Table VII-17 Market Price of Vegetables

Vegetable	Market Price		Area Produced
	Rainy season (Kip/kg)	Dry season (Kip/kg)	
Cucumber	80	40	Vientiane
Longbean	150	30 - 40	Vientiane
Eggplant	120	30 - 60	Vientiane
Leaf vegetables	300	30 - 40	Vientiane
Chilli (fresh)	300 - 400	200	Vientiane
Chilli(dry)	1500	800	Vientiane
Garlic	600 - 700	200 - 300	Xienkhuang
Red onion	300	300	Vientiane
Sweet potato	120	100	Vientiane
Tomato	500	30	Vientiane (dry season)
			Thailand (rainy season)
Onion	600	250	Thailand
Potato	200	100	Pakxe
Cabbage	200	100	Pakxe, Thailand
Carrot	300	100 - 200	Pakxe, Thailand
Chinese cabbage	300	-	Pakxe, Thailand
Green pepper	500 - 600	-	Pakxe, Thailand

Remark: Market prices at Vientiane markets in 1988 surveyed by the Study team

Table VII-18 Farm Gate Price of Farm Products and Inputs (as of 1988)

(Unit: Kip/kg, day)

Description			Price
1.	Farm Products		
		Dried Paddy	50
		Soybean	130
		Groundnut	60
		Garlic	200
2.	Farm Inputs		
	Seed	Paddy	55
		Soybean	250
		Groundnut	250
		Garlic (bulb)	500
	Fertilizer	Urea	110
		Ammophos	120
	Agro-chemical	Diazinon	720
		Sevin	2,800
		Foridan	850
3.	Farm Labor	(throughout a year)	400

Source: Department of Cooperatives of MAF and the farm interview survey by the Study team.

Table VII-19 Production Cost of Paddy under Present Condition

	Description	Unit Price	Wet Season Paddy (Amount/ha)	(Kip/ha)	Dry Season Paddy (Amount/ha)	(Kip/ha)
1.	Farm Inputs					
	Seed	55 Kip/kg	66 kg	3,600	102 kg	5,600
	Fertilizers					
	Urea	110 Kip/kg	7 kg	800	0 kg	0
	Ammophos	120 Kip/kg	17 kg	2,100	104 kg	12,500
	Farm chemicals					
	Insecticide	720 Kip/kg	0.04 kg	0	2.40 kg	1,700
2.	Labor cost	400 Kip/man-day	127 man-day	50,800	153 man-day	61,200
3.	Others					
	Equipment etc.	5% of others		2,900		4,100
	Total Cost			60,200		85,100

Note: Unit prices are given in 1988 price based on the information from MAF.

Table VII-20 Results of Farm Budget Survey

(Unit: Kip/household/year)

Village	Nos. of Sampling Farmers	Average Farm Size (ha)	Average Family Size (No.)	Income			Expendi-ture	Balance
				Farm Income	Off-farm Income	Total Income		
B. Pha Khao	16	1.57	7.08	147,800	181,800	329,600	136,300	193,300
B. Sa Phang Muk	7	2.79	7.29	165,100	59,400	224,600	131,700	92,900
B. Don Noun	10	2.40	7.30	255,300	175,300	430,600	224,800	205,800
B. Xai	8	3.11	6.50	207,400	51,30	258,700	175,400	83,300
B. Na Khe	5	2.18	6.20	115,000	311,800	426,800	161,200	265,600
B. Dan Xang	10	1.54	7.40	169,200	111,000	280,200	137,400	142,800
B. Don Sang Hinh	5	1.52	6.40	116,400	52,800	169,200	121,000	48,200
B. Na	10	1.95	8.40	157,100	49,400	206,500	113,900	92,600
B. Sok Nhai	9	1.94	6.78	114,900	132,400	247,40	161,100	86,300
B. Sok Noi	10	2.37	7.89	163,300	61,100	224,400	120,100	104,300
B. Phone Thong	4	2.05	7.00	153,300	46,200	199,50	150,300	49,200
B. Na Biene	3	2.53	9.00	144,300	40,400	184,700	145,900	38,800
Scale: 0-1 ha	17	0.84	6.94	109,000	85,500	194,500	151,600	42,900
Scale: 1-2 ha	36	1.68	7.22	135,700	126,600	262,300	118,500	143,800
Scale: 2- ha	40	3.05	7.45	213,000	110,300	323,300	175,200	148,000
Total Average	93	2.12	7.27	164,100	112,000	276,100	148,800	127,300

Remark: Out of 97 interviewed families, 4 are not farm households.

Table VII-21 Composition of Income in Farm Budget

(Unit: Kip/household/year)

Village	Farm Income						Off-farm Income					Total Income
	Short term crop	(rice)	Long term crop	Live-stock	Others	Total	Rent of farm-land	Wage salaly	Remit-tance	Others	Total	
B. Pha Khao	115,400	(28,900)	11,200	9,800	11,400	147,800	0	128,00	16,100	37,700	181,800	329,600
B. Sa Phang Muk	146,600	(21,400)	0	8,600	10,000	165,100	0	26,600	12,300	20,600	59,400	224,600
B. Don Noun	185,900	(22,900)	1,100	53,300	15,000	255,300	0	42,000	72,900	60,400	175,300	430,600
B. Xai	173,400	(43,600)	600	33,400	0	207,400	0	42,000	0	9,300	51,300	258,700
B. Na Khe	101,000	(23,000)	0	0	14,000	115,000	0	74,400	600	236,800	311,800	426,800
B. Dan Xang	116,500	(7,800)	0	47,900	4,800	169,200	600	78,600	0	31,800	111,000	280,200
B. Dong Sang Hinh	92,400	(6,000)	0	22,000	2,000	116,400	0	48,000	0	4,800	52,800	169,200
B. Na	134,200	(4,500)	300	13,200	9,400	157,100	0	6,200	0	43,200	49,400	206,500
B. Sok Nhai	95,000	(8,900)	0	18,900	1,000	114,900	0	25,300	8,400	98,700	132,400	247,400
B. Sok Noi	125,300	(26,700)	1,600	35,800	700	163,300	0	31,300	17,800	12,000	61,100	224,400
B. Phone Thong	118,000	(6,300)	0	33,800	1,500	153,300	0	19,200	0	27,000	46,200	199,500
B. Na Biene	142,600	(32,000)	0	1,700	0	144,300	0	40,400	0	0	40,400	184,700
Scale: 0-1 ha	87,000	(9,400)	600	14,300	7,100	109,000	400	56,700	7,900	20,500	85,500	194,500
(%)	44.7%	(4.8%)	0.3%	7.4%	3.7%	56.0%	0.2%	29.2%	4.1%	10.5%	44.0%	100.0%
Scale: 1-2 ha	103,400	(9,500)	4,100	21,400	6,800	135,700	0	42,500	8,100	76,000	126,600	262,300
(%)	39.4%	(3.6%)	1.6%	8.2%	2.6%	51.7%	0.0%	16.2%	3.1%	29.0%	48.3%	100.0%
Scale: 2- ha	173,200	(32,700)	500	33,200	6,200	213,000	0	57,100	20,900	32,300	110,300	323,300
(%)	53.6%	(10.1%)	0.2%	10.3%	1.9%	65.9%	0.0%	17.7%	6.5%	10.0%	34.1%	100.0%
Total Average	130,400	(19,500)	1,900	25,200	6,600	164,100	100	51,300	13,600	47,000	112,000	276,100
(%)	47.2%	(7.1%)	0.7%	9.1%	2.4%	59.4%	0.0%	18.6%	4.9%	17.0%	40.6%	100.0%

Table VII-22 Composition of Expenditure in Farm Budget

(Unit: Kip/household/year)

Village	Rice	Other food	Clothing	Residence	Education	Medical Care	Others	Total Expenditure
B. Pha Khao	28,300	13,800	33,800	7,400	4,600	9,500	39,400	136,300
B. Sa Phang Muk	25,600	21,400	25,100	8,100	2,700	7,500	41,100	131,700
B. Don Noun	4,100	9,600	42,500	7,400	12,900	16,300	132,000	224,800
B. Xai	30,900	56,300	29,600	4,900	13,100	12,200	28,500	175,400
B. Na Khe	11,000	72,000	29,000	5,400	4,000	8,700	31,200	161,200
B. Dan Xang	22,100	45,000	34,100	4,600	2,800	7,300	21,600	137,400
B. Dong Sang Hinh	20,400	39,600	9,600	0	1,200	21,400	28,800	121,000
B. Na	3,600	46,800	30,000	6,700	4,000	6,600	16,200	113,900
B. Sok Nhai	13,400	50,400	24,200	4,000	3,000	9,900	56,100	161,100
B. Sok Noi	28,200	51,300	16,300	3,200	2,400	6,200	12,400	120,100
B. Phone Thong	0	129,600	12,000	1,200	1,500	3,000	3,000	150,300
B. Na Biene	59,100	32,000	27,700	800	4,000	10,300	12,000	145,900
Scale: 0-1 ha	21,800	41,300	31,900	5,300	2,600	9,200	39,500	151,600
(%)	14.4%	27.2%	21.0%	3.5%	1.7%	6.1%	26.1%	100.0%
Scale: 1-2 ha	16,200	36,200	24,000	5,100	4,400	9,100	23,500	118,500
(%)	13.7%	30.5%	20.3%	4.3%	3.7%	7.7%	19.8%	100.0%
Scale: 2- ha	21,200	47,000	30,100	5,000	6,800	10,800	54,300	175,200
(%)	12.1%	26.8%	17.2%	2.9%	3.9%	6.2%	31.0%	100.0%
Total Average	19,400	41,700	28,000	5,100	5,100	9,800	39,700	148,800
(%)	13.0%	28.0%	18.8%	3.4%	3.4%	6.6%	26.7%	100.0%

Table VII-23 Production Cost of Paddy under Proposed Farming Practices

Description	Unit Price	Wet Season Paddy (Amount/ha)	Wet Season Paddy (Kip/ha)	Dry Season Paddy (Amount/ha)	Dry Season Paddy (Kip/ha)
1. Farm Inputs					
Seed	55 Kip/kg	40 kg	2,200	40 kg	2,200
Fertilizers					
Urea	110 Kip/kg	100 kg	11,000	100 kg	11,000
Ammophos	120 Kip/kg	250 kg	30,000	250 kg	30,000
Farm chemicals					
Insecticide	720 Kip/kg	10 kg	7,200	10 kg	7,200
2. Labor cost	400 Kip/man-day	152 man-day	60,800	155 man-day	62,000
3. Machinary land preparation	25,000 Kip/ha	20%	5,000	20%	5,000
4. Others					
Equipment etc.	5% of others		5,600		5,600
Total Cost			121,800		123,000

Remark: Unit prices are given in 1988 price based on the information from MAF.

