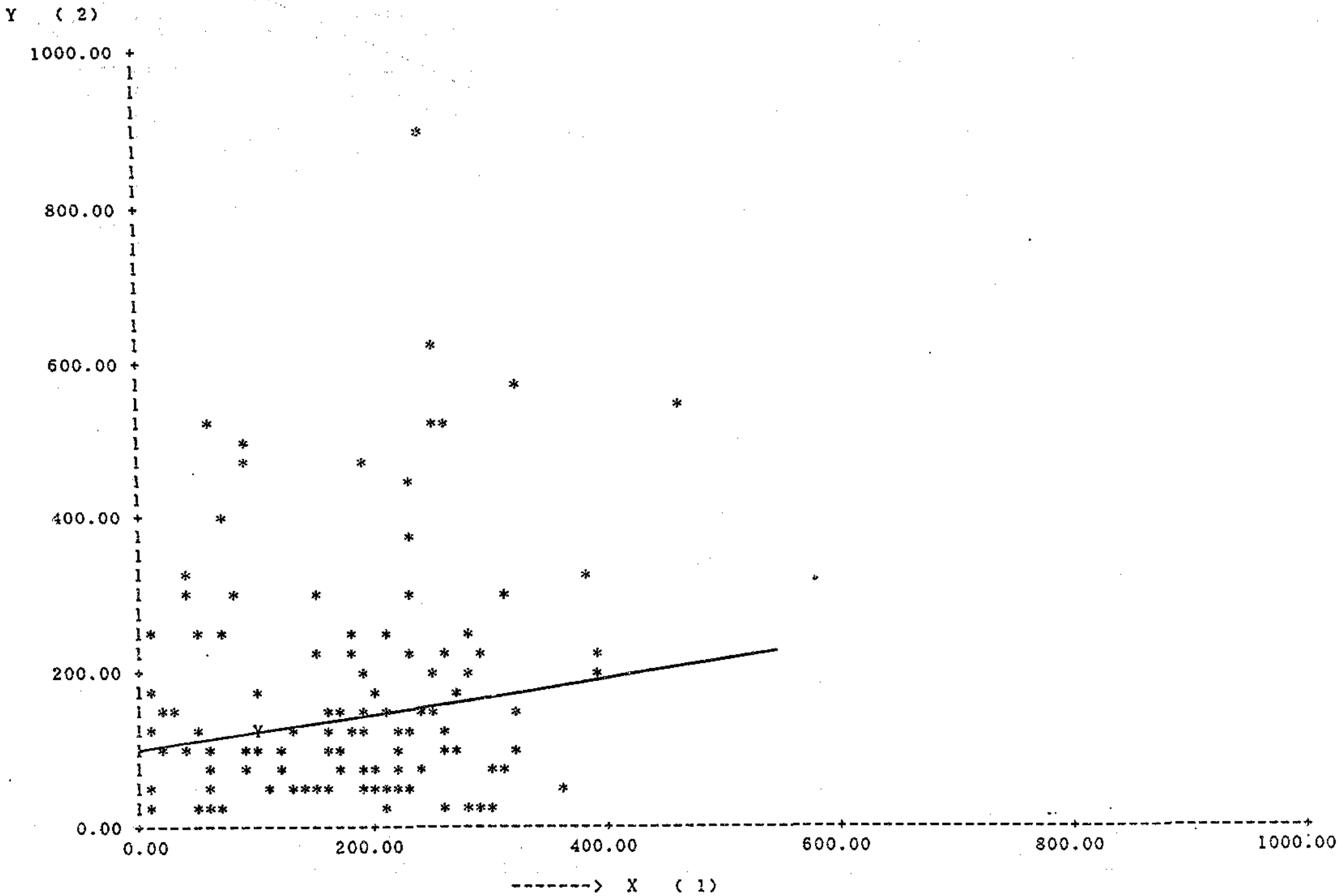
Y =   0.702 X +   13.217 (MM   ) R = 0.858
X =   1.049 Y +   38.412 (MM   )



***** THE REGRESSION LINE OF CO-RELATION OF RAINFALL BETWEEN CHAWANG AND LAN SAKA *****

1973--1987

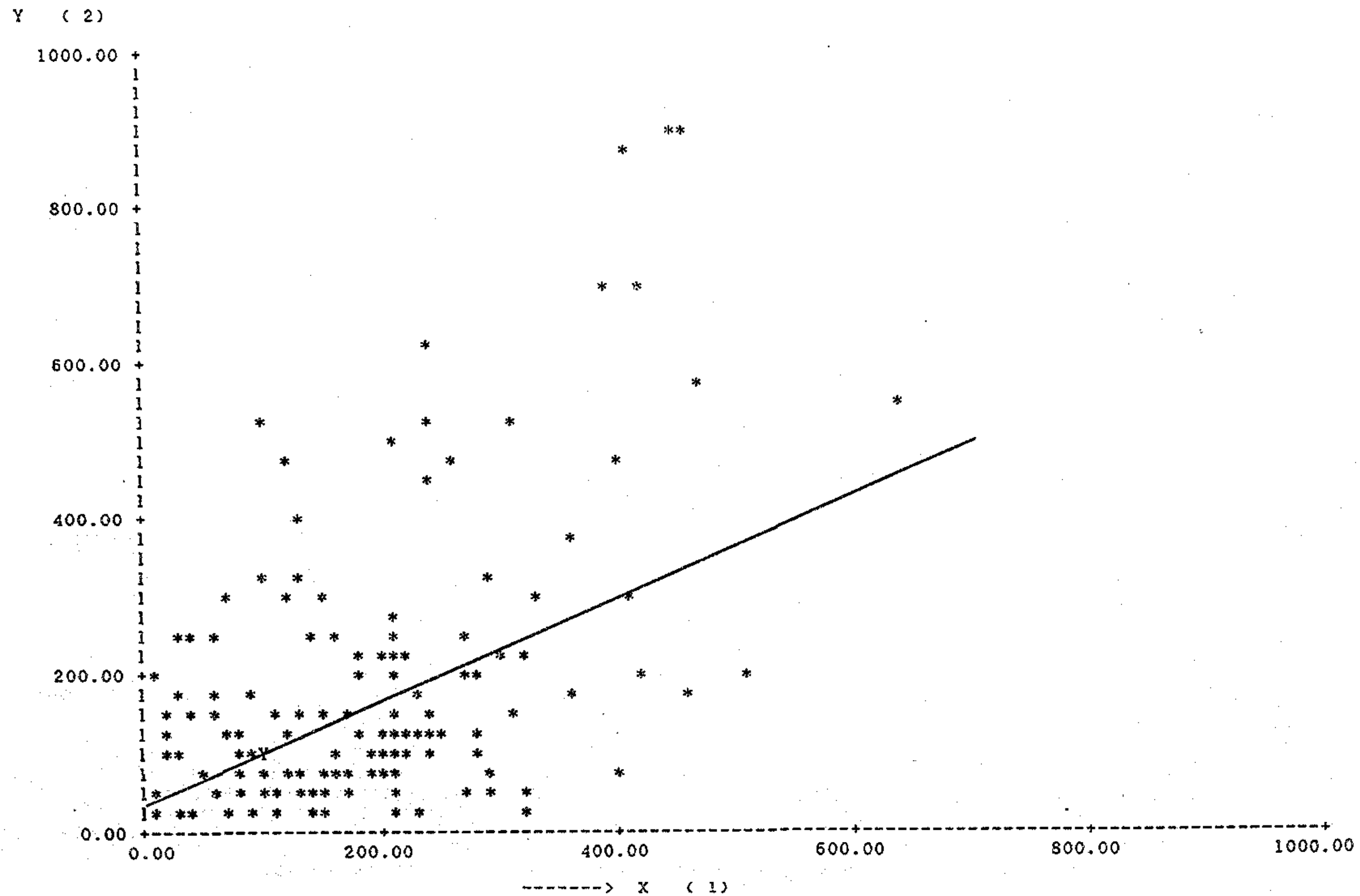
Y = 0.302 X + 106.708 (MM) R = 0.205
X = 0.139 Y + 147.301 (MM)



***** THE REGRESSION LINE OF CO-RELATION OF RAINFALL BETWEEN THUNG SONG AND LAN SAKA   *****

1973--1987

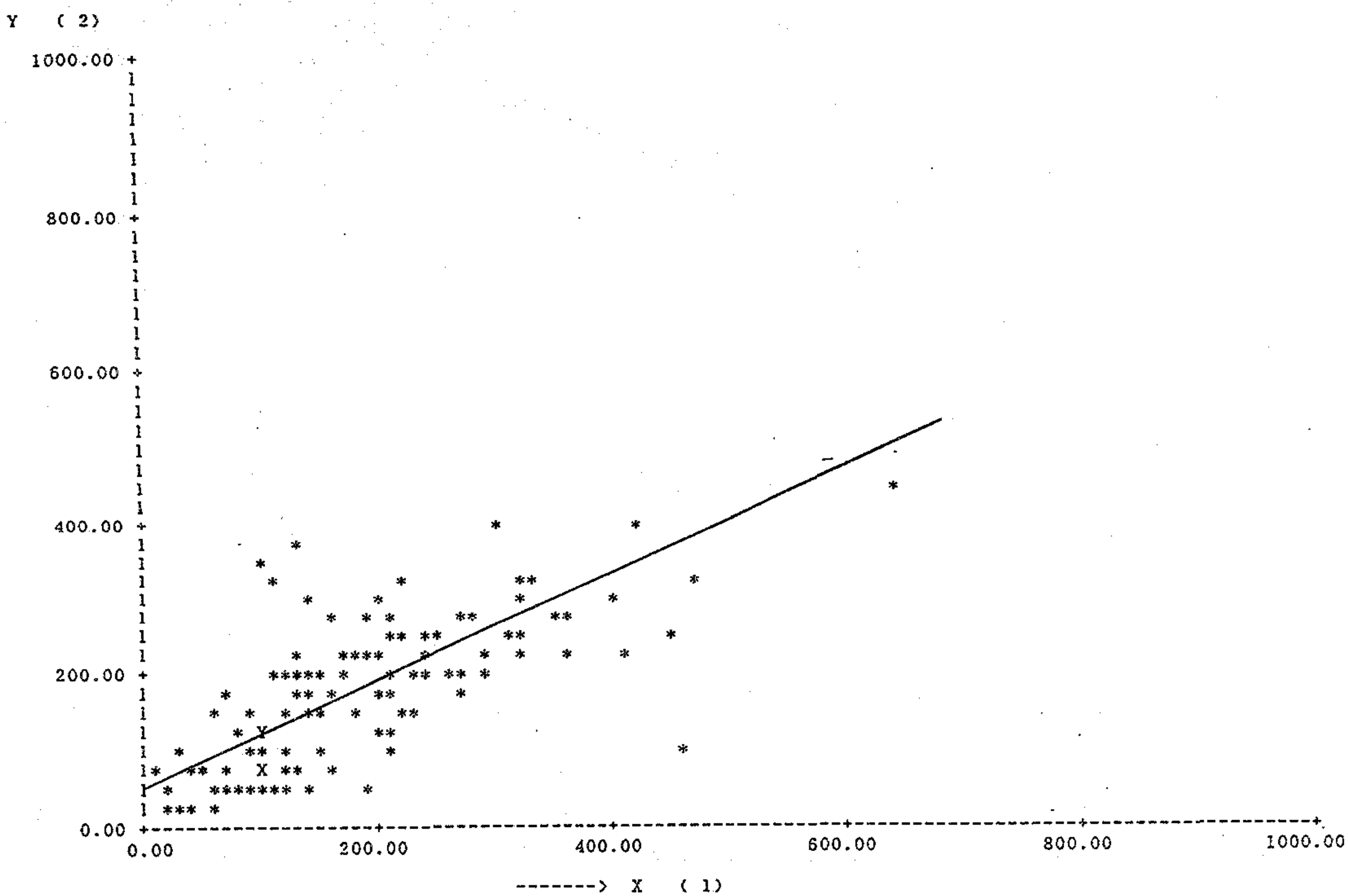
Y = 0.728 X + 38.245 (MM) R = 0.494
X = 0.334 Y + 127.236 (MM)



***** THE REGRESSION LINE OF CO-RELATION OF RAINFALL BETWEEN THUNG SONG AND CHAWANG *****

1973--1987

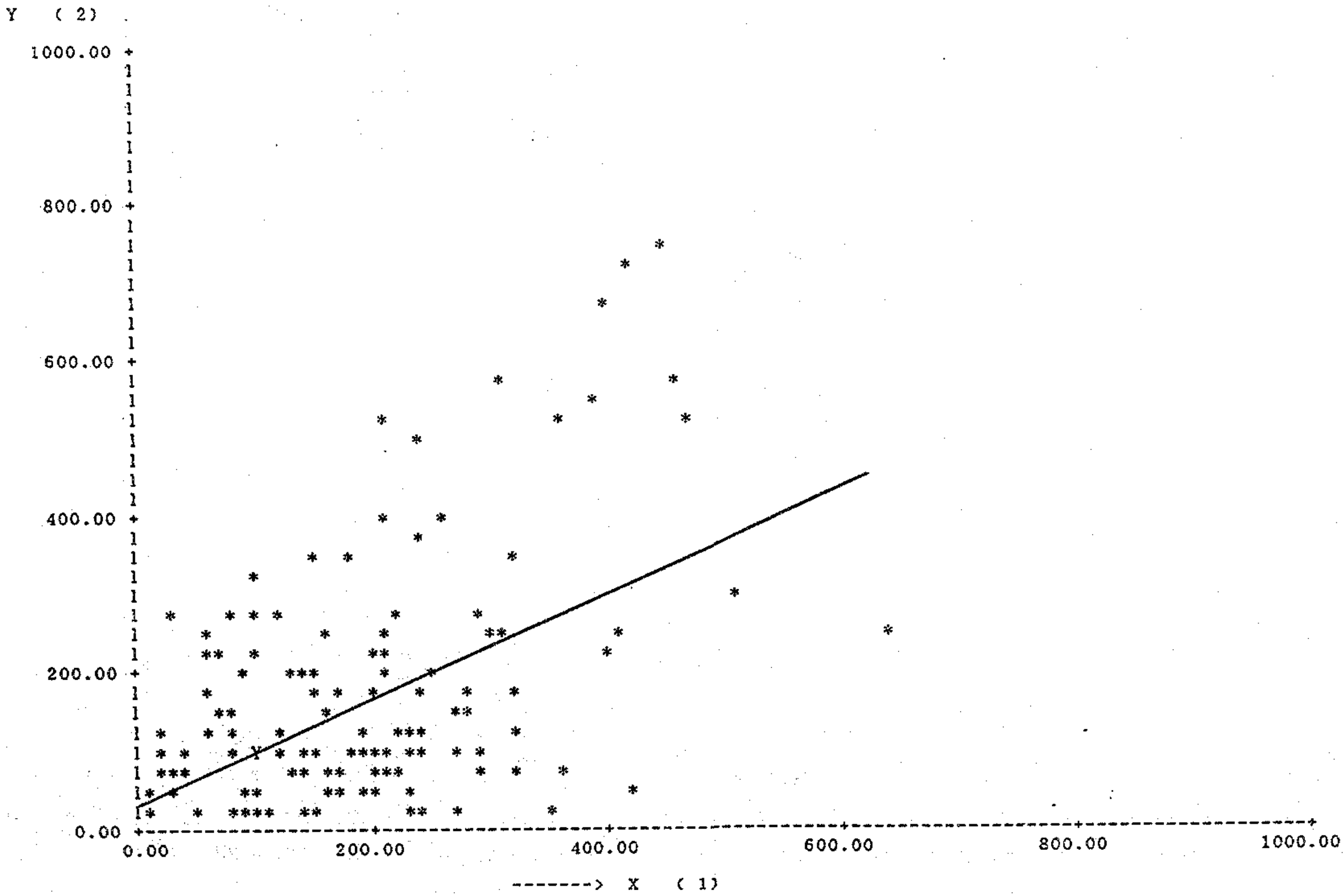
Y = 0.649 X + 56.458 (MM) R = 0.732
X = 0.826 Y + 37.553 (MM)



***** THE REGRESSION LINE OF CO-RELATION OF RAINFALL BETWEEN THUNG SONG AND RON PHIBUN *****

1973--1987

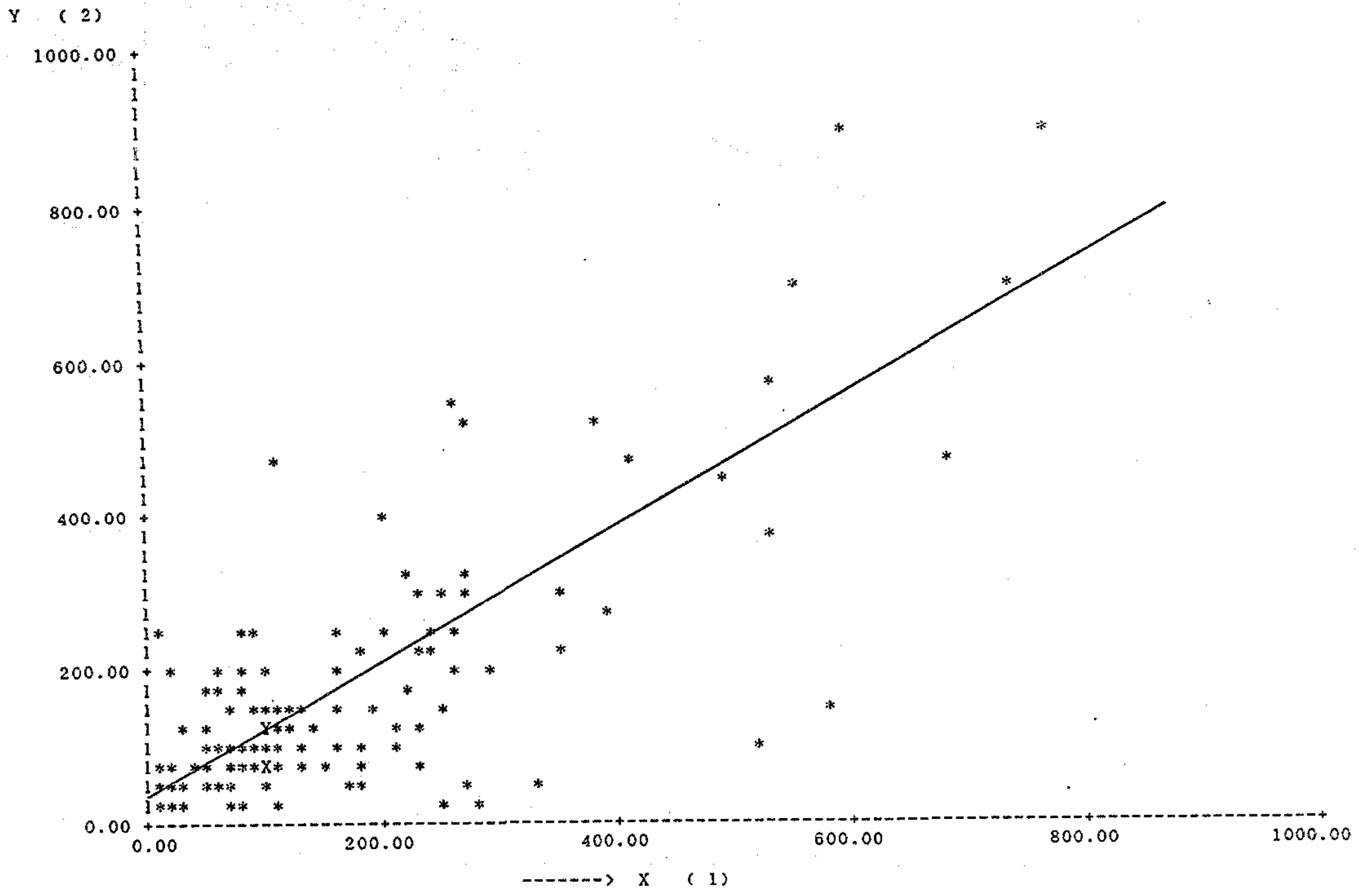
Y = 0.671 X + 34.597 (MM) R = 0.510
X = 0.387 Y + 125.210 (MM)



***** THE REGRESSION LINE OF CO-RELATION OF RAINFALL BETWEEN RON PHIBUN AND LAN SAKA *****

1973--1987

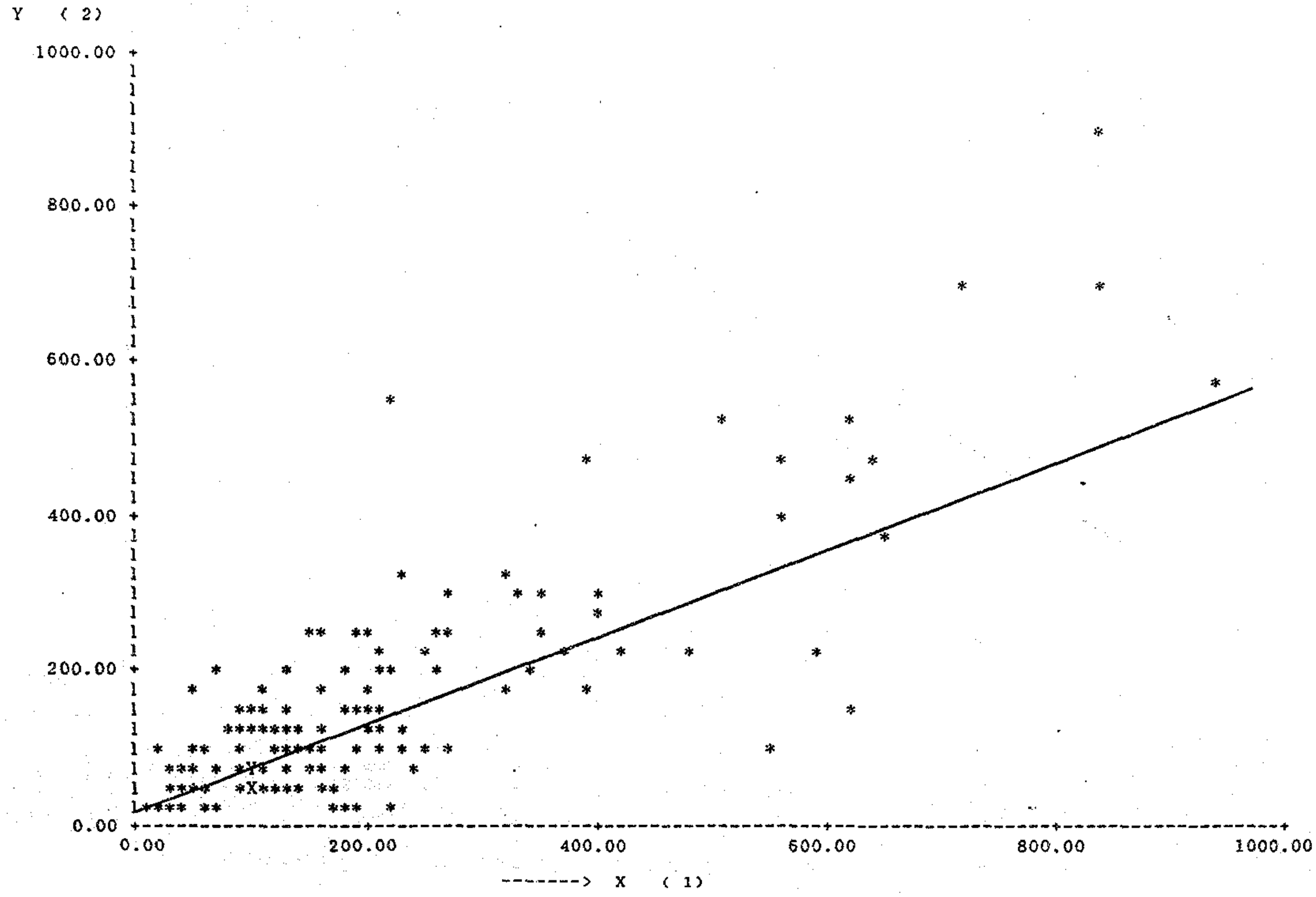
Y = 0.795 X + 37.098 (MM) R = 0.749
X = 0.705 Y + 44.645 (MM)



***** THE REGRESSION LINE OF CO-RELATION OF RAINFALL BETWEEN NAKORN SI THAMMARAT AND LAN*****

1973--1987

Y = 0.680 X + 18.829 (MM) R = 0.829
X = 1.010 Y + 40.788 (MM)



***** THE REGRESSION LINE OF CO-RELATION OF RAINFALL BETWEEN RON PHIBUN AND CHAWEANG *****

1973--1987

Y = 0.174 X + 146.806 (MM) R = 0.230
X = 0.304 Y + 91.949 (MM)

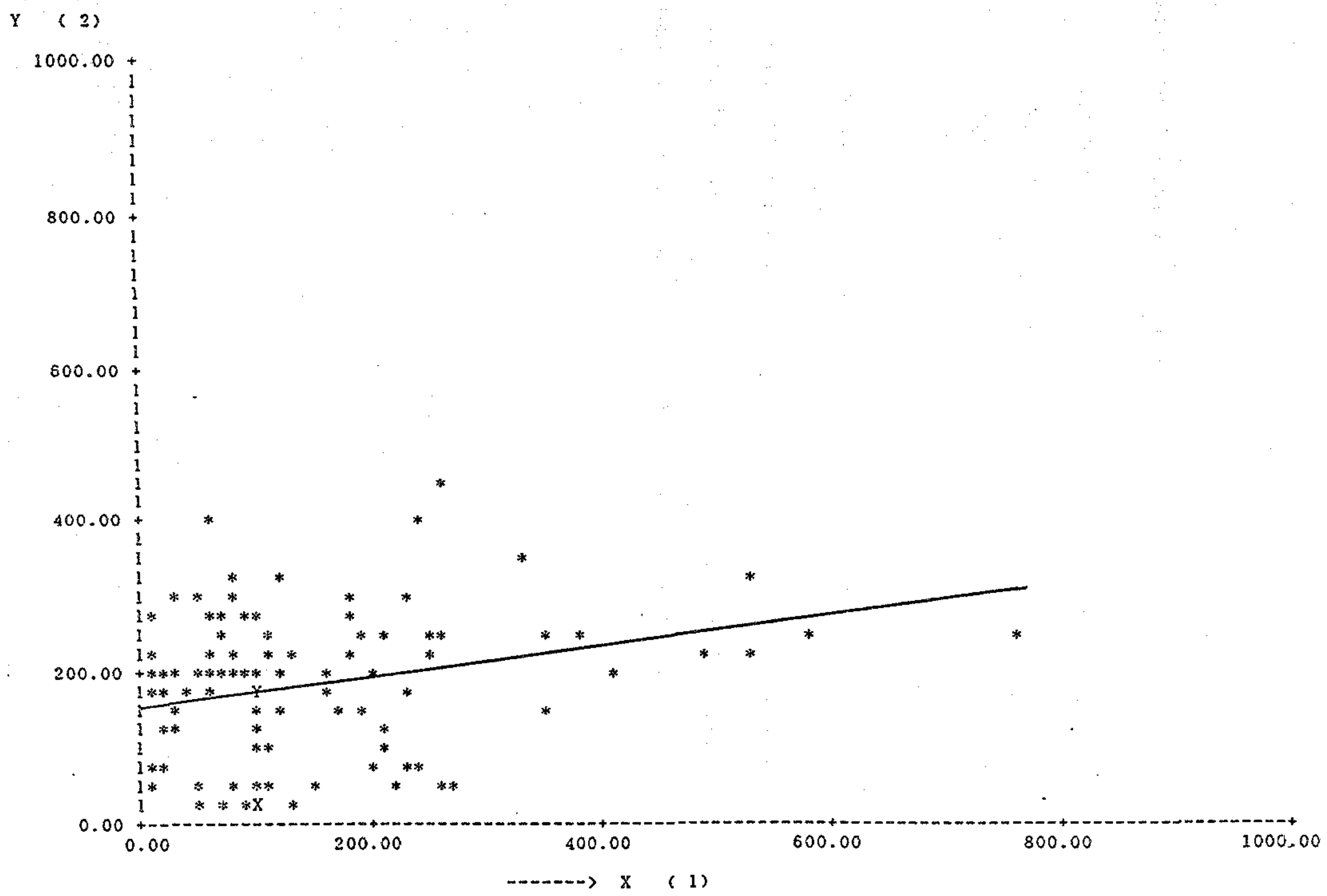


Table Ab-3-1 Co-relationship of Rainfall Stations

	THUNG	LAN	RON	OHAWENG	NAKON
THUGN	-	0.510	0.494	0.732	0.498
LAN	0.510	-	0.749	0.230	0.829
RON	0.494	0.749	-	0.205	0.858
CHAWENG	0.732	0.230	0.205	-	0.316
NAKON	0.498	0.829	0.858	0.316	-

Rainfall at Lan Saka = 0.68 x Nakon + 0.63 (mm)

Rainfall at Ron Phiboon = 0.702 x Nakon + 0.44 (mm)

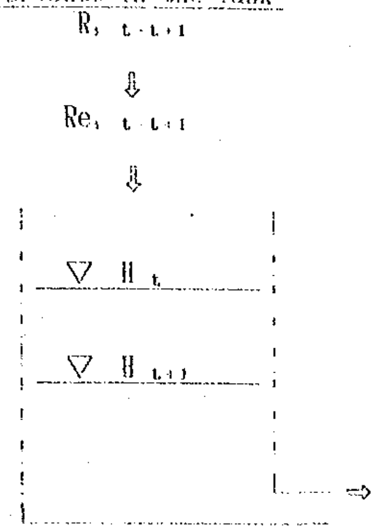
Rainfall at Thung Song = 1.049 x Chawang + 1.28 (mm)

6-3-2 Runoff Model

(1) Tank Model

(a) General

Water Balance in the Tank



Basic Equation

$Q = Qo \times e^{-Kt}$

The water balance in the tank is given by the following differential equation :

$$H_{t+1} = H_t + (Re,_{t-t+1} - (Q_t + Q_{t+1})/2)\,dt$$

where: H_{t+1} = water stage in the tank at t = t+1

H_t = -do- at t = t

$Re,_{t-t+1}$ = effective rain poured into tank during time t and t+1

Q_t = outflow from tank at t = t

Q_{t+1} = -do- at t = t+1

dt = time interval for calculation

Giving that dt = 1.0 day, $Q_t = KH_t$ and $Q_{t+1} = KH_{t+1}$, then ;

$$H_{t+1} = H_t + Re,_{t-t+1} - KH_{t+1}/2$$

$$H_{t+1} = (1-K/2)/(1+K/2)H_t + 1/(1+K/2)Re,_{t-t+1}$$

$$= aH_t + bRe,_{t-t+1}$$

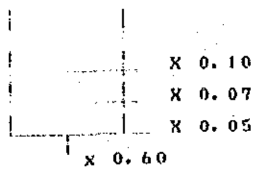
FIGURE A6-3-1 TANK MODEL AT X-70

Location X-70

Initial Water Depth (mm)

Catchment 39.0 km²

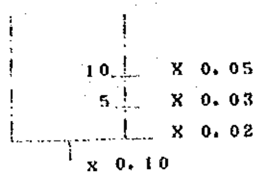
Top Tank



0

Studay Period 1976 - 1979 (4 yrs)

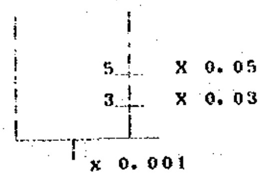
Second Tank



0

Areal Rainfall 1723 mm/yr in Study Period

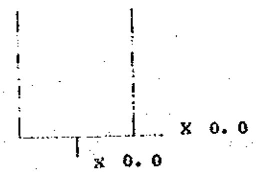
Third Tank



1 0 0

Rainfall Stayion	(%)		Adjusted
Lon Saka	100	X	1,047

Fourth Tank



0

Evapotranspiration (mm/day);

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2.2	2.9	3.0	3.2	2.8	3.1	3.0	3.2	2.6	2.4	1.9	2.1	

Note: Evapotranspiration = Potential Evapotranspiration X 0.7

Operation 1 : Evapotranspiration Subtracted from top to thirt tanks, from top tank when water in top tank, from second tank when no water in top tank, so on.

