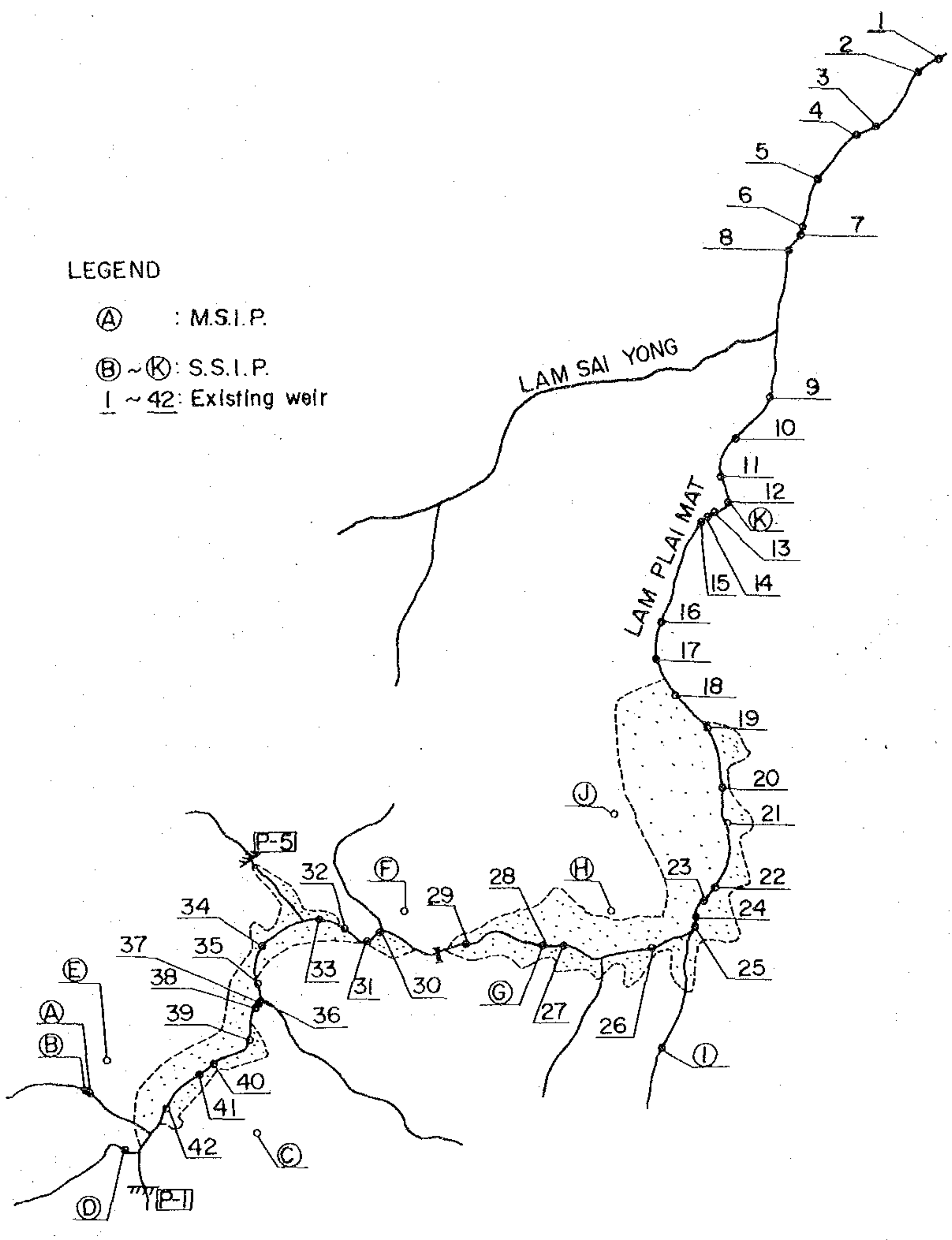
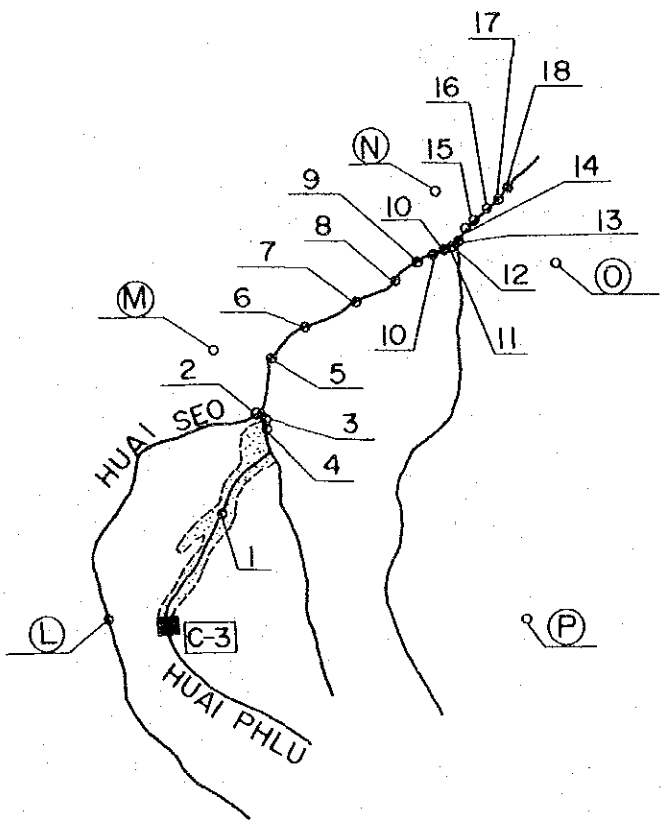
Figure D-8-1 Location Map of Existing Facilities (1/2)
— Lam Plai Mat —



Figuer D-8-2 Location Map of Existing Facilities (2/2)

— Huai Phlu —



LEGEND. Ⓟ : S.S.I.P.

5 : Existing weir

Table D-8-1 Summary of Existing Weir (1/4)

Basin	No.	Name	Location	Embankment Section			Concrete Section			Irrigable Area (rai)	Const-ructed by
				Const-ruction	Height (m)	Length (m)	Const-raction	Height (m)	Length (m)		
Lam Plai Mat	1	B. Taluk Yaw	T1, A1	1976	2.0	1,000.0	1980	2.5	6.5	-	G.D.F
"	2	B. Kra Had	T1, A1	1976	2.0	1,000,0	1980	2.5	6.0	-	G.D.F
"	3	B. Rong Shub	T1, A1	-	2.0	200.0	1979	2.0	5.0	-	G.D.F
"	4	B. Khok Pet	T1, A1	1976	2.0	300.0	-	-	-	3,000	V.& G.D.F
"	5	Maud Moo	T2, A2	1977	1.5	80.0	-	-	-	1,500	G.D.F
"	6	B Khok Yang	T2, A1	1976	1.0	40.0	-	-	-	1,500	G.D.F
"	7	Gum None	T2, A1	1963	-	30.0	-	-	-	1,500	V.
"	8	Poo Yai Ngam	T2, A1	1963	1.2	22.0	-	-	-	-	C.B
"	9	B. Rai	T3, A1	1976	5.2	60.0	-	-	-	6,000	A.B
"	10	Ta Po Dang	T3, A1	1976	-	48.0	1981	-	25.0	6,000	C.B.& A.R.D
"	11	Dha Ta Chi	T3, A1	-	-	200.0	-	-	-	-	V.
"	12	Tung Ma Non	T4, A1	-	-	-	-	-	-	-	S.S.I.P
"	13	Tung Ta Wan Toog	T4, A1	1981	-	25.0	-	-	-	-	J.C.P
"	14	Tung Ta Dwang	T4, A1	1976	-	-	-	-	-	3,000	J.C.P
"	15	B. Nong Prong	T4, A1	-	-	-	-	-	-	1,800	Contribution
"	16	B. Poo Dhong	T4, A1	1962	4.0	400.0	1982	4.0	15.0	5,000	J.C.P
"	17	Wang To Ploy	T4, A1	-	-	100.0	-	-	-	4,000	J.C.P
"	18	B. Khok Yang	T4, A1	1982	1.0	800.0	1982	-	10.0	2,000	J.C.P
"	19	B. Ta Kun	T4, A1	-	-	20.0	-	-	-	1,200	V.
"	20	Klung Yai	T5, A2	1961	-	20.0	-	-	-	1,500	V
"	21	B. Sra Ma No	T5, A2	1964	-	25.0	-	-	-	200	V.

Table D-8-1 Summary of Existing Weir (2/4)

Basin	No.	Name	Location	Embankment Section Const-raction	Embankment Section Height (m)	Embankment Section Length (m)	Concrete Section Const-raction	Concrete Section Height (m)	Concrete Section Length (m)	Irrigable Area (rai)	Const-ructed by
Lam Plai Mat	22	Ta Yim	T5, A2	1976	3.0	30.0	-	-	-	1,000	T.C.B
"	23	Ta Kumu	T5, A2	1962	-	20.0	-	-	-	100	V.
"	24	B. Nong Prasat	T5, A2	1962	4.0	20.0	-	-	-	100	V
"	25	B. Suk Samran	T5, A2	1974	2.0	100.0	1974	4.0	20.0	-	V.
"	26	B. Nong Nam Kun	T6, A2	1980	-	70.0	1980	-	6.0	-	V.
"	27	Nong Ai	T7, A2	1981	-	25.0	-	-	-	1,000	J.C.P
"	28	B. Khok Ma Muang	T7, A2	-	-	-	-	-	-	-	S.S.I.P
"	29	B. Khok Patana	T7, A2	1962	-	120.0	-	-	-	4,000	V.
"	30	B. Khok But	T8, A3	-	-	22.0	-	-	-	-	J.C.P
"	31	"	T8, A3	-	-	40.0	-	-	-	-	-
"	32	"	T8, A3	-	-	30.0	-	-	-	2,500	-
"	33	B. Don Nong Lumpuk	T8, A3	1981	3.0	25.0	-	-	-	5,000	V.& J.C.I.P
"	34	B. Tao Lek	T8, A3	1983	-	100.0	-	-	42.0	-	V.
"	35	B. Sra To Khien	T9, A3	1978	4.0	20.0	-	-	-	-	V.
"	36	"	T9, A3	1977	-	29.0	-	-	-	-	V.
"	37	"	T9, A3	1983	-	20.0	-	-	-	-	V.
"	38	"	T9, A3	1972	1.2	25.0	-	-	-	300	V.
"	39	B. Mai	T9, A3	-	-	22.0	-	-	-	100	V.
"	40	B. Nong Kai Nam	T9, A3	1976	-	30.0	-	-	-	2,000	V.
"	41	B. Nong Hin	T9, A3	1976	-	20.0	1976	-	20.0	2,000	A.R.D
"	42	B. Nong Kla	T10, A3	1976	-	-	-	-	-	-	J.C.P

Table D-8-1 Summary of Existing Weir (3/4)

Basin	No.	Name	Location	Embankment Section Const-raction	Embankment Section Height (m)	Embankment Section Length (m)	Concrete Section Const-raction	Concrete Section Height (m)	Concrete Section Length (m)	Irrigable Area (rai)	Const-ructed by
Huai Seo	1	Lowung	T11, A4	1964	3.0	30.0	-	-	-	-	V.
"	2	Ta Plim	T12, A5	1950	5.0	40.0	-	-	-	-	V.
"	3	Ta Ten	T13, A4	1957	5.0	30.0	-	-	-	-	V.
"	4	Nuy Plaung	T13, A4	1958	5.0	30.0	-	-	-	-	V.
"	5	Ta Banne	T12, A5	1960	3.0	40.0	-	-	-	-	V.
"	6	Ta Chang	T12, A5	1952	7.0	30.0	-	-	-	-	V.
"	7	Yai	T12, A5	1981	12.0	40.0	-	-	-	-	J.C.P
"	8	Kru Kune	T12, A5	1976	5.0	30.0	-	-	-	-	V.
"	9	Ta Pal	T12, A5	1965	5.0	30.0	-	-	-	-	V.
"	10	Nuy Wieng	T12, A5	1975	5.0	140.0	-	-	-	-	A.B
"	11	Nuy Kriak	T12, A5	1967	3.0	20.0	-	-	-	-	V.
"	12	Nuy Pone	T12, A5	1980	-	40.0	-	-	-	-	V.
"	13	Ta Pit	T12, A5	1957	3.0	10.0	-	-	-	-	V.
"	14	Ta Cha Long	T14, A4	1958	6.0	30.0	-	-	-	-	V.
"	15	Ta Kaew	T14, A4	1968	4.0	20.0	-	-	-	-	V.
"	16	Kru Aun	T14, A4	1942	4.0	40.0	-	-	-	-	V.
"	17	Nuy Khok	T14, A4	1973	3.0	12.0	-	-	-	-	V.
"	18	Nuy Suio	T14, A4	1980	4.0	20.0	-	-	-	-	V.