Table VII-24 Production Cost of Upland Crops under Proposed Farming Practices

Description	Unit Price	Soybean (Amount/ha)	Soybean (Kip/ha)	Groundnut (Amount/ha)	Groundnut (Kip/ha)	Garlic (Amount/ha)	Garlic (Kip/ha)
1. Farm Inputs							
Seed	250 Kip/kg	60 kg	15,000	80 kg	20,000	1,000 kg	500,000
Fertilizers							
Urea	110 Kip/kg	60 kg	6,600	40 kg	4,400	75 kg	8,300
Ammophos	120 Kip/kg	200 kg	24,000	200 kg	24,000	150 kg	18,000
Farm chemicals							
Insecticide	720 Kip/kg	10 kg	7,200	10 kg	7,200	0 kg	0
2. Labor cost	400 Kip/man-day	97 man-day	38,800	104 man-day	41,600	126 man-day	50,400
3. Machinary land preparation	25,000 Kip/ha	20%	5,000	20%	5,000	20%	5,000
4. Others							
Equipment etc.	5% of others		4,600		4,900		28,800
Total Cost			101,200		107,100		610,500

Remarks: 1. Unit prices are given in 1988 price based on the information from MAF.
2. Unit price of garlic seed is estimated at Kip 500 per kg

Table VII-25 Estimation of Production Value under with Project Condition

Items	Irrigated Rainy Season Paddy	Irrigated Dry Season Paddy	Rainfed Rainy Season Paddy	Soybean	Ground-nut	Garlic	Total
Planted Area (ha)	2,700	2,150	701	350	160	40	6,101
Unit Yield (ton/ha)	4.5	5.5	1.5	2.0	2.5	7.0	-
Production (ton)	1,2150	1,1825	1,052	700	400	280	-
Unit Price (Kip/kg)	50	50	50	130	60	200	-
Gross Production Value (Kip 1,000)	607,500	591,250	52,575	91,000	24,000	56,000	1,422,325
Unit Production Cost (Kip/ha)	121,800	123,000	60,200	101,200	107,100	610,500	-
Production Cost (Kip 1,000)	328,860	264,450	42,200	35,420	17,136	24,420	712,486
Net Production Value (Kip 1,000)	278,640	326,800	10,375	55,580	6,864	31,580	709,839

Table VII-26 Future Farm Budget under with and without Project Condition

Case-1: Paddy-Paddy

(Unit: Kip/household/year)

Items (average ha)	Without project 0 - 1 ha 0.84	1 - 2 ha 1.68	2 ha - 3.05	With project 0 - 1 ha 0.84	1 - 2 ha 1.68	2 ha - 3.05
Increase of production						
Paddy (ton)				7.14	14.28	25.93
Increase income				357,000	714,000	1,296,300
Income						
Farm income	109,000	135,700	213,000	466,000	849,700	1,509,300
Off-farm income	85,500	126,600	110,300	85,500	126,600	110,300
Total income	194,500	262,300	323,300	551,500	976,300	1,619,600
Expenditure						
Farm expense	7,900	15,800	28,700	102,500	205,000	372,100
Agro-tax	4,200	8,400	15,300	6,700	13,400	24,400
Living expense	151,600	118,500	175,200	240,100	321,600	767,200
Total expense	163,700	142,700	219,200	349,300	540,000	1,163,700
Net reserve	30,800	119,600	104,100	202,200	436,300	455,900
Annual disposable income	182,400	238,100	279,300	442,300	757,900	1,223,100

Case-2: Paddy-Upland Crops

(Unit: Kip/household/year)

Items (average ha)	Without project 0 - 1 ha 0.84	1 - 2 ha 1.68	2 ha - 3.05	With project 0 - 1 ha 0.84	1 - 2 ha 1.68	2 ha - 3.05
Increase of production						
Paddy (ton)				2.52	5.04	9.15
Soybean (ton)				1.07	2.14	3.88
Groundnut (ton)				0.61	1.22	2.22
Garlic (ton)				0.43	0.86	1.56
Increase income				387,400	774,800	1,406,700
Income						
Farm income	109,000	135,700	213,000	496,400	910,500	1,619,700
Off-farm income	85,500	126,600	110,300	85,500	126,600	110,300
Total income	194,500	262,300	323,300	581,900	1,037,100	1,730,000
Expenditure						
Farm expense	7,900	15,800	28,700	134,900	269,900	489,900
Agro-tax	4,200	8,400	15,300	6,700	13,400	24,400
Living expense	151,600	118,500	175,200	239,000	319,800	762,600
Total expense	163,700	142,700	219,200	380,600	603,100	1,276,900
Net reserve	30,800	119,600	104,100	201,300	434,000	453,100
Annual disposable income	182,400	238,100	279,300	440,300	753,800	1,215,700

Remark: Ratio of planted area for upland crops in each farm is assumed to be the same as that of total production area, i.e., Soybean:Groundnut:Garlic = 350:160:40