Operation 2 : Evapotranspiration reduced to 80% when rainy day.

Hydrological Water Balance (Average in study Period)

	Areal Rainfall (mm/yr)	Observed Runoff (mm/yr)	Computed Runoff (mm/yr)	Evapotrans-piration (mm/yr)	Ground Water Recharge (mm/yr)
Water Depth	1,723	1,938	1,448	288	0
Ratio		1,124	0,840	0.167	0

(2) Multiple Regression Model

(a) General

Runoff (Q) is generally explained in the following formula as rainfall (R) Funetion ;

$$Qi = f(R_{i1}, R_{i2}, R_{i3}, \ldots\ldots R_{in}) \quad \text{-------}(1)$$

where R_{i1} ; Today's Rainfall

R_{i2} ; Previous day's Rainfall

R_{i3} ; 2 days before Rainfall

Suppose that runoff is decribed as the linear combination of rainfall; formula (1) will be as follows,

$$Q_i = \beta_0 + \beta_1 R_{i1} + \beta_2 R_{i2} + \ldots\ldots + \beta_n R_{in} + \delta_i \quad \text{----}(2)$$

where,

β_0, β_1,----β_n ; unknown constant

δ_i ; Balance which can not be explained by R_{i1} .....-R_{in}.

Multiple regression analysis is to obtain the most reliable impartial estimate among these unknown parameters by

Now the balance square addition should be minimized in order to obtain the estimate of β_0, β_1, ... β_n, b_0, b_1, ... b_n

$$E = \Sigma \left\{ Q_i - (b_0 + b_1 R_{i1} + \ldots\ldots\ldots + b_n R_{i1}) \right\}^2 \quad \text{----}(3)$$

Namely

$$\left.\begin{aligned}
\frac{\alpha E}{\alpha b_0} &= -2\Sigma\left\{Q_i - (b_0 + b_1R_{i1} + \cdots\cdots\cdots + b_n R_{i1})\right\} = 0 \\
\frac{\alpha E}{\alpha b_1} &= -2\Sigma R_{i1}\left\{Q_i - (b_0 + b_1R_{i1} + \cdots\cdots + b_n R_{i1})\right\} = 0 \\
&\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots \\
&\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots \\
\frac{\alpha E}{\alpha b_n} &= -2\Sigma R_{i1}\left\{Q_i - (b_0 + b_1R_{i1} + \cdots\cdots + b_n R_{i1})\right\} = 0
\end{aligned}\right\} \text{---(4)}$$

By arranging the above equations, simultaneous equation can be obtained,

$$\left.\begin{aligned}
&n b_0 + (\Sigma R_{i1})\, b_1 + (\Sigma R_{i1})\, b_2 + \cdots\cdots + (\Sigma R_{i1})\, b_n = \Sigma Q_i \\
&(\Sigma R_{i1})\, b_0 + (\Sigma R_{i1}^2)\, b_1 + (\Sigma R_{i1} R_{i2})\, b_2 + \cdots + (\Sigma R_{i1} R_{in}) = \Sigma R_{i1} Q_i \\
&\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots \\
&\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots \\
&(\Sigma R_{i1}) b_0 + (\Sigma R_{i1} R_{i1}) b_1 + (\Sigma R_{i2} R_{in}) b_2 + \cdots + (\Sigma R_{i1}^2) b_n = \Sigma R_{i1} Q_i
\end{aligned}\right\} (5)$$

The quadratic term describing non-linear runoff will be the following equation;

$$\ell_1 = Q_i - E\,Q_i$$

$$\alpha_0 + \sum_{j=k}^{i+n} \sum_{k=j}^{i+n} \alpha_{jk} R_j R_k \quad E_i \text{ -------- (6)}$$

As the same way as linear equation, α_0, α_{ij} can be obtained by minimizing the balance aquare addition (7)

$$E = \Sigma\left\{\ell_1 - (a_0 + \sum_{j=k}^{i+n} \sum_{k=j}^{i+n} a_{jk} R_j R_k)\right\}^2 \text{ ------ (7)}$$

In order to minimize (7), the following formula must be formed.

$$\left.\begin{aligned} \frac{\alpha E}{\delta a_0} &= -2\Sigma \left\{ e_i - (a_0 + \sum_{j=k}^{i+n} \sum_{k=j}^{i+n} a_{jk} R_j R_k) \quad R_{i1}) \right\} = 0 \\ \frac{\alpha E}{\delta a_{em}} &= -2\Sigma\ R_i \cdot R_m + \left\{ e_i - (a_0 + \sum_{j=k}^{i+n} \sum_{k=j}^{i+n} a_{jk} R_j R_k) R_{i1}) \right\} = 0 \end{aligned}\right\} (8)$$

Now,

$$\gamma a_0 + \sum_{j=k}^{i+n} \sum_{k=j}^{i+n} a_{jk} R_j R_k = \Sigma e_I$$

$$(\Sigma R_\iota R_m)\, a_0 + \Sigma \left\{ R_\iota R_m \sum_{j=k}^{i+n} \sum_{k=j}^{i+n} a_{jk} R_j R_k \right\} = \Sigma R_\iota R_m\ e_i$$

RUNOFF ANALYSIS BY TANK MODEL (DAILY BASE)

- LOCATION : THUNG SONG
- ANALYSED POINT : X－70
  LAN SAKA
- CA : 39.000 (km²)

DIMENSION OF TANK

		UPPER HOLE	MIDDLE HOLE	LOWER HOLE	PENETRATION	EVAPORATION RATE
TANK 1	COEFF	0.100000	0.070000	0.050000	0.600000	1.000
	HEIGHT	60.0	30.0	0.0		
TANK 2	COEFF	0.050000	0.030000	0.020000	0.400000	0.0
	HEIGHT	10.0	5.0	0.0		
TANK 3	COEFF	0.050000	0.030000	0.025000	0.001000	0.0
	HEIGHT	5.0	3.0	0.0		
TANK 4	COEFF	0.0	0.0	0.0	0.0	0.0
	HEIGHT	0.0	0.0	0.0		

【MONTHLY EVAPORATION】

(mm/D)

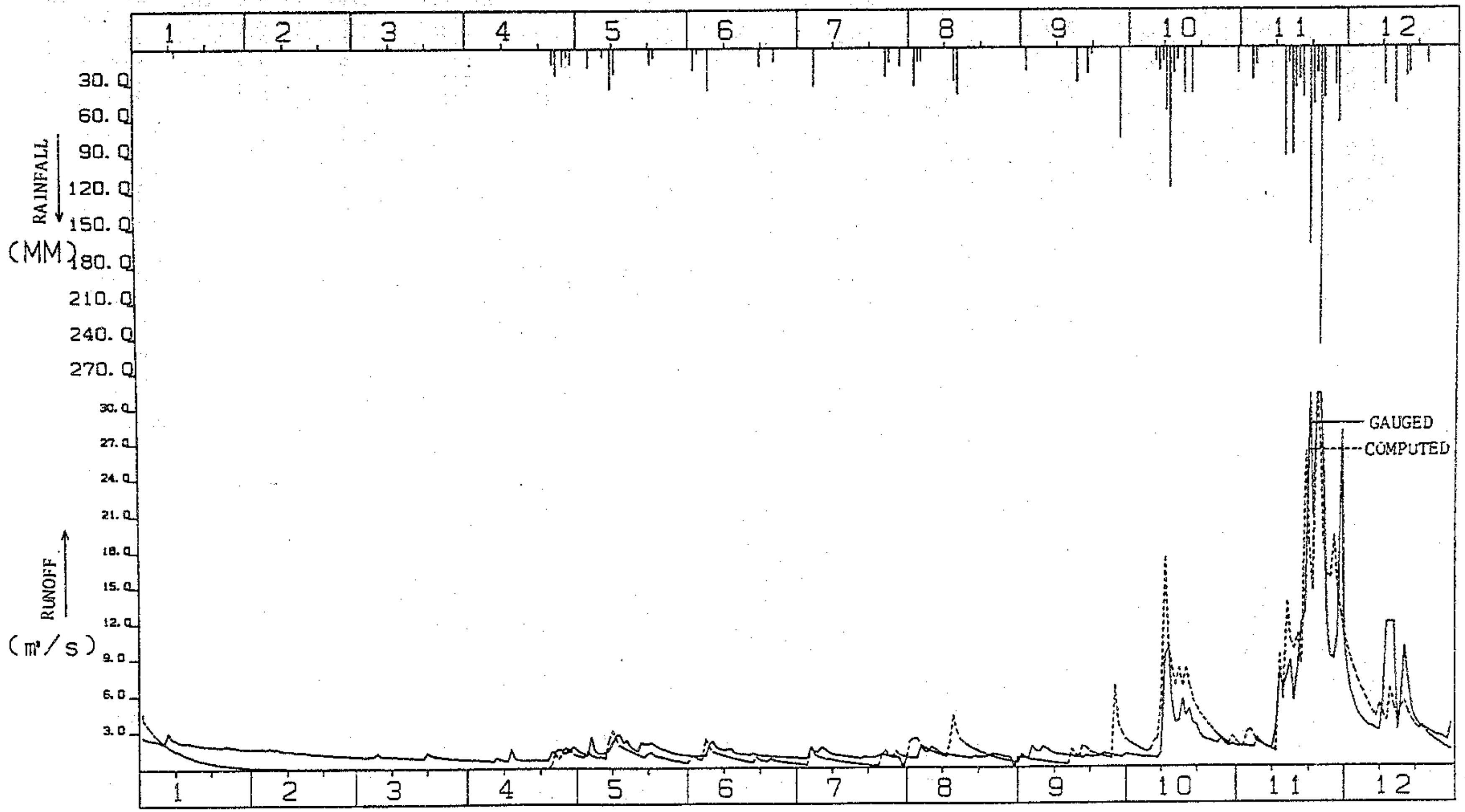
	1	2	3	4	5	6	7	8	9	10	11	12
RATE	2.20	2.90	3.00	3.20	2.80	3.10	3.00	3.20	2.60	2.40	1.90	2.10

RUNOFF ANALYSIS BY TANK MODEL

(1976)

RAINFALL STATION: LAN SAKA

COEFFICIET = 0.8132



GAUGING STATION : X-70 (CA = 39.00 km²)

< DAILY RAINFALL > THUNG SONG
(1976) LAN SAKA

UNIT = (mm/D)

	1 JAN	2 FEB	3 MAR	4 APR	5 MAY	6 JUN	7 JUL	8 AUG	9 SEP	10 OCT	11 NOV	12 DEC	
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2	0.0	0.0	0.0	0.0	0.0	17.8	0.0	31.4	18.8	0.0	0.0	0.0	
3	0.0	0.0	0.0	0.0	0.0	4.2	0.0	10.5	0.0	0.0	0.0	0.0	
4	0.0	0.0	0.0	0.0	15.2	0.0	0.0	10.5	0.0	0.0	26.2	0.0	
5	0.0	0.0	0.0	0.0	0.0	0.0	31.4	0.0	0.0	0.0	13.6	0.0	
	(0.0)	(0.0)	(0.0)	(0.0)	(15.2)	(22.0)	(31.4)	(52.3)	(18.8)	(0.0)	(39.8)	(0.0)	
AVERAGE	< 0.0>	< 0.0>	< 0.0>	< 0.0>	< 3.0>	< 4.4>	< 6.3>	< 10.5>	< 3.8>	< 0.0>	< 8.0>	< 0.0>	
6	0.0	0.0	0.0	0.0	0.0	34.6	0.0	0.0	0.0	0.0	0.0	0.0	
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
8	0.0	0.0	0.0	0.0	6.3	0.0	0.0	0.0	0.0	10.5	0.0	0.0	
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	18.8	0.0	0.0	
10	0.0	0.0	0.0	0.0	33.5	0.0	0.0	0.0	0.0	10.5	0.0	0.0	
	(0.0)	(0.0)	(0.0)	(0.0)	(39.8)	(34.6)	(0.0)	(0.0)	(0.0)	(39.8)	(0.0)	(0.0)	
AVERAGE	< 0.0>	< 0.0>	< 0.0>	< 0.0>	< 8.0>	< 6.9>	< 0.0>	< 0.0>	< 0.0>	< 8.0>	< 0.0>	< 0.0>	
11	0.0	0.0	0.0	0.0	20.9	0.0	0.0	0.0	0.0	52.3	0.0	31.4	
12	5.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	116.2	0.0	0.0	
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	27.2	0.0	20.9	90.0	0.0	
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	38.7	0.0	9.4	12.6	47.1	
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	89.0	0.0	
	(5.2)	(0.0)	(0.0)	(0.0)	(20.9)	(0.0)	(0.0)	(66.0)	(0.0)	(198.9)	(191.6)	(78.5)	
AVERAGE	< 1.0>	< 0.0>	< 0.0>	< 0.0>	< 4.2>	< 0.0>	< 0.0>	< 13.2>	< 0.0>	< 39.8>	< 38.3>	< 15.7>	
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	28.3	37.7	33.5	0.0	
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	26.2	24.1	
18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	37.7	41.9	20.9	
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.9	0.0	0.0	0.0	
20	0.0	0.0	0.0	0.0	0.0	14.7	0.0	0.0	5.2	0.0	163.3	0.0	
	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(14.7)	(0.0)	(0.0)	(54.4)	(75.4)	(264.9)	(45.0)	
AVERAGE	< 0.0>	< 0.0>	< 0.0>	< 0.0>	< 0.0>	< 2.9>	< 0.0>	< 0.0>	< 10.9>	< 15.1>	< 53.0>	< 9.0>	
21	0.0	0.0	0.0	0.0	12.6	0.0	0.0	0.0	0.0	0.0	47.1	0.0	
22	0.0	0.0	0.0	0.0	7.3	0.0	0.0	0.0	0.0	0.0	20.9	0.0	
23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	246.0	13.6	
24	0.0	0.0	0.0	12.6	0.0	10.5	0.0	0.0	0.0	0.0	41.9	0.0	
25	0.0	0.0	0.0	22.0	0.0	0.0	23.0	0.0	0.0	0.0	0.0	0.0	
	(0.0)	(0.0)	(0.0)	(34.6)	(19.9)	(10.5)	(23.0)	(0.0)	(0.0)	(0.0)	(356.0)	(13.6)	
AVERAGE	< 0.0>	< 0.0>	< 0.0>	< 6.9>	< 4.0>	< 2.1>	< 4.6>	< 0.0>	< 0.0>	< 0.0>	< 71.2>	< 2.7>	
26	0.0	0.0	0.0	0.0	0.0	0.0	11.5	0.0	0.0	0.0	0.0	0.0	
27	0.0	0.0	0.0	13.6	0.0	0.0	0.0	0.0	0.0	0.0	31.4	0.0	
28	0.0	0.0	0.0	6.3	0.0	0.0	0.0	0.0	75.4	0.0	62.8	0.0	
29	0.0	0.0	0.0	12.6	0.0	0.0	14.7	0.0	0.0	0.0	0.0	0.0	
30	0.0	**********	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
31	0.0	**********	0.0	**********	0.0	**********	0.0	0.0	**********	20.9	**********	0.0	
	(0.0)	(0.0)	(0.0)	(32.5)	(0.0)	(0.0)	(26.2)	(0.0)	(75.4)	(20.9)	(94.2)	(0.0)	
AVERAGE	< 0.0>	< 0.0>	< 0.0>	< 6.5>	< 0.0>	< 0.0>	< 4.4>	< 0.0>	< 15.1>	< 3.5>	< 18.8>	< 0.0>	
GRAND_TOTAL	5.2	0.0	0.0	67.0	95.8	81.7	80.6	118.3	148.7	335.0	946.5	137.2	2016.0
AVERAGE	0.2	0.0	0.0	2.2	3.1	2.7	2.6	3.8	5.0	10.8	31.5	4.4	5.5
MAX	5.2	0.0	0.0	22.0	33.5	34.6	31.4	38.7	75.4	116.2	246.0	47.1	
MIN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

GAUGED
DAILY RUNOFF < THUNG SONG LAN SAKA > (1976)

UNIT = (mm/D)

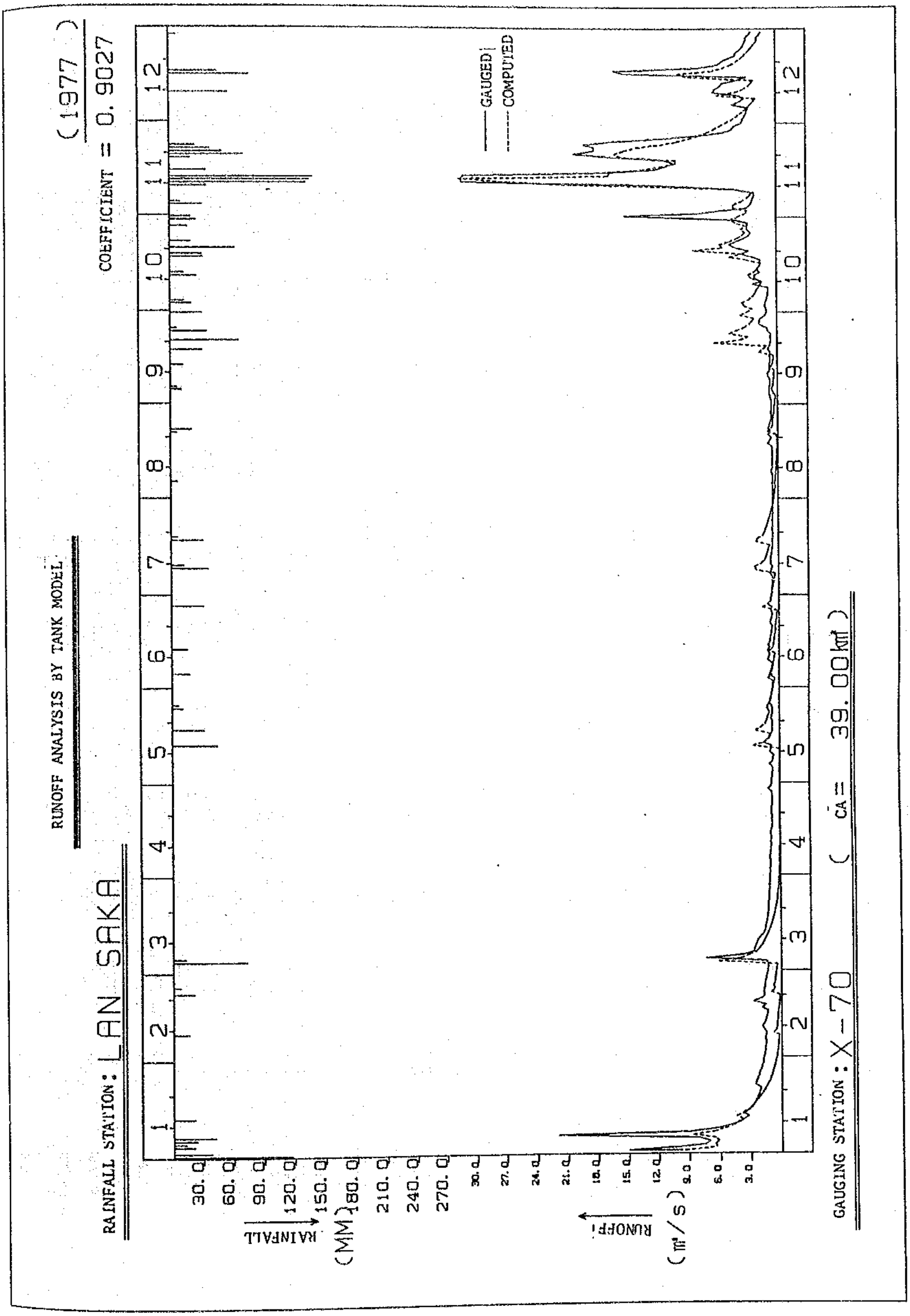
	1 JAN	2 FEB	3 MAR	4 APR	5 MAY	6 JUN	7 JUL	8 AUG	9 SEP	10 OCT	11 NOV	12 DEC		
1	2.650	1.650	1.030	0.770	1.500	1.070	0.850	0.850	0.850	1.070	1.700	11.000		
2	2.590	1.650	1.030	0.730	1.300	1.030	0.810	0.810	0.810	0.980	1.650	8.010		
3	2.470	1.650	0.980	0.730	1.210	0.980	0.810	0.810	0.810	0.940	1.700	6.170		
4	2.410	1.700	0.980	0.690	1.070	0.980	0.810	0.810	0.810	0.890	1.650	5.250		
5	2.350	1.600	1.030	0.650	2.590	1.070	1.750	1.750	1.750	0.850	1.600	4.500		
	(12.470)	(8.250)	(5.050)	(3.570)	(7.670)	(5.130)	(5.030)	(5.030)	(5.030)	(4.730)	(8.300)	(34.930)		
AVERAGE	<2.494>	<1.650>	<1.010>	<0.714>	<1.534>	<1.026>	<1.006>	<1.006>	<1.006>	<0.946>	<1.660>	<6.986>		
6	2.290	1.700	1.030	0.650	1.450	1.030	1.350	1.350	1.350	0.810	1.550	4.000		
7	2.180	1.600	1.300	0.610	1.210	1.960	1.300	1.300	1.300	0.810	2.350	3.580		
8	2.130	1.650	1.030	0.570	1.250	2.240	1.700	1.700	1.700	0.770	1.910	3.300		
9	3.020	1.500	1.030	0.890	1.250	1.700	1.500	1.500	1.500	0.770	1.700	3.300		
10	2.470	1.450	0.980	0.690	1.550	1.550	1.300	1.300	1.300	0.730	1.550	3.020		
	(12.090)	(7.900)	(5.370)	(3.410)	(6.710)	(8.480)	(7.150)	(7.150)	(7.150)	(3.890)	(9.060)	(17.200)		
AVERAGE	<2.418>	<1.580>	<1.074>	<0.682>	<1.342>	<1.696>	<1.430>	<1.430>	<1.430>	<0.778>	<1.812>	<3.440>		
11	2.410	1.450	0.980	0.650	2.070	1.450	1.120	1.120	1.120	1.100	1.500	2.950		
12	2.240	1.450	0.980	0.610	2.650	1.500	1.070	1.070	1.070	9.160	3.020	5.700		
13	2.180	1.400	0.940	1.600	2.770	1.550	1.030	1.030	1.030	10.000	7.750	12.000		
14	2.180	1.400	0.940	0.810	2.070	1.210	0.980	0.980	0.980	5.550	6.490	12.000		
15	2.130	1.400	0.940	0.690	2.290	1.160	0.940	0.940	0.940	3.650	7.410	12.000		
	(11.140)	(7.100)	(4.780)	(4.360)	(11.850)	(6.870)	(5.140)	(5.140)	(5.140)	(29.460)	(26.170)	(44.650)		
AVERAGE	<2.228>	<1.420>	<0.956>	<0.872>	<2.370>	<1.374>	<1.028>	<1.028>	<1.028>	<5.892>	<5.234>	<8.930>		
16	2.070	1.350	0.890	0.650	1.800	1.120	0.890	0.890	0.890	3.790	8.800	3.020		
17	2.020	1.300	0.890	0.650	1.550	1.120	0.850	0.850	0.850	5.620	5.530	5.470		
18	1.960	1.250	0.850	0.650	1.400	1.070	0.810	0.810	0.810	4.280	8.260	9.970		
19	1.910	1.250	0.850	0.730	2.070	1.210	0.770	0.770	0.770	4.800	12.000	7.070		
20	1.910	1.210	0.850	0.690	2.020	1.070	0.940	0.940	0.940	3.580	13.000	4.720		
	(9.870)	(6.360)	(4.330)	(3.370)	(8.840)	(5.590)	(4.260)	(4.260)	(4.260)	(22.070)	(47.590)	(30.250)		
AVERAGE	<1.974>	<1.272>	<0.866>	<0.674>	<1.768>	<1.118>	<0.852>	<0.852>	<0.852>	<4.414>	<9.518>	<6.050>		
21	1.850	1.210	1.350	0.650	2.020	1.030	0.850	0.850	0.850	3.440	38.000	3.930		
22	1.850	1.160	1.070	0.650	2.070	0.980	0.850	0.850	0.850	2.650	21.000	3.440		
23	1.800	1.160	1.030	0.650	1.850	0.980	0.850	0.850	0.850	2.290	45.000	3.160		
24	1.800	1.120	0.980	1.400	1.700	0.940	0.980	0.980	0.980	2.180	71.000	3.020		
25	1.910	1.120	0.940	1.350	1.550	0.940	1.120	1.120	1.120	2.130	24.000	2.830		
	(9.210)	(5.770)	(5.370)	(4.700)	(9.190)	(4.870)	(4.650)	(4.650)	(4.650)	(12.690)	(199.000)	(16.380)		
AVERAGE	<1.842>	<1.154>	<1.074>	<0.940>	<1.838>	<0.974>	<0.930>	<0.930>	<0.930>	<2.538>	<39.800>	<3.276>		
26	1.800	1.120	0.890	1.600	1.450	0.890	1.030	1.030	1.030	2.020	12.000	2.650		
27	1.800	1.070	0.850	1.450	1.350	0.890	0.980	0.980	0.980	1.910	9.160	2.470		
28	1.750	1.070	0.810	1.700	1.250	0.890	0.890	0.890	0.890	2.350	8.890	2.470		
29	1.700	1.030	0.810	1.350	1.160	0.850	0.850	0.850	0.850	1.850	11.000	2.290		
30	1.700	*********	0.770	1.800	1.120	0.850	0.810	0.810	0.810	1.700	28.000	2.130		
31	1.650	*********	0.770	*********	1.070	*********	0.0	0.0	*********	1.800	*********	3.510		
	(10.400)	(4.290)	(4.900)	(7.900)	(7.400)	(4.370)	(4.560)	(4.560)	(4.560)	(11.630)	(69.050)	(15.520)		
AVERAGE	<1.733>	<1.072>	<0.817>	<1.580>	<1.233>	<0.874>	<0.760>	<0.760>	<0.912>	<1.938>	<13.810>	<2.587>		
GRAND TOTAL	65.180	39.670	29.800	27.310	51.660	35.310	30.790	30.790	30.790	84.470	359.170	158.930	943.869	(m³/s)
	144.	88.	66.	61.	114.	78.	68.	68.	68.	187.	796.	352.	2091.	(mm)
AVERAGE	2.103	1.368	0.961	0.910	1.666	1.177	0.993	0.993	1.026	2.725	11.972	5.127	2.579	(m³/s)
MAX	3.020	1.700	1.350	1.800	2.770	2.240	1.750	1.750	1.750	10.000	71.000	12.000		(m³/s)
MIN	1.650	1.030	0.770	0.570	1.070	0.850	0.0	0.0	0.770	0.730	1.500	2.130		(m³/s)

COMPUTED

< DAILY RUNOFF > THUNG SONG
(1976) LAN SAKA

UNIT = (mm/D)

