Table IV-13 Selection of Irrigation Development Projects (1/2)

No.	Location and River Basin	Potential Area (Ha) Study area	Potential Area (Ha) Outside of Study area	Easy access for water operation	Positive activities of water users association	Easy approch of agriculture support syst.	Advantageous approach for demonstration	Project Scale	Total	Present Status of Areas	Selection of Projects
	Paksong										
	Xe Pian										
1	Gravity Lower Xe Pian	750		3	2	2	1	3	11		○
	H.Makchan										
2	Gravity Upper Makchan	470		3	2	2	3	3	13		○
3	Lower Makchan	340		3	2	2	3	2	12		○
	H.Namtang										
4	Gravity Middle Namtang	265		3	2	2	3	2	12		○
	Xe Katam										
5	Gravity Thonvay	100		2	3	2	2	2	11	Existing Project	
6	Thong Hong	20		2	3	2	1	1	9	Existing Project	
7	Middle Xe Katam	620		3	3	2	3	3	14		○
	H.Chuang										
8	Gravity Thonvay	80		2	2	2	2	1	9	Existing Project	
	Laongam										
	H.Tapoung										
9	Gravity Upper Tapoung	50		3	2	2	3	1	11		○
10	Middle Tapoung	450		3	2	2	3	3	13		○
11	Lower Tapoung	4,500		3	2	2	3	2	12		○
12	New Area	7,000	8,000	2	2	2	2	1	9		
	H.Kapheu										
13	Gravity Upper Kapheu	1,100		3	3	3	3	3	15		○
	H.Palai										
14	Gravity Houay Palai	240		3	3	3	2	2	13	Existing Project	
	H.Champi										
15	Gravity Upper Champi	730		3	2	2	3	3	13		○
16	Lower Champi	1,500	1,100	3	2	2	3	2	12		○
17	New Area	0	1,300	2	2	2	1	3	10		
	Salavan										
	Xe Set										
18	Gravity Houay Set	50		2	2	2	2	1	9	Existing Project	
19	Lower Xe Set	1,800		3	2	2	3	3	13		○
	H.Thon										
20	Gravity Upper Thon	640		3	2	2	3	3	13		○
21	New Area	2,500		2	2	2	2	2	10		
	H.Tay - Un										
22	Gravity H.Nonglao	150		3	3	3	2	2	13	Existing Project	
23	Upper Tay - Un	350		3	2	2	2	2	11		○
24	Middle Lanphan	250	2,660	2	2	2	3	2	11		○
	H.Laha										
25	Gravity B.Vioang Kham	40		3	2	3	2	1	11	Existing Project	
26	B.Phao - Gnai	50		3	2	3	2	1	11	Existing Project	

Table IV-13 Selection of Irrigation Development Projects (2/2)

27		B.Soung	50		3	2	3	2	1	11	Existing Project	
	H.Namsai											
28	Gravity	Namsai	2,590		2	2	2	2	2	10	Existing Project	
29		Houay Xai	590		3	2	2	2	3	12	Existing Project	
30		Lower Namsai	1,350	5,850	3	2	2	2	2	11		O
	Total	Gravity	28,625	18,910								

Table IV-14 Priority Irrigation Schemes in the Study Area

No.	PROPOSED SCHEMES	WATER RESOURCES	PROPOSED CROPS / CROPPING PATTERN	IRRIGATION AREA (ha) for Master Plan NET	IRRIGATION AREA (ha) for Feasibility Study NET	REMARKS
1	UPPER CHAMPI	H. CHAMPI	Coffee	725	620	
			Type-C	5	110	
				730	730	
2	UPPER TAPOUNG	H. TAPOUNG	Type-C	50	80	
				50	80	
3	LOWER XE PIAN	XE PIAN	Coffee	650		
			Type-C	100		
				750		
4	UPPER MAKCHAN	H. MAKCHAN	Coffee	370		
			Type-C	100		
				470		
5	MIDDLE XE KATAM	XE KATAM	Type-A	140		Full management in rainy season
			Type-B	480		Critical season for dry season paddy
				620		
6	MIDDLE NAMTANG	H. NAMTANG	Coffee	145		Main crop is coffee
			Type-B	120		
				265		
7	LOWER MAKCHAN-GNAI	H. MAKCHAN-GNAI	Coffee	260		Main crop is coffee
			Type-B	80		
				340		
8	LOWER CHAMPI	H. CHAMPI	Type-A1 (fallow-paddy)	1,610		Supplemental Irrigation for rainy season paddy
			Type-B 2	990		
				2,600		
9	UPPER KAPHEU	H. KAPHEU	Coffee	860	900	Supplemental Irrigation for rainy season paddy
			Type-B 1	80	100	is cancelled due to the decrease of land resources.
			Type-A1 (fallow-paddy)	60	0	
				1,000	1,000	
10	MIDDLE TAPOUNG	H. TAPOUNG	Coffee	370		
			Type-B	80		
				450		
11	LOWER TAPOUNG	H. TAPOUNG	Coffee	190		Supplemental Irrigation for rainy season paddy
			Type-A1 (fallow-paddy)	3,890		
			Type-B 1	420		
			Type-C	0		
				4,500		
12	LOWER XE SET	XE SET	Type-A	0	200	Supplemental Irrigation for rainy season paddy
			Type-B 1	1,240	800	is carried out through trans-basin plan to the
			Type-A1 (fallow-paddy)	560	0	Upper Thon Scheme.
				1,800	1,000	
13	LOWER NAMSAI	H. NAMSAI	Type-A	1,500		Supplemental Irrigation for rainy season paddy
			Type-B	640		
			Type-A1 (fallow-paddy)	1,720		
				3,860		
14	UPPER THON	Xe Set	Type-A	0		Supplemental Irrigation for rainy season paddy
			Type-B	240		
			Type-A1 (fallow-paddy)	400		
				640		
15	MIDDLE LAMPHAN	H. LAMPHAN	Type-A	2,000		Multi Purpose Water Resources
			Type-B	900		Development
				2,900		
16	UPPER TAY-UN	H. TAY-UN / H. THON	Type-A	45	70	Supplemental Irrigation for rainy season paddy
			Type-B 1	45	80	
			Type-A1 (fallow-paddy)	240	180	
				330	330	
	TOTAL			21,285	3,140	

Table IV-15 Selection of the Priority Development Projects

No.	PROPOSED PROJECT	WATER RESOURCES	PROPOSED CROPS / CROPPING PATTERN	POTENTIAL IRRIGATION AREA (ha)	SELECTION CRITERIA: Agricultural Extension	Effectiveness of Demonstration	Typical Agric./ Suitable Crops	Better Coordination with Existing projects	Easy Access to the Project areas	Scale of Development	TOTAL	EVALUATION	REMARKS
1	UPPER CHAMPI	H. CHAMPI	COFFEE	730	3	3	3	3	3	3	18	O	
2	UPPER TAPOUNG	H. TAPOUNG	COFFEE	50	3	3	3	3	3	2	17	#	
			VEGETABLE-UPLAND CROPS / TYPE-C		2	3	3	2	3	2	15		
3	LOWER XE PIAN	XE PIAN	COFFEE	750	3	1	3	3	1	3	14		
4	UPPER MAKCHAN	H. MAKCHAN	COFFEE	470	1	2	3	1	3	3	13		
			VEGETABLE-UPLAND CROPS / TYPE-C		1	2	2	1	3	3	12		
5	MIDDLE XE KATAM	XE KATAM	PADDY-PADDY / TYPE-A	620	1	1	2	1	1	3	9		Supplemental Irrigation
6	MIDDLE NAMTANG	H. NAMTANG	UPLAND CROPS-PADDY / TYPE-B	265	1	1	2	1	1	2	8		Supplemental Irrigation
7	LOWER MAKCHAN-GNAI	H. MAKCHAN-GNAI	UPLAND CROPS-PADDY / TYPE-B	340	1	1	2	1	1	3	9		Supplemental Irrigation
8	LOWER CHAMPI	H. CHAMPI	UPLAND CROPS-PADDY / TYPE-B	2,600	3	1	3	3	3	3	16		Supplemental Irrigation
9	UPPER KAPHEU	H. KAPHEU	COFFEE	1,100	3	3	3	3	3	2	17	#	
			UPLAND CROPS-PADDY / TYPE-B		2	3	3	2	3	3			Supplemental Irrigation
10	MIDDLE TAPOUNG	H. TAPOUNG	COFFEE	450	3	3	2	3	3	2	16		
11	LOWER TAPOUNG	H. TAPOUNG	COFFEE	4,500	3	3	2	3	2	3	16		
			UPLAND CROPS-PADDY / TYPE-B		3	3	3	3	3	3			Supplemental Irrigation
12	LOWER XE SET	XE SET	UPLAND CROPS-PADDY / TYPE-B	1,800	3	3	3	3	3	3	18	O	Supplemental Irrigation
13	LOWER NAMSAI	H. NAMSAI	UPLAND CROPS-PADDY / TYPE-B	7,200	1	3	3	1	2	3	13		Supplemental Irrigation
14	UPPER THON	H. THON	PADDY-PADDY / TYPE-A	640	1	3	3	1	3	2	13		
15	MIDDLE LAMPHAN	H. LAMPHAN	PADDY-PADDY / TYPE-A	2,900	1	3	3	2	1	3	13		Multi Purpose Water Resources Development
16	UPPER TAY-UN	H. TAY-UN	COFFEE	350	3	3	3	3	3	2	17	#	
			UPLAND CROPS-PADDY / TYPE-B		3	3	3	3	3	2			Supplemental Irrigation
	TOTAL			24,765									

Figures

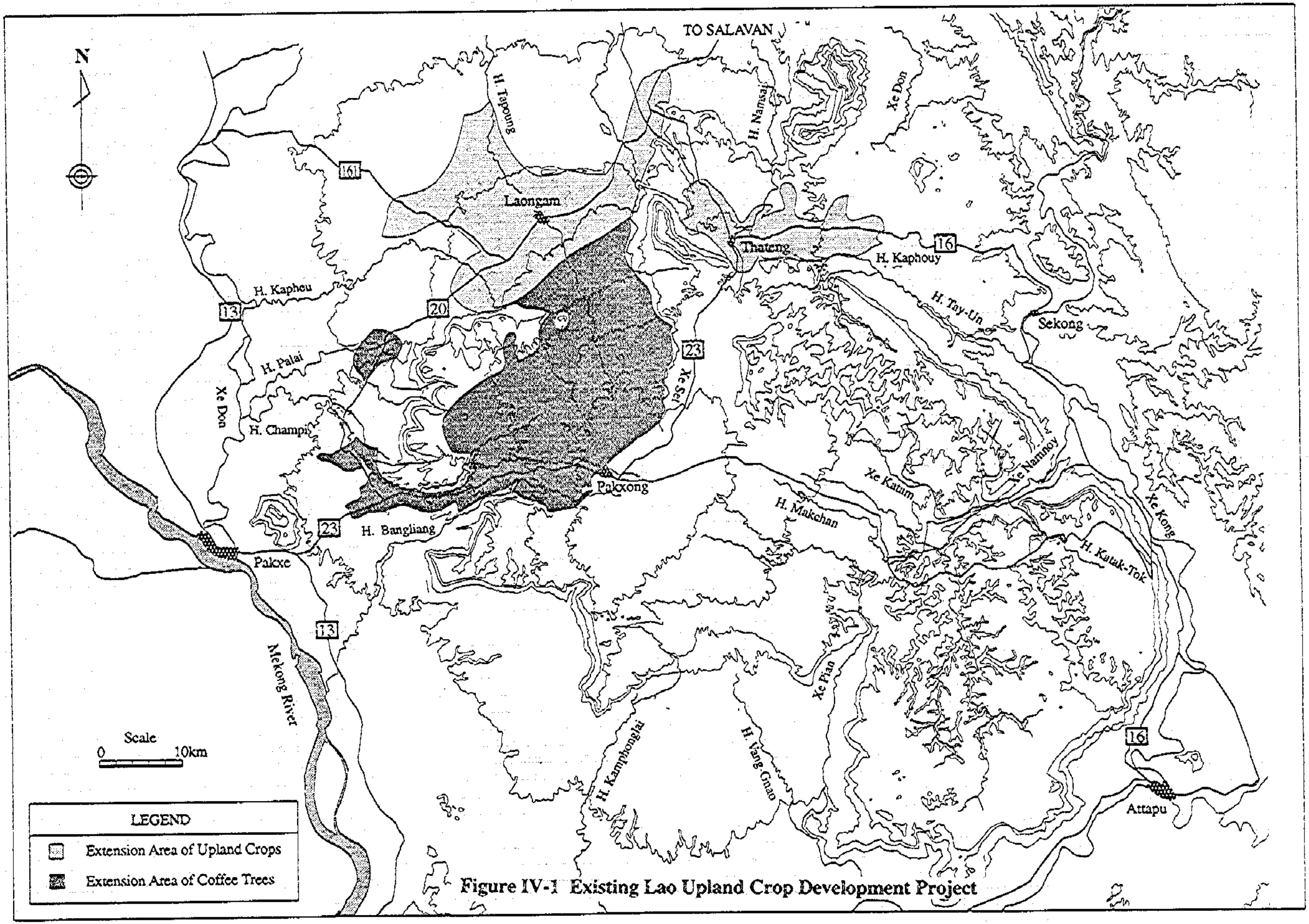


Figure IV-1 Existing Lao Upland Crop Development Project

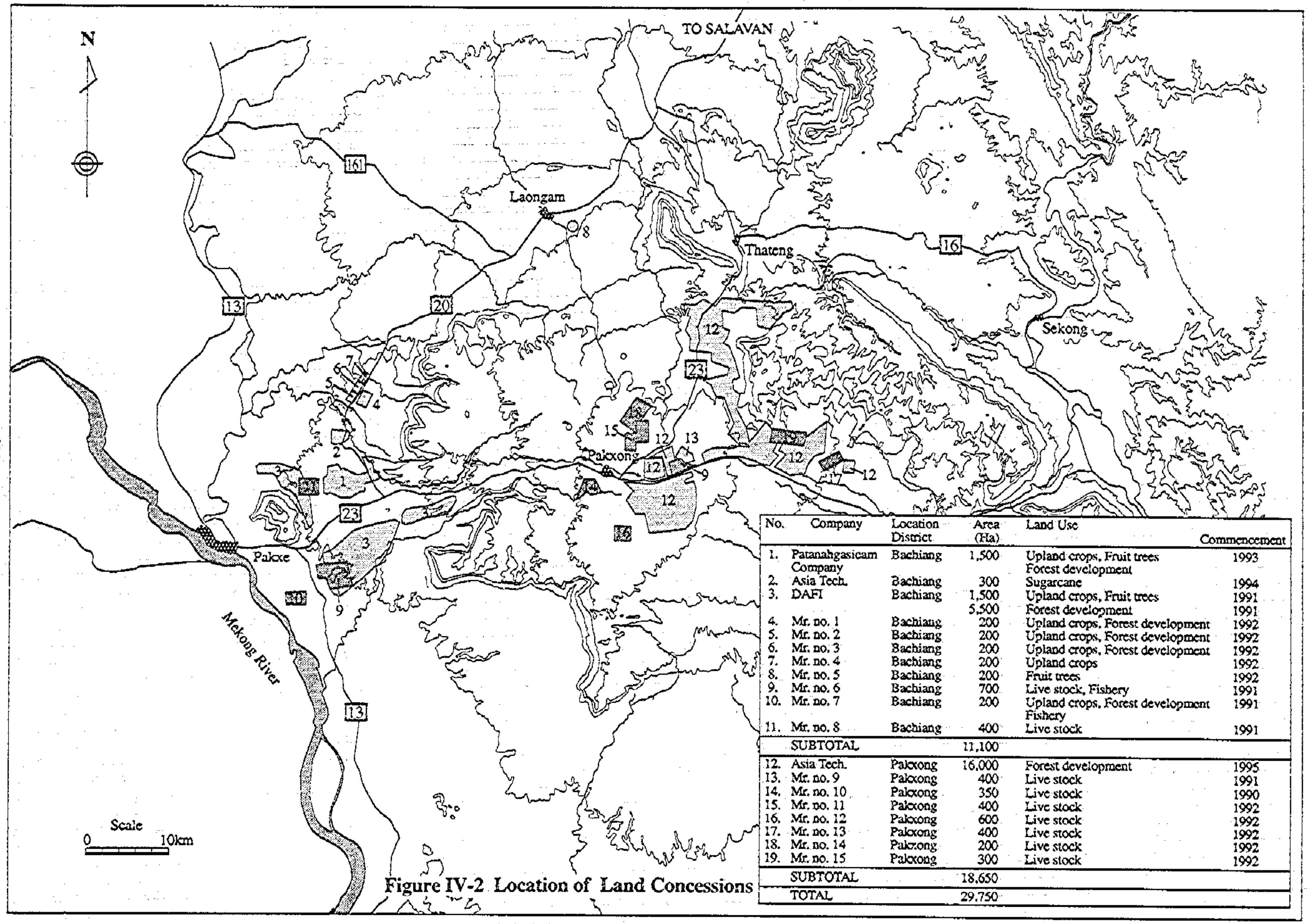
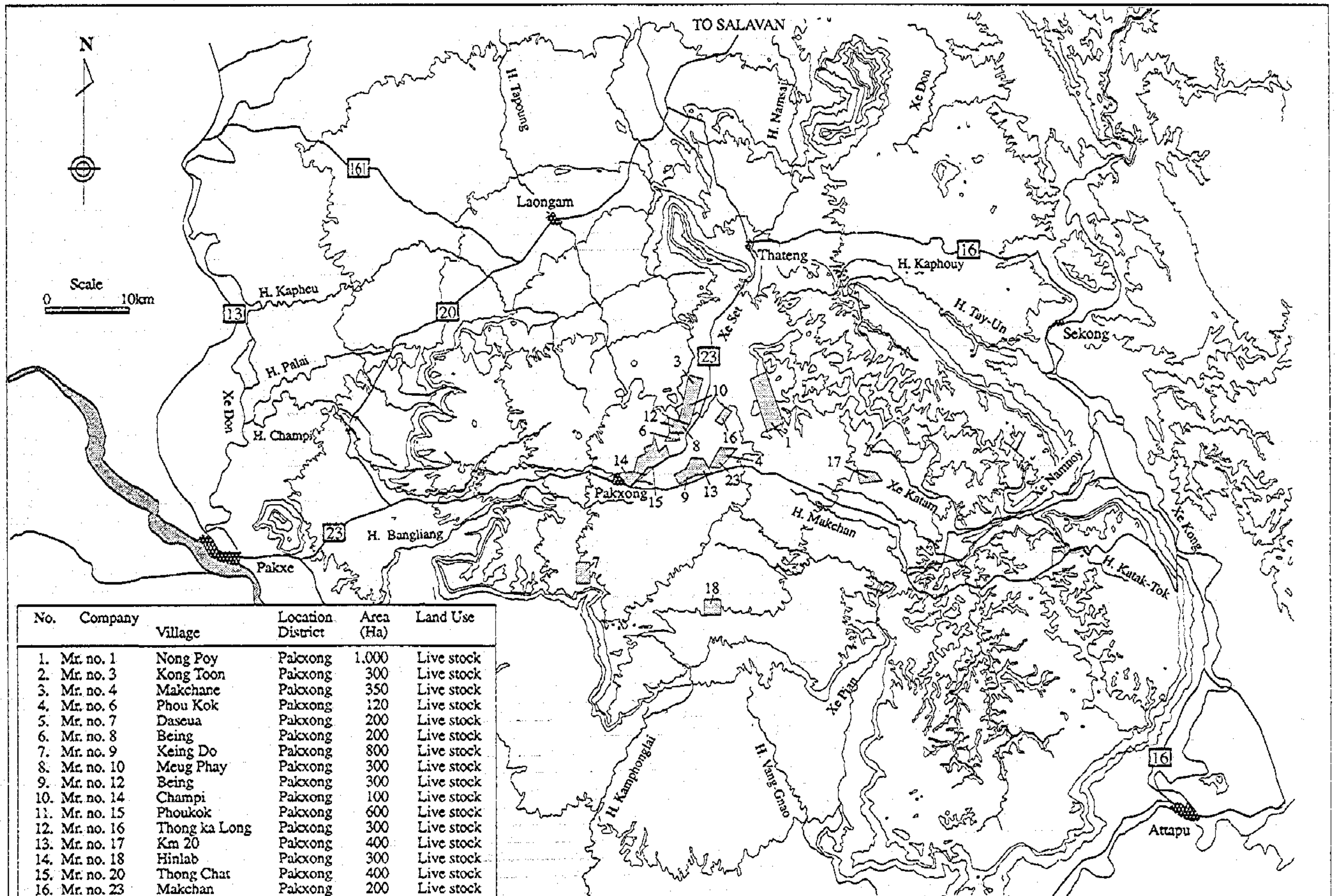


Figure IV-2 Location of Land Concessions

No.	Company	Location District	Area (Ha)	Land Use	Commencement
1.	Patanahgasicam Company	Bachiang	1,500	Upland crops, Fruit trees Forest development	1993
2.	Asia Tech.	Bachiang	300	Sugarcane	1994
3.	DAFI	Bachiang	1,500	Upland crops, Fruit trees	1991
			5,500	Forest development	1991
4.	Mr. no. 1	Bachiang	200	Upland crops, Forest development	1992
5.	Mr. no. 2	Bachiang	200	Upland crops, Forest development	1992
6.	Mr. no. 3	Bachiang	200	Upland crops, Forest development	1992
7.	Mr. no. 4	Bachiang	200	Upland crops	1992
8.	Mr. no. 5	Bachiang	200	Fruit trees	1992
9.	Mr. no. 6	Bachiang	700	Live stock, Fishery	1991
10.	Mr. no. 7	Bachiang	200	Upland crops, Forest development Fishery	1991
11.	Mr. no. 8	Bachiang	400	Live stock	1991
	SUBTOTAL		11,100		
12.	Asia Tech.	Pakxong	16,000	Forest development	1995
13.	Mr. no. 9	Pakxong	400	Live stock	1991
14.	Mr. no. 10	Pakxong	350	Live stock	1990
15.	Mr. no. 11	Pakxong	400	Live stock	1992
16.	Mr. no. 12	Pakxong	600	Live stock	1992
17.	Mr. no. 13	Pakxong	400	Live stock	1992
18.	Mr. no. 14	Pakxong	200	Live stock	1992
19.	Mr. no. 15	Pakxong	300	Live stock	1992
	SUBTOTAL		18,650		
	TOTAL		29,750		



No.	Company	Village	Location District	Area (Ha)	Land Use
1.	Mr. no. 1	Nong Poy	Pakxong	1,000	Live stock
2.	Mr. no. 3	Kong Toon	Pakxong	300	Live stock
3.	Mr. no. 4	Makchane	Pakxong	350	Live stock
4.	Mr. no. 6	Phou Kok	Pakxong	120	Live stock
5.	Mr. no. 7	Daseua	Pakxong	200	Live stock
6.	Mr. no. 8	Being	Pakxong	200	Live stock
7.	Mr. no. 9	Keing Do	Pakxong	800	Live stock
8.	Mr. no. 10	Meug Phay	Pakxong	300	Live stock
9.	Mr. no. 12	Being	Pakxong	300	Live stock
10.	Mr. no. 14	Champi	Pakxong	100	Live stock
11.	Mr. no. 15	Phoukok	Pakxong	600	Live stock
12.	Mr. no. 16	Thong ka Long	Pakxong	300	Live stock
13.	Mr. no. 17	Km 20	Pakxong	400	Live stock
14.	Mr. no. 18	Hinlab	Pakxong	300	Live stock
15.	Mr. no. 20	Thong Chat	Pakxong	400	Live stock
16.	Mr. no. 23	Makchan	Pakxong	200	Live stock
	TOTAL			5870	

Figure IV-3 Location of Application for Land Concessions

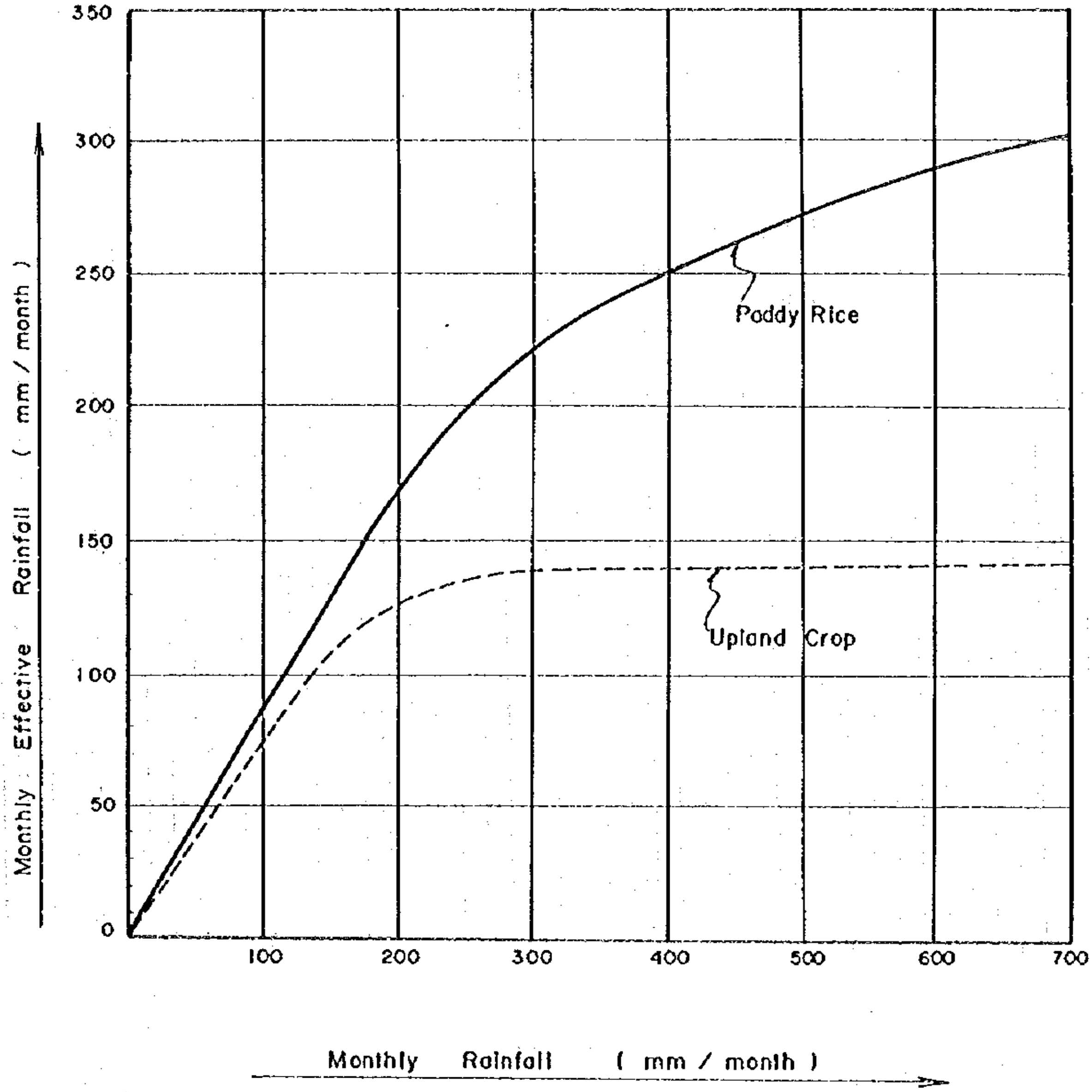


Figure IV-4 Monthly Effective Rainfall Curve

" Data Source : The Committee for Co-ordination of Investigation of the Lower Mekong Basin "