Table D-8-1 ... Summary of Existing Weir (4/4)

in cloumn of "LOCATION"

T1 : Tambon Lhum Ni
T2 : " Gan Laung
T3 : " Nong Bot
T4 : " Soeng Sang
T5 : " Pa Kham
T6 : " Nong Bua
T7 : " Khok Makha
T8 : " Kut Bot
T9 : " Sra Ta Khian
T10: " Non Seombum
T11: " Nong Mai Ngam
T12: " Khao Khok
T13: " Bung Charoen
T14: " Ban Kruat

A1 : Amphoe Nang Rong
A2 : " Pa Kham
A3 : " Soeng Sang
A4 : " Ban Kruat
A5 : " Pra Kone Chai

in column of "CONSTRUCTED BY"

V. : villager
G.D.F. : Government Distribution Fund
C.B : Changwat's Budget
A.R.D : Accerelated Rural Development
S.S.I.P : Small Scale Irrigation Project
J.C.P : Job Creation Program
T.C.B : Tambon Council's Budget
A.B : Amphoe's Budget

Table D-8-2 Summary of the Existing Irrigation Project

Basin	No.	Scale	Project	Coordinates in 1/50,000 map	Constructed Year	Irrigable area (rai)	Dimension of Major Facilities
Lam Plai Mat	A	Medium	Huai Hin	TA 200-878	1980	2,500	Broad Crest Weir and Canal
"	B	Small	Huai Hin	TA 210-879	1979	1,000	R, W=1.00m, L=2.0km, H=0.75m, V=-
"	C	"	B. Nong Ta Bag	TA 294-853	1983	250	R, W=4.00m, L=500m, H=8.40m, $V=218x10^3m^3$
"	D	"	B. Rat Sa Muk Kee	TA 234-847	1983	500	R, W=4.00m, L 680m, H=7.00m, $V=146x10^3m^3$
"	E	"	B. Nong Gha Tum	TA 227-891	1979	-	WR -
"	F	"	B. Nong Sa Nuan	TA 366-968	1983	500	R, W=3.50m, L=450m, H=5.30m, $V=96x10^3m^3$
"	G	"	B. Khok Ma Muang	TA 434-943	1983	200	R, W=4.00m, L=1620m, H=4.60m, $V=209x10^3m^3$
"	H	"	B. Don Nang Ghaum	TA 480-965	1983	100	R, W=3.00m, L=385m, H=5.60m, $V=250x10^3m^3$
"	I	"	B. Khok Mai Daeng	TA 514-880	1980	1,500	R, W=3.00m, L=420m, H=7.00m, $V=156x10^3m^3$
"	J	"	B. Khok Loy	TB 485-012	1982	700	R, W=4.00m, L=620m, H=3.00m, $V=330x10^3m^3$
"	K	"	B. Chum Sang	TB 548-161	1981	1,060	WR, L=32.0m -
Huai Seo	L	Small	B. Kokhong	TA 832-862	1982	450	R, W=3.0, 4.0m, L=935m, H=4.0m, $V=98x10^3m^3$
"	M	"	Khao Khok	TA 870-974	1982	-	R, W=4.0m, L=575m, H=4.0m, $V=272x10^3m^3$
"	N	"	B. Khok Loi	TA 945-023	1978	500	R, W=4.0m, L=715m, H=5.0m, $V=189x10^3m^3$
"	O	"	Huai Thamo	TA 992-000	1978	2,100	R, W=3.0m, L=784m, H=3.3m, $V=225x10^3m^3$
"	P	"	Huai O Bok	TA 969-869	1981	1,500	R, W=4.0m, L=530m, H=7.0m, $V=535x10^3m^3$

R : Reservoir W : Width
H : Height WR : Weir
L : Length V : Capacity

LIST OF REFERENCES

1. Asian Institute of Technology (1978). Water for the Northeast: A Strategy for the Development of Small-scale Water Resources.

2. Dept. of Agricultural Extension, MOAC (1982). Village-wise Agricultural Statistics for the Concerned Tambons with Project Area.

3. Dept. of Agricultural Economics, MOAC (1981/82). Agricultural Statistics of Thailand.

4. FAO (1979). Proceedings: FAO/Thailand National Workshop on Research and Development of Rainfed Crop Production.

5. JICA (1981). Data on the Present Situation and the Forecast on the Northeast (written in Japanese).

6. Kyoto University (1983). A rice-growing Village Revised: An Integrated Study of Rural Development in Northeast Thailand (Interim Report).

7. Khon Kaen University, Faculty of Agriculture (1977 & 1978). 1977 & 1978 Cropping Systems Project.

8. Khon Kaen University, Cropping Systems Project (1982). An Agroecosystem Analysis of Northeast Thailand.

9. Khon Kaen University, Cropping Systems Project (1982). Tambon and Village Agricultural Systems in Northeast Thailand.

10. Kasetsart University, Research and Development Institute (1981). Report on the Evaluation of the Northeast Livestock Development Project.

11. Koichi Mizuno, (1971). Social System of Don Daeng Village: A Community Study in Northeast Thailand.

12. MOAC, Huai Sithon Northeast Agriculture Office (Kalasin) (1981 - 1983). Annual Report on Experiment.

13. National Statistical Office, Office of the Prime Minister (1978). 1978 Agricultural Census Report, Thailand, Changwat Nakhon Ratchasima, Buriram.

14. NEDECO (1982). Development of the Lower Mun Basin Feasibility Study.

15. US. Bureau of Reclamation (1971). Nam Mun Project Thailand Feasibility Report

16. UNDP/FAO (1975). Crop Production Manual for Irrigated Areas in Northeast Thailand.

17. NESDB (1982). Socio Economic Constraints in Rainfed Agriculture Production in the Lower Northeast.

ANNEX E WATER USE AND RESERVOIR OPERATIONS

ANNEX E. WATER USE AND RESERVOIR OPERATIONS

Page

LIST OF TABLE

LIST OF FIGURE

ANNEX E. WATER USE AND RESERVOIR OPERATIONS

E.1. Water Requirement

E.1.1. Reference Crop Evapotranspiration (ETo)

Definition ------ The rate of evapotranspiration from an extensive surface of 8 to 15 cm tall, green grass cover of uniform height, actively growing, completely shading the ground and not short of water. The open water evaporation of shallow water is about 1.1 x ETo.

Calculation ---- (1) Modified Penman method as recommended by the FAO (1977), which would offer the best results with minimum possible error of plus or minus 10 percent in summer and up to 20 percent under low evaporative conditions.

(2) Haise-Jensen method, with reference to "Estimating Evapotranspiration from Solar Radiation" by Howard R. Haise and Marvin E. Jensen, Journal of Irrigation and Drainage Division, ASCEV.89, N.IR4, December 1963 and "Empirical Methods of Estimating or Predicting Evapotranspiration Using Radiation" by M.E. Jensen, December 1966 conference proceedings - Evapotranspiration and Its role in Water Resources management. Due to the type of data available and accuracy required, this empirical method has been applied in the Feasibility Report of Nam Mun Project", 1971 prepared by USBR and "Summary of Monthly and Yearly Hydro-Meteorological Data in the Thai Part of the Lower Mekong Basin", 1975 prepared by Committee for Coordination of Investigations of the Lower Mekong Basin.

Reference Crop Evapotranspiration

(Unit: mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
	118	123	164	159	140	126	124	115	102	121	117	115	1,524

Nakhon Ratchashima (1961-1969) in Nam Mun Project, Feasibility Study

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Haise-Jensen	137	148	188	197	193	176	173	167	151	159	139	131	1,959
Blaney-Criddle	147	145	176	180	189	188	187	181	168	164	148	145	2,018
Class "A" Pan	152	158	196	197	174	178	171	165	136	140	135	142	1,944

Nakhon Ratchashima (1970-1979) in Lower Mun Basin, Feasibility Study

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Modified Penman	115	123	156	155	140	125	126	115	100	118	113	113	1,499

Class "A" Pan Evaporation by Meteorological Department

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Nakhon Ratchashima (EL 189m) (1962-80)	146	152	193	194	183	173	169	160	132	137	135	141	1,916
Nang Rong (EL 185m) (1970-82)	123	128	159	161	154	138	134	124	114	116	110	117	1,578

E.1.2. Crop Evapotranspiration (ETcrop)

To account for the effect of the crop characteristics on crop water requirements, crop coefficients (Kc) are presented. Crop evapotranspiration (ETcrop) can be found by:

$$ETcrop = Kc \times ETo$$

The Kc value relates to evapotranspiration of a disease-free crop grown in large fields under optimum soil water and fertility conditions and achieving full production potential under the given growing environment. Procedures for selection of an appropriate Kc values are given taking into account the crop characteristics, time of planting or sowing, and stages of crop development and general climatic conditions.

"Crop Water Requirements", FAO Paper No.24, 1977 gives the Kc value for paddy rice for different geographical locations and seasons:

-Humid Asia-	Planting	Harvest	First & Second Month	Mid-season	Last 4 weeks
Wet season (monsoon)	Jun to Jul.	Nov-Dec.			
Light to mod. wind			1.1	1.05	0.95
Strong wind			1.15	1.1	1.0
Dry season /*					
Light to mod. wind			1.1	1.25	1.0
Strong wind			1.15	1.35	1.05

/* ... When the minimum relative humidity is more than 70 percent, the Kc values for wet season should be used.

For the field and vegetable crops, the Kc values are given in each of four stages during the crop growing season at different climatic conditions:

(1) Initial stage ---- germination and early growth when the soil surface is not or is hardly covered by the crop (ground cover 10%). For this, a graph prepared for relation among the level of ETo, the frequency of irrigation and/or significant rain in terms of day and the Kc value.

(2) Crop development stage ---- from end of initial stage to attainment of effective full groundcover (groundcover = 70 to 80%).

(3) Mid-season stage ---- from attainment of effective full groundcover to time of start of maturing as indicated by discolouring of leaves.

(4) Late season stage ---- from end of mid-season stage until full maturity or harvest.

	Min. Relative Humidity	70%		20%	
	Wind (m/sec)	0 - 5	5 - 8	0 - 5	5 - 8
All field crops	Crop stage Initial: 1 Crop dev.: 2	Use the graph, By interpolation.			
Beans (green)	Mid-season: 3	0.95	0.95	1.0	1.05
	At harvest or maturity: 4	0.85	0.85	0.9	0.9
Groundnuts	3	0.95	1.0	1.05	1.1
	4	0.55	0.55	0.6	0.6
Soybeans	3	1.0	1.05	1.1	1.15
	4	0.45	0.45	0.45	0.45
Tomato	3	1.05	1.1	1.2	1.25
	4	0.6	0.6	0.65	0.65

The FAO data as introduced above have been used in the Feasibility Study on Development of the Lower Mun Basin prepared by NEDECO for NEA in 1982.

On the other hand, the Kc values for representative crops have been examined in more detail in the World Bank-assisted Northeast Thailand Irrigation Improvement Project, Stage II Feasibility Study as prepared by Tahal Consulting Engineers in 1976.

	Percent of Growing Season										
	0	10	20	30	40	50	60	70	80	90	100
Paddy rice	0.85	0.87	0.95	1.06	1.15	1.20	1.19	1.15	1.10	1.03	0.90
Maize	0.20	0.30	0.40	0.57	0.90	1.02	1.06	1.06	0.94	0.60	0.50
Groundnuts, Tobacco & Mungbeans	0.15	0.25	0.40	0.55	0.66	0.70	0.77	0.77	0.70	0.55	0.35
Tomatoes	0.20	0.20	0.25	0.35	0.56	0.74	0.82	0.72	0.48	0.35	0.20

E.1.3. Deep Percolation for Paddy Rice

The current deep percolation rate in the Study area for wet season paddy would be neglible small under imperfectly to poorly drained conditions and partly because a rather impermeable horizontal layer in the soil is developed as a result of land preparation practices. When equipped with a drainage system with the Project, deep percolation would be promoted to a certain extent. It is assumed at 2.0 mm per day which has been taken as a standard value in the Northeast Thai region under the RID's Medium Scale Irrigation Project.

E.1.4. Effective Rainfall

Not all of the local rainfall covering the proposed irrigation service area is effective. The amount of rainfall that can be considered effective would depend upon many factors such as (1) intensity and distribution of rainfall, (2) storage available at the time rain falls, (3) water requirements, (4) irrigation method, (5) topography and related drainage characteristics, (6) operation of the irrigation systems and others.

(1) As a matter of fact, there would have been no established theory for the computation of effective rainfall. A model which simulates the inflow into and outflow from the paddy field or groundwater body has been developed in "Summary of Monthly and Yearly Hydro-Meteorological Data in the Thai Part of the Lower Mekong Basin" as prepared by Committee for Coordination of Investigations of the Lower Mekong Basin, 1975. Such simulation model can only approximate the effective rainfall. THe field water balance equation as used in this Study is introduced below:

$$WDn = WDn-1 + Rn - WRn$$

Where,
- WDn = field water level at the end of the day n (mm)
- WDn-1= field water level at the end of the previous day n-1 (mm)
- Rn = rainfall on the day n (mm)
- WRn = total field water requirement on the day n (mm) = ETcrop + N + LP + P
- ETcrop = crop evapotranspiration (mm)
- N = nursery water requirement (mm)
- LP = land preparation water requirement (mm)
- P = deep percolation (mm)

(2) Before arriving at the water balance model which is run day-after-day to account for the carry-over effect, several important factors should be introduced:

- The water depth in the field is treated in an algebraic manner; viz. positive above the ground surface and negative below.

(a) For the case of paddy field, there is water stored on the ground surface depending upon the height of bund. Each bund usually has a notch which allows water to flow from one field to another. Taking into account the paddy cultivation practices prevailing in the Northeast Thai, the following assumptions have been introduced:

Maximum Water Level (WDmax)	+ 135 mm	° The water depth is not allowed to rise above 135 mm. Eventual excess water is assumed to be drained.
Normal Water Level (WDnor)	+ 90 mm	° As soon as the water depth falls below 45 mm, an irrigation application of 45 mm or more is made to maintain the normal water depth of 90 mm.
Minimum Water Level (WDmin)	+ 45 mm	
Ground Surface	0 mm	

The standing water in the paddy field is completely drained out 15 days before harvesting. The theoretical minimum limit of water depth coincides with the wilting point. For practical application, it is set to be the water holding capacity (WHC) of the soil by using the following equation:

$$WHC = FC \times B \times D$$

where, FC = field capacity (%) = 30%
B = bulk ratio of soil = 1.65
D = depth of crop root zone = 250 mm

Since the roots of a crop are not uniformly distributed throughout this zone, a constant factor denoted by AVE (= 0.5) is introduced so that the equivalent uniform root zone may be written as AVE x D. Thus, the above equation becomes:

$$WHC = FC \times B \times AVE \times D$$
$$= 0.3 \times 1.65 \times 0.5 \times 250 = 60 \text{ mm for paddy.}$$

Maximum Water level = Ground Surface (WDmax) 0 mm

Normal Water Level (WD nor) -15 mm

Minimum Water Level = WHC (WD min) - 60 mm

- The water depth on the ground surface is not allowed. Eventual excess water is assumed to be drained out.

- As soon as the water depth falls below -60 mm, an irrigation application of 45 mm or more is made to maintain the noraml water level of -15 mm.

- Deep percolation may be neglected.

(a) For the upland crops, the consideration similar with the conditions of paddy rice after the standing water on the field is completely drained out 15 days before harvesting could be made. The water holding capacity (WHC) for upland crops at a particular location and a different growth stage would depend upon the depth of crop root zone. The values of WHC for different upland crops are introduced in "Assessment of Rainfed Irrigation in Northeast Thailand" presented by AIT in October 1981, viz. 115 mm for sweet corn, 80 mm for groundnuts, 113 mm for sorghum and 111 mm for mungbeans and soybeans. It would be considered, however, that these WHC values are too large because the depth of such crop zone is calculated at 330 to 475 mm.

It would be assumed that the depth of upland crop zone is 250 mm on an average among various crops and during the growth stage, and the WHC value is 60 mm with FC (0.30), B(1.6) and AVE (0.5). For the upland crops, there should not be the ponded water on the ground surface.

Maximum Water Level = Ground Surface (WDmax)	0 mm
Normal Water Level (WDnor)	-15 mm
Minimum Water Level = WHC (WDmin)	-60 mm

° An irrigation application of 45 mm or more is made to keep the normal water level at -15 mm, as soon as the water depth falls below -60 mm.