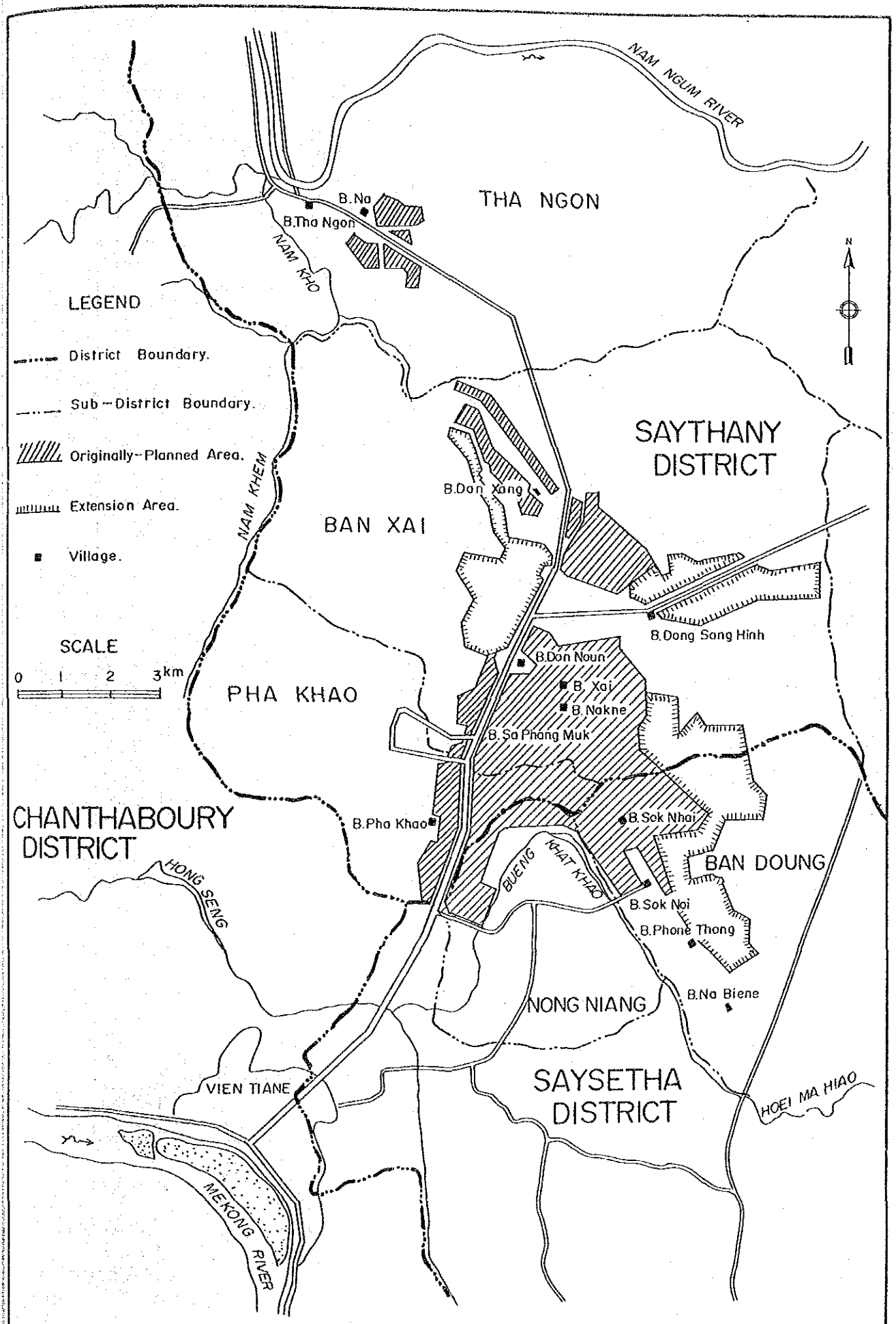

Fig. VII-1 ADMINISTRATION MAP OF THE PROJECT AREA

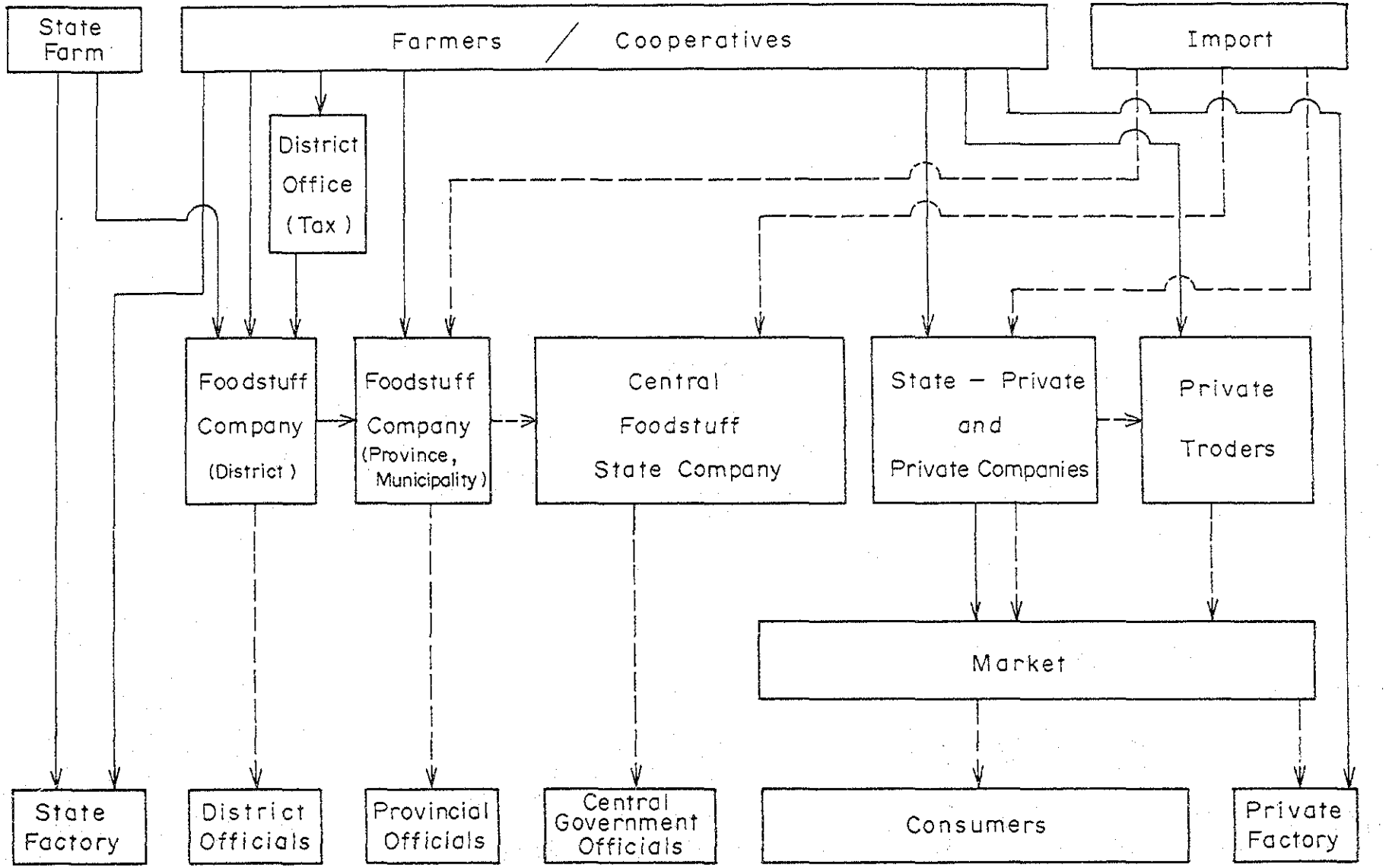

Fig. VII-2 MARKETING ROUTE OF PADDY

ANNEX VIII

ENGINEERING DESIGN

ANNEX VIII

ENGINEERING DESIGN

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1. Alternative Study on Pump Irrigation Layout

1.1 General

The net irrigation area of the Project will consist of originally-planned area of 1,700 ha and extension area of 1,000 ha. The originally-planned area is the irrigation area which has been proposed in the original design made by MAF. The major part of this area is the existing paddy field located in a flat land with a topographic slope of 1/1,000 to 1/2,000 and an elevation mostly ranging from EL 167 m to EL 164 m. The extension area is the irrigation area which has been proposed for the further development. The area is mostly forest land located on a gentle slope area with a topographic slope of 1/200 to 1/500 and an elevation of EL 171 m to EL 166 m.

The source of the irrigation water for such area of 2,700 ha is the Nam Ngum river. Although this river has abundant water throughout the year, water level of the river is too low for the gravity irrigation to the said area. According to the hydrological study, the low water level of the river with 90 % dependability is estimated at EL 152 m. Furthermore, the major part of irrigation area; 2,410 ha is located about 11 km far from the river, and water head of several meters is required only for conveyance of the water by canal. For the reasons mentioned above, the use of pumps is absolutely necessary for the irrigation system of the Project.

1.2 Alternative Plan

On the right bank of the Nam Ngum river, a pump station will be provided to lift the river water. This station is hereinafter called "main pump station". Irrigation canal will convey the pumped water to a regulation pond, which will be provided at the upstream of and near the major part of the irrigation area; 2,410 ha in order to regulate the water according to irrigation operation. This canal is hereinafter called "headreach". The major part of the irrigation area, i.e. originally-planned area of 1,410 ha and whole extension area of 1,000 ha will be irrigated by the water to be released from the regulation pond. The remaining 290 ha, which are scattered along the headreach, will be supplied with irrigation water directly from the headreach.

In order to determine the most appropriate pump irrigation layout, the following alternative plans are compared from technical and economical viewpoints:

(1) Plan-I

The main pump station is to be designed to lift the river water to a high point so that sufficient water head is secured to irrigate the whole irrigation area of 2,700 ha by gravity. Under this plan, the water head for the main pump station will be as high as 41 m, and the embankment of the headreach will become inevitably high.

(2) Plan-II

The main pump station is to be designed to lift the river water to a point with an elevation just sufficient to irrigate the low-lying land of 1,700 ha (originally-planned area) by gravity. For the irrigation of the remaining 1,000 ha (extension area), booster pump stations are to be provided to relift water from the regulation pond and irrigation canal. The extension area consists of eastern area of 770 ha and western area of 230 ha. The water for the former is pumped by the booster pump station No.1, while the water for the latter is pumped by the booster pump station No.2. Under this plan, water head is 28 m for the main pump station, 6 m for the booster pump station No.1 and 2.4 m for the booster pump station No.2.

For the alternative study, the following assumptions are made for simplicity of the study:

i) The comparison is made only for main pump station, headreach, and two booster pump stations. Regulation pond and irrigation canals located at the downstream of regulation pond are neglected, because there are little difference between construction costs of the two plans.

ii) Type of pumps for the main pump station is inclined pump. Pump type, water head, diameter of pump, and required power for all the pump stations are shown in main and booster pump stations 2.2 and 2.3 of this Chapter.

iii) The headreach is a concrete-lined open canal with a design discharge of 4.86 m^3/sec. The dimensions and hydraulic properties are as follows:

Canal base	:	1.50 m
Water depth	:	1.46 m
Inner slope	:	1:1.5
Velocity	:	0.90 m/sec
Gradient	:	1/4,000
Crest width of bank	:	2 m and 4.5 m

iv) The operation hours for the main pump station and the booster pump stations are assumed to be 24 hours and 18 hours, respectively.

v) Work quantity for the headreach and all the pump stations is estimated on the basis of preliminary designs and layouts, using 1:10,000 topographic map.

The sketch and technical dimensions of the respective alternative plans are shown in Fig. VIII-1 and Table VIII-1.

1.3 Comparison

(1) Cost aspect

For the above mentioned plans, direct construction costs of the headreach are estimated as shown in Table VIII-2 and are summarized below:

(Unit: US$1,000)

Items	Plan-I	Plan-II
Main pump station	3,967	3,634
Headreach	7,952	5,600
Booster pump stations No.1 & No.2	-	1,366
Total	11,919	10,600

As shown in the above table, plan-II is lower than plan-I in direct construction cost. However, since the direct cost does not include operation and maintenance costs, cost comparison is made in annual equivalent cost. The annual equivalent cost, and operation and maintenance costs are estimated on the following conditions:

- Project life of civil work is 50 years and durable period of pumps and electrical facilities are 25 years.

- Annual interest rate is 1%. Consequently, capital recovery factor for the civil work is 0.0255 and that for the pumps and electrical work is 0.0454.

- Annually required electric power for plan-I is 12,300 MWH and that for plan-II is 9,000 MWH, and electric charge is US$ 0.015/kWH.

- Annual maintenance cost is 0.05% of direct construction cost.

Annual Cost

(Unit: US$)

Items		Plan-I	Plan-II
(a)	Annual equivalent cost		
	- Civil work	211,200	156,000
	- Pumps & electric work	165,100	203,600
(b)	Operation cost		
	- Electric charge	184,500	135,000
	- Staff salary	1,100	3,300
(c)	Maintenance cost		
	- Civil work	4,100	3,100
	- Pumps & electric work	1,800	2,200
	Total	567,800	503,200

As shown in the above table, plan-II is more economical than plan-I in both direct construction cost and annual equivalent cost.

(2) Technical aspects

Plan-I requires high embankment canal with a height of 6 to 10 m for a reach of 4.8 km. In this study, syphon is applied to such reach instead of the high embankment canal for economical reason. Plan-II also requires the high

embankment, but the maximum height is about 6 m. Syphon is applied only to the crossing of national roads and rivers. Total syphon length is about 4,850 m for plan-I and 400 m for plan-II. Technically, long syphon or excessive high embankment canal is not recommendable for the safety of canal, and smooth operation and maintenance work. For this reason, plan-II is technically more desirable than plan-I.

1.4 Conclusion

On the basis of the above-mentioned comparative study, it is concluded that plan-II is economically and technically superior to plan-I and that plan-II should be adopted as the most appropriate pump irrigation layout for the Project.

2. Irrigation Facilities

2.1 Irrigation System

The irrigation facilities to supply the water to fields will consist of main pump station, two booster pump stations, regulation pond, headreach, and main, secondary, tertiary and field canals with related structures.