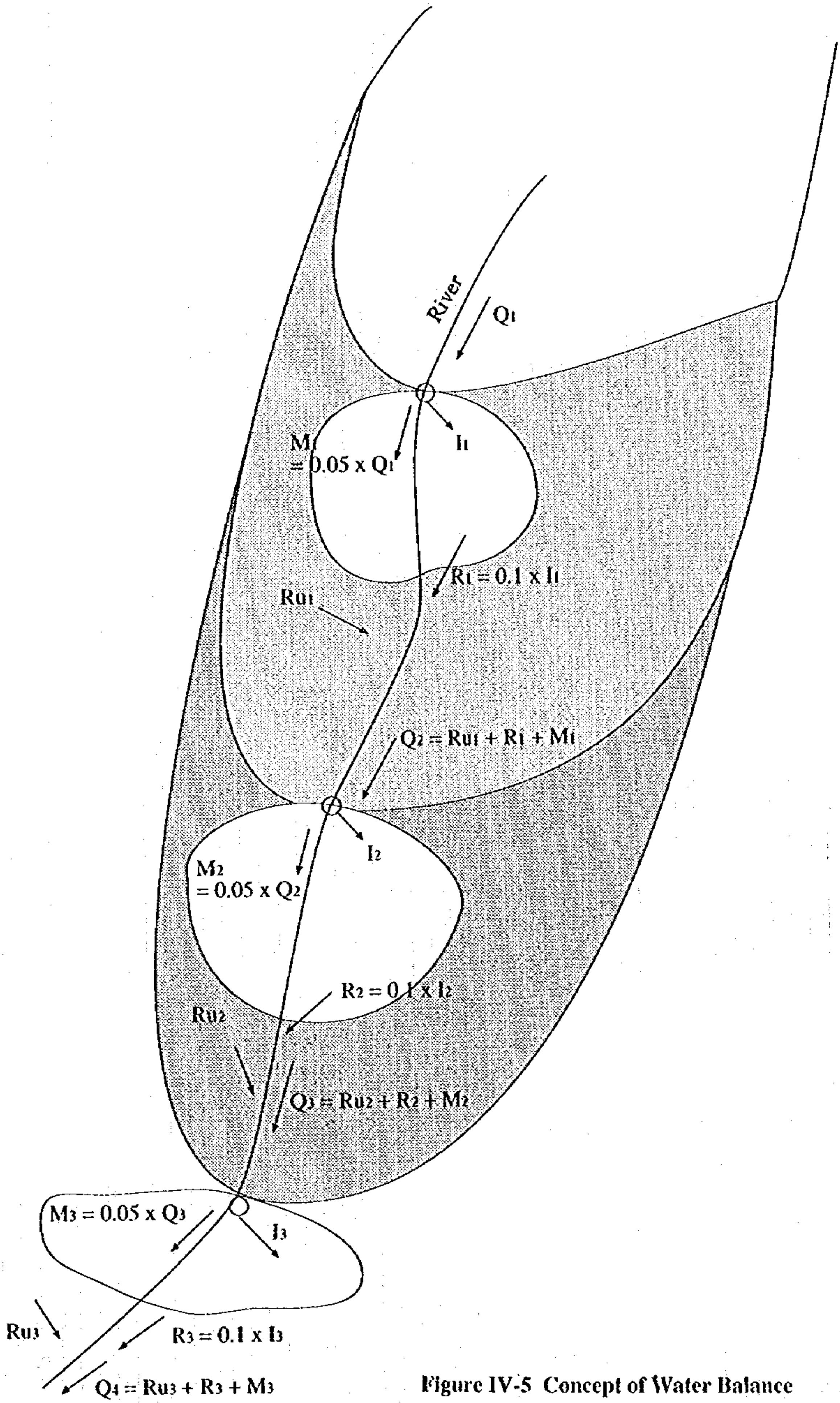


Figure IV-5 Concept of Water Balance

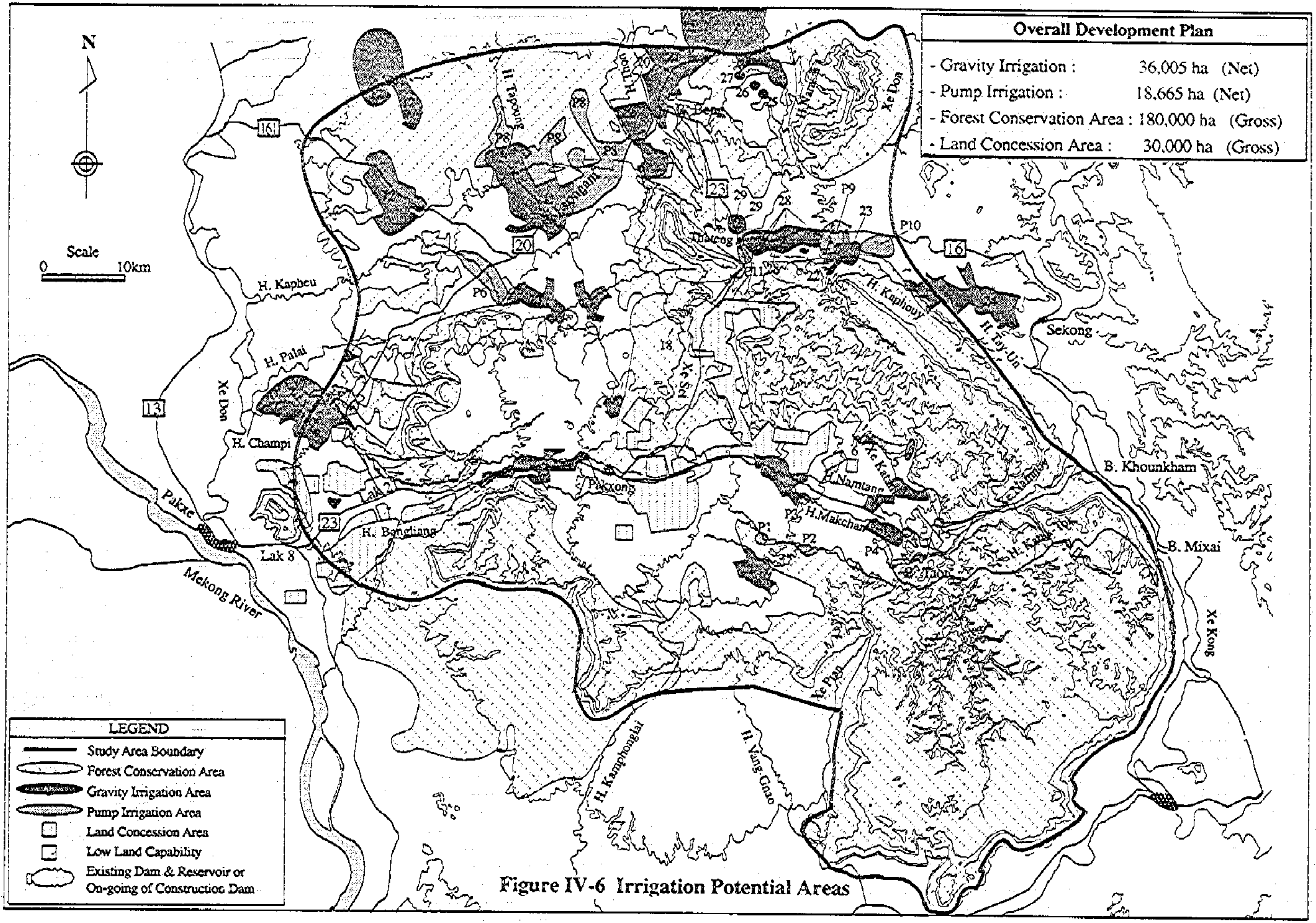


Figure IV-6 Irrigation Potential Areas

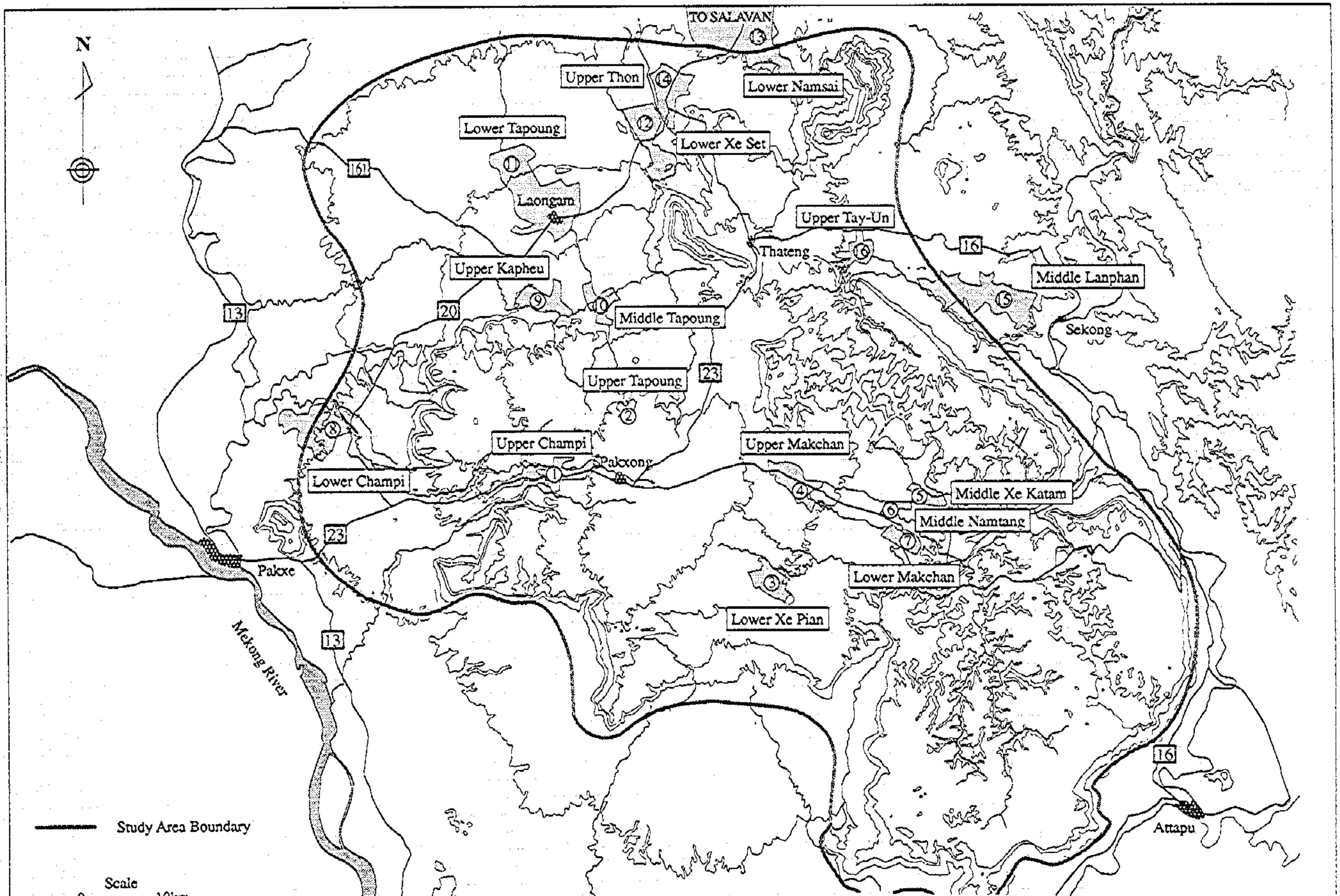


Figure IV-7 Selected Projects for the Integrated Agricultual and Rural Development

Figure IV-8 Implementation Program

No.	PROPOSED PROJECT	POTENTIAL IRRIGATION AREA (ha)	IMPLEMENTATION SCHEDULE (Year) Phase I 1	2	3	4	5	Phase II 6	7	8	9	10	Phase III 11	12	13	14	15
PHASE I																	
	UPPER CHAMPI	730	■	■													
	UPPER TAPOUNG	50	■														
	UPPER KAPHEU	1,000	■	■													
	LOWER XE SET	1,800			■	■											
	UPPER TAY-UN	330					■										
	SUBTOTAL	3,910															
PHASE II																	
	LOWER XE PIAN	750							■	■							
	MIDDLE TAPOUNG	450						■									
	LOWER TAPOUNG	4,500								■	■	■					
	UPPER THON	640						■									
	UPPER MAKCHAN	470							■								
	SUBTOTAL	6,810															
PHASE III																	
	MIDDLE XE KATAM	620											■				
	MIDDLE NAMTANG	265												■			
	LOWER MAKCHAN-GNAI	340													■		
	LOWER CHAMPI	2,600														■	■
	LOWER NAMSAI	3,840											■	■	■		
	MIDDLE LAMPHAN	2,900											■	■	■	■	
	SUBTOTAL	10,565															
	GRAND TOTAL	21,285															

FEASIBILITY STUDY

ANNEX-IV
IRRIGATION AND DRAINAGE

Table of Contents

Pages

List of Tables

List of Figures

FEASIBILITY STUDY

ANNEX IV
(IRRIGATION AND DRAINAGE)

1 PRESENT CONDITIONS

1.1 Existing Irrigation Areas in and around the Schemes

Small irrigation systems constructed and managed by farmers themselves were found out at 5 sites in and around the 3 Scheme areas, namely Upper Kapheu, Lower Xe Set and Upper Tay-Un. Water off-take systems for the irrigation areas are mainly small brush weirs which are made with stone, wood and bamboo. Irrigation water is conveyed through small earth canals by gravity method. Related structures are not constructed and diversion of water supply is carried out by timber stop logs. Irrigation water supply is carried out for rainy season paddy cultivation only. Drainage canal systems are not found out. The followings are the features of the existing irrigation systems:

No.	Location	Village	Water Source	Weir Type	Area (ha)	No. of Farmers
1.	Upper Kapheu	B.Sixiangmai	Kapheu River	Brush weir	4	6
2.	Lower Xe Set	B.Nateu	Thon River	Brush weir	7	5
3.	"	B.Natou	Xe Set River	Brush weir	7	13
4.	"	-	Spring	-	10	19
5.	Upper Tay-Un	B.Chakamrit	Thon River	Brush weir	13	6

1.2 Water Management of Existing Irrigation Areas

Operation and maintenance works of all existing irrigation systems are conducted by some farmer themselves as follows, but irrigation water user group are not established. Operation of irrigation water supply is carried out only in the rainy season and no irrigation practices is done in the dry season in all existing systems. Operation and maintenance works of canals are executed by farmers themselves.

2 DEVELOPMENT CONSTRAINTS

Development constraints in the 5 Scheme areas are generally pointed out (1) accessibility to intake sites due to deep valley of the rivers, (2) high dam-up of intake, (3) limitation of water resources in dry season due to small watershed management area, (4) soil erosion in the opened forest, bush and grassland which are left after slash and burn cultivation. Constraints to the each Scheme Development are summarized as follows;

2.1 Upper Champi Scheme

The H. Champi which is water resources of the Scheme has formulated a deep valley from up stream to down stream of the Scheme area, and both the banks of the river has a steep cliff. These deep valley gives severe conditions to make plans on intake structure and canal layout of head race section. As for the result that the intake structure is selected to provide in upstream in order to avoid higher dam-up at intake structure, water resources of irrigation in the dry season is limited due to the decrease of watershed management area. Soil erosion problems are generally found out in the entire Scheme area, and specially in the opened land such as tea and coffee plantation areas and grassland.

2.2 Upper Tapoung Scheme

Land capability of left bank of the H. Tapoung is evaluated to severe conditions for upland farm development, but the left bank has suitable conditions for development. Soil erosion problems are found out in the entire Scheme area, specially, in grassland and watershed management area of the proposed reservoir.

2.3 Upper Kapheu Scheme

The H. Kapheu flows in deep valley, and steep and long cliff is formulated. The accessibility to the proposed intake structure is much severe. Layout of headrace of irrigation canals has also severe conditions. Water resource for irrigation in the Scheme area is limited in the dry season due to small watershed management. Soil erosion problems are specially found out in the opened forest land.

2.4 Lower Xe Set Scheme

Water resources of irrigation is the Xe Set river, and the river water at intake structure is the water released from the hydropower station. The design flood discharge is estimated at about 1,000 m3/sec. at intake structure site, taking into account the design discharge of spillway of the Xe Set dam. The discharge of river water is not stable at intake structure in the dry season due to the peak operation system of hydropower station. Therefore, complicated water management will need for off-taking irrigation water in the dry season. Lower irrigation areas of the Scheme has severe conditions for paddy and upland field development due to low land capability evaluated from view points of the rockiness and gravel of the soils. Soil erosion problems are generally found out in the entire Scheme area, specially in bush area, grassland and the opened forest areas.

2.5 Upper Tay-Un Scheme

Water resources of irrigation are the H.Tay-Un river and the H. Thon river. Water resource of the H. Tay-Un is limited in the dry season due to absorption of irrigation water in upper stream areas. Soil erosion problems are specially found out in the bush and grassland.

3 DEVELOPMENT CONCEPT

3.1 Irrigation Development for High Land Vegetable Cultivation

High land vegetable cultivation is proposed in terrace with the altitude of more than 1,200 m instead of coffee plantation because of cool climate condition. In the Feasibility Study, vegetable cultivation is also proposed in the 2 scheme areas, namely Upper Champi and Upper Tapoung Schemes. Small and primitive vegetable practices are conducted in back yard of village areas and remote hill slopes currently, but the yield and production are unstable and low due to insufficient farm input, extension technology, climate condition, insect and decease, transportation and marketing, etc.. One of the most significant reasons on the unstable and low production is water shortage and water management.

To sustain stable and high yield and production of vegetable cultivation, simple and economic irrigation facilities are provided in vegetable cultivation areas. The simple and economic irrigation facilities are proposed as earth canal system, farm pond, small related structures and drainage canal system only in order to conduct irrigation at vegetable farms by furrow irrigation method. Modernized irrigation facilities such as sprinkler and pipe line system, drip irrigation system are not proposed because expensive initial investment, expensive maintenance and complicated management will nor be expected in this development stage.

However, farm roads which have another functions such as inspection road for tertiary canal and drain, farm bund for soil conservation are also provided as well as irrigation and drainage development facilities.

In agricultural extension development program, the high land vegetable demonstration and trial station is proposed to construction the Upper Champi Scheme area. As the station has demonstration vegetable farms of more than 30 ha, irrigation and drainage canals and related facilities are provided as one irrigation block of the Upper Champi irrigation scheme.

3.2 Supplemental Irrigation for Rainy Season Paddy

Supplementary irrigation in rainy season aims to sustain the stable growth of rainy season paddy, if existing paddy field and / or potentials of paddy field development are confirmed in and around the Scheme area. In the Feasibility Study, this concept can be adopted in the two (2) Schemes, namely Lower Xe Set and Upper Tay-Un Schemes.

Surplus water discharge of the Xe Set river in rainy season which is deducted the maintenance flow to down stream areas and irrigation water for the Xe Set Scheme from river discharge at just before intake structure can be conveyed to paddy fields of the neighboring scheme as irrigation water of paddy field. Because irrigation potentials in the Xe Set Scheme can not expanded, since the Scheme area is scheduled to develop fully based on land suitability. In this case, the supplemental irrigation can be carried out, using the water resource of the Scheme, but the beneficial paddy fields are in the other Scheme area. In the Upper Tay-Un Scheme, surplus discharge of both water resources, namely the H. Tay-Un and the H. Thon can be used as irrigation water for rainy season paddy cultivation in the Scheme area.

3.3 Irrigation for Coffee

Irrigation method and / or system for coffee plantation have not been established in the Boloven Plateau area as well the Laos country area. In an implementation program of the Boloven coffee project which is technical assistance project undertaken by French Government, research works of irrigation practices is scheduled in future stage because of lack of water resources development facilities. A present, agronomic research and extension works are implemented.

Current coffee plantation has met water shortage problem during flowering to fruiting stages of coffee in the dry season, specially, in the lower altitude areas of less than 700 m above mean sea level. Due to this water shortage problem, production of coffee is always unstable and furthermore, is affected by the starting of rainy season.

On the other hand, labors for unloading and drying works of coffee fruits are family labors and seasonal labors. Seasonal labors are currently procured from low land area after harvesting rainy season paddy in the area. In the full development stage of coffee plantation through the implementation of the Scheme and the Boloven coffee project, severe problems of labor procurement will be focused.

Taking into consideration these subjects, irrigation for coffee aims to control flowering to fruiting stage of coffee trees for 3 months and to sustain stable coffee production. Controlling the flowering stage can indirectly effect to control peak labor requirement during harvest season and to give more reasonable business opportunity to coffee grower.

3.4 Inland Fishery Development by Construction of Irrigation Facilities

Daily markets are not located in a walking distance in the each the Scheme, and village peoples' protein consumption is generally low because of physical problems of marketing system and transportation and market prices. Their main protein resources are chicken, fishes and wild animals.

On the other hand, in irrigation development plan, the impounding pond facilities such as reservoir and regulation / farm ponds are planed to construct in the each scheme area. Therefore, development component on simple inland fishery is involved to improve the village peoples' food conditions.

4 DEVELOPMENT PLAN

4.1 Off-taking Method and Intake Structures

Intake sites of the Upper Champi and Lower Xe Set Schemes are generally formulated by deep valley and steep cliff, and rather high dam-up of intake structure need to take off irrigation water and domestic supply water. But, gravity off-taking method is adopted, because application of pump up method is questionable for future water management and maintenance works, taking into consideration current farmers' farming practice and agricultural supporting services, etc. as description of off-taking method in the Part I, Master plan. Type of intake structure at both the Schemes is a concrete weir with a intake gate.

The off-taking method at the other 3 Schemes is also gravity method. Type of intake structure is a concrete weir for the Upper Kapheu and Upper Tapoung Schemes and an homogeneous earthfill dam and a concrete weir for Upper Tay-Un Scheme.

4.2 Irrigation Water Requirement

Based on rainfall date for 10 years from 1986 to 1995 and the proposed cropping patterns, irrigation water requirement is estimated by using the following formula.

$$IWR = (ETc + Pr + Pd + Nr - ER) / Ei$$

where :			
	IWR	:	gross irrigation water requirement
	WR	:	net water requirement
	Ei	:	overall irrigation efficiency
	ETc	:	crop consumptive use of water
	Pr	:	percolation for paddy
	Pd	:	puddling requirement for paddy
	Nr	:	nursery requirement for paddy
	ER	:	effective rainfall

Basic data for this calculation such as potential evapo-transpiration (ETo), crop coefficient (Kc), effective rainfall (ER), percolation (Pr), puddling requirement (Pd), nursery requirement (Nr) and overall irrigation efficiency (Ei) are used the same figures presented in the Part I, the Master Plan Study. Detailed estimation on irrigation requirement of the each Scheme are shown in Tables IV.1 to IV.5 . Seasonal irrigation requirement of the each cropping pattern is estimated as shown below, adopting rainfall data for there 10 years.

Scheme	Prposed Cropping Pattern	Seasonal Irrigation Requirement (mm)
Upper Champi	Type-C (Veg.-Upland Crop) Coffee	305 - 729 79 - 160
Upper Tapoung	Type-C (Veg.- Upland Crop)	305 - 729
Upper kapheu	Type-B 1 (Upland Crop-Paddy) Coffee	911 - 1,360 123 - 205
Lower Xe Set	Type-A (Paddy-Paddy) Type-B 2 (Upland Crop-Paddy)	1,627 - 2,299 1,170 - 1,649
Upper Tay-Un	Type-A (Paddy-Paddy) Type-B 2 (Upland Crop - Paddy)	1,222 - 2,291 778 - 1,707

4.3 Irrigation Areas and Irrigation Methods

In accordance with test result on field intake rate, the basic intake rate in the 5 Scheme areas is estimated about 25 mm / hr. at the maximum level. In evaluation of land capability, the maximum topographical slopes in suitable to moderately suitable land for development is adopted about 4 %, and the majority of irrigation areas of the all Schemes has been screened as the land with slopes of less than 4 %. Therefore, any irrigation method for upland crops can be adopted in all the Schemes from view points of the soils and topography.

The following three (3) methods are adopted for irrigation of each crop.

(i) Furrow irrigation method for upland crops including vegetables,
(ii) Border irrigation method for coffee and
(iii) Surface irrigation method for paddy.

4.4 Small Impounding Water Management

To aim the optimized use of water resources in the rainy season and to expand irrigation areas as much as possible based on the land suitability in the each Scheme area, small impounding ponds are provided, taking into consideration topographical conditions and location of irrigation areas.

Except for the Lower Xe Set Scheme, eight (8) small impounding ponds are provided to construct small scale earthfill dams with dam height ranging from 8 m to 20 m in the four (4) Scheme areas such as one (1) site in the Upper Champi Scheme, one (1) site in the Upper Tapoung Scheme, four (4) sites in the Upper Kapheu Scheme and two (2) sites in the Upper Tay-Un Scheme.

Water management of all impounding ponds are to operate through all the seasons, and to storage river water in the rainy season as much as possible for irrigation use in the dry season. Reservoir storage curve of the each scheme is shown in Figures IV.1 to IV.4.

Storage capacity of reservoirs is determined to supply water in all irrigation areas during a drought year of 80 % chance base on water balance calculation, and the following storage capacities of respective reservoirs are provided.

Scheme	Dam & Reservoir	Active Capacity (1,000 m3)
1 Upper Champi	Champi Dam	105
2 Upper Tapoung	Tapoung Reservoir	240
3 Upper Kaphue	Dam No.1	140
4	Dam No.2	57
5	Dam No.3	58
6	Dam No.4	140
	Subtotal	395
7 Upper Tay-Un	Dam No.2	135
8	Regulation Pond	65
	Subtotal	200

4.5 Water Balance and Irrigation Potential

Water resources for the development are estimated based on monthly water balance calculation between river runoff at the proposed dam site, water demand consisting of irrigation water, domestic water supply, water loss in the reservoir and maintenance river flow for ten (10) years, from 1986 to 1995.

Concept of water balance is presented in the following formula.

$$(R - (L1 + L2 + M + D)) = C + SP$$

Where,

R :	Seasonal runoff	L1 :	Evaporation loss
L2 :	Seepage loss	M :	Maintenance flow
SP :	Spill out discharge	C :	Reservoir capacity
D :	Irrigation demand and domestic water supply		

Evaporation and seepage losses from reservoir are assumed at 7 mm/day. The maintenance flow released from a dam are estimated as 5 % of the total flow, taking into consideration the current social condition and water use in the down stream areas. As for the Lower Xe Set Scheme area, water balance at intake site is included the current irrigation demand of the two (2) existing irrigation projects, namely, Nong Deng and Soutava Di projects, located downstream of the Lower Xe Set Scheme area.

Water resources for irrigation in the each the Scheme is estimated to sustain full water supply during drought year of 80 % chance, based on the proposed cropping patterns, and, irrigation areas of all the schemes are determined taking into consideration the land suitability and results of water balance in the each scheme as shown below. The detailed is shown in Tables IV.6 to IV.10.

No.	PROPOSED SCHEME	WATER RESOURCES	PROPOSED CROPS / CROPPING PATTERN (Master Plan)	IRRIGATION AREA (ha) for Feasibility Study NET
1	UPPER CHAMPI	H. CHAMPI	Coffee	620
			Type-C	110
	SUBTOTAL			730
2	UPPER TAPOUNG	H. TAPOUNG	Type-C	80
				80
3	UPPER KAPHEU	H. KAPHEU	Coffee	900
			Type-B 1	100
	SUBTOTAL			1,000
4	LOWER XE SET	XE SET	Type-A	200
			Type-B 1	800
	SUBTOTAL			1,000
5	UPPER TAY-UN	H. TAY-UN / H. THON	Type-A	70
			Type-B 1	80
			Type-A1 (fallow-paddy)	180
	SUBTOTAL			330
	TOTAL			3,140

4.6 Irrigation Canal Layout

Irrigation canal networks generally consists of head race, main canal, secondary canal and tertiary canal. Concrete block lining is provide from head race to secondary canals. Head race and main canal are basically laid out vertical direction against to contour lines. Secondary canals are laid out to branch off from main canal with a interval of about 500 m, and to follow the contour lines. Tertiary irrigation block is roughly demarcated about 30 ha.

Basic concept of canal layout on the each scheme is considered as follows;

(1) Upper Champi Scheme

Irrigation area is expanded from km 47 to km 35 of the national road No. 23 , and the irrigation blocks of about 610 ha and 120 ha are respectively located in the northern area and southern area from the road. Irrigation water is conveyed to settling basin, and distributed through 2 main canal systems.

A main canal system is laid out to supply water in the upper irrigation area of the northern irrigation block including the high land vegetable demonstration and trial station. The other main canal system is expanded in the both irrigation blocks, coinciding a small scale impounding pond which are located in just down stream from vegetable farm blocks. A secondary canal, namely SI-2 is branched off near km 43 to supply water in the southern irrigation block , going across the national road No.23, and the other secondary canal, namely SI-3 extends to km 35 of the national road No.23. General canal layout is shown in Figure IV.5.

(2) Upper Tapoung Scheme

Main canal is laid out on the left bank of the H.Tapoung river along the river course. Main canal goes across a provincial road about 300 m far from the intake structure site. A level crossing structure is provided at crossing point with a small tributary of the river. General canal layout is shown in Figure IV.6.

(3) Upper Kapheu Scheme

Irrigation area is broadly divided into 2 irrigation blocks by a provincial road, and expands along the road from Sixiagmai village area to On-gnai village area. Main canals of 2 systems are laid out in the irrigation area. A main canal system is branched off near Sixiagmai village area and goes across the provincial road to supply water in the southern area from the road. This main canal system has four (4) small scale impounding ponds to optimize irrigation water use, and conveys irrigation water to down stream area and is laid out to supply irrigation water in the down stream area of both the blocks, going across the provincial road near On-noi village again. The other main canal system extends substantially to supply water in the northern irrigation block nearby On-gnai village. General canal layout is shown in Figure IV. 7.

(4) Lower Xe Set Scheme

Main canals of four (4) systems are laid out to cover the eastern and northern areas of the Scheme. A main canal system extends nearby Natteu village of the eastern area from just the down stream of a regulation pond, and the other main canals of 3 systems extend to go across a national road No. 20 to supply irrigation water in the northern area to supply irrigation water nearby Sengvang-noi village at the eastern boundary of the Scheme and Natou village at the western boundary of the Scheme. General canal layout is shown in Figure IV.8.

(5) Upper Tay-Un Scheme

Main canals are broadly divided into 3 system due to the 2 water resources of the Scheme, namely, the H. Tay-Un and the H. Thong. A main canal system which the water resources is the H. Tay-Un supplies irrigation water in the upper irrigation area of the Scheme and conveys water to a regulation pond. The second main canal system which the water resources is the H. Thong convey water to irrigate in the upper irrigation area expanding nearby the conjunction of the both the main systems. The third main canal system is laid out to carry out irrigation in the lower irrigation area from the conjunction of both the first and second main canal systems. General canal layout is shown in Figure IV.9.

4.7 Canal Lining

According to results of soil investigation, soils in the majority areas of all schemes are dystric nitosols soils group which origin of soil is basaltic rock. It' characteristics is so pouras and erosive against to rainfall. Therefore, in the design on canal system, thin concrete block lining which the material will be consisting of basaltic gravel, sand and cement is adopted to save seepage loss of irrigation water, to increase the irrigation efficiency and to make easy maintenance works by farmers, themselves. The canal lining is adopted to provide in main and secondary canals.

Type of concrete block is pre cast concrete blocks which is made near the construction sites, and thickness of concrete blocks is 7 cm. Total length of concrete lining is about 75 km including tertiary canal lining of about 20 km , and concrete canal lining is planed in the each Scheme as shown below.

No.	Scheme	canal Length (km)
1	UPPER CHAMPI	
	Main Canal	4.7
	Secondary canal	13.0
	SUBTOTAL	17.7
2	UPPER TAPOUNG	
	Main Canal	1.6
	Secondary canal	0.8
	SUBTOTAL	2.4
3	UPPER KAPHEU	
	Main Canal	2.2
	Secondary canal	11.8
	SUBTOTAL	14.0
4	LOWER XE SET	
	Main Canal	3.6
	Secondary canal	11.0
	SUBTOTAL	14.6
5	UPPER TAY-UN	
	Main Canal	2.5
	Secondary canal	2.3
	SUBTOTAL	4.8
	TOTAL	53.5

4.8 Operation and Maintenance Plan

Operation and maintenance plan of irrigation facilities are considered at following 4 points;

(i) Construction and provision of O & M facilities
(ii) Establishment of O & M organization
(iii) Irrigation operation
(iv) Maintenance schedule

4.8.1 Construction and Provision of O & M Facilities

(1) Provision of discharge measurement structures for water operation

Discharge measurement of irrigation water need to carry out sufficient and successful water operation in the entire irrigation areas. Since irrigation water is taken off at intake structure and distributed to lower grade canals such as secondary and tertiary canals by turn out and / or division box, the measuring structures are provided at downstream from the each intake gates, turn out and division box. The measurement also need at just down stream from farm pond which is constructed at head section of secondary canal in order to carry out timely and sufficient irrigation in upland crop fields. Type of measuring structure is designed as a broad crested weir for main canal system and to provide a gauging staff for tertiary canal system.