° The water depth on the ground surface is not allowed. Eventual excess water is assumed to be drained out.

° Deep percolation may be neglected.

(3) The water balance analysis to estimate the effective rainfall can be carried out in the following manner:

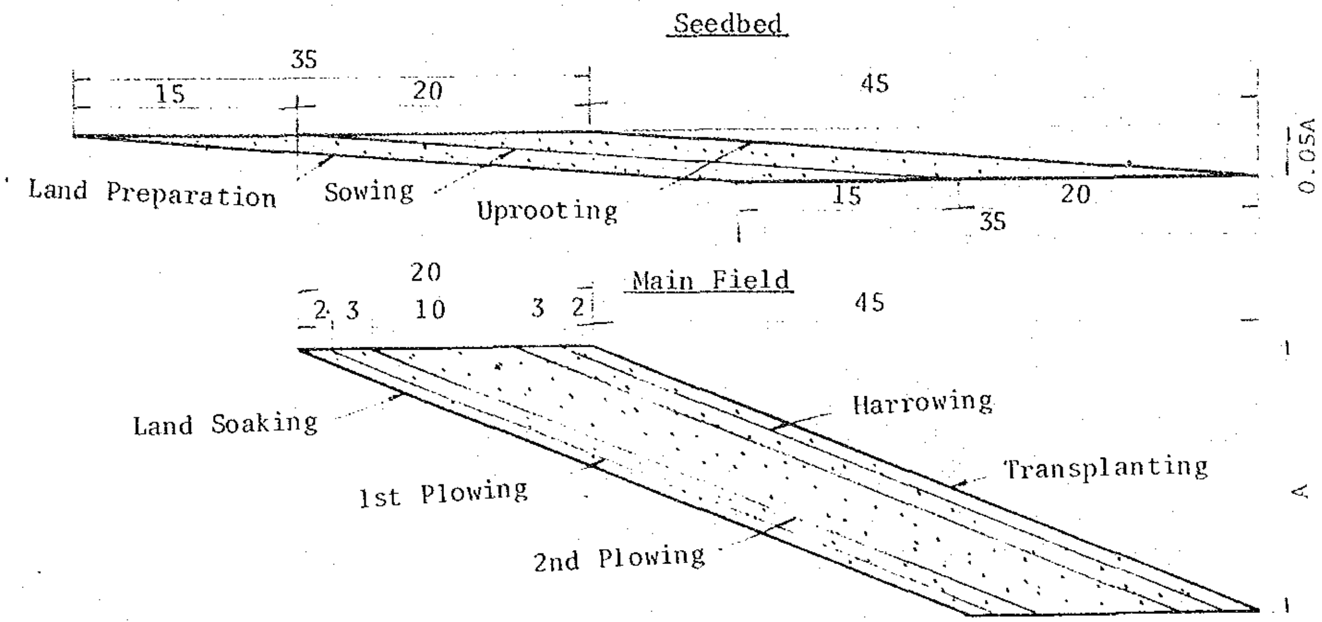
- When the field water level at the end of the day n is higher than the maximum water level (WDmax), the effective rainfall for the day n (Rn) is taken:

  Rn = WDmax + WRn - WDn-1 and

  WD is corrected to WDmax.

- When the tentatively computed WDn is smaller than, or equal to WDmax, the effective rainfall for the day n is taken equal to Rn and WDn is taken equal to the tentatively computed WDn unless the tentatively computed WDn is smaller than WDmin in which case WDn is set equal to WDnor with irrigation application.

E.1.5. Land Preparation



(1) Seedbed for Paddy Rice

The seedbed would be prepared 35 days before the transplanting to the main field. The seedbed water demand includes those of soaking for shallow plowing and harrowing, maintaining a water depth of about 50 mm during most of the period, applying this again after each drainage to encourage the growth of vigorous seedlings and supplying the evapotranspiration and deep percolation losses. It is assumed that about 600 mm of water is required during the total period covering about 5 percent of the transplanted main field.

Total seedbed demand excluding the losses of water conveyance and application would be as follows:

$$dB \text{ cu.m per day} \times 35 \text{ days} = 600 \text{ mm} \times 5\% \times A \text{ ha}$$

$$dB = 0.001 A$$

where, dB = Seedbed demand in cu.m per day.

Under the above conditions, the net seedbed demand in cu.m per day would be numerically equal to the transplanted area in 1,000 sq.m, giving the seedbed demand of approx. 1 mm per day taken over the whole transplanted main field. In view of the relatively small quantities involved and the approximate nature of the other assumptions in estimating the land preparation demand, this calculation method would be practically justifiable.

(2) Main Field

Water supplied during the land soaking and preparation period is used to saturate new field and to maintain the water layer in the already saturated area. The transplanting would begin about 20 days after the start of land soaking and progress at a constant rate. Because of this overlapping demand, a water conveyance program for constant land preparation progress in any area would show a minimum flow in the beginning to a maximum that would be beyond the canal capacity for that area.

Van de Goor/1 and Zijlstra/1, Wen/2, Chin/3 and others have suggested a constant rate of water delivery for this period even though it results in a variable rate and speeding up of land preparation progress in the beginning of the period.

/1 ... Van de goor, G.A.W. and A Zijlstra, "International Land Reclamation Improvement (Wageningen, the Netherlands)", Pub. No. 14, 1968.

/2 ... L.J. Wen, "The Journal of Chinese Agricultural Engineering" Vol. 18, No.1, 1972.

/3 ... L.T. Chin, "Water Management in Philippines Irrigation Systems: Research and Operations", IRRI, 1973.

The following equations have been developed by Goor and Zijlstra:

$$I = \frac{M}{1 - e^{\frac{-MT}{S}}} \qquad (1)$$

$$\frac{t}{T} = \log_e \left(\frac{I}{I - M \cdot \frac{Y}{A}} - \frac{I}{I - M} \right) \qquad (2)$$

$$T = \frac{S}{M} \cdot \log_e \frac{I}{I - M} \qquad (3)$$

Where:

- I ... Supply required during land preparation period expressed in mm per day over the total area "A" to be irrigated.
- t ... Time in days taken from the start of the land soaking and preparation period.
- M ... Supply required for maintaining the water layer after land preparation is completed (in mm per day).
- Y ... Land preparation area completed in time "t".
- S ... Water required for soil saturation in mm.
- T ... Duration of land preparation period in days.

Multiplying Equation (1) by the area "A" and adding the conveyance and application efficiency "Ef", Equation (1) becomes:

$$IA = \frac{A.M}{Ef.(1 - e^{\frac{-MT}{s}})} = Q$$

Where:

Q ... Canal capacity in cu.m per day.

° <u>"M": Ponding replenishment demand</u>

A 40 to 60 mm water layer should be kept continuously over the newly plowed soil (1) to induce decomposition of stubble, weeds and other organic matters, (2) to prevent the weed growth, (3) to prevent the oxidation of ammonia into nitrogen gas, (4) to make plowing and harrowing prior to transplanting and (5) to maintain the newly transplanted seedlings.

The losses due to open water evaporation of shallow water and deep percolation would be taken into account. When part of the area under consideration is already transplanted, the water demand for that part would be calculated according to the crop evapotranspiration of newly transplatend seedlings.

° "T": Length of land preparation period

The land preparation period in an area of paddy fields is from the first flooding to the final harrowing and puddling of the last day just prior to transplanting. In practice, an average time would be usually three weeks. The following three aspects would be taken into account:

- An average farmer with one buffalo can plow his average holding of 15 rai (2.4 ha) in 7 to 14 days given a land preparation period for the whole farm holding of 28 to 35 days. It is not usual for an individual farmer to extend the transplanting time even longer taking into account a logical time in harvesting.

- It cannot be expected that all the farmers in a project as a whole will start and finish the land preparation at the same time, because of various sizes of plots, non-uniformity in water deliveries, availability of seed and implements, several modes of preparedness and other social factors.

"Operation and Maintenance Manual, Northeast Thailand Irrigation Improvement Project", October 1979 explains the following:

Approx. Size of an Irrigation Block (ha)	Total Land Preparation Period (day)
100 - 250	35
250 - 1,000	42
1,000 - 2,000	49

This would be in agreement with the present practices and customs observed in the fields. Lower values would give larger discharges than required and then waste if these are not realistic.

- When the total water demand during this period is found to be greater than the canal capacity, then lengthening of the land preparation period to a value larger should be considered. Attention should be paid not to lengthen the period too long that would not allow full growth or proper ripening of the crop before harvest.

° <u>"S": Water Required for Soil Saturation</u>

The water amount needed to saturate the soil in order to facilitate the plowing and harrowing would depend upon the soil characteristics, its moisture content at the time of land preparation and the depth to be saturated. This can be calculated from the following formula:

$$S = (n - w)D + H$$

where:

S ... Soil saturation demand in mm.
n ... Porosity of soil as a fraction of the volume.
w ... Soil moisture content as a fraction of the volume.
D ... Depth of soil to be saturated in mm, 150 to 300 mm depending upon soil characteristics, crop variety and local plows, implements and practices.

h ... Depth of ponding water in mm, 40 to 60 mm for transplanted rice, while no ponding water for field crops.

In practice, 145 mm of S for the transplanted paddy and 80 mm for the field crops would be assumed.

E.1.6. Water Losses

The water losses encountered in the operation of irrigation systems are (1) farm waste, (2) tertiary or farm ditch losses and (3) main and lateral losses:

- Field application efficiency (Ea)

  Ratio between water directly available to the crop and that received at the field inlet.

  Farm waste --- quantity of water lost in the farm due to seepage and leakages in the paddy dikes, uneven levelling of paddy leading to excess ponding in low spots and demand over-application of the irrigation water to cover sufficiently the high spots, unscheduled drainage and spillage. In the case of upland crop cultivation on the paddy field, low application efficiency would occur when the water rate applied exceeds the infiltration rate and excess is lost by runoff; when the water depth applied exceeds the storage capacity of the root zone, excess is lost by deep drainage. With surface irrigation, field layout and land grading is most essential; uneven distribution of water causes drainage losses in one part and possibly under-irrigatin in other part of the field resulting in very flow efficiency. Ea may vary during the growing season usually with the highest efficiency during peak demand period.

- Field canal efficiency (Eb)

  Ratio between water received at tertiary inlet and that received at the inlet of the block of fields.

Tertiary and farm ditch losses --- quantity of water lost due to seepages and leakages in the ditches and through illegal water take-offs by the farmers. Eb may be affected primarily by the method and control of operation, the soil type in respect of seepage losses, length of ditches, size of the irrigation service unit and field blocks.

- Conveyance efficiency (Ec)

  Ratio between water received at turnout to the tertiary canals and that released at the Project headworks.

  Main and lateral losses --- quantity of water lost due to seepages and evaporation during conveyance and through breaks in lining, illegal diversions and leakages through gates. Operation losses would occur when water supply is not attuned to the demand, partly depending upon the skill of the operation personnel. Adjustment of the water supply in rather long canal systems would take several hours, during which much water may have to be spilled. Operation efficiency also accounts for unavoidable losses during the wet season when a quick adjustment of the water supply to local rainfall would not often be possible. A consideration would be involved in the proposed Project on maximum utilization of existing large ponds and SSIP reservoirs which are located within the irrigation systems and are connected to main and lateral canals in order to absorb the operation losses.

Conveyance efficiency (Ec) and field canal efficiency (Eb) are sometimes combined as distribution efficiency (Ed = Ec.Eb); field canal efficiency (Eb) and field application efficiency (Ea) are combined as farm efficiency (Ef = Eb.Ea). The distribution efficiency (Ed) would be shown to be particularly sensitive to quantity of technical as well as organizational operation procedures. The farm efficiency (Ef) would be much dictated by the operation of the main supply system in meeting the actual field supply requirements as well as by the irrigation skill of the farmers.

In the planning stage, efficiency values for the various stages of water distribution and application are estimated on the basis of experience. When estimated too high, water deficiencies would occur and either selective irrigation and/or improvement in operational and technicl control would be required. When estimated too low, the irrigation area is reduced, and the system is therefore over-designed and probably wasteful irrigation is practised. For the proposed Project after full development in the case of well designed, built and operated system for some years, the following efficiencies would be applicable in reference to Bos M.G. and Nugteren J. "On Irrigation Efficiencies", publication 19, International Institute for Land Reclamation and Improvement, 1974 which are based mainly upon a recent comprehensive ICID/ILRI survey and USDA and US (SCS) sources:

Field application efficiency (Ea):
- Paddy cultivation 85%
- Upland crop cultivation.... 85% in the case of furrow method and much higher by hand.

Field canal efficiency (Eb).......... 85%

Conveyance efficiency (Ec):
- Lined canal................ 85%
- Unlined canal.............. 70%
- The main canal and about a half of the laterals passing through permeable soils are concrete lined: 80%

Overall efficiencies (Ea.Eb.Ec):
- Paddy cultivation.......... 0.58%
- Upland crop cultivation.... 0.58%

E.1.7. Other Water Requirements

Village pond for fisheries and domestic water supply as well as with a function of a night storage reservoir.

It is envisaged that in the wet season, the paddy crop would occupy 100 percent of the net irrigable area and the irrigation water would be supplied 24 hours a day. Apart from adjustments in supply to account for rainfall on the Project service area, the system operations would not be complicated. In the dry season, part of the area so-called a special service unit in each of mubans would be planted with upland crops which should preferably be irrigated in the daytime only. Consequently, there would be a difference between the daytime and night-time irrigation supply which depends upon the water requirements and the area planted with each crop. Since a constant flow a day in the main and lateral canals is a prerequisite for efficient management, a night storage reservoir is required.

A concept of a village pond is a possible magnification of the night storage reservoir for multiple use of the village fisheries and domestic water supply. Total water requirements for this village ponds as a whole would be usually only a small fraction of irrigation requirements and fall within the accuracy limits of the calculations of irrigation requirements.

Per capita water demand is given as follows:

Item	Requirement per day	Supply Period
1. Domestic Use		
- For Drinking	5 l. per capita/1	Dec. to 20th May
- For Other Use	40 l. per capita/1	
2. Livestock		
- For Drinking		
Buffalo	50 l. per capita/1	Dec. to 20th May
Cattle	57 l. per capita/1	
- Bathing of Buffalo	8 mm of evaporation ($3m^2$ bathing pond/three head)	
3. Fish Culture	Evaporation and other waer loss	Throughout the year

Water demand of the muban water supply is shown in Table E-1-1.

E.1.8. Maintenance Work

The cropping calendar takes the need for maintenance into account. Large maintenance work can take place in May and early June. Small maintenance is possible in December when the wet season rice is being harvested.