The water for an entire irrigation area of 2,700 ha will be lifted from the main pump station located on the right bank of the Nam Ngum river and will be conveyed through the 11.4 km-long headreach to the regulation pond with a capacity of 110,000 m^3. Two main canals will be started from the pond; west main canal No.1 and east main canal. At 600 m downstream of the pond, west main canal No.2 will be branched off from the west main canal No.1. The command area of the west main canal No.1, including that of west main canal No.2, will be 1,640 ha in total; 1,410 ha of the originally-planned area and 230 ha of the extension area. The east main canal will cover 770 ha of the extension area. The irrigation area of 290 ha which is located along the headreach and is included in the originally-planned area, will be covered by the headreach.

As explained in the alternative study on pump irrigation layout, at the beginning point of the east main canal, booster pump station No.1 will be provided for the water supply to the extension area of 770 ha and booster pump station No.2 will be provided for the extension area of 230 ha on secondary canal W1-1 which is branched off from the west main canal No.1. The water will be generally conveyed from such main canals to fields through secondary, tertiary and field canals. The general canal layout is shown in Fig. VIII-2

2.2 Main Pump Station

(1) Pumps

The main pump station will be provided on the right bank of the Nam Ngum river to lift the river water of 4.86 m^3/sec. For the design of the main pump station, selection of pump types is firstly made from economical and technical viewpoints. Since the pump type is closely related with the civil work of the station, the cost comparison among alternative pump types is made for the entire pump station by adding costs of civil work, electrical work and operation house to the cost of pumps with auxiliary facilities. The basic condition for the study is as follows :

- Design discharge : 4.86 m^3/sec
- The Nam Ngum river
  - High water level with 90% dependability : EL 167.00 m
  - Low water level with 90% dependability : EL 152.00 m
- Outlet structure
  - Water level : EL 175.5 m
- Static water head : 23.5 m
- Pump operation hour at peak time : 24 hours/day

The following five cases are taken up for the comparison and pump stations with the use of respective pumps are illustrated in Fig. VIII-3

Case-I : Mixed flow pump (vertical shaft), ϕ900 mm x 4 units
Case-II : Submersible pump, ϕ500 mm x 10 units
Case-III Inclined pump mixed flow, ϕ600 mm x 7 units
Case-IV : Floating pump station with volute pump, ϕ600 mm x 4 units x 2 pontoons
Case-V : Volute pump (horizontal shaft), ϕ900 mm x 4 units

The approximate costs for the above cases are estimated as follows:

Cost Comparison

(Units: US$ 1,000)

Pump Type	Total cost	Breakdown		
		Pump	Civil work	Elec.work
Case - I	4,087	3,190	814	83
Case - II	5,378	4,590	705	83
Case - III	3,634	3,235	316	83
Case - IV	5,038	4,769	186	83
Case - V	3,555	2,725	747	83

There are several technical points to be compared. In this comparison, however, priority is put on an easiness of operation and maintenance work since this pump station will be one of the largest stations in Lao PDR, and operation and

maintenance work for such station has not yet been experienced. The five cases are examined mainly in this aspect as follows :

i) Volute pump (Case-V) is the lowest in cost, but this type is not recommended due to technical limitation. This pump has to be installed at an elevation within 5 m above the low water level and pump house substructure has to be kept water-tight. Generally, full-time care is required to keep the pump house water-tight. Furthermore maintenance is not so easy since the pumps and motors are located at a depth of about 13 m from the ground surface.

ii) Inclined pump (Case-III) is the second lowest in cost. This type is used for existing pump stations in and around the Project area, and operation and maintenance of such pumps have already been experienced by local people. In addition, structure of pump station for such type is very simple and civil work does not require heavy earth work. For these reasons, inclined pump is adopted. Although, this pump is liable to damage by drifting woods in river, it is judged from past experience of existing pump stations that there are few drifting woods in the Nam Ngum river throughout the year and no serious damage caused by such materials may occur.

iii) Mixed flow pump (Case-I) is costlier than inclined pump since substructure of pump house for mixed flow pump requires heavy earth work. As for degree of easiness for operation and maintenance, both are almost same.

iv) Submersible pump (Case-II) is inferior to the inclined pump in both cost and easiness of operation and maintenance work. This case requires 10 units of pumps and all of them are installed in the water. The number of pumps is too many and maintenance work requires special task to pull out the pumps from the water.

v) Floating type (Case-IV) is also inferior to the inclined pump in cost and easiness of operation work. This type requires the laborious adjustment of mooring wires and delivery pipes according to the fluctuation of water level.

(2) Main pump station

i) Pumps and auxiliary facilities

Pumps and auxiliary facilities for the main pump station are as follows:

Discharge	:	4.86 m^3/sec (0.81 m^3/sec x 6)
Pump type	:	Inclined pump (mixed flow)
Diameter of pump	:	600 mm
Number of pump	:	7 units including one stand-by pump
Static water head	:	23.5 m
Total water head	:	28.2 m
Speed	:	1,000 rpm
Motor output	:	380 kW x 6
Suction pipe	:	ϕ600 mm x 39 m x 7
Delivery pipe	:	ϕ1,000 mm x 55 m x 1
		ϕ1,200 mm x 55 m x 1
Transmission line	:	1 km extension from the existing 22 kV transmission line

ii) Pump station

The main pump station consists of inclined concrete base, suction pipes with pumps and motors, delivery pipes and switchyard. They are shown in the drawing of main pump station.

iii) Foundation of pump station

No geological boring has been made by the Team since the following data are available for the study on the foundation of the main pump station:

- Geological boring record near the pump station carried out in 1981 under the Nam Ngum Project (Data Book for Nam Ngum Project, Volume-II)

- Geological boring record for the Tha Ngon pump station carried out in 1971 by JICA Team under the Tha Ngon Project

- Geological boring record for the pump station of the original design carried out under Soviet Union technical aid program

Through the examination of such data, the geological boring data carried out under the Nam Ngum Project (17 m deep) is deemed as the foundation conditions at the main pump station site are assumed as shown in the drawing of main pump station.

The elevation of the ground is about EL 166 m. The top layer is clay with a depth of 2 m and below the layer, sandy clay and pebble layer, and sandy clay layer are alternately formed by each depth of 2-4 m down to EL 149 m. The foundation below EL 149 m is assumed to be sandy clay and pebble layer. The allowable bearing capacity is assumed to be more than 30 tons/m^2. However, it should be noted that the foundation and its bearing capacity be confirmed at the detailed design stage.

2.3 Booster Pump Station

Two booster pump stations will be constructed for irrigation to the extension area of 1,000 ha. The booster pump station No.1 will be provided on the bank of regulation pond to re-lift the water of 1.85 m^3/sec from the pond for the east main canal covering 770 ha. The booster pump station No.2 will be provided at turnout No.1 of secondary canal W1-1 to re-lift the water of 0.56 m^3/sec for the irrigation of the remaining 230 ha. Those stations will consist of suction pits, pumps with motors, suction pipes, delivery pipes and switchyard as shown in the drawing of booster pump station. The pumps and auxiliary facilities for those booster pump stations are shown in the following table.

Items	Booster Pump Station No.1	Booster Pump Station No.2
- Discharge	1.85 m^3/sec (0.925 m^3/sec x 2)	0.56 m^3/sec (0.28 m^3/sec x 2)
- Pump type	Mixed flow pump with horizontal shaft	Mixed flow pump with horizontal shaft
- Diameter of pump	700 mm	400 mm
- Number of pump	3 units including one stand-by pump	2 units
- Static water head	5 m	2 m
- Total water head	6 m	2.4 m
- Speed	500 rpm	600 rpm
- Motor output	80 kW x 2	10 kW x 2
- Suction pipe	ϕ700 mm x 5 m x 3	ϕ400 mm x 4 m x 2
- Delivery pipe	ϕ1000 mm x 340 m	ϕ500 mm x 20 m
- Transmission line	2 km extension from the existing line	350 m extension from the existing line

2.4 Regulation Pond

Irrigation water will be conveyed by the headreach from the main pump station on a 24-hour per day basis, but irrigation operation at fields will be 18 hours per day. In order to store the water for the balance of 6 hours, a regulation pond is required at the end of the headreach. The storage capacity is estimated at 110,000 m^3. The high water level of the pond will be EL 171 m and the low water level will be EL 170 m. The bank of the pond will be 4 m in crest width and 1 : 2.0 in side slope. On the bank, inlet and outlet structures and spillway will be provided. No special treatment for seepage prevention is designed, considering the fact that the foundation of the pond consists of impermeable silt and clay.

2.5 Irrigation Canals and Related Structures

(1) Irrigation canals

The irrigation canals of the Project include headreach,main canals, secondary canals, tertiary canals and field canals. The headreach will convey the water from the main pump station to the regulation pond. Main canals will convey the water from the pond to secondary and tertiary canals. Secondary canals will convey the water to tertiary and field canals. The headreach will be trapezoidal concrete-lined channels, while other canals will be trapezoidal earthen channels. Approximate command areas of these canals are as follows:

Canals	Command Area (ha)
Headreach	2,410 to 2,700
Main canal	250 to 1,640
Secondary canal	60 to 380
Tertiary canal	12 to 120
Field canal	< 24

A list of canals is shown in Table VIII-3, and is summarized below:

Canals	Originally-planned Area (m)	Extension Area (m)
Headreach	11,400	-
Main canals	9,210	10,090
Secondary canals	16,970	3,790
Tertiary canals	41,440	29,240
Field canals	117,000	69,000

(2) Concrete lining

The headreach will be considerably large scale canal in size and length in Lao PDR. Due to this large scale, it is anticipated that operation and maintenance

work is very hard for local people. In order to carry out such work smoothly, concrete lining only for the headreach is proposed taking into account scale of canal, degree of importance and construction costs. Although concrete lining for all the canals is desirable, concrete lining for other canals is not proposed for economic reason.