(2) O & M facilities

For irrigation operation and maintenance works of irrigation facilities, the following facilities shall be provided.

(i) Radio system for irrigation operation
(ii) Vehicle and motor cycle for transportation, operation, monitoring and maintenance works
(iii) Maintenance equipment of irrigation facilities which will be sustained by the

Government agencies
(iv) O & M work office and gate keeper houses

4.8.2 O & M Organization

Establishment of water users' association and village water users' group needs to carry out successful O & M works. The water users' association and village water users' group shall be collaborated with village agriculture association and supported by other government agencies such as district agriculture services, provincial agriculture authority and Ministry of Agriculture and Forestry, and conduct the following 4 main activities and functions as much as possible.

(i) Maintenance works
(ii) Establishment of irrigation schedule
(iii) Monitoring work
(iv) Collection of water charge

(1) Maintenance works

Maintenance works of the facilities is broadly divided into 2 groups depending to a scale of budget and engineering / technical aspects. The responsibility of maintenance works are undertaken that maintenance on main canal system which covers from a diversion structure at water resources to secondary canal is carried out by the government agencies such as provincial agriculture authority and Ministry of Agriculture and Forestry, and that those of tertiary canal system is carried out by the water users' association and village water users' group.

Maintenance works are scheduled to carry out as periodical and emergency maintenance works because all the scheme have diversion weirs, small scale impounding ponds and farm ponds.

(2) Establishment of irrigation schedule

Based on agricultural extension program on cropping patterns, the water users' association and village water users' group confirm their own operation of irrigation water supply and establish the irrigation schedule in the entire irrigation area.

(3) Monitoring works

Monitoring system and schedule are established in periodical and emergency cases under smooth cooperation with the government agencies such as provincial agriculture authority and Ministry of Agriculture and Forestry. The filing system on monitored data and information are planed to use for the preparation of maintenance schedule.

(4) Collection of water charge

The optimized water charge are planed to collect from all beneficiaries by the water users' association to provide the budget for maintenance works.

4.8.3 Irrigation Operation

Irrigation operation is generally effected by the proposed cops such as coffee, upland crops including vegetables and paddy. Irrigation hours is scheduled to conduct 24 hours for paddy, 12 hours for upland crops and coffee. The irrigation hours of upland crops and coffee is estimated at the peak irrigation requirement period. A farm pond is provided at head section of secondary canal in order to control water supply in the command area. Therefore, gate operation of farm pond shall be periodically reviewed during cultivation period.

Furthermore, irrigation of coffee aims to control the flowering to fruiting stage of coffee and indirectly to control labor requirement in the harvest period. To reach these goals, rotation of irrigation is scheduled for about 3 months from the end of December to the beginning of January. Therefore, gate operation of turn out of main canals is also specially reviewed during these 3 months to fit rotation schedule.

4.8.4 Maintenance Schedule

Maintenance work of the facilities are divided into periodical and emergency maintenance works. Both the maintenance works are considered in the plan. Main maintenance works are repairing works of gates at diversion weir, disposal of sediment in settling basin, cleaning works of earthfill dam and impounding pond, cleaning works of farm pond and cleaning of lining canal section. Maintenance method and schedule shall be timely established in the future stage, based on the collected information and data through monitoring works in collaboration with the government agencies.

4.9 Drainage Requirement

Drainage requirement for the priority development schemes are estimated by using rainfall data for ten (10) years from 1986 to 1995. Estimation methodology of the drainage water requirement for the selected priority area is divided into two, paddy and upland fields. For the paddy field, such requirement is estimated to evacuate the surplus rain water with the drainage period of 3 days by using the probable daily rainfall which has a probability of once in a 5-years. Besides, rational formula is applied for the upland field to estimate the drainage water requirement with a probability of once in a 5-years. The runoff coefficient is assumed at 0.5, taking into consideration the proposed crops, crop farming system and soil conservation plan at on-farm. Drainage period of four (4) hours for vegetables and one (1) day for other upland crops are considered. Estimated results are as follows;

Priority Project Area	Probable Daily Rainfall (mm/day)	Paddy Field	Upland Field	
		q (lit./sec/ha)	r_t (mm/hr)	q (lit./sec/ha)
Upper Champi	272.1	10.5	27.8	38.6
Upper Tapoung	272.1	10.5	27.8	38.6
Upper Kapheu	186.0	7.2	7.8	10.8
Lower Xe Set	186.0	7.2	7.8	10.8
Upper Tay-Un	86.0	3.3	3.6	5.0

4.10 Soil Conservation Plan

Soil conservation plan is proposed from view points of farming technology and civil engineering. In this canal layout, since surface drainage on farm level is designed to sustain the farm ditch in horizontal direction, soil conservation method such as mulch-cultivation , shade tree, etc. will be planed. As for soil conservation method from view point of civil engineering aspect, 2 method such as (i) farm bund and (ii) boulder drop structure are planed.

Farm bund is designed to lay out with horizontal direction to topographic contour line to make a natural gentle terrace for a long term. Farm bund is planed as an alley cultivation and is earth embankment with a gravel filter section at crossing point with a tertiary drain. A width of farm bund is 2 m. The other dimension are as follows;

RANGE OF GROUND SLOPE (%)	INTERVAL OF FARM BUND (m)	HEIGHT OF FARM BUND (m)
Less than 5 %	100	1
5%-8%	50	1

Furthermore, other small farm bund, namely, on-farm bund is also provided as temporary farm bund from view point of farming technology.

Boulder drop structure is planed to provide in main drains which have a vertical direction against topographic contour lines to sustain the allowable maximum velocity of drainage canal. Material of the structure is mainly boulders which can be collected near the sites.

4.11 Drainage Canal Layout

Drainage canal system is consisting of main, secondary and tertiary drains. Main drains are laid out in river courses and / or existing drains as much as possible. If drainage length is laid out so rather long, main drain is connected with rivers and / or other drainage system in order to distribute big drainage discharge and to protect soil erosion along the drain. A tertiary drain is provided in the each tertiary irrigation block. Tertiary drain is basically laid out to follow topographical contour line. Total length of secondary drains to be constructed is about 12 km, and the detailed of the each scheme is as shown below. General layout of main drains in the each scheme are shown in Figures IV.5 to IV.9.

No.	PROPOSED SCHEME	LENGTH (m)
1	UPPER CHAMPI	
	Secondary drain	3.0
2	UPPER TAPOUNG	
	Secondary drain	0.2
3	UPPER KAPHEU	
	Secondary drain	1.1
4	LOWER XE SET	
	Secondary drain	7.6
5	UPPER TAY-UN	
	Secondary drain	0.1
	TOTAL	12.0

4.12 Salient Features of Irrigation and Drainage Development Plans

The salient features of the each scheme are shown in Tables IV.11 to IV.12. The basic features of the schemes are presented below.

4.12.1 Upper Champi Scheme

Irrigation water is off-taken by concrete diversion weir proposed at upper stream of the Champi river which is adjacent to the post km 47 along the national road No.20 from Pakxe to Pakxong and supplied to the left bank area of the Champi. Diversion weir has a height of 9.5 m and a width of 43 m. The irrigation area is 730 ha, and the crops to be irrigated are vegetables, upland crops and coffee.

Irrigation canal networks consist of 2 main canals of about 5 km, 3 secondary canals of approximately 13 km, tertiary canals, an impounding pond with an active storage capacity of about 105,000 m^3, farm ponds and related structures. Canal lining of about 23 km is planed in main irrigation canals networks to increase the irrigation efficiency. Drain networks consisting of 8 secondary drains of about 3 km and related structures, and inspection and farm roads networks of about 22 km paved with gravel are planed. General layout is shown in

Figure IV.5.

In line with agriculture extension development program, highland vegetable trial and demonstration station is planed to be constructed in the area. The station area is about 50 ha including office buildings, accommodation, trial and demonstration farms, etc..

4.12.2 Upper Tapoung Scheme

Irrigation water is off-taken at the outlet of existing pond of the Tapoung river located near B.Xetapung village by concrete diversion weir with a height of 7.5 m and a width of 38 m. Irrigation area is upland field of 80 ha which is expanded at left bank of the river. Main crops are vegetables and upland crops. Storage capacity of existing pond is increased by about 240,000 m^3. New inland fish cultivation is planed in the newly developed reservoir. In canal and drain networks, one (1) main and one (1) secondary irrigation canal are planed to layout about 2.5 km in total length, and one (1) secondary drain is laid out with a total length of approximately 200 m. Canal lining is also planed to provide about 3 km in main to tertiary canals. Inspection and farm roads are planed about 5 km with gravel pavement. General layout is shown in Figure IV.6.

4.12.3 Upper Kapheu Scheme

Water resource for irrigation development is the Kapheu river, and concrete diversion weir is planed to construct at about 1.5 km upstream from B.Sixiangmai. Height of weir is 3.5 m and a width is 14 m. Irrigation water is conveyed to an area of 1,000 ha by main and secondary canal networks of about 14 km. Main canal networks consist of 2 main canals, 3 secondary canals and tertiary canals, 4 impounding ponds with total effective capacities of about 395,000 m^3 and related structures. Canal lining is planed to provide about 21 km in main and secondary canal networks. Main crops to be irrigated are coffee, upland crops and wet season paddy. Main and secondary drains networks compose of 6 secondary drain of about 1.1 km in length. Farm road networks including inspection road of canals are laid out about 16 km with gravel pavement. General layout is shown in Figure IV.7.

4.12.4 Lower Xe Set Scheme

Irrigation water is off-taken about 2 km downstream from Xe Set power station by concrete diversion weir with a height of 11.5 m and a width of 75 m and regulated by storing water in pond which is laid out at just downstream from the diversion weir in order to deal with the released discharge from the Xe Set hydro-power station. Irrigation area is 1,000 ha, and main crops are paddy and upland crops. Main canal networks consist of 3 main canals and 5 secondary canals, farm ponds and related structures. The length of main canal networks is about 15 km. Main drain networks of about 8 km consist of 4 secondary drains and related structures. Road networks including inspection road are planed about 26 km with gravel pavement. General layout is shown in Figure IV.8.

4.12.5 Upper Tay-Un Scheme

Water resources for irrigation development is 2 rivers, namely, the Tay-Un river and the Thon river, and small impounding ponds are planed to construct at each the river basin. Irrigation water is conveyed to the irrigation area of approximately 330 ha by main canal networks of about 5 km in a total length. A regulation pond is planed to construct along main canal stretched from the H. Tay-Un river. An effective storage capacity of the regulation pond is about 65,000 m^3. Irrigation areas are 330 ha of paddy in wet season and about 190 ha of upland crops in the dry season. Main drain networks is planed to layout about 100 m in a total length, and farm road networks of about 5 km including inspection roads are planed with a gravel pavement. General layout is shown in Figure IV.9.

5 DESIGN

5.1 Design Standard

Design standards on earthfill dam, impounding pond, diversion weir and irrigation and drainage canals and related structure are adopted based on the standards issued by the Ministry of Agriculture, Forestry and Fishery, Japan.

5.2 Design Concept

Irrigation and drainage facilities are designed based on the following concept, taking into consideration present natural, social and environmental conditions of the respective schemes.

(1) Irrigation and drainage facilities for easy O & M works

Except for diversion weir and earthfill, irrigation and drainage facilities are designed to aim at easy O & M works. For easy maintenance works, irrigation canal and farm pond are designed to be lined by pre-cast concrete blocks to sustain easy production of concrete blocks and easy maintenance of canal section by water users' group in future maintenance stage. For more easy operation, simple facilities such as broad crest weir of discharge measuring structures and vertical type of intake tower with sluice gates for impounding pond are designed. Water level of farm pond is also designed to control by using side spillway.

(2) Irrigation and drainage facilities taking into account soil conservation

For soil conservation, the facilities to protect soil erosion in farm plot and along drainage canal are designed. The facilities are designed to be low cost, easy maintenance and no technology for maintenance. The facilities are farm bund combined with an alley cultivation and boulder drop structure.

5.3 Irrigation and Drainage Flow Chart

Chart flow of irrigation and drainage canals are shown in Figures IV.10 to IV. 19. Design discharges of canal and drain are multiplied irrigation area by the peak irrigation requirement of the each crop in the each scheme.

5.4 Design Discharge

(1) Design Discharge of Irrigation Canals

Irrigation water supply is scheduled to be 24 hour - supply for paddy field and 12 hour-supply during the peak requirement for upland crops, vegetables and orchards. Irrigation discharge of the each canal is multiplied irrigation area by the peak irrigation requirement of paddy, upland crops and coffee. Design discharge is determined to take into consideration the peak water requirement for each crop and rotation of water supply. Design discharge of main, secondary and irrigation canals are estimated in the each scheme area as shown below.

(i) Upper Champi Scheme
Main and Secondary Irrigation Canal — Q=0.004 m^3/s to 0.153 m^3/s
Tertiary Irrigation Canal — Q=0.003 m^3/s to 0.043 m^3/s

(ii) Upper Tapoung Scheme
Main and Secondary Irrigation Canal — Q=0.009 m^3/s to 0.035 m^3/s

	Tertiary Irrigation Canal	Q=0.018 m^3/s to 0.038 m^3/s
(iii)	Upper Kapheu Scheme	
	Main and Secondary Irrigation Canal	Q=0.004 m^3/s to 0.275 m^3/s
	Tertiary Irrigation Canal	Q=0.006 m^3/s to 0.038 m^3/s
(iv)	Lower Xe Set Scheme	
	Main and Secondary Irrigation Canal	Q=0.032 m^3/s to 3.300 m^3/s
	Tertiary Irrigation Canal	Q=0.018 m^3/s to 0.219 m^3/s
(v)	Upper Tay-Un Scheme	
	Main and Secondary Irrigation Canal	Q=0.036 m^3/s to 0.489 m^3/s
	Tertiary Irrigation Canal	Q=0.006 m^3/s to 0.181 m^3/s

(2) Flood Design Discharge of Diversion Weir and Dam

Design flood discharge are basically provable flood discharge with a return period of 5-year for diversion weir and that of 30-year for dam spillway. However, design flood discharge of Tay-Un dam No.2 is determined as provable flood discharge of 100 - year taking into consideration village areas, namely B. Chakamlit and profitable agriculture land. The design flood discharges of each diversion weir and dam spillway are determined as follows.

(i) Upper Champi

Intake weir Q=102.2 m^3/s
Dam No.1 Q=19.6 m^3/s

(ii) Upper Tapoung

Intake weir Q=33.6 m^3/s

(iii) Upper Kapheu

Intake weir Q=122.0 m^3/s
Dam No.1 Q=1.3 m^3/s
Dam No.2 Q=5.1 m^3/s
Dam No.3 Q=5.6 m^3/s
Dam No.4 Q=3.4 m^3/s

(iv) Lower Xe Set

Intake weir Q=1042.0 m^3/s

(v) Upper Tay-Un

Dam No.1 Q=138.0 m^3/s
Dam No.2 Q=61.1 m^3/s
Dam No.3 Q=1.6 m^3/s

(3) Design Discharge of drains

Design discharges of drain in the each scheme is estimated as follows.

(i) Upper Champi

Secondary Drains Q=0.121 m^3/s to 1.136 m^3/s

Tertiary Drains Q=0.027 m^3/s to 1.011 m^3/s

(ii) Upper Tapoung

Secondary Drains Q=1.865 m^3/s
Tertiary Drains Q=0.320 m^3/s to 1.636 m^3/s

(iii) Upper Kapheu

Secondary Drains Q=0.135 m^3/s to 0.616 m^3/s
Tertiary Drains Q=0.022 m^3/s to 0.878 m^3/s

(iv) Lower Xe Set

Secondary Drains Q=0.225 m^3/s to 1.876 m^3/s
Tertiary Drains Q=0.073 m^3/s to 0.933 m^3/s

(v) Upper Tay-Un

Secondary Drains Q=0.067 m^3/s
Tertiary Drains Q=0.005 m^3/s to 0.198 m^3/s

5.5 Design of Canals, Drains and Roads

Irrigation canal has a trapezoidal section, and inside slope of canal is 1 : 1.5. Canal lining is expanded from main and secondary canals by concrete block. Type of concrete block is pre cast concrete blocks which is made near the construction sites, and 3 types of concrete blocks such as type-1, 100 (L) x 300 (W) x 7 (t) cm, type-2, 100 (L) x 200 (W) x 7 (t) cm and type-3, foot type are designed. Thickness of concrete blocks is 7 cm. Weephole is designed to provide in excavation section of canals.

Maximum velocity on canal is determined 0.9 m / sec. for concrete lining and 0.6 m / sec. for earth canal taking into consideration stable hydraulic flow and prevent soil erosion. Minimum velocity of canal is determined 0.45 m / sec. to prevent aquatic plants' growth and siltation.

Drainage canal s earth canal with trapezoidal section, and inside slope is designed to be 1 : 1.5. Maximum velocity of drain is deigned 0.9 m sec. during peak discharge to prevent soil erosion.

Roughness coefficient (n) of canals are determined as follow.

Concrete lining n = 0.015
Earth canal n = 0.03

Free board of canal (F) is determined by the following formula.

$F>0.05 \times h+(V^2/(2 \times g))+0.1$

Inspection roads with a gravel pavement are laid out along canals and drains. Inspection road are broadly divided into two (2) types, namely, Type A and Type B. Type A is provided along main and secondary canals . Total and effective widths of Type A road are respectively 5 m and 3 m. Those of Type B are 3.5 m and 2.5 m respectively. The pavement is 15 cm in thickness. Farm road is designed to link these inspection road in order to intensify the effective function of canal inspection and regional transportation. Outside slope of road is 1 : 1.5 and shoulder portion and outside slope of the road is designed to cover by sod facing.

Typical sections of canal, drain and road are shown in Figure IV.20.

5.6 Design of Major Structures

(1) Dam

Earthfill dam is homogeneous type , and riprap of 1 m in thickness is provided at surface of upstream slope. Dam which dam height is more than 10 m is designed to provide toe drain consisting of stone and sand filter. slopes of upper and down stream sides are basically determined to divided into 2 cases. In case of dam which dam height is less than 10 m, both the slopes are 1 : 2.5, and in case of dam height is more than 10 m, slope of upper stream side is 1 : 3.0 and the slope of down stream side is 1 : 2.5.

Flood discharge is designed to spill out through intake tower of duck bill type and flood way. As for dam No. 1 & dam No.2 in the Upper Tay-Un, flood discharge is designed to spill out through side spillway and intake tower. Major dimension of each dam are as follows. Typical section of dams are illustrated in Figures IV.21 to IV.22 as sample drawings.

Scheme	Name of Dam	Width of Crest (m)	Length of Crest (m)	River Bed EL.	F.W.L	H.W.L	L.W.L
Upper Champi	Dam No.1	6.0	30.0	1170.00	1185.00	1184.00	1174.00
Upper Kapheu	Dam No.1	4.0	140.0	677.50	684.50	684.00	678.00
ditto	Dam No.2	4.0	190.0	671.50	676.50	676.00	672.00
ditto	Dam No.3	4.0	170.0	661.50	666.50	666.00	662.00
ditto	Dam No.4	4.0	150.0	655.50	662.50	662.00	656.00
Upper Tay-Un	Dam No.1	6.0	155.0	608.50	616.00	614.50	614.00
ditto	Dam No.2	6.0	305.0	602.00	609.00	608.00	604.00
ditto	Dam No.3	4.0	200.0	608.10	610.50	610.00	609.00

Scheme	Name of Dam	Elevation of Crest	Elevation of Drain	Slope of Inside	Slope of Outside
Upper Champi	Dam No.1	1186.00	1175.00	1:3.0	1:2.0
Upper Kapheu	Dam No.1	685.50	none	1:2.5	1:2.5
ditto	Dam No.2	677.50	none	1:2.5	1:2.5
ditto	Dam No.3	667.50	none	1:2.5	1:2.5
ditto	Dam No.4	663.50	none	1:2.5	1:2.5
Upper Tay-Un	Dam No.1	617.00	611.00	1:3.0	1:2.0
ditto	Dam No.2	610.00	605.00	1:3.0	1:2.0
ditto	Dam No.3	611.50	none	1:2.5	1:2.5

(2) Diversion Weir

Diversion weir is broad crest concrete weir, and height of retaining walls is designed to add freeboard to high water level during design flood. Design flood discharge is designed to spill out through main weir body. Scouring sluice Crest length of weir is basically determined to sustain width of existing river, and dimension of scouring sluice is designed to flush out boulders of less than 0.5 m, and length of scouring sluice is designed to be of less than half of the length.

Settling basin is provided in the Upper Champi and Upper Kapheu Schemes.

Settling basin is designed to provide at immediately down stream of intake structure, if wide and opened land is available. Dimension of settling basin is designed to occur siltation of the particles of minimum 0.3 mm. Dimension of each settling basin are as follows. Typical section of diversion weir is illustrated in Figure IV. 23.

Scheme	Length of Crest (m)	River Bed EL.	H.W.L	Elevation of Crest	Elevation of Intake	Scouring Sluice
Upper Champi	43.0	1218.00	1224.60	1223.50	1223.00	3.0 m
Upper Tapoung	38.0	1221.50	1226.60	1226.00	1225.00	2.5 m
Upper Kapheu	14.0	794.50	798.60	796.00	795.50	1.5 m
Lower Xe Set	75.0	367.50	378.00	374.50	374.00	5.0 m

Scheme	Length of Upper Apron(m)	Length of Lower Apron(m)	Length of Riprap (m)
Upper Champi	13.0	19.0	30.0
Upper Tapoung	10.5	12.0	10.0
Upper Kapheu	9.0	7.0	15.0
Lower Xe Set	14.5	26.5	45.0

(3) Intake Structure

Intake structure is divided into 2 types such as intake gate of weir and intake tower of dam. Intake structure consists of gate and steel screen. Dimension of intake gate is 0.6 m (H) x 0.6 m (B) taking into consideration manual operation of gate and maintenance works. Intake tower is concrete tower of duck bill type, and water is off - taken through sluice gates which are provided about 2 m interval from normal high water level of reservoir.

The other type of intake structures is provided in order to off - take water for domestic water supply at diversion weirs of Upper Champi, Upper Kapheu and Lower Xe Set schemes. Off taking of stable water amount is regulated by gate operation.

(4) Regulation Pond

For adjustment of water supply from hydro-power station in the Xe Set Scheme during the peak hydro-power operation system in dry season, concrete lined regulation pond which an effective capacity is 130, 000 m3 is provided. Regulation pond is earthfill type, and outside slope of embankment is designed to covered by sod facing in order to prevent soil erosion. Dimension of regulation pond is as follows. Typical section of regulation pond is illustrated in Figure IV.24.

Crest width of embankment	2.0 m
Side slope of embankment	1 : 1.5
Thickness of concrete lining at slope	0.07 cm
Thickness of concrete lining at bottom	0.15 cm
Effective water depth	2.0 m
Free board	1.0 m

(5) Farm Pond

farm pond is provided at head section of tertiary canal which the command area is covered by upland crops, coffee and tea to adjust time - lag of water supply among main to tertiary canals and water supply amount for tertiary canal. Farm pond is earthfill type of rectangular size, and 8 types of farm ponds are designed as shown below, depending topographical condition. Dimension of farm pond are basically as follows. Typical section of regulation pond is illustrated in Figure IV.24.

Crest width of embankment	1.0 m
Side slope of embankment	1 : 1.5
Thickness of concrete lining at slope	0.07 cm
Thickness of concrete lining at bottom	0.10 cm
Effective water depth	1.0 m
Free board	0.7 m

Type	Basic Dimension			Type	Basic Dimension	
	Width (m)	Volume (m^3)			Width (m)	Volume (m^3)
1	15	225		5	35	1,225
2	20	400		6	40	1,600
3	25	625		7	45	2,025
4	30	900		8	50	2,500

(6) Turnout and Measuring Devices

Turnout is provided at off branching point of main and secondary canals, and 5 types of turnouts are designed depending to elevation of mother canal base as shown below. Turnout consists of inlet transition, conduit and out let transition sections. Conduit section is designed as reinforced concrete box because of thin earth covering. For maintenance works of turnout, specially, conduit section, concrete beam of concrete box is designed to open. Measuring device is also designed to provide immediately down stream of turnout as board crest weir. Typical sections of turnout and measuring devices are shown in Figures IV.24 to IV.25.

Type	Inlet		Barrel		Outlet	
	Basehight(m)	Length (m)	Width (m)	Height (m)	Width (m)	Height (m)
1	0.3	1.10	0.30	0.50	0.50	1.90
2	0.4	1.25	0.30	0.50	0.50	1.90
3	0.5	1.40	0.30	0.50	0.50	1.90
4	0.6	1.55	0.30	0.50	0.50	1.90
5	0.7	1.70	0.30	0.50	0.50	1.90

(7) Impact Box

For stable distribution of irrigation water to lower grade canal through turnout in steep gradient section of main and secondary canals, impact box is provided to dissipate hydraulic energy in transition section from unsteady flow at steep gradient section to steady flow at gentle gradient section. Impact box is provided 3 types shown below. Typical sections of impact box are shown in Figeure IV.24 to IV.25.

Type	Discharge (m^3/sec)	Width (m)	Length (m)
1	less than 0.10	1.00	1.50
2	from 0.10 to 1.00	1.50	2.00
3	more than 1.00	2.50	3.50

(8) Drop

Drops of 2 types, namely inclined drop and vertical drop, are provided depending to gradient of canals and discharge. Dimension of drops are as follows. Typical sections are shown in Figures IV. 24 to IV.25.

Inclined Drop

Length (m)				Basewidth(m)	Wall height (m)	
Inlet transition	Chute section	Energy dissipater	Outlet transition	Chute & Dissipator	Chute section	Energy dissipator
3.00	4.00	2.00	0.80	0.50	0.30	0.80

Vertical Drop

Design discharge	Settling basin length	Settling basin width	Depth of water cushion
less than 1.0 m^3/sec	3.50 m	2.50 m	0.35 m
more than 1.0 m^3/sec	6.00 m	2.50 m	0.80 m

(9) Culvert

Box culvert and pipe culvert are deigned for irrigation and drain respectively. Box culvert is divided into 2 types such as single conduit and 2 conduits types depending to design discharge. Pipe culvert provided for drain is also divided into 2 types as shown below. Typical sections are also shown in Figures IV. 24 to IV.25.

Type	Barrel (m)		Type	Barrel (m)	
	Width	Height		Width	Height
Single Barrel			Double Barrel		
1	0.40	0.40	10	0.90	0.50
2	0.60	0.40	11	1.10	0.60
3	0.80	0.40	12	1.30	0.80
4	0.90	0.50	13	1.60	0.80
5	1.00	0.50	14	2.00	1.00
6	1.10	0.60	Pipe Barrel		
7	1.30	0.80	P-1	Dia. 900 mm	
8	1.60	0.80	P-2	Dia. 1,000 mm	
9	2.00	1.00			

(10) Gabion mattress at confluence points with drain and canal

Tertiary drain is designed directly to connect with tertiary drain in order to evacuate excess water to be conveyed from irrigation canal system. However, since connection section between tertiary canal and tertiary drain is generally steep, gabion mattress is designed to construct by using boulder collected at site.

On the other hand, other type of gabion mattress of 15 m is designed to provide at confluence point among drains.

5.7 Design of On - farm Facilities

(1) Canal Layout

On - farm development facilities consists of tertiary and quarterly canals, tertiary and quarterly drains and related structures. Tertiary canal of about 40 % is designed to be concrete lined canal, and quarterly canal is earth canal. Unit command area of tertiary canal is basically 20 ha. Typical canal layout of on-farm development is shown in Figures IV.27 to IV.29.

(2) Land Preparatory Works

land preparation works such as rough land grading works including clearing and stripping works are designed. As for land preparation of paddy field, rough leveling work is also designed.

(3) Farm Bund

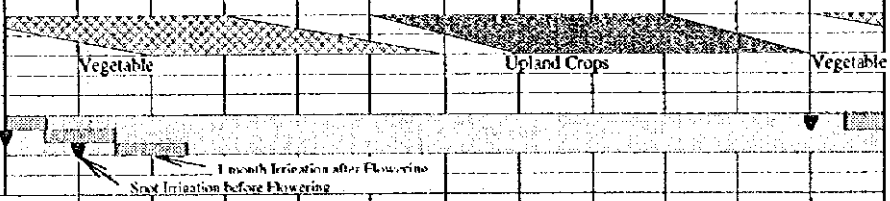
For soil conservation, farm bund involving alley cultivation is designed as described in section 4.10.