In the irrigation service units where the dry season crops are not introduced, all maintenance work can be done during the dry season.

Table E-1-1. Plan of Water Supply (1)

Sub-System : Direct Diversion from Lam Plai Mat Dam (Unit 1000 m^3)

Period		Drinking Water	Water Supply for Buffalo	Water Supply for Cattle	Water Supply for Fish Breeding	Total Net Water Supply
Apr.	1/1	7.3	1.2	0.2	5.5	14.2
	2	29.2	4.9	0.6	17.9	52.6
	3	-	-	-	-	-
May	1	-	-	-	-	-
	2	-	-	-	-	-
	3	-	-	-	3.8	3.8
Jun.	1	-	-	-	3.3	3.3
	2	-	-	-	3.3	3.3
	3	-	-	-	3.3	3.3
Jul.	1	-	-	-	3.1	3.1
	2	-	-	-	3.1	3.1
	3	-	-	-	3.5	3.5
Aug.	1	-	-	-	3.0	3.0
	2	-	-	-	3.0	3.0
	3	-	-	-	3.3	3.3
Sep.	1	-	-	-	2.8	2.8
	2	-	-	-	2.8	2.8
	3	-	-	-	2.8	2.8
Oct.	1	-	-	-	3.1	3.1
	2	-	-	-	3.1	3.1
	3	-	-	-	3.4	3.4
Nov.	1	-	-	-	5.5	5.5
	2	-	-	-	5.5	5.5
	3	-	-	-	5.5	5.5
Dec.	1	7.3	1.3	0.2	6.8	15.5
	2	7.3	1.3	0.2	6.8	15.5
	3	8.0	1.4	0.2	7.5	17.1
Jan.	1	7.3	1.3	0.2	7.0	15.7
	2	7.3	1.3	0.2	7.0	15.7
	3	8.0	1.4	0.2	7.7	17.3
Feb.	1	7.3	1.3	0.2	7.3	16.0
	2	7.3	1.3	0.2	7.3	16.0
	3	5.8	1.0	0.2	5.8	12.8
Mar.	1	7.3	1.3	0.2	6.9	15.6
	2	7.3	1.3	0.2	6.9	15.6
	3	8.0	1.4	0.2	7.6	17.2

/1 1, 2, 3 : Early, Middle and End of each month.

Table E-1-1. Plan of Water Supply (2)

Sub-System : Pa Kham Diversion Dam Weir (Unit 1000 m^3)

Period		Drinking Water	Water Supply for Buffalo	Water Supply for Cattle	Water Supply for Fish Breeding	Total Net Water Supply
Apr.	1/1	18.1	6.0	1.1	12.1	37.3
	2	72.4	23.7	4.3	39.6	139.9
	3	-	-	-	-	-
May	1	-	-	-	-	-
	2	-	-	-	-	-
	3	-	-	-	8.5	8.5
Jun.	1	-	-	-	7.4	7.4
	2	-	-	-	7.4	7.4
	3	-	-	-	7.4	7.4
Jul.	1	-	-	-	6.9	6.9
	2	-	-	-	6.9	6.9
	3	-	-	-	7.6	7.6
Aug.	1	-	-	-	6.6	6.6
	2	-	-	-	6.6	6.6
	3	-	-	-	7.3	7.3
Sep.	1	-	-	-	6.3	6.3
	2	-	-	-	6.3	6.3
	3	-	-	-	6.3	6.3
Oct.	1	-	-	-	6.8	6.8
	2	-	-	-	6.8	6.8
	3	-	-	-	7.5	7.5
Nov.	1	-	-	-	12.2	12.2
	2	-	-	-	12.2	12.2
	3	-	-	-	12.2	12.2
Dec.	1	18.1	6.1	1.1	15.1	40.3
	2	18.1	6.1	1.1	15.1	40.3
	3	19.9	6.7	1.2	16.6	40.3
Jan.	1	18.1	6.1	1.1	15.5	40.8
	2	18.1	6.1	1.1	15.5	40.8
	3	19.9	6.7	1.2	17.0	40.8
Feb.	1	18.1	6.1	1.1	16.1	41.4
	2	18.1	6.1	1.1	16.1	41.4
	3	14.5	4.9	0.9	12.9	33.1
Mar.	1	18.1	6.1	1.1	15.3	40.6
	2	18.1	6.1	1.1	15.3	40.6
	3	19.9	6.7	1.2	16.8	44.6

/1 1, 2, 3 : Early, Middle and End of each month.

Table E-I-1. Plan of Water Supply (3)

Sub-System : Nong Lum Puk (Unit 1000 m^3)

Period	Drinking Water	Water Supply for Buffalo	Water Supply for Cattle	Water Supply for Fish Breeding	Total Net Water Supply
Apr. 1 /1	2.6	0.2	0.1	1.7	4.6
2	10.3	0.8	0.3	5.7	17.1
3	-	-	-	-	-
May 1	-	-	-	-	-
2	-	-	-	-	-
3	-	-	-	1.2	1.2
Jun. 1	-	-	-	1.1	1.1
2	-	-	-	1.1	1.1
3	-	-	-	1.1	1.1
Jul. 1	-	-	-	1.0	1.0
2	-	-	-	1.0	1.0
3	-	-	-	1.1	1.1
Aug. 1	-	-	-	1.0	1.0
2	-	-	-	1.0	1.0
3	-	-	-	1.0	1.0
Sep. 1	-	-	-	0.9	0.9
2	-	-	-	0.9	0.9
3	-	-	-	0.9	0.9
Oct. 1	-	-	-	1.0	1.0
2	-	-	-	1.0	1.1
3	-	-	-	1.1	1.1
Nov. 1	-	-	-	1.7	1.7
2	-	-	-	1.7	1.7
3	-	-	-	1.7	1.7
Dec. 1	2.6	0.2	0.1	2.2	2.2
2	2.6	0.2	0.1	2.2	2.2
3	2.8	0.2	0.1	2.4	2.4
Jan. 1	2.6	0.2	0.1	2.2	2.2
2	2.6	0.2	0.1	2.2	2.2
3	2.8	0.2	0.1	2.4	2.4
Feb. 1	2.6	0.2	0.1	2.3	2.3
2	2.6	0.2	0.1	2.3	2.3
3	2.1	0.2	0.1	1.8	1.8
Mar. 1	2.6	0.2	0.1	2.2	2.2
2	2.6	0.2	0.1	2.2	2.2
3	2.8	0.2	0.1	2.4	2.4

/1 1, 2, 3 : Early, Middle and End of each month.

Table E-1-1. Plan of Water Supply (4)

Sub-System : Huai Phlu (Unit 1000 m^3)

Period		Drinking Water	Water Supply for Buffalo	Water Supply for Cattle	Water Supply for Fish Breeding	Total Net Water Supply
Apr.	1/1	2.8	0.8	0.1	2.4	6.0
	2	11.0	3.0	0.3	7.7	22.0
	3	-	-	-	-	-
May	1	-	-	-	-	-
	2	-	-	-	-	-
	3	-	-	-	1.6	1.6
Jun.	1	-	-	-	1.4	1.4
	2	-	-	-	1.4	1.4
	3	-	-	-	1.4	1.4
Jul.	1	-	-	-	1.3	1.3
	2	-	-	-	1.3	1.3
	3	-	-	-	1.5	1.5
Aug.	1	-	-	-	1.3	1.3
	2	-	-	-	1.3	1.3
	3	-	-	-	1.4	1.4
Sep.	1	-	-	-	1.2	1.2
	2	-	-	-	1.2	1.2
	3	-	-	-	1.2	1.2
Oct.	1	-	-	-	1.3	1.3
	2	-	-	-	1.3	1.3
	3	-	-	-	1.4	1.4
Nov.	1	-	-	-	2.4	2.4
	2	-	-	-	2.4	2.4
	3	-	-	-	2.4	2.4
Dec.	1	2.8	0.8	0.1	2.9	2.9
	2	2.8	0.8	0.1	2.9	2.9
	3	3.0	0.8	0.1	3.2	3.2
Jan.	1	2.8	0.8	0.1	2.9	2.9
	2	2.8	0.8	0.1	2.9	2.9
	3	3.0	0.8	0.1	3.2	3.2
Feb.	1	2.8	0.8	0.1	2.9	2.9
	2	2.8	0.8	0.1	2.9	2.9
	3	2.2	0.6	0.1	2.3	2.3
Mar.	1	2.8	0.8	0.1	3.4	3.4
	2	2.8	0.8	0.1	3.4	3.4
	3	3.0	0.9	0.1	3.8	3.8

/1 1, 2, 3 : Early, Middle and End of each month.

E.2. Water Operations Study

E.2.1. Basic Conditions

Simulation of the irrigation water balances and operations has been undertaken by using the information on the damsite hydrology and irrigation water requirement in order to identify an optimal size of the reservoir and irrigable area for each Sub-Project, under the following conditions:

(1) Reservoir H-V and H-A Relations:

- see Figures E-2-1, E-2-2, and E-2-3.
- low water level of the reservoir has been given taking into account the sediment storage for 100 years.

(2) Irrigable Area:

- The net irrigable area of existing paddy field with the Project is assumed at 90 percent of the gross area planimetered as described previously.

- In principle, the existing paddy field which would be irrigable through the gravity canals from the dam and/or diversion dam(s) has been incorporated in the proposed projects.

(3) Lowflow Availability at Diversion Dams:

- For the Sub-Project of Lam Plai Mat, an irrigation scheme with a diversion dam has been introduced taking into account (1) the removal of disadvantage due to extraordinary extension of the main/feeder canal directly from the dam as well as (2) the effective use of runoff from the downstream drainage basin in addition to the damsite runoff.

- As is shown in Section 3-2, the ten-days runoff from the downstream drainage basin has been taken at 70 percent of the damsite runoff.

- In addition, 90 percent of the ten-days runoff has been considered to be possibly diverted into the main canal when the canal has enough conveyance capacity, taking into consideration (1) daily fluctuation of the average ten-days runoff at M82 as well as (2) possible water diversion efficiency at the diversion dam and intake facilities.

(4) Reservoir Losses

Due to creation of the reservoir, the runoff from reservoir area would change. Without the reservoir, a part of rainfall would replenish groundwater storage especially in the wet season and another part would evapo-transpire through the vegetation or evaporate on the surface; thus, the balance would be the runoff. Once the reservoir is constructed, all rainfall would be converted into runoff, but water would evaporate from the reservoir surface. The "E-ET" as given below neglects variations in groundwater storage. It is clear that this estimation method could give only rough approximations of the increase in losses after construction of the reservoir.

(a) Evaporation Losses (EL)

- Losses without Reservoir:

  Actual evapotranspiration (E) would be equal to ETP or R, whichever is small.

  ETP: Potential evapotranspiration for natural vegetation, generally taken at about 70 percent of the crop reference evapotranspiration (ETo) by the Modified Penman method.

  R: Average rainfall.

- Losses with Reservoir:

  Open water evaporation (E) would be conservatively taken at 110 percent of ETo.

- Evaporation Losses (El) = E - ET

(b) Percolation and Leakages Losses (PL) --- Assumed at 15 mm/month or 0.5 mm/day.

(c) Total Losses: EL + PL

Reservoir losses are given on monthly basis in the Preliminary Study and are compiled in Tables E-2-1 to E-2-2.

(5) Initial Conditions of Reservoir Capacity

There would be a problem with respect to an initial reservoir capacity for 30-year water operations. In this Study, the first calculation for 30 years has been made based upon the conditions that the initial storage is full of water, then the second calculation for 30-year water operations has been carried out with the initial condition that is equivalent to the storage at the end of March 1982 as obtained in the first calculation. The water operations explain the results of the above-mentioned second calculation.

(6) Period of Water Balance and Operation

These water balance and operation simulation have been carried out for 30 years from 1952 to 1981 on ten-days basis.

E.2.2. Water Balance Study

The reservoir water balance study has been carried out to examine an optimum sizes of the proposed reservoir and related irrigation area taking into calculation the reservoir inflow and 100 percent of the downstream water demand together with such relevant factors as various water losses and additional water availability in its downstream.

Several alternative study on the basis of various combination of reservoir capacity and service area has been examined, however, optimum both size could not be found out in the achievement which have index of B per C ratio (benefit producing by irrigation for the service area per direct construction cost), then optimum size of the proposed reservoir has been fixed taking the following items into consideration:

i) water shortage occurrence in three to five years is permitted.

ii) to store water resource effectively, effective capacity is deemed to be 1.2 to 1.3 times as much as annual average inflow at the damsites.

Based on the above conditions, case studies having variable of irrigation area and index of C per A ratio (direct construction cost per average irrigated area) have been made as shown in Table E-2-3 and selected combination of both sizes of each sub-project is shown brief as follwos:

	Effective Storage (MCM)	Irrigation Area (ha)
Lam Plai Mat	90.0	9,000
Nong Lum Puk	4.0	350
Huai Phlu	6.0	700

Moreover, attention should be paid to the conditions of the existing paddy field and topography and finally, the sizes of the proposed reservoir and related irrigation area are decided as follows:

	Effective Storage (MCM)	Irrigation Area (ha)
Lam Plai Mat	90.0	9,100
Nong Lum Puk	4.0	300
Huai Phlu	6.0	700

Computed water balances of case studies and decided case as shown in Table E-2-4.

This study has revealed that the optimum reservoir capacity would have the water shortage to a considerable extent in the Lower Northeast basins. This water shortage means that a portion of 100 percent of the downstream water demand could not be delivered during the course of stored water release due to lack of water in the reservoir.

E.2.3. Water Operation Study

Actual water release from the reservoir should be made in such manner not to be in short supply for the downstream water demand scheduled in advance. In order to achieve this objective, the downstream water demand should be reduced to a suitable extent in accordance with the residual reservoir capacity after the last season and the predicted rainfall during the next season. A detailed study has identified that three would be no method and procedure to estimate the rainfall during the next wet season on the basis of any record just before, hence, it has been viewed that the water operations rule for reservoir should be given on the basis of residual water storage after the last season.

Attention should be made to proper distribution of the schedule irrigable area after reduction of the irrigation service area when it is in the poor situation of reservoir water. Appropriate procedures should be introduced in a simple mode to apply a yearly rotational irrigation scheduling on the basis of the given zones in case of the Lam Plai Mat subproject and of some groups of service units in the subprojects of Nong Lum Puk and Huai Phlu.

The water operations concluded are shown in Table E-2-5.