	1 JAN	2 FEB	3 MAR	4 APR	5 MAY	6 JUN	7 JUL	8 AUG	9 SEP	10 OCT	11 NOV	12 DEC		
1	4.586	0.151	0.027	0.012	1.072	0.413	0.336	0.859	0.397	2.272	2.079	11.103		
2	4.100	0.135	0.026	0.012	0.996	1.000	0.301	2.258	1.058	2.045	1.789	9.879		
3	3.665	0.121	0.026	0.011	0.912	0.916	0.270	2.355	0.790	1.864	1.639	8.860		
4	3.276	0.108	0.025	0.011	1.360	0.716	0.241	2.414	0.673	1.694	2.739	7.956		
5	2.929	0.096	0.024	0.011	1.060	0.680	1.656	1.834	0.636	1.531	3.067	7.132		
	(18.556)(	0.611)(	0.129)(	0.057)(	5.400)(	3.726)(	2.804)(	9.719)(	3.554)(	9.406)(	11.313)(	44.930)		
AVERAGE	< 3.711><	0.122><	0.026><	0.011><	1.080><	0.745><	0.561><	1.944><	0.711><	1.881><	2.263><	8.986>		
6	2.618	0.086	0.024	0.011	0.954	2.364	1.200	1.620	0.588	1.378	2.487	6.388		
7	2.341	0.080	0.023	0.010	0.880	1.754	0.893	1.484	0.537	1.237	2.062	5.718		
8	2.092	0.075	0.023	0.010	0.939	1.326	0.828	1.355	0.487	1.427	1.871	5.115		
9	1.870	0.071	0.022	0.010	0.795	1.210	0.774	1.227	0.439	2.142	1.708	4.575		
10	1.672	0.067	0.021	0.009	2.367	1.120	0.711	1.107	0.395	2.321	1.548	4.091		
	(10.594)(	0.379)(	0.113)(	0.050)(	5.934)(	7.774)(	4.406)(	6.792)(	2.446)(	8.505)(	9.677)(	25.888)		
AVERAGE	< 2.119><	0.076><	0.023><	0.010><	1.187><	1.555><	0.881><	1.358><	0.489><	1.701><	1.935><	5.178>		
11	1.495	0.063	0.021	0.009	3.085	1.024	0.647	0.995	0.354	5.806	1.396	5.156		
12	1.456	0.060	0.020	0.009	2.401	0.929	0.585	0.892	0.317	17.468	1.255	4.380		
13	1.255	0.056	0.020	0.009	1.853	0.838	0.527	1.977	0.284	10.109	9.329	3.727		
14	1.130	0.053	0.019	0.009	1.681	0.753	0.473	4.295	0.254	8.202	5.612	6.464		
15	1.015	0.050	0.019	0.008	1.540	0.676	0.424	2.968	0.227	6.767	13.767	4.953		
	(6.350)(	0.282)(	0.099)(	0.044)(	10.560)(	4.220)(	2.657)(	11.127)(	1.435)(	48.351)(	31.360)(	24.679)		
AVERAGE	< 1.270><	0.056><	0.020><	0.009><	2.112><	0.844><	0.531><	2.225><	0.287><	9.670><	6.272><	4.936>		
16	0.910	0.047	0.018	0.008	1.403	0.606	0.380	2.278	1.476	8.188	10.488	4.124		
17	0.815	0.045	0.018	0.008	1.270	0.542	0.340	1.982	1.074	6.668	9.795	4.924		
18	0.730	0.042	0.017	0.008	1.144	0.485	0.304	1.802	0.814	8.200	11.072	5.412		
19	0.653	0.040	0.017	0.007	1.028	0.434	0.272	1.645	1.725	6.645	8.534	4.524		
20	0.584	0.037	0.016	0.007	0.922	0.869	0.243	1.490	1.612	5.605	26.299	3.780		
	(3.692)(	0.211)(	0.087)(	0.038)(	5.767)(	2.935)(	1.538)(	9.197)(	6.700)(	35.307)(	66.188)(	22.763)		
AVERAGE	< 0.738><	0.042><	0.017><	0.008><	1.153><	0.587><	0.308><	1.839><	1.340><	7.061><	13.238><	4.553>		
21	0.522	0.035	0.016	0.007	1.223	0.612	0.217	1.343	1.242	4.929	18.794	3.390		
22	0.467	0.034	0.016	0.007	1.289	0.565	0.194	1.207	1.126	4.434	14.711	3.067		
23	0.417	0.033	0.015	0.007	1.017	0.527	0.173	1.083	1.043	4.000	43.182	3.274		
24	0.373	0.032	0.015	0.302	0.947	0.777	0.155	0.970	0.953	3.596	26.711	2.809		
25	0.333	0.031	0.014	1.238	0.869	0.585	1.067	0.869	0.864	3.227	18.891	2.507		
	(2.111)(	0.164)(	0.076)(	1.561)(	5.346)(	3.067)(	1.806)(	5.473)(	5.227)(	20.185)(	122.289)(	15.048)		
AVERAGE	< 0.422><	0.033><	0.015><	0.312><	1.069><	0.613><	0.361><	1.095><	1.045><	4.037><	24.458><	3.010>		
26	0.298	0.030	0.014	0.811	0.789	0.548	1.408	0.777	0.779	2.892	16.043	2.270		
27	0.266	0.029	0.014	1.280	0.713	0.504	0.972	0.695	0.700	2.589	15.795	2.046		
28	0.238	0.029	0.013	1.243	0.642	0.459	0.843	0.622	6.712	2.317	19.319	1.839		
29	0.212	0.028	0.013	1.604	0.576	0.415	1.328	0.556	3.589	2.073	14.785	1.650		
30	0.190	*********	0.013	1.192	0.516	0.374	1.023	0.497	2.802	1.854	12.759	1.478		
31	0.169	*********	0.012	*********	0.462	*********	0.927	0.444	*********	2.497	*********	1.323		
	(1.372)(	0.116)(	0.079)(	6.130)(	3.698)(	2.301)(	6.502)(	3.590)(	14.582)(	14.221)(	78.702)(	10.606)		
AVERAGE	< 0.229><	0.029><	0.013><	1.226><	0.616><	0.460><	1.084><	0.598><	2.916><	2.370><	15.740><	1.768>		
GRAND TOTAL	42.676	1.763	0.584	7.881	36.705	24.023	19.713	45.898	33.944	135.975	319.527	143.913	812.602	(m³/s)
AVERAGE	95.	4.	1.	17.	81.	53.	44.	102.	75.	301.	708.	319.	1800.	(mm)
MAX	1.377	0.061	0.019	0.263	1.184	0.801	0.636	1.481	1.131	4.386	10.651	4.642	2.220	(m³/s)
MIN	4.586	0.151	0.027	1.604	3.085	2.364	1.656	4.295	6.712	17.468	43.182	11.103		(m³/s)
	0.169	0.028	0.012	0.007	0.462	0.374	0.155	0.444	0.227	1.237	1.255	1.323		(m³/s)


RUNOFF ANALYSIS BY TANK MODEL
RAINFALL STATION : LAN SAKA
(1977)
COEFFICIENT = 0.9027
GAUGING STATION : X-70
(CA = 39.00 km²)
GAUGED
COMPUTED
RAINFALL
(MM)
RUNOFF
(m³/s)
30.0
60.0
90.0
120.0
150.0
180.0
210.0
240.0
270.0
27.0
24.0
21.0
18.0
15.0
12.0
9.0
6.0
3.0
1
2
3
4
5
6
7
8
9
10
11
12

< DAILY RAINFALL > THUNG SONG LAN SAKA (1977)

UNIT = (mm/D)

	1 JAN	2 FEB	3 MAR	4 APR	5 MAY	6 JUN	7 JUL	8 AUG	9 SEP	10 OCT	11 NOV	12 DEC	
1	117.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2	37.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.9	0.0	0.0	
4	20.9	0.0	73.3	0.0	0.0	0.0	0.0	0.0	0.0	13.6	32.5	0.0	
5	12.6	0.0	12.6	0.0	0.0	17.8	0.0	0.0	10.5	0.0	10.5	0.0	
	(188.5)	(0.0)	(85.9)	(0.0)	(0.0)	(17.8)	(0.0)	(0.0)	(10.5)	(34.6)	(42.9)	(0.0)	
AVERAGE	<37.7>	<0.0>	<17.2>	<0.0>	<0.0>	<3.6>	<0.0>	<0.0>	<2.1>	<6.9>	<8.6>	<0.0>	
6	23.0	0.0	0.0	0.0	0.0	0.0	0.0	6.3	6.3	0.0	0.0	0.0	
7	41.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
9	0.0	15.7	0.0	0.0	0.0	0.0	36.6	0.0	0.0	0.0	0.0	0.0	
10	0.0	0.0	0.0	0.0	0.0	0.0	12.6	0.0	0.0	0.0	36.6	58.6	
	(64.9)	(15.7)	(0.0)	(0.0)	(0.0)	(0.0)	(49.2)	(6.3)	(6.3)	(0.0)	(36.6)	(58.6)	
AVERAGE	<13.0>	<3.1>	<0.0>	<0.0>	<0.0>	<0.0>	<9.8>	<1.3>	<1.3>	<0.0>	<7.3>	<11.7>	
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	135.1	0.0	
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	26.2	138.2	0.0	
13	20.9	0.0	0.0	0.0	45.0	15.7	0.0	0.0	12.6	13.6	141.3	0.0	
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	36.6	0.0	
	(20.9)	(0.0)	(0.0)	(0.0)	(45.0)	(15.7)	(0.0)	(0.0)	(12.6)	(39.8)	(451.3)	(0.0)	
AVERAGE	<4.2>	<0.0>	<0.0>	<0.0>	<9.0>	<3.1>	<0.0>	<0.0>	<2.5>	<8.0>	<90.3>	<0.0>	
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	79.6	
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	48.2	
18	0.0	0.0	0.0	0.0	31.4	0.0	31.4	0.0	31.4	32.5	0.0	0.0	
19	0.0	0.0	0.0	0.0	0.0	0.0	6.3	0.0	0.0	31.4	20.9	0.0	
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	73.3	0.0	
	(0.0)	(0.0)	(0.0)	(0.0)	(31.4)	(0.0)	(37.7)	(0.0)	(31.4)	(63.9)	(94.2)	(127.7)	
AVERAGE	<0.0>	<0.0>	<0.0>	<0.0>	<6.3>	<0.0>	<7.5>	<0.0>	<6.3>	<12.8>	<18.8>	<25.5>	
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	68.1	64.9	52.3	0.0	
22	0.0	20.9	0.0	0.0	0.0	0.0	0.0	6.3	0.0	0.0	39.8	0.0	
23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.9	0.0	20.9	25.1	0.0	
24	0.0	7.3	0.0	0.0	0.0	0.0	0.0	0.0	36.6	0.0	0.0	0.0	
25	0.0	0.0	0.0	0.0	10.5	0.0	0.0	0.0	6.3	0.0	0.0	0.0	
	(0.0)	(28.3)	(0.0)	(0.0)	(10.5)	(0.0)	(0.0)	(27.2)	(111.0)	(85.9)	(117.3)	(0.0)	
AVERAGE	<0.0>	<5.7>	<0.0>	<0.0>	<2.1>	<0.0>	<0.0>	<5.4>	<22.2>	<17.2>	<23.5>	<0.0>	
26	0.0	0.0	0.0	0.0	6.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
27	0.0	0.0	0.0	0.0	0.0	31.4	0.0	0.0	0.0	0.0	0.0	0.0	
28	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.8	0.0	0.0	
29	0.0	*********	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.3	
30	0.0	*********	0.0	0.0	0.0	0.0	0.0	0.0	31.4	26.2	0.0	0.0	
31	0.0	*********	0.0	*********	0.0	*********	0.0	0.0	*********	20.9	*********	0.0	
	(0.0)	(0.0)	(0.0)	(0.0)	(6.3)	(31.4)	(0.0)	(0.0)	(31.4)	(64.9)	(0.0)	(7.3)	
AVERAGE	<0.0>	<0.0>	<0.0>	<0.0>	<1.0>	<6.3>	<0.0>	<0.0>	<6.3>	<10.8>	<0.0>	<1.2>	
GRAND TOTAL	274.3	44.0	85.9	0.0	93.2	64.9	86.9	33.5	203.1	289.0	742.3	193.7	2110.7
AVERAGE	8.8	1.6	2.8	0.0	3.0	2.2	2.8	1.1	6.8	9.3	24.7	6.2	5.8
MAX	117.3	20.9	73.3	0.0	45.0	31.4	36.6	20.9	68.1	64.9	141.3	79.6	
MIN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

< GAUGED DAILY RUNOFF > (1977) THUNG SONG LAN SAKA

UNIT = (mm/D)

	1 JAN	2 FEB	3 MAR	4 APR	5 MAY	6 JUN	7 JUL	8 AUG	9 SEP	10 OCT	11 NOV	12 DEC		
1	9.970	1.750	1.350	1.070	0.810	0.650	0.730	0.530	0.610	1.030	15.000	3.440		
2	15.000	1.700	1.300	1.030	0.850	0.650	0.690	0.530	0.610	1.070	7.670	3.300		
3	10.000	1.600	1.300	1.030	0.770	0.610	0.650	0.530	0.730	1.210	5.470	3.160		
4	7.410	1.600	1.450	0.980	0.770	1.120	0.650	0.530	0.810	1.120	2.950	2.950		
5	7.070	1.550	7.330	0.980	0.730	0.770	0.610	0.530	0.810	1.030	2.590	2.830		
	(49.450)	(8.200)	(12.730)	(5.090)	(3.930)	(3.800)	(3.330)	(2.650)	(3.570)	(5.460)	(33.680)	(15.680)		
AVERAGE	< 9.890>	< 1.640>	< 2.546>	< 1.018>	< 0.786>	< 0.760>	< 0.666>	< 0.530>	< 0.714>	< 1.092>	< 6.736>	< 3.136>		
6	8.090	1.500	3.790	0.980	0.730	0.890	0.610	0.570	0.810	0.940	2.410	2.710		
7	22.000	1.600	2.650	1.070	1.030	0.770	0.610	0.530	0.770	0.890	2.290	4.280		
8	8.980	1.550	2.590	0.980	0.730	0.730	0.890	0.530	0.730	0.850	2.180	3.580		
9	6.410	1.450	2.470	0.940	0.650	0.690	0.690	0.570	0.770	0.850	2.180	3.090		
10	5.020	1.700	2.350	0.940	0.610	1.160	0.650	0.690	0.890	2.350	4.420	3.650		
	(50.500)	(7.800)	(13.850)	(4.910)	(3.750)	(4.240)	(3.450)	(2.890)	(3.970)	(5.880)	(13.480)	(17.310)		
AVERAGE	< 10.100>	< 1.560>	< 2.770>	< 0.982>	< 0.750>	< 0.848>	< 0.690>	< 0.578>	< 0.794>	< 1.176>	< 2.696>	< 3.462>		
11	4.140	1.910	2.240	0.890	0.980	0.980	0.810	0.530	0.980	1.500	13.000	6.170		
12	3.720	1.650	1.960	0.940	0.890	0.940	0.810	0.570	0.770	2.180	48.000	6.010		
13	3.300	1.550	1.700	0.890	0.810	1.160	0.770	0.570	0.810	2.180	59.000	5.470		
14	3.860	1.450	1.550	0.890	1.600	0.940	0.690	0.570	0.770	1.650	31.000	5.320		
15	3.160	1.400	1.500	0.980	1.210	1.120	0.650	0.570	0.730	1.960	17.000	3.930		
	(18.180)	(7.960)	(8.950)	(4.590)	(5.490)	(5.140)	(3.730)	(2.810)	(4.060)	(9.470)	(168.000)	(26.900)		
AVERAGE	< 3.636>	< 1.592>	< 1.790>	< 0.918>	< 1.098>	< 1.028>	< 0.746>	< 0.562>	< 0.812>	< 1.894>	< 33.600>	< 5.380>		
16	2.890	1.350	1.450	0.850	0.980	0.890	0.610	0.570	0.730	1.650	12.000	2.890		
17	2.650	1.910	1.400	0.810	0.810	0.890	0.570	0.570	0.810	1.650	11.000	15.000		
18	2.530	1.550	1.350	0.770	0.730	0.810	0.610	0.570	0.730	1.600	10.000	16.000		
19	2.410	2.770	1.300	0.850	0.770	0.770	0.570	1.030	0.940	2.240	11.000	7.670		
20	2.240	1.910	1.250	0.810	0.730	0.730	0.570	0.810	0.770	3.510	16.000	5.700		
	(12.720)	(9.490)	(6.750)	(4.090)	(4.020)	(4.090)	(2.930)	(3.550)	(3.980)	(10.650)	(60.000)	(47.260)		
AVERAGE	< 2.544>	< 1.898>	< 1.350>	< 0.818>	< 0.804>	< 0.818>	< 0.586>	< 0.710>	< 0.796>	< 2.130>	< 12.000>	< 9.452>		
21	2.130	1.650	1.250	0.850	0.690	0.650	0.570	0.650	0.650	2.770	20.000	5.320		
22	2.030	1.750	1.250	0.850	0.850	0.890	0.610	0.980	0.610	4.070	18.000	4.800		
23	2.590	1.700	1.210	0.850	0.770	0.810	0.570	0.770	0.650	4.650	18.000	4.000		
24	2.470	1.600	1.160	0.810	0.730	0.730	0.570	0.980	0.610	4.000	19.000	3.930		
25	2.350	1.600	1.160	0.770	0.730	0.650	0.570	0.810	0.940	3.230	16.000	3.510		
	(11.570)	(8.300)	(6.030)	(4.130)	(3.770)	(3.730)	(2.890)	(4.190)	(3.460)	(18.720)	(91.000)	(21.560)		
AVERAGE	< 2.314>	< 1.660>	< 1.206>	< 0.826>	< 0.754>	< 0.746>	< 0.578>	< 0.838>	< 0.692>	< 3.744>	< 18.200>	< 4.312>		
26	2.240	1.500	1.160	0.810	0.770	0.810	0.570	0.770	0.980	2.710	11.000	3.230		
27	2.180	1.450	1.120	0.810	1.030	0.690	0.530	0.650	1.750	2.530	7.580	3.090		
28	2.020	1.400	1.120	0.810	0.850	1.120	0.530	0.610	1.750	2.950	5.320	2.950		
29	1.960	*********	1.120	1.210	0.810	0.810	0.530	0.650	1.650	2.890	4.350	2.950		
30	1.800	*********	1.070	0.890	0.770	0.770	0.530	0.610	1.160	2.830	4.140	2.650		
31	1.800	*********	1.070	*********	0.690	*********	0.530	0.610	*********	4.070	*********	2.410		
	(12.000)	(4.350)	(6.660)	(4.530)	(4.920)	(4.200)	(3.220)	(3.900)	(7.290)	(17.980)	(32.390)	(17.280)		
AVERAGE	< 2.000>	< 1.450>	< 1.110>	< 0.906>	< 0.820>	< 0.840>	< 0.537>	< 0.650>	< 1.458>	< 2.997>	< 6.478>	< 2.880>		
GRAND TOTAL	154.420	46.100	54.970	27.340	25.880	25.200	19.550	19.990	26.330	68.160	398.550	145.990	1012.478	(m³/s)
AVERAGE	342.	102.	122.	61.	57.	56.	43.	44.	58.	151.	883.	323.	2243.	(mm)
MAX	4.981	1.646	1.773	0.911	0.835	0.840	0.631	0.645	0.878	2.199	13.285	4.709	2.774	(m³/s)
MIN	22.000	2.770	7.330	1.210	1.600	1.160	0.890	1.030	1.750	4.650	59.000	16.000		(m³/s)
	1.800	1.350	1.070	0.770	0.610	0.610	0.530	0.530	0.610	0.850	2.180	2.410		(m³/s)

< COMPUTED DAILY RUNOFF > THUNG SONG
(1977) LAN SAKA

UNIT = (mm/D)

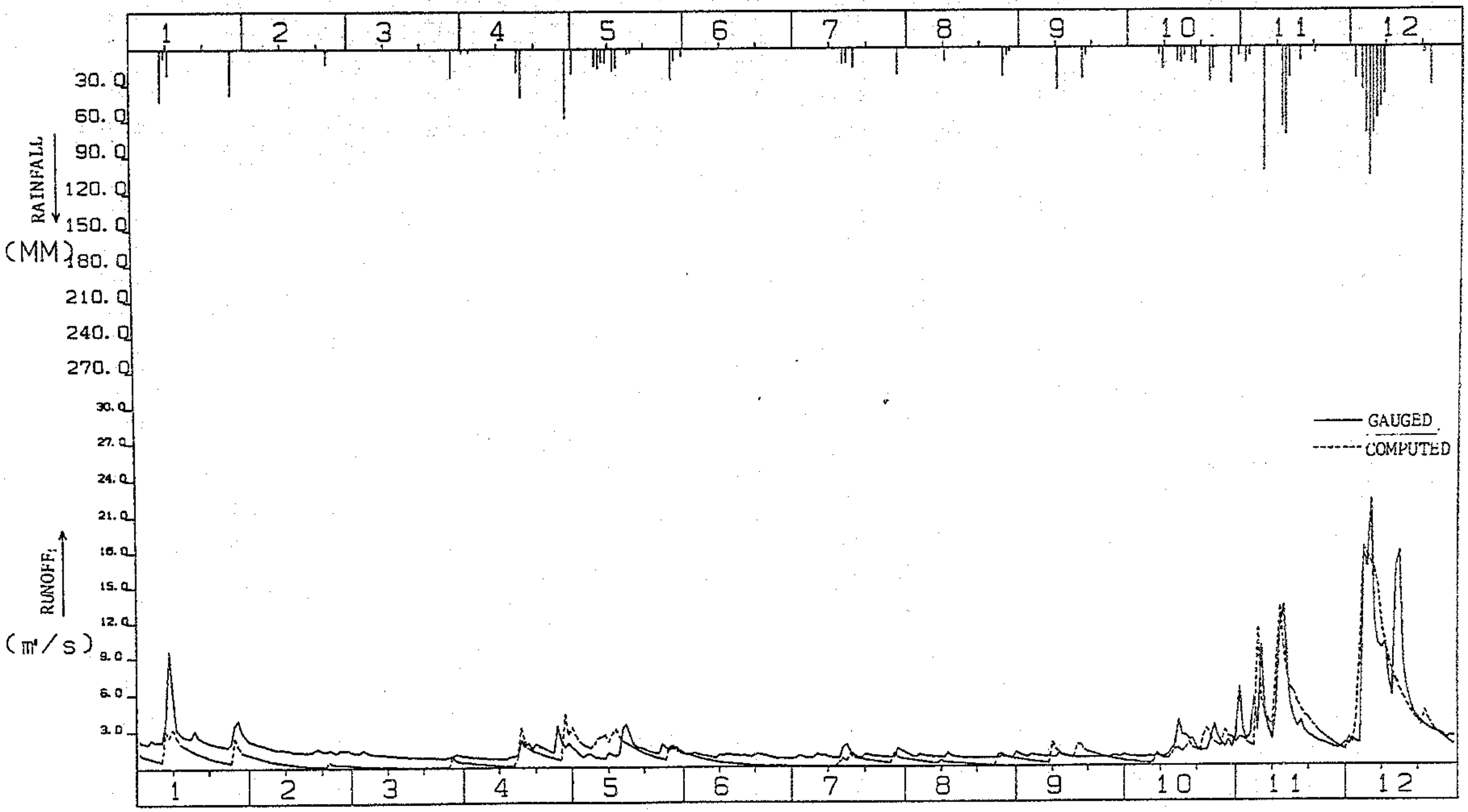
	1 JAN	2 FEB	3 MAR	4 APR	5 MAY	6 JUN	7 JUL	8 AUG	9 SEP	10 OCT	11 NOV	12 DEC		
1	13.088	0.509	0.472	0.153	0.027	0.621	0.742	0.446	0.304	2.944	3.823	4.920		
2	9.393	0.454	0.426	0.136	0.026	0.557	0.683	0.398	0.272	2.424	3.166	4.404		
3	6.421	0.406	0.383	0.122	0.025	0.499	0.622	0.356	0.244	3.199	2.833	3.940		
4	6.517	0.363	6.081	0.109	0.025	0.446	0.562	0.318	0.218	3.445	4.280	3.525		
5	6.169	0.324	3.984	0.097	0.024	1.030	0.506	0.284	0.505	2.805	4.197	3.152		
	(41.589)	(2.056)	(11.347)	(0.616)	(0.126)	(3.152)	(3.115)	(1.802)	(1.543)	(14.817)	(18.299)	(19.941)		
AVERAGE	<8.318>	<0.411>	<2.269>	<0.123>	<0.025>	<0.630>	<0.623>	<0.360>	<0.309>	<2.963>	<3.660>	<3.988>		
6	6.555	0.290	3.083	0.086	0.023	0.744	0.455	0.375	0.606	2.407	3.478	2.818		
7	8.660	0.259	2.404	0.080	0.023	0.658	0.408	0.288	0.445	2.183	2.938	2.520		
8	6.660	0.231	2.111	0.076	0.022	0.618	0.365	0.266	0.429	1.984	2.652	2.253		
9	5.578	0.747	1.917	0.071	0.021	0.569	2.203	0.243	0.401	1.792	2.409	2.014		
10	4.797	0.504	1.748	0.067	0.021	0.518	2.317	0.220	0.369	1.613	4.209	5.796		
	(32.251)	(2.031)	(11.264)	(0.381)	(0.110)	(3.107)	(5.747)	(1.393)	(2.249)	(9.979)	(15.687)	(15.400)		
AVERAGE	<6.450>	<0.406>	<2.253>	<0.076>	<0.022>	<0.621>	<1.149>	<0.279>	<0.450>	<1.996>	<3.137>	<3.080>		
11	4.313	0.458	1.582	0.064	0.020	0.469	1.729	0.198	0.335	1.448	19.070	3.986		
12	3.894	0.434	1.426	0.060	0.020	0.422	1.385	0.178	0.303	2.465	26.467	3.239		
13	4.425	0.403	1.281	0.057	2.597	0.912	1.264	0.160	0.680	2.806	31.437	2.729		
14	3.749	0.368	1.149	0.053	1.603	0.643	1.168	0.143	0.477	2.232	16.631	2.462		
15	3.289	0.334	1.029	0.050	1.120	0.588	1.066	0.128	0.442	1.870	16.371	2.242		
	(19.671)	(1.996)	(6.466)	(0.284)	(5.361)	(3.034)	(6.612)	(0.807)	(2.238)	(10.821)	(109.976)	(14.658)		
AVERAGE	<3.934>	<0.399>	<1.293>	<0.057>	<1.072>	<0.607>	<1.322>	<0.161>	<0.448>	<2.164>	<21.995>	<2.932>		
16	2.978	0.301	0.921	0.047	0.979	0.550	0.965	0.114	0.414	1.702	13.293	8.811		
17	2.689	0.271	0.824	0.045	0.910	0.506	0.870	0.102	0.381	1.555	11.360	9.605		
18	2.419	0.243	0.737	0.042	2.371	0.460	2.233	0.091	1.828	3.002	9.873	6.389		
19	2.171	0.218	0.659	0.040	1.833	0.416	2.097	0.082	1.373	4.638	9.875	5.247		
20	1.946	0.195	0.589	0.038	1.429	0.375	1.574	0.078	1.024	3.465	15.389	4.403		
	(12.203)	(1.227)	(3.730)	(0.212)	(7.523)	(2.306)	(7.740)	(0.467)	(5.020)	(14.363)	(59.791)	(34.455)		
AVERAGE	<2.441>	<0.245>	<0.746>	<0.042>	<1.505>	<0.461>	<1.548>	<0.093>	<1.004>	<2.873>	<11.958>	<6.891>		
21	1.742	0.174	0.527	0.035	1.304	0.336	1.395	0.073	6.169	8.165	15.978	3.896		
22	1.559	0.963	0.471	0.034	1.202	0.301	1.284	0.177	3.675	5.334	15.035	3.513		
23	1.395	0.669	0.421	0.033	1.096	0.270	1.175	1.005	2.885	5.620	13.767	3.174		
24	1.247	0.816	0.376	0.032	0.992	0.241	1.066	0.659	4.678	4.633	11.351	2.857		
25	1.115	0.643	0.336	0.031	1.198	0.216	0.962	0.543	4.028	3.848	9.734	2.566		
	(7.059)	(3.265)	(2.130)	(0.165)	(5.792)	(1.365)	(5.882)	(2.458)	(21.436)	(27.601)	(65.864)	(16.007)		
AVERAGE	<1.412>	<0.653>	<0.426>	<0.033>	<1.158>	<0.273>	<1.176>	<0.492>	<4.287>	<5.520>	<13.173>	<3.201>		
26	0.997	0.612	0.300	0.030	1.221	0.193	0.865	0.526	3.258	3.438	8.489	2.300		
27	0.891	0.568	0.268	0.029	1.000	1.607	0.776	0.494	2.777	3.108	7.588	2.060		
28	0.797	0.520	0.240	0.029	0.925	1.150	0.696	0.455	2.508	3.531	6.818	1.844		
29	0.712	*********	0.214	0.028	0.845	0.853	0.623	0.415	2.280	2.987	6.124	1.855		
30	0.637	*********	0.191	0.027	0.766	0.792	0.557	0.375	3.582	4.024	5.492	1.580		
31	0.569	*********	0.171	*********	0.690	*********	0.498	0.338	*********	4.606	*********	1.427		
	(4.603)	(1.700)	(1.384)	(0.144)	(5.447)	(4.595)	(4.016)	(2.604)	(14.405)	(21.693)	(34.511)	(11.067)		
AVERAGE	<0.767>	<0.567>	<0.231>	<0.029>	<0.908>	<0.919>	<0.669>	<0.434>	<2.881>	<3.616>	<6.902>	<1.844>		
GRAND_TOTAL	117.375	12.276	36.322	1.801	24.359	17.560	33.111	9.532	46.891	99.274	304.127	111.528	814.156	(m³/s)
AVERAGE	260.	27.	80.	4.	54.	39.	73.	21.	104.	220.	674.	247.	1804.	(mm)
MAX	3.786	0.438	1.172	0.060	0.786	0.585	1.068	0.307	1.563	3.202	10.138	3.598	2.231	(m³/s)
MIN	13.088	0.963	6.081	0.153	2.597	1.607	2.317	1.005	6.169	8.165	31.437	9.605		(m³/s)
	0.569	0.174	0.171	0.027	0.020	0.193	0.365	0.073	0.218	1.448	2.409	1.427		(m³/s)

RUNOFF ANALYSIS BY TANK MODEL

(1978)

RAINFALL STATION : LAN SAKA

COEFFICIENT = 0.8249



GAUGING STATION : X-70 (CA = 39.00 km²)

< DAILY RAINFALL > THUNG SONG
(1978) LAN SAKA

UNIT = (mm/D)