Tables

Table IV.1 (1/3) UNIT IRRIGATION WATER REQUIREMENT (CHAMPI)

Rainfall : Pakxong
ET Data : Pakxong
Condition : 3 month time lag. Spot irrigation (20mm) 2 weeks before flowering and one month irrigation after flowering

	Jan.	Feb.	Mar.	Apr	May	June	July	Aug.	Sept	Oct.	Nov.	Dec	
CROPPING PATTERN - C													
COFFEE													



	Jan.	Feb.	Mar.	Apr	May	June	July	Aug.	Sept	Oct.	Nov.	Dec	
Monthly Rainfall	1.7	34.7	145.5	183.1	291.3	289.9	690.8	464.8	268.5	179.6	20.1	54.9	2,624.9
Potential Evapo-transpiration (Pakxong)	128.0	150.0	170.0	174.0	152.0	126.0	124.0	116.0	117.0	135.0	154.0	141.0	1,690.0
Effective Rainfall (Paddy)	1.4	29.5	123.7	156.7	214.1	213.5	297.9	266.8	204.1	154.3	17.1	46.7	1,725.9
Effective Rainfall (Upland Crops)	1.3	25.7	105.9	120.7	140.1	140.0	140.0	140.0	138.1	119.5	14.9	40.6	1,126.7

	Jan.	Feb.	Mar.	Apr	May	June	July	Aug.	Sept	Oct.	Nov.	Dec	
CROPPING PATTERN - C													
Vegetable													
Crop Coefficient (Kc)	0.70	0.78	0.78	0.82	0.85	0.75						0.65	
Crop Evapo-transpiration (ETcrop)	89.6	117.5	131.8	142.1	129.2	94.5						93.6	798
Effective Rainfall	1.3	25.7	105.9	120.7	140.1	140.0						40.6	574
Area Factor	0.50	0.83	1.00	0.83	0.50	0.17						0.17	
Net Irrigation Requirement	44	76	26	18								9	173
Upland Crops													
Crop Coefficient (Kc)						0.75	0.83	0.88	0.92	0.93	0.9		
Crop Evapo-transpiration (ETcrop)						94.5	102.3	102.5	107.3	124.9	130.9		662
Effective Rainfall						140.0	140.0	140.0	138.1	119.5	14.9		693
Area Factor						0.25	0.75	1.00	1.00	0.75	0.25		
Net Irrigation Requirement										4	29		33
Irrigation Efficiency	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	
Conveyance Efficiency 85 %													
Application Efficiency 60 % of upland crops													
Gross Irrigation Requirement	87	149	51	35						8	57	18	404
(lit/sec/ha)	0.32	0.62	0.19	0.13						0.03	0.22	0.07	

	Jan.	Feb.	Mar.	Apr	May	June	July	Aug.	Sept	Oct.	Nov.	Dec	
Coffee													
Crop Coefficient (Kc)	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	
Crop Evapo-transpiration (ETcrop)	83.2	97.5	110.5	113.1	98.8	81.9	80.6	75.4	76.1	87.8	100.1	93.6	1,099
Effective Rainfall	1.3	25.7	105.9	120.7	140.1	140.0	140.0	140.0	138.1	119.5	14.9	40.6	1,127
Area Factor	0.33	0.33	0.17									0.17	
Flowering Water	6.66	6.66										6.66	
Net Irrigation Requirement	33.3	21.8										1.9	57
Irrigation Efficiency	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	
Conveyance Efficiency 85 %													
Application Efficiency 70 %													
Gross Irrigation Requirement	56	37										3	96
(lit/sec/ha)	0.21	0.15										0.01	
Rainfall (Pakxong)													
1991	21.4	0.3	69.5	294.0	264.0	551.1	958.6	1,218.7	488.2	153.7	0.2	8.4	4,028.1
1992	45.0	11.8	41.0	130.2	211.2	866.7	566.6	836.8	373.3	125.3	9.6	23.8	3,241.3
1993		4.1	40.2	150.6	335.5	251.0	522.5	758.4	392.4	57.9	80.2	8.9	2,601.7
1994	0.6	48.4	318.2	292.1	374.7	500.9	1,213.8	594.9	606.2	181.8	53.7	67.2	4,252.5
1995	1.7	34.7	345.5	183.1	291.3	289.9	690.8	464.8	268.5	179.6	20.1	54.9	2,624.9
Monthly Unit Irrigation Requirement by Year (Rainfall) : lit/sec./ha													
CROPPING PATTERN - C	0.27	0.79	0.59	0.01						0.08	0.25	0.11	2.10
COFFEE	0.15	0.27										0.12	0.54
CROPPING PATTERN - C	0.21	0.73	0.74	0.29	0.00					0.18	0.23	0.09	2.48
COFFEE	0.08	0.23	0.02									0.08	0.41
CROPPING PATTERN - C	0.33	0.77	0.75	0.31						0.45	0.14	0.11	2.75
COFFEE	0.21	0.26	0.02									0.12	0.61
CROPPING PATTERN - C	0.33	0.55		0.01						0.03	0.17	0.05	1.14
COFFEE	0.21	0.10											0.32
CROPPING PATTERN - C	0.32	0.62	0.19	0.13						0.03	0.22	0.07	1.58
COFFEE	0.21	0.15										0.01	0.37

Table IV.1 (2/3) IRRIGATION WATER REQUIREMENT (UPPER CHMPI SCHEME)

Rainfall : Pakxong ET Data : Pakxong

Condition: 3 month time lag. Spot irrigation (20mm) 2 weeks before flowering and one month irrigation after flowering with Storage Pond (effective capacity 310,000 cu.m)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept	Oct.	Nov.	Dec	Total
Basic Data : Irrigation Unit Water Requirement (lit./sec./ha)													
1986 C.Pattern - A	1.08	1.43	1.12									0.18	
C.Pattern - B.2	0.65	0.97	0.55	0.14								0.33	
C.Pattern - C	0.33	0.70	0.43	0.15							0.20	0.10	
Coffee	0.21	0.21										0.09	
1987 C.Pattern - A	1.08	1.53	1.33								0.09	0.29	
C.Pattern - B.2	0.65	1.07	0.76	0.06							0.20	0.38	
C.Pattern - C	0.33	0.79	0.65	0.02							0.25	0.12	
Coffee	0.21	0.27										0.14	
1988 C.Pattern - A	0.93	0.84	1.44								0.02	0.29	
C.Pattern - B.2	0.52	0.36	0.86	0.06							0.04	0.38	
C.Pattern - C	0.25	0.20	0.76	0.01							0.23	0.12	
Coffee	0.13		0.03									0.14	
1989 C.Pattern - A	1.02	1.53	1.13									0.28	
C.Pattern - B.2	0.59	1.07	0.56	0.06								0.38	
C.Pattern - C	0.30	0.79	0.44	0.01							0.16	0.12	
Coffee	0.18	0.27										0.14	
1990 C.Pattern - A	1.08	1.53	1.08	0.19								0.29	
C.Pattern - B.2	0.65	1.07	0.52	0.21								0.38	
C.Pattern - C	0.33	0.79	0.39	0.26							0.20	0.12	
Coffee	0.21	0.27										0.14	
1991 C.Pattern - A	0.96	1.53	1.27								0.09	0.24	
C.Pattern - B.2	0.54	1.07	0.70	0.06							0.20	0.36	
C.Pattern - C	0.27	0.79	0.59	0.01						0.08	0.25	0.11	
Coffee	0.15	0.27										0.12	
1992 C.Pattern - A	0.84	1.47	1.42	0.22						0.04	0.04	0.16	
C.Pattern - B.2	0.43	1.00	0.84	0.23						0.04	0.08	0.32	
C.Pattern - C	0.21	0.73	0.74	0.29	0.00					0.18	0.23	0.09	
Coffee	0.08	0.23	0.02									0.08	
1993 C.Pattern - A	1.08	1.51	1.43	0.11						0.40		0.24	
C.Pattern - B.2	0.65	1.05	0.85	0.18						0.40		0.36	
C.Pattern - C	0.33	0.77	0.75	0.21						0.45	0.14	0.11	
Coffee	0.21	0.26	0.02									0.12	
1994 C.Pattern - A	1.07	1.25	0.24										
C.Pattern - B.2	0.64	0.78	0.09	0.06								0.20	
C.Pattern - C	0.33	0.55		0.01						0.03	0.17	0.05	
Coffee	0.21	0.10											
1995 C.Pattern - A	1.07	1.33	0.87										
C.Pattern - B.2	0.64	0.87	0.32	0.14								0.23	
C.Pattern - C	0.32	0.62	0.19	0.13						0.03	0.22	0.07	
Coffee	0.21	0.15										0.01	

WATER DEFICIT FOR IRRIGATION OF PLANNED CROPPING AREA

Cropping Area	(ha)
C.Pattern - A	
C.Pattern - B.2	
C.Pattern - C	
Coffee	570
Total	570

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept	Oct.	Nov.	Dec	Total
Irrigation Requirment	m3./sec.												(MCM)
1985	0.122	0.120										0.053	0.761
1987	0.122	0.154										0.079	0.911
1988	0.074		0.015									0.079	0.451
1989	0.102	0.154										0.078	0.853
1990	0.122	0.154										0.079	0.911
1991	0.084	0.153										0.068	0.779
1992	0.043	0.131	0.011									0.048	0.589
1993	0.122	0.146	0.012									0.067	0.893
1994	0.121	0.060											0.468
1995	0.119	0.086										0.007	0.545
Deficit	m3/sec.												
1986													
1987													
1988													
1989		0.000											0.001
1990													
1991													
1992													
1993													
1994													
1995													
Days of month	31	28	31	30	31	30	31	31	30	31	30	31	
Deficit	cu.m												
1986													
1987													
1988													
1989		1,163											1,163
1990													
1991													
1992													
1993													
1994													
1995													

Table IV. 1 (3/3) IRRIGATION WATER REQUIREMENT (UPPER CHIMPI SCHEME)

Rainfall : Pakxong — ET Data : Pakxong

Condition: 3 month time lag. Spot irrigation (20mm) 2 weeks before flowering and one month irrigation after flowering with Storage Pond (effective capacity 310,000 cu.m)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept	Oct.	Nov.	Dec	Total
Basic Data : Irrigation Unit Water Requirement (lit./sec./ha)													
1986 C.Pattern - A	1.08	1.43	1.12									0.18	
C.Pattern - B.2	0.65	0.97	0.55	0.14								0.33	
C.Pattern - C	0.33	0.70	0.43	0.15							0.20	0.10	
Coffee	0.21	0.21										0.09	
1987 C.Pattern - A	1.08	1.53	1.33								0.09	0.29	
C.Pattern - B.2	0.65	1.07	0.76	0.06							0.20	0.38	
C.Pattern - C	0.33	0.79	0.65	0.02							0.25	0.12	
Coffee	0.21	0.27										0.14	
1988 C.Pattern - A	0.93	0.84	1.44								0.02	0.29	
C.Pattern - B.2	0.52	0.36	0.86	0.06							0.04	0.38	
C.Pattern - C	0.25	0.20	0.76	0.01							0.23	0.12	
Coffee	0.13		0.03									0.14	
1989 C.Pattern - A	1.02	1.53	1.13									0.28	
C.Pattern - B.2	0.59	1.07	0.56	0.06								0.38	
C.Pattern - C	0.30	0.79	0.44	0.01							0.16	0.12	
Coffee	0.18	0.27										0.14	
1990 C.Pattern - A	1.08	1.53	1.08	0.19								0.29	
C.Pattern - B.2	0.65	1.07	0.52	0.21								0.38	
C.Pattern - C	0.33	0.79	0.39	0.26							0.20	0.12	
Coffee	0.21	0.27										0.14	
1991 C.Pattern - A	0.96	1.53	1.27								0.09	0.24	
C.Pattern - B.2	0.54	1.07	0.70	0.06							0.20	0.36	
C.Pattern - C	0.27	0.79	0.59	0.01						0.08	0.25	0.11	
Coffee	0.15	0.27										0.12	
1992 C.Pattern - A	0.84	1.47	1.42	0.22						0.04	0.04	0.16	
C.Pattern - B.2	0.43	1.00	0.84	0.23						0.04	0.08	0.32	
C.Pattern - C	0.21	0.73	0.74	0.29	0.00					0.18	0.23	0.09	
Coffee	0.08	0.23	0.02									0.08	
1993 C.Pattern - A	1.08	1.51	1.43	0.11						0.40		0.24	
C.Pattern - B.2	0.65	1.05	0.85	0.18						0.40		0.36	
C.Pattern - C	0.33	0.77	0.75	0.21						0.45	0.14	0.11	
Coffee	0.21	0.26	0.02									0.12	
1994 C.Pattern - A	1.07	1.25	0.24										
C.Pattern - B.2	0.64	0.78	0.09	0.06								0.20	
C.Pattern - C	0.33	0.55		0.01						0.03	0.17	0.05	
Coffee	0.21	0.10											
1995 C.Pattern - A	1.07	1.33	0.87										
C.Pattern - B.2	0.64	0.87	0.32	0.14								0.23	
C.Pattern - C	0.32	0.62	0.19	0.13						0.03	0.22	0.07	
Coffee	0.21	0.15										0.01	

WATER DEFICIT FOR IRRIGATION OF PLANNED CROPPING AREA

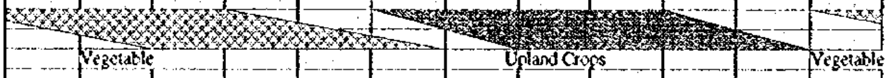
Cropping Area	(ha)
C.Pattern - A	
C.Pattern - B.2	
C.Pattern - C	110
Coffee	50
Total	160

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept	Oct.	Nov.	Dec	Total
Irrigation Requirement	m3/sec.												(MCM)
1986	0.047	0.088	0.048	0.016							0.022	0.016	0.606
1987	0.047	0.100	0.071	0.002							0.027	0.020	0.688
1988	0.034	0.022	0.085	0.001							0.025	0.020	0.495
1989	0.042	0.100	0.049	0.001							0.017	0.020	0.586
1990	0.047	0.100	0.043	0.029							0.022	0.020	0.668
1991	0.037	0.100	0.065	0.001						0.009	0.027	0.018	0.662
1992	0.026	0.092	0.083	0.032	0.000					0.019	0.026	0.015	0.755
1993	0.047	0.097	0.083	0.023						0.050	0.015	0.018	0.864
1994	0.047	0.066		0.001						0.003	0.019	0.006	0.360
1995	0.046	0.076	0.021	0.015						0.003	0.024	0.008	0.492
Deficit	m3/sec.												
1986													
1987													
1988													
1989													
1990													
1991													
1992													
1993													
1994													
1995													
Days of month	31	28	31	30	31	30	31	31	30	31	30	31	
Deficit	cu.m												
1986													
1987													
1988													
1989													
1990													
1991													
1992													
1993													
1994													
1995													

Table IV.2 (1/2) UNIT IRRIGATION WATER REQUIREMENT (TAPOUNG)

Rainfall : Pakxong
ET Data : Pakxong
Condition : 3 mouth time lag. Spot irrigation (20mm) 2 weeks before flowering and one month irrigation after flowering

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept	Oct.	Nov.	Dec	
CROPPING PATTERN - C													



	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept	Oct.	Nov.	Dec	
Monthly Rainfall	1.7	34.7	145.5	183.1	291.3	289.9	690.8	464.8	268.5	179.6	20.1	54.9	2,624.9
Potential Evapo-transpiration (Pakxong)	128.0	150.0	170.0	174.0	152.0	126.0	124.0	116.0	117.0	135.0	154.0	144.0	1,690.0
Effective Rainfall (Paddy)	1.4	29.5	123.7	156.7	214.1	213.5	297.9	266.8	204.1	154.3	17.1	46.7	1,725.9
Effective Rainfall (Upland Crops)	1.3	25.7	105.9	120.7	140.1	140.0	140.0	140.0	138.1	119.5	14.9	40.6	1,126.7

CROPPING PATTERN - C													
Vegetable													
Crop Coefficient (Kc)	0.70	0.78	0.78	0.82	0.85	0.75						0.65	
Crop Evapo-transpiration (ETcrop)	89.6	117.5	131.8	142.1	129.2	94.5						93.6	798
Effective Rainfall	1.3	25.7	105.9	120.7	140.1	140.0						40.6	574
Area Factor	0.50	0.83	1.00	0.83	0.50	0.17						0.17	
Net Irrigation Requirement	44	76	26	18								9	173
Upland Crops													
Crop Coefficient (Kc)						0.75	0.83	0.75	0.90	1.00	0.9		
Crop Evapo-transpiration (ETcrop)						94.5	102.3	87.0	105.3	135.0	130.9		655
Effective Rainfall						140.0	140.0	140.0	138.1	119.5	14.9		693
Area Factor						0.25	0.75	1.00	1.00	0.75	0.25		
Net Irrigation Requirement										12	29		41
Irrigation Efficiency	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	
Conveyance Efficiency 85 %													
Application Efficiency 60 % of upland crops													
Gross Irrigation Requirement	87	149	51	35						23	57	18	419
(lit/sec/ha)	0.32	0.62	0.19	0.13						0.09	0.22	0.07	

Rainfall (Pakxong)													
1986		17.3	97.8	137.9	526.9	391.4	656.9	865.0	370.0	285.7	35.5	19.4	3,443.8
1987			58.1	284.7	285.6	575.3	642.8	946.4	318.3	238.8			3,350.0
1988	27.3	118.6	38.0	346.3	414.1	368.0	436.4	566.6	338.8	358.2	13.2		3,025.5
1989	11.4		96.2	379.0	374.9	361.4	705.1	524.2	472.1	238.8	64.8	1.1	3,229.0
1990			105.6	135.0	355.1	514.7	404.4	797.4	494.1	271.9	34.5		3,112.7
1991	21.4	0.3	69.5	294.0	264.0	551.1	958.6	1218.7	488.2	153.7	0.2	8.4	4,028.1
1992	45.0	11.8	41.0	130.2	211.2	866.7	566.5	836.8	373.3	125.3	9.6	23.8	3,241.3
1993		4.1	40.2	150.6	335.5	251.0	522.5	758.4	392.4	57.9	80.2	8.9	2,601.7
1994	0.6	48.4	318.2	292.1	374.7	500.9	1,213.8	594.9	606.2	181.8	53.7	67.2	4,252.5
1995	1.7	34.7	145.5	183.1	291.3	289.9	690.8	464.8	268.5	179.6	20.1	54.9	2,624.9
Monthly Unit Irrigation Requirement by Year : lit/sec/ha													
1986 CROPPING PATTERN - C	88	170	116	38							51	26	490
1987 CROPPING PATTERN - C	88	191	174	4						1	64	31	554
1988 CROPPING PATTERN - C	68	48	203	3							59	31	414
1989 CROPPING PATTERN - C	80	191	119	3						1	41	31	466
1990 CROPPING PATTERN - C	88	191	105	67							52	31	535
1991 CROPPING PATTERN - C	72	191	157	3						37	64	29	554
1992 CROPPING PATTERN - C	55	177	199	74	1					62	61	25	654
1993 CROPPING PATTERN - C	88	186	200	55						136	35	29	729
1994 CROPPING PATTERN - C	87	133		3						22	45	15	305
1995 CROPPING PATTERN - C	87	149	51	35						23	57	18	419

Table IV.2 (2/2) IRRIGATION WATER REQUIREMENT (TAPOUNG)

Rainfall : Pakxong　　ET Data : Pakxong

Condition: 100% Vegetable - Upland Crops, with Storage (effcitve capacity 200,000 cu.m)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept	Oct.	Nov.	Dec	Total
Basic Data : Irrigation Unit Water Requirement (lit./sec./ha)													
1986 C.Pattern - A	1.08	1.43	1.12									0.18	3.82
C.Pattern - B.2	0.65	0.97	0.55	0.14								0.33	2.64
C.Pattern - C	0.33	0.70	0.43	0.15							0.20	0.10	1.91
Coffee	0.21	0.21										0.09	0.52
1987 C.Pattern - A	1.08	1.53	1.33								0.09	0.29	4.32
C.Pattern - B.2	0.65	1.07	0.76	0.06							0.20	0.38	3.12
C.Pattern - C	0.33	0.79	0.65	0.02							0.25	0.12	2.15
Coffee	0.21	0.27										0.14	0.62
1988 C.Pattern - A	0.93	0.84	1.44								0.02	0.29	3.52
C.Pattern - B.2	0.52	0.36	0.86	0.06							0.04	0.38	2.22
C.Pattern - C	0.25	0.20	0.76	0.01							0.23	0.12	1.57
Coffee	0.13		0.03									0.14	0.30
1989 C.Pattern - A	1.02	1.53	1.13									0.28	3.96
C.Pattern - B.2	0.59	1.07	0.56	0.06								0.38	2.67
C.Pattern - C	0.30	0.79	0.44	0.01							0.16	0.12	1.82
Coffee	0.18	0.27										0.14	0.58
1990 C.Pattern - A	1.08	1.53	1.08	0.19								0.29	4.17
C.Pattern - B.2	0.65	1.07	0.52	0.21								0.38	2.83
C.Pattern - C	0.33	0.79	0.39	0.26							0.20	0.12	2.09
Coffee	0.21	0.27										0.14	0.62
1991 C.Pattern - A	0.96	1.53	1.27								0.09	0.24	4.10
C.Pattern - B.2	0.54	1.07	0.70	0.06							0.20	0.36	2.93
C.Pattern - C	0.27	0.79	0.59	0.01						0.08	0.25	0.11	2.10
Coffee	0.15	0.27										0.12	0.54
1992 C.Pattern - A	0.84	1.47	1.42	0.22						0.04	0.04	0.16	4.19
C.Pattern - B.2	0.43	1.00	0.84	0.23						0.04	0.08	0.32	2.95
C.Pattern - C	0.21	0.73	0.74	0.29	0.00					0.18	0.23	0.09	2.48
Coffee	0.08	0.23	0.02									0.08	0.41
1993 C.Pattern - A	1.08	1.51	1.43	0.11						0.40		0.24	4.76
C.Pattern - B.2	0.65	1.05	0.85	0.18						0.40		0.36	3.48
C.Pattern - C	0.33	0.77	0.75	0.21						0.45	0.14	0.11	2.75
Coffee	0.21	0.26	0.02									0.12	0.61
1994 C.Pattern - A	1.07	1.25	0.24										2.57
C.Pattern - B.2	0.64	0.78	0.09	0.06								0.20	1.78
C.Pattern - C	0.33	0.55		0.01						0.03	0.17	0.05	1.14
Coffee	0.21	0.10											0.32
1995 C.Pattern - A	1.07	1.33	0.87										3.27
C.Pattern - B.2	0.64	0.87	0.32	0.14								0.23	2.20
C.Pattern - C	0.32	0.62	0.19	0.13						0.03	0.22	0.07	1.58
Coffee	0.21	0.15										0.01	0.37

WATER DEFICIT FOR IRRIGATION OF PLANNED AREA

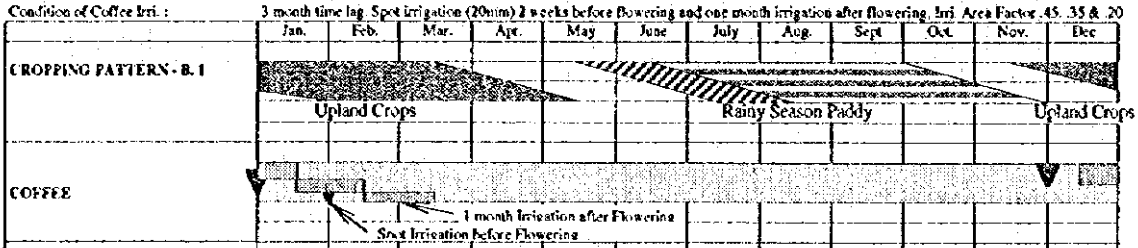
Planned Area = 80 ha

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept	Oct.	Nov.	Dec	Total
Irrigation Requirement	m3/sec.												MCM
1986	0.026	0.056	0.035	0.012							0.016	0.008	0.392
1987	0.026	0.063	0.052	0.001							0.020	0.009	0.442
1988	0.020	0.016	0.061	0.001							0.018	0.009	0.331
1989	0.024	0.063	0.035	0.001							0.013	0.009	0.372
1990	0.026	0.063	0.031	0.021							0.016	0.009	0.428
1991	0.022	0.063	0.047	0.001						0.007	0.020	0.009	0.431
1992	0.016	0.059	0.059	0.023	0.000					0.014	0.019	0.008	0.512
1993	0.026	0.062	0.060	0.017						0.036	0.011	0.009	0.571
1994	0.026	0.044		0.001						0.002	0.014	0.004	0.232
1995	0.026	0.049	0.015	0.011						0.002	0.018	0.005	0.323
Deficit	m3/sec.												MCM
1986		0.006	0.001										0.016
1987		0.014	0.020										0.087
1988			0.018										0.047
1989		0.025	0.011										0.090
1990		0.018	0.001										0.047
1991		0.014	0.015										0.073
1992			0.018										0.048
1993		0.017	0.033										0.128
1994		0.007											0.016
1995													
Days of month	31	28	31	30	31	30	31	31	30	31	30	31	
Deficit	cu.m												cu.m
1986		14,145	2,132										16,276
1987		32,717	54,223										86,940
1988			46,988										46,988
1989		60,263	29,368										89,631
1990		44,372	2,566										46,938
1991		32,690	40,104										72,794
1992			47,972										47,972
1993		40,195	87,903										128,098
1994		16,093											16,093
1995													
													47,972

Table IV.3 (1/2) IRRIGATION WATER REQUIREMENT (KAPHEU)

Rainfall : Laongam — ET Data : Salavan

Condition of Coffee Irri. : 3 month time lag. Spot irrigation (20mm) 2 weeks before flowering and one month irrigation after flowering, Irri. Area Factor .45, .35 & .20



	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept	Oct.	Nov.	Dec	Total
Monthly Rainfall		12.2	7.6	24.3	140.4	227.9	358.1	225.1	217.3	158.5	12		1,383
Potential Evapo-transpiration (Salavan)	145.0	181.0	219.0	208.0	199.0	141.0	147.0	128.0	140.0	158.0	162.0	151.0	1979.0
Effective Rainfall (Paddy)		10.4	6.5	20.7	119.3	183.8	238.6	182.3	177.9	134.7	10.2		
Effective Rainfall (Upland Crops)		9.0	5.6	18.0	103.4	132.1	140.0	131.5	129.9	111.6	8.9		

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept	Oct.	Nov.	Dec	Total
CROPPING PATTERN - B.1													
Upland Crops													
Crop Coefficient (Kc)	0.78	0.88	0.90	0.90	0.80						0.70	0.73	
Crop Evapo-transpiration (ETcrop)	113.6	159.9	197.1	187.2	159.2						113.4	109.5	1,040
Effective Rainfall		9.0	5.6	18.0	103.4						8.9		145
Area Factor	0.90	1.00	0.94	0.50	0.06						0.05	0.40	
Net Irrigation Requirement	102	151	180	85	3						5	44	570
Rainy Season Paddy													
Crop Coefficient (Kc)						0.90	0.95	1.05	1.13	1.20	1.15		
Crop Evapo-transpiration (ETcrop)						126.9	139.7	134.4	158.7	189.6	186.3		936
Percolation						60.0	64	64	60	64	60		372
Effective Rainfall					119.3	183.8	238.6	182.3	177.9	134.7	10.2		1,047
Area Factor						0.06	0.5	0.94	0.94	0.5	0.06		
Puddling Water					11	79	79						169
Nursery Water					6	9	6						21
Net Irrigation Requirement								4	28		5		36
Irrigation Efficiency	0.51	0.51	0.51	0.51	0.51/0.6	0.6	0.6	0.6	0.6	0.6	0.6/0.51	0.51	
Conveyance Efficiency 85 %													
Application Efficiency 70 % of paddy field, 60 % of upland crops													
Gross Irrigation Requirement	200	296	353	166	7			7	46		18	86	1,178
(lit/sec/ha)	0.75	1.22	1.32	0.64	0.02			0.03	0.18		0.07	0.32	

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept	Oct.	Nov.	Dec	Total
COFFEE													
Crop Coefficient (Kc)	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	
Crop Evapo-transpiration (ETcrop)	94.3	117.7	142.4	135.2	129.4	91.7	95.6	83.2	91.0	102.7	105.3	98.2	1,286
Effective Rainfall		9.0	5.6	18.0	103.4	132.1	140.0	131.5	129.9	111.6	8.9		790
Area Factor	0.40	0.28	0.10									0.23	
Flowering Water	7.00	4.00										9.00	
Net Irrigation Requirement	44.7	30.9	11.8									31.1	118
Irrigation Efficiency	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	
Conveyance Efficiency 85 %													
Application Efficiency 70 %													
Gross Irrigation Requirement	75	52	20									52	199
(lit/sec/ha)	0.28	0.21	0.07									0.20	
Rainfall (Laongam)													
1986		11.5	64.3	117.2	346.7	252.4	429.3	562.5	243.9	186.2	23.7	12.9	2,250.6
1987			38.7	187.4	183.8	370.6	419.0	600.0	210.4	158.4			2,168.4
1988	18.1	77.9	25.3	228.0	271.4	243.3	287.0	372.3	223.3	235.9	8.8		1,991.5
1989	18.8		61.6	183.6	440.3	193.1	402.7	273.5	186.1	128.7	0.8		1,889.2
1990	0.5	0.8	126.1	71.7	238.4	305.0	292.0	367.4	233.2	218.8	22.6		1,876.5
1991	0.4	0.3	5.8	26.3	207.8	259.8	414.9	560.9	301.5	266.2	0.1	5.5	2,049.5
1992	54.9	5.6	0.1	56.7	214.3	434.8	330.7	552.8	332.5	97.3			2,079.7
1993		2.5	37.4	44.2	261.1	26.3	249.2	377.7	392.9	47.7	6.5		1,445.5
1994		1.7	65.9	136.4	218.3	285.7	461	249.2	309.2	110.2	4.2		1,841.8
1995		12.2	7.6	24.3	140.4	227.9	358.1	225.1	217.3	158.5	12		1,383.4
Monthly Unit Irrigation Requirement by Year : lit/sec/ha													
CROPPING PATTERN - B.1	0.75	1.22	1.32	0.64	0.02			0.03	0.18		0.07	0.32	4.55
COFFEE	0.28	0.21	0.07									0.20	0.76
1986 CROPPING PATTERN - B.1	200	297	276	98	2				22		9	78	983
COFFEE	75	52										43	171
1987 CROPPING PATTERN - B.1	200	313	310	64	5				53		36	86	1,067
COFFEE	75	61	3									52	192
1988 CROPPING PATTERN - B.1	177	200	329	54	2				40		23	86	911
COFFEE	59	2	10									52	123
1989 CROPPING PATTERN - B.1	176	313	279	65	2				78	29	35	86	1,063
COFFEE	58	61										52	171
1990 CROPPING PATTERN - B.1	200	312	191	132	3				31		9	86	965
COFFEE	75	60										52	187
1991 CROPPING PATTERN - B.1	200	313	355	164	4						36	83	1,155
COFFEE	75	61	21									48	205
1992 CROPPING PATTERN - B.1	129	305	363	142	4					73	36	86	1,138
COFFEE	25	57	24									52	158
1993 CROPPING PATTERN - B.1	200	310	312	151	3	128				144	26	86	1,360
COFFEE	75	59	4									52	190
1994 CROPPING PATTERN - B.1	200	311	273	84	3					55	29	86	1,043
COFFEE	75	60										52	187
1995 CROPPING PATTERN - B.1	200	296	353	166	7			7	46		18	86	1,178
COFFEE	75	52	20									52	199