(3) Canal structures

A number of canal structures such as turnout, check, syphon and culvert will be provided in canals. All of them will be of reinforced concrete construction. A list of structures is shown in Table VIII-4, and is summarized below:

Structures	Originally-planned Area (nos.)	Extension Area (nos.)
Turnout	43	18
Check	26	2
Syphon	9	-
Culvert	25	3
Drop	6	1
Spillway/waste way	9	3
Cross drain	13	1
Foot path bridge	33	13
Division box on tertiary canal	293	176
On-farm culvert	266	156
On-farm syphon	186	109
On-farm cross drain	107	63
Division box on field canal	2,019	1,188

(4) Design criteria

The basic design criteria for irrigation canals and related structures are as follows:

i) Design discharge

- Headreach and related structures : 1.8 lit/sec/ha
- Main, secondary, tertiary and field canals, and related structures : 2.4 lit/sec/ha

ii) Hydraulic formula : Manning's formula

iii) Allowable velocity

Canal/structure	Max.	Min.
Lined canal	1.2 m/sec	0.3 m/sec
Unlined canal	0.6 m/sec	0.3 m/sec
Concrete structure	2 m/sec	0.3 m/sec

iv) Roughness coefficient

- Lined canal and concrete structure : 0.015
- Unlined canal : 0.027

v) Freeboard

- Minimum freeboard for lined canal (Headreach)
  - Height from full water level to top of concrete lining : 0.3 m
  - Height from top of concrete lining to top of embankment : 0.4 m
- Minimum freeboard for unlined canals
  - Main and secondary canals : 0.3 m
  - Tertiary and field canals : 0.2 m

vi) Cross section of canals

Canal base width (B)- water depth (H) ratio for concrete lined canal is determined considering the hydraulically effective section, while such ratio for unlined canal is empirically determined. Crest width of bank is also determined empirically. Internal and external side slopes of canals are determined on the basis of soil mechanical test. Factors necessary for determination of cross section of canal are as follows:

Canals	B/H	Internal Side Slope (1:z)	Crest widthB of Bank (m)	Freeboard (m)
Headreach	1	1.5	2	0.7
Main canal	Around 0.6	1.5	1.5	0.3
Secondary canal	Around 0.6	1.5	1	0.3
Tertiary canal	Less than 1	1	0.4	0.2
Field canal	Less than 1	1	0.3	0.2

Filling Height or Cutting Depth D (m)	External Side Slope for Filling Portion of Canal	Internal Side Slope for Cutting Portion of Canal
D < 2.5	1 : 1.5	1 : 1.5
2.5 < D < 4	1 : 2	1 : 2

Note: In case of D > 4 m, a berm of 1.5 m wide will be provided to internal side slope of canals.

Irrigation flow diagram is shown in Fig. VIII-4. Typical cross sections of canals and farm roads are shown in Fig. VIII-5.

3. Drainage Facilities

(1) Drainage system

The drainage facilities of the Project will consist of main, secondary, tertiary and field drains, and related structures. All the water coming from the Project area will be drained by gravity. Generally, excess water collected by field drains will be conveyed by tertiary, secondary and main drains. Such water will be drained into natural rivers. The Project area is largely divided into two in respect to drainage system; northern area and southern area bordered approximately by east-to-west line of the national road of route 13. The excess water coming from the northern area will be drained into the Nam Ngum river through the Nam Kho river, while the excess water coming from the southern area will be drained into the Mekong river through the Bueng Khat Khao swamp and the Houei Ma Hiao river. The general layout is shown in Fig. VIII-2.

(2) *Drains and related structures*

All the drains will be trapezoidal unlined channels. Approximate catchment areas of main, secondary, tertiary and field drains are shown below:

Drains	Catchment Area (ha)
Main drains	550 to 1,700
Secondary drains	110 to 890
Tertiary drains	10 to 180
Field drains	< 24

In drains, drainage structures such as drainage culvert and drainage syphon will be provided. All those structures will be of reinforced concrete construction. A list of drains and that of drainage structures are shown in Tables VIII-5 and VIII-6, respectively, and are summarized below:

Drains/structures	Originally-planned Area	Extension Area
Main drain	8,920 m	-
Secondary drain	20,140 m	10,340 m
Tertiary drain	22,570 m	18,690 m
Field drain	122,000 m	72,000 m
Drainage culvert	32 nos.	6 nos.
Drainage drop	7 nos.	9 nos.
On-farm drainage culvert	80 nos.	47 nos.
On-farm drainage syphon	27 nos.	16 nos.

(3) Design criteria

The basic design criteria for drains and drainage structures are as follows :

i) Design discharge
- For paddy field : 5.4 lit/sec/ha
- For upland field : by triangular unit hydrograph

ii) Hydraulic formula : Manning's formula

iii) Allowable velocity

Drain/structure	Max.	Min.
- Drain	0.9 m/sec	0.3 m/sec
- Concrete structure	2.5 m/sec	0.8 m/sec

iv) Roughness coefficient
- Drain : 0.035
- Concrete Structure : 0.015

v) Side slope of drain : 1 : 1.5

iv) Freeboard (F) : F > 0

Drainage flow diagram is shown in Fig. VIII-6. Typical cross sections of drains are shown in Fig. VIII-7.

4. On-farm Development Work

The on-farm development work is necessary for irrigation and drainage development of the Project. This work will consist of the following:

i) Construction of tertiary and field canals with related structures such as division box, and on-farm culvert, syphon and cross drain

ii) Construction of tertiary and field drains with related structures such as on-farm drainage culvert and syphon

iii) Construction of farm roads with a width of 3.0 m to be provided alongside the tertiary and field canals

In addition, land clearing and land levelling works will be carried out for the present forest land of 880 ha in total; 170 ha in the originally-planned area and 710 ha in the extension area, which will be used as paddy field under the Project. The land levelling will not be carried out for the present grass land, since such land is mostly fallow-land and farmers could carry out the levelling work if necessary. The land levelling work generally consists of rough levelling and precise finishing work. Under the Project, the rough levelling work only will be carried out and the remaining finishing work will be carried out by farmers themselves.

For the design of land levelling work, standard farm plot size is determined through a preliminary comparative study.

In the determination of farm plot size, future use of farm machinery is considered although use of buffaloes is proposed in the agricultural development plan as draft animal. Three farm plot sizes are conceived, namely 1 ha (200 m x 50 m), 0.5 ha (100 m x 50 m) and 0.3 ha (100 m x 30 m). However, since farm plot size of 1 ha is considerably large for paddy cultivation, the comparative study is made for 0.5 ha size and 0.3 ha size. The study is made in respect to cost, namely earth-moving volume per hectare. As shown in the following table, farm plot size of 0.3 ha is adopted as appropriate standard size.

Land Slope	Earth-Moving Volume (m^3/ha)	
	0.3 ha (100 m x 30 m)	0.5 ha (100 m x 50 m)
1 / 1,500 to 1 / 750	140	160
1 / 750 to 1 / 500	200	230
1 / 500 to 1 / 200	500	580

5. Farm Roads

National roads of route 10 and 13 run through the Project area from south to north as shown in the location map. They are asphalt-paved and well maintained. On the other hand, roads in the Project area are considerably poor in both density and quality. In order to strengthen the road network in the Project area with the objectives of (i) smooth village to village traffic, (ii) efficient transportation of agricultural input and output to and/or from village and market, and (iii) smooth operation and maintenance work of canals and structures, farm roads will be constructed under the Project. Farm roads will be provided alongside the headreach, main canals, secondary canals, tertiary canals, and field canals. Subsequently, the farm roads will be connected to the national roads and other existing roads.

The farm roads will be earthen roads with a width of 4.5 m for the headreach, and main and secondary canals, and 3.0 m for the tertiary and field canals. The surface will be paved with laterite of 3.5 m wide and 0.15 m thick only for farm roads to be provided alongside the headreach, and main and secondary canals considering the importance of roads. The typical cross sections of the roads are shown in Fig.VIII-5.

6. Demonstration Farm

Introduction and extension of the improved farming practice and water management practice are indispensably necessary for the optimum agricultural production in the Project area. Such practices have to be improved through field trials to meet the local requirement in the area. In addition, in order to secure seeds for irrigated paddy cultivation of 2,700 ha, seed multiplication is required. In order to excute such extension and field trials, and seed multiplication, construction of demonstration farm (64 ha in net) is proposed under the Project.

The proposed site is located near Ban Don Noun and Ban Xai, and western border of the farm is adjacent to national road of route 13 as shown in Fig.VIII-2. This area is located at the central part of the Project area and is very near the proposed Project office. This location is very effective for demonstration and is very convenient to carry out technical guidance of the Project office.

The proposed area is mostly rainfed paddy field and partly grass land. All the area is privately owned by farmers of Ban Don Noun, Ban Xai and Ban Na Khe.

In order to produce the demonstration effect, the following considerations are given to the demonstration farm:

i) Land consolidation is not proposed for irrigation area of the Project but only the demonstration farm is proposed to be consolidated.

ii) The use of buffaloes is proposed in the agricultural development plan as draft animal but the use of small tractors is proposed instead of such animals for land preparation of the demonstration farm.

The demonstration farm will consist of two tertiary blocks. Irrigation water will be supplied from west main canal No.1 and drainage water will be collected by secondary drains 1-3 and main drain 1 which is connected to the Bueng Khat Khao. General layout of demonstration farm is prepared as shown in Fig. VIII-8.

The operation and maintenance of the farm will be made by farmers under the technical guidance of the Project office. For the use of tractors in the demonstration farm, 3 units of tractors (30PS) will be procured by the Project office. The operation and maintenance of such tractors will be made by the Project office.

In order to store agricultural farm machinery and equipment, and their spare parts as well as multiplied seeds and agricultural inputs, a warehouse with a total floor area of 700 m^2 will be constructed near the Project office. The warehouse will be managed by the Project office.