Table E-2-1 Reservoir Losses - Lam Plai Mat & Nong Lum Puk

(Unit: mm)

Month	Evaporation Losses: Losses w/o Reservoir: Potential Evapo-Transpiration for Natural Vegetation 1/ (ETP)	Rainfall 2/ (R)	Actual Evapo-Transpiration 3/ (ET)	Losses w/ Reservoir: Open Water & Evaporation 4/ (E)	E-ET α/ (EL)	Percolation and Leakage Losses 5/ (PL)	Total Losses EL + PL
Apr.	111	82	82	175	93	15	108
May	98	153	98	154	56	15	71
Jun.	88	103	88	139	51	15	66
Jul.	87	121	87	136	49	15	64
Aug.	81	118	81	127	46	15	61
Sep.	71	227	71	112	41	15	56
Oct.	85	151	85	133	48	15	63
Nov.	82	35	35	129	94	15	109
Dec.	81	3	3	127	124	15	139
Jan.	83	2	2	130	128	15	143
Feb.	86	16	16	135	119	15	134
Mar.	115	54	54	180	126	15	141
Total	1,068	1,065	702	1,677	975	180	1,155

1/ ... Generally taken at about 0.7 x Crop Reference Evapotranspiration (ETO) by the modified Penman at N.R. (1951 - 80).

2/ ... Average rainfall at Lam Plai Mat (1952 - 81).

3/ ... Equal to ETP or R, whichever is smaller.

4/ ... Conservatively taken at 1.1 x ETO.

5/ ... Assumed at 15 mm/month or 0.5 mm/day.

α/ ... Due to creation of the reservoir, the runoff from reservoir area would change. Without the reservoir case, a part of rainfall will replenish groundwater storage esp. in the wet season and another part will evapo-transpiration through the vegetation or evaporate on the surface; thus, the balance would run off. Once the reservoir is constructed, all rainfall would be converted into runoff, but water would evaporate from the reservoir surface. The above "E-ET" neglects variations in groundwater storage. It is clear that this estimation method could give only rough approximations of the increase in losses after construction of the reservoir.

Table E-2-2 Reservoir Losses - Huai Phlu

(Unit: mm)

Month	Evaporation Losses: Losses w/o Reservoir: Potential Evapo-Transpiration for Natural Vegetation 1/ (ETP)	Rainfall 2/ (R)	Actual Evapo-Transpiration (ET)	Losses w/ Reservoir: Open Water & Evaporation (E)	E-ET (EL)	Percolation and Leakage Losses (PL)	Total Losses EL + PL
Apr.	111	78	78	175	97	15	112
May	98	160	98	154	56	15	71
Jun.	88	170	88	139	51	15	66
Jul.	87	165	87	136	49	15	64
Aug.	81	171	81	127	46	15	61
Sep.	71	305	71	112	41	15	56
Oct.	85	172	85	133	48	15	63
Nov.	82	31	31	129	98	15	113
Dec.	81	1	1	127	126	15	141
Jan.	83	5	5	130	125	15	140
Feb.	86	25	25	135	110	15	125
Mar.	115	29	29	180	151	15	166
Total	1,068	1,312	679	1,677	998	180	1,178

1/ ... Generally taken at about 0.7 x Crop Reference Evapotranspiration (ETO) by the modified Penman at N.R. (1951 - 80).

2/ ... Average rainfall at Huai Seo (1952 - 81).

Table E-2-3 Summary of Water Balance Study

Sub-Project	Case No.	Effective Storage (MCM)	Irrigation Area (ha)	Water Shortage (% of Water Demand in 20 years)	Direct Construciton Cost: Dam	Direct Construciton Cost: Irrigation	Direct Construciton Cost: Total (M฿)	Average Irrigated Area (ha)	Cost/Area (1000฿/ha)
Lam Plai Mat	1	90.0	8,000	0	301	246	547	8,000	68.4
	2	90.0	9,000	4.4	301	272	573	8,604	66.6
	3	90.0	10,000	12.9	301	298	599	8,710	68.8
	4	90.0	11,000	20.0	301	324	625	8,800	71.0
Nong Lum Puk	1	4.0	250	0.5	26.7	7.5	34.2	249	137
	2	4.0	300	6.9	26.7	9.0	35.7	279	128
	3	4.0	350	16.3	26.7	10.5	37.2	293	127
	4	4.0	400	24.9	26.7	12.0	38.7	300	129
Huai Phlu	1	6.0	600	4.0	44.8	19.7	64.5	576	112
	2	6.0	700	10.5	44.8	23.0	67.8	627	108
	3	6.0	800	21.0	44.8	26.3	71.1	632	113

Table E-2-4

Water Balances for the Proposed Reservoirs

(Yearly Summary on ten days basis
for the years 1952 to 1981)

Lam Plai Mat Reservoir (1)

WATER BALANCE FOR LAM PLAI MAT RESERVOIR (DA = 485. KM2)

EFFECTIVE STORAGE = 90.000 (MCM)
SERVICE AREA = 8000. (HA) DIRECT S.A. = 1712. (HA) U.L.R. = 856.0 (HA) L.L.R. = 856.0 (HA) VEGET. = 149.3 (HA) NURSE. = 152.8 (HA)
0.1 S.A. = 6288. (HA) U.L.R. = 3144.0 (HA) L.L.R. = 3144.0 (HA) VEGET. = 554.0 (HA) NURSE. = 381.7 (HA)
0.2 S.A. = 0. (HA)

YEAR 1952 - 1981

(Case-1)

YEAR	INFLOW (MCM) 9)	WATER DEMAND DIRECT (MCM) 10)	WATER DEMAND SUB-TOTAL (MCM) 11)=3+7+10	RESERVOIR LOSS (MCM) 12)	SURPLUS OR DEFICIT (MCM) 13)=9-11-12	YEAR END STORAGE (MCM) 14)	DEFICIT STORAGE (MCM) 15)	SPILL OUT (MCM) 16)	SERVICE AREA (HA) 17)
1952	99.866	10.799	44.704	10.242	44.920	79.125	0.000	6.843	8000.00
1953	58.384	9.395	35.502	10.683	12.199	61.627	0.000	29.697	8000.00
1954	67.623	11.923	44.393	9.996	13.234	54.679	0.000	20.182	8000.00
1955	101.767	12.826	46.274	10.895	44.598	77.580	0.000	21.696	8000.00
1956	112.515	11.174	31.681	10.941	69.893	88.360	0.000	59.113	8000.00
1957	70.383	12.739	52.601	10.878	6.903	67.856	0.000	27.406	8000.00
1958	113.781	9.719	31.171	10.657	71.953	68.082	0.000	71.727	8000.00
1959	205.780	10.972	36.929	10.532	158.319	68.058	0.000	158.343	8000.00
1960	53.849	9.860	35.601	10.711	7.537	75.594	0.000	0.000	8000.00
1961	53.015	9.290	37.389	10.591	5.035	68.087	0.000	12.542	8000.00
1962	64.859	11.081	44.655	10.522	9.682	64.533	0.000	13.236	8000.00
1963	107.548	8.212	33.883	11.111	62.554	78.482	0.000	48.605	8000.00
1964	132.982	9.162	26.303	11.165	95.513	87.775	0.000	86.221	8000.00
1965	98.232	9.382	38.148	11.196	48.888	75.836	0.000	60.826	8000.00
1966	153.459	11.816	42.205	10.772	100.481	65.220	0.000	111.097	8000.00
1967	95.520	10.688	41.252	10.325	43.943	58.814	0.000	50.350	8000.00
1968	26.107	13.156	54.927	7.460	-36.279	22.534	0.000	0.000	8000.00
1969	79.152	10.991	46.228	8.059	24.865	47.399	0.000	0.000	8000.00
1970	70.849	9.278	33.480	10.630	26.738	72.033	0.000	2.104	8000.00
1971	53.917	11.593	45.966	10.301	-2.349	69.684	0.000	0.000	8000.00
1972	39.818	10.674	45.002	9.740	-14.924	54.759	0.000	0.000	8000.00
1973	39.120	9.316	40.948	8.592	-10.421	44.338	0.000	0.000	8000.00
1974	42.229	10.195	42.351	7.859	-7.981	36.356	0.000	0.000	8000.00
1975	46.948	10.427	43.554	7.460	-4.067	32.289	0.000	0.000	8000.00
1976	72.454	7.596	30.633	8.802	33.019	65.308	0.000	0.000	8000.00
1977	38.746	11.224	45.447	9.424	-16.124	49.184	0.000	0.000	8000.00
1978	74.084	11.126	39.193	9.913	24.978	59.292	0.000	14.869	8000.00
1979	17.465	14.563	63.270	6.336	-52.141	7.151	0.000	0.000	8000.00
1980	113.281	7.447	20.202	9.638	83.441	81.753	0.000	8.839	8000.00
1981	18.338	11.279	49.841	9.200	-40.703	41.049	0.000	0.000	8000.00
AVERAGE	77.402	10.597	40.791	9.821	26.790	60.761	0.000	26.790	8000.0

WATER BALANCE FOR LAM PLAI MAT RESERVOIR (DA = 485. KM2)

EFFECTIVE STORAGE = 90.000 (MCM)
SERVICE AREA = 9000. (HA) DIRECT S.A. = 1926. (HA) U.L.R. = 963.0 (HA) L.L.R. = 963.0 (HA) VEGET. = 167.9 (HA) NURSE. = 171.9 (HA)
0.1 S.A. = 7074. (HA) U.L.R. = 3537.0 (HA) L.L.R. = 3537.0 (HA) VEGET. = 623.3 (HA) NURSE. = 429.4 (HA)
0.2 S.A. = 0. (HA)

YEAR 1952 - 1981

(Case-2)

YEAR	INFLOW (MCM) 9)	WATER DEMAND DIRECT (MCM) 10)	WATER DEMAND SUB-TOTAL (MCM) 11)=3+7+10	RESERVOIR LOSS (MCM) 12)	SURPLUS OR DEFICIT (MCM) 13)=9-11-12	YEAR END STORAGE (MCM) 14)	DEFICIT STORAGE (MCM) 15)	SPILL OUT (MCM) 16)	SERVICE AREA (HA) 17)
1952	99.866	12.098	50.485	9.697	39.684	73.520	0.000	0.000	9000.00
1953	58.384	10.518	40.073	10.502	7.808	58.935	0.000	22.373	9000.00
1954	67.623	13.362	50.421	9.749	7.453	51.085	0.000	15.303	9000.00
1955	101.767	14.379	52.544	10.678	38.545	74.251	0.000	15.378	9000.00
1956	112.515	12.520	36.563	10.816	65.136	86.458	0.000	52.929	9000.00
1957	70.383	14.281	59.640	10.743	-.001	65.884	0.000	20.573	9000.00
1958	113.781	10.883	35.279	10.515	67.986	66.137	0.000	67.733	9000.00
1959	205.780	12.292	41.944	10.381	153.455	66.110	0.000	153.482	9000.00
1960	53.849	11.042	40.306	10.349	3.195	69.305	0.000	0.000	9000.00
1961	53.015	10.401	42.466	10.296	.253	66.143	0.000	3.415	9000.00
1962	64.859	12.415	50.759	10.344	3.756	62.126	0.000	7.773	9000.00
1963	107.548	9.188	38.142	11.034	58.373	77.764	0.000	42.734	9000.00
1964	132.982	10.257	29.945	11.089	91.948	85.918	0.000	83.794	9000.00
1965	98.232	10.504	43.234	11.118	43.880	74.819	0.000	54.978	9000.00
1966	153.459	13.243	48.523	10.663	94.272	62.942	0.000	106.149	9000.00
1967	95.520	11.973	46.608	10.146	38.766	55.696	0.000	46.013	9000.00
1968	26.107	14.750	62.208	6.595	-42.696	13.000	0.000	0.000	9000.00
1969	79.152	12.314	52.190	6.922	20.040	35.567	-2.527	0.000	9000.00
1970	70.849	10.387	38.219	9.636	22.993	58.560	0.000	0.000	9000.00
1971	53.917	12.991	52.026	8.961	-7.071	51.489	0.000	0.000	9000.00
1972	39.818	11.958	50.891	7.963	-19.036	32.453	0.000	0.000	9000.00
1973	39.120	10.429	46.026	6.190	-13.096	19.356	0.000	0.000	9000.00
1974	42.229	11.419	47.875	4.755	-10.401	8.955	0.000	0.000	9000.00
1975	46.948	11.679	49.292	4.414	-6.758	9.485	-7.288	0.000	9000.00
1976	72.454	8.494	34.693	6.899	30.862	51.446	-11.100	0.000	9000.00
1977	38.746	12.577	51.296	7.983	-20.532	30.914	0.000	0.000	9000.00
1978	74.084	12.466	44.531	8.964	20.589	51.503	0.000	0.000	9000.00
1979	17.465	16.332	71.425	3.817	-57.777	.013	-6.288	0.000	9000.00
1980	113.281	8.328	23.583	9.031	80.667	80.321	-.158	.518	9000.00
1981	18.338	12.638	56.070	8.752•	-46.484	33.836	0.000	0.000	9000.00
AVERAGE	77.402	11.871	46.242	8.967	22.193	52.466	-.912	23.106	9000.0

Lam Plai Mat Reservoir (2)

WATER BALANCE FOR LAM PLAI MAT RESERVOIR (DA = 485. KM2)

EFFECTIVE STORAGE = 90.000 (MCM)
SERVICE AREA =10000. (HA)

DIRECT S.A. = 2140. (HA)	0.1 S.A. = 7860. (HA)	0.2 S.A. = 0. (HA)
U.L.R. = 1070.0 (HA)	U.L.R. = 3930.0 (HA)	
L.L.R. = 1070.0 (HA)	L.L.R. = 3930.0 (HA)	
VEGET. = 186.6 (HA)	VEGET. = 692.5 (HA)	
NURSE. = 191.0 (HA)	NURSE. = 477.1 (HA)	

YEAR 1952 - 1981

(Case-3)