Table IV.3 (2/2) IRRIGATION WATER REQUIREMENT (UPPER KAPHEU SCHEME)

Rainfall : Laongam | ET Data : Salavan

Condition of Coffee Irri. : 3 month time lag. Spot irrigation (20mm) 2 weeks before flowering and one month irrigation after flowering. Irri. Area Factor .45, .35 & .20%
with 3 Storage Ponds (total effective capacity 300,000 cu m)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug	Sept	Oct.	Nov.	Dec	Total
Basic Data : Irrigation Unit Water Requirement (lit./sec./ha)													
1986 C.Pattern - A	1.00	1.71	1.78	0.93					0.18	0.45	0.62	0.29	
C.Pattern - B.1	0.75	1.23	1.03	0.38	0.01				0.09		0.04	0.29	
C.Pattern - B.2	0.75	1.13	1.03	0.37	0.01				0.18	0.45	0.64	0.30	
C.Pattern - C	0.37	0.94	0.89	0.55	0.11					0.13	0.23	0.11	
Coffee	0.28	0.22										0.16	
1987 C.Pattern - A	1.00	1.77	1.92	0.54					0.30	0.60	0.75	0.42	
C.Pattern - B.1	0.75	1.30	1.16	0.25	0.02				0.20		0.14	0.32	
C.Pattern - B.2	0.75	1.17	1.16	0.24	0.02				0.29	0.60	0.77	0.40	
C.Pattern - C	0.37	1.00	1.03	0.31	0.18				0.00	0.19	0.26	0.12	
Coffee	0.28	0.25	0.01									0.20	
1988 C.Pattern - A	0.90	1.32	1.99	0.39					0.26	0.27	0.70	0.42	
C.Pattern - B.1	0.66	0.83	1.23	0.21	0.01				0.16		0.09	0.32	
C.Pattern - B.2	0.66	0.75	1.23	0.20	0.01				0.25	0.27	0.72	0.40	
C.Pattern - C	0.32	0.59	1.11	0.25	0.11					0.07	0.25	0.12	
Coffee	0.22	0.01	0.04									0.20	
1989 C.Pattern - A	0.90	1.77	1.80	0.56					0.40	0.76	0.75	0.42	
C.Pattern - B.1	0.66	1.30	1.04	0.25	0.01				0.30	0.11	0.13	0.32	
C.Pattern - B.2	0.66	1.17	1.04	0.24	0.01				0.39	0.76	0.77	0.40	
C.Pattern - C	0.32	1.00	0.91	0.32	0.11				0.05	0.28	0.26	0.12	
Coffee	0.22	0.25										0.20	
1990 C.Pattern - A	1.00	1.77	1.46	1.18					0.22	0.32	0.63	0.42	
C.Pattern - B.1	0.75	1.29	0.71	0.51	0.01				0.12		0.04	0.32	
C.Pattern - B.2	0.75	1.17	0.71	0.49	0.01				0.21	0.32	0.64	0.40	
C.Pattern - C	0.37	1.00	0.56	0.77	0.13					0.09	0.23	0.12	
Coffee	0.28	0.25										0.20	
1991 C.Pattern - A	1.00	1.77	2.09	1.43					0.02	0.17	0.75	0.36	
C.Pattern - B.1	0.75	1.29	1.33	0.63	0.01						0.14	0.31	
C.Pattern - B.2	0.75	1.17	1.33	0.61	0.01				0.02	0.17	0.77	0.36	
C.Pattern - C	0.37	1.00	1.21	0.99	0.15					0.05	0.26	0.12	
Coffee	0.28	0.25	0.08									0.18	
1992 C.Pattern - A	0.71	1.74	2.12	1.26						0.92	0.75	0.42	
C.Pattern - B.1	0.48	1.26	1.36	0.55	0.01					0.27	0.14	0.32	
C.Pattern - B.2	0.48	1.14	1.36	0.53	0.01					0.92	0.77	0.40	
C.Pattern - C	0.22	0.97	1.24	0.84	0.15					0.41	0.26	0.12	
Coffee	0.09	0.24	0.09									0.20	
1993 C.Pattern - A	1.00	1.76	1.93	1.33		0.50				1.18	0.72	0.42	
C.Pattern - B.1	0.75	1.28	1.17	0.58	0.01	0.49				0.54	0.10	0.32	
C.Pattern - B.2	0.75	1.16	1.17	0.57	0.01	0.48				1.18	0.73	0.40	
C.Pattern - C	0.37	0.99	1.04	0.90	0.12	0.27				0.61	0.25	0.12	
Coffee	0.28	0.24	0.01									0.20	
1994 C.Pattern - A	1.00	1.76	1.77	0.83				0.03		0.85	0.73	0.42	
C.Pattern - B.1	0.75	1.29	1.02	0.32	0.01					0.21	0.11	0.32	
C.Pattern - B.2	0.75	1.16	1.02	0.31	0.01			0.03		0.85	0.75	0.40	
C.Pattern - C	0.37	0.99	0.89	0.45	0.14					0.35	0.25	0.12	
Coffee	0.28	0.25										0.20	
1995 C.Pattern - A	1.00	1.70	2.08	1.44				0.11	0.20	0.60	0.69	0.42	
C.Pattern - B.1	0.75	1.22	1.32	0.64	0.02			0.03	0.18		0.07	0.32	
C.Pattern - B.2	0.75	1.10	1.32	0.62	0.02			0.11	0.27	0.60	0.70	0.40	
C.Pattern - C	0.37	0.94	1.20	1.00	0.24					0.19	0.24	0.12	
Coffee	0.28	0.21	0.07									0.20	

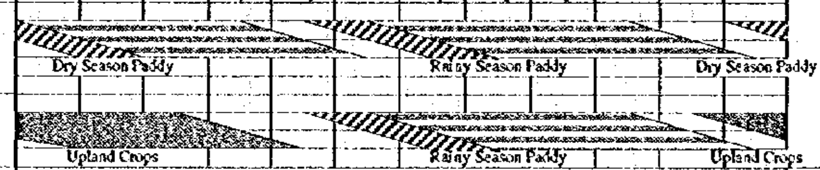
WATER DEFICIT FOR IRRIGATION OF PLANNED CROPPING AREA

Cropping Area	(ha)
C.Pattern - A	
C.Pattern - B.1	100
C.Pattern - B.2	
C.Pattern - C	
Coffee	900
Total	1,000

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug	Sept	Oct.	Nov.	Dec	Total
Irrigation Requirment	m3/sec.												(MCM)
1986	0.327	0.317	0.103	0.038	0.001				0.009		0.004	0.175	2.520
1987	0.327	0.357	0.126	0.025	0.002				0.020		0.014	0.208	2.791
1988	0.263	0.091	0.157	0.021	0.001				0.016		0.009	0.208	2.021
1989	0.260	0.357	0.104	0.025	0.001				0.030	0.011	0.013	0.208	2.605
1990	0.325	0.354	0.071	0.051	0.001				0.012		0.004	0.208	2.651
1991	0.326	0.356	0.203	0.063	0.001						0.014	0.194	2.998
1992	0.132	0.338	0.216	0.055	0.001					0.027	0.014	0.208	2.561
1993	0.327	0.348	0.129	0.058	0.001	0.049				0.054	0.010	0.208	3.073
1994	0.327	0.351	0.102	0.032	0.001					0.021	0.011	0.208	2.728
1995	0.327	0.315	0.198	0.064	0.002			0.003	0.018		0.007	0.208	2.970
Deficit	m3/sec.												(MCM)
1986		0.044											0.106
1987		0.088											0.212
1988													
1989		0.149											0.360
1990		0.085											0.205
1991		0.123	0.062										0.463
1992													
1993		0.119											0.287
1994	0.034	0.165											0.489
1995		0.011											0.025
Days of month	31	28	31	30	31	30	31	31	30	31	30	31	
Deficit	cu m												
1986		105,795											105,795
1987		211,736											211,736
1988													
1989		359,677											359,677
1990		205,128											205,128
1991		297,116	165,713										462,829
1992													
1993		287,241											287,241
1994	90,026	399,035											489,061
1995		25,482											25,482

Table IV.4 (1/2) IRRIGATION WATER REQUIREMENT (LOWER XE SET SCHEME)

Rainfall : Laongam ET Data : Salavan



	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept	Oct.	Nov.	Dec	
Monthly Rainfall	0	12.2	7.6	24.3	140.4	227.9	358.1	225.1	217.3	158.5	12	0	1,383
Potential Evapo-transpiration (Salavan)	145.0	181.0	219.0	208.0	199.0	141.0	147.0	128.0	140.0	158.0	162.0	151.0	1979.0
Effective Rainfall (Paddy)	0.0	10.4	6.5	20.7	119.3	183.8	238.6	182.3	177.9	134.7	10.2	0.0	
Effective Rainfall (Upland Crops)	0.0	9.0	5.6	18.0	103.4	132.1	140.0	131.5	129.9	111.6	8.9	0.0	
CROPPING PATTERN - A													
Dry Season Paddy													
Crop Coefficient (Kc)	1.00	1.10	1.13	1.13	1.10	1.00						0.00	
Crop Evapotranspiration (ETcrop)	145.0	199.1	248.2	235.7	218.9	141.0						0.0	1,188
Percolation	93.0	84.0	93.0	90.0	93.0	90.0						0.0	543
Effective Rainfall	0.0	10.4	6.5	20.7	119.3	183.8						0.0	341
Area Factor	0.25	0.75	1.00	0.75	0.3	0.0						0.0	
Puddling Water	90.0	45.0										45.0	180
Nursery Water	11.0											10.0	21
Net Irrigation Requirement	161	247	335	224	0	0						55	1,021
Rainy Season Paddy													
Crop Coefficient (Kc)						0.90	0.95	1.07	1.15	1.15	1.08	1.00	
Crop Evapo-transpiration (ETcrop)						126.9	139.7	136.5	161.0	181.7	174.2	151.0	1,071
Percolation						60	64	64	60	64	60	64	436
Effective Rainfall					119.3	183.8	238.6	182.3	177.9	134.7	10.2	0.0	1,047
Area Factor						0.06	0.5	0.94	1	0.94	0.5	0.06	
Puddling Water					11	79	79	11					180
Nursery Water					11	10							21
Net Irrigation Requirement					0	0	0	17	43	96	107	13	276
Irrigation Efficiency	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	
Conveyance Efficiency 85 %													
Application Efficiency 70 % of paddy field													
Gross Irrigation Requirement	268	412	558	373	0	0	0	29	72	160	178	113	2,162
(lit/sec/ha)	1.00	1.70	2.08	1.44	0.00	0.00	0.00	0.11	0.28	0.60	0.69	0.42	
CROPPING PATTERN - B 2													
Upland Crops													
Crop Coefficient (Kc)	0.85	0.95	0.90	0.40							0.70	0.73	
Crop Evapo-transpiration (ETcrop)	123.3	172.0	197.1	83.2							113.4	109.5	798
Effective Rainfall	0.0	9.0	5.6	18.0							4.2	0.0	37
Area Factor	0.90	1.00	0.94	0.50	0.06						0.05	0.40	
Net Irrigation Requirement	111	163	180	33	0						5	41	536
Rainy Season Paddy													
Crop Coefficient (Kc)						0.90	0.95	1.07	1.15	1.15	1.08	1.00	
Crop Evapo-transpiration (ETcrop)						126.9	139.7	136.5	161.0	181.7	174.2		920
Percolation						60	64	64	60	64	60	64	436
Effective Rainfall					119.3	183.8	238.6	182.3	177.9	134.7	10.2	0.0	1,047
Area Factor						0.06	0.5	0.94	1	0.94	0.5	0.06	
Puddling Water					11	79	79	11					180
Nursery Water					11	10	0	0					21
Net Irrigation Requirement					0	0	0	17	43	96	107	4	267
Irrigation Efficiency	0.51	0.51	0.51	0.51	0.51/0.6	0.6	0.6	0.6	0.6	0.6	0.6/0.51	0.6/0.51	
Conveyance Efficiency 85 %													
Application Efficiency 70 % of paddy field, 60 % of upland crops													
Gross Irrigation Requirement	218	319	353	64	0	0	0	29	72	160	189	92	1,496
(lit/sec/ha)	0.81	1.32	1.32	0.25	0.00	0.00	0.00	0.11	0.28	0.60	0.73	0.34	
Rainfall (Laongam)													
1986	0.0	11.5	64.3	117.2	346.7	252.4	429.3	562.5	243.9	186.2	23.7	12.9	2,250.6
1987	0.0	0.0	38.7	187.4	183.8	370.6	419.0	600.0	210.4	158.4	0.0	0.0	2,168.4
1988	18.1	77.9	25.3	228.0	271.4	243.3	287.0	372.3	223.3	235.9	8.8	0.0	1,991.5
1989	18.8	0.0	61.6	183.6	410.3	193.1	402.7	273.5	186.1	128.7	0.8	0.0	1,889.2
1990	0.5	0.8	126.1	71.7	238.4	305.0	292.0	367.4	233.2	218.8	22.6	0.0	1,876.5
1991	0.4	0.3	5.8	26.3	207.8	259.8	414.9	560.9	301.5	266.2	0.1	5.5	2,049.5
1992	54.9	5.6	0.1	56.7	214.3	434.8	330.7	552.8	332.5	97.3	0	0	2,079.7
1993	0	2.5	37.4	44.2	261.1	26.3	249.2	377.7	392.9	47.7	6.5	0	1,445.5
1994	0	1.7	65.9	136.4	218.3	285.7	461	249.2	309.2	110.2	4.2	0	1,841.8
1995	0	12.2	7.6	24.3	140.4	227.9	358.1	225.1	217.3	158.5	12	0	1,383.4
Monthly Unit Irrigation Requirement by Year : lit/sec/ha													
CROPPING PATTERN - A	1.00	1.70	2.06	1.44	0.00	0.00	0.00	0.11	0.28	0.60	0.69	0.42	8.31
CROPPING PATTERN - B 2	0.81	1.32	1.32	0.25	0.00	0.00	0.00	0.11	0.28	0.60	0.73	0.34	5.75
1986 CROPPING PATTERN - A	268	429	514	141	0	0	0	0	78	161	195	113	1,899
CROPPING PATTERN - B 2	218	320	276	0	0	0	0	0	48	120	172	82	1,236
1987 CROPPING PATTERN - A	268	429	514	141	0	0	0	0	78	161	195	113	1,899
CROPPING PATTERN - B 2	218	337	310	0	0	0	0	0	78	161	206	92	1,403
1988 CROPPING PATTERN - A	242	318	533	101	0	0	0	0	66	71	183	113	1,627
CROPPING PATTERN - B 2	194	224	329	0	0	0	0	0	66	71	193	92	1,170
1989 CROPPING PATTERN - A	241	429	481	145	0	0	0	0	104	203	194	113	1,910
CROPPING PATTERN - B 2	193	337	279	0	0	0	0	0	104	203	205	92	1,413
1990 CROPPING PATTERN - A	267	428	390	306	0	0	0	0	57	87	163	113	1,811
CROPPING PATTERN - B 2	217	336	191	30	0	0	0	0	57	87	173	92	1,184
1991 CROPPING PATTERN - A	267	428	560	370	0	0	0	0	5	46	195	98	1,969
CROPPING PATTERN - B 2	213	337	355	62	0	0	0	0	5	46	206	84	1,313
1992 CROPPING PATTERN - A	190	421	569	327	0	0	0	0	0	247	195	113	2,061
CROPPING PATTERN - B 2	146	329	363	40	0	0	0	0	0	247	206	92	1,424
1993 CROPPING PATTERN - A	268	425	516	345	0	130	0	0	0	317	186	113	2,299
CROPPING PATTERN - B 2	218	334	312	50	0	130	0	0	0	317	197	92	1,649
1994 CROPPING PATTERN - A	268	426	475	218	0	0	0	8	0	229	189	113	1,922
CROPPING PATTERN - B 2	218	335	273	0	0	0	0	8	0	229	200	92	1,354
1995 CROPPING PATTERN - A	268	412	558	373	0	0	0	29	72	160	178	113	2,162
CROPPING PATTERN - B 2	218	319	353	64	0	0	0	29	72	160	189	92	1,496

Table IV.4 (3/3) IRRIGATION WATER REQUIREMENT (LOWER KE SET SCHEME)

Rainfall Category: El Coto Salerno
Condition: Main Crop: Upland, Paddy   Deducted by Right for Downstream

		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Basic Data: Irrigation Unit Water Requirement (lit/sec/ha)														
1986	C Pattern A	2.07	1.75	1.76	0.93					0.18	0.40	0.62	0.29	
	C Pattern B2	0.41	1.52	1.03						0.18	0.46	0.66	0.31	
	C Pattern C	0.57	0.94	0.89	0.53	0.11					0.13	0.23	0.11	
	C Pattern C2	0.41	1.52	1.03								0.04	0.29	
	Coffee	0.73	0.95	0.80	0.41	0.02						0.73	0.76	
1987	C Pattern A	1.30	1.33	1.92	0.54					0.30	0.80	0.75	0.42	
	C Pattern B2	0.81	1.38	1.14						0.30	0.60	0.80	0.34	
	C Pattern C	0.37	1.20	1.03	0.31	0.16				0.08	0.13	0.26	0.12	
	C Pattern C2	0.81	1.38	1.14								0.06	0.32	
	Coffee	0.73	1.01	0.92	0.18	0.14					0.01	0.84	0.76	
1988	C Pattern A	0.90	1.32	1.99	0.39					0.26	0.27	0.70	0.42	
	C Pattern B2	0.72	1.03	1.23						0.26	0.27	0.75	0.34	
	C Pattern C	0.32	1.39	1.21	0.25	0.11					0.07	0.25	0.12	
	C Pattern C2	0.72	1.03	1.23								0.04	0.32	
	Coffee	0.64	1.61	0.78	0.11	0.03						0.50	0.76	
1989	C Pattern A	0.90	1.77	1.60	0.56					0.40	0.76	0.75	0.42	
	C Pattern B2	0.72	1.39	1.04						0.40	0.76	0.79	0.34	
	C Pattern C	0.32	1.00	0.91	0.32	0.11				0.05	0.38	0.26	0.12	
	C Pattern C2	0.72	1.39	1.04								0.04	0.32	
	Coffee	0.64	1.01	0.81	0.19	0.02					0.12	0.84	0.76	
1990	C Pattern A	1.30	1.77	1.46	1.18					0.22	0.82	0.63	0.42	
	C Pattern B2	0.81	1.39	0.71	0.41					0.22	0.30	0.67	0.34	
	C Pattern C	0.37	1.00	0.36	0.77	0.13					0.09	0.23	0.12	
	C Pattern C2	0.81	1.39	0.71	0.41							0.04	0.32	
	Coffee	0.73	1.00	0.51	0.63	0.06						0.75	0.76	
1991	C Pattern A	1.00	1.77	2.09	1.43					0.02	0.17	0.75	0.36	
	C Pattern B2	0.81	1.39	1.33	0.34					0.02	0.17	0.80	0.31	
	C Pattern C	0.37	1.00	1.21	0.99	0.15					0.05	0.26	0.12	
	C Pattern C2	0.81	1.39	1.33	0.24							0.04	0.31	
	Coffee	0.73	1.00	1.07	0.84	0.10						0.84	0.73	
1992	C Pattern A	0.71	1.74	2.12	1.36						0.92	0.75	0.42	
	C Pattern B2	0.54	1.36	1.36	0.16						0.92	0.80	0.34	
	C Pattern C	0.22	0.97	1.24	0.64	0.15					0.41	0.26	0.12	
	C Pattern C2	0.54	1.36	1.36	0.16							0.04	0.32	
	Coffee	0.47	0.98	1.10	0.70	0.09					0.26	0.84	0.76	
1993	C Pattern A	1.00	1.96	1.93	1.33		0.50				1.18	0.72	0.42	
	C Pattern B2	0.81	1.38	1.17	0.19		0.50				1.18	0.76	0.34	
	C Pattern C	0.37	0.99	1.04	0.90	0.12	0.17				0.61	0.25	0.12	
	C Pattern C2	0.81	1.38	1.17	0.19		0.08					0.04	0.32	
	Coffee	0.73	0.99	0.93	0.76	0.34	0.53				0.49	0.81	0.76	
1994	C Pattern A	1.00	1.76	1.77	0.63				0.01		0.85	0.73	0.42	
	C Pattern B2	0.81	1.38	1.02					0.01		0.85	0.77	0.34	
	C Pattern C	0.37	0.99	0.89	0.45	0.14					0.35	0.25	0.12	
	C Pattern C2	0.81	1.38	1.02								0.04	0.32	
	Coffee	0.73	1.00	0.79	0.31	0.06					0.20	0.82	0.76	
1995	C Pattern A	1.00	1.70	2.06	1.44				0.11	0.26	0.60	0.69	0.42	
	C Pattern B2	0.81	1.52	1.32	0.25				0.11	0.26	0.60	0.73	0.34	
	C Pattern C	0.37	0.94	1.20	1.00	0.24					0.19	0.24	0.12	
	C Pattern C2	0.81	1.52	1.32	0.25							0.04	0.32	
	Coffee	0.73	0.74	1.06	0.15	0.25					0.01	0.78	0.76	

WATER DEFICIT FOR IRRIGATION OF PLANNED CROPPING AREA

Cropping Area	(ha)
C Pattern A	200
C Pattern B2	800
C Pattern C	
C Pattern C2	
Coffee	
Total	1,000

		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Irrigation Requirement		m3/sec												(MCM)
	1986	0.849	1.401	1.179	0.136					0.385	0.442	0.655	0.303	13.497
	1987	0.849	1.469	1.361	0.109					0.303	0.599	0.767	0.360	15.019
	1988	0.759	1.064	1.580	0.475					0.255	0.266	0.734	0.360	12.613
	1989	0.756	1.464	1.194	0.112					0.401	0.756	0.763	0.360	13.529
	1990	0.847	1.463	0.863	0.927					0.325	0.325	0.661	0.360	13.089
	1991	0.847	1.468	1.480	0.476					0.017	0.175	0.767	0.325	14.443
	1992	0.577	1.426	1.309	0.377						0.921	0.767	0.360	15.515
	1993	0.849	1.455	1.318	0.419		0.501				1.185	0.751	0.360	17.74
	1994	0.849	1.459	1.172	0.165				0.018		0.854	0.764	0.350	14.679
	1995	0.849	1.367	1.474	0.485				0.107	0.272	0.500	0.720	0.360	16.290
Deficit		m3/sec												(MCM)
	1986													
	1987													
	1988													
	1989													
	1990													
	1991													
	1992													
	1993													
	1994													
	1995													
Days of month		31	28	31	30	31	30	31	31	30	31	30	31	
Deficit		cu m												
	1986													
	1987													
	1988													
	1989													
	1990													
	1991													
	1992													
	1993													
	1994													
	1995													

WATER DEFICIT FOR IRRIGATION OF PLANNED CROPPING AREA

Cropping Area	Dry II	Rainy II
Paddy	350	700
Upland Crops		
C Pattern C		
Coffee		
Total	350	700

		Dry Season					Rainy Season						Dry	
		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Irrigation Requirement		m3/sec												
	1986	[illegible]	[illegible]	[illegible]	[illegible]					[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	1987	[illegible]	[illegible]	[illegible]	[illegible]					[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	1988	[illegible]	[illegible]	[illegible]	[illegible]					[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	1989	[illegible]	[illegible]	[illegible]	[illegible]					[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	1990	[illegible]	[illegible]	[illegible]	[illegible]					[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	1991	[illegible]	[illegible]	[illegible]	[illegible]					[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	1992	[illegible]	[illegible]	[illegible]	[illegible]					[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	1993	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]					[illegible]	[illegible]	[illegible]	[illegible]
	1994	[illegible]	[illegible]	[illegible]	[illegible]						[illegible]	[illegible]	[illegible]	[illegible]
	1995	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]						[illegible]	[illegible]	[illegible]
Runoff		Unit m3/sec												
	1986	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	1987	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	1988	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	1989	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	1990	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	1991	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	1992	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	1993	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	1994	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	1995	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
Balance														
	1986	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	1987	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	1988	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	1989	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	1990	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	1991	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	1992	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	1993	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	1994	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	1995	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	

Table IV.5 (1/2) IRRIGATION WATER REQUIREMENT (TAY-UN SCHEME)

Rainfall : Sekong   ET Data : Salavan

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept	Oct.	Nov.	Dec	Total
CROPPING PATTERN - A	Dry Season Paddy						Rainy Season Paddy				Dry Season Paddy		
CROPPING PATTERN - B2	Upland Crops						Rainy Season Paddy				Upland Crops		
Monthly Rainfall (Salavan 1988)	0	0.5	0	88.6	340.3	235	383.7	160.6	142.3	110.3	9.7	20.1	1,491
Potential Evapo-transpiration (Salavan)	145.0	181.0	219.0	208.0	199.0	141.0	147.0	128.0	140.0	158.0	162.0	151.0	1979.0
Effective Rainfall (Paddy)	0.0	0.4	0.0	75.3	231.7	187.7	246.5	136.5	121.0	93.8	8.2	17.1	
Effective Rainfall (Upland Crops)	0.0	0.4	0.0	65.6	140.0	133.4	140.0	112.5	104.3	81.6	7.2	14.9	

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept	Oct.	Nov.	Dec	Total
CROPPING PATTERN - A													
Dry Season Paddy													
Crop Coefficient (Kc)	1.00	1.10	1.13	1.13	1.10	1.00						0.00	
Crop Evapotranspiration (ETcrop)	145.0	199.1	248.2	235.7	218.9	141.0						0.0	1,188
Percolation	93.0	85.0	93.0	90.0	93.0	90.0						0.0	543
Effective Rainfall	0.0	0.4	0.0	75.3	232.7	187.7						17.1	513
Area Factor	0.25	0.75	1.00	0.75	0.3	0.0						0.0	
Puddling Water	90.0	45.0										45.0	180
Nursery Water	11.0											10.0	21
Net Irrigation Requirement	161	257	341	169	0	0						38	966
Rainy Season Paddy													
Crop Coefficient (Kc)						0.90	0.95	1.07	1.15	1.15	1.08	1.00	
Crop Evapo-transpiration (ETcrop)						126.9	139.7	136.5	161.0	181.7	174.2	151.0	1,071
Percolation						60	64	64	60	64	60	64	436
Effective Rainfall					232.7	187.7	246.5	136.5	121.0	93.8	8.2	17.1	1,043
Area Factor						0.06	0.5	0.94	1	0.94	0.5	0.06	
Puddling Water					11	79	79	11					180
Nursery Water					11	10							21
Net Irrigation Requirement					0	0	0	63	100	137	109	0	409
Irrigation Efficiency	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	
Conveyance Efficiency 85 %													
Application Efficiency 70 % of paddy field													
Gross Irrigation Requirement	268	428	569	282	0	0	0	105	167	229	181	63	2,291
(lit/sec/ha)	1.00	1.77	2.12	1.09	0.00	0.00	0.00	0.39	0.64	0.85	0.70	0.24	

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept	Oct.	Nov.	Dec	Total
CROPPING PATTERN - B2													
Upland Crops													
Crop Coefficient (Kc)	0.85	0.95	0.90	0.40							0.70	0.73	
Crop Evapo-transpiration (ETcrop)	123.3	172.0	197.1	83.2							113.4	109.5	798
Effective Rainfall	0.0	0.4	0.0	65.6							5.4	7.0	76
Area Factor	0.90	1.00	0.94	0.50	0.06						0.05	0.40	
Net Irrigation Requirement	111	172	185	9	0						6	41	523
Rainy Season Paddy													
Crop Coefficient (Kc)						0.90	0.95	1.07	1.15	1.15	1.08	1.00	
Crop Evapo-transpiration (ETcrop)						126.9	139.7	136.5	161.0	181.7	174.2		920
Percolation						60	64	64	60	64	60	64	436
Effective Rainfall					232.7	187.7	245.5	136.5	121.0	93.8	8.2	17.1	1,043
Area Factor						0.06	0.5	0.94	1	0.94	0.5	0.06	
Puddling Water					11	79	79	11					180
Nursery Water					11	10	0	0					21
Net Irrigation Requirement					0	0	0	63	100	137	109	0	409
Irrigation Efficiency	0.51	0.51	0.51	0.51	0.51/0.6	0.6	0.6	0.6	0.6	0.6	0.6/0.51	0.6/0.51	
Conveyance Efficiency 85 %													
Application Efficiency 70 % of paddy field, 60 % of upland crops													
Gross Irrigation Requirement	218	336	363	17	0	0	0	105	167	229	192	80	1,707
(lit/sec/ha)	0.81	1.39	1.36	0.07	0.00	0.00	0.00	0.39	0.54	0.85	0.74	0.30	