Table VIII-1 Alternative Plans

Items		Plan-I	Plan-II
1.	Main Pump Station		
1.1	Discharge (m^3/s)	4.86	4.86
1.2	Water level at the outlet of discharge pipeline (m)	EL 186.50	EL 175.50
1.3	Water head (m)	41.40	28.20
1.4	Pump diameter (mm)	600	600
1.5	Nos. of pumps (unit)	7 /1	7 /1
1.6	Required power (kW)	3,350	2,280
2.	Headreach		
2.1	Discharge (m^3/s)	4.86	4.86
2.2	Length (m)	11,200	11,400
2.3	Nos. of syphon (nos.)	4	4
2.4	Total syphon length (m)	4,850	400
3.	Regulation Pond		
3.1	HWL /2 (m)	EL 176.00	EL 171.00
3.2	LWL /3 (m)	EL 175.00	EL 170.00
4.	Booster Pump Station No.1		
4.1	Discharge (m^3/s)	-	1.85
4.2	Water head (m)	-	6
4.3	Pump diameter (mm)	-	700
4.4	Nos. of pumps (unit)	-	3 /1
4.5	Required power (kW)	-	160
5.	Booster Pump Station No.2		
5.1	Discharge (m^3/s)	-	0.56
5.2	Water head (m)	-	2.4
5.3	Pump diameter (mm)	-	400
5.4	Nos. of pumps (unit)	-	2
5.5	Required power (kW)	-	20
6.	Total Required Power (kW)	3,350	2,460
7.	Related Structures		
7.1	Turnout (nos.)	6	6
7.2	Check (nos.)	5	5
7.3	Culvert (nos.)	7	7
7.4	Footpath bridge (nos.)	6	6
7.5	Spillway/wasteway (nos.)	4	4
7.6	Cross drain (nos.)	9	9
7.7	Syphon (nos.)	4	4
7.8	Gate (nos.)	20	20

/1 : One stand-by pump is included
/2 : High water level
/3 : Low water level

Table VIII-2 Cost Comparison for Alternative Study

Works	Unit	Plan-I		Plan-II	
		Quantity	Cost (US$)	Quantity	Cost (US$)
Embankment	m^3	187,300	752,700	428,000	1,721,200
Backfill	m^3	57,600	67,400	4,300	5,000
Excavation	m^3	147,600	186,000	274,000	345,200
Stripping	m^3	12,200	10,000	15,300	12,500
Sod facing	m^2	48,600	70,500	117,000	169,600
Laterite pavement	m^3	3,500	16,500	5,800	27,300
Land clearing	ha	16.90	15,400	14.90	13,600
Con. lining	m^2	55,000	1,254,000	93,000	2,121,000
Concrete (1:2:4)	m^3	1,470	152,000	1,470	152,000
Concrete (1:3:6)	m^3	2,700	231,800	2,070	177,700
Form	m^2	12,000	80,400	11,000	73,700
Reinforcement bar	ton	120.00	61,300	120.00	61,300
Gate	nos.	20	235,500	20	235,500
Con. pipe (1,500 mm)	m	13,300	4,802,800	1,330	480,300
Con. pipe (500 mm)	m	190	15,900	40	3,700
Total			7,952,200		5,599,600

Table VIII-3 List of Canals (1/2)

Canals	Canal Type	Originally-Planned Area (m)	Extension Area (m)	Total (m)
1. Headreach	A	11,400	-	11,400
2. Main canals				
- West main canal No.1	B,C,D	4,150	-	4,150
- West main canal No.2	E,F	5,060	-	5,060
- East main canal	D,E,F	-	10,090	10,090
Sub-total (2)		(9,210)	(10,090)	(19,300)
3. Secondary canals				
- SC H1	H	1,040	-	1,040
- SC W1-1	D,G,H	5,350	-	5,350
- SC W1-2	F,G,H	4,620	-	4,620
- SC W1-3	F,G,H	3,230	-	3,230
- SC W2-1	G	910	-	910
- SC W2-2	H	1,820	-	1,820
- SC W1-1-1	H	-	1,820	1,820
- SC E1	G	-	1,970	1,970
Sub-total (3)		(16,970)	(3,790)	(20,760)
4. Tertiary canals				
- TC HR-1	J	800	-	800
- TC HR-2	J	900	-	900
- TC HR-3	J	1,690	-	1,690
- TC HR-5	J	930	-	930
- TC HR-6	I	1,970	-	1,970
- TC WM1-1	J	480	-	480
- TC WM1-3	I	970	-	970
- TC WM1-5	J	580	-	580
- TC WM1-6	I	1,250	-	1,250
- TC WM2-1	J	1,150	-	1,150
- TC WM2-2	I	760	-	760
- TC WM2-3	I	1,470	-	1,470
- TC WM2-4	I	1,140	-	1,140
- TC EM-1	I	-	1,570	1,570
- TC EM-2	I	-	1,200	1,200
- TC EM-3	I	-	1,380	1,380
- TC EM-4	J	-	650	650
- TC EM-5	J	-	900	900
- TC EM-6	I	-	1,600	1,600

Table VIII-3 List of Canals (2/2)

Canals	Canal Type	Originally-Planned Area (m)	Extension Area (m)	Total (m)
- TC EM-7	I	-	750	750
- TC EM-8	I	-	1,600	1,600
- TC EM-9	I	-	650	650
- TC EM-10	I	-	1,850	1,850
- TC EM-11	J	-	900	900
- TC EM-12	I	-	2,300	2,300
- TC H1-1	J	650	-	650
- TC H1-2	J	1,500	-	1,500
- TC H1-3	J	1,020	-	1,020
- TC H1-4	J	980	-	980
- TC W1-1-2	I	2,040	-	2,040
- TC W1-1-3	I	2,650	-	2,650
- TC W1-2-1	I	880	-	880
- TC W1-2-2	I	750	-	750
- TC W1-2-3	I	520	-	520
- TC W1-2-4	J	870	-	870
- TC W1-2-5	I	1,840	-	1,840
- TC W1-2-6	J	870	-	870
- TC W1-3-1	I	870	-	870
- TC W1-3-2	I	1,340	-	1,340
- TC W1-3-3	I	440	-	440
- TC W1-3-4	J	450	-	450
- TC W1-3-5	I	1,100	-	1,100
- TC W1-3-6	I	1,740	-	1,740
- TC W1-3-7	J	440	-	440
- TC W2-1-1	J	750	-	750
- TC W2-1-2	J	750	-	750
- TC W2-1-3	I	1,180	-	1,180
- TC W2-1-4	I	1,180	-	1,180
- TC W2-2-1	J	620	-	620
- TC W2-2-2	I	1,920	-	1,920
- TC W1-1-1-1	I	-	2,630	2,630
- TC W1-1-1-2	J	-	1,310	1,310
- TC W1-1-1-3	I	-	700	700
- TC W1-1-1-4	J	-	4,090	4,090
- TC E1-1	J	-	1,260	1,260
- TC E1-2	I	-	2,200	2,200
- TC El-3	I	-	1,700	1,700
Sub-total (4)		(41,440)	(29,240)	(70,680)
5. Field canals	K	117,000	69,000	186,000

Table VIII-4 List of Canal Structures

Canals	Originally-Planned Area (nos.)	Extension Area (nos.)
1. Headreach		
- Turnout	6	-
- Check	5	-
- Syphon	4	-
- Culvert	7	-
- Drop	-	-
- Spillway / Wasteway	4	-
- Cross drain	9	-
- Foot path bridge	6	-
2. Main canals		
- Turnout	13	12
- Check	8	6
- Syphon	2	-
- Culvert	7	3
- Drop	-	1
- Spillway / Wasteway	3	3
- Cross drain	1	1
- Foot path bridge	10	8
3. Secondary canals		
- Turnout	24	6
- Check	13	2
- Syphon	3	-
- Culvert	11	-
- Drop	6	-
- Spillway / Wasteway	2	-
- Cross drain	3	-
- Foot path bridge	17	5
4. Tertiary canals		
- Division box	293	176
- On-farm culvert	266	156
- On-farm syphon	186	109
- On-farm cross drain	107	63
5. Field canals		
- Division box	2,019	1,188

Table VIII-5 List of Drains (1/2)

Drains	Drain Type	Originally-Planned Area (m)	Extension Area (m)	Total (m)
1. Main drains				
- MD 1	A,C	3,240	-	3,240
- MD 2	A	2,600	-	2,600
- MD 3	A,B,C	3,080	-	3,080
Sub-total (1)		(8,920)	-	(8,920)
2. Secondary drains				
- SD 1-1	D	2,650	1,360	4,010
- SD 1-2	E	1,040	-	1,040
- SD 1-3	D,E	1,540	1,010	2,550
- SD 2-1	C,D	2,330	-	2,330
- SD 3-1	D,E	-	1,700	1,700
- SD 3-2	E,F	500	800	1,300
- SD 3-3	D	880	2,000	2,880
- SD 4	B,D	3,750	-	3,750
- SD 5	C,D	1,000	2,550	3,550
- SD 6	C	3,180	920	4,100
- SD 7	E	1,860	-	1,860
- SD 8	E	1,410	-	1,410
Sub-total (2)		(20,140)	(10,340)	(30,480)
3. Tertiary drains				
- TD 1-1	F	780	-	780
- TD 1-2	F	1,080	-	1,080
- TD 1-3	F	890	-	890
- TD 1-4	F	970	-	970
- TD 1-1-1	F	-	580	580
- TD 1-2-1	F	-	500	500
- TD 1-2-2	F	-	690	690
- TD 1-2-3	F	-	1,100	1,100
- TD 1-3-1	F	1,240	-	1,240
- TD 1-3-2	F	1,090	-	1,090
- TD 1-3-3	F	-	240	240
- TD 1-3-4	F	-	470	470
- TD 2-1	F	200	-	200
- TD 2-2	F	850	-	850
- TD 2-3	F	430	-	430

Table VIII-5 List of Drains (2/2)