	1 JAN	2 FEB	3 MAR	4 APR	5 MAY	6 JUN	7 JUL	8 AUG	9 SEP	10 OCT	11 NOV	12 DEC	
1	0.0	0.0	0.0	3.1	19.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.6	26.2	
3	0.0	0.0	0.0	3.1	0.0	0.0	0.0	0.0	0.0	0.0	7.3	0.0	
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	35.6	
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	72.2	
	(0.0)	(0.0)	(0.0)	(6.3)	(19.9)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(19.9)	(134.0)	
AVERAGE	< 0.0>	< 0.0>	< 0.0>	< 1.3>	< 4.0>	< 0.0>	< 0.0>	< 0.0>	< 0.0>	< 0.0>	< 4.0>	< 26.8>	
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	107.3	
7	0.0	0.0	0.0	0.0	13.6	0.0	0.0	0.0	0.0	0.0	102.6	72.2	
8	0.0	0.0	0.0	0.0	15.7	0.0	0.0	0.0	0.0	0.0	0.0	59.9	
9	42.9	0.0	0.0	0.0	10.5	0.0	0.0	0.0	0.0	6.3	0.0	50.3	
10	7.3	0.0	0.0	0.0	11.5	0.0	0.0	0.0	0.0	17.8	0.0	38.9	
	(50.3)	(0.0)	(0.0)	(0.0)	(51.3)	(0.0)	(0.0)	(0.0)	(0.0)	(24.1)	(102.6)	(328.7)	
AVERAGE	< 10.1>	< 0.0>	< 0.0>	< 0.0>	< 10.3>	< 0.0>	< 0.0>	< 0.0>	< 0.0>	< 4.8>	< 20.5>	< 65.7>	
11	20.9	0.0	0.0	0.0	0.0	0.0	0.0	10.5	34.6	0.0	0.0	0.0	
12	0.0	0.0	0.0	0.0	17.8	0.0	0.0	0.0	0.0	0.0	67.0	0.0	
13	0.0	0.0	0.0	0.0	15.7	0.0	0.0	0.0	0.0	0.0	73.3	0.0	
14	0.0	0.0	0.0	0.0	0.0	0.0	12.6	0.0	0.0	11.5	24.7	0.0	
15	0.0	0.0	0.0	0.0	0.0	0.0	11.5	0.0	0.0	12.6	0.0	0.0	
	(20.9)	(0.0)	(0.0)	(0.0)	(33.5)	(0.0)	(24.1)	(10.5)	(34.6)	(24.1)	(165.0)	(0.0)	
AVERAGE	< 4.2>	< 0.0>	< 0.0>	< 0.0>	< 6.7>	< 0.0>	< 4.8>	< 2.1>	< 6.9>	< 4.8>	< 33.0>	< 0.0>	
16	0.0	0.0	0.0	18.8	4.2	0.0	0.0	0.0	0.0	7.3	0.0	0.0	
17	0.0	0.0	0.0	39.8	3.1	0.0	15.7	0.0	0.0	0.0	11.1	0.0	
18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	25.1	11.5	0.0	0.0	
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.3	13.6	0.0	0.0	
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	(0.0)	(0.0)	(0.0)	(58.6)	(7.3)	(0.0)	(15.7)	(0.0)	(31.4)	(32.5)	(11.1)	(0.0)	
AVERAGE	< 0.0>	< 0.0>	< 0.0>	< 11.7>	< 1.5>	< 0.0>	< 3.1>	< 0.0>	< 6.3>	< 6.5>	< 2.2>	< 0.0>	
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.8	4.7	
22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
23	0.0	12.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	28.3	0.0	31.4	
24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.8	0.0	0.0	
25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	(0.0)	(12.6)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(46.1)	(4.8)	(36.1)	
AVERAGE	< 0.0>	< 2.5>	< 0.0>	< 0.0>	< 0.0>	< 0.0>	< 0.0>	< 0.0>	< 0.0>	< 9.2>	< 1.0>	< 7.2>	
26	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
27	0.0	0.0	0.0	0.0	0.0	0.0	0.0	23.0	0.0	0.0	0.0	0.0	
28	37.7	0.0	0.0	0.0	25.1	0.0	0.0	6.3	0.0	0.0	0.0	0.0	
29	0.0	**********	23.0	57.6	9.4	0.0	22.0	3.1	0.0	30.4	0.0	0.0	
30	0.0	**********	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
31	0.0	**********	0.0	**********	6.3	**********	0.0	0.0	**********	7.3	**********	0.0	
	(37.7)	(0.0)	(23.0)	(57.6)	(40.8)	(0.0)	(22.0)	(32.5)	(0.0)	(37.7)	(0.0)	(0.0)	
AVERAGE	< 6.3>	< 0.0>	< 3.8>	< 11.5>	< 6.8>	< 0.0>	< 3.7>	< 5.4>	< 0.0>	< 6.3>	< 0.0>	< 0.0>	
GRAND TOTAL	108.9	12.6	23.0	122.5	152.9	0.0	61.8	42.9	66.0	164.4	303.4	498.8	1557.1
AVERAGE	3.5	0.4	0.7	4.1	4.9	0.0	2.0	1.4	2.2	5.3	10.1	16.1	4.3
MAX	42.9	12.6	23.0	57.6	25.1	0.0	22.0	23.0	34.6	30.4	102.6	107.3	
MIN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

GAUGED

< DAILY RUNOFF > THUNG SONG LAN SAKA

(1978)

UNIT = (mm/D)

	1 JAN	2 FEB	3 MAR	4 APR	5 MAY	6 JUN	7 JUL	8 AUG	9 SEP	10 OCT	11 NOV	12 DEC		
1	2.290	2.240	1.300	0.990	1.650	1.120	0.650	1.160	1.160	0.940	2.350	1.850		
2	2.130	2.130	1.250	0.940	1.400	1.070	0.690	1.030	1.030	0.820	6.410	1.700		
3	2.070	2.020	1.210	0.890	1.030	1.120	0.940	0.850	0.850	0.770	2.890	2.180		
4	2.020	1.910	1.450	0.850	0.850	1.160	0.850	0.770	0.770	0.770	2.070	1.910		
5	2.350	1.850	1.350	0.850	1.070	1.070	0.770	0.990	0.990	0.730	2.470	1.800		
	(10.860)(	10.150)(	6.560)(	4.520)(	6.000)(	5.540)(	3.900)(	4.800)(	4.800)(	4.030)(	16.190)(	9.440)		
AVERAGE	< 2.172><	2.030><	1.312><	0.904><	1.200><	1.108><	0.780><	0.960><	0.960><	0.806><	3.238><	1.888>		
6	2.180	1.750	1.160	0.810	1.120	0.990	0.770	0.940	0.940	0.730	5.620	18.080		
7	2.240	1.650	1.120	0.810	0.850	0.940	0.770	0.850	0.850	0.730	2.890	16.650		
8	2.130	1.550	1.120	0.770	0.810	0.890	1.070	0.850	0.850	0.810	9.880	22.370		
9	3.720	1.500	1.070	0.770	0.770	0.810	0.940	0.810	0.810	0.730	4.350	12.200		
10	9.610	1.550	1.070	0.770	0.730	0.770	0.990	0.810	0.810	0.890	3.020	10.060		
	(19.880)(	8.000)(	5.540)(	3.930)(	4.280)(	4.400)(	4.540)(	4.260)(	4.260)(	3.890)(	25.760)(	79.360)		
AVERAGE	< 3.976><	1.600><	1.108><	0.786><	0.856><	0.880><	0.908><	0.852><	0.852><	0.778><	5.152><	15.872>		
11	5.850	1.450	1.030	0.730	1.210	1.030	0.850	0.770	0.770	0.770	2.180	9.610		
12	3.230	1.450	1.030	0.730	1.070	0.990	0.770	0.770	0.770	0.770	4.500	10.150		
13	2.830	1.350	0.980	0.690	0.940	1.070	0.770	1.120	1.120	0.890	11.710	7.070		
14	2.590	1.350	0.940	0.890	1.160	1.030	0.730	0.850	0.850	1.350	13.400	5.700		
15	2.530	1.350	0.940	0.890	3.230	0.990	1.550	0.810	0.810	1.650	8.530	16.650		
	(17.030)(	6.950)(	4.920)(	3.930)(	7.610)(	5.110)(	4.670)(	4.320)(	4.320)(	5.430)(	40.320)(	49.180)		
AVERAGE	< 3.406><	1.390><	0.984><	0.786><	1.522><	1.022><	0.934><	0.864><	0.864><	1.086><	8.064><	9.836>		
16	2.470	1.300	0.940	1.030	3.510	0.990	1.850	0.770	0.770	3.720	5.100	17.970		
17	3.090	1.300	0.890	2.240	2.650	0.940	1.250	0.690	0.690	2.470	3.860	8.710		
18	2.530	1.300	0.890	1.700	1.850	0.990	0.990	0.730	0.730	2.470	3.160	6.410		
19	2.350	1.500	0.890	2.020	1.650	0.890	0.810	0.730	0.730	2.130	3.650	5.170		
20	2.240	1.550	0.850	1.500	1.600	0.850	0.730	0.690	0.690	2.180	2.830	4.280		
	(12.680)(	6.950)(	4.460)(	8.490)(	11.260)(	4.660)(	5.630)(	3.610)(	3.610)(	12.970)(	18.600)(	42.540)		
AVERAGE	< 2.536><	1.390><	0.892><	1.698><	2.252><	0.932><	1.126><	0.722><	0.722><	2.594><	3.720><	8.508>		
21	2.070	1.400	0.850	1.960	1.500	1.070	1.030	0.690	0.690	1.500	2.470	3.860		
22	2.020	1.350	0.850	1.750	1.350	1.070	0.990	0.730	0.730	1.210	2.290	3.510		
23	1.910	1.450	0.850	1.600	1.250	0.990	0.890	0.690	0.690	1.250	2.070	3.230		
24	1.850	1.300	0.850	1.450	1.210	0.940	0.890	0.690	0.690	1.250	1.910	3.020		
25	1.800	1.250	0.810	1.350	1.120	0.850	0.850	0.690	0.690	2.070	1.850	2.830		
	(9.650)(	6.750)(	4.210)(	8.110)(	6.430)(	4.920)(	4.650)(	3.490)(	3.490)(	7.280)(	10.590)(	16.450)		
AVERAGE	< 1.930><	1.350><	0.842><	1.622><	1.286><	0.984><	0.930><	0.698><	0.698><	1.456><	2.118><	3.290>		
26	1.750	1.450	0.810	1.210	1.910	0.770	0.810	0.690	0.690	3.370	1.700	2.710		
27	2.070	1.400	0.810	3.440	1.600	0.730	0.810	0.730	0.730	2.470	1.600	2.650		
28	3.510	1.450	0.890	2.130	1.450	0.730	0.770	0.850	0.850	1.960	1.450	2.470		
29	3.930	*********	0.940	1.650	1.550	0.690	0.770	0.810	0.810	1.500	1.400	2.180		
30	2.890	*********	1.120	1.960	1.650	0.650	1.500	0.770	0.770	2.070	1.550	2.410		
31	2.530	*********	1.030	*********	1.250	*********	1.350	0.730	*********	1.500	*********	2.290		
	(16.680)(	4.300)(	5.600)(	10.390)(	9.410)(	3.570)(	6.010)(	4.580)(	3.850)(	12.870)(	7.700)(	14.710)		
AVERAGE	< 2.780><	1.433><	0.933><	2.078><	1.568><	0.714><	1.002><	0.763><	0.770><	2.145><	1.540><	2.452>		
GRAND TOTAL	86.780	43.100	31.290	39.370	44.990	28.200	29.400	25.060	24.330	46.470	119.160	211.680	729.829	(m³/s)
AVERAGE	192.	95.	69.	87.	100.	62.	65.	56.	54.	103.	264.	469.	1617.	(mm)
MAX	2.799	1.539	1.009	1.312	1.451	0.940	0.948	0.808	0.811	1.499	3.972	6.828	2.000	(m³/s)
MIN	9.610	2.240	1.450	3.440	3.510	1.160	1.850	1.160	1.160	3.720	13.400	22.370		(m³/s)
	1.750	1.250	0.810	0.690	0.730	0.650	0.650	0.690	0.690	0.730	1.400	1.700		(m³/s)

COMPUTED

< DAILY RUNOFF > THUNG SONG
(1978) LAN SAKA

UNIT = (mm/D)

	1 JAN	2 FEB	3 MAR	4 APR	5 MAY	6 JUN	7 JUL	8 AUG	9 SEP	10 OCT	11 NOV	12 DEC		
1	1.285	1.093	0.211	0.452	3.268	1.151	0.059	0.628	0.622	0.419	1.926	1.265		
2	1.153	1.003	0.191	0.428	2.566	1.067	0.056	0.584	0.570	0.375	2.259	2.307		
3	1.034	0.912	0.172	0.396	2.086	0.976	0.053	0.535	0.518	0.335	2.285	1.853		
4	0.926	0.824	0.154	0.362	1.888	0.885	0.050	0.486	0.468	0.299	1.915	3.803		
5	0.829	0.742	0.138	0.329	1.727	0.799	0.047	0.439	0.421	0.267	1.715	9.970		
	(5.227)	(4.574)	(0.866)	(1.967)	(11.535)	(4.878)	(0.265)	(2.672)	(2.599)	(1.695)	(10.101)	(19.198)		
AVERAGE	<1.045>	<0.915>	<0.173>	<0.393>	<2.307>	<0.976>	<0.053>	<0.534>	<0.520>	<0.339>	<2.020>	<3.840>		
6	0.741	0.666	0.123	0.296	1.569	0.718	0.044	0.395	0.377	0.239	1.567	18.354		
7	0.663	0.597	0.110	0.266	1.876	0.644	0.042	0.354	0.338	0.214	11.394	17.703		
8	0.593	0.535	0.098	0.239	2.367	0.577	0.039	0.318	0.303	0.191	5.496	17.080		
9	3.061	0.478	0.088	0.214	2.495	0.517	0.037	0.284	0.271	0.323	4.454	16.353		
10	2.556	0.428	0.081	0.191	2.657	0.462	0.035	0.254	0.242	1.008	3.654	15.151		
	(7.614)	(2.704)	(0.501)	(1.207)	(10.963)	(2.919)	(0.198)	(1.605)	(1.531)	(1.974)	(26.565)	(84.641)		
AVERAGE	<1.523>	<0.541>	<0.100>	<0.241>	<2.193>	<0.584>	<0.040>	<0.321>	<0.306>	<0.395>	<5.313>	<16.928>		
11	3.262	0.383	0.076	0.171	2.092	0.413	0.034	0.513	1.935	0.725	3.191	11.891		
12	2.591	0.342	0.072	0.153	2.715	0.370	0.033	0.348	1.396	0.603	8.063	10.095		
13	2.046	0.306	0.068	0.137	3.118	0.330	0.032	0.332	1.017	0.578	13.254	8.722		
14	1.852	0.273	0.064	0.122	2.489	0.295	0.363	0.308	0.925	0.926	9.825	7.722		
15	1.693	0.244	0.060	0.109	2.129	0.264	0.719	0.282	0.867	1.342	7.609	6.928		
	(11.444)	(1.547)	(0.341)	(0.692)	(12.543)	(1.673)	(1.180)	(1.784)	(6.140)	(4.173)	(41.943)	(45.359)		
AVERAGE	<2.289>	<0.309>	<0.068>	<0.138>	<2.509>	<0.335>	<0.236>	<0.357>	<1.228>	<0.835>	<8.389>	<9.072>		
16	1.540	0.218	0.057	0.773	1.990	0.236	0.475	0.256	0.797	1.427	6.360	6.232		
17	1.392	0.195	0.054	3.241	1.822	0.211	1.077	0.231	0.726	1.105	6.065	5.593		
18	1.254	0.174	0.051	2.117	1.639	0.188	0.767	0.208	1.758	1.436	5.174	5.013		
19	1.126	0.155	0.048	1.534	1.480	0.168	0.683	0.187	1.716	1.905	4.599	4.489		
20	1.009	0.139	0.045	1.345	1.332	0.150	0.645	0.167	1.305	1.479	4.147	4.017		
	(6.321)	(0.881)	(0.255)	(9.009)	(8.263)	(0.953)	(3.648)	(1.050)	(6.303)	(7.352)	(26.345)	(25.345)		
AVERAGE	<1.264>	<0.176>	<0.051>	<1.802>	<1.653>	<0.191>	<0.730>	<0.210>	<1.261>	<1.470>	<5.269>	<5.069>		
21	0.904	0.124	0.043	1.234	1.196	0.134	0.597	0.150	1.160	1.292	3.851	3.697		
22	0.809	0.111	0.040	1.135	1.072	0.120	0.545	0.134	1.077	1.194	3.415	3.266		
23	0.724	0.490	0.038	1.033	0.960	0.107	0.494	0.119	0.987	2.442	3.070	4.445		
24	0.647	0.299	0.036	0.934	0.859	0.095	0.445	0.107	0.896	3.020	2.755	3.740		
25	0.579	0.287	0.034	0.841	0.768	0.085	0.400	0.095	0.809	2.394	2.469	3.149		
	(3.662)	(1.310)	(0.190)	(5.176)	(4.856)	(0.541)	(2.480)	(0.605)	(4.928)	(10.343)	(15.560)	(18.297)		
AVERAGE	<0.732>	<0.262>	<0.038>	<1.035>	<0.971>	<0.108>	<0.496>	<0.121>	<0.986>	<2.069>	<3.112>	<3.659>		
26	0.517	0.273	0.033	0.755	0.687	0.080	0.359	0.085	0.727	1.917	2.211	2.824		
27	0.462	0.254	0.032	0.677	0.614	0.075	0.321	0.993	0.653	1.737	1.978	2.564		
28	2.459	0.233	0.031	0.606	1.619	0.071	0.288	1.011	0.585	1.593	1.770	2.315		
29	1.761	*********	0.903	4.340	1.777	0.067	1.123	0.839	0.524	2.922	1.582	2.082		
30	1.320	*********	0.580	2.695	1.312	0.063	0.792	0.704	0.469	2.356	1.415	1.869		
31	1.180	*********	0.460	*********	1.356	*********	0.658	0.669	*********	2.307	*********	1.675		
	(7.700)	(0.761)	(2.040)	(9.073)	(7.365)	(0.355)	(3.541)	(4.301)	(2.958)	(12.832)	(8.956)	(13.329)		
AVERAGE	<1.283>	<0.254>	<0.340>	<1.815>	<1.228>	<0.071>	<0.590>	<0.717>	<0.592>	<2.139>	<1.791>	<2.222>		
GRAND TOTAL	41.968	11.778	4.191	27.125	55.525	11.318	11.311	12.017	24.458	38.370	129.469	206.169	573.699	(m³/s)
AVERAGE	93.	26.	9.	60.	123.	25.	25.	27.	54.	85.	287.	457.	1271.	(mm)
MAX	1.354	0.421	0.135	0.904	1.791	0.377	0.365	0.388	0.815	1.238	4.316	6.651	1.572	(m³/s)
MIN	3.262	1.093	0.903	4.340	3.268	1.151	1.123	1.011	1.935	3.020	13.254	18.354		(m³/s)
	0.462	0.111	0.031	0.109	0.614	0.063	0.032	0.085	0.242	0.191	1.415	1.265		(m³/s)

APPENDIX A-3-1

Study on Flow and Pressure Measurement in Distribution System

Appendix STUDY ON FLOW AND PRESSURE MEASUREMENTS IN DISTRIBUTION SYSTEM

(1) Introduction

To evaluate the characteristics of the distribution system, pressure and flow measurements were made from 7 to 8 September, 1988.

(2) Methods and Results

The flow measurements of 24-hours were conducted of the main distribution pipe in the treatment plant using the ultrasonic flow meter with pen recorder. The pressure measurements were made by installing pressure gage at 5 house connections in the distribution system of Thung Song.

Due to the lack of data for the existing distribution system, these tests for Na Bon were not conducted.

The results of flow measurement at the Thung Song water-works, Location of Pressure measurement points and the results of pressure measurement are shown in Figures A3-1, A3-2 and A3-3 to A3-7, respectively.

The results of pressure measurements in the existing distribution system show similar pressure dconditions with distribution network analysis (refer to section 3.1.3).

The results confirm the low pressure area identified by Thung Song PWA's official.

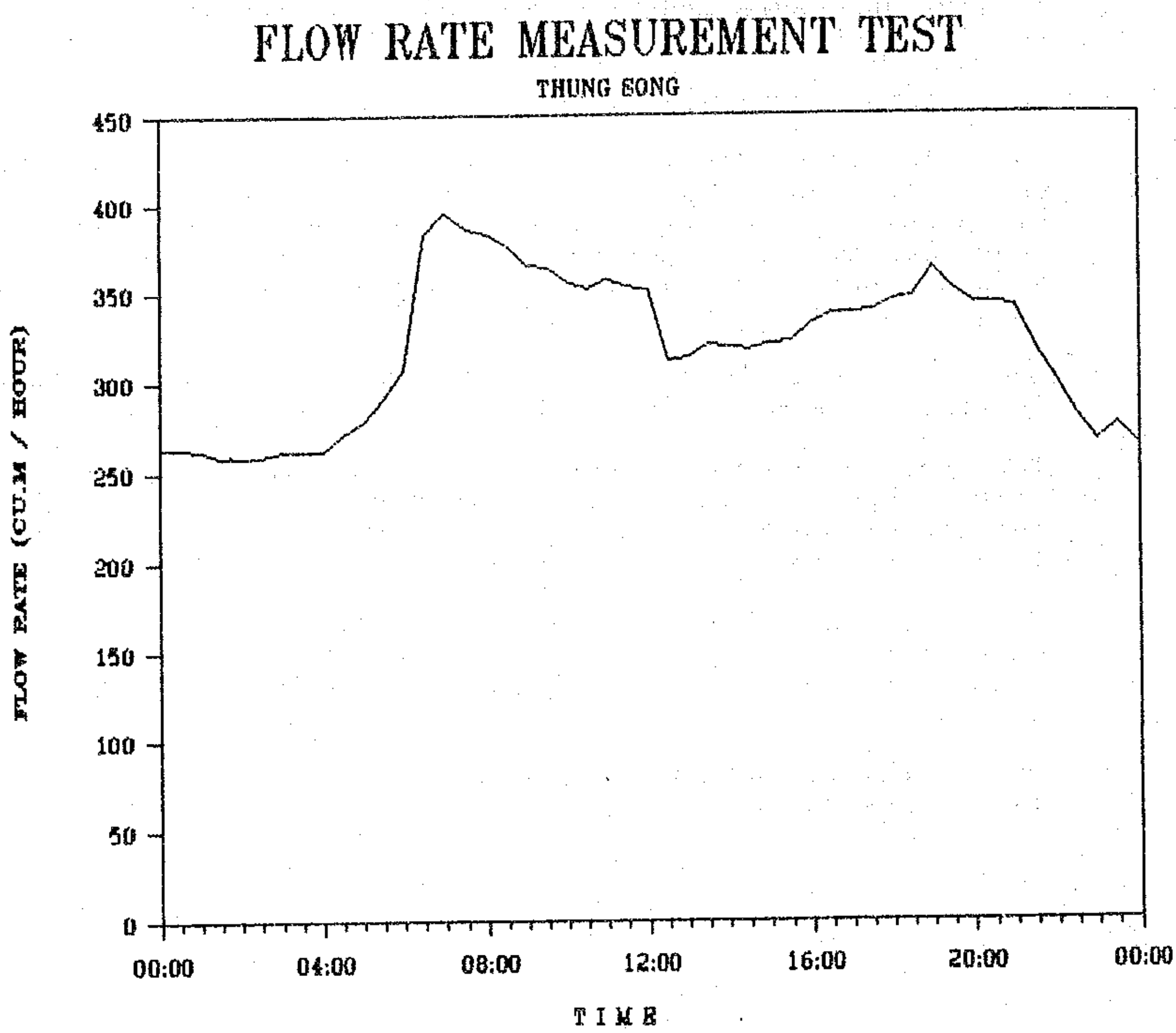


FIGURE A3-1

FLOW RATE MEASUREMENT TEST

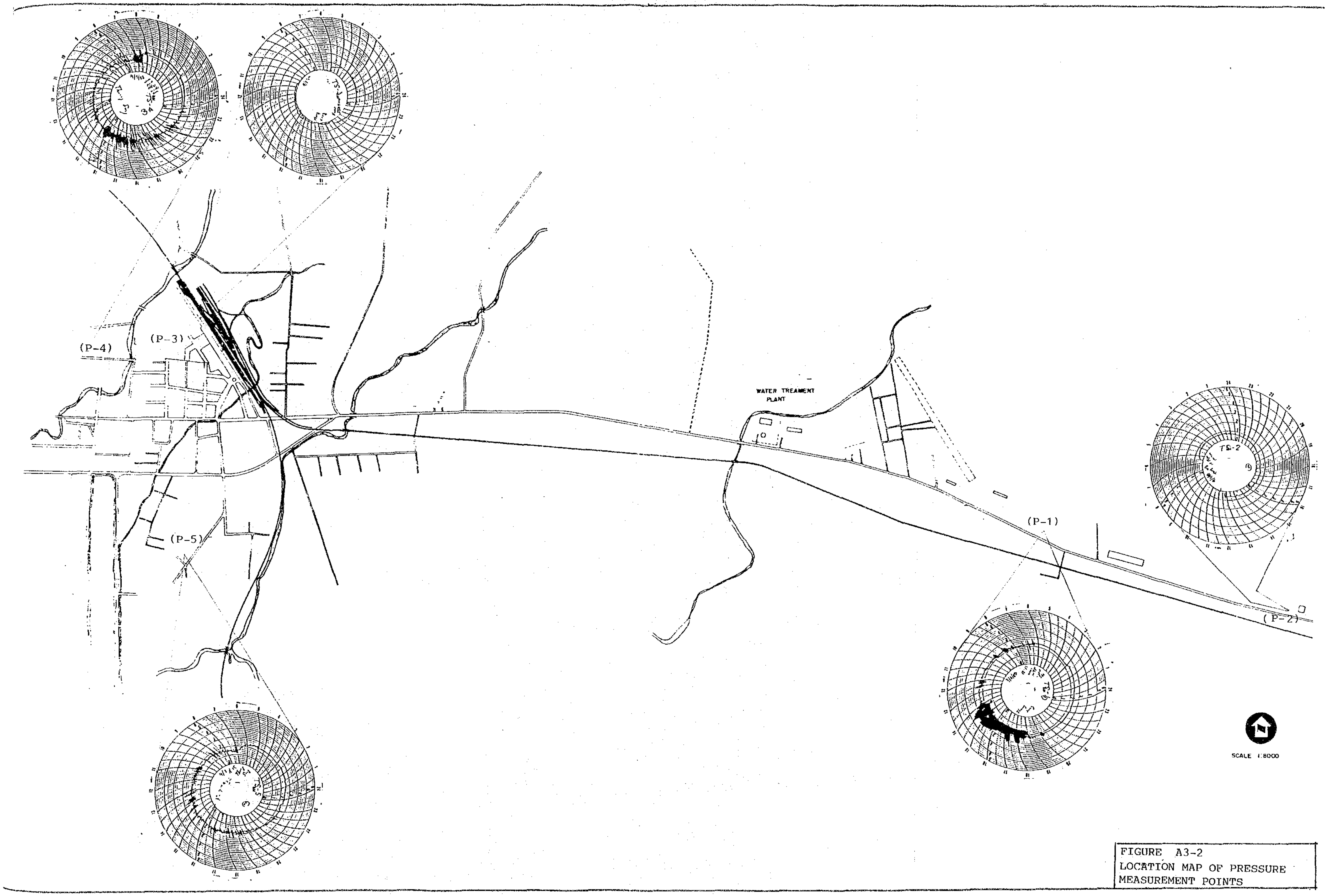


FIGURE A3-2
LOCATION MAP OF PRESSURE MEASUREMENT POINTS

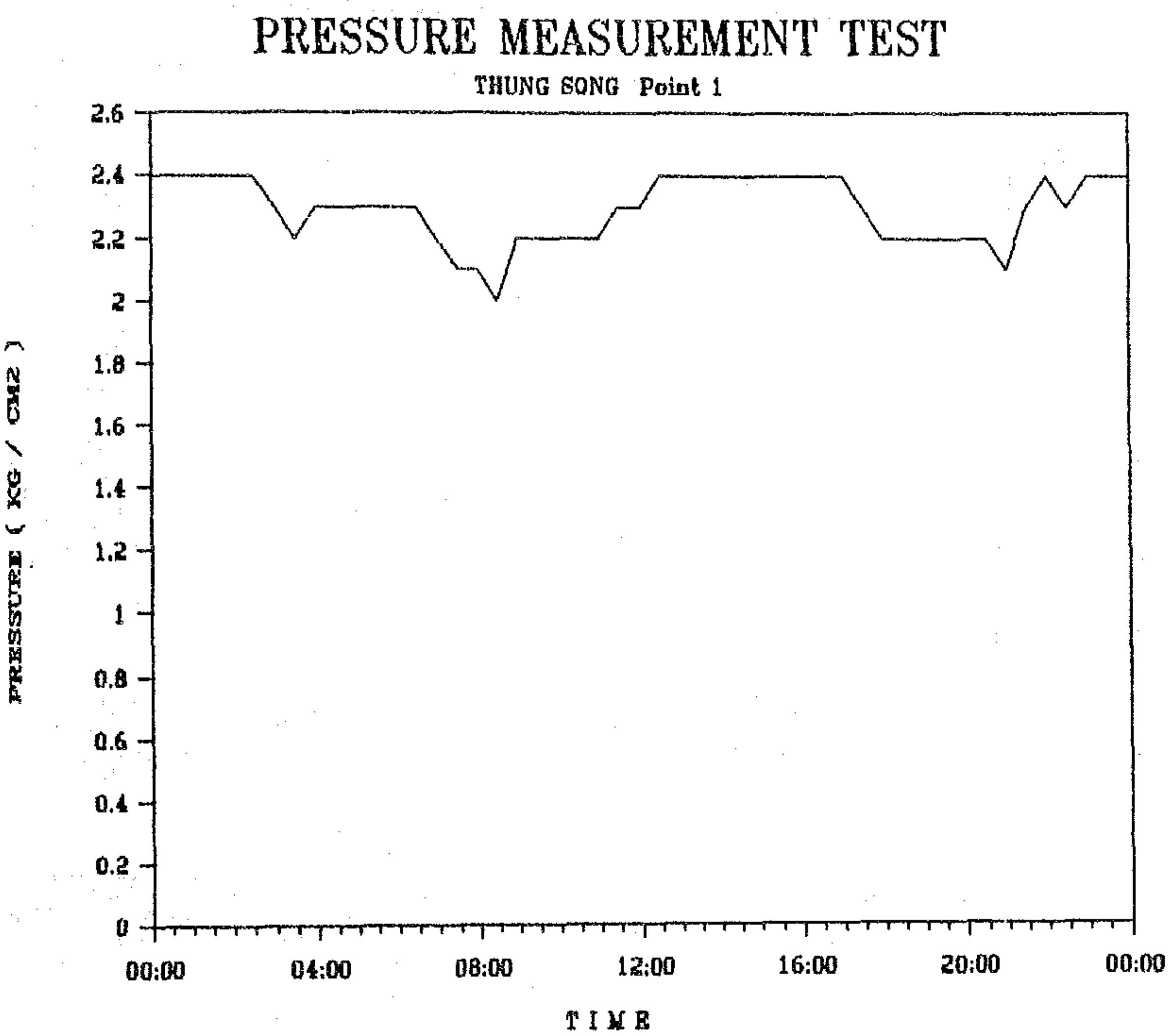


FIGURE A3-3

PRESSURE MEASUREMENT TEST
(Point 1)