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept	Oct.	Nov.	Dec	Total
Rainfall (Sekong)													
1986	0.0	12.7	70.3	128.2	378.8	272.9	467.4	610.7	266.8	202.3	26.0	14.2	2,450.3
1987	0.0	0.0	42.7	204.9	198.5	400.4	455.6	642.6	230.5	173.8	0.0	0.0	2,348.8
1988	19.9	85.1	27.8	249.3	295.9	266.5	313.5	406.5	244.3	257.9	9.7	0.0	2,176.4
1989	8.4	0.0	70.2	269.9	267.4	257.3	490.2	373.3	337.9	171.0	47.3	0.8	2,293.6
1990	0.0	0.0	76.7	98.0	257.5	372.0	290.2	552.2	354.2	196.6	25.3	0.0	2,222.7
1991	7.4	136.2	359.9	54	167	149.6	288.1	320.9	133.3	263.6	298	112.8	2,290.8
1992	44.6	45.9	133.4	132	138.7	133.6	173.9	260.7	280.1	126	142.4	92.2	1,703.5
1993	17.5	37	113.3	162.7	214.7	307	188.7	300.1	412.9	211.1	293.8	182.5	2,441.3
1994	0	0	70.1	93.2	169.5	302.7	317	512.5	243	80.2	1.8	4.8	1,794.8
1995	0	0.5	0	88.6	340.3	235	383.7	160.6	142.3	110.3	9.7	20.1	1,491.1
Monthly Unit Irrigation Requirement by Year (Rainfall) : lit/sec/ha													
CROPPING PATTERN - A	1.00	1.77	2.12	1.09	0.00	0.00	0.00	0.39	0.64	0.85	0.70	0.24	8.80
CROPPING PATTERN - B2	0.81	1.39	1.36	0.07	0.00	0.00	0.00	0.39	0.64	0.85	0.74	0.30	6.56
1986 CROPPING PATTERN - A	268	411	469	226	0	0	0	0	29	103	158	73	1,737
CROPPING PATTERN - B2	218	319	267	0	0	0	0	0	29	103	169	82	1,187
1987 CROPPING PATTERN - A	268	429	508	123	0	0	0	0	60	139	195	113	1,834
CROPPING PATTERN - B2	218	337	305	0	0	0	0	0	60	139	206	92	1,357
1988 CROPPING PATTERN - A	239	306	529	82	0	0	0	0	48	53	181	113	1,554
CROPPING PATTERN - B2	191	214	325	0	0	0	0	0	48	53	192	92	1,115
1989 CROPPING PATTERN - A	256	429	469	66	0	0	0	0	0	143	128	111	1,601
CROPPING PATTERN - B2	207	337	268	0	0	0	0	0	0	143	138	91	1,183
1990 CROPPING PATTERN - A	268	429	460	268	0	0	0	0	0	109	159	113	1,806
CROPPING PATTERN - B2	218	337	259	10	0	0	0	0	0	109	169	92	1,195
1991 CROPPING PATTERN - A	257	236	170	331	0	0	0	0	179	48	0	0	1,222
CROPPING PATTERN - B2	208	139	105	42	0	0	0	0	179	48	1	55	778
1992 CROPPING PATTERN - A	204	364	380	220	0	0	55	0	19	206	0	0	1,449
CROPPING PATTERN - B2	159	271	181	0	0	0	55	0	19	206	6	61	959
1993 CROPPING PATTERN - A	243	376	408	177	0	0	34	0	0	94	0	0	1,332
CROPPING PATTERN - B2	195	283	209	0	0	0	34	0	0	94	1	36	852
1994 CROPPING PATTERN - A	268	429	469	275	0	0	0	0	49	271	193	100	2,053
CROPPING PATTERN - B2	218	337	268	14	0	0	0	0	49	271	204	85	1,444
1995 CROPPING PATTERN - A	268	428	569	282	0	0	0	105	167	229	181	63	2,291
CROPPING PATTERN - B2	218	336	363	17	0	0	0	105	167	229	192	80	1,707

Table IV.5 (2/2) IRRIGATION WATER REQUIREMENT (UPPER TAY-UN SCHEME)

Rainfall : Sekong   ET Data : Salavan

with Storages (total effective capacity 200,000 cu m)

		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept	Oct.	Nov.	Dec	Total
Basic Data : Irrigation Unit Water Requirement (lit./sec./ha)														
1986	C.Pattern - A	1.00	1.70	1.75	0.87					0.11	0.39	0.61	0.27	6.70
	C.Pattern - B.2	0.81	1.32	1.00						0.11	0.39	0.65	0.31	4.58
	C.Pattern - C	0.37	0.93	0.86	0.49	0.11					0.11	0.22	0.11	3.21
	Coffee	0.59	0.75	0.57	0.26							0.56	0.55	3.28
1987	C.Pattern - A	1.00	1.77	1.90	0.47					0.23	0.52	0.75	0.42	7.07
	C.Pattern - B.2	0.81	1.39	1.14						0.23	0.52	0.80	0.34	5.23
	C.Pattern - C	0.37	1.00	1.01	0.28	0.16					0.16	0.26	0.12	3.37
	Coffee	0.59	0.82	0.70	0.05	0.03						0.68	0.62	3.48
1988	C.Pattern - A	0.89	1.27	1.98	0.32					0.18	0.20	0.70	0.42	5.96
	C.Pattern - B.2	0.71	0.88	1.21						0.18	0.20	0.74	0.34	4.28
	C.Pattern - C	0.32	0.56	1.09	0.22	0.11					0.05	0.25	0.12	2.72
	Coffee	0.50	0.38	0.76								0.64	0.62	2.90
1989	C.Pattern - A	0.95	1.77	1.75	0.25						0.53	0.49	0.41	6.17
	C.Pattern - B.2	0.77	1.39	1.00							0.53	0.53	0.34	4.57
	C.Pattern - C	0.35	1.00	0.86	0.21	0.11					0.16	0.19	0.12	3.01
	Coffee	0.55	0.82	0.57								0.46	0.61	3.01
1990	C.Pattern - A	1.00	1.77	1.72	1.04						0.41	0.61	0.42	6.97
	C.Pattern - B.2	0.81	1.39	0.97	0.04						0.41	0.65	0.34	4.62
	C.Pattern - C	0.37	1.00	0.83	0.64	0.12					0.12	0.22	0.12	3.42
	Coffee	0.59	0.82	0.54	0.41							0.56	0.62	3.53
1991	C.Pattern - A	0.96	0.98	0.63	1.28					0.69	0.18			4.72
	C.Pattern - B.2	0.78	0.57	0.39	0.16					0.69	0.18	0.00	0.20	2.99
	C.Pattern - C	0.35	0.29	0.22	0.85	0.20				0.22	0.05		0.02	2.20
	Coffee	0.56	0.11	0.01	0.62	0.09							0.09	1.49
1992	C.Pattern - A	0.76	1.50	1.42	0.85			0.21		0.08	0.77			5.58
	C.Pattern - B.2	0.59	1.12	0.68				0.21		0.08	0.77	0.02	0.23	3.69
	C.Pattern - C	0.25	0.76	0.52	0.48	0.24	0.02	0.02			0.29	0.06	0.04	2.68
	Coffee	0.38	0.58	0.27	0.24	0.17					0.06	0.01	0.19	1.90
1993	C.Pattern - A	0.91	1.56	1.52	0.68			0.13			0.35			5.15
	C.Pattern - B.2	0.73	1.17	0.78				0.13			0.35	0.00	0.13	3.29
	C.Pattern - C	0.32	0.81	0.63	0.37	0.15					0.10			2.37
	Coffee	0.51	0.63	0.37	0.14	0.00								1.65
1994	C.Pattern - A	1.00	1.77	1.75	1.06					0.19	1.01	0.74	0.37	7.90
	C.Pattern - B.2	0.81	1.39	1.00	0.05					0.19	1.01	0.79	0.32	5.56
	C.Pattern - C	0.37	1.00	0.86	0.66	0.19					0.48	0.26	0.12	3.95
	Coffee	0.59	0.82	0.57	0.43	0.08					0.27	0.67	0.59	4.03
1995	C.Pattern - A	1.00	1.77	2.12	1.09				0.39	0.64	0.85	0.70	0.24	8.80
	C.Pattern - B.2	0.81	1.39	1.36	0.07				0.39	0.64	0.85	0.74	0.30	6.56
	C.Pattern - C	0.37	1.00	1.24	0.69	0.11			0.00	0.18	0.35	0.25	0.10	4.29
	Coffee	0.59	0.81	0.89	0.45						0.13	0.64	0.52	4.04

WATER DEFICIT FOR IRRIGATION OF PLANNED CROPPING AREA

Cropping Area	Dry S.	Rainy S.
Paddy	70	330
Upland Crops	80	
C.Pattern - C		
Coffee		
Total	150	330

	Dry Season					Rainy Seson						Dry		
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept	Oct.	Nov.	Dec	Total	
Irrigation Requirment	m3/sec.												(MCM)	
1986	0.135	0.224	0.202	0.061					0.037	0.127	0.201	0.044		
1987	0.135	0.236	0.224	0.033					0.076	0.171	0.248	0.057		
1988	0.120	0.160	0.236	0.022					0.061	0.065	0.231	0.057		
1989	0.129	0.236	0.203	0.018						0.176	0.163	0.056		
1990	0.135	0.236	0.197	0.076						0.134	0.203	0.057		
1991	0.129	0.114	0.076	0.102					0.229	0.060		0.016	1.89	
1992	0.101	0.195	0.153	0.059			0.068		0.025	0.254		0.018	2.28	
1993	0.122	0.203	0.169	0.048			0.042			0.116		0.011	1.84	
1994	0.135	0.236	0.203	0.079					0.062	0.334	0.245	0.051	3.51	
1995	0.135	0.235	0.257	0.081				0.129	0.212	0.282	0.231	0.041	4.19	
Deficit	m3/sec.												(MCM)	
1986														
1987														
1988														
1989			0.020											
1990		0.022	0.022											
1991														
1992														
1993														
1994		0.022	0.049										0.18	
1995		0.085	0.169	0.035									0.75	
Days of month	31	28	31	30	31	30	31	31	30	31	30	31		
Deficit	cu m												Dry S.	Rainy S.
1986														
1987														
1988														
1989			52,911										52,911	
1990		54,049	59,879										113,928	
1991														
1992														
1993														
1994		53,220	130,149										183,369	
1995		205,172	453,509	90,716									749,397	

Table IV. 6 Water Balance Calculation (Upper Champi Scheme)

Champi Scheme

Runoff

***

		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Total
(m3/sec)		31	28	31	30	31	30	31	31	30	31	30	31	
Runoff-1	1986	0.41	0.32	0.25	0.24	0.60	0.96	1.44	1.96	2.06	1.46	0.99	0.54	
	1987	0.41	0.32	0.25	0.31	0.48	0.89	1.63	2.01	2.02	1.46	0.81	0.46	
	1988	0.38	0.32	0.27	0.37	0.60	1.07	0.92	1.65	1.35	1.24	0.79	0.42	
	1989	0.32	0.24	0.18	0.21	0.72	1.16	1.14	1.60	1.41	1.13	0.69	0.39	
	1990	0.29	0.21	0.18	0.15	0.37	0.64	0.97	1.24	1.70	1.47	0.86	0.41	
	1991	0.32	0.25	0.30	0.31	0.28	0.50	0.75	1.33	1.40	1.29	0.98	0.70	
	1992	0.39	0.31	0.26	0.23	0.31	0.49	0.81	1.19	1.34	1.15	0.69	0.42	
	1993	0.30	0.23	0.18	0.16	0.27	0.52	0.66	0.82	1.29	1.14	0.82	0.60	
	1994	0.29	0.21	0.15	0.14	0.23	0.56	0.98	1.31	1.46	1.12	0.51	0.31	
	1995	0.22	0.15	0.09	0.05	0.26	0.42	0.81	0.83	0.87	0.65	0.31	0.17	
Irrigation Demand-1 (m3/sec.)	1986	0.05	0.09	0.05	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	
	1987	0.05	0.10	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.02	
	1988	0.03	0.02	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.02	
	1989	0.04	0.10	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	
	1990	0.05	0.10	0.04	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	
	1991	0.04	0.10	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.02	
	1992	0.03	0.09	0.08	0.03	0.00	0.00	0.00	0.00	0.00	0.02	0.03	0.01	
	1993	0.05	0.10	0.08	0.02	0.00	0.00	0.00	0.00	0.00	0.05	0.01	0.02	
	1994	0.05	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	
	1995	0.05	0.08	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	
Runoff-2	1986	0.36	0.23	0.21	0.22	0.60	0.96	1.44	1.96	2.06	1.46	0.96	0.52	
	1987	0.36	0.22	0.18	0.31	0.48	0.89	1.63	2.01	2.02	1.46	0.79	0.44	
	1988	0.34	0.30	0.19	0.37	0.60	1.07	0.92	1.65	1.35	1.24	0.76	0.40	
	1989	0.28	0.14	0.13	0.21	0.72	1.16	1.14	1.60	1.41	1.13	0.67	0.37	
	1990	0.25	0.11	0.13	0.12	0.37	0.64	0.97	1.24	1.70	1.47	0.84	0.39	
	1991	0.29	0.15	0.24	0.31	0.28	0.50	0.75	1.33	1.40	1.28	0.95	0.68	
	1992	0.36	0.22	0.18	0.19	0.31	0.49	0.81	1.19	1.34	1.13	0.67	0.40	
	1993	0.25	0.13	0.10	0.13	0.27	0.52	0.66	0.82	1.29	1.09	0.80	0.59	
	1994	0.25	0.15	0.15	0.14	0.23	0.56	0.98	1.31	1.46	1.12	0.49	0.31	
	1995	0.18	0.07	0.07	0.03	0.26	0.42	0.81	0.83	0.87	0.64	0.28	0.17	
Irrigation Demand-2 (m3/sec.)	1986	0.12	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	
	1987	0.12	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	
	1988	0.07	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	
	1989	0.10	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	
	1990	0.12	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	
	1991	0.08	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	
	1992	0.04	0.13	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	
	1993	0.12	0.15	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	
	1994	0.12	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	1995	0.12	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	

*** Domestic Water Demand (m3/sec.)	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
1986 Water Loss (m3/sec.)												
Surface water area (km2)	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27
Potential ET (mm)	145	181	219	208	199	141	147	128	140	158	162	151
*** Water loss (1,000 m3)	47	59	71	67	64	46	48	41	45	51	52	49
Total of outflow (1,000 m3)	387	361	84	80	78	59	61	55	58	65	65	206
Reservoir Storage (1,000 m3)	105	105	105	105	105	105	105	105	105	105	105	105
Water Balance (I-O)	679	303	571	604	1,635	2,530	3,895	5,298	5,384	3,950	2,540	1,291
Water Balance incld. reservoir (1,000 m3)	679	303	571	604	1,635	2,530	3,895	5,298	5,384	3,950	2,540	1,291
	105	105	105	105	105	105	105	105	105	105	105	105
Required Reservoir Capacity (1,000 m3)	105											
Deficit ****	0	0	0	0	0	0	0	0	0	0	0	0
1987 Water Loss (m3/sec.)												
Surface water area (km2)	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27
Water loss (1,000 m3)	47	59	71	67	64	46	48	41	45	51	52	49
Total of outflow (1,000 m3)	387	443	84	80	78	59	61	55	58	65	65	274
Reservoir Storage (1,000 m3)	105	105	105	105	105	105	105	105	105	105	105	105
Water Balance (I-O)	679	187	492	828	1,306	2,358	4,405	5,446	5,279	3,950	2,080	1,022
Water Balance incld. reservoir (1,000 m3)	679	187	492	828	1,306	2,358	4,405	5,446	5,279	3,950	2,080	1,022
	105	105	105	105	105	105	105	105	105	105	105	105
Deficit ****	0	0	0	0	0	0	0	0	0	0	0	0
1988 Water Loss (m3/sec.)												
Surface water area (km2)	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27
Water loss (1,000 m3)	47	59	71	67	64	46	48	41	45	51	52	49
Total of outflow (1,000 m3)	259	71	125	80	78	59	61	55	58	65	65	274
Reservoir Storage (1,000 m3)	105	105	105	105	105	105	105	105	105	105	105	105
Water Balance (I-O)	762	755	487	981	1,623	2,813	2,508	4,479	3,545	3,367	2,021	891
Water Balance incld. reservoir (1,000 m3)	762	755	487	981	1,623	2,813	2,508	4,479	3,545	3,367	2,021	891
	105	105	105	105	105	105	105	105	105	105	105	105
Deficit ****	0	0	0	0	0	0	0	0	0	0	0	0
1989 Water Loss (m3/sec.)												
Surface water area (km2)	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27
Water loss (1,000 m3)	47	59	71	67	64	46	48	41	45	51	52	49
Total of outflow (1,000 m3)	334	443	84	80	78	59	61	55	58	65	65	270
Reservoir Storage (1,000 m3)	105	105	2	105	105	105	105	105	105	105	105	105
Water Balance (I-O)	520	2	277	569	1,952	3,046	3,109	4,326	3,689	3,063	1,777	834
Water Balance incld. reservoir (1,000 m3)	520	2	277	569	1,952	3,046	3,109	4,326	3,689	3,063	1,777	834
	105	2	105	105	105	105	105	105	105	105	105	105
Deficit ****	0	0	0	0	0	0	0	0	0	0	0	0
1990 Water Loss (m3/sec.)												
Surface water area (km2)	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27
Water loss (1,000 m3)	47	59	71	67	64	46	48	41	45	51	52	49
Total of outflow (1,000 m3)	387	443	84	80	78	59	61	55	58	65	65	274
Reservoir Storage (1,000 m3)	105	105	0	105	105	105	105	105	105	105	105	105
Water Balance (I-O)	375	-65	269	328	1,018	1,703	2,640	3,366	4,446	3,972	2,219	873

Water Balance incld. reservoir (1,000 m3)	375	0	269	328	1,018	1,703	2,640	3,366	4,446	3,972	2,219	873
	105	0	105	105	105	105	105	105	105	105	105	105
Deficit ****	0	-65	0	0	0	0	0	0	0	0	0	0
1991 Water Loss (m3/sec.)												
Surface water area (km2)	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27
Water loss (1,000 m3)	47	59	71	67	64	46	48	41	45	51	52	49
Total of outflow (1,000 m3)	287	441	84	80	78	59	61	55	58	65	65	244
Reservoir Storage (1,000 m3)	105	105	35	105	105	105	105	105	105	105	105	105
Water Balance (I-O)	588	35	581	834	788	1,342	2,062	3,599	3,667	3,467	2,502	1,683
Water Balance incld. reservoir (1,000 m3)	588	35	581	834	788	1,342	2,062	3,599	3,667	3,467	2,502	1,683
	105	35	105	105	105	105	105	105	105	105	105	105
Deficit ****	0	0	0	0	0	0	0	0	0	0	0	0
1992 Water Loss (m3/sec.)												
Surface water area (km2)	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27
Water loss (1,000 m3)	47	59	71	67	64	46	48	41	45	51	52	49
Total of outflow (1,000 m3)	176	387	114	80	78	59	61	55	58	65	65	190
Reservoir Storage (1,000 m3)	105	105	105	105	105	105	105	105	105	105	105	105
Water Balance (I-O)	898	255	461	530	857	1,305	2,201	3,236	3,522	3,058	1,766	993
Water Balance incld. reservoir (1,000 m3)	898	255	461	530	857	1,305	2,201	3,236	3,522	3,058	1,766	993
	105	105	105	105	105	105	105	105	105	105	105	105
Deficit ****	0	0	0	0	0	0	0	0	0	0	0	0
1993 Water Loss (m3/sec.)												
Surface water area (km2)	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27
Water loss (1,000 m3)	47	59	71	67	64	46	48	41	45	51	52	49
Total of outflow (1,000 m3)	387	423	117	80	78	59	61	55	58	65	65	243
Reservoir Storage (1,000 m3)	105	105	0	105	105	105	105	105	105	105	105	105
Water Balance (I-O)	397	-7	142	369	757	1,391	1,823	2,249	3,402	2,958	2,118	1,435
Water Balance incld. reservoir (1,000 m3)	397	0	142	369	757	1,391	1,823	2,249	3,402	2,958	2,118	1,435
	105	0	105	105	105	105	105	105	105	105	105	105
Deficit ****	0	-7	0	0	0	0	0	0	0	0	0	0
1994 Water Loss (m3/sec.)												
Surface water area (km2)	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27
Water loss (1,000 m3)	47	59	71	67	64	46	48	41	45	51	52	49
Total of outflow (1,000 m3)	384	215	84	80	78	59	61	55	58	65	65	62
Reservoir Storage (1,000 m3)	105	105	105	105	105	105	105	105	105	105	105	105
Water Balance (I-O)	379	248	433	394	641	1,498	2,678	3,562	3,841	3,033	1,313	861
Water Balance incld. reservoir (1,000 m3)	379	248	433	394	641	1,498	2,678	3,562	3,841	3,033	1,313	861
	105	105	105	105	105	105	105	105	105	105	105	105
Deficit ****	0	0	0	0	0	0	0	0	0	0	0	0
1995 Water Loss (m3/sec.)												
Surface water area (km2)	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27
Water loss (1,000 m3)	47	59	71	67	64	46	48	41	45	51	52	49

Total of outflow (1,000 m3)	379	280	84	80	78	59	61	55	58	65	65	80	
Reservoir Storage (1,000 m3)	105	105	6	101	103	105	105	105	105	105	105	105	
Water Balance (I-O)	199	6	101	103	710	1,123	2,207	2,277	2,310	1,767	778	470	
Water Balance incld. reservoir (1,000 m3)	199	6	101	103	710	1,123	2,207	2,277	2,310	1,767	778	470	
	105	6	101	103	105	105	105	105	105	105	105	105	
Deficit ****	0	0	0	0	0	0	0	0	0	0	0	0	
Deficit (1,000 m3)													
1986	0	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	-65	0	0	0	0	0	0	0	0	0	0	-65
1991	0	0	0	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	0	0	0	0	0
1993	0	-7	0	0	0	0	0	0	0	0	0	0	-7
1994	0	0	0	0	0	0	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0	0	0	0	0	0	0

Table IV. 7 · Water Balance Calculation (Upper Tapoung Scheme)

Tapoung Scheme

		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Runoff	(m3/sec)													
***		31	28	31	30	31	30	31	31	30	31	30	31	
Runoff	1986	0.08	0.05	0.03	0.03	0.11	0.16	0.25	0.33	0.34	0.27	0.21	0.14	
	1987	0.08	0.05	0.03	0.05	0.08	0.16	0.27	0.37	0.33	0.27	0.19	0.12	
	1988	0.08	0.06	0.04	0.06	0.10	0.17	0.16	0.28	0.24	0.23	0.17	0.11	
	1989	0.06	0.04	0.02	0.04	0.11	0.17	0.22	0.28	0.29	0.24	0.19	0.13	
	1990	0.07	0.04	0.03	0.03	0.07	0.13	0.17	0.25	0.33	0.28	0.21	0.13	
	1991	0.08	0.05	0.03	0.03	0.09	0.15	0.29	0.51	0.45	0.36	0.24	0.15	
	1992	0.10	0.06	0.04	0.03	0.04	0.15	0.27	0.36	0.33	0.26	0.18	0.11	
	1993	0.07	0.04	0.03	0.03	0.05	0.07	0.15	0.27	0.27	0.21	0.15	0.10	
	1994	0.06	0.04	0.06	0.08	0.13	0.18	0.36	0.43	0.41	0.34	0.23	0.17	
	1995	0.09	0.06	0.04	0.05	0.09	0.10	0.18	0.22	0.23	0.19	0.14	0.09	
Irrigation Dε	1986	0.03	0.06	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	
	1987	0.03	0.06	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	
	1988	0.02	0.02	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	
	1989	0.02	0.06	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	
	1990	0.03	0.06	0.03	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	
	1991	0.02	0.06	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	
	1992	0.02	0.06	0.06	0.02	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	
	1993	0.03	0.06	0.06	0.02	0.00	0.00	0.00	0.00	0.00	0.04	0.01	0.01	
	1994	0.03	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	
	1995	0.03	0.05	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	
*** Domestic Water Demand (m3/sec.)		0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	
1986 Water Loss (m3/sec.)														
Surface water area (km2)		0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	
Potential ET (mm)		128	150	170	174	152	126	124	116	117	135	154	144	
*** Water loss (1,000 m3)		51	59	67	69	60	50	49	46	46	53	61	57	
Total of outflow (1,000 m3)		126	201	166	104	66	55	54	51	52	59	107	84	
Reservoir Storage (1,000 m3)		240	240	162	87	73	240	240	240	240	240	240	240	
Water Balance (I-O)		326	162	87	73	294	594	842	1,081	1,073	913	680	529	
Water Balance incld. reservoir (1,000 m3)		326	162	87	73	294	594	842	1,081	1,073	913	680	529	
		240	162	87	73	240	240	240	240	240	240	240	240	
Required Reservoir Capacity (1,000 m3)		240												
Deficit ****		0	0	0	0	0	0	0	0	0	0	0	0	
1987 Water Loss (m3/sec.)														
Surface water area (km2)		0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	
Water loss (1,000 m3)		51	59	67	69	60	50	49	46	46	53	61	57	
Total of outflow (1,000 m3)		126	217	212	77	66	55	54	51	52	59	118	87	
Reservoir Storage (1,000 m3)		240	240	143	16	61	212	240	240	240	240	240	240	
Water Balance (I-O)		326	143	16	61	212	582	895	1,177	1,038	913	623	475	
Water Balance incld. reservoir (1,000 m3)		326	143	16	61	212	582	895	1,177	1,038	913	623	475	
		240	143	16	61	212	240	240	240	240	240	240	240	
Deficit ****		0	0	0	0	0	0	0	0	0	0	0	0	
1988 Water Loss (m3/sec.)														

Surface water area (km2)	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33
Water loss (1,000 m3)	51	59	67	69	60	50	49	46	46	53	61	57
Total of outflow (1,000 m3)	110	103	235	77	66	55	54	51	52	59	114	87
Reservoir Storage (1,000 m3)	240	240	240	120	207	240	240	240	240	240	240	240
Water Balance (I-O)	334	275	120	207	404	638	626	950	804	802	574	438
Water Balance incld. reservoir (1,000 m3)	334	275	120	207	404	638	626	950	804	802	574	438
	240	240	120	207	240	240	240	240	240	240	240	240
Deficit ****	0	0	0	0	0	0	0	0	0	0	0	0
1989 Water Loss (m3/sec.)												
Surface water area (km2)	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33
Water loss (1,000 m3)	51	59	67	69	60	50	49	46	46	53	61	57
Total of outflow (1,000 m3)	120	217	168	77	66	55	54	51	52	59	99	87
Reservoir Storage (1,000 m3)	240	240	115	13	47	240	240	240	240	240	240	240
Water Balance (I-O)	290	115	13	47	281	632	776	939	930	829	635	490
Water Balance incld. reservoir (1,000 m3)	290	115	13	47	281	632	776	939	930	829	635	490
	240	115	13	47	240	240	240	240	240	240	240	240
Deficit ****	0	0	0	0	0	0	0	0	0	0	0	0
1990 Water Loss (m3/sec.)												
Surface water area (km2)	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33
Water loss (1,000 m3)	51	59	67	69	60	50	49	46	46	53	61	57
Total of outflow (1,000 m3)	126	217	157	128	66	55	54	51	52	59	107	87
Reservoir Storage (1,000 m3)	240	240	131	56	0	118	240	240	240	240	240	240
Water Balance (I-O)	308	131	56	-4	118	390	632	870	1,043	931	668	502
Water Balance incld. reservoir (1,000 m3)	308	131	56	0	118	390	632	870	1,043	931	668	502
	240	131	56	0	118	240	240	240	240	240	240	240
Deficit ****	0	0	0	-4	0	0	0	0	0	0	0	0
1991 Water Loss (m3/sec.)												
Surface water area (km2)	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33
Water loss (1,000 m3)	51	59	67	69	60	50	49	46	46	53	61	57
Total of outflow (1,000 m3)	114	217	199	76	66	55	54	51	52	77	117	86
Reservoir Storage (1,000 m3)	240	240	143	30	34	209	240	240	240	240	240	240
Water Balance (I-O)	336	143	30	34	209	538	954	1,565	1,366	1,125	747	567
Water Balance incld. reservoir (1,000 m3)	336	143	30	34	209	538	954	1,565	1,366	1,125	747	567
	240	143	30	34	209	240	240	240	240	240	240	240
Deficit ****	0	0	0	0	0	0	0	0	0	0	0	0
1992 Water Loss (m3/sec.)												
Surface water area (km2)	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33
Water loss (1,000 m3)	51	59	67	69	60	50	49	46	46	53	61	57
Total of outflow (1,000 m3)	100	206	232	134	66	55	54	51	52	97	115	83
Reservoir Storage (1,000 m3)	240	240	190	69	21	68	240	240	240	240	240	240
Water Balance (I-O)	400	190	69	21	68	404	914	1,153	1,051	853	593	463
Water Balance incld. reservoir (1,000 m3)	400	190	69	21	68	404	914	1,153	1,051	853	593	463
	240	190	69	21	68	240	240	240	240	240	240	240

Deficit ****	0	0	0	0	0	0	0	0	0	0	0	0	
1993 Water Loss (m3/sec.)													
Surface water area (km2)	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	
Water loss (1,000 m3)	51	59	67	69	60	50	49	46	46	53	61	57	
Total of outflow (1,000 m3)	126	213	233	118	66	55	54	51	52	155	94	86	
Reservoir Storage (1,000 m3)	240	240	136	0	0	81	217	240	240	240	240	240	
Water Balance (I-O)	308	136	-25	-48	81	217	552	922	892	634	523	409	
Water Balance incld. reservoir (1,000 m3)	308	136	0	0	81	217	552	922	892	634	523	409	
	240	136	0	0	81	217	240	240	240	240	240	240	
Deficit ****	0	0	-25	-48	0	0	0	0	0	0	0	0	
1994 Water Loss (m3/sec.)													
Surface water area (km2)	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	
Water loss (1,000 m3)	51	59	67	69	60	50	49	46	46	53	61	57	
Total of outflow (1,000 m3)	126	171	73	77	66	55	54	51	52	64	102	74	
Reservoir Storage (1,000 m3)	240	240	160	238	240	240	240	240	240	240	240	240	
Water Balance (I-O)	265	150	238	379	520	655	1,151	1,331	1,251	1,074	730	612	
Water Balance incld. reservoir (1,000 m3)	265	160	238	379	520	655	1,151	1,331	1,251	1,074	730	612	
	240	160	238	240	240	240	240	240	240	240	240	240	
Deficit ****	0	0	0	0	0	0	0	0	0	0	0	0	
1995 Water Loss (m3/sec.)													
Surface water area (km2)	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	
Water loss (1,000 m3)	51	59	67	69	60	50	49	46	46	53	61	57	
Total of outflow (1,000 m3)	125	184	113	102	66	55	54	51	52	65	112	77	
Reservoir Storage (1,000 m3)	240	240	203	207	240	240	240	240	240	240	240	240	
Water Balance (I-O)	362	203	207	244	405	446	679	789	791	679	482	398	
Water Balance incld. reservoir (1,000 m3)	362	203	207	244	405	446	679	789	791	679	482	398	
	240	203	207	240	240	240	240	240	240	240	240	240	
Deficit ****	0	0	0	0	0	0	0	0	0	0	0	0	
Deficit (1,000 m3)													
1986	0	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	-4	0	0	0	0	0	0	0	0	-4
1991	0	0	0	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	0	0	0	0	0
1993	0	0	-25	-48	0	0	0	0	0	0	0	0	-73
1994	0	0	0	0	0	0	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0	0	0	0	0	0	0