YEAR	INFLOW (MCM) 9)	WATER DEMAND DIRECT (MCM) 10)	WATER DEMAND SUB-TOTAL (MCM) 11)=3+7+10	RESERVOIR LOSS (MCM) 12)	SURPLUS OR DEFICIT (MCM) 13)=9-11-12	YEAR END STORAGE (MCM) 14)	DEFICIT STORAGE (MCM) 15)	SPILL OUT (MCM) 16)	SERVICE AREA (HA) 17)
1952	99.866	13.398	56.266	8.676	34.924	60.083	0.000	0.000	10000.00
1953	58.384	11.642	44.645	10.206	3.533	56.243	0.000	7.373	10000.00
1954	67.623	14.802	56.449	9.494	1.681	47.494	0.000	10.430	10000.00
1955	101.767	15.931	58.814	10.422	32.531	70.924	0.000	9.101	10000.00
1956	112.515	13.866	41.859	10.683	59.972	84.558	0.000	46.338	10000.00
1957	70.383	15.823	66.679	10.604	-6.900	63.913	0.000	13.744	10000.00
1958	113.781	12.048	40.329	10.364	63.088	64.195	0.000	62.806	10000.00
1959	205.780	13.613	47.017	10.228	148.536	64.164	0.000	148.566	10000.00
1960	53.849	12.224	45.010	9.963	-1.124	63.040	0.000	0.000	10000.00
1961	53.015	11.511	47.543	9.726	-4.254	58.786	0.000	0.000	10000.00
1962	64.859	13.750	56.862	9.863	-1.866	56.920	0.000	0.000	10000.00
1963	107.548	10.164	42.400	10.918	54.230	77.045	0.000	34.104	10000.00
1964	132.982	11.351	33.642	11.010	88.330	84.063	0.000	81.312	10000.00
1965	98.232	11.626	48.320	11.037	38.874	73.802	0.000	49.135	10000.00
1966	153.459	14.669	54.864	10.552	88.042	60.665	0.000	101.179	10000.00
1967	95.520	13.258	32.215	9.956	33.350	52.579	0.000	41.435	10000.00
1968	26.107	16.344	69.489	5.547	-48.928	3.651	0.000	0.000	10000.00
1969	79.152	13.637	58.245	6.315	14.591	32.873	-14.631	0.000	10000.00
1970	70.849	11.496	42.959	9.199	18.690	51.562	0.000	0.000	10000.00
1971	53.917	14.389	58.087	8.066	-12.235	39.327	0.000	0.000	10000.00
1972	39.818	13.242	56.781	6.356	-23.318	16.008	0.000	0.000	10000.00
1973	39.120	11.543	51.104	4.409	-16.393	8.091	-8.477	0.000	10000.00
1974	42.229	12.642	53.398	4.024	-15.193	6.665	-13.767	0.000	10000.00
1975	46.948	12.932	55.030	4.024	-12.107	7.284	-12.726	0.000	10000.00
1976	72.454	9.393	38.753	6.742	26.959	50.664	-16.422	0.000	10000.00
1977	38.746	13.929	57.146	7.553	-25.952	24.712	0.000	0.000	10000.00
1978	74.084	13.806	49.869	8.177	16.038	40.750	0.000	0.000	10000.00
1979	17.465	18.102	79.580	2.993	-65.108	.013	-24.372	0.000	10000.00
1980	113.281	9.208	27.308	8.882	77.091	77.262	-.158	0.000	10000.00
1981	18.338	13.998	62.298	8.142	-52.103	25.159	0.000	0.000	10000.00
AVERAGE	77.402	13.145	51.765	8.471	17.166	47.416	-3.018	20.184	10000.0

WATER BALANCE FOR LAM PLAI MAT RESERVOIR (DA = 485. KM2)

EFFECTIVE STORAGE = 90.000 (MCM)
SERVICE AREA =11000. (HA)

DIRECT S.A. = 2354. (HA)	0.1 S.A. = 8646. (HA)	0.2 S.A. = 0. (HA)
U.L.R. = 1177.0 (HA)	U.L.R. = 4323.0 (HA)	
L.L.R. = 1177.0 (HA)	L.L.R. = 4323.0 (HA)	
VEGET. = 205.2 (HA)	VEGET. = 761.8 (HA)	
NURSE. = 210.0 (HA)	NURSE. = 524.8 (HA)	

YEAR 1952 - 1981

(Case-4)

YEAR	INFLOW (MCM) 9)	WATER DEMAND DIRECT (MCM) 10)	WATER DEMAND SUB-TOTAL (MCM) 11)=3+7+10	RESERVOIR LOSS (MCM) 12)	SURPLUS OR DEFICIT (MCM) 13)=9-11-12	YEAR END STORAGE (MCM) 14)	DEFICIT STORAGE (MCM) 15)	SPILL OUT (MCM) 16)	SERVICE AREA (HA) 17)
1952	99.866	14.697	62.047	7.521	30.298	46.473	0.000	0.000	11000.00
1953	58.384	12.766	49.216	9.384	-.216	46.257	0.000	0.000	11000.00
1954	67.623	16.242	62.476	8.923	-3.776	42.480	0.000	0.000	11000.00
1955	101.767	17.484	65.083	10.111	26.573	67.603	0.000	1.450	11000.00
1956	112.515	15.212	47.632	10.545	54.338	82.659	0.000	39.281	11000.00
1957	70.383	17.364	73.718	10.309	-13.644	58.812	0.000	10.203	11000.00
1958	113.781	13.212	45.379	10.118	58.284	62.253	0.000	54.844	11000.00
1959	205.780	14.934	52.089	10.073	143.618	62.219	0.000	143.651	11000.00
1960	53.849	13.406	49.772	9.565	-5.488	56.731	0.000	0.000	11000.00
1961	53.015	12.622	52.619	8.981	-8.585	48.146	0.000	0.000	11000.00
1962	64.859	15.084	62.966	8.716	-6.824	41.322	0.000	0.000	11000.00
1963	107.548	11.140	46.839	10.468	50.242	76.327	0.000	15.237	11000.00
1964	132.982	12.446	37.654	10.928	84.400	82.209	0.000	78.518	11000.00
1965	98.232	12.748	53.406	10.951	33.875	72.670	0.000	43.414	11000.00
1966	153.459	16.095	61.205	10.404	81.850	57.640	0.000	96.880	11000.00
1967	95.520	14.544	57.978	9.720	27.822	49.466	0.000	35.996	11000.00
1968	26.107	17.938	76.770	3.829	-54.491	1.909	-6.935	0.000	11000.00
1969	79.152	14.960	64.322	6.009	8.820	30.180	-19.450	0.000	11000.00
1970	70.849	12.606	47.699	8.746	14.403	44.582	0.000	0.000	11000.00
1971	53.917	15.788	64.148	7.051	-17.281	27.300	0.000	0.000	11000.00
1972	39.818	14.525	62.670	4.292	-27.144	.783	-.627	0.000	11000.00
1973	39.120	12.657	56.188	3.477	-20.544	5.642	-25.403	0.000	11000.00
1974	42.229	13.866	58.927	3.666	-20.364	4.465	-19.188	0.000	11000.00
1975	46.948	14.185	60.768	3.658	-17.479	5.109	-18.123	0.000	11000.00
1976	72.454	10.292	42.812	6.620	23.021	49.882	-21.752	0.000	11000.00
1977	38.746	15.282	63.241	7.022	-31.516	18.366	0.000	0.000	11000.00
1978	74.084	15.146	55.223	7.322	11.538	29.904	0.000	0.000	11000.00
1979	17.465	19.872	87.735	2.373	-72.644	.013	-42.753	0.000	11000.00
1980	113.281	10.088	31.033	8.705	73.543	73.715	-.158	0.000	11000.00
1981	18.338	15.357	68.527	7.349	-57.538	16.176	0.000	0.000	11000.00
AVERAGE	77.402	14.419	57.338	7.895	12.170	42.043	-5.146	17.316	10999.9

Lam Plai Mat Reservoir (3)

WATER BALANCE FOR LAM PLAI MAT RESERVOIR (DA = 485. KM2)

EFFECTIVE STORAGE = 90.000 (MCM)
SERVICE AREA = 9100. (HA) DIRECT S.A. = 1950. (HA) 0.1 S.A. = 7150. (HA) 0.2 S.A. = 0. (HA)
U.L.R. = 975.0 (HA) U.L.R. = 3575.0 (HA)
L.L.R. = 975.0 (HA) L.L.R. = 3575.0 (HA)
VEGET. = 170.0 (HA) VEGET. = 630.0 (HA)
NURSE. = 174.0 (HA) NURSE. = 434.0 (HA)

YEAR 1952 - 1981

YEAR	DIVERSION 1: SIDEFLOW DA=538.KM2 (MCM) 1)	DIVERSION 1: WATER DEMAND (MCM) 2)	DIVERSION 1: DEPENDED WATER (MCM) 3)	DIVERSION 1: SURPLUS FLOW (MCM) 4)	DIVERSION 2: SIDEFLOW DA= 0.KM2 (MCM) 5)	DIVERSION 2: WATER DEMAND (MCM) 6)	DIVERSION 2: DEPENDED WATER (MCM) 7)	UNEFFECTIVE SIDEFLOW (MCM) 8)
1952	77.216	43.302	38.820	72.734	0.000	0.000	0.000	72.734
1953	45.142	37.621	29.888	37.409	0.000	0.000	0.000	37.409
1954	52.286	48.117	37.502	41.671	0.000	0.000	0.000	41.671
1955	78.686	51.866	38.621	65.442	0.000	0.000	0.000	65.442
1956	86.996	45.140	24.425	66.281	0.000	0.000	0.000	66.281
1957	54.420	51.234	45.891	49.076	0.000	0.000	0.000	49.076
1958	87.975	38.823	24.771	73.923	0.000	0.000	0.000	73.923
1959	159.108	43.971	30.015	145.153	0.000	0.000	0.000	145.153
1960	41.636	39.403	29.605	31.837	0.000	0.000	0.000	31.837
1961	40.991	37.105	32.449	36.335	0.000	0.000	0.000	36.335
1962	50.149	44.439	38.804	44.514	0.000	0.000	0.000	44.514
1963	83.156	32.662	29.271	79.765	0.000	0.000	0.000	79.765
1964	102.821	36.498	19.935	86.258	0.000	0.000	0.000	86.258
1965	75.952	37.252	33.113	71.813	0.000	0.000	0.000	71.813
1966	118.653	47.699	35.756	106.710	0.000	0.000	0.000	106.710
1967	73.856	42.780	35.023	66.104	0.000	0.000	0.000	66.104
1968	20.186	53.109	48.008	15.085	0.000	0.000	0.000	15.085
1969	61.200	44.263	40.325	57.261	0.000	0.000	0.000	57.261
1970	54.780	37.234	28.183	45.729	0.000	0.000	0.000	45.729
1971	41.689	46.632	39.486	34.542	0.000	0.000	0.000	34.542
1972	30.787	42.959	39.379	27.207	0.000	0.000	0.000	27.207
1973	30.247	37.214	35.980	29.014	0.000	0.000	0.000	29.014
1974	32.651	40.891	36.872	28.633	0.000	0.000	0.000	28.633
1975	36.300	41.956	38.047	32.390	0.000	0.000	0.000	32.390
1976	56.021	29.948	26.504	52.577	0.000	0.000	0.000	52.577
1977	29.959	44.990	39.154	24.123	0.000	0.000	0.000	24.123
1978	57.281	44.869	32.451	44.863	0.000	0.000	0.000	44.863
1979	13.504	59.133	55.710	10.080	0.000	0.000	0.000	10.080
1980	97.568	29.595	15.531	73.524	0.000	0.000	0.000	73.524
1981	14.179	45.336	43.903	12.745	0.000	0.000	0.000	12.745
AVERAGE	59.847	42.535	34.781	52.093	0.000	0.000	0.000	52.093

WATER BALANCE FOR LAM PLAI MAT RESERVOIR (DA = 485. KM2)

EFFECTIVE STORAGE = 90.000 (MCM)
SERVICE AREA = 9100. (HA) DIRECT S.A. = 1950. (HA) 0.1 S.A. = 7150. (HA) 0.2 S.A. = 0. (HA)
U.L.R. = 975.0 (HA) U.L.R. = 3575.0 (HA)
L.L.R. = 975.0 (HA) L.L.R. = 3575.0 (HA)
VEGET. = 170.0 (HA) VEGET. = 630.0 (HA)
NURSE. = 174.0 (HA) NURSE. = 434.0 (HA)

YEAR 1952 - 1981

YEAR	INFLOW (MCM) 9)	WATER DEMAND: DIRECT (MCM) 10)	WATER DEMAND: SUB-TOTAL (MCM) 11)=3+7+10	RESERVOIR LOSS (MCM) 12)	SURPLUS OR DEFICIT (MCM) 13)=9-11-12	YEAR END STORAGE (MCM) 14)	DEFICIT STORAGE (MCM) 15)	SPILL OUT (MCM) 16)	SERVICE AREA (HA) 17)
1952	99.866	12.244	51.064	9.615	39.186	72.302	0.000	0.000	9100.00
1953	58.384	10.645	40.533	10.475	7.376	58.666	0.000	21.012	9100.00
1954	67.623	13.524	51.026	9.725	6.873	50.725	0.000	14.813	9100.00
1955	101.767	14.553	53.174	10.653	37.940	73.916	0.000	14.749	9100.00
1956	112.515	12.671	37.096	10.803	64.616	86.268	0.000	52.264	9100.00
1957	70.383	14.454	60.345	10.730	-.691	65.686	0.000	19.890	9100.00
1958	113.781	11.014	35.785	10.500	67.495	65.943	0.000	67.239	9100.00
1959	205.780	12.440	42.455	10.366	152.959	65.916	0.000	152.986	9100.00
1960	53.849	11.175	40.779	10.311	2.759	68.674	0.000	0.000	9100.00
1961	53.015	10.525	42.974	10.265	-.224	65.949	0.000	2.502	9100.00
1962	64.859	12.565	51.369	10.327	3.163	61.885	0.000	7.226	9100.00
1963	107.548	9.297	38.568	11.026	57.953	77.692	0.000	42.147	9100.00
1964	132.982	10.379	30.314	11.081	91.586	85.732	0.000	83.546	9100.00
1965	98.232	10.630	43.743	11.110	43.379	74.717	0.000	54.393	9100.00
1966	153.459	13.403	49.158	10.652	93.648	62.715	0.000	105.651	9100.00
1967	95.520	12.117	47.146	10.128	38.247	55.384	0.000	45.577	9100.00
1968	26.107	14.929	62.937	6.510	-43.339	12.045	0.000	0.000	9100.00
1969	79.152	12.462	52.787	6.868	19.497	35.297	-3.756	0.000	9100.00
1970	70.849	10.512	38.695	9.593	22.561	57.858	0.000	0.000	9100.00
1971	53.917	13.148	52.634	8.874	-7.591	50.267	0.000	0.000	9100.00
1972	39.818	12.102	51.481	7.823	-19.485	30.781	0.000	0.000	9100.00
1973	39.120	10.554	46.534	5.956	-13.370	17.411	0.000	0.000	9100.00
1974	42.229	11.556	48.428	4.602	-10.801	8.674	-2.065	0.000	9100.00
1975	46.948	11.820	49.867	4.337	-7.256	9.264	-7.846	0.000	9100.00
1976	72.454	8.595	35.099	6.888	30.467	51.368	-11.638	0.000	9100.00
1977	38.746	12.729	51.883	7.943	-21.079	30.289	0.000	0.000	9100.00
1978	74.084	12.616	45.068	8.888	20.128	50.417	0.000	0.000	9100.00
1979	17.465	16.531	72.241	3.675	-58.451	.013	-9.048	0.000	9100.00
1980	113.281	8.426	23.957	9.023	80.301	80.177	-.158	.296	9100.00
1981	18.338	12.791	56.693	8.706	-47.061	33.115	0.000	0.000	9100.00
AVERAGE	77.402	12.014	46.794	8.915	21.693	51.971	-1.117	22.810	9100.0