Drains	Drain Type	Originally-Planned Area (m)	Extension Area (m)	Total (m)
- TD 2-4	F	1,340	-	1,340
- TD 2-5	F	2,280	-	2,280
- TD 2-6	F	780	-	780
- TD 2-7	F	340	-	340
- TD 2-1-1	F	1,370	-	1,370
- TD 2-1-2	E	800	-	800
- TD 5-1	F	1,300	-	1,300
- TD 5-2	F	-	1,610	1,610
- TD 5-3	F	-	1,100	1,100
- TD 5-4	F	-	1,450	1,450
- TD 5-5	F	-	650	650
- TD 5-6	F	-	420	420
- TD 6-1	F	300	570	870
- TD 7-1	F	680	-	680
- TD 8-1	F	200	-	200
- TD 8-2	F	940	-	940
- TD 2	F	-	1,900	1,900
- TD 3	F	660	-	660
- TD 4	F	800	-	800
- TD 3-1-1	E	-	1,080	1,080
- TD 3-1-2	F	-	920	920
- TD 3-1-3	F	-	830	830
- TD 3-1-4	F	-	450	450
- TD 3-1	E,F	760	1,300	2,060
- TD 3-2-1	F	-	890	890
- TD 3-2-2	F	-	1,940	1,940
- TD 3-2	F	540	-	540
- TD 5	F	450	-	450
- TD 6	F	1,500	-	1,500
Sub-total (3)		(22,570)	(18,690)	(41,260)
4. Field Drains	G	122,000	72,000	194,000

Table VIII-6 List of Drainage Structures

Drains	Originally-Planned Area (nos.)	Extension Area (nos.)
1. Main drains		
- Drainage culvert	6	-
- Drainage drop	-	-
2. Secondary drains		
- Drainage culvert	26	6
- Drainage drop	7	9
3. Tertiary drains		
- On-farm drainage culvert	80	47
- On-farm drainage syphon	27	16

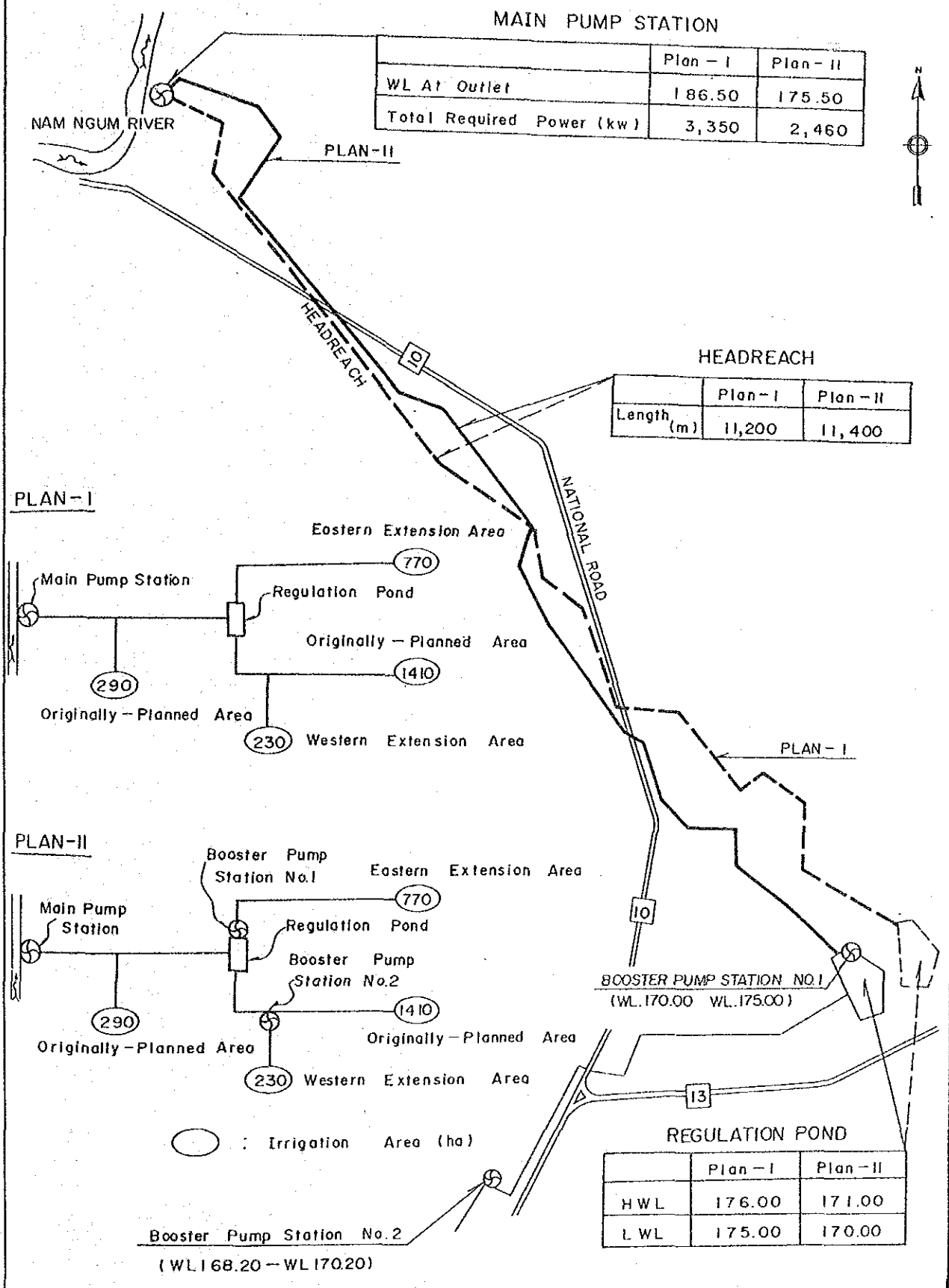


Fig. VIII-1 ALTERNATIVE PUMP IRRIGATION LAYOUT

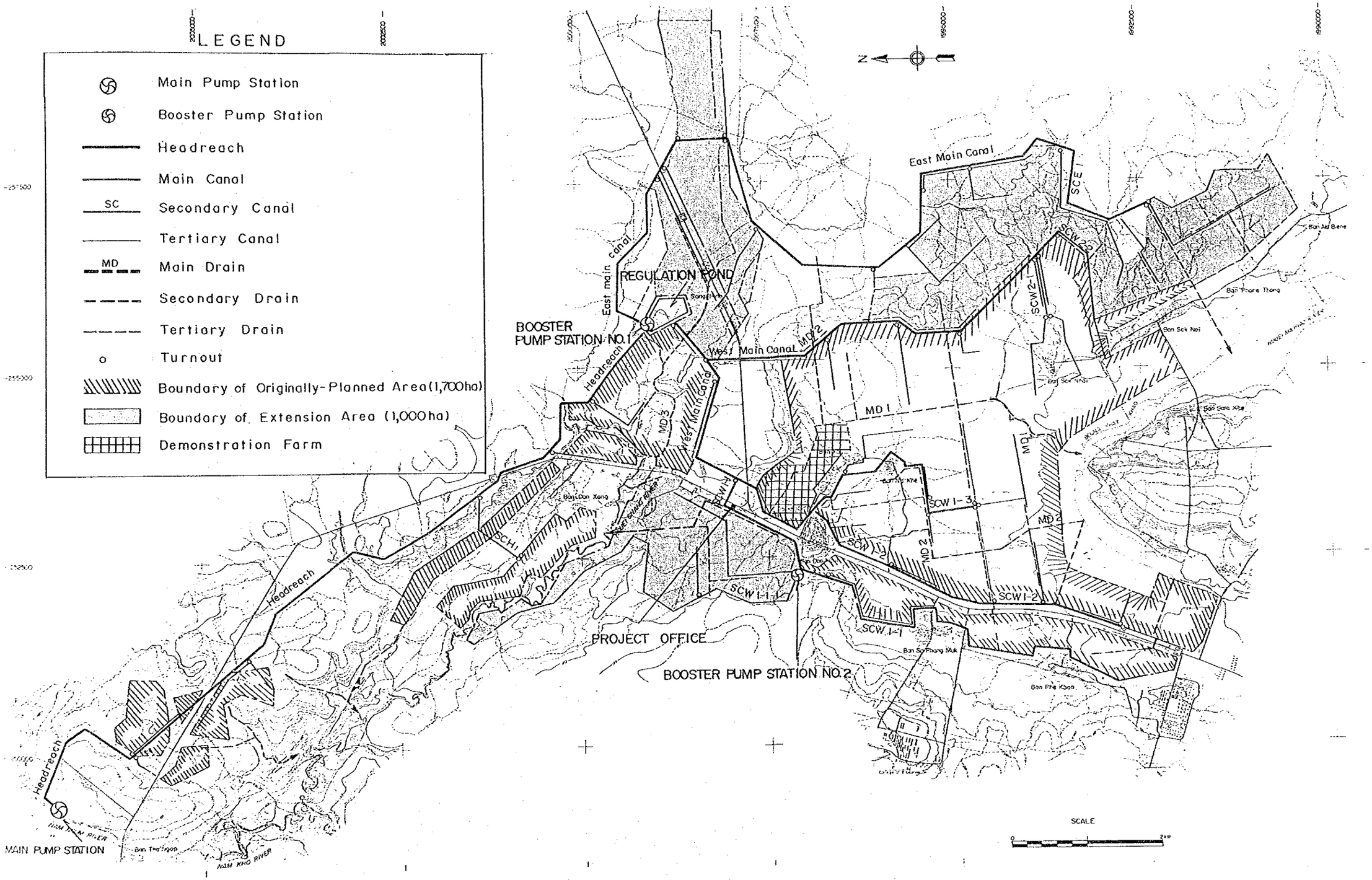
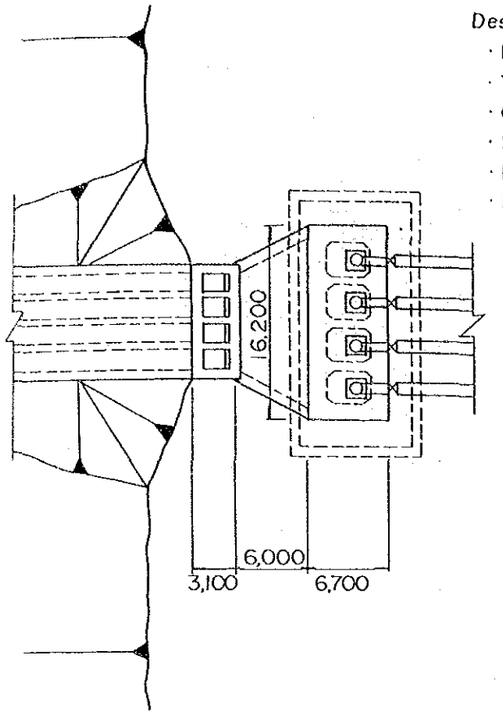