Table IV. 8 Water Balance Calculation (Upper Kapheu Scheme)

Kapheu Scheme

		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Runoff	(m3/sec)													
***		31	28	31	30	31	30	31	31	30	31	30	31	
Runoff	1986	0.44	0.27	0.18	0.18	0.55	0.83	1.30	1.78	1.84	1.48	1.14	0.74	
	1987	0.44	0.27	0.17	0.24	0.42	0.85	1.41	1.97	1.77	1.48	1.04	0.64	
	1988	0.40	0.29	0.22	0.31	0.50	0.92	0.87	1.51	1.27	1.24	0.92	0.56	
	1989	0.35	0.21	0.13	0.20	0.60	0.93	1.16	1.48	1.46	1.26	0.97	0.62	
	1990	0.44	0.27	0.18	0.16	0.41	0.76	1.00	1.53	1.98	1.68	1.24	0.78	
	1991	0.51	0.23	0.14	0.12	0.39	0.68	1.41	2.55	2.32	1.90	1.28	0.81	
	1992	0.53	0.35	0.22	0.17	0.22	0.76	1.40	1.90	1.78	1.44	0.98	0.61	
	1993	0.38	0.23	0.13	0.12	0.25	0.36	0.70	1.32	1.43	1.09	0.76	0.48	
	1994	0.29	0.19	0.23	0.38	0.61	0.90	1.76	2.10	2.06	1.71	1.16	0.82	
	1995	0.48	0.30	0.21	0.23	0.38	0.49	0.90	1.13	1.21	1.00	0.72	0.44	
Irrigation Dc	1986	0.33	0.32	0.10	0.04	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.17	
	1987	0.33	0.36	0.13	0.02	0.00	0.00	0.00	0.00	0.02	0.00	0.01	0.21	
	1988	0.26	0.09	0.16	0.02	0.00	0.00	0.00	0.00	0.02	0.00	0.01	0.21	
	1989	0.26	0.36	0.19	0.03	0.00	0.00	0.00	0.00	0.03	0.01	0.01	0.21	
	1990	0.33	0.35	0.07	0.05	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.21	
	1991	0.33	0.36	0.20	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.19	
	1992	0.13	0.34	0.22	0.05	0.00	0.00	0.00	0.00	0.00	0.03	0.01	0.21	
	1993	0.33	0.35	0.13	0.06	0.00	0.05	0.00	0.00	0.00	0.05	0.01	0.21	
	1994	0.33	0.35	0.10	0.03	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.21	
	1995	0.33	0.32	0.20	0.06	0.00	0.00	0.00	0.00	0.02	0.00	0.01	0.21	
*** Domestic Water Demand (m3/sec.)		0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	
1986 Water Loss (m3/sec.)														
Surface water area (km2)		0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	
Potential ET (mm)		145	181	219	208	199	141	147	128	140	158	162	151	
*** Water loss (1,000 m3)		23	28	34	32	31	22	23	20	22	25	25	24	
Total of outflow (1,000 m3)		907	804	318	139	41	30	31	28	52	33	42	499	
Reservoir Storage (1,000 m3)		395	395	254	395	395	395	395	395	395	395	395	395	
Water Balance (I-O)		656	254	413	710	1,819	2,524	3,847	5,125	5,111	4,315	3,299	1,878	
Water Balance incld. reservoir (1,000 m3)		656	254	413	710	1,819	2,524	3,847	5,125	5,111	4,315	3,299	1,878	
		395	254	395	395	395	395	395	395	395	395	395	395	
Required Reservoir Capacity (1,000 m3)		395												
Deficit ****		0	0	0	0	0	0	0	0	0	0	0	0	
1987 Water Loss (m3/sec.)														
Surface water area (km2)		0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	
Water loss (1,000 m3)		23	28	34	32	31	22	23	20	22	25	25	24	
Total of outflow (1,000 m3)		907	899	380	104	44	30	31	28	82	33	69	588	
Reservoir Storage (1,000 m3)		395	395	148	217	395	395	395	395	395	395	395	395	
Water Balance (I-O)		656	148	217	730	1,469	2,578	4,130	5,632	4,902	4,316	3,011	1,515	
Water Balance incld. reservoir (1,000 m3)		656	148	217	730	1,469	2,578	4,130	5,632	4,902	4,316	3,011	1,515	
		395	148	217	395	395	395	395	395	395	395	395	395	
Deficit ****		0	0	0	0	0	0	0	0	0	0	0	0	

1988 Water Loss (m3/sec.)												
Surface water area (km2)	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
Water loss (1,000 m3)	23	28	34	32	31	22	23	20	22	25	25	24
Total of outflow (1,000 m3)	735	255	464	94	42	30	31	23	70	33	56	588
Reservoir Storage (1,000 m3)	395	395	395	395	395	395	395	395	395	395	395	395
Water Balance (I-O)	729	846	521	1,110	1,705	2,755	2,697	4,410	3,628	3,677	2,735	1,312
Water Balance incld. reservoir (1,000 m3)	729	846	521	1,110	1,705	2,755	2,697	4,410	3,628	3,677	2,735	1,312
	395	395	395	395	395	395	395	395	395	395	395	395
Deficit ****	0	0	0	0	0	0	0	0	0	0	0	0
1989 Water Loss (m3/sec.)												
Surface water area (km2)	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
Water loss (1,000 m3)	23	28	34	32	31	22	23	20	22	25	25	24
Total of outflow (1,000 m3)	728	899	321	105	41	30	31	28	108	62	68	588
Reservoir Storage (1,000 m3)	395	395	0	25	395	395	395	395	395	395	395	395
Water Balance (I-O)	605	0	25	439	1,953	2,783	3,478	4,329	4,072	3,700	2,846	1,477
Water Balance incld. reservoir (1,000 m3)	605	0	25	439	1,953	2,783	3,478	4,329	4,072	3,700	2,846	1,477
	395	0	25	395	395	395	395	395	395	395	395	395
Deficit ****	0	0	0	0	0	0	0	0	0	0	0	0
1990 Water Loss (m3/sec.)												
Surface water area (km2)	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
Water loss (1,000 m3)	23	28	34	32	31	22	23	20	22	25	25	24
Total of outflow (1,000 m3)	902	892	233	172	42	30	31	28	61	33	43	588
Reservoir Storage (1,000 m3)	395	395	154	395	395	395	395	395	395	395	395	395
Water Balance (I-O)	660	154	410	633	1,453	2,326	3,042	4,455	5,463	4,858	3,564	1,905
Water Balance incld. reservoir (1,000 m3)	660	154	410	633	1,453	2,326	3,042	4,455	5,463	4,858	3,564	1,905
	395	154	395	395	395	395	395	395	395	395	395	395
Deficit ****	0	0	0	0	0	0	0	0	0	0	0	0
1991 Water Loss (m3/sec.)												
Surface water area (km2)	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
Water loss (1,000 m3)	23	28	34	32	31	22	23	20	22	25	25	24
Total of outflow (1,000 m3)	903	896	585	205	43	30	31	28	30	33	69	550
Reservoir Storage (1,000 m3)	395	395	62	0	106	395	395	395	395	395	395	395
Water Balance (I-O)	860	62	-146	106	1,097	2,136	4,128	7,197	6,390	5,448	3,655	2,019
Water Balance incld. reservoir (1,000 m3)	860	62	0	106	1,097	2,136	4,128	7,197	6,390	5,448	3,655	2,019
	395	62	0	106	395	395	395	395	395	395	395	395
Deficit ****	0	0	-146	0	0	0	0	0	0	0	0	0
1992 Water Loss (m3/sec.)												
Surface water area (km2)	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
Water loss (1,000 m3)	23	28	34	32	31	22	23	20	22	25	25	24
Total of outflow (1,000 m3)	385	853	620	183	43	30	31	28	30	106	69	588
Reservoir Storage (1,000 m3)	395	395	383	344	395	395	395	395	395	395	395	395
Water Balance (I-O)	1,429	383	344	591	932	2,338	4,103	5,451	4,975	4,147	2,863	1,434
Water Balance incld. reservoir (1,000 m3)	1,429	383	344	591	932	2,338	4,103	5,451	4,975	4,147	2,863	1,434

	395	383	344	395	395	395	395	395	395	395	395	395	
Deficit ****	0	0	0	0	0	0	0	0	0	0	0	0	
1993 Water Loss (m3/sec.)													
Surface water area (km2)	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	
Water loss (1,000 m3)	23	28	34	32	31	22	23	20	22	25	25	24	
Total of outflow (1,000 m3)	907	878	388	192	42	158	31	28	30	176	59	588	
Reservoir Storage (1,000 m3)	395	395	72	35	146	395	395	395	395	395	395	395	
Water Balance (I-O)	507	72	35	146	771	1,172	2,244	3,913	4,072	3,150	2,300	1,096	
Water Balance incld. reservoir (1,000 m3)	507	72	35	146	771	1,172	2,244	3,913	4,072	3,150	2,300	1,096	
	395	72	35	146	395	395	395	395	395	395	395	395	
Deficit ****	0	0	0	0	0	0	0	0	0	0	0	0	
1994 Water Loss (m3/sec.)													
Surface water area (km2)	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	
Water loss (1,000 m3)	23	28	34	32	31	22	23	20	22	25	25	24	
Total of outflow (1,000 m3)	907	885	316	124	43	30	31	28	30	88	63	588	
Reservoir Storage (1,000 m3)	395	274	0	304	395	395	395	395	395	395	395	395	
Water Balance (I-O)	274	-160	304	1,156	1,988	2,692	5,073	5,993	5,700	4,889	3,330	2,000	
Water Balance incld. reservoir (1,000 m3)	274	0	304	1,156	1,988	2,692	5,073	5,993	5,700	4,889	3,330	2,000	
	274	0	304	395	395	395	395	395	395	395	395	395	
Deficit ****	0	-160	0	0	0	0	0	0	0	0	0	0	
1995 Water Loss (m3/sec.)													
Surface water area (km2)	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	
Water loss (1,000 m3)	23	28	34	32	31	22	23	20	22	25	25	24	
Total of outflow (1,000 m3)	907	798	574	206	46	30	31	35	76	33	51	588	
Reservoir Storage (1,000 m3)	395	395	334	315	395	395	395	395	395	395	395	395	
Water Balance (I-O)	762	334	315	693	1,362	1,637	2,769	3,389	3,456	3,040	2,202	995	
Water Balance incld. reservoir (1,000 m3)	762	334	315	693	1,362	1,637	2,769	3,389	3,456	3,040	2,202	995	
	395	334	315	395	395	395	395	395	395	395	395	395	
Deficit ****	0	0	0	0	0	0	0	0	0	0	0	0	
Deficit (1,000 m3)													
1986	0	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0	0	0	0
1991	0	0	-146	0	0	0	0	0	0	0	0	0	-146
1992	0	0	0	0	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0	0	0	0	0	0
1994	0	-160	0	0	0	0	0	0	0	0	0	0	-160
1995	0	0	0	0	0	0	0	0	0	0	0	0	0

Table IV. 9 Water Balance Calculation (Lower Xe Set Scheme)

Xe Set Scheme

		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Runoff	(m3/sec)													
***		31	28	31	30	31	30	31	31	30	31	30	31	
Runoff	1986	3.99	2.50	1.73	2.61	13.45	20.91	31.84	42.48	43.12	28.03	17.16	7.52	
	1987	4.35	2.74	1.70	5.04	10.12	19.96	36.46	43.50	42.91	28.20	13.27	6.14	
	1988	4.30	3.59	2.57	6.58	12.65	23.62	19.35	36.23	27.58	24.95	13.74	5.60	
	1989	3.85	2.29	1.44	3.75	16.25	25.60	24.95	35.91	30.61	22.42	12.77	5.76	
	1990	3.51	1.99	1.67	1.33	8.16	15.25	21.77	27.90	39.27	30.90	15.87	5.97	
	1991	3.84	2.55	2.30	2.65	6.09	11.29	32.82	41.87	41.71	37.18	17.07	9.66	
	1992	4.76	2.56	1.86	1.98	4.15	15.89	28.65	45.34	32.12	20.26	9.55	5.87	
	1993	3.49	2.48	2.00	2.05	5.55	5.38	14.31	27.39	33.77	15.24	7.26	4.34	
	1994	2.58	1.75	1.48	4.88	10.51	14.87	28.86	30.69	32.15	19.32	8.99	5.11	
	1995	3.49	2.49	1.88	1.81	5.25	5.56	12.39	20.49	23.79	16.71	8.32	4.71	
Irrigation Dc	1986	0.85	1.40	1.18	0.19	0.00	0.00	0.00	0.00	0.18	0.45	0.66	0.30	
	1987	0.85	1.47	1.31	0.11	0.00	0.00	0.00	0.00	0.30	0.60	0.79	0.36	
	1988	0.76	1.00	1.38	0.08	0.00	0.00	0.00	0.00	0.26	0.27	0.74	0.36	
	1989	0.76	1.47	1.19	0.11	0.00	0.00	0.00	0.00	0.40	0.76	0.78	0.36	
	1990	0.85	1.46	0.86	0.33	0.00	0.00	0.00	0.00	0.22	0.32	0.66	0.36	
	1991	0.85	1.47	1.48	0.48	0.00	0.00	0.00	0.00	0.02	0.17	0.79	0.32	
	1992	0.58	1.44	1.51	0.38	0.00	0.00	0.00	0.00	0.00	0.92	0.79	0.36	
	1993	0.85	1.45	1.32	0.42	0.00	0.50	0.00	0.00	0.00	1.18	0.75	0.36	
	1994	0.85	1.46	1.17	0.17	0.00	0.00	0.00	0.03	0.00	0.85	0.76	0.36	
	1995	0.85	1.40	1.47	0.48	0.00	0.00	0.00	0.11	0.28	0.60	0.72	0.36	
*** Domestic Water Demand (m3/sec.)		0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	
1986 Water Loss (m3/sec.)														
Surface water area (km2)		0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	
Potential ET (mm)		145	181	219	208	199	141	147	128	140	158	162	151	
*** Water loss (1,000 m3)		10	13	16	15	14	10	11	9	10	11	12	11	
Total of outflow (1,000 m3)		2,293	3,409	3,183	505	22	18	19	17	497	1,223	1,718	830	
Reservoir Storage (1,000 m3)		0	0	0	0	0	0	0	0	0	0	0	0	
Water Balance (I-O)		8,400	2,630	1,464	6,250	36,007	54,172	85,257	113,754	111,259	73,858	42,748	19,314	
Water Balance incld. reservoir (1,000 m3)		8,400	2,630	1,464	6,250	36,007	54,172	85,257	113,754	111,259	73,858	42,748	19,314	
		0	0	0	0	0	0	0	0	0	0	0	0	
Required Reservoir Capacity (1,000 m3)		0												
Deficit ****		0	0	0	0	0	0	0	0	0	0	0	0	
1987 Water Loss (m3/sec.)														
Surface water area (km2)		0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	
Water loss (1,000 m3)		10	13	16	15	14	10	11	9	10	11	12	11	
Total of outflow (1,000 m3)		2,293	3,575	3,535	305	22	18	19	17	802	1,625	2,060	983	
Reservoir Storage (1,000 m3)		0	0	0	0	0	0	0	0	0	0	0	0	
Water Balance (I-O)		9,359	3,041	1,027	12,748	27,076	51,728	97,636	116,481	110,412	73,896	32,336	15,458	
Water Balance incld. reservoir (1,000 m3)		9,359	3,041	1,027	12,748	27,076	51,728	97,636	116,481	110,412	73,896	32,336	15,458	
		0	0	0	0	0	0	0	0	0	0	0	0	
Deficit ****		0	0	0	0	0	0	0	0	0	0	0	0	
1988 Water Loss (m3/sec.)														

	Surface water area (km2)	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
	Water loss (1,000 m3)	10	13	16	15	14	10	11	9	10	11	12	11
	Total of outflow (1,000 m3)	2,052	2,450	3,720	224	22	18	19	17	679	733	1,932	983
	Reservoir Storage (1,000 m3)	0	0	0	0	0	0	0	0	0	0	0	0
	Water Balance (I-O)	9,467	6,245	3,154	16,843	33,865	61,195	51,811	97,013	70,803	66,088	33,681	14,014
	Water Balance incld. reservoir (1,000 m3)	9,467	6,245	3,154	16,843	33,865	61,195	51,811	97,013	70,803	66,088	33,681	14,014
		0	0	0	0	0	0	0	0	0	0	0	0
	Deficit ****	0	0	0	0	0	0	0	0	0	0	0	0
1989	Water Loss (m3/sec.)												
	Surface water area (km2)	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
	Water loss (1,000 m3)	10	13	16	15	14	10	11	9	10	11	12	11
	Total of outflow (1,000 m3)	2,044	3,575	3,221	314	22	18	19	17	1,056	2,045	2,048	983
	Reservoir Storage (1,000 m3)	0	0	0	0	0	0	0	0	0	0	0	0
	Water Balance (I-O)	8,269	1,959	630	9,415	43,498	66,337	66,799	96,165	78,284	58,002	31,040	14,442
	Water Balance incld. reservoir (1,000 m3)	8,269	1,959	630	9,415	43,498	66,337	66,799	96,165	78,284	58,002	31,040	14,442
		0	0	0	0	0	0	0	0	0	0	0	0
	Deficit ****	0	0	0	0	0	0	0	0	0	0	0	0
1990	Water Loss (m3/sec.)												
	Surface water area (km2)	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
	Water loss (1,000 m3)	10	13	16	15	14	10	11	9	10	11	12	11
	Total of outflow (1,000 m3)	2,287	3,564	2,334	870	22	18	19	17	590	889	1,733	983
	Reservoir Storage (1,000 m3)	0	0	0	0	0	0	0	0	0	0	0	0
	Water Balance (I-O)	7,106	1,248	2,131	2,590	21,830	39,519	58,303	74,719	101,198	81,864	39,412	15,008
	Water Balance incld. reservoir (1,000 m3)	7,106	1,248	2,131	2,590	21,830	39,519	58,303	74,719	101,198	81,864	39,412	15,008
		0	0	0	0	0	0	0	0	0	0	0	0
	Deficit ****	0	0	0	0	0	0	0	0	0	0	0	0
1991	Water Loss (m3/sec.)												
	Surface water area (km2)	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
	Water loss (1,000 m3)	10	13	16	15	14	10	11	9	10	11	12	11
	Total of outflow (1,000 m3)	2,288	3,571	3,988	1,262	22	18	19	17	63	484	2,058	889
	Reservoir Storage (1,000 m3)	0	0	0	0	0	0	0	0	0	0	0	0
	Water Balance (I-O)	7,989	2,608	2,181	5,594	16,288	29,239	87,885	112,132	108,039	99,089	42,193	24,994
	Water Balance incld. reservoir (1,000 m3)	7,989	2,608	2,181	5,594	16,288	29,239	87,885	112,132	108,039	99,089	42,193	24,994
		0	0	0	0	0	0	0	0	0	0	0	0
	Deficit ****	0	0	0	0	0	0	0	0	0	0	0	0
1992	Water Loss (m3/sec.)												
	Surface water area (km2)	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
	Water loss (1,000 m3)	10	13	16	15	14	10	11	9	10	11	12	11
	Total of outflow (1,000 m3)	1,564	3,494	4,066	1,000	22	18	19	17	18	2,490	2,060	983
	Reservoir Storage (1,000 m3)	0	0	0	0	0	0	0	0	0	0	0	0
	Water Balance (I-O)	11,172	2,702	903	4,142	11,087	41,181	76,729	121,414	83,229	51,783	22,691	14,746
	Water Balance incld. reservoir (1,000 m3)	11,172	2,702	903	4,142	11,087	41,181	76,729	121,414	83,229	51,783	22,691	14,746
		0	0	0	0	0	0	0	0	0	0	0	0

Deficit ****	0	0	0	0	0	0	0	0	0	0	0	0	
1993 Water Loss (m3/sec.)													
Surface water area (km2)	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	
Water loss (1,000 m3)	10	13	16	15	14	10	11	9	10	11	12	11	
Total of outflow (1,000 m3)	2,293	3,539	3,553	1,108	22	1,316	19	17	18	3,193	1,966	983	
Reservoir Storage (1,000 m3)	0	0	0	0	0	0	0	0	0	0	0	0	
Water Balance (I-O)	7,043	2,468	1,797	4,214	14,833	12,617	38,302	73,347	87,502	37,616	16,846	10,650	
Water Balance incld. reservoir (1,000 m3)	7,043	2,468	1,797	4,214	14,833	12,617	38,302	73,347	87,502	37,616	16,846	10,650	
	0	0	0	0	0	0	0	0	0	0	0	0	
Deficit ****	0	0	0	0	0	0	0	0	0	0	0	0	
1994 Water Loss (m3/sec.)													
Surface water area (km2)	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	
Water loss (1,000 m3)	10	13	16	15	14	10	11	9	10	11	12	11	
Total of outflow (1,000 m3)	2,293	3,551	3,162	451	22	18	19	93	18	2,308	1,999	983	
Reservoir Storage (1,000 m3)	0	0	0	0	0	0	0	0	0	0	0	0	
Water Balance (I-O)	4,607	690	814	12,195	28,131	38,531	77,268	82,104	83,317	49,435	21,291	12,712	
Water Balance incld. reservoir (1,000 m3)	4,607	690	814	12,195	28,131	38,531	77,268	82,104	83,317	49,435	21,291	12,712	
	0	0	0	0	0	0	0	0	0	0	0	0	
Deficit ****	0	0	0	0	0	0	0	0	0	0	0	0	
1995 Water Loss (m3/sec.)													
Surface water area (km2)	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	
Water loss (1,000 m3)	10	13	16	15	14	10	11	9	10	11	12	11	
Total of outflow (1,000 m3)	2,293	3,399	3,963	1,280	22	18	19	304	736	1,623	1,886	983	
Reservoir Storage (1,000 m3)	0	0	0	0	0	0	0	0	0	0	0	0	
Water Balance (I-O)	7,067	2,618	1,068	3,421	14,027	14,394	33,160	54,589	60,919	43,133	19,679	11,627	
Water Balance incld. reservoir (1,000 m3)	7,067	2,618	1,068	3,421	14,027	14,394	33,160	54,589	60,919	43,133	19,679	11,627	
	0	0	0	0	0	0	0	0	0	0	0	0	
Deficit ****	0	0	0	0	0	0	0	0	0	0	0	0	
Deficit (1,000 m3)													
1986	0	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0	0	0	0	0	0	0

Table IV. 10 Water Balance Calculation (Upper Tay-Un Scheme)

Tay-Un Scheme

Runoff (m3/sec)

		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Total
***		31	28	31	30	31	30	31	31	30	31	30	31	
Runoff	1986	0.41	0.32	0.25	0.24	0.60	0.96	1.44	1.96	2.06	1.46	0.99	0.54	
	1987	0.41	0.32	0.25	0.31	0.48	0.89	1.63	2.01	2.02	1.46	0.81	0.46	
	1988	0.38	0.32	0.27	0.37	0.60	1.07	0.92	1.65	1.35	1.24	0.79	0.42	
	1989	0.32	0.24	0.18	0.21	0.72	1.16	1.14	1.60	1.41	1.13	0.69	0.39	
	1990	0.29	0.21	0.18	0.15	0.37	0.64	0.97	1.24	1.70	1.47	0.86	0.41	
	1991	0.32	0.25	0.30	0.31	0.28	0.50	0.75	1.33	1.40	1.29	0.98	0.70	
	1992	0.39	0.31	0.26	0.23	0.31	0.49	0.81	1.19	1.34	1.15	0.69	0.42	
	1993	0.30	0.23	0.18	0.16	0.27	0.52	0.66	0.82	1.29	1.14	0.82	0.60	
	1994	0.29	0.21	0.15	0.14	0.23	0.56	0.98	1.31	1.46	1.12	0.51	0.31	
	1995	0.22	0.15	0.09	0.05	0.26	0.42	0.81	0.83	0.87	0.65	0.31	0.17	
Irrigation Dε	1986	0.13	0.22	0.20	0.06	0.00	0.00	0.00	0.00	0.04	0.13	0.20	0.04	
	1987	0.13	0.24	0.22	0.03	0.00	0.00	0.00	0.00	0.08	0.17	0.25	0.06	
	1988	0.12	0.16	0.24	0.02	0.00	0.00	0.00	0.00	0.06	0.07	0.23	0.06	
	1989	0.13	0.24	0.20	0.02	0.00	0.00	0.00	0.00	0.00	0.18	0.16	0.06	
	1990	0.13	0.24	0.20	0.08	0.00	0.00	0.00	0.00	0.00	0.13	0.20	0.06	
	1991	0.13	0.11	0.08	0.10	0.00	0.00	0.00	0.00	0.23	0.06	0.00	0.02	
	1992	0.10	0.19	0.15	0.06	0.00	0.00	0.07	0.00	0.02	0.25	0.00	0.02	
	1993	0.12	0.20	0.17	0.05	0.00	0.00	0.04	0.00	0.00	0.12	0.00	0.01	
	1994	0.13	0.24	0.20	0.08	0.00	0.00	0.00	0.00	0.06	0.33	0.25	0.05	
	1995	0.13	0.24	0.26	0.08	0.00	0.00	0.00	0.13	0.21	0.28	0.23	0.04	
*** Domestic Water Demand (m3/sec.)		0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	
1986 Water Loss (m3/sec.)														
Surface water area (km2)		0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	
Potential ET (mm)		145	181	219	208	199	141	147	128	140	158	162	151	
*** Water loss (1,000 m3)		10	13	16	15	14	10	11	9	10	11	12	11	
Total of outflow (1,000 m3)		374	558	561	175	17	13	13	12	110	354	536	130	
Reservoir Storage (1,000 m3)		200	200	200	200	200	200	200	200	200	200	200	200	
Water Balance (I-O)		912	414	318	645	1,791	2,671	4,038	5,436	5,427	3,755	2,221	1,503	
Water Balance incld. reservoir (1,000 m3)		912	414	318	645	1,791	2,671	4,038	5,436	5,427	3,755	2,221	1,503	
		200	200	200	200	200	200	200	200	200	200	200	200	
Required Reservoir Capacity (1,000 m3)		200												
Deficit ****		0	0	0	0	0	0	0	0	0	0	0	0	
1987 Water Loss (m3/sec.)														
Surface water area (km2)		0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	
Water loss (1,000 m3)		10	13	16	15	14	10	11	9	10	11	12	11	
Total of outflow (1,000 m3)		374	585	618	104	17	13	13	12	209	472	658	167	
Reservoir Storage (1,000 m3)		200	200	200	200	200	200	200	200	200	200	200	200	
Water Balance (I-O)		912	383	244	904	1,461	2,499	4,548	5,584	5,223	3,638	1,653	1,278	
Water Balance incld. reservoir (1,000 m3)		912	383	244	904	1,461	2,499	4,548	5,584	5,223	3,638	1,653	1,278	
		200	200	200	200	200	200	200	200	200	200	200	200	
Deficit ****		0	0	0	0	0	0	0	0	0	0	0	0	
1988 Water Loss (m3/sec.)														
Surface water area (km2)		0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	
Water loss (1,000 m3)		10	13	16	15	14	10	11	9	10	11	12	11	

Total of outflow (1,000 m3)	334	402	649	75	17	13	13	12	170	189	613	167
Reservoir Storage (1,000 m3)	200	200	200	200	200	200	200	200	200	200	200	200
Water Balance (I-O)	874	572	284	1,085	1,779	2,954	2,651	4,617	3,528	3,337	1,634	1,146
Water Balance incld. reservoir (1,000 m3)	874	572	284	1,085	1,779	2,954	2,651	4,617	3,528	3,337	1,634	1,146
	200	200	200	200	200	200	200	200	200	200	200	200
Deficit ****	0	0	0	0	0	0	0	0	0	0	0	0
1989 Water Loss (m3/sec.)												
Surface water area (km2)	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Water loss (1,000 m3)	10	13	16	15	14	10	11	9	10	11	12	11
Total of outflow (1,000 m3)	357	585	561	64	17	13	13	12	13	485	437	164
Reservoir Storage (1,000 m3)	200	200	198	126	200	200	200	200	200	200	200	200
Water Balance (I-O)	703	198	126	611	2,108	3,187	3,252	4,464	3,830	2,738	1,545	1,088
Water Balance incld. reservoir (1,000 m3)	703	198	126	611	2,108	3,187	3,252	4,464	3,830	2,738	1,545	1,088
	200	198	126	200	200	200	200	200	200	200	200	200
Deficit ****	0	0	0	0	0	0	0	0	0	0	0	0
1990 Water Loss (m3/sec.)												
Surface water area (km2)	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Water loss (1,000 m3)	10	13	16	15	14	10	11	9	10	11	12	11
Total of outflow (1,000 m3)	374	585	547	214	17	13	13	12	13	374	540	167
Reservoir Storage (1,000 m3)	200	200	131	52	200	200	200	200	200	200	200	200
Water Balance (I-O)	608	131	52	216	1,174	1,844	2,783	3,504	4,587	3,757	1,897	1,128
Water Balance incld. reservoir (1,000 m3)	608	131	52	216	1,174	1,844	2,783	3,504	4,587	3,757	1,897	1,128
	200	131	52	200	200	200	200	200	200	200	200	200
Deficit ****	0	0	0	0	0	0	0	0	0	0	0	0
1991 Water Loss (m3/sec.)												
Surface water area (km2)	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Water loss (1,000 m3)	10	13	16	15	14	10	11	9	10	11	12	11
Total of outflow (1,000 m3)	359	291	222	283	17	13	13	12	605	174	14	57
Reservoir Storage (1,000 m3)	200	200	200	200	200	200	200	200	200	200	200	200
Water Balance (I-O)	710	523	782	730	944	1,483	2,205	3,737	3,215	3,477	2,719	2,013
Water Balance incld. reservoir (1,000 m3)	710	523	782	730	944	1,483	2,205	3,737	3,215	3,477	2,719	2,013
	200	200	200	200	200	200	200	200	200	200	200	200
Deficit ****	0	0	0	0	0	0	0	0	0	0	0	0
1992 Water Loss (m3/sec.)												
Surface water area (km2)	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Water loss (1,000 m3)	10	13	16	15	14	10	11	9	10	11	12	11
Total of outflow (1,000 m3)	284	487	429	172	17	13	195	12	77	695	14	62
Reservoir Storage (1,000 m3)	200	200	200	200	200	200	200	200	200	200	200	200
Water Balance (I-O)	956	473	462	615	1,014	1,445	2,162	3,374	3,599	2,574	1,978	1,255
Water Balance incld. reservoir (1,000 m3)	956	473	462	615	1,014	1,445	2,162	3,374	3,599	2,574	1,978	1,255
	200	200	200	200	200	200	200	200	200	200	200	200
Deficit ****	0	0	0	0	0	0	0	0	0	0	0	0
1993 Water Loss (m3/sec.)												
Surface water area (km2)	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Water loss (1,000 m3)	10	13	16	15	14	10	11	9	10	11	12	11