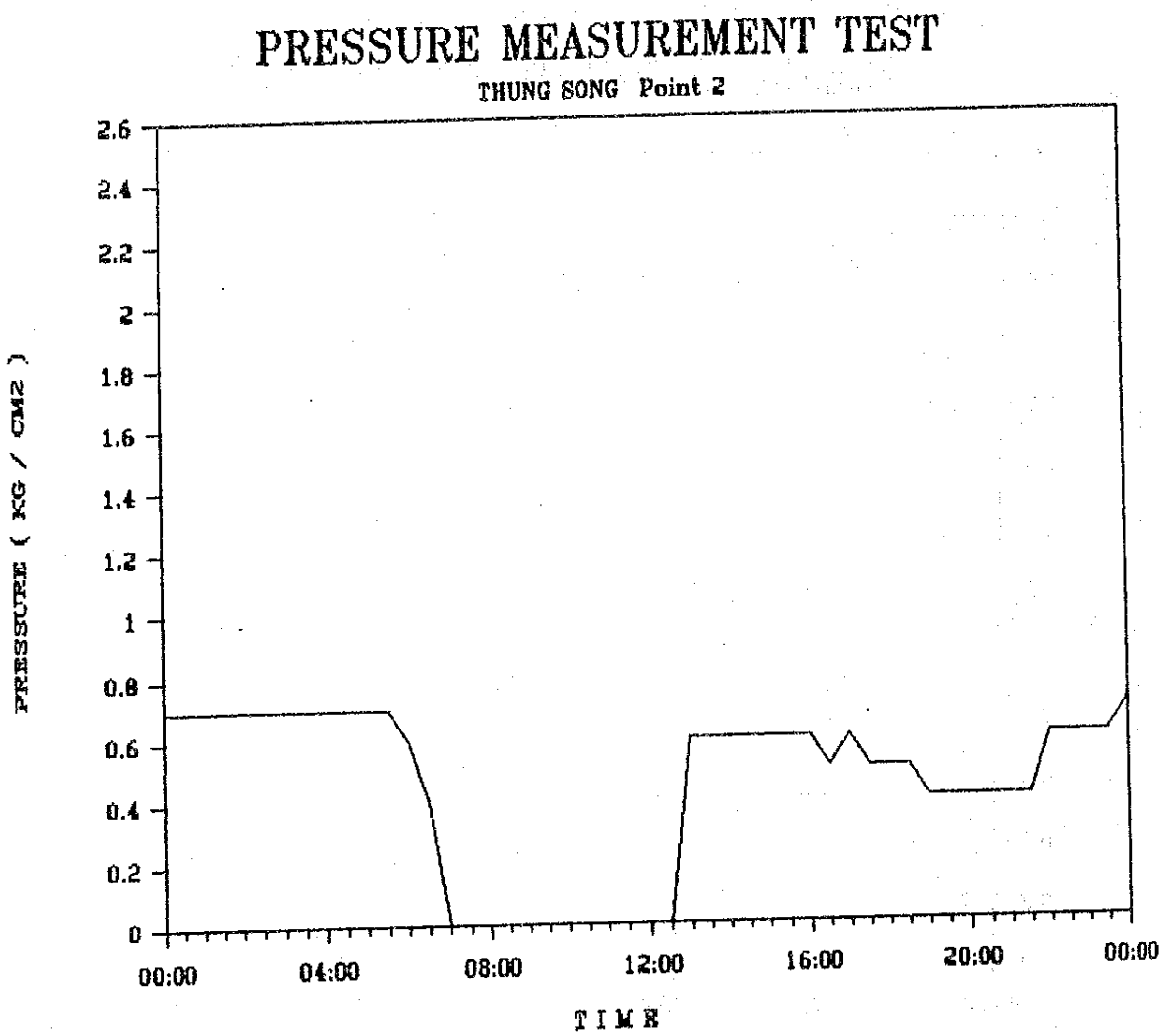


FIGURE A3-4

PRESSURE MEASUREMENT TEST
(Point 2)

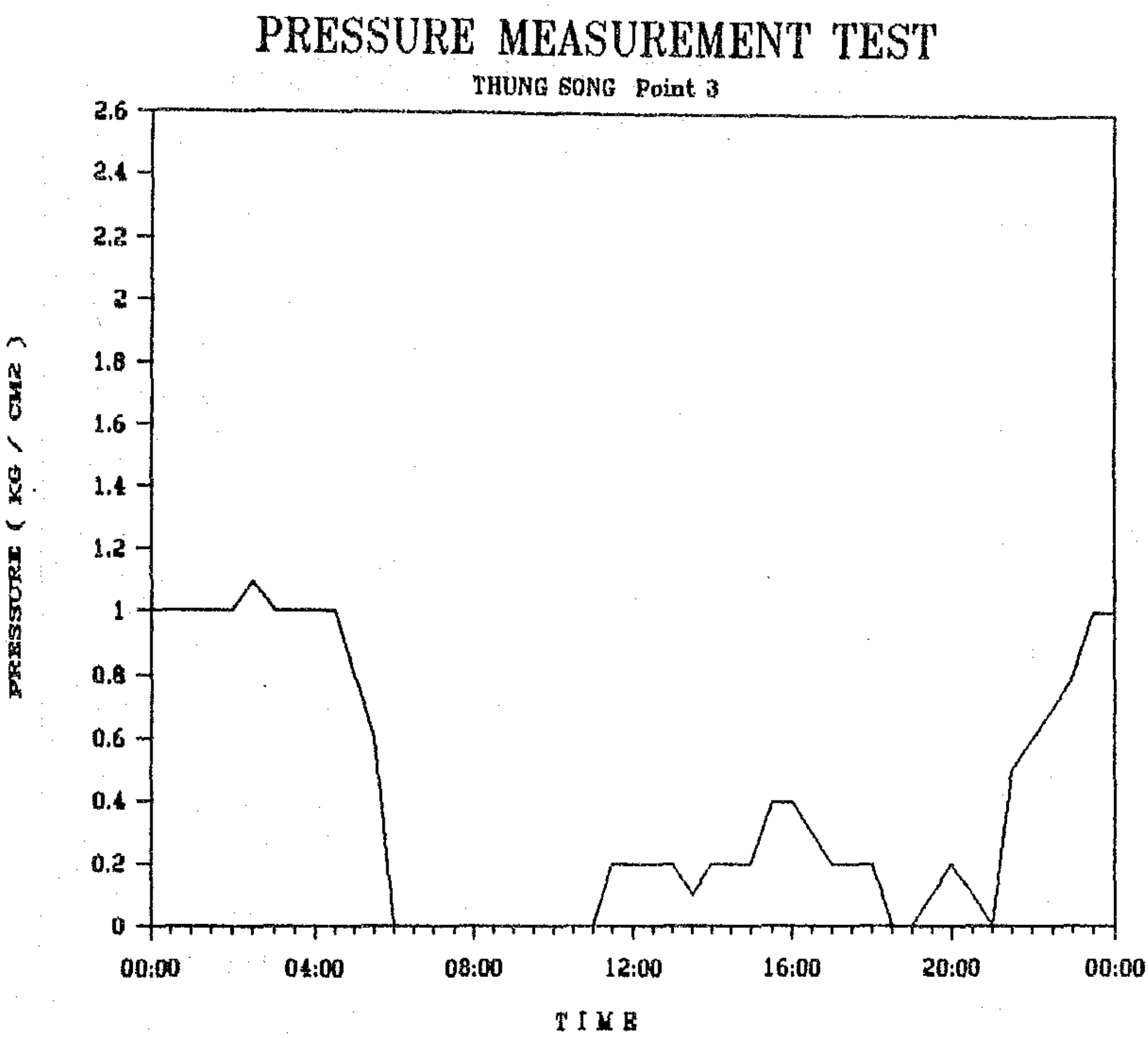


FIGURE A3-5

PRESSURE MEASUREMENT TEST
(Point 3)

PRESSURE MEASUREMENT TEST

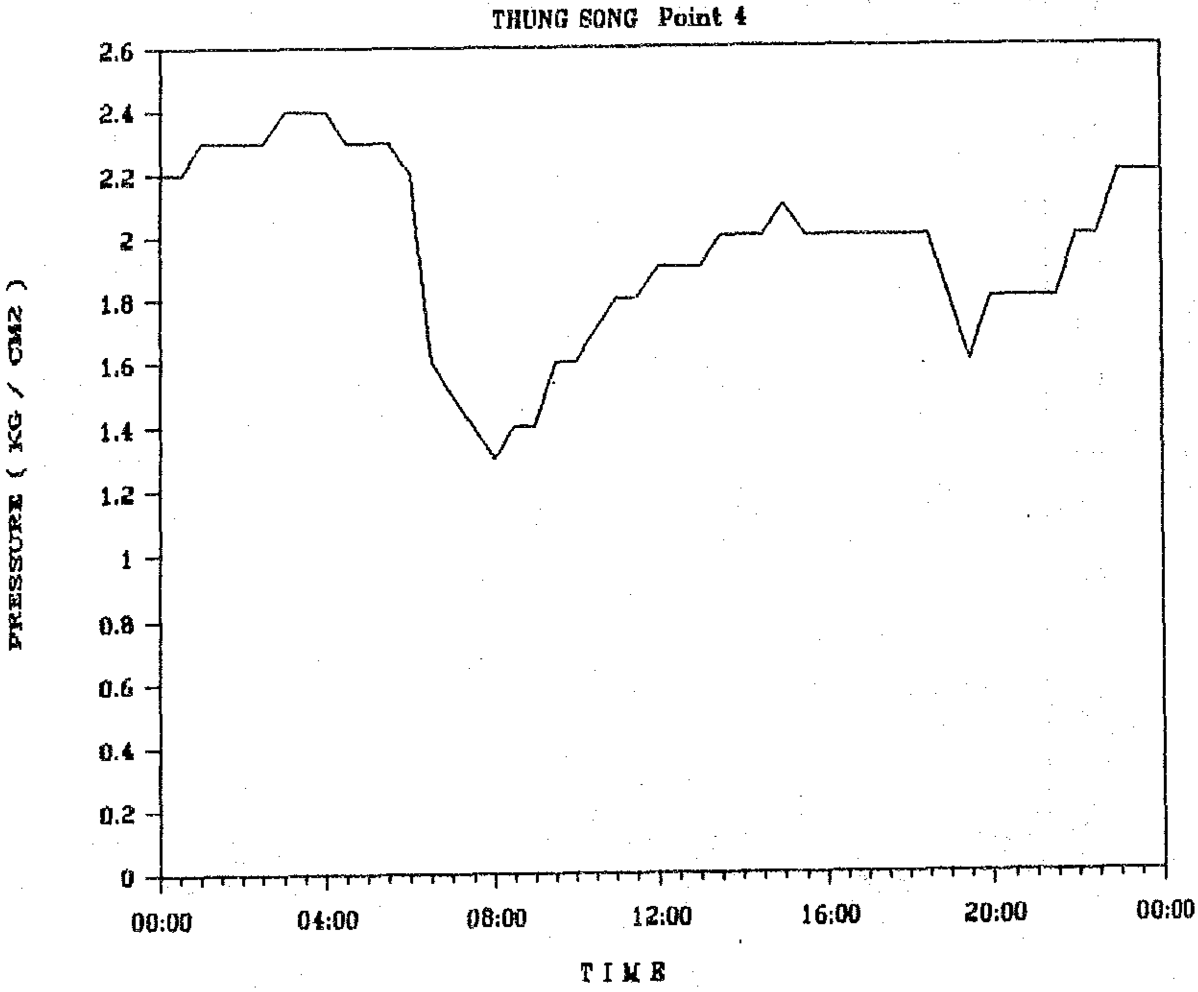


FIGURE A3-6

PRESSURE MEASUREMENT TEST
(Point 4)

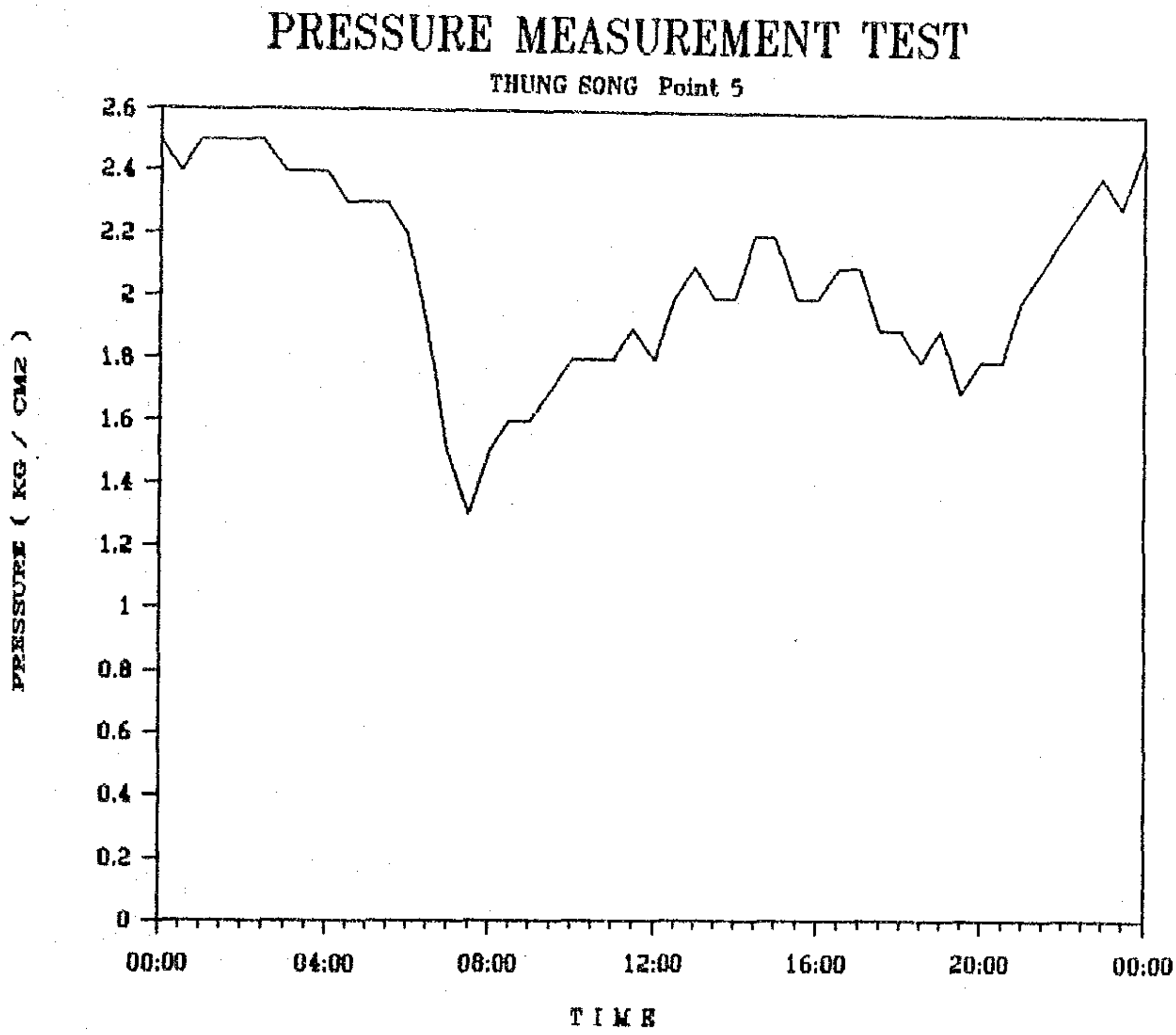


FIGURE A3-7

PRESSURE MEASUREMENT TEST
(Point 5)

APPENDIX A-3-2

Study on Water Quality on Distribution Network

APPENDIX WATER QUALITY ON DISTRIBUTION NETWORK

(1) General

Water quality analysis was conducted along the existing distribution mains by use of a portable water quality analizer. Parameters of the analysis are pH, temperature and conductivity.

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

(2) Causes of high pH

Results shown that only one sampling point No. 3 is pH 9.3. Other points show relatively low pH within the water quality standard. Based on the field investigation, the following causes may result in calcium dissolution from the inner wall of asbestos cement pipes.

a) Pipe are newly installed (less than two years ago).

b) Water is retained long inside of pipe due to low water flow.

(3) Countermeasure

Drain-off from hydrants or blow-off pipes should be periodically carried out in this area.

Table A 4-1 Results of Water Quality Analysis

Items	Sampling Point 1	2	3	4	5	6	7	8	9	*1 10
pH	7.18	7.67	9.30	7.13	6.97	7.50	7.20	7.20	6.85	7.20
Temp. (°C)	28.5	30.7	29.5	31.6	31.2	29.5	30.2	30.1	30.2	27.2
Conductivity ($5x10^2$µs)	5.0	5.8	6.7	4.6	5.9	5.8	5.6	5.3	5.5	5.5

Note: *1 Treated Water at Water Treatment Plant

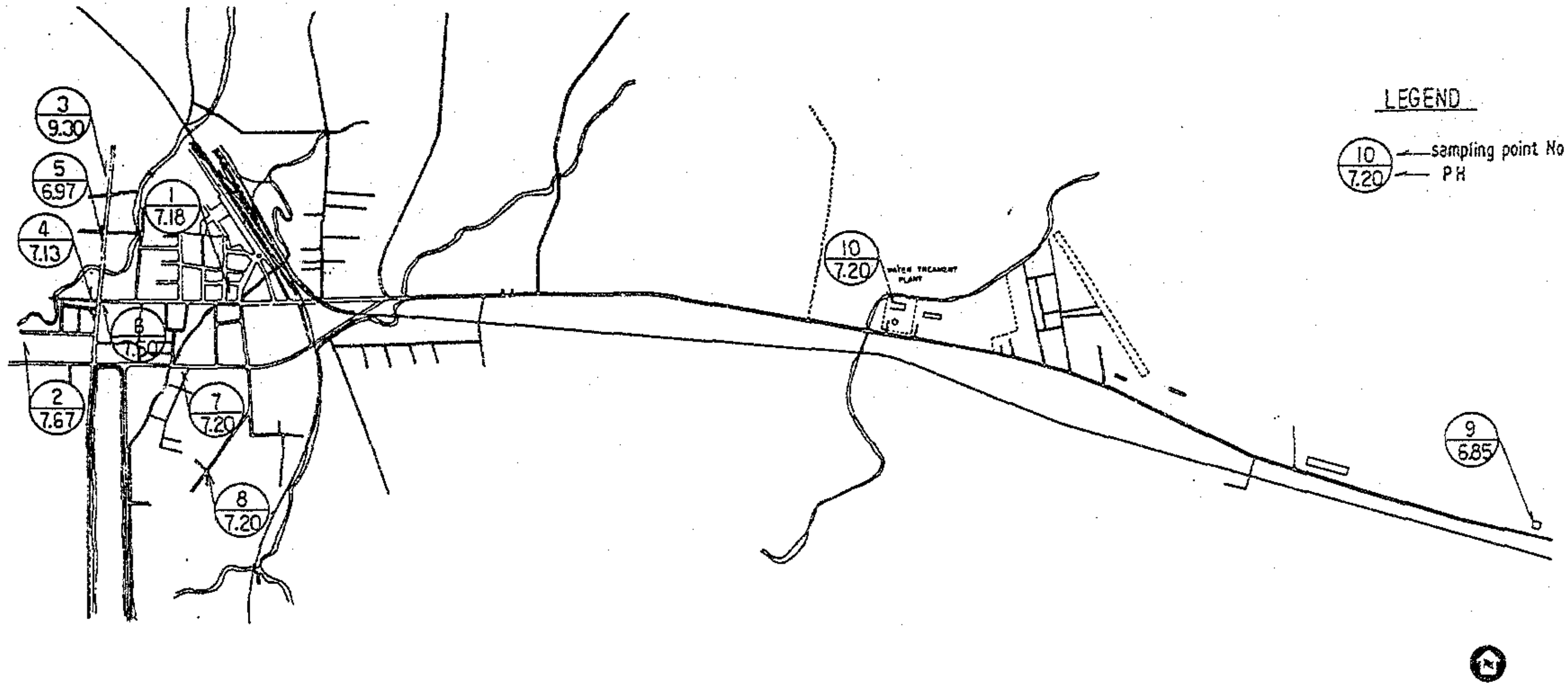


FIGURE A-4-1
SAMPLING POINTS

APPENDIX A-3-3

Jar Test on Raw Water of the Water Treatment Plant

APPENDIX JAR TEST

1 General

Jar Test was conducted to evaluate the present dosage rate of coagulant and to verify the appropriate dosage rate. The test was conducted on September 1988 for the raw water presently used by the waterworks.

2 Coagulant Used

Aluminum sulfate is being used as coagulant at Thung Song Waterworks as well as the other waterworks. The chemical is a solid type in a package of 25 kg bag, which is dissolved in the coagulant solution tank with an effective volume of about 1.0 cu.m.

According to the operator, they are consuming 50 kg (two bags) of aluminum sulfate a day. From this amount of consumption, dosage rate is calculated as below:

Dosage rate (R) for daily average flow rate:

R = 50,000 g/4,700 cu.m/day =10.6 mg/l

Concentration of the coagulant in the solution tank is calculated from the amount of chemical dissolved and the volume of the tank as follows:

Concentration of coagulant solution (C)

C = 50,000 g/1.0 cu m = 50,000 mg/l

This solution was diluted 10 times for use of Jar Test; therefore, solution had the concentration of:

50,000 x (1/10) = 5,000 mg/l

3 Test Procedure

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

a) Coagulant dosed

b) Rapid Mixing, 60 rpm - 7.5 min

c) Flocculation, 40 rpm - 7.5 min

d) Flocculation, 25 rpm - 5.0 min

e) Sedimentation, about 5 min

4 Condition and Results

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

Table A5-1 Jar Test Condition and Result

	1	2	3	4	5	6
1. Coagulant Solution (ml)	0.5	1.0	2.0	3.0	4.0	5.0
2. Dosage Rate (mg/l)	2.5	5.0	10	15	20	25
3. Turbidity after setting	2.3	<1.0	2.3	2.3	2.3	2.3
4. pH	6.81	6.50	6.10	5.80	5.12	4.85
5. Conductivity (micro ohm/cm)	4.9	5.0	5.1	5.3	5.8	6.6
6. Characteristics of floc	No floc	floc size 1-2 mm	No floc	No floc	No floc	No floc

From the results above, it is observed that dosage rate of 5.0 mg/l shows the most effective removal of turbidity. Considering this, present dosage rate (10.6 mg/l) may be reduced although the dosage should be made evenly through the operation with a proper mixing and flocculation process.

APPENDIX A-4-1

Study on Water Consumption

APPENDIX STUDY ON WATER CONSUMPTION

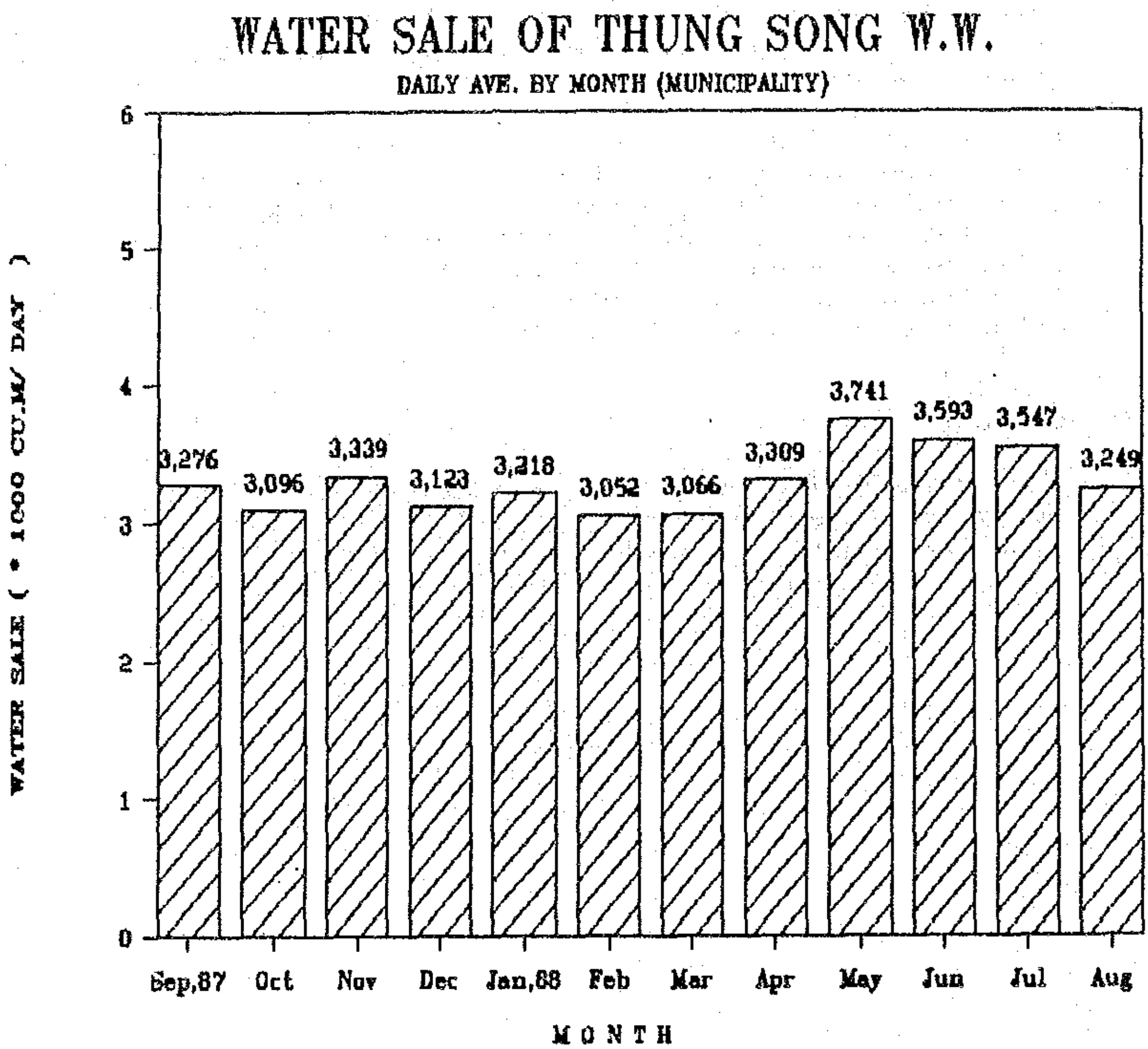
1 Data Collection

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

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

2 Collected Data

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



WATER SALE OF THUNG SONG W.W.
DAILY AVE. BY MONTH (MUNICIPALITY)
WATER SALE (* 1000 CU.M/ DAY)
3,276
3,096
3,339
3,123
3,218
3,052
3,066
3,309
3,741
3,593
3,547
3,249
Sep,87
Oct
Nov
Dec
Jan,88
Feb
Mar
Apr
May
Jun
Jul
Aug
MONTH

FIGURE A2 - 2 -1

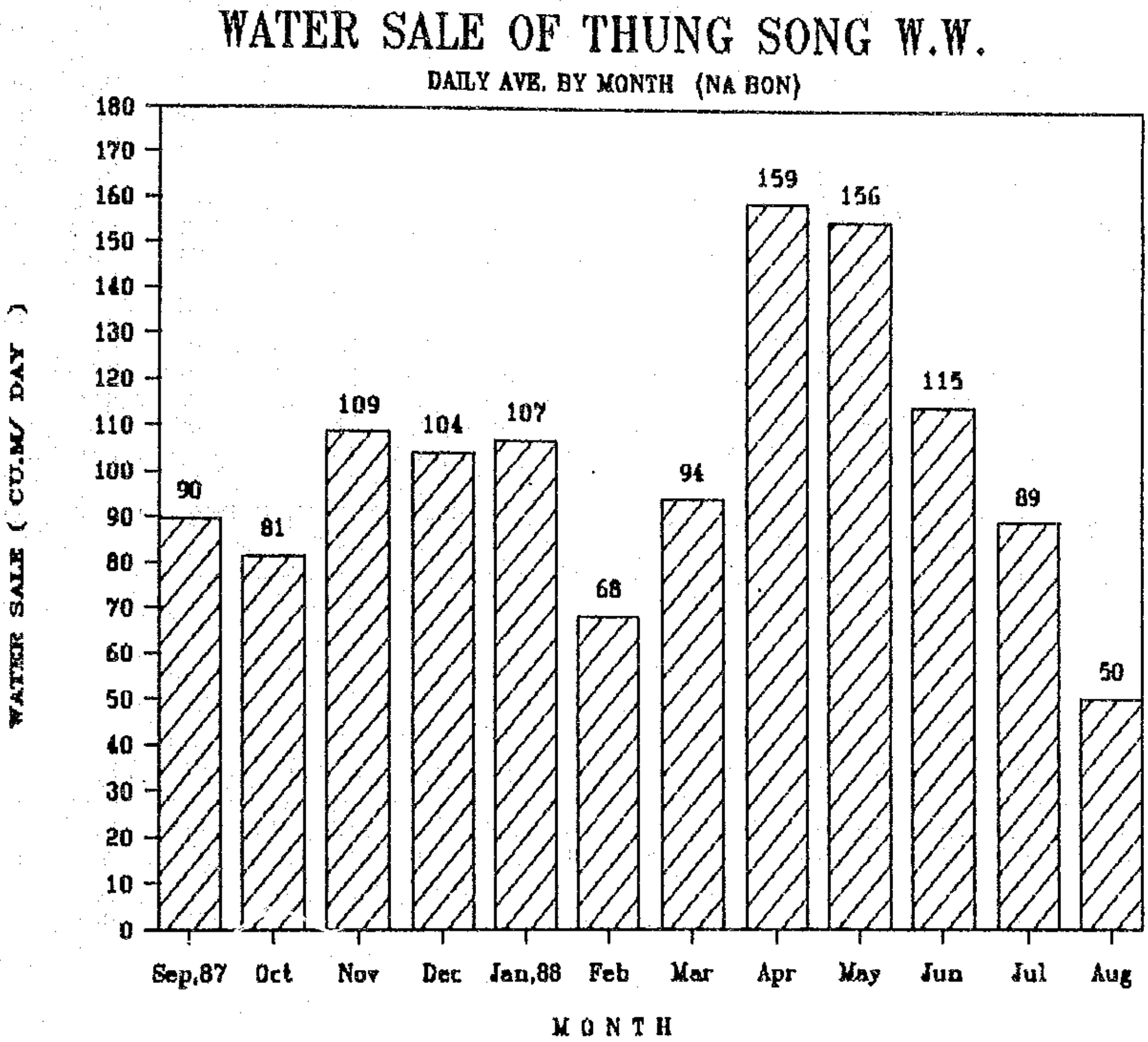

WATER SALE OF THUNG SONG W.W.
DAILY AVE. BY MONTH (NA BON)
WATER SALE (CU.M/ DAY)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
90
81
109
104
107
68
94
159
156
115
89
50
Sep,87
Oct
Nov
Dec
Jan,88
Feb
Mar
Apr
May
Jun
Jul
Aug
MONTH

FIGURE A2 - 2 - 2

Table A2 - 2 - 1

Grand Summary of Thung Song Waterworks

Thung Song Municipality

File No.	Sep,87	Oct	Nov	Dec	Jan,88	Feb	Mar	Apr	May	Jun	Jul	Aug	Total	Day Ave.
0	34,924	31,630	33,432	33,984	31,872	27,060	27,869	24,626	36,456	34,682	34,500	33,519	384,554	1098.66
1-1	5,757	6,074	6,818	6,726	7,078	5,947	6,250	6,627	7,826	7,112	7,273	7,290	80,778	224.38
1-2	4,329	4,556	4,409	4,220	4,660	3,987	4,254	5,144	6,021	4,510	4,847	4,363	55,300	151.51
1-3	2,364	2,537	2,441	2,283	2,653	2,516	2,867	3,002	3,597	3,377	3,470	3,002	34,109	94.75
2-1	3,580	3,552	3,561	3,486	3,584	3,202	3,489	3,553	3,938	3,596	4,119	3,279	51,812	119.92
2-2	3,057	3,143	3,190	2,969	3,176	2,924	3,103	3,528	3,582	3,396	3,475	3,004	41,734	109.81
3-1	5,665	5,635	6,190	5,117	6,024	4,992	5,587	6,385	6,650	6,056	5,900	5,847	70,048	194.58
3-2	4,578	4,941	4,361	4,285	4,434	4,249	4,408	5,358	5,344	5,149	5,299	4,997	57,403	157.85
4-1	2,712	2,594	2,470	2,494	2,690	2,159	2,229	2,666	2,982	2,934	2,802	2,735	32,177	88.16
4-2	3,312	3,238	3,783	3,095	4,069	3,413	3,205	3,902	4,485	4,244	4,064	3,880	44,690	122.44
5-1	5,604	5,160	6,201	5,567	5,888	5,181	5,932	6,285	7,125	6,061	6,305	5,999	71,308	195.36
5-2	3,080	3,176	4,041	3,037	3,261	2,974	3,421	3,530	4,128	3,449	3,500	3,165	40,762	115.07
5-3	2,181	2,358	2,261	2,279	2,324	2,354	2,882	2,487	2,939	2,486	2,811	1,956	29,318	80.32
5-4	1,943	2,150	1,991	1,974	2,138	1,838	2,300	2,066	2,521	2,213	2,565	2,055	25,754	75.38
6-1	1,815	2,011	1,915	2,019	1,884	1,697	1,929	2,595	2,039	2,141	1,914	1,489	23,448	64.24
6-2	1,946	2,310	2,193	2,301	2,162	1,933	2,285	2,298	2,473	2,396	2,378	1,947	26,622	72.94
6-3	2,750	2,706	2,138	2,462	2,290	2,590	2,709	2,472	2,538	2,413	2,624	2,271	29,963	82.09
6-4	1,024	987	1,096	1,258	1,297	1,207	1,235	1,296	1,348	1,206	1,217	1,012	14,183	40.94
7-1	4,161	3,859	3,757	3,605	4,098	3,517	4,179	5,615	4,215	4,297	4,681	3,785	49,769	136.35
7-2	3,509	3,354	3,915	3,637	4,188	4,776	4,907	5,848	5,764	6,057	6,227	5,135	57,317	180.71
Total(cu.m/mo)	98,291	95,971	100,163	96,798	99,770	88,516	95,040	99,283	115,971	107,775	109,971	100,730	1,221,049	3,405
Total(cu.m/d)	3,276	3,096	3,339	3,123	3,218	3,052	3,066	3,309	3,741	3,593	3,547	3,249		

Na Bon

File No.	Sep,87	Oct	Nov	Dec	Jan,88	Feb	Mar	Apr	May	Jun	Jul	Aug	Total	Day Ave.
N1	1,317	1,209	1,672	1,716	1,809	891	1,169	2,343	2,409	1,699	1,435	599	19,854	53.35
N2	1,381	1,316	1,587	1,519	1,514	1,091	1,752	2,431	2,413	1,742	1,334	966	19,046	52.18
Total(cu.m/mo)	2,698	2,525	3,259	3,235	3,323	1,982	2,921	4,774	4,822	3,441	2,769	1,565	38,900	106
Total(cu.m/d)	90	81	109	104	107	68	94	159	156	115	89	50		

APPENDIX A-4-2

Questionnaire Survey for Residents

APPENDIX QUESTIONNAIRE SURVEY IN THUNG SONG (RESIDENTIAL)

1 Objective

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

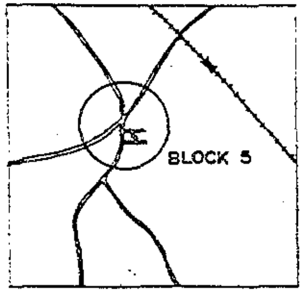
2 Survey Area

The survey area was divided into 5 blocks taking into account the boundry of the municipality, railway and roads as shown in Figure A1-2-1. All blocks were fully or partially served by the municipal system.