Nong Lum Puk Reservoir (1)

WATER BALANCE FOR NONG LUM PUK RESERVOIR (DA = 25. KM2)

EFFECTIVE STORAGE = 4.000 (MCM)
SERVICE AREA = 250. (HA) DIRECT S.A. = 250. (HA) D.1 S.A. = 0. (HA) D.2 S.A. = 0. (HA)
U.L.R. = 125.0 (HA) U.L.R. = 0.0 (HA)
L.L.R. = 125.0 (HA) L.L.R. = 0.0 (HA)
VEGET. = 25.0 (HA) VEGET. = 0.0 (HA)
NURSE. = 20.0 (HA) NURSE. = 0.0 (HA)

YEAR 1952 - 1981

(Case-1)

YEAR	INFLOW (MCM) 9)	WATER DEMAND DIRECT (MCM) 10)	WATER DEMAND SUB-TOTAL (MCM) 11)=3+7+10	RESERVOIR LOSS (MCM) 12)	SURPLUS OR DEFICIT (MCM) 13)=9-11-12	YEAR END STORAGE (MCM) 14)	DEFICIT STORAGE (MCM) 15)	SPILL OUT (MCM) 16)	SERVICE AREA (HA) 17)
1952	4.289	1.642	1.642	.727	1.920	1.947	-.027	0.000	250.00
1953	3.742	1.447	1.447	1.136	1.159	2.577	0.000	.529	250.00
1954	4.304	1.815	1.815	1.096	1.393	2.337	0.000	1.633	250.00
1955	7.232	1.944	1.944	1.213	4.075	3.218	0.000	3.195	250.00
1956	7.196	1.705	1.705	1.232	4.260	3.906	0.000	3.571	250.00
1957	4.116	1.931	1.931	1.241	.943	2.807	0.000	2.043	250.00
1958	5.624	1.492	1.492	1.159	2.972	2.736	0.000	3.043	250.00
1959	10.462	1.674	1.674	1.128	7.659	2.764	0.000	7.632	250.00
1960	3.786	1.510	1.510	1.196	1.080	3.233	0.000	.611	250.00
1961	1.634	1.431	1.431	1.081	-.878	2.355	0.000	0.000	250.00
1962	2.700	1.690	1.690	1.030	-.021	2.334	0.000	0.000	250.00
1963	4.431	1.271	1.271	1.173	1.987	3.094	0.000	1.228	250.00
1964	9.362	1.406	1.406	1.262	6.694	3.829	0.000	5.959	250.00
1965	8.842	1.436	1.436	1.277	6.128	3.102	0.000	6.855	250.00
1966	12.582	1.797	1.797	1.232	9.552	2.813	0.000	9.842	250.00
1967	7.098	1.630	1.630	1.190	4.278	2.580	0.000	4.510	250.00
1968	2.088	1.991	1.991	.956	-.859	1.721	0.000	0.000	250.00
1969	3.759	1.680	1.680	1.016	1.063	2.644	0.000	.140	250.00
1970	3.873	1.428	1.428	1.233	1.212	3.150	0.000	.706	250.00
1971	2.717	1.766	1.766	1.171	-.221	2.930	0.000	0.000	250.00
1972	1.909	1.634	1.634	1.033	-.758	2.172	0.000	0.000	250.00
1973	1.548	1.429	1.429	.850	-.730	1.442	0.000	0.000	250.00
1974	1.680	1.560	1.560	.667	-.547	.894	0.000	0.000	250.00
1975	2.322	1.595	1.595	.664	.062	.956	0.000	0.000	250.00
1976	3.551	1.182	1.182	.863	1.506	2.462	0.000	0.000	250.00
1977	2.561	1.708	1.708	1.024	-.171	2.291	0.000	0.000	250.00
1978	3.444	1.700	1.700	1.100	.644	2.489	0.000	.446	250.00
1979	.233	2.198	2.198	.550	-2.515	0.000	-.026	0.000	250.00
1980	3.412	1.161	1.161	.699	1.552	1.579	-.027	0.000	250.00
1981	.537	1.720	1.720	.441	-1.624	0.000	-.045	0.000	250.00
AVERAGE	4.368	1.619	1.619	1.021	1.727	2.345	-.004	1.731	250.0

WATER BALANCE FOR NONG LUM PUK RESERVOIR (DA = 25. KM2)

EFFECTIVE STORAGE = 4.000 (MCM)
SERVICE AREA = 300. (HA) DIRECT S.A. = 300. (HA) D.1 S.A. = 0. (HA) D.2 S.A. = 0. (HA)
U.L.R. = 150.0 (HA) U.L.R. = 0.0 (HA)
L.L.R. = 150.0 (HA) L.L.R. = 0.0 (HA)
VEGET. = 30.0 (HA) VEGET. = 0.0 (HA)
NURSE. = 24.0 (HA) NURSE. = 0.0 (HA)

YEAR 1952 - 1981

(Case-2)

YEAR	INFLOW (MCM) 9)	WATER DEMAND DIRECT (MCM) 10)	WATER DEMAND SUB-TOTAL (MCM) 11)=3+7+10	RESERVOIR LOSS (MCM) 12)	SURPLUS OR DEFICIT (MCM) 13)=9-11-12	YEAR END STORAGE (MCM) 14)	DEFICIT STORAGE (MCM) 15)	SPILL OUT (MCM) 16)	SERVICE AREA (HA) 17)
1952	4.289	1.945	1.945	.682	1.663	1.739	-.077	0.000	300.00
1953	3.742	1.710	1.710	1.106	.926	2.448	0.000	.218	300.00
1954	4.304	2.152	2.152	1.062	1.090	2.167	0.000	1.372	300.00
1955	7.232	2.307	2.307	1.192	3.734	3.182	0.000	2.718	300.00
1956	7.196	2.020	2.020	1.217	3.959	3.816	0.000	3.326	300.00
1957	4.116	2.291	2.291	1.223	.602	2.712	0.000	1.706	300.00
1958	5.624	1.765	1.765	1.137	2.722	2.643	0.000	2.792	300.00
1959	10.462	1.983	1.983	1.101	7.377	2.634	0.000	7.386	300.00
1960	3.786	1.786	1.786	1.173	.827	3.187	0.000	.274	300.00
1961	1.634	1.691	1.691	1.038	-1.095	2.092	0.000	0.000	300.00
1962	2.700	2.002	2.002	.935	-.237	1.855	0.000	0.000	300.00
1963	4.431	1.500	1.500	1.123	1.809	3.058	0.000	.606	300.00
1964	9.362	1.661	1.661	1.250	6.451	3.742	0.000	5.767	300.00
1965	8.842	1.697	1.697	1.267	5.877	3.053	0.000	6.565	300.00
1966	12.582	2.131	2.131	1.216	9.235	2.705	0.000	9.584	300.00
1967	7.098	1.930	1.930	1.169	3.999	2.433	0.000	4.271	300.00
1968	2.088	2.363	2.363	.868	-1.143	1.290	0.000	0.000	300.00
1969	3.759	1.989	1.989	.900	.869	2.159	0.000	0.000	300.00
1970	3.873	1.688	1.688	1.184	1.001	3.097	0.000	.063	300.00
1971	2.717	2.093	2.093	1.116	-.493	2.605	0.000	0.000	300.00
1972	1.909	1.934	1.934	.925	-.951	1.654	0.000	0.000	300.00
1973	1.548	1.689	1.689	.689	-.830	.824	0.000	0.000	300.00
1974	1.680	1.846	1.846	.497	-.663	.482	-.320	0.000	300.00
1975	2.322	1.888	1.888	.502	-.069	.451	-.038	0.000	300.00
1976	3.551	1.392	1.392	.775	1.383	2.364	-.530	0.000	300.00
1977	2.561	2.024	2.024	.963	-.426	1.939	0.000	0.000	300.00
1978	3.444	2.014	2.014	1.046	.384	2.323	0.000	0.000	300.00
1979	.233	2.612	2.612	.370	-2.749	0.000	-.426	0.000	300.00
1980	3.412	1.367	1.367	.668	1.378	1.405	-.027	0.000	300.00
1981	.537	2.038	2.038	.308	-1.809	0.000	-.404	0.000	300.00
AVERAGE	4.368	1.917	1.917	.957	1.494	2.135	-.061	1.555	300.0

Nong Lum Puk Reservoir (2)

WATER BALANCE FOR NONG LUM PUK RESERVOIR (DA = 25. KM2)

EFFECTIVE STORAGE = 4.000 (MCM)
SERVICE AREA = 350. (HA) DIRECT S.A. = 350. (HA) D.1 S.A. = 0. (HA) D.2 S.A. = 0. (HA)
U.L.R. = 175.0 (HA) U.L.R. = 0.0 (HA)
L.L.R. = 175.0 (HA) L.L.R. = 0.0 (HA)
VEGET. = 35.0 (HA) VEGET. = 0.0 (HA)
NURSE. = 28.0 (HA) NURSE. = 0.0 (HA)

YEAR 1952 - 1981

(Case -3)

YEAR	INFLOW (MCM) 9)	WATER DEMAND DIRECT (MCM) 10)	WATER DEMAND SUB-TOTAL (MCM) 11)=3+7+10	RESERVOIR LOSS (MCM) 12)	SURPLUS OR DEFICIT (MCM) 13)=9-11-12	YEAR END STORAGE (MCM) 14)	DEFICIT STORAGE (MCM) 15)	SPILL OUT (MCM) 16)	SERVICE AREA (HA) 17)
1952	4.289	2.247	2.247	.666	1.376	1.695	-.319	0.000	350.00
1953	3.742	1.973	1.973	1.086	.683	2.319	0.000	.059	350.00
1954	4.304	2.489	2.489	1.027	.788	1.997	0.000	1.110	350.00
1955	7.232	2.670	2.670	1.170	3.393	3.147	0.000	2.243	350.00
1956	7.196	2.335	2.335	1.202	3.659	3.726	0.000	3.080	350.00
1957	4.116	2.651	2.651	1.204	.260	2.618	0.000	1.368	350.00
1958	5.624	2.037	2.037	1.115	2.471	2.549	0.000	2.540	350.00
1959	10.462	2.292	2.292	1.074	7.096	2.505	0.000	7.140	350.00
1960	3.786	2.062	2.062	1.141	.583	3.088	0.000	0.000	350.00
1961	1.634	1.951	1.951	.983	-1.299	1.789	0.000	0.000	350.00
1962	2.700	2.314	2.314	.820	-.434	1.355	0.000	0.000	350.00
1963	4.431	1.728	1.728	1.058	1.645	3.000	0.000	0.000	350.00
1964	9.362	1.916	1.916	1.237	6.208	3.654	0.000	5.554	350.00
1965	8.842	1.958	1.958	1.258	5.626	3.005	0.000	6.276	350.00
1966	12.582	2.464	2.464	1.198	8.920	2.581	0.000	9.343	350.00
1967	7.098	2.230	2.230	1.147	3.721	2.286	0.000	4.017	350.00
1968	2.088	2.735	2.735	.780	-1.427	.859	0.000	0.000	350.00
1969	3.759	2.299	2.299	.813	.647	1.910	-.404	0.000	350.00
1970	3.873	1.947	1.947	1.104	.822	2.732	0.000	0.000	350.00
1971	2.717	2.420	2.420	1.001	-.704	2.028	0.000	0.000	350.00
1972	1.909	2.235	2.235	.750	-1.076	.952	0.000	0.000	350.00
1973	1.548	1.949	1.949	.449	-.849	.213	-.110	0.000	350.00
1974	1.680	2.132	2.132	.408	-.860	.379	-1.026	0.000	350.00
1975	2.322	2.181	2.181	.454	-.313	.350	-.284	0.000	350.00
1976	3.551	1.603	1.603	.764	1.185	2.324	-.790	0.000	350.00
1977	2.561	2.339	2.339	.910	-.688	1.636	0.000	0.000	350.00
1978	3.444	2.327	2.327	.943	.173	1.810	0.000	0.000	350.00
1979	.233	3.025	3.025	.281	-3.074	0.000	-1.264	0.000	350.00
1980	3.412	1.573	1.573	.636	1.203	1.230	-.027	0.000	350.00
1981	.537	2.356	2.356	.272	-2.091	0.000	-.861	0.000	350.00
AVERAGE	4.368	2.215	2.215	.898	1.255	1.925	-.169	1.424	350.0

WATER BALANCE FOR NONG LUM PUK RESERVOIR (DA = 25. KM2)

EFFECTIVE STORAGE = 4.000 (MCM)
SERVICE AREA = 400. (HA) DIRECT S.A. = 400. (HA) D.1 S.A. = 0. (HA) D.2 S.A. = 0. (HA)
U.L.R. = 200.0 (HA) U.L.R. = 0.0 (HA)
L.L.R. = 200.0 (HA) L.L.R. = 0.0 (HA)
VEGET. = 40.0 (HA) VEGET. = 0.0 (HA)
NURSE. = 32.0 (HA) NURSE. = 0.0 (HA)

YEAR 1952 - 1981

(Case -4)