Total of outflow (1,000 m3)	339	506	471	141	17	13	125	12	13	326	14	42	
Reservoir Storage (1,000 m3)	200	200	200	200	200	200	200	200	200	200	200	200	
Water Balance (I-O)	666	241	210	464	913	1,532	1,853	2,387	3,543	2,925	2,303	1,778	
Water Balance incld. reservoir (1,000 m3)	666	241	210	464	913	1,532	1,853	2,387	3,543	2,925	2,303	1,778	
	200	200	200	200	200	200	200	200	200	200	200	200	
Deficit ****	0	0	0	0	0	0	0	0	0	0	0	0	
1994 Water Loss (m3/sec.)													
Surface water area (km2)	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	
Water loss (1,000 m3)	10	13	16	15	14	10	11	9	10	11	12	11	
Total of outflow (1,000 m3)	374	585	561	221	17	13	13	12	173	909	650	151	
Reservoir Storage (1,000 m3)	200	200	131	0	152	200	200	200	200	200	200	200	
Water Balance (I-O)	608	131	-17	152	748	1,639	2,820	3,700	3,821	2,291	873	884	
Water Balance incld. reservoir (1,000 m3)	608	131	0	152	748	1,639	2,820	3,700	3,821	2,291	873	884	
	200	131	0	152	200	200	200	200	200	200	200	200	
Deficit ****	0	0	-17	0	0	0	0	0	0	0	0	0	
1995 Water Loss (m3/sec.)													
Surface water area (km2)	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	
Water loss (1,000 m3)	10	13	16	15	14	10	11	9	10	11	12	11	
Total of outflow (1,000 m3)	374	584	707	229	17	13	13	358	563	769	613	122	
Reservoir Storage (1,000 m3)	200	200	0	0	0	200	200	200	200	200	200	200	
Water Balance (I-O)	422	-21	-472	-108	667	1,264	2,350	2,069	1,900	1,167	388	544	
Water Balance incld. reservoir (1,000 m3)	422	0	0	0	667	1,264	2,350	2,069	1,900	1,167	388	544	
	200	0	0	0	200	200	200	200	200	200	200	200	
Deficit ****	0	-21	-472	-108	0	0	0	0	0	0	0	0	
Deficit (1,000 m3)													
1986	0	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0	0	0	0	0	0
1994	0	0	-17	0	0	0	0	0	0	0	0	0	-17
1995	0	-21	-472	-108	0	0	0	0	0	0	0	0	-601

Table IV.11 Salient Features of Upper Champi, Upper Tapoung and Upper Kapheu Schemes

Upper Champi Scheme

	General Description	
Scheme Name	**Upper Champi**	
Location and Altitude	Pakxong District, Champasak Province (EL 900 to 1,200 m)	
No. of Target Villages	8 villages	
Village Name	Lak33, Lak35, Lak36, Lak38, Lak40, Lak42, Lak43, Lak45	
Households	828 households	
Population	4,731	
Irrigation and Drainage Facilities		
- Water sources	H.Champi	
- Proposed cropping pattern and Irrigation area (net)	Coffee : 620 ha, Upland Crops - Vegetables : 110 ha	730 ha
- Diversion weir	Concrete diversion weir, Width = 43.0 m	1 place
- Earthfill dam	V = 34,000 m3	1 no.
- Reservoir	Effective storage capacity = 105,000 m3	
- Design discharge		0.117 m3/sec.
- Main irrigation canals	Concrete lining canal, 2 canals	4.7 km
- Secondary irrigation canals	Concrete lining canal, 3 canals	13.0 km
- Secondary drainage canals	Earth canal, 8 canals	3.0 km
- Farm road	Effective width = 3.0m, Gravel pavement	21.2 km
- Farm ponds	Cut and embankment pond	43 places

Upper Tapoung Scheme

	General Description	
Scheme Name	**Upper Tapoung**	
Location and Altitude	Pakxong District, Champasak Province (EL 900 to 1,300 m)	
No. of Target Villages	3 villages	
Village Name	Phoulangkeo, Houaisan, Xetapung	
Households	262 households	
Population	1,478	
Irrigation and Drainage Facilities		
- Water sources	H.Tapoung	
- Proposed cropping pattern and Irrigation area (net)	Upland Crop - Vegetable : 80 ha	80 ha
- Diversion weir	Concrete diversion weir, Width = 38.0 m	1 place
- Reservoir	Effective storage capacity = 240,000 m3	
- Design discharge		0.063 m3/sec.
- Main irrigation canals	Concrete lining canal, 1 canal	1.6 km
- Secondary irrigation canals	Concrete lining canal, 1 canal	0.8 km
- Secondary drainage canals	Earth canal, 1 canal	0.2 km
- Farm roads	Effective width = 3.0m, Gravel pavement	5.3 km
- Farm ponds	Cut and embankment pond	5 places

Upper Kapheu Scheme

	General Description	
Scheme Name	**Upper Kapheu**	
Location and Altitude	Laongam District, Salavan Province (EL 600 to 800m)	
No. of Target Villages	5 villages	
Village Name	Phouak-noi, Sixiangmai, On-noi, Phouak-gnai, On-gnai	
Households	456 households	
Population	2,393	
Irrigation and Drainage Facilities		
- Water sources	H.Kapheu	
- Proposed cropping pattern and Irrigation area (net)	Coffee : 900 ha, Paddy - Upland Crops : 100 ha	1,000 ha
- Diversion weir	Concrete diversion weir, Width = 14.0 m	1 place
- Earthfill dam	V1 = 20,000 m3, V2 = 16,000 m3, V3 = 18,000 m3, V4 = 18,000 m3	4 nos.
- Reservoir	Dam No.1: Effective storage capacity = 137,000 m3	
	Dam No.2: Effective storage capacity = 64,000 m3	
	Dam No.3: Effective storage capacity = 52,000 m3	
	Dam No.4: Effective storage capacity = 142,000 m3	
- Design discharge		0.272 m3/sec.
- Main irrigation canals	Concrete lining canal, 2 canals	2.2 km
- Secondary irrigation canals	Concrete lining canal, 3 canals	11.8 km
- Secondary drainage canals	Earth canal, 6 canals	1.1 km
- Farm roads	Effective width = 3.0m, Gravel pavement	15.3 km
- Farm roads	Cut and embankment pond	35 places

Table IV.12 Salient Features of the Lower Xe Set and Upper Tay - Un Schemes

Lower Xe Set Scheme

	General Description	
Scheme Name	Lower Xe Set	
Location and Altitude	Salavan District, Salavan Province (EL 300 to 400m)	
No. of Target Villages	6 villages	
Village Name	Natteu, Sengvang-gnai, Houakhoua, Sengvang-noi, Khonleng, Natou	
Households	386 households	
Population	2,309	
(2) Irrigation and Drainage Facilities		
- Water sources	H.Xe Set	
- Proposed cropping pattern and Irrigation area (net)	Paddy - Paddy : 200 ha, Paddy - Upland Crops : 800 ha	1,000 ha
- Diversion Weir	Concrete diversion weir, Width = 75.0 m	1 place
- Regulation pond		1 place
- Design discharge		9.030 m3/sec.
- Main irrigation canals	Concrete lining canal, 3 canals	3.6 km
- Secondary irrigation canals	Concrete lining canal, 5 canals	11.0 km
- Secondary drainage canals	Earth canal, 4 canals	7.6 km
- Farm roads	Effective width = 3.0 m, Gravel pavement	26.0 km
- Farm ponds	Cut and embankment pond	35 places

Upper Tay - Un Scheme

	General Description	
Scheme Name	Upper Tay-Un	
Location and Altitude	Thateng District, Sekong Province (EL 500 to 600m)	
No. of Target Villages	3 villages	
Village Name	Chakamlit, Khamkok, Chakam-mai	
Households	108 households	
Population	871	
Irrigation and Drainage Facilities		
- Water sources	H.Tay-un, and H.Thon	
- Proposed cropping pattern and Irrigation area (net)	Paddy - Paddy : 70 ha, Paddy - Upland Crops : 80 ha	
	Rainy Season Paddy : 180 ha	330 ha
- Diversion weir	H.Tay-Un, Dam No.1 Earthfill dam	1 place
	H.Thon, Dam No.2 Earthfill dam	1 place
	Dam No.3 Earthfill dam	1 place
- Earthfill dam	V1 = 21,000 m3, V2 = 49,000 m3, V3 = 10,000 m3	3 nos.
- Reservoir	Effective storage capacity = - m3	
	Effective storage capacity = 158,000 m3	
	Effective storage capacity = 65,000 m3	
- Regulation pond		1 place
- Design discharge	Dam No.1	0.489 m3/sec.
	Dam No.2	0.382 m3/sec.
- Main irrigation canals	Concrete lining canal, 2 canals	2.5 km
- Secondary irrigation canals	Concrete lining canal, 3 canals	2.3 km
- Secondary drainage canals	Earth canal, 1 canal	0,1 km
- Inspection roads	Effective width = 3.0 m, Gravel pavement	5.0 km

Figures

Figure IV.1 Reservoir Storage Curve of Upper Champi Scheme

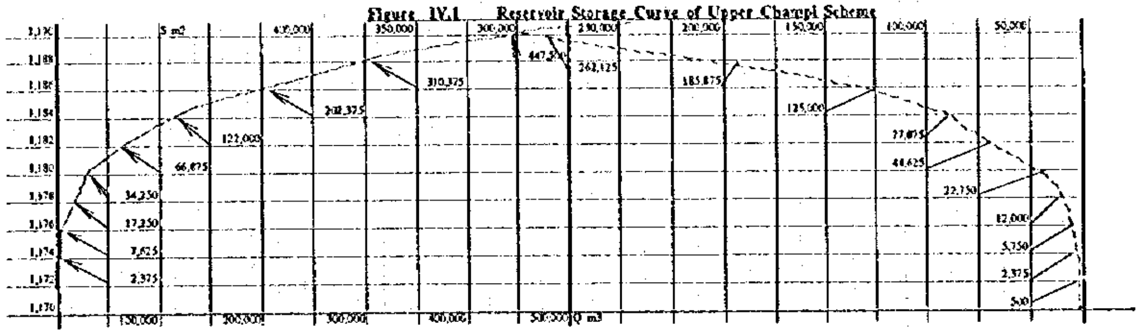


Figure IV.2 Reservoir Storage Curve of Upper Tapoung Scheme

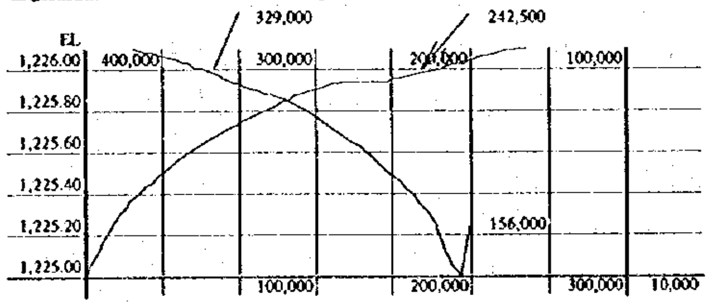


Figure IV.3 Reservoir Storage Curve of Kapheu Scheme

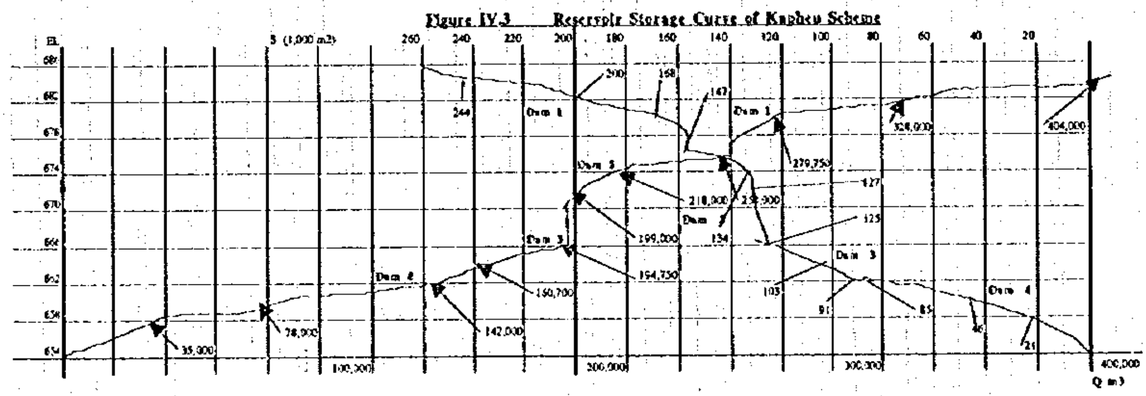
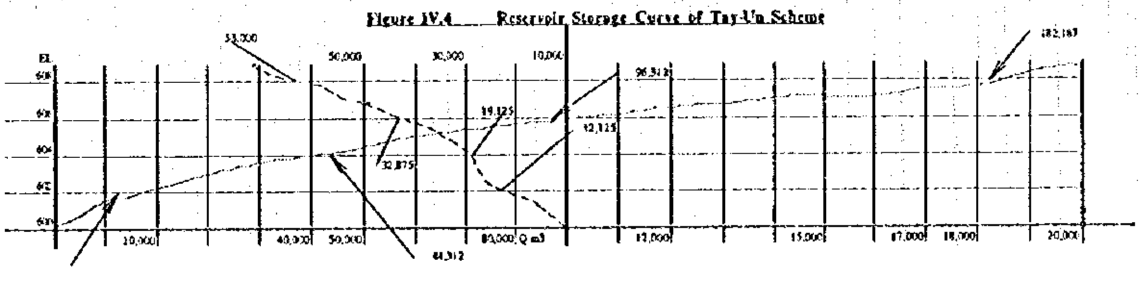


Figure IV.4 Reservoir Storage Curve of Tay-Un Scheme



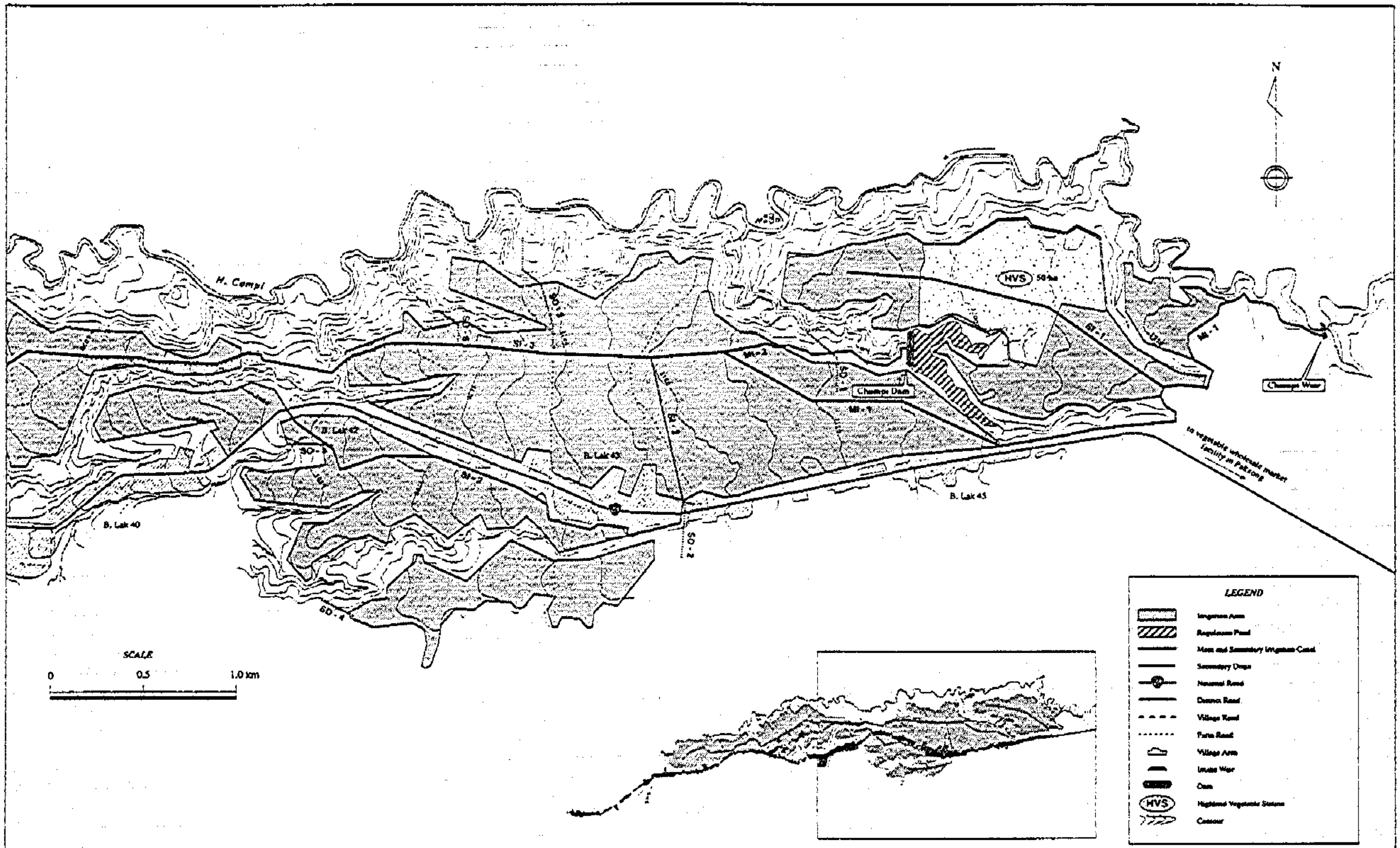


Figure IV.5 Canal Layout of Upper Champi Scheme (1/2)

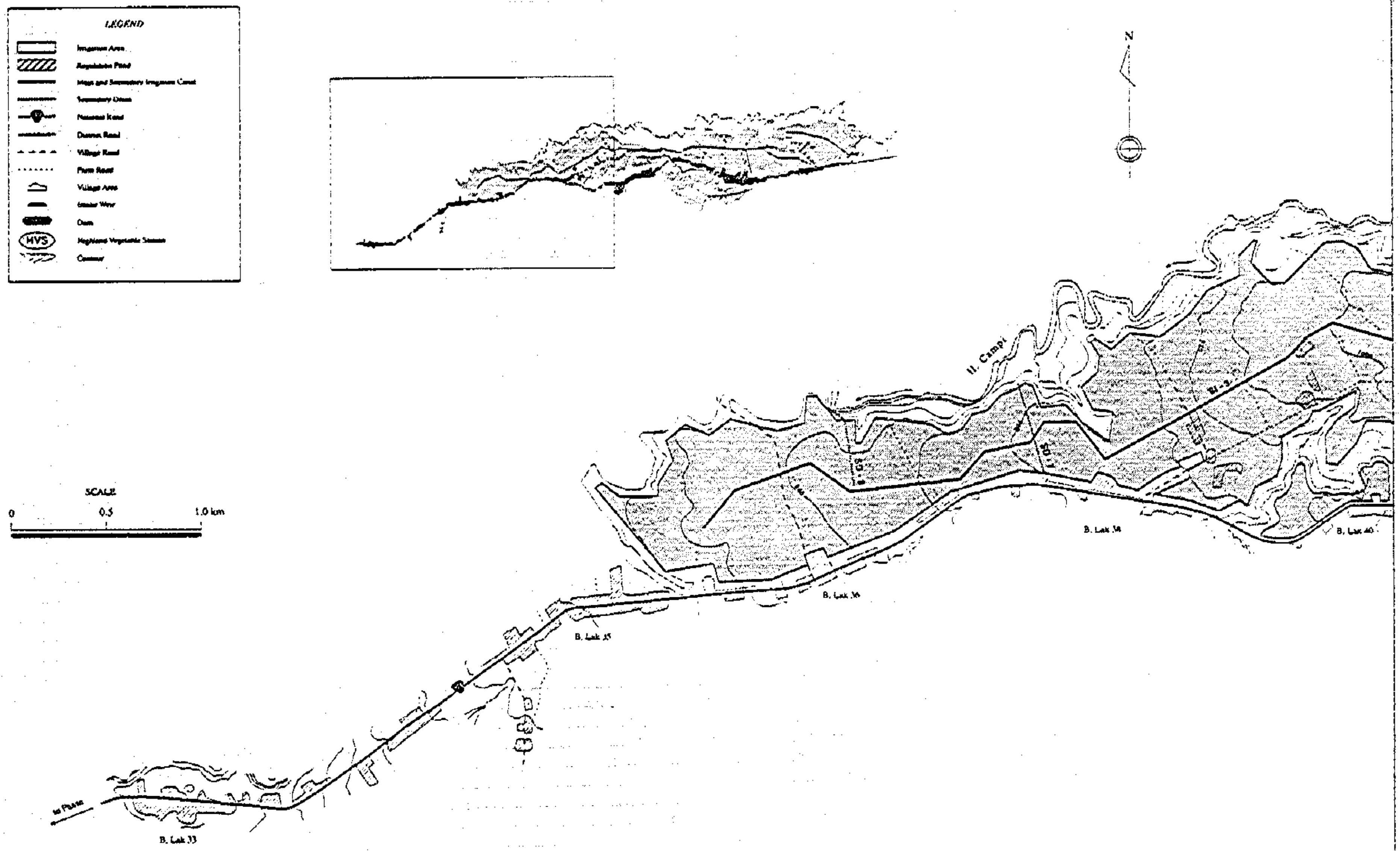


Figure IV.5 Canal Layout of Upper Champi Scheme (2/2)

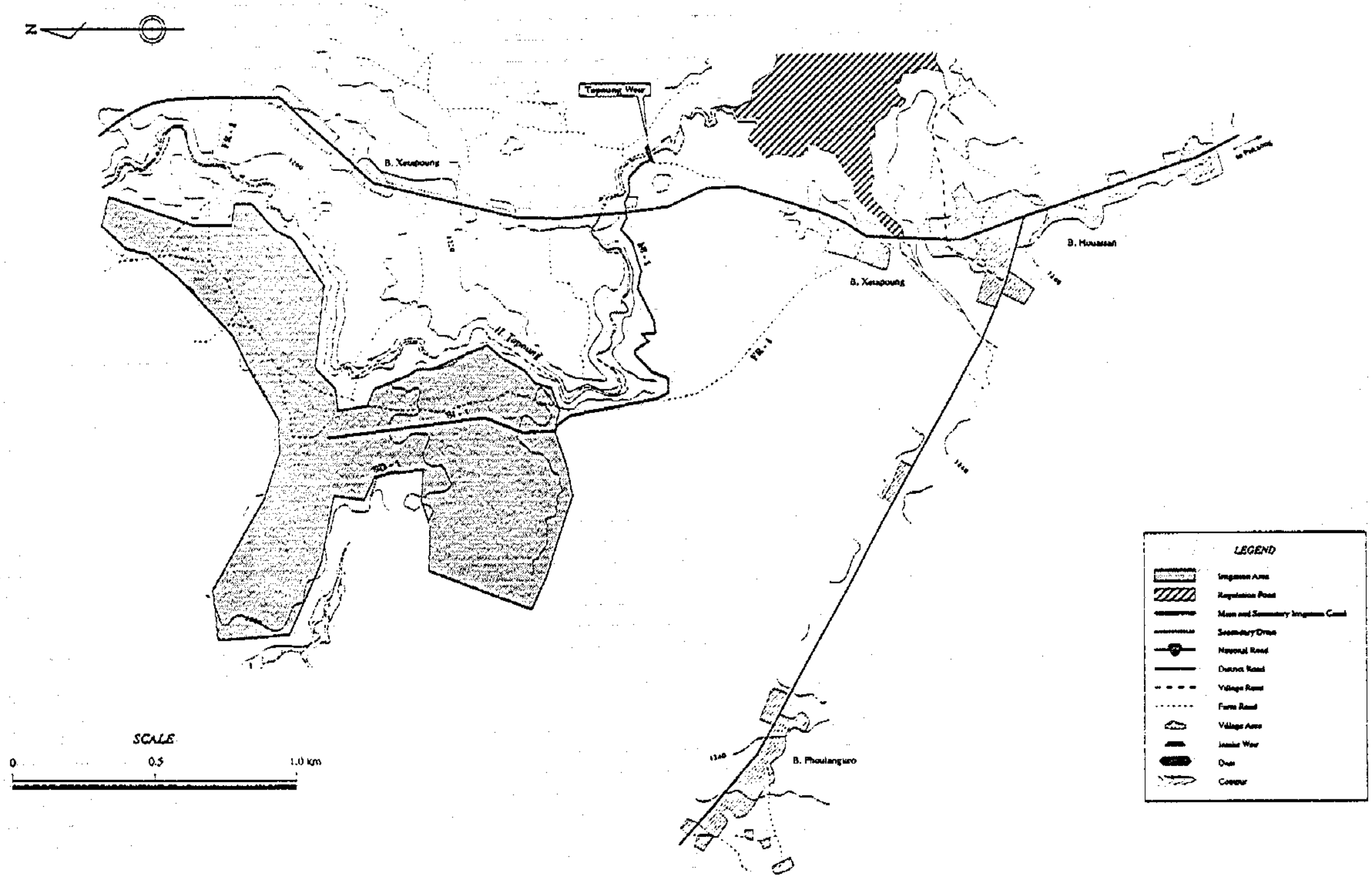


Figure IV.6 Canal Layout of Upper Tapoung Scheme

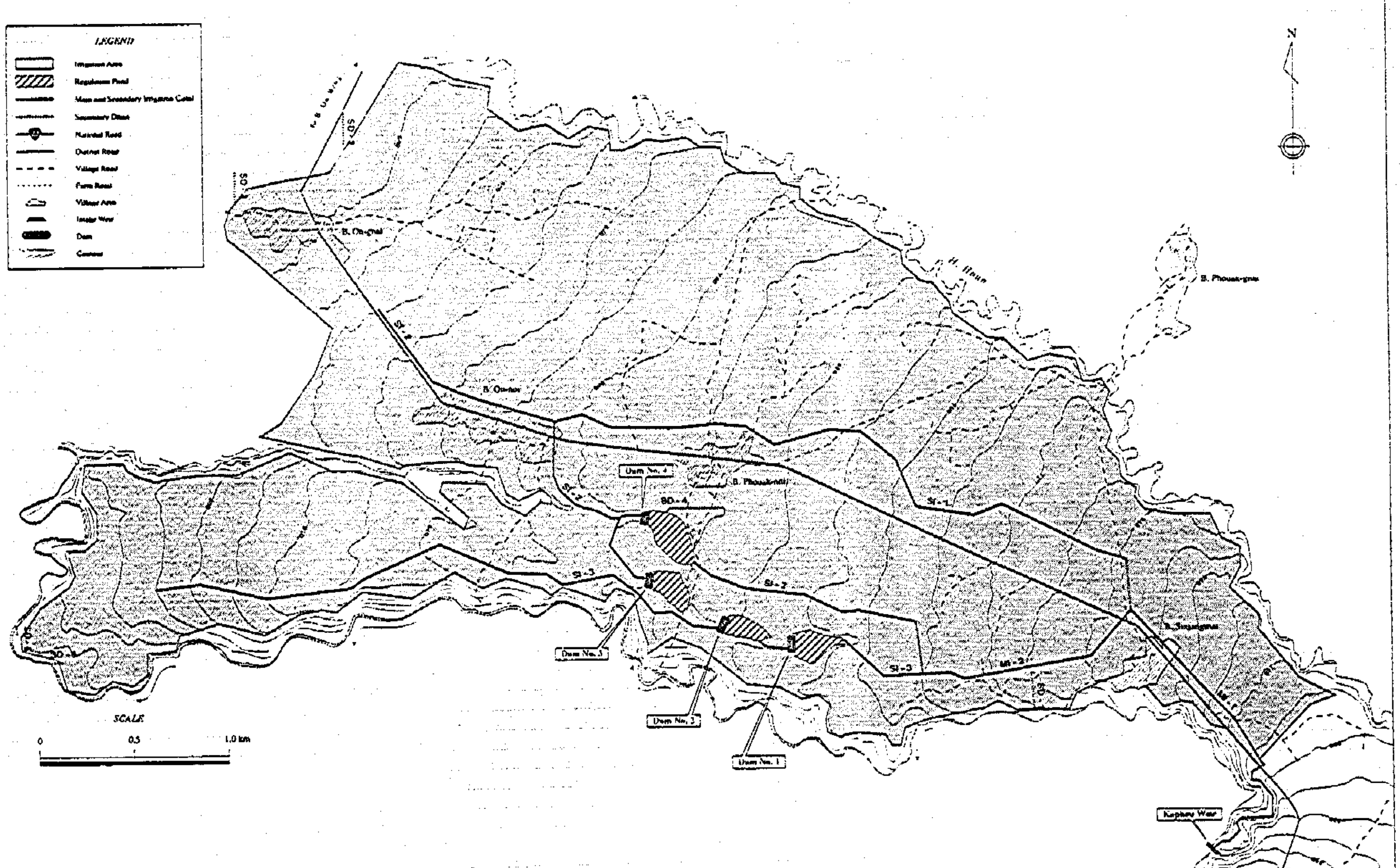


Figure IV.7 Canal Layout of Upper Kapheu Scheme

Figure IV.8 Canal Layout of Lower Xe Set Scheme (1/2)