3 Survey Item

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

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



NABON AREA

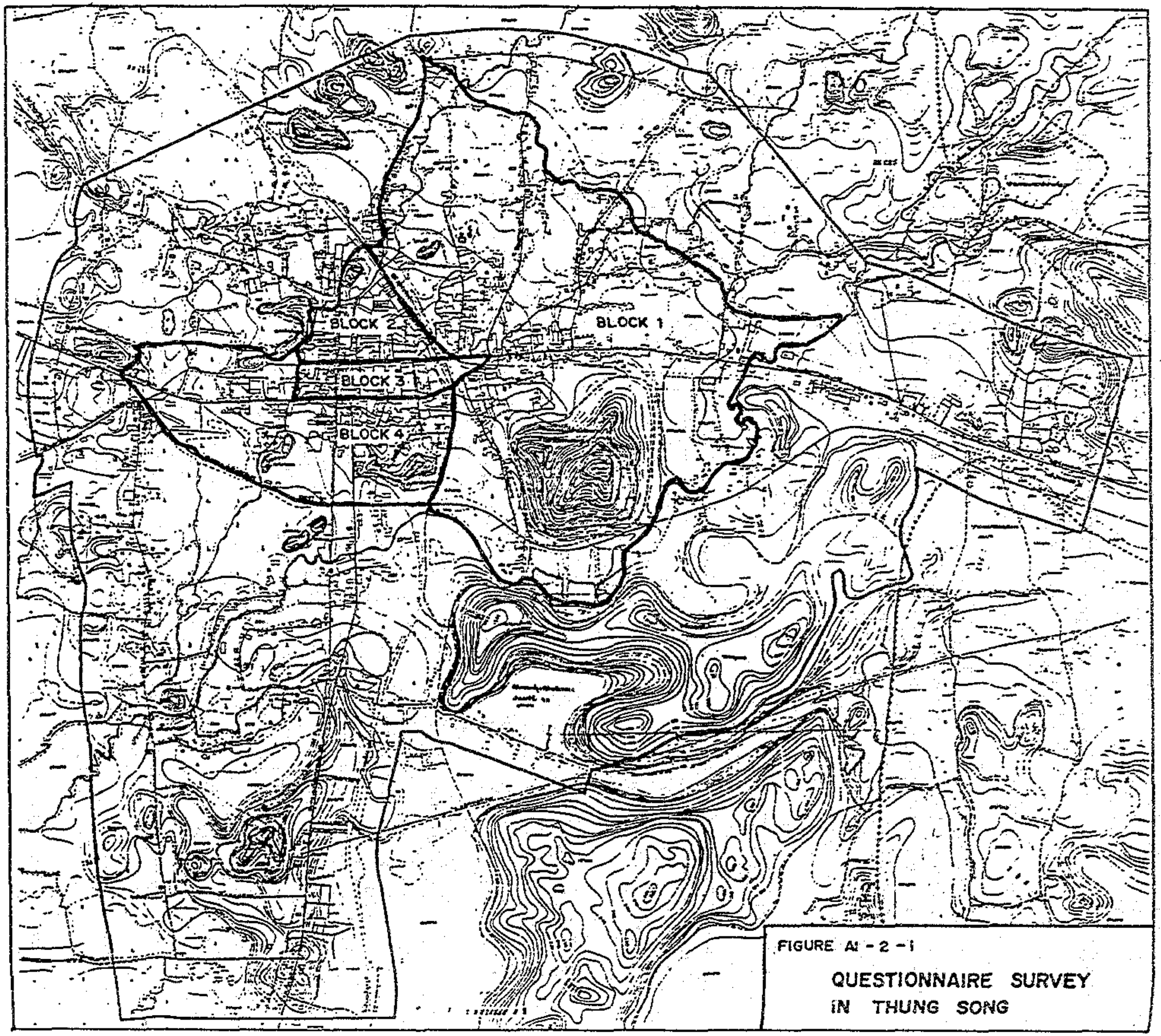


FIGURE A-2-1
QUESTIONNAIRE SURVEY
IN THUNG SONG

8. Average Monthly Water Charge

9. Willingness to Pay for Water Charge

10. Water Quality in case of Other Source

    10.1 Color
    10.2 Smell
    10.3 Turbidity

11. Willingness to Connect to the Municipal System

12. Willingness to Pay for Connection Fee

13. Willingness to Pay for Water Charge

4 Survey Method

College students were employed as interviewers and were engaged in the questionnaire survey with the guidance of the PWA Head Office staff. The survey was conducted to 183 residents on September 8, 1988.

5 Survey Results

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

1) General

55.2% of the respondents lived in residential houses while 43.7% in commercial buildings and the remaining 1.1% was unknown due to the omission of confirmation by the interviewers.

The total numbers of persons in families and employees were 918 and 434, respectively. Accordingly, one household is composed of 5.02 family members and 2.37 employees on an average with a ttotal of 7.39 persons.

Regarding the average monthly income, 82.0% of the respondents were in the up-to-6,000 Baht bracket, or 14.2% in the up-to-2,000 Baht, 33.9% in the 2,001-3,000 Baht, 15.9% in the 3,001-4,500 Baht and 18.0% in the 4,501-6,000 Baht brackets, respectively. The average in respondents weighted by the number of persons and the median in each income bracket was approximately 4,700 Baht, but the number of persons was biggest in the 2,001-3,000 Baht bracket.

As to the average monthly medical expense, 39.9% was in the up-to-50 Baht bracket and 14.7%, 11.5% and 20.8% were in the 51-100, 101-200 and 201-500 Baht brackets, respectively. The average in respondents calculated by the same method as the above is 300 Baht, but the number of persons was biggest in the the up-to-50 Baht bracket.

2) Type of Water Supply

60.1% of the respondents used the municipal system only, 23.0% the other source than the municipal system and 16.9% the combined system of the municipal system and other source(s).

87.7% or 64 out of 73 other sources was groundwater as shown below.

Block No.	1	2	3	4	5	Total
Municipal System Only	14	30	25	28	13	110
plus Rain/River	1	-	4	-	-	5
plus Pond/Reservoir	-	1	-	-	-	1
plus Water Vendor	-	-	-	1	-	1
plus Well	7	-	2	5	10	24
Well Only	18	-	-	15	6	39
plus Water Vendor	-	-	-	1	-	1
Rain/River Only	-	-	-	-	2	2
Total	40	31	31	50	31	183

3) Response to Municipal System

The reputation of the PWA waterworks among 141 respondents using the municipal system was not so good, that is to say, 47.5% complained of low pressure, 24.8% of insufficient water, 36.2% of color, 47.5% of smell and 50.4% of turbidity. However, there were big gaps in response by the block. Though the low pressure took place in all blocks, especially in Block 5 (Nabon), the respondents except for Block 5 have insufficient water. The complaint of color was conspicious in Blocks 2 and 3, while smell was mostly detected in Blocks 1, 2 and 3 and turbidity was found in Blocks 1, 2, 3 and 5.

4) Potability

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

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

	Tap Water	Well Water
Drinking	54 (49.1%)	28 (71.8%)
Not Drinking	6 (5.4%)	8 (20.5%)
Both	50 (45.5%)	- (-)
Unknown	- (-)	3 (7.7%)
Total	110 (100%)	39 (100%)

49.1% used well water for drinking and 45.5% for drinking and not-drinking in spite of their complaints of its water quality, while 71.8% used well water for drinking.

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

5) Water Quality of Other Sources

As mentioned above, the main water source was the groundwater. 23.3% complained of color, 19.2% of smell and 24.6% of turbidity. Scrutinizing the data block by block, such complaints mostly took place in Block 4, while Blocks 1 and 5 were comparatively blessed with water quality. Compared with those in tap water, the complaint of water quality was rather less in well water.

6) Conditions of Wells

The well depth distribution is shown below. Between 2.4 and 30 m and 79.7% wells had depths of not more than 10 m. The almost wells with depths of more than 10 m were located in Block 5.

Block No.	<5m	>5m <10m	>10m <15m	>15m <20m	>20m <30m	Un-known	Total
1	13	11	1	-	-	-	25
2	-	-	-	-	-	-	-
3	-	2	-	-	-	-	2
4	10	10	1	-	-	-	21
5	1	4	5	5	1	-	16
Total	24	27	7	5	1	-	
Well Dep. (m)	4.4 (24)	7.5 (27)	14.0 (7)	19.2 (5)	30.0 (1)		
Water Dep. (m)	2.6 (24)	4.5 (26)	8.6 (7)	13.2 (5)	27.0 (1)		
Operation Time (h/d)	1.9 (10)	1.6 (15)	1.8 (6)	9.3 (4)	2.0 (1)		
No.of Fetching Time (1/d)	13.3 (14)	6.1 (10)	10.2 (2)	2.0 (1)	- (-)		

The figures in parentheses show the number of wells used for the average calculation.

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

Regarding the average monthly water consumption, 44.7% belonged to the up-to-15 cu m bracket and 31.2% to the 16-30 cu m bracket.

27.7% of the respondents paid for the water charge in the up-to-50 Baht bracket and 37.6% in the 51-100 Baht brackets, while, according to the result on the willingness-to-pay for water charge, 41.1% wanted that the water charge would be in the up-to-50 Baht bracket and 39.7% in the 51-100 Baht bracket. The expectant amount was rather less than the actual payment.

8) Willingness-to-Connect

Out of 183 respondents, 42 didn't use the municipal system at present. However, 49.6% was willing to connect to the municipal system. Such people mainly lived in Blocks 1, 4 and 5. They wanted that the connection fee would be less than 2,500 Baht (65%) and the water charge less than 100 Baht (85.0%), which a little bit more than that of existing consumers as mentioned above.

Reasons for unwillingness-to-conect were summarized below.

Block No.	1	2	3	4	5	Total
There is a well	2	-	-	2	-	4
Well water is enough	-	-	-	5	-	4
Don't use much water	2	-	-	-	-	2
Not necessary	1	-	-	-	-	1
Lack of money	-	-	-	-	1	1
Tap water is expensive in installation	1	-	-	2	-	3
Tap water is expensive	3	-	-	-	-	3
Others	1	-	-	-	1	2
Unknown	1	-	-	-	-	1
Total	11	-	-	9	2	22

Contents of others were as follows:

- o It will take time to connect the municipal system and the connection work will be difficult.
- o Although having already paid for the connection fee, I give up it due to no work.

Most people who were unwilling to connect to the municipal system thought that they already had wells and those were enough or clean. Wells were very close and indispensable to their living.

Table A1-5-1 SUMMARY OF QUESTIONNAIR SURVEY IN THUNG SONG

Block No.	1	2	3	4	5	Total	Rate (%)
No. of Samples	40	31	31	50	31	183	
1. General							
1.1 Address							
1.2 Type of House							
Residential	26	4	14	37	20	101	55.2
Commercial	14	26	17	12	11	80	43.7
Residential/Commercial	-	1	-	1	-	2	1.1
Unknown	-	-	-	-	-	-	-
1.3 No.of Persons in Family	178	142	165	249	184	918	
Unknown (No. of Samples)	-	-	-	-	-	-	
1.4 No.of Employees	66	69	93	102	104	434	
Unknown (No. of Samples)	-	-	-	-	-	-	
1.5 Ave. Monthly Income							
Baht							
up to 2,000	5	4	6	8	3	26	14.2
2,001-3,000	17	10	4	27	4	62	33.9
3,001-4,500	9	6	4	5	5	29	15.9
4,501-6,000	5	4	9	6	9	33	18.0
6,001-7,500	3	-	3	1	2	9	4.9
7,501-10,000	1	3	4	1	2	11	6.0
10,001-15,000	-	2	1	2	5	10	5.5
15,001-50,000	-	2	-	-	-	2	1.1
Over 50,000	-	-	-	-	1	1	0.5
Unknown	-	-	-	-	-	-	-
1.6 Ave. Monthly Medical Expense							
Baht							
up to 50	4	20	18	13	18	73	39.9
51-100	16	1	2	2	6	27	14.7
101-200	7	-	1	11	2	21	11.5
201-500	9	4	4	16	5	38	20.8
501-1,000	2	-	5	6	-	13	7.1
1,001-2,000	-	3	-	2	-	5	2.7
2,001-5,000	-	1	1	-	-	2	1.1
Over 5,000	-	2	-	-	-	2	1.1
Unknown	2	-	-	-	-	-	1.1
2. Type of Water Supply							
Municipal System	14	30	25	28	13	110	60.1
Combined	8	1	6	6	10	31	16.9
Other Sources	18	-	-	16	8	42	23.0
Unknown	-	-	-	-	-	-	-
3. Municipal System							
3.1 Pressure							
Low	12	16	12	8	19	67	47.5
High	10	14	18	26	4	72	51.1
Unknown	-	1	1	-	-	2	1.4
3.2 Quantity							
Sufficient	15	31	30	28	1	105	74.5
Not Sufficient	7	-	-	6	22	35	24.8
Unknown	-	-	1	-	-	1	0.7

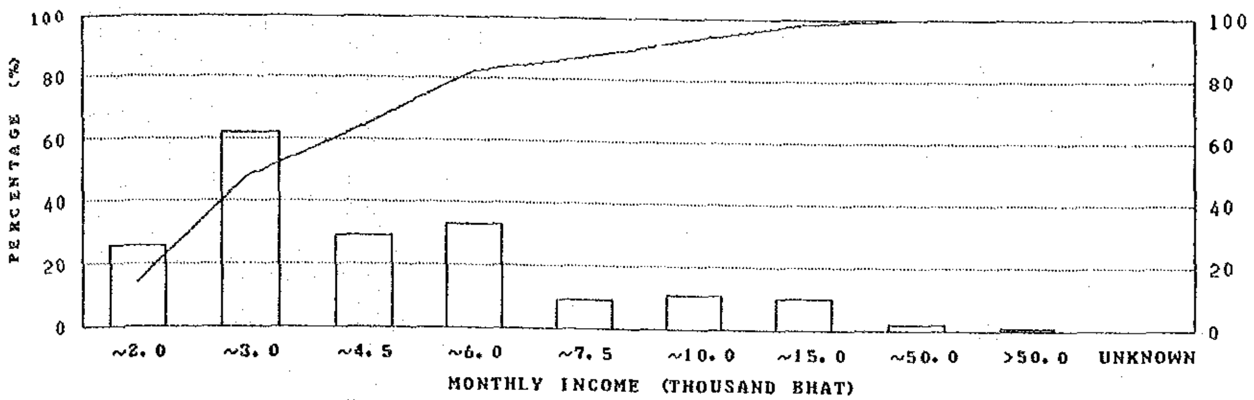
Table A1-5-1 SUMMARY OF QUESTIONNAIR SURVEY IN THUNG SONG (CONT'D)

Block No.	1	2	3	4	5	Total	Rate (%)
4. Other Sources							
Rain/River	1	-	4	-	2	7	
Pond/Reservoir	-	1	-	-	-	1	
Water Vendor	-	-	-	2	-	2	
Groundwater-Shallow Well	25	-	2	21	16	64	
-Deep Well	-	-	-	-	-	-	
Unknown	-	-	-	-	-	-	
5. Potability							
Drinking	35	1	2	40	25	103	56.3
Not Drinking	5	-	2	10	-	17	9.3
Both	-	30	27	-	-	57	31.1
Unknown	-	-	-	-	6	6	3.3
6. Water Quality (Municipal System)							
6.1 Color							
Yes	9	15	19	5	3	51	36.2
No	11	16	12	29	19	87	61.7
Unknown	2	-	-	-	1	3	2.1
6.2 Smell							
Yes	14	16	23	9	5	67	47.5
No	8	15	8	25	17	73	51.8
Unknown	-	-	-	-	1	1	0.7
6.3 Turbidity							
Yes	12	15	21	6	17	71	50.4
No	9	16	10	28	5	68	48.2
Unknown	1	-	-	-	1	2	1.4
7. Ave. Monthly Water Consumption							
Up to 15 cu m	8	20	12	11	12	63	44.7
16-30 cu m	9	7	7	14	7	44	31.2
31-50 cu m	1	2	3	1	-	7	5.0
51-75 cu m	1	1	1	-	-	3	2.1
76-100 cu m	2	1	6	-	-	9	6.4
101-150 cu m	-	-	2	1	-	3	2.1
151-200 cu m	-	-	-	-	-	-	-
201-300 cu m	-	-	-	-	-	-	-
Over 300 cu m	-	-	-	-	-	-	-
Unknown	1	-	-	7	4	12	8.5
8. Ave. Monthly Water Charge							
Baht							
Up to 50	8	8	7	5	11	39	27.7
51-100	8	13	8	19	5	53	37.6
101-150	2	8	5	5	4	24	17.0
151-200	1	-	1	4	2	8	5.7
201-300	1	1	6	-	-	8	5.7
301-500	1	1	1	-	-	3	2.1
501-1,000	-	-	2	1	1	4	2.8
Over 1,000	-	-	1	-	-	1	0.7
Unknown	1	-	-	-	-	1	0.7

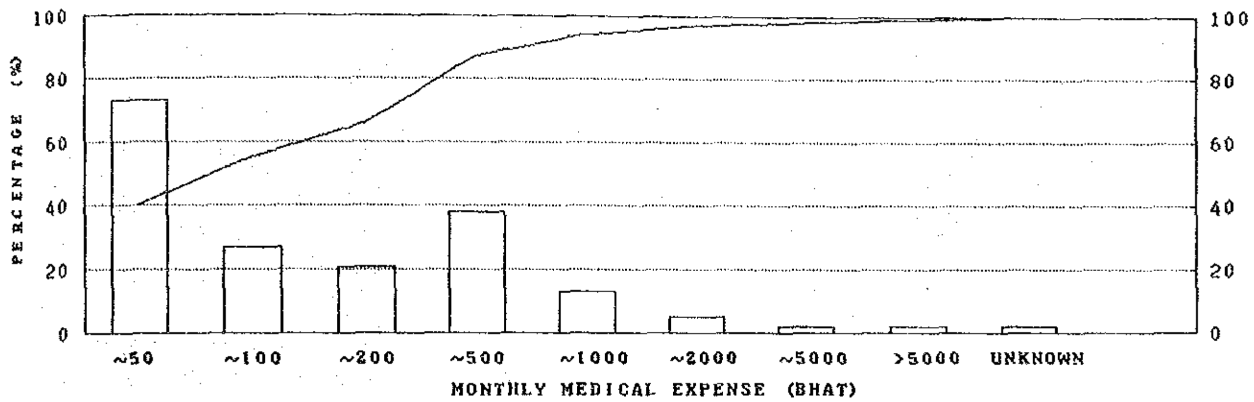
Table A1-5-1 SUMMARY OF QUESTIONNAIR SURVEY IN THUNG SONG (CONT'D)

Block No.	1	2	3	4	5	Total	Rate (%)
9. Willingness to Pay							
Baht							
Up to 50	15	8	14	12	9	58	41.1
51-100	5	13	11	20	7	56	39.7
101-200	2	8	4	1	4	19	13.5
201-500	-	2	2	-	2	6	4.3
501-1,000	-	-	-	1	-	1	0.7
Over 1,000	-	-	-	-	1	1	0.7
Unknown	-	-	-	-	-	-	
10. Water Quality (Other Source)							
10.1 Color							
Yes	2	-	1	11	3	17	23.3
No	23	1	3	10	14	51	69.9
Unknown	1	-	2	1	1	5	6.8
10.2 Smell							
Yes	5	1	-	6	2	14	19.2
No	21	-	4	15	15	55	75.3
Unknown	-	-	2	1	1	4	5.5
10.3 Turbidity							
Yes	5	-	-	11	2	18	24.6
No	21	1	4	10	15	51	69.9
Unknown	-	-	2	1	1	4	5.5
11. Willingness to Connect							
Yes	7	-	-	7	6	20	47.6
No	11	-	-	9	2	22	52.4
Unknown	-	-	-	-	-	-	-
12. Willingness to Pay for Connection Fee							
Baht							
Up to 1,000	3	-	-	-	-	3	15.0
1,001-2,000	3	-	-	1	6	10	50.0
2,001-2,500	-	-	-	1	-	1	5.0
2,501-3,000	1	-	-	4	-	5	25.0
3,001-4,000	-	-	-	1	-	1	5.0
4,001-5,000	-	-	-	-	-	-	-
5,001-6,000	-	-	-	-	-	-	-
Over 6,000	-	-	-	-	-	-	-
Unknown	-	-	-	-	-	-	-
13. Willingness to Pay for Water Charge							
Baht							
Up to 50	4	-	-	1	-	5	25.0
51-100	3	-	-	3	6	12	60.0
101-200	-	-	-	3	-	3	15.0
201-500	-	-	-	-	-	-	-
501-1,000	-	-	-	-	-	-	-
Over 1,000	-	-	-	-	-	-	-
Unknown	-	-	-	-	-	-	-

MONTHLY INCOME DISTRIBUTION



MONTHLY MEDICAL EXPENSE DISTRIBUTION



TYPE OF WATER SOURCE & WILLINGNESS-TO-CONNECT

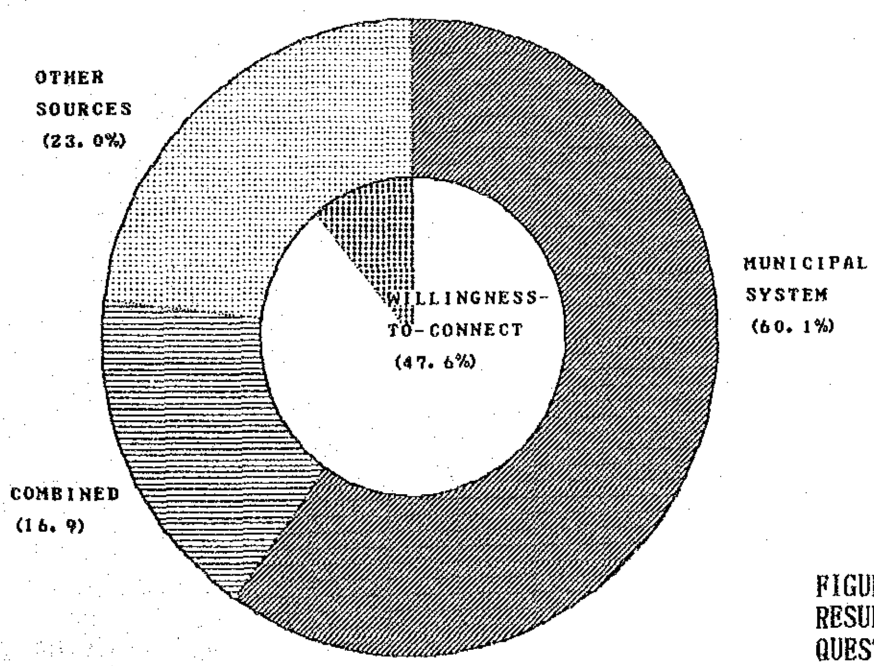
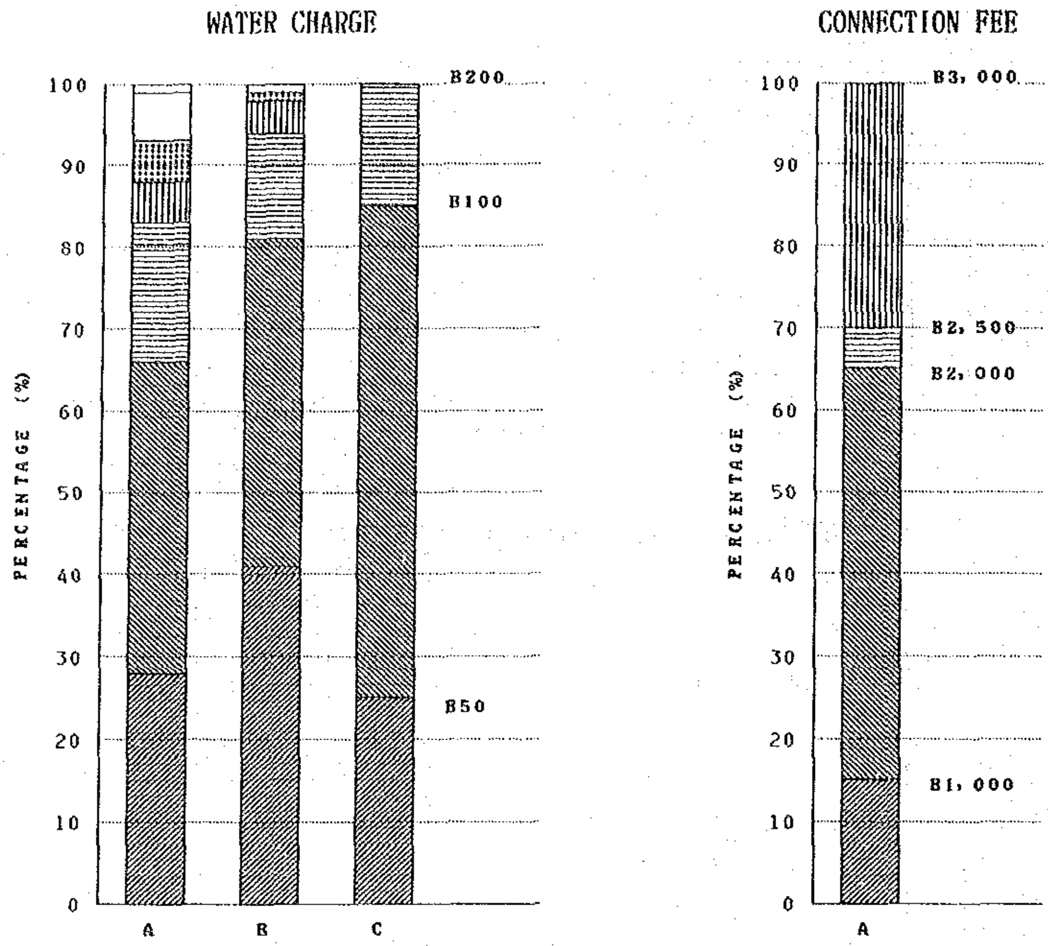


FIGURE A1-5-2
RESULTS OF
QUESTIONNAIRE SURVEY (1)
(THUNG SONG)