YEAR	INFLOW (MCM) 9)	WATER DEMAND DIRECT (MCM) 10)	WATER DEMAND SUB-TOTAL (MCM) 11)=3+7+10	RESERVOIR LOSS (MCM) 12)	SURPLUS OR DEFICIT (MCM) 13)=9-11-12	YEAR END STORAGE (MCM) 14)	DEFICIT STORAGE (MCM) 15)	SPILL OUT (MCM) 16)	SERVICE AREA (HA) 17)
1952	4.289	2.549	2.549	.650	1.089	1.651	-.561	0.000	400.00
1953	3.742	2.236	2.236	1.052	.454	2.104	0.000	0.000	400.00
1954	4.304	2.826	2.826	.984	.495	1.828	0.000	.771	400.00
1955	7.232	3.032	3.032	1.147	3.053	3.111	0.000	1.770	400.00
1956	7.196	2.650	2.650	1.187	3.360	3.635	0.000	2.836	400.00
1957	4.116	3.011	3.011	1.183	-.078	2.523	0.000	1.034	400.00
1958	5.624	2.309	2.309	1.094	2.221	2.456	0.000	2.288	400.00
1959	10.462	2.600	2.600	1.046	6.815	2.375	0.000	6.895	400.00
1960	3.786	2.338	2.338	1.074	.374	2.749	0.000	0.000	400.00
1961	1.634	2.211	2.211	.872	-1.449	1.301	0.000	0.000	400.00
1962	2.700	2.626	2.626	.675	-.601	.865	-.165	0.000	400.00
1963	4.431	1.956	1.956	.918	1.557	2.422	0.000	0.000	400.00
1964	9.362	2.171	2.171	1.210	5.981	3.567	0.000	4.836	400.00
1965	8.842	2.219	2.219	1.248	5.374	2.956	0.000	5.985	400.00
1966	12.582	2.797	2.797	1.178	8.606	2.437	0.000	9.125	400.00
1967	7.098	2.530	2.530	1.124	3.445	2.138	0.000	3.743	400.00
1968	2.088	3.108	3.108	.680	-1.699	.439	0.000	0.000	400.00
1969	3.759	2.609	2.609	.736	.414	1.782	-.928	0.000	400.00
1970	3.873	2.207	2.207	1.044	.623	2.404	0.000	0.000	400.00
1971	2.717	2.747	2.747	.887	-.917	1.487	0.000	0.000	400.00
1972	1.909	2.535	2.535	.557	-1.183	.304	0.000	0.000	400.00
1973	1.548	2.208	2.208	.354	-1.014	.101	-.811	0.000	400.00
1974	1.680	2.418	2.418	.374	-1.112	.276	-1.287	0.000	400.00
1975	2.322	2.474	2.474	.419	-.571	.249	-.544	0.000	400.00
1976	3.551	1.813	1.813	.748	.990	2.284	-1.045	0.000	400.00
1977	2.561	2.655	2.655	.854	-.947	1.337	0.000	0.000	400.00
1978	3.444	2.641	2.641	.832	-.029	1.308	0.000	0.000	400.00
1979	.233	3.439	3.439	.204	-3.410	0.000	-2.102	0.000	400.00
1980	3.412	1.779	1.779	.604	1.029	1.056	-.027	0.000	400.00
1981	.537	2.674	2.674	.239	-2.376	0.000	-1.320	0.000	400.00
AVERAGE	4.368	2.512	2.512	.839	1.016	1.705	-.293	1.309	400.0

Huai Phlu Reservoir (1)

WATER BALANCE FOR HUAI PHLU RESERVOIR (DA = 21. KM2)

EFFECTIVE STORAGE = 6.000 (MCM)
SERVICE AREA = 600. (HA) DIRECT S.A. = 600. (HA) 0.1 S.A. = 0. (HA) 0.2 S.A. = 0. (HA)
U.L.R. = 300.0 (HA) U.L.R. = 0.0 (HA)
L.L.R. = 300.0 (HA) L.L.R. = 0.0 (HA)
VEGET. = 34.3 (HA) VEGET. = 0.0 (HA)
NURSE. = 32.6 (HA) NURSE. = 0.0 (HA)

YEAR 1952 - 1981

(Case-1)

YEAR	INFLOW (MCM) 9)	WATER DEMAND DIRECT (MCM) 10)	WATER DEMAND SUB-TOTAL (MCM) 11)=3+7+10	RESERVOIR LOSS (MCM) 12)	SURPLUS OR DEFICIT (MCM) 13)=9-11-12	YEAR END STORAGE (MCM) 14)	DEFICIT STORAGE (MCM) 15)	SPILL OUT (MCM) 16)	SERVICE AREA (HA) 17)
1952	3.888	3.659	3.659	.501	-.271	2.056	-1.809	0.000	600.00
1953	2.527	3.141	3.141	.616	-1.230	.826	0.000	0.000	600.00
1954	4.063	4.021	4.021	.470	-.427	.658	-.259	0.000	600.00
1955	3.033	4.350	4.350	.192	-1.509	0.000	-.951	0.000	600.00
1956	4.385	3.788	3.788	.255	.342	.393	-.052	0.000	600.00
1957	8.292	4.277	4.277	.956	3.060	4.135	-.974	.291	600.00
1958	4.901	3.239	3.239	1.306	.357	4.055	0.000	.437	600.00
1959	7.861	3.669	3.669	1.272	2.919	4.144	0.000	2.831	600.00
1960	7.541	3.302	3.302	1.323	2.917	4.420	0.000	2.641	600.00
1961	2.960	3.096	3.096	1.174	-1.310	3.110	0.000	0.000	600.00
1962	3.320	3.709	3.709	.886	-1.275	1.835	0.000	0.000	600.00
1963	3.941	2.739	2.739	.814	.388	2.223	0.000	0.000	600.00
1964	5.447	3.074	3.074	1.114	1.259	3.483	0.000	0.000	600.00
1965	6.973	3.134	3.134	1.301	2.538	4.231	0.000	1.789	600.00
1966	6.606	4.001	4.001	1.351	1.254	3.857	0.000	1.628	600.00
1967	4.484	3.584	3.584	1.201	-.301	3.556	0.000	0.000	600.00
1968	4.710	4.450	4.450	1.056	-.796	2.760	0.000	0.000	600.00
1969	6.017	3.698	3.698	1.191	1.129	3.796	0.000	.093	600.00
1970	4.142	3.126	3.126	1.217	-.200	3.595	0.000	0.000	600.00
1971	3.200	3.894	3.894	.942	-1.636	1.959	0.000	0.000	600.00
1972	7.674	3.589	3.589	1.200	2.885	3.847	0.000	.998	600.00
1973	4.089	3.135	3.135	1.189	-.235	3.612	0.000	0.000	600.00
1974	3.210	3.428	3.428	.959	-1.178	2.434	0.000	0.000	600.00
1975	3.904	3.520	3.520	.866	-.482	1.951	0.000	0.000	600.00
1976	2.826	2.494	2.494	.697	-.365	1.586	0.000	0.000	600.00
1977	3.170	3.769	3.769	.487	-1.086	.500	0.000	0.000	600.00
1978	4.072	3.749	3.749	.443	-.119	.381	0.000	0.000	600.00
1979	2.841	4.959	4.959	.117	-2.236	0.000	-1.855	0.000	600.00
1980	6.476	2.484	2.484	.810	3.181	3.216	-.035	0.000	600.00
1981	1.693	3.785	3.785	.607	-2.698	.518	0.000	0.000	600.00
AVERAGE	4.608	3.562	3.562	.884	.162	2.438	-.194	.357	600.0

WATER BALANCE FOR HUAI PHLU RESERVOIR (DA = 21. KM2)

EFFECTIVE STORAGE = 6.000 (MCM)
SERVICE AREA = 700. (HA) DIRECT S.A. = 700. (HA) 0.1 S.A. = 0. (HA) 0.2 S.A. = 0. (HA)
U.L.R. = 350.0 (HA) U.L.R. = 0.0 (HA)
L.L.R. = 350.0 (HA) L.L.R. = 0.0 (HA)
VEGET. = 40.0 (HA) VEGET. = 0.0 (HA)
NURSE. = 38.0 (HA) NURSE. = 0.0 (HA)

YEAR 1952 - 1981

(Case-2)

YEAR	INFLOW (MCM) 9)	WATER DEMAND DIRECT (MCM) 10)	WATER DEMAND SUB-TOTAL (MCM) 11)=3+7+10	RESERVOIR LOSS (MCM) 12)	SURPLUS OR DEFICIT (MCM) 13)=9-11-12	YEAR END STORAGE (MCM) 14)	DEFICIT STORAGE (MCM) 15)	SPILL OUT (MCM) 16)	SERVICE AREA (HA) 17)
1952	3.888	4.240	4.240	.423	-.775	1.941	-2.715	0.000	700.00
1953	2.527	3.636	3.636	.497	-1.606	.335	0.000	0.000	700.00
1954	4.063	4.662	4.662	.364	-.963	.352	-.980	0.000	700.00
1955	3.033	5.046	5.046	.150	-2.164	0.000	-1.811	0.000	700.00
1956	4.385	4.391	4.391	.179	-.185	.310	-.494	0.000	700.00
1957	8.292	4.961	4.961	.924	2.408	3.966	-1.500	.251	700.00
1958	4.901	3.751	3.751	1.253	-.102	3.864	0.000	0.000	700.00
1959	7.861	4.253	4.253	1.217	2.391	3.910	0.000	2.345	700.00
1960	7.541	3.824	3.824	1.271	2.447	4.253	0.000	2.105	700.00
1961	2.960	3.583	3.583	1.080	-1.703	2.550	0.000	0.000	700.00
1962	3.320	4.299	4.299	.680	-1.658	.892	0.000	0.000	700.00
1963	3.941	3.167	3.167	.582	.192	1.377	-.293	0.000	700.00
1964	5.447	3.557	3.557	.889	1.001	2.378	0.000	0.000	700.00
1965	6.973	3.628	3.628	1.189	2.156	4.073	0.000	.461	700.00
1966	6.606	4.640	4.640	1.291	.675	3.514	0.000	1.225	700.00
1967	4.484	4.153	4.153	1.062	-.732	2.782	0.000	0.000	700.00
1968	4.710	5.163	5.163	.807	-1.260	1.522	0.000	0.000	700.00
1969	6.017	4.285	4.285	.884	.848	2.369	0.000	0.000	700.00
1970	4.142	3.618	3.618	.884	-.360	2.010	0.000	0.000	700.00
1971	3.200	4.514	4.514	.484	-1.798	.211	0.000	0.000	700.00
1972	7.674	4.158	4.158	.885	2.631	2.842	0.000	0.000	700.00
1973	4.089	3.630	3.630	.936	-.478	2.365	0.000	0.000	700.00
1974	3.210	3.971	3.971	.623	-1.384	.981	0.000	0.000	700.00
1975	3.904	4.079	4.079	.436	-.611	.370	0.000	0.000	700.00
1976	2.826	2.882	2.882	.486	-.541	1.218	-1.389	0.000	700.00
1977	3.170	4.369	4.369	.387	-1.585	.189	-.556	0.000	700.00
1978	4.072	4.345	4.345	.191	-.465	0.000	-.276	0.000	700.00
1979	2.841	5.757	5.757	.065	-2.982	0.000	-2.982	0.000	700.00
1980	6.476	2.869	2.869	.759	2.847	2.882	-.035	0.000	700.00
1981	1.693	4.387	4.387	.376	-3.070	0.000	-.187	0.000	700.00
AVERAGE	4.608	4.127	4.127	.708	-.227	1.782	-.441	.213	700.0

WATER BALANCE FOR HUAI PHLU RESERVOIR (DA = 21. KM2)

EFFECTIVE STORAGE = 6.000 (MCM)
SERVICE AREA = 800. (HA) DIRECT S.A. = 800. (HA) 0.1 S.A. = 0. (HA) 0.2 S.A. = 0. (HA)
U.L.R. = 400.0 (HA) U.L.R. = 0.0 (HA)
L.L.R. = 400.0 (HA) L.L.R. = 0.0 (HA)
VEGET. = 45.7 (HA) VEGET. = 0.0 (HA)
NURSE. = 43.4 (HA) NURSE. = 0.0 (HA)

YEAR 1952 - 1981

(Case-3)

YEAR	INFLOW (MCM) 9)	WATER DEMAND DIRECT (MCM) 10)	WATER DEMAND SUB-TOTAL (MCM) 11)=3+7+10	RESERVOIR LOSS (MCM) (2)	SURPLUS OR DEFICIT (MCM) 13)=9-11-12	YEAR END STORAGE (MCM) 14)	DEFICIT STORAGE (MCM) 15)	SPILL OUT (MCM) 16)	SERVICE AREA (HA) 17)
1952	3.888	4.821	4.821	.408	-1.341	1.851	-3.193	0.000	800.00
1953	2.527	4.131	4.131	.353	-1.957	0.000	-.106	0.000	800.00
1954	4.063	5.304	5.304	.254	-1.495	.052	-1.546	0.000	800.00
1955	3.033	5.743	5.743	.102	-2.812	0.000	-2.761	0.000	800.00
1956	4.385	4.994	4.994	.131	-.740	.310	-1.050	0.000	800.00
1957	8.292	5.646	5.646	.898	1.749	3.797	-1.950	.212	800.00
1958	4.901	4.262	4.262	1.147	-.507	3.290	0.000	0.000	800.00
1959	7.861	4.836	4.836	1.128	1.897	3.672	0.000	1.514	800.00
1960	7.541	4.346	4.346	1.218	1.978	4.086	0.000	1.564	800.00
1961	2.960	4.070	4.070	.987	-2.097	1.989	0.000	0.000	800.00
1962	3.320	4.888	4.888	.424	-1.993	0.000	-.004	0.000	800.00
1963	3.941	3.595	3.595	.469	-.123	1.250	-1.373	0.000	800.00
1964	5.447	4.041	4.041	.797	.609	1.859	0.000	0.000	800.00
1965	6.973	4.122	4.122	1.068	1.783	3.642	0.000	0.000	800.00
1966	6.606	5.278	5.278	1.224	.104	3.165	0.000	.580	800.00
1967	4.484	4.722	4.722	.927	-1.165	2.000	0.000	0.000	800.00
1968	4.710	5.876	5.876	.502	-1.669	.332	0.000	0.000	800.00
1969	6.017	4.873	4.873	.533	.611	.943	0.000	0.000	800.00
1970	4.142	4.111	4.111	.482	-.450	.493	0.000	0.000	800.00
1971	3.200	5.135	5.135	.186	-2.121	0.000	-1.628	0.000	800.00
1972	7.674	4.728	4.728	.764	2.182	2.182	0.000	0.000	800.00
1973	4.089	4.124	4.124	.733	-.768	1.414	0.000	0.000	800.00
1974	3.210	4.514	4.514	.332	-1.636	.160	-.332	0.000	800.00
1975	3.904	4.637	4.637	.142	-.875	.008	-.724	0.000	800.00
1976	2.826	3.269	3.269	.443	-.885	1.158	-2.035	0.000	800.00
1977	3.170	4.969	4.969	.311	-2.110	.004	-.956	0.000	800.00
1978	4.072	4.942	4.942	.138	-1.008	0.000	-1.004	0.000	800.00
1979	2.841	6.556	6.556	.059	-3.774	0.000	-3.774	0.000	800.00
1980	6.476	3.255	3.255	.707	2.513	2.548	-.035	0.000	800.00
1981	1.693	4.989	4.989	.305	-3.601	0.000	-1.052	0.000	800.00
AVERAGE	4.608	4.693	4.693	.572	-.657	1.340	-.786	.129	800.0