WILLINGNESS-TO-PAY



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

COMPLAINTS OF RESPONDENTS

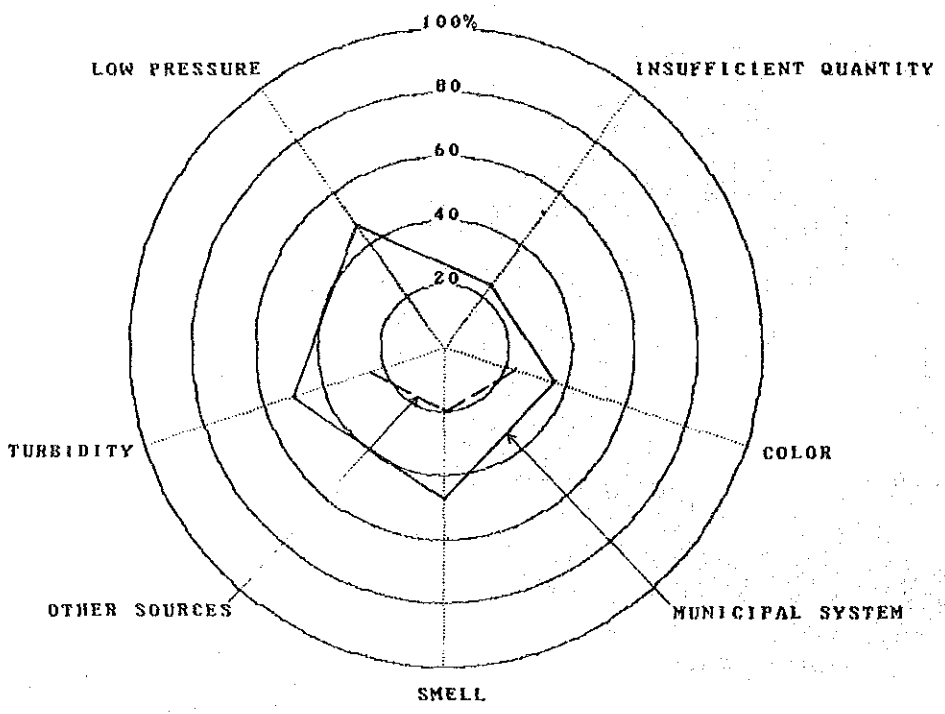


FIGURE A1-5-2
RESULTS OF
QUESTIONNAIRE SURVEY (2)
(THUNG SONG)

APPENDIX A-6-1

Construction Unit Cost

Unit Cost

Item	Material	Fitting	Labor	SubTotal	Transprt (<800km)	Profit etc.(21%)	Total 1 (w/10%cont)	Pavement	Total 2
Pipeline									
	<################			P W A 's Unit Rate (1987)		########################>			
a. A/C Pipe(Normal Tytpe)		(25%)							
100 mm	85	21	56	162	6	35	224	140	364
150 mm	142	36	77	255	11	56	353	154	507
200 mm	255	64	90	409	19	90	569	166	735
250 mm	352	88	126	566	29	125	792	179	971
300 mm	507	127	167	801	40	177	1119	223	1342
400 mm	970	243	248	1461	80	324	2050	248	2298
500 mm	1362	341	278	1981	132	444	2812	283	3095
600 mm	1761	440	354	2555	161	570	3615	319	3934
b. Steel Pipe		(35%)							
150 mm	545	191	99	835	12	178	1127	140	1267
200 mm	720	252	111	1083	22	232	1471	154	1625
250 mm	1080	378	153	1611	38	346	2195	166	2361
300 mm	1330	465	202	1998	58	432	2736	179	2915
400 mm	1420	497	250	2167	80	472	2991	223	3214
500 mm	1785	625	361	2771	160	615	3901	248	4149
600 mm	2140	749	468	3357	264	760	4820	283	5103
700 mm	2495	873	582	3950	322	897	5686	319	6005

Unit Cost

For Transmission Pipeline (Transportation < 800 km)

Item	Material	Fitting (10%)	Labor	SubTotal	Transprt (<800km)	Profit etc.(21%)	Total 1 (w/10%cont)	Pavement	Total 2	PWA Price (1987)	Ratio	Adopted (1988)
	<****** Unit Rate Based on Pipe Material Cost as of December,1988								*******>			
a. A/C Pipe (Class 20 Normal type)		(10 %)										
100 mm	115	12	63	190	7	41	261	153	414	364	1.14	410
150 mm	189	19	87	295	12	64	408	168	577	507	1.14	580
200 mm	328	33	101	462	21	101	643	181	824	735	1.12	820
250 mm	454	45	142	641	32	141	895	196	1091	971	1.12	1,090
300 mm	643	64	188	895	44	197	1249	244	1493	1342	1.11	1,490
400 mm	1217	122	279	1618	87	358	2270	271	2541	2298	1.11	2,540
500 mm	1699	170	313	2182	144	488	3096	309	3405	3095	1.10	3,410
600 mm	2187	219	398	2804	176	626	3967	349	4315	3934	1.10	4,320
b. Steel Pipe		(15 %)										
150 mm	550	83	111	744	13	159	1008	168	1176	1267	0.93	1,270
200 mm	908	136	125	1168	24	250	1587	181	1769	1625	1.09	1,770
250 mm	1210	182	172	1564	42	337	2136	196	2332	2361	0.99	2,360
300 mm	1507	226	227	1960	63	425	2693	244	2937	2915	1.01	2,940
400 mm	1887	283	281	2451	87	533	3378	271	3649	3214	1.14	3,650
500 mm	2261	339	406	3006	175	668	4233	309	4542	4149	1.09	4,540
600 mm	2723	408	526	3657	288	829	5252	349	5600	5103	1.10	5,600
700 mm	3179	477	655	4311	352	979	6206	407	6612	6005	1.10	6,610
800 mm	4527	679	932	6138	460	1385	8781	465	9246			9,250
900 mm	5104	766	1051	6921	582	1575	9986	523	10508			10,510
1000 mm	6804	1021	1401	9225	718	2088	13234	581	13815			13,820
1100 mm	7926	1189	1632	10746	869	2439	15460	639	16099			16,100
1200 mm	9048	1357	1863	12268	1034	2793	17705	697	18402			18,400
1350 mm	11000	1650	2265	14915	1309	3407	21594	784	22378			22,380
1500 mm	12953	1943	2667	17563	1616	4027	25526	871	26398			26,400

*** Note: Pipe material prices are estimated from the contractor's purchasing price as of Dec.1988

Unit Cost

For Distribution Pipeline (Transportation < 800 km)

Item	Material	Fitting	Labor	SubTotal	Transprt (<800km)	Profit etc.(21%)	Total 1 (w/10%cont)	Pavement	Total 2	PWA Price (1987)	Ratio	Adopted (1988)
	<****** Unit Rate Based on Pipe Material Cost as of December,1988								*******>			
a. A/C Pipe (Class 20 Normal type)		(25 %)										
100 mm	115	29	63	207	7	45	284	153	437	364	1.20	440
150 mm	189	47	87	323	12	70	446	168	614	507	1.21	610
200 mm	328	82	101	511	21	112	708	181	890	735	1.21	890
250 mm	454	113	142	709	32	155	986	196	1181	971	1.22	1,180
300 mm	643	161	188	991	44	217	1378	244	1621	1342	1.21	1,620
400 mm	1217	304	279	1801	87	397	2513	271	2784	2298	1.21	2,780
500 mm	1699	425	313	2437	144	542	3435	309	3744	3095	1.21	3,740
600 mm	2187	547	398	3132	176	695	4403	349	4752	3934	1.21	4,750
b. Steel Pipe		(35 %)										
150 mm	550	193	111	854	13	182	1154	168	1322	1267	1.04	1,320
200 mm	908	318	125	1350	24	289	1829	181	2010	1625	1.24	2,010
250 mm	1210	424	172	1806	42	388	2459	196	2654	2361	1.12	2,650
300 mm	1507	527	227	2262	63	488	3095	244	3338	2915	1.15	3,340
400 mm	1887	660	281	2828	87	612	3880	271	4151	3214	1.29	4,150
500 mm	2261	791	406	3458	175	763	4835	309	5144	4149	1.24	5,140
600 mm	2723	953	526	4202	288	943	5977	349	6325	5103	1.24	6,330
700 mm	3179	1113	655	4946	352	1113	7052	407	7459	6005	1.24	7,460
800 mm	4527	1584	932	7043	460	1576	9986	465	10451			10,450
900 mm	5104	1786	1051	7941	582	1790	11344	523	11867			11,870
1000 mm	6804	2381	1401	10586	718	2374	15045	581	15626			15,630
1100 mm	7926	2774	1632	12332	869	2772	17570	639	18209			18,210
1200 mm	9048	3167	1863	14077	1034	3173	20113	697	20810			20,810
1350 mm	11000	3850	2265	17115	1309	3869	24522	784	25307			25,310
1500 mm	12953	4533	2667	20153	1616	4571	28974	871	29846			29,850

*** Note: Pipe material prices are estimated from the contractor's purchasing price as of Dec.1988

Unit Cost

For Transmission Pipeline (Transportation >= 800 km)

(****** Unit Rate Based on Pipe Material Cost as of December,1988 *******)

Item	Material	Fitting (10%)	Labor	SubTotal	Transprt (>=800km)	Profit etc.(21%)	Total 1 (w/10%cont)	Pavement	Total 2			Adopted (1988)
a. A/C Pipe (Class 20 Normal type)		(10 %)										
100 mm	115	12	63	190	13	43	270	153	423	364	1.16	420
150 mm	189	19	87	295	24	67	424	168	593	507	1.17	590
200 mm	328	33	101	462	42	106	670	181	852	735	1.16	850
250 mm	454	45	142	641	63	148	937	196	1133	971	1.17	1,130
300 mm	643	64	188	895	87	206	1308	244	1551	1342	1.16	1,550
400 mm	1217	122	279	1618	175	377	2387	271	2658	2298	1.16	2,660
500 mm	1699	170	313	2182	288	519	3288	309	3597	3095	1.16	3,600
600 mm	2187	219	398	2804	352	663	4201	349	4549	3934	1.16	4,550
b. Steel Pipe		(15 %)										
150 mm	550	83	111	744	26	162	1025	168	1193	1267	0.94	1,270
200 mm	908	136	125	1168	48	255	1619	181	1801	1625	1.11	1,800
250 mm	1210	182	172	1564	83	346	2192	196	2387	2361	1.01	2,390
300 mm	1507	226	227	1960	127	438	2778	244	3022	2915	1.04	3,020
400 mm	1887	283	281	2451	175	551	3495	271	3766	3214	1.17	3,770
500 mm	2261	339	406	3006	350	705	4466	309	4775	4149	1.15	4,780
600 mm	2723	408	526	3657	577	889	5636	349	5984	5103	1.17	5,980
700 mm	3179	477	655	4311	704	1053	6674	407	7081	6005	1.18	7,080
800 mm	4527	679	932	6138	919	1482	9393	465	9857			9,860
900 mm	5104	766	1051	6921	1163	1698	10760	523	11283			11,280
1000 mm	6804	1021	1401	9225	1436	2239	14190	581	14771			14,770
1100 mm	7926	1189	1632	10746	1738	2622	16616	639	17256			17,260
1200 mm	9048	1357	1863	12268	2068	3011	19081	697	19778			19,780
1350 mm	11000	1650	2265	14915	2617	3682	23336	784	24120			24,120
1500 mm	12953	1943	2667	17563	3231	4367	27677	871	28548			28,550

*** Note: Pipe material prices are estimated from the contractor's purchasing price
as of Dec.1988

Unit Cost

For Distribution Pipeline (Transportation >= 800 km)

Item	Material	Fitting	Labor	SubTotal	Transprt (>=800km)	Profit etc. (21%)	Total 1 (w/10%cont)	Pavement	Total 2			Adopted (1988)
<****** Unit Rate Based on Pipe Material Cost as of December,1988 *******>												
a. A/C Pipe (Class 20 Normal type)		(25 %)										
100 mm	115	29	63	207	13	46	293	153	446	364	1.23	450
150 mm	189	47	87	323	24	73	462	168	630	507	1.24	630
200 mm	328	82	101	511	42	116	736	181	917	735	1.25	920
250 mm	454	113	142	709	63	162	1028	196	1223	971	1.26	1,220
300 mm	643	161	188	991	87	227	1436	244	1680	1342	1.25	1,680
400 mm	1217	304	279	1801	175	415	2630	271	2901	2298	1.26	2,900
500 mm	1699	425	313	2437	288	572	3627	309	3936	3095	1.27	3,940
600 mm	2187	547	398	3132	352	732	4637	349	4986	3934	1.27	4,990
b. Steel Pipe		(35 %)										
150 mm	550	193	111	854	26	185	1171	168	1340	1267	1.06	1,340
200 mm	908	318	125	1350	48	294	1861	181	2042	1625	1.26	2,040
250 mm	1210	424	172	1806	83	397	2514	196	2709	2361	1.15	2,710
300 mm	1507	527	227	2262	127	502	3179	244	3423	2915	1.17	3,420
400 mm	1887	660	281	2828	175	631	3997	271	4269	3214	1.33	4,270
500 mm	2261	791	406	3458	350	800	5068	309	5377	4149	1.30	5,380
600 mm	2723	953	526	4202	577	1004	6361	349	6709	5103	1.31	6,710
700 mm	3179	1113	655	4946	704	1187	7520	407	7927	6005	1.32	7,930
800 mm	4527	1584	932	7043	919	1672	10598	465	11062			11,060
900 mm	5104	1786	1051	7941	1163	1912	12118	523	12641			12,640
1000 mm	6804	2381	1401	10586	1436	2525	16001	581	16582			16,580
1100 mm	7926	2774	1632	12332	1738	2955	18726	639	19365			19,370
1200 mm	9048	3167	1863	14077	2068	3391	21490	697	22187			22,190
1350 mm	11000	3850	2265	17115	2617	4144	26264	784	27049			27,050
1500 mm	12953	4533	2667	20153	3231	4911	31125	871	31996			32,000

*** Note: Pipe material prices are estimated from the contractor's purchasing price as of Dec.1988

Unit Cost

Construction Works		Price in 3 Lowest Tenders (1988) (A)		Estimated Cost (A)*1.35	PWA's Unit Cost (for 1987)	Adopted Cost (1988)
Concrete Work (incl.Form Work,Scafolding)	Baht	2,200 /cu m	Baht	2,970 /cu m	-	
Re-Bar	Baht	18 /kg	Baht	24 /kg	-	
Unit Concrete Cost (incl.Form Work,Scafolding, Re-Bar(100kg/cu m concrete)))			Baht	5,370 /cu m	-	5,400
Earth Work						
Excavation (with Backfill)		55 /cu m		79 /cu m	-	80
Soil Fill		53 /cu m		76		120 (From PWA Cost)
Architectural Works						
Administration Bldg.		4,516 /sq m		6,451 /sq m		
Head Quarter Bldg.		3,612		5,160		5,000
Chlorination House	Baht	2,830 /sq m	Baht	4,043 /sq m	3610 - 4300	3,800
Pump House (excl.pump pit)	Baht	1,860 /sq m	Baht	2,657 /sq m	3540 - 4200	3,600

Unit Cost

Construction Works	PWA's Cost (for 1987) (Baht 1000)	Unit Cost (Baht/cu m/h) (A)	Estimated Cost (for 1989) (A)*1.30	Adopted Cost (1988)
Treatment Facilities			Unit Cost (Baht/cu m/h)	Unit Cost (Baht/cu m/h)
Sedimentation Basin				
50 cu m/hr	1,310	26,200	34,100	34,000
100 cu m/hr	1,633	16,330	21,200	21,000
200 cu m/hr	3,136	15,680	20,400	20,000
250 cu m/hr	5,133	20,532	26,700	27,000
500 cu m/hr	7,708	15,416	20,000	20,000
1000 cu m/hr	17,723	17,723	23,000	23,000
Filters				
50 cu m/hr	588	11,760	15,300	15,000
100 cu m/hr	1,044	10,440	13,600	14,000
200 cu m/hr	2,227	11,135	14,500	15,000
250 cu m/hr	2,337	9,348	12,200	12,000
500 cu m/hr	4,674	9,348	12,200	12,000
1000 cu m/hr	11,356	11,356	14,800	15,000
Clear Water Reservoir			Unit Cost (Baht/cu m)	Unit Cost (Baht/cu m)
500 cu m	887	1,774	2,300	2,300
1000 cu m	1,628	1,628	2,100	2,100
1500 cu m	2,699	1,799	2,300	2,300
2000 cu m	2,803	1,402	1,800	1,800
2250 cu m	3,282	1,459	1,900	1,900
3000 cu m	6,633	2,211	2,900	2,900
3300 cu m	6,603	2,001	2,600	2,600
4000 cu m	7,730	1,933	2,500	2,500
5800 cu m	10,809	1,864	2,400	2,400
Elevated Tank			Cost (Baht 1000)	Cost (Baht 1000)
50 cu m	722		940	900
120 cu m	1,146		1,490	1,500
250 cu m	1,394		1,810	1,800

APPENDIX A-8-1

Capacity Calculation of the Water Treatment Plant

Capacity Calculation for Treatment Plant

Item	Total System (for 2011)
Planned Flow (Daily Max)	Q= 8,400 cu m/d = 350 cu m/hr = 5.8 cu m/min = 0.097 cu m/sec
No. of Treatment Line	2 Lines 4,200 cu m/d x 2 lines
(1) Receiving Well	
Criteria	T= 1.5 min d= 2.8 m
No.	1 unit
Dimension	Circular Dia 2.0 m v= 9 cu m t= 1.5 min
(2) Mixing Tank	
Criteria	T= 1.0 min
Dimension	Square x 3 units L m x W m x D m x units 1.2 1.2 1.5 3 v = 6.48 cu m t = 1.1 min
Mixer	Mechanical Flush Mixer

Capacity Calculation for Treatment Plant

Item	Total System (for 2011)
(3) Coagulant Mixing	
Coagulant	Solid Aluminum Sulphate ($Al2(SO4)3$) containing 15 % Al2-O3
	Dosage Rate : 10-25 mg-solid alum/l Average 10 mg/l
	Coagulant Solution : 5 % solution
	Dosage Amount : 84 kg-Alum/day
	Coagulant Solution (5 % solution) = 2 cu m/day
No. of Mixer	2 units
Type	Batch Type Mixing
Capacity	0.8 cu m/unit
Dimension	Square x 3 units (1 stand by) L m x W m x D m x units 1.0 1.0 1.0 2
	v = 1.0 cu m/unit
	Total V = 2.0 cu m

Capacity Calculation for Treatment Plant

Item	Total System (for 2011)
(4) Flocculator	
Type	Hydraulic Flocculation
No.	N = 2 lines x 2 units
	= 4 units
Unit Flow	q = 1.46 cu m/min/unit
Criteria	T = 30 min
Dimension	W m x L m x D m x n units 1.2 15.0 2.5 4
	v = 45 cu m/unit
	t = 30.9 min

Capacity Calculation for Treatment Plant

Item	Total System (for 2011)
(5) Sedimentation Basin	
Type	Rectanglar, Horizontal Flow
No.	N = 2 line x 1 basins
	= 2 basins
Unit Flow	q = 175.0 cu m/hr/basin
Criteria	Retention Time T = 4 hours
Dimension	W m x L m x D m x N 6 30 4.0 2
	v = 720 cu m/basin
	t = 4.1 hours
Flow velocity	v = 12.2 cm/min
Surface Load	a = 23.3 m3/m2/day
Sludge Removal	Mechanical Scraper
Sludge Amount	
Solid Amount (ton-DS)	So = Q(K(T1-T2)+0.16xB)x10^-6 where So:Sludge dry weight(ton) Q :Treated water amount(m3/d) K :Coefficient converting turbidity to SS (0.8~1.5 ->>1.2) T1 :Turbidity in raw water (ave= 12) T2 :Turbidity after Sedimentation (ave = 7) B :Alum dosage rate (ave.= 10 mg/l)
	So = 0.06 ton-DS/day
	Water Contents of Drained Sludge
	w = 99.5 %
	Sludge Volume
	v = 13 cu m/d

Capacity Calculation for Treatment Plant

Item	Total System (for 2011)
(6) Rapid Sand Filter	
Type	Down Flow, Single Media
No.	N = 2 lines x 4 units
	= 8 units
Unit Flow	q = 1,050 cu m/day/unit
Criteria	Surface Load 120 - 150 m3/m2/day
Dimension	W m x L m x N units 2.5 3.0 8
	a = 8 sq m/unit
Surface Load	La = 140.0 m3/m2/day
Filter Washing	
Frequency	Once a day for each filter
Rate	Surface Washing
	0.2 m3/m2/min x 5 min
	Backwashing
	0.6 m3/m2/min x 10 min
Water Amount required	Surface Washing
	v = 8 sq m/unit x 8 units
	x 0.2 m3/m2/min x 5 min
	= 60 cu m/day
	Backwashing
	v = 8 sq m/unit x 8 units
	x 0.6 m3/m2/min x 10 min
	= 360 cu m/day
	Total q= 420 cu m/day

Capacity Calculation for Treatment Plant

Item	Total System (for 2011)
Solid Amount in Wastewater	
Solid Amount (ton-DS)	So = Q*K*(T1-T2)*10^-6 where So:Sludge dry weight(ton) Q :Treated water amount(m3/d) K :Coefficient converting turbidity to SS (0.8-1.5 ->>1.2) T1 :Turbidity before filter(ave= 7) T2 :Turbidity after filter(ave = 0) So = 0.07 ton-DS/day
SS Contents	s = 168 mg/l

(7) Clear Water Reservoir	
No.	N = 1 units
Criteria	Retention Time T = 8 hours
Required Volume	V = 2,800 cu m
Dimension	L m x W m x D m x N units 20 30 5 1 Total Volume v = 3,000 cu m
Retention Time	t = 8.6 hours

Capacity Calculation for Treatment Plant

Item	Total System (for 2011)
(8) Chlorination Equipment	
Injection Point	at the Inlet of Clear Water Reservoir
Dosage Rate	2.0 ppm
Type	Liquid Chlorine (1-ton cylinder)
Amount	17 kg- Cl gas/day
Injector	Vacuum Type Injector
	No. of unit 2 units (excl. 1 units stand-by)
	Rate 0.35 kg/h/unit
	Capacity 10 kg/h/unit
Storage	1 month
Storage Amount	17 kg /day x 30 day = 504 kg
	= 11 cylinders (50 kg)
(9) Clear Water Pump	
No.	N = 3 units + 1 stand-by
Flow per unit	q = 2.7 cu m/min/unit
Diameter	D = 200 mm
Head	H = 30 m
Motor output	P = 30 KW
Total Capacity	Q = 11,760 cu m/day

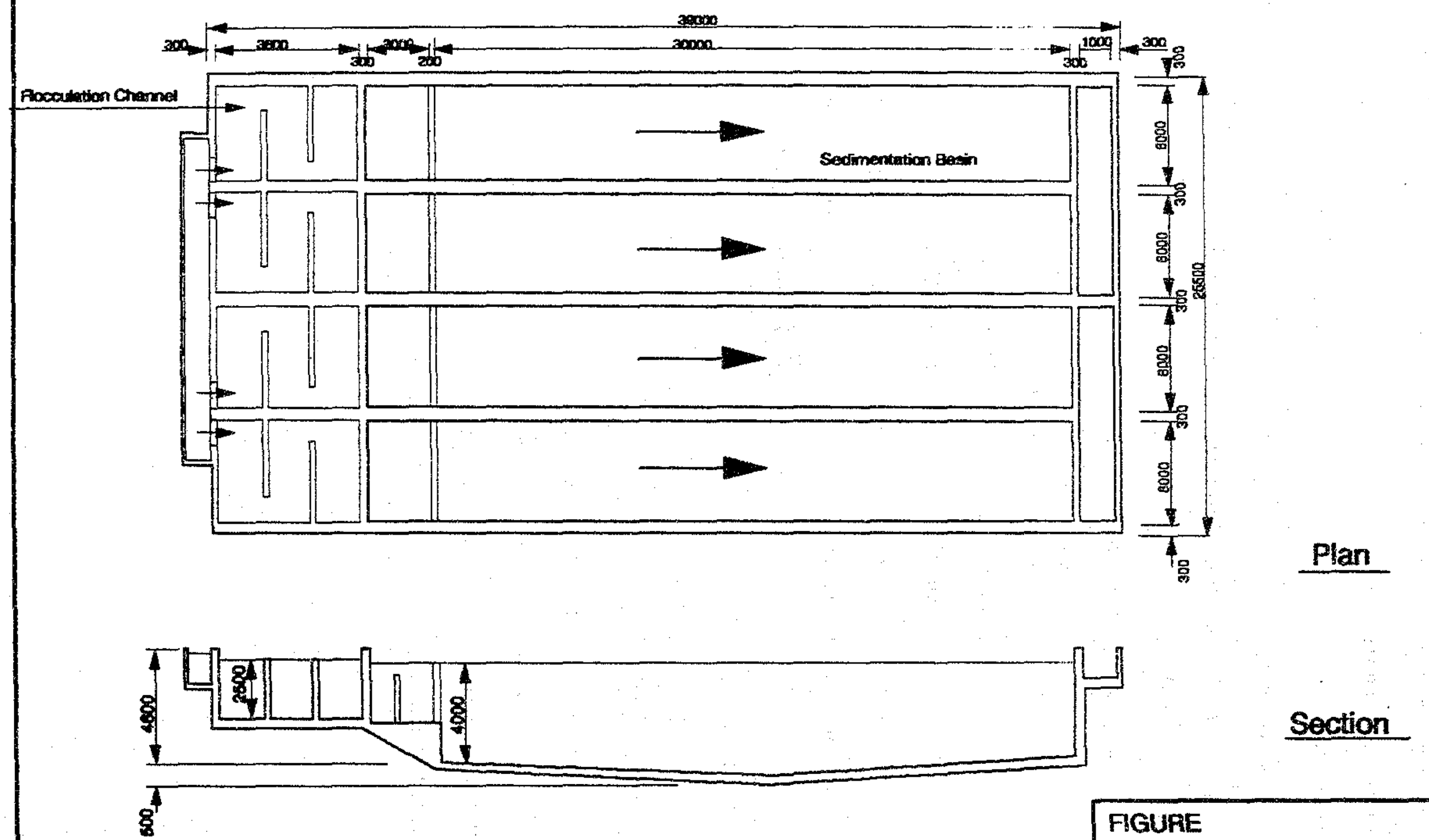
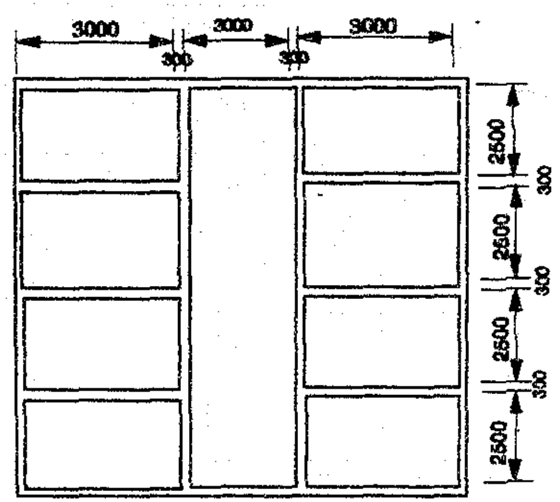
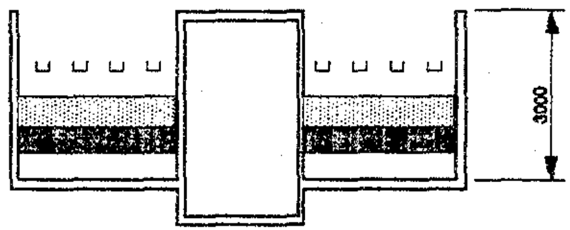


FIGURE
Flocculation Channel and
Sedimentation Basin



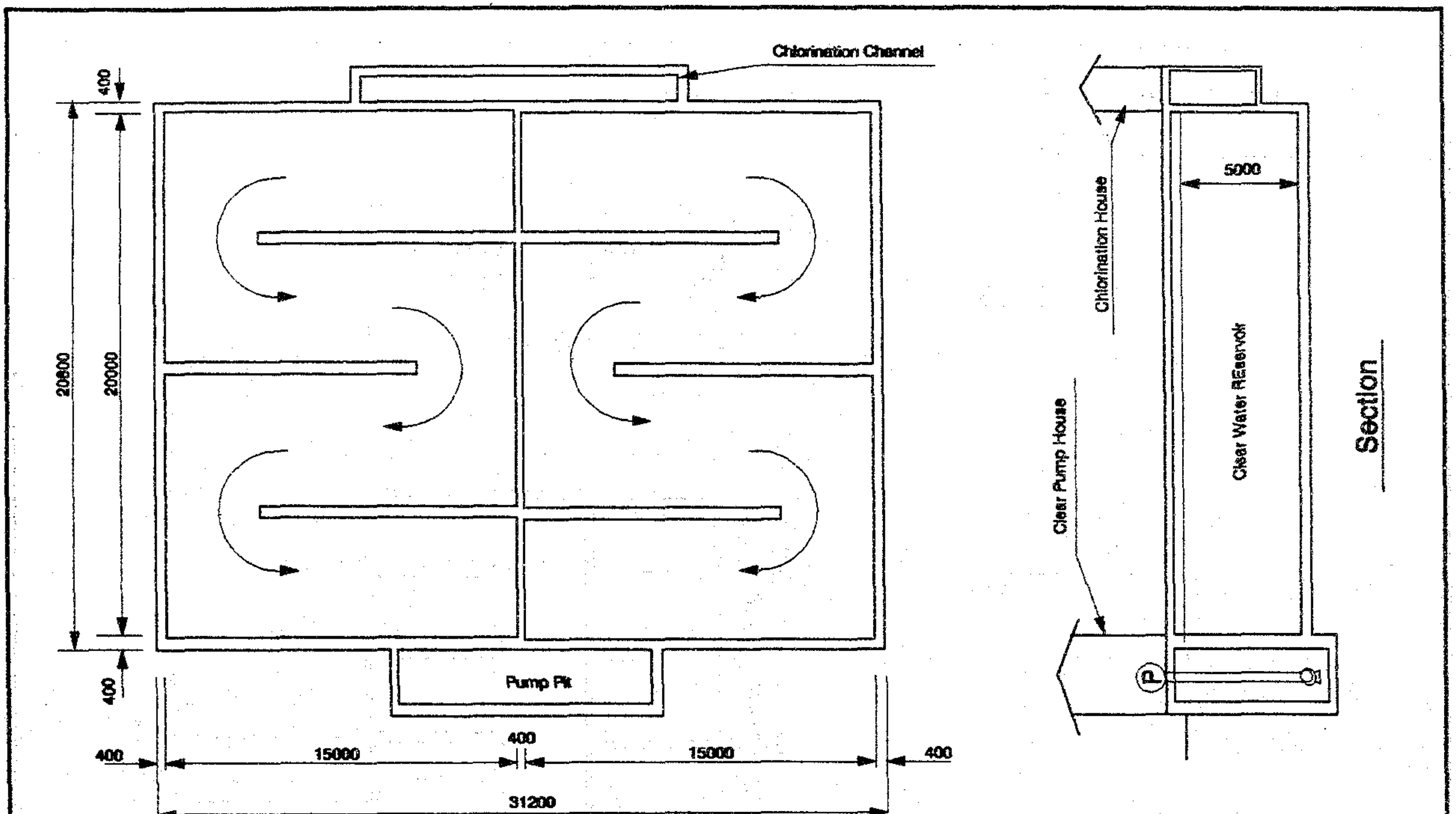
Plan



Section

FIGURE

Rapid Sanf Filter



FIGURE

Clear Water Reservoir

APPENDIX A-8-2

Distribution Network Analysis

Table 6-3-1 Results of Distribution Network Analysis

T I T L E	:	Thung Song (Proposed)
NO. OF PIPES	:	141
NO. OF NODES	:	124
PEAK FACTOR	:	1.25
MAX HEADLOSS/Km	:	100
MAX UNBAL(LPS)	:	.007

PIPE NO.	FROM Node	TO Node	LENGTH (M)	DIA (MM)	HWC	FLOW (LPS)	VELOCITY (MPS)	HEADLOSS (M/KM)	HEADLOSS (M)
1	200	1	110.00	400	110	126.94	1.01	3.39	0.37
2	1	2	423.00	250	110	31.20	0.64	2.49	1.05
3	2	3	920.00	200	110	24.34	0.77	4.67	4.30
4	3	4	680.00	200	110	7.18	0.23LO	0.49	0.33
5	4	5	1120.00	150	100	5.01	0.28LO	1.21	1.36
6	1	6	462.00	400	110	95.74	0.76	2.01	0.93
7	6	7	1152.00	400	110	92.97	0.74	1.91	2.19
8	7	8	240.00	300	100	91.44	1.29	8.95	2.15
9	8	9	436.00	300	100	89.25	1.26	8.55	3.73
10	9	10	258.00	300	100	7.29	0.10LO	0.08	0.02
12	10	12	256.00	100	100	4.36	0.55	6.76	1.73
13	12	13	292.00	100	110	3.11	0.40	3.03	0.89
14	9	14	296.00	300	100	79.54	1.13	6.91	2.05
15	14	15	70.00	150	100	2.18	0.12LO	0.26	0.02
16	15	16	394.00	100	100	0.92	0.12LO	0.38	0.15
17	15	17	410.00	100	100	0.60	0.08LO	0.17	0.07
18	14	18	106.00	300	100	77.36	1.09	6.57	0.70
19	18	19	186.00	200	100	21.52	0.69	4.44	0.82
20	19	20	28.00	200	100	16.23	0.52	2.63	0.07
21	19	23	328.00	150	100	5.08	0.29LO	1.24	0.41
22	20	21	106.00	200	110	16.23	0.52	2.21	0.23
23	21	22	126.00	200	110	9.64	0.31	0.84	0.11
24	23	22	28.00	150	100	1.87	0.11LO	0.20	0.01
25	23	24	375.00	100	110	1.44	0.18LO	0.73	0.27
26	24	25	200.00	100	110	0.83	0.11LO	0.26	0.05
27	21	26	176.00	150	100	6.16	0.35	1.78	0.31
28	22	26	175.00	100	110	1.87	0.24LO	1.18	0.21
29	26	27	454.00	150	100	6.87	0.39	2.18	0.99
30	27	28	110.00	100	110	1.20	0.15LO	0.52	0.06
31	29	28	116.00	100	110	2.01	0.26LO	1.35	0.16
32	18	30	226.00	300	100	54.83	0.78	3.47	0.79
33	22	37	20.00	200	110	9.05	0.29LO	0.75	0.01
34	30	31	44.00	200	100	17.65	0.56	3.07	0.14
35	31	32	284.00	150	100	3.81	0.22LO	0.73	0.21
36	32	33	18.00	100	100	1.46	0.19LO	0.89	0.02
37	33	34	270.00	100	100	0.88	0.11LO	0.35	0.09
38	31	35	164.00	200	100	11.62	0.37	1.42	0.23
39	35	36	80.00	200	100	10.05	0.32	1.08	0.09
40	36	50	90.00	150	100	0.32	0.02LO	0.01	0.00
41	36	37	20.00	200	100	8.11	0.26LO	0.73	0.01
42	37	38	62.00	150	110	4.20	0.24LO	0.73	0.05

PIPE NO.	FROM Node	TO Node	LENGTH (M)	DIA (MM)	HWC	FLOW (LPS)	VELOCITY (MPS)	HEADLOSS (M/KM)	(M)
43	37	41	44.00	200	100	12.88	0.41	1.71	0.08
44	38	39	62.00	150	110	3.53	0.20LO	0.53	0.03
45	39	40	18.00	150	100	3.01	0.17LO	0.47	0.01
46	39	43	70.00	100	100	0.26	0.03LO	0.04	0.00
47	40	44	80.00	100	110	1.71	0.22LO	1.01	0.08
48	40	45	182.00	100	100	1.07	0.14LO	0.50	0.09
49	44	46	16.00	100	110	1.71	0.22LO	1.01	0.02
50	45	46	66.00	100	100	0.38	0.05LO	0.07	0.00
51	41	42	70.00	100	110	0.45	0.06LO	0.08	0.01
52	43	42	46.00	100	110	0.00	0.00LO	0.00	0.00
53	46	47	18.00	100	100	0.02	0.00LO	0.00	0.00
54	48	47	50.00	100	110	0.91	0.12LO	0.31	0.02
55	49	48	70.00	100	110	1.59	0.20LO	0.88	0.06
56	41	49	20.00	200	100	12.33	0.39	1.58	0.03
57	46	61	92.00	100	110	1.59	0.20LO	0.87	0.08
58	47	57	70.00	100	110	0.39	0.05LO	0.06	0.00
59	49	54	34.00	200	110	10.65	0.34	1.01	0.03
60	30	51	114.00	300	100	35.25	0.50	1.53	0.17
61	51	52	120.00	100	110	2.53	0.32	2.07	0.25
62	51	80	104.00	300	100	32.57	0.46	1.32	0.14
63	52	53	100.00	100	110	2.40	0.31	1.88	0.19
64	53	58	104.00	150	110	0.51	0.03LO	0.01	0.00
65	53	54	24.00	150	100	1.11	0.06LO	0.08	0.00
66	54	55	34.00	200	110	11.69	0.37	1.20	0.04
67	55	56	70.00	100	110	0.45	0.06LO	0.08	0.01
68	56	57	60.00	100	110	0.11	0.01LO	0.01	0.00
69	55	59	26.00	200	110	10.75	0.34	1.03	0.03
70	59	60	136.00	150	110	2.88	0.16LO	0.37	0.05
71	60	61	18.00	150	100	2.47	0.14LO	0.33	0.01
72	80	81	20.00	100	110	2.80	0.36	2.50	0.05
73	81	82	255.00	100	110	1.01	0.13LO	0.38	0.10
74	80	83	90.00	300	100	27.92	0.39	1.00	0.09
75	61	62	122.00	100	110	1.89	0.24LO	1.20	0.15
76	62	63	106.00	100	100	1.25	0.16LO	0.67	0.07
77	63	64	76.00	100	100	0.43	0.05LO	0.09	0.01
78	65	64	44.00	100	100	2.48	0.32	2.37	0.10
79	61	65	104.00	100	100	1.68	0.21LO	1.15	0.12
80	59	67	64.00	200	110	7.74	0.25LO	0.56	0.04
81	67	66	36.00	200	110	12.88	0.41	1.44	0.05
82	66	65	166.00	150	100	3.20	0.18LO	0.53	0.09
83	64	69	160.00	100	100	0.54	0.07LO	0.14	0.02
84	70	69	210.00	150	110	3.50	0.20LO	0.52	0.11
85	66	70	176.00	200	110	8.03	0.26LO	0.60	0.11
86	70	71	160.00	200	110	3.73	0.12LO	0.15	0.02
87	71	72	190.00	150	110	6.26	0.35	1.54	0.29
88	72	73	130.00	150	110	3.03	0.17LO	0.40	0.05
89	73	74	150.00	150	110	1.52	0.09LO	0.11	0.02
90	74	75	450.00	150	110	0.61	0.03LO	0.02	0.01

PIPE NO.	FROM Node	TO Node	LENGTH (M)	DIA (MM)	HWC	FLOW (LPS)	VELOCITY (MPS)	HEADLOSS (M/KM)	(M)
91	68	67	25.00	200	100	5.22	0.17LO	0.32	0.01
92	83	68	310.00	200	100	9.56	0.30	0.99	0.31
93	68	77	204.00	150	110	3.57	0.20LO	0.54	0.11
94	77	76	170.00	150	110	3.13	0.18LO	0.43	0.07
95	76	71	26.00	200	110	4.55	0.14LO	0.21	0.01
96	83	84	6.00	300	100	17.56	0.25LO	0.42	0.00
97	84	85	20.00	150	100	4.22	0.24LO	0.88	0.02
98	85	86	236.00	150	100	4.22	0.24LO	0.88	0.21
99	86	87	20.00	100	100	3.92	0.50	5.57	0.11
100	86	90	96.00	100	100	0.29	0.04LO	0.05	0.00
101	87	88	60.00	100	100	0.06	0.01LO	0.00	0.00
102	87	89	96.00	100	100	3.79	0.48	5.22	0.50
103	84	91	146.00	200	100	13.13	0.42	1.78	0.26
104	91	92	90.00	100	100	1.89	0.24LO	1.44	0.13
105	91	94	182.00	200	110	10.44	0.33	0.98	0.18
106	92	93	160.00	100	100	0.12	0.02LO	0.01	0.00
107	92	77	172.00	100	100	0.57	0.07LO	0.16	0.03
108	78	76	170.00	150	110	1.89	0.11LO	0.17	0.03
109	78	79	194.00	100	100	0.39	0.05LO	0.08	0.01
110	101	78	50.00	200	110	2.68	0.09LO	0.08	0.00
111	101	102	100.00	200	100	0.18	0.01LO	0.00	0.00
112	103	101	3.00	200	110	3.35	0.11LO	0.12	0.00
113	94	103	117.00	200	110	3.89	0.12LO	0.16	0.02
114	94	95	40.00	200	100	6.08	0.19LO	0.43	0.02
115	95	97	310.00	100	100	0.25	0.03LO	0.03	0.01
116	95	96	22.00	100	100	5.36	0.68	9.91	0.22
117	96	98	285.00	100	100	4.14	0.53	6.13	1.75
118	98	99	212.00	100	110	3.80	0.48	4.40	0.93
119	99	100	380.00	100	110	2.60	0.33	2.17	0.83
201	6	201	700.00	100	110	0.86	0.11LO	0.28	0.20
202	201	202	470.00	100	110	0.31	0.04LO	0.04	0.02
203	201	203	580.00	100	110	0.35	0.04LO	0.05	0.03
204	7	204	1250.00	100	110	0.21	0.03LO	0.02	0.02
205	9	226	880.00	100	110	0.15	0.02LO	0.01	0.01
206	226	205	800.00	100	110	0.15	0.02LO	0.01	0.01
207	205	206	670.00	100	110	0.15	0.02LO	0.01	0.01
209	13	208	240.00	100	110	2.44	0.31	1.94	0.46
212	208	211	670.00	100	110	2.44	0.31	1.94	1.30
213	211	29	350.00	100	110	2.44	0.31	1.94	0.68
215	75	213	650.00	100	110	0.49	0.06LO	0.10	0.07
216	74	214	700.00	100	110	0.43	0.05LO	0.08	0.05
218	100	216	720.00	100	110	0.60	0.08LO	0.14	0.10
219	216	217	900.00	100	110	0.18	0.02LO	0.02	0.01
220	216	218	150.00	100	110	0.00	0.00LO	0.00	0.00
221	218	219	800.00	100	110	0.31	0.04LO	0.04	0.03
224	222	218	1130.00	100	110	0.97	0.12LO	0.35	0.40
225	223	222	900.00	100	110	1.70	0.22LO	0.99	0.89
226	89	223	620.00	100	110	3.34	0.43	3.47	2.15

PIPE NO.	FROM Node	TO Node	LENGTH (M)	DIA (MM)	HWC	FLOW (LPS)	VELOCITY (MPS)	HEADLOSS (M/KM)	(M)
227	223	224	870.00	100	110	0.65	0.08LO	0.17	0.14
228	17	207	730.00	100	110	0.00	0.00LO	0.00	0.00
229	5	225	440.00	100	110	0.24	0.03LO	0.03	0.01
230	5	227	450.00	100	110	0.22	0.03LO	0.02	0.01

NODE NO.	FLOW (LPS)	ELEVATION (M)	H G L (M)	PRESSURE (M)
1	0.000	61.10	85.83	24.73
2	-6.858	61.44	84.77	23.33
3	-17.158	60.79	80.48	19.69
4	-2.173	62.53	80.14	17.61
5	-4.549	73.53	78.78	5.25
6	-1.913	60.07	84.90	24.83
7	-1.326	55.92	82.70	26.78
8	-2.190	55.48	80.56	25.08
9	-2.271	54.08	76.83	22.75
10	-2.927	53.66	76.81	23.15
12	-1.250	53.30	75.08	21.78
13	-0.670	53.70	74.19	20.49
14	0.000	52.71	74.78	22.07
15	-0.657	52.02	74.76	22.74
16	-0.924	53.48	74.61	21.13
17	-0.599	52.00	74.69	22.69
18	-1.007	51.70	74.08	22.38
19	-0.218	53.46	73.26	19.80
20	0.000	53.46	73.19	19.73
21	-0.434	52.58	72.95	20.37
22	-0.587	51.79	72.85	21.06
23	-1.766	51.79	72.85	21.06
24	-0.610	50.72	72.58	21.86
25	-0.829	50.62	72.53	21.91
26	-1.154	53.00	72.64	19.64
27	-5.669	53.30	71.65	18.35
28	-3.209	53.38	71.59	18.21
29	-0.429	53.30	71.75	18.45
30	-1.931	51.44	73.30	21.86
31	-2.218	51.44	73.16	21.72
32	-2.355	50.59	72.96	22.37
33	-0.579	50.58	72.94	22.36
34	-0.879	50.21	72.85	22.64
35	-1.571	51.60	72.93	21.33
36	-1.619	51.79	72.85	21.06
37	-0.094	51.79	72.83	21.04
38	-0.664	51.70	72.79	21.09
39	-0.267	51.60	72.75	21.15
40	-0.223	51.70	72.74	21.04

NODE NO.	FLOW (LPS)	ELEVATION (M)	H G L (M)	PRESSURE (M)
41	-0.105	51.60	72.76	21.16
42	-0.447	51.58	72.75	21.17
43	-0.259	51.57	72.75	21.18
44	0.000	51.57	72.66	21.09
45	-0.692	51.60	72.65	21.05
46	-0.484	51.57	72.65	21.08
47	-0.540	51.57	72.65	21.08
48	-0.687	51.58	72.66	21.08
49	-0.078	51.61	72.72	21.11
50	-0.320	51.61	72.84	21.23
51	-0.148	51.55	73.13	21.58
52	-0.134	51.56	72.88	21.32
53	-0.778	51.50	72.69	21.19
54	-0.079	51.50	72.69	21.19
55	-0.494	51.48	72.65	21.17
56	-0.343	51.50	72.64	21.14
57	-0.491	51.52	72.64	21.12
58	-0.506	51.35	72.69	21.34
59	-0.125	51.48	72.62	21.14
60	-0.407	51.50	72.57	21.07
61	-0.496	51.50	72.56	21.06
62	-0.640	51.40	72.42	21.02
63	-0.817	52.20	72.35	20.15
64	-2.360	51.85	72.34	20.49
65	-2.407	51.60	72.44	20.84
66	-1.640	51.30	72.53	21.23
67	-0.090	51.35	72.58	21.23
68	-0.764	51.35	72.59	21.24
69	-4.045	52.13	72.32	20.19
70	-0.803	51.25	72.43	21.18
71	-2.023	51.53	72.40	20.87
72	-3.225	51.90	72.11	20.21
73	-1.517	52.23	72.06	19.83
74	-0.477	52.68	72.04	19.36
75	-0.115	52.70	72.03	19.33
76	-0.466	51.53	72.41	20.88
77	-1.011	51.25	72.48	21.23
78	-0.407	51.30	72.44	21.14
79	-0.388	50.94	72.42	21.48
80	-1.846	51.52	72.99	21.47
81	-1.796	50.40	72.94	22.54
82	-1.006	47.88	72.84	24.96
83	-0.804	51.53	72.90	21.37
84	-0.207	51.53	72.90	21.37
85	0.000	51.53	72.88	21.35
86	0.000	51.05	72.67	21.62
87	-0.076	51.05	72.56	21.51
88	-0.057	50.95	72.56	21.61

NODE NO.	FLOW (LPS)	ELEVATION (M)	H G L (M)	PRESSURE (M)
89	-0.449	50.90	72.06	21.16
90	-0.295	50.90	72.66	21.76
91	-0.801	51.47	72.64	21.17
92	-1.200	51.27	72.51	21.24
93	-0.119	50.94	72.51	21.57
94	-0.473	50.90	72.46	21.56
95	-0.472	50.86	72.44	21.58
96	-1.224	50.89	72.22	21.33
97	-0.250	50.38	72.43	22.05
98	-0.336	50.96	70.48	19.52
99	-1.204	50.05	69.54	19.49
100	-1.995	49.59	68.72	19.13
101	-0.489	50.99	72.44	21.45
102	-0.182	50.85	72.44	21.59
103	-0.532	50.94	72.44	21.50
200 R	126.939	61.20	86.20	25.00
201	-0.205	62.00	84.70	22.70
202	-0.306	64.10	84.68	20.58
203	-0.348	63.00	84.67	21.67
204	-0.205	59.30	82.68	23.38
205	0.000	58.50	76.81	18.31
206	-0.149	60.10	76.80	16.70
207	0.000	52.00	74.69	22.69
208	0.000	54.50	73.73	19.23
211	0.000	54.50	72.43	17.93
213	-0.494	52.60	71.97	19.37
214	-0.429	50.80	71.99	21.19
216	-0.420	50.00	68.61	18.61
217	-0.180	53.10	68.60	15.50
218	-0.667	49.50	68.61	19.11
219	-0.307	51.00	68.58	17.58
222	-0.727	48.00	69.01	21.01
223	-0.997	48.00	69.91	21.91
224	-0.647	48.00	69.76	21.76
225	-0.243	73.53	78.77	5.24
226	0.000	56.20	76.82	20.62
227	-0.218	73.53	78.77	5.24

Table 6-4-1 Results of Distribution Network Analysis

T I T L E	:	NA 8on (Proposed)
NO. OF PIPES	:	27
NO. OF NODES	:	24
PEAK FACTOR	:	1.25
MAX HEADLOSS/Km	:	100
MAX UNBAL(LPS)	:	.005

PIPE NO.	FROM Node	TO Node	LENGTH (M)	DIA (MM)	HWC	FLOW (LPS)	VELOCITY (MPS)	HEADLOSS (M/KM)	HEADLOSS (M)
1	400	13	30.00	150	100	15.32	0.87	9.59	0.29
2	2	1	115.00	150	100	0.64	0.04LO	0.03	0.00
3	3	2	30.00	150	100	0.69	0.04LO	0.03	0.00
4	4	3	115.00	150	100	0.97	0.05LO	0.06	0.01
5	5	4	140.00	150	100	2.72	0.15LO	0.39	0.05
6	6	5	25.00	150	100	3.46	0.20LO	0.61	0.02
7	7	6	75.00	150	100	4.36	0.25LO	0.94	0.07
8	7	8	67.00	100	100	0.10	0.01LO	0.01	0.00
9	4	9	88.00	100	100	0.27	0.03LO	0.04	0.00
10	7	9	213.00	100	100	1.26	0.16LO	0.68	0.14
11	10	7	25.00	150	100	5.91	0.33	1.65	0.04
12	11	10	85.00	150	100	5.91	0.33	1.65	0.14
13	12	11	260.00	150	100	7.25	0.41	2.41	0.63
14	15	11	123.00	150	100	0.30	0.02LO	0.01	0.00
15	13	12	75.00	150	100	7.25	0.41	2.41	0.18
16	13	14	208.00	150	100	8.06	0.46	2.93	0.61
17	14	15	188.00	100	100	1.59	0.20LO	1.04	0.20
18	16	15	60.00	150	100	1.50	0.09LO	0.13	0.01
19	14	17	87.00	150	100	5.53	0.31	1.46	0.13
20	17	16	110.00	150	100	3.29	0.19LO	0.56	0.06
21	15	22	47.00	150	100	1.16	0.07LO	0.08	0.00
22	22	23	23.00	150	100	0.36	0.02LO	0.01	0.00
23	22	21	53.00	100	100	0.62	0.08LO	0.18	0.01
24	17	18	63.00	100	100	1.56	0.20LO	1.01	0.06
25	18	19	130.00	100	100	0.58	0.07LO	0.16	0.02
26	21	19	20.00	100	100	0.43	0.05LO	0.09	0.00
27	19	20	92.00	100	100	0.31	0.04LO	0.05	0.00

NODE NO.	FLOW (LPS)	ELEVATION (M)	H G L (M)	PRESSURE (M)
400 R	15.315	55.46	70.46	15.00
1	-0.637	52.11	69.03	16.92
2	-0.050	49.34	69.04	19.70
3	-0.280	50.01	69.04	19.03
4	-1.487	51.54	69.04	17.50
5	-0.734	51.22	69.10	17.88
6	-0.902	54.40	69.11	14.71
7	-0.195	54.13	69.18	15.05
8	-0.097	54.71	69.18	14.47

NODE NO.	FLOW (LPS)	ELEVATION (M)	H G L (M)	PRESSURE (M)
9	-1.523	52.28	69.04	16.76
10	0.000	53.12	69.23	16.11
11	-1.644	52.43	69.37	16.94
12	0.000	56.15	69.99	13.84
13	0.000	57.46	70.17	12.71
14	-0.949	57.71	69.56	11.85
15	-1.636	54.38	69.37	14.99
16	-1.788	54.72	69.38	14.66
17	-0.676	53.57	69.44	15.87
18	-0.980	54.86	69.37	14.51
19	-0.697	54.21	69.35	15.14
20	-0.313	53.92	69.35	15.43
21	-0.190	54.21	69.35	15.14
23	-0.358	53.24	69.36	16.12
22	-0.178	54.20	69.36	15.16

APPENDIX A-11-1

Details of Operation Cost

WATER TRANSMISSION AND DISTRIBUTION COST STUDY (Thung Song)

Item	1990	1991	1992	1993	1994	Y 1995	1996	1997	E 1998	1999	2000	A 2001	2002	2003	R 2004	2005	2006	2007	2008	2009	2010	2011
1. Planned Daily Average Water Demand (cu m/d)																						
Thung Song	4,394	4,512	4,594	4,677	4,763	4,849	4,938	5,034	5,132	5,232	5,333	5,437	5,578	5,723	5,871	6,021	6,175	6,338	6,505	6,675	6,848	7,024
Na Bon	558	577	597	616	637	657	678	699	721	743	766	789	813	837	861	886	911	937	963	989	1,016	1,044
Total	4,952	5,089	5,191	5,293	5,400	5,506	5,616	5,733	5,853	5,975	6,099	6,226	6,391	6,560	6,732	6,907	7,086	7,275	7,468	7,664	7,864	8,068
2. Planned Daily Maximum Water Demand: QDM (cu m/d)																						
Peak Factor =	1.30																					
Thung Song	5,712	5,866	5,972	6,080	6,192	6,304	6,419	6,544	6,672	6,802	6,933	7,068	7,251	7,440	7,632	7,827	8,028	8,239	8,457	8,678	8,902	9,131
Na Bon	725	750	776	801	828	854	881	909	937	966	996	1,026	1,057	1,088	1,119	1,152	1,184	1,218	1,252	1,286	1,321	1,357
Total	6,438	6,616	6,748	6,881	7,020	7,158	7,301	7,453	7,609	7,768	7,929	8,094	8,308	8,528	8,752	8,979	9,212	9,458	9,708	9,963	10,223	10,488

3. Treatment Plant

Existing Plant |##)) Max. Capacity 5,760 cu m/d Net Capacity 5,333 cu m/day 5,330 cu m/d ############################))

New Treatment Unit |##########################)) Max. Capacity 8,400 cu m/d Net Capacity 7,778 cu m/day ############################))

Item	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Treatment Capacity	5,760	5,760	5,760	5,760	5,760	14,160	14,160	14,160	14,160	14,160	14,160	14,160	14,160	14,160	14,160	14,160	14,160	14,160	14,160	14,160	14,160	14,160
Net Treatment Capa	5,333	5,333	5,333	5,333	5,333	13,111	13,111	13,111	13,111	13,111	13,111	13,111	13,111	13,111	13,111	13,111	13,111	13,111	13,111	13,111	13,111	13,111
4. Water Amount for Intake Design : (cu m/d)																						
Raw water for Treatment Plant (Daily Max)*1.08*1.1	7,648	7,859	8,017	8,175	8,340	8,503	8,673	8,854	9,039	9,228	9,419	9,615	9,870	10,131	10,397	10,667	10,944	11,236	11,534	11,836	12,145	12,460
5 Daily Average Intake Amount																						
Raw water for Treatment Plant	4,952	5,089	5,191	5,293	5,400	5,506	5,616	5,733	5,853	5,975	6,099	6,226	6,391	6,560	6,732	6,907	7,086	7,275	7,468	7,664	7,864	8,068

6. Pump Characteristics

Raw Water Pump — Dia= 200 mm, P = 20 KW, H = 10.0 m, Q = 4.3 cu m/min, No.of Pumps = 2 units (excluding 1 unit stand-by)

Clear Water Pump

at New WTP — Dia= 200 mm, P = 20 KW, H = 30.0 m, Q = 2.5 cu m/min, No.of Pumps = 3 units (excluding 1 unit stand-by)

at Exis.WTP — Exis.Pump — Dia= 200 mm, P = 40 KW, H = 35.0 m, Q = 3.7 cu m/min, No.of Pumps = 2 units

WATER TRANSMISSION AND DISTRIBUTION COST STUDY (Thung Song)

Item	1990	1991	1992	1993	1994	Y 1995	1996	1997	E 1998	1999	2000	A 2001	2002	2003	R 2004	2005	2006	2007	2008	2009	2010	2011
8. No.of Operating Pumps																						
Raw Water Pump	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2
Max.Capa.of Pump	6,230	6,230	6,230	6,230	6,230	6,230	6,230	6,230	6,230	6,230	12,460	12,460	12,460	12,460	12,460	12,460	12,460	12,460	12,460	12,460	12,460	12,460
Clear Water Pump																						
at New WTP						1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	3	3
Max.Capa.of Pump						3,630	3,630	3,630	3,630	7,259	7,259	7,259	7,259	7,259	7,259	7,259	7,259	7,259	7,259	7,259	10,889	10,889
at Exis.WTP	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Max.Capa.of Pump	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560	10,560
Total Capacity (cu m)	10,560	10,560	10,560	10,560	10,560	14,190	14,190	14,190	14,190	17,819	17,819	17,819	17,819	17,819	17,819	17,819	17,819	17,819	17,819	17,819	21,449	21,449
9. Motor Output (Kw)																						
Raw Water Pump	20	20	20	20	20	20	20	20	20	20	40	40	40	40	40	40	40	40	40	40	40	40
Clear Water Pump	80	80	80	80	80	100	100	100	100	120	120	120	120	120	120	120	120	120	120	120	140	140
10. Energy Consumption (Kwh/day)																						
Raw Water Pump	589	606	618	630	643	655	668	682	696	711	726	741	760	781	801	822	843	866	889	912	936	960
Clear Water Pump	970	970	970	970	970	838	855	873	891	966	986	1,006	1,033	1,060	1,088	1,116	1,145	1,176	1,207	1,239	1,320	1,354
11. Pump Operation Cost (Baht x1,000/year)																						
Demand Charge	275	275	275	275	275	330	330	330	330	385	440	440	440	440	440	440	440	440	440	440	495	495
Energy Charge	700	707	713	718	724	670	684	698	713	753	768	784	805	826	848	870	893	917	941	966	1,013	1,039
Total Cost	975	982	987	993	999	1,000	1,014	1,028	1,042	1,137	1,208	1,224	1,245	1,266	1,288	1,310	1,332	1,356	1,381	1,405	1,507	1,534
																			Total (1990-2011) =			26,213

Chemical Cost

Item	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Alum (ave 10.0 mg/l)																						
Chemical (kg/y)	16,038	16,469	16,768	17,071	17,385	17,699	18,024	18,374	18,732	19,097	19,465	19,845	20,360	20,889	21,429	21,977	22,539	23,134	23,743	24,364	24,995	25,638
Cost (Baht 1000)	65.0	66.7	67.9	69.1	70.4	71.7	73.0	74.4	75.9	77.3	78.8	80.4	82.5	84.6	86.8	89.0	91.3	93.7	96.2	98.7	101.2	103.8
Lime (ave 8.0 mg/l)																						
Chemical (kg/y)	12,830	13,175	13,414	13,657	13,908	14,159	14,419	14,699	14,985	15,277	15,572	15,876	16,288	16,711	17,143	17,581	18,031	18,507	18,995	19,491	19,996	20,510
Cost (Baht 1000)	16.0	16.5	16.8	17.1	17.4	17.7	18.0	18.4	18.7	19.1	19.5	19.8	20.4	20.9	21.4	22.0	22.5	23.1	23.7	24.4	25.0	25.6
Chlorine (ave 2.0 mg/l)																						
Chemical (kg/y)	3,208	3,294	3,354	3,414	3,477	3,540	3,605	3,675	3,746	3,819	3,893	3,969	4,072	4,178	4,286	4,395	4,508	4,627	4,749	4,873	4,999	5,128
Cost (Baht 1000)	50.0	51.4	52.3	53.3	54.2	55.2	56.2	57.3	58.4	59.6	60.7	61.9	63.5	65.2	66.9	68.6	70.3	72.2	74.1	76.0	78.0	80.0
Total cost(Baht 1000	131.0	134.6	137.0	139.5	142.0	144.6	147.3	150.1	153.0	156.0	159.0	162.1	166.3	170.7	175.1	179.5	184.1	189.0	194.0	199.1	204.2	209.5
																					Total	3,628

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