Fig. VIII-2 GENERAL LAYOUT

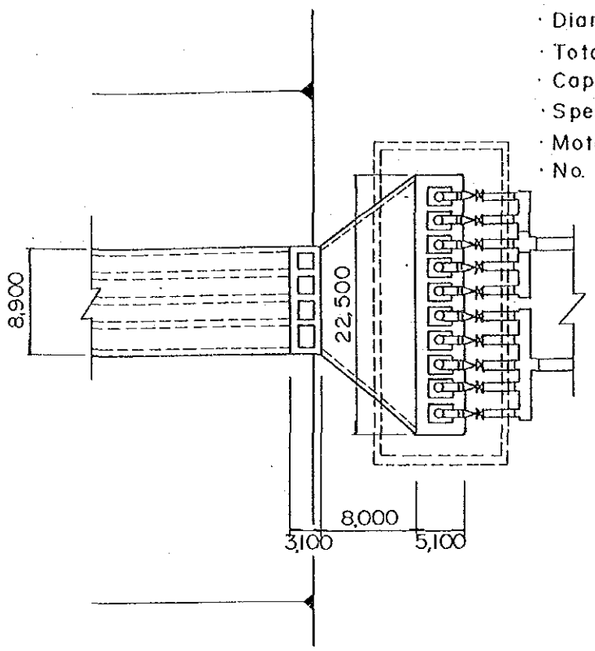
① MIXED FLOW PUMP (VERTICAL SHAFT TYPE)



Design Data

- Diameter : 900mm
- Total Head : 28.2m
- Capacity : 97.2m/min
- Speed : 750rpm
- Motor : 710KW
- No. of pump : 4 nos

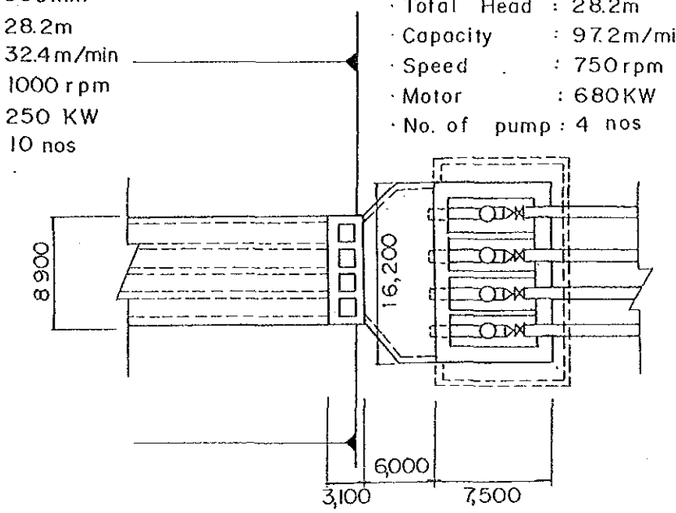
② SUBMERSIBLE PUMP



Design Data

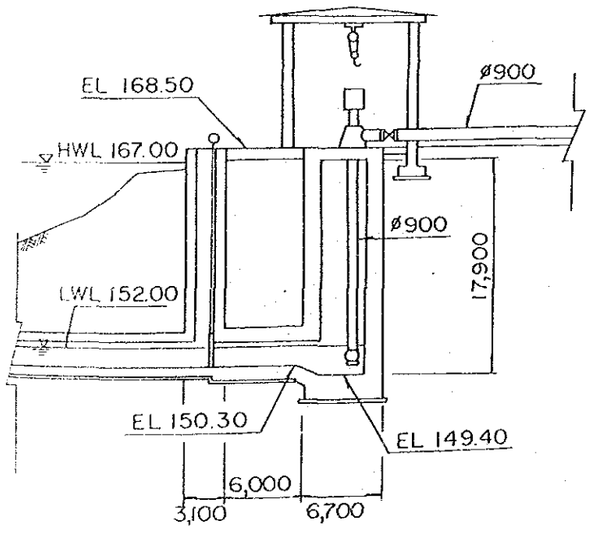
- Diameter : 500mm
- Total Head : 28.2m
- Capacity : 32.4m/min
- Speed : 1000rpm
- Motor : 250 KW
- No. of pump : 10 nos

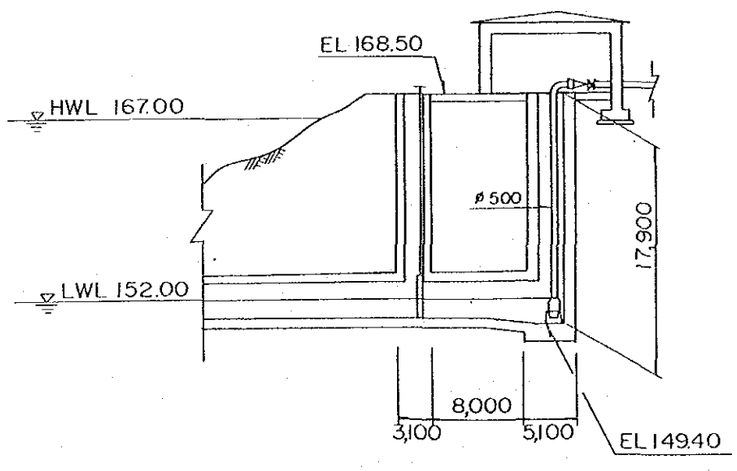
③ VOLUTE PUMP



Design Data

- Diametet : 900mm
- Total Head : 28.2m
- Capacity : 97.2m/min
- Speed : 750rpm
- Motor : 680KW
- No. of pump : 4 nos





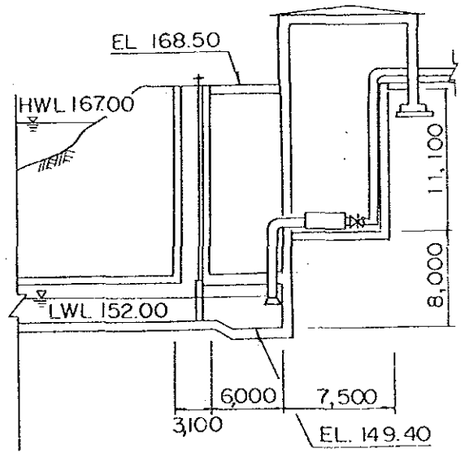
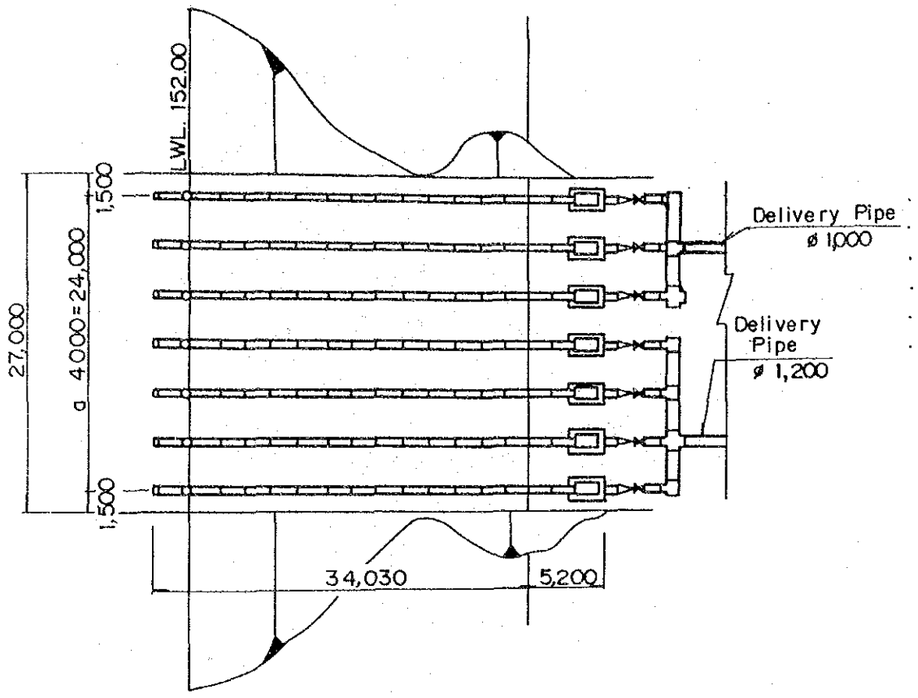


Fig. VIII-3 MAIN PUMP STATION FOR ALTERNATIVE STUDY (1/2)

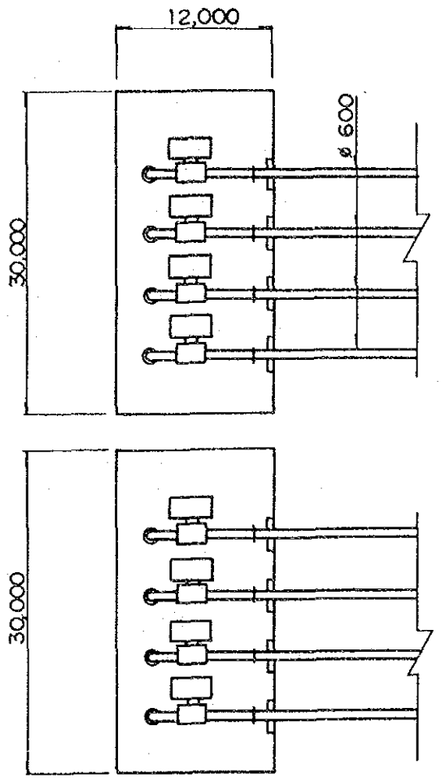
④ INCLINED PUMP



Design Data

· Diameter	600 mm
· Total head	28.2 m
· Capacity	48.6 m³/min
· Speed	1000 rpm
· Motor	380 kw
· No. of pump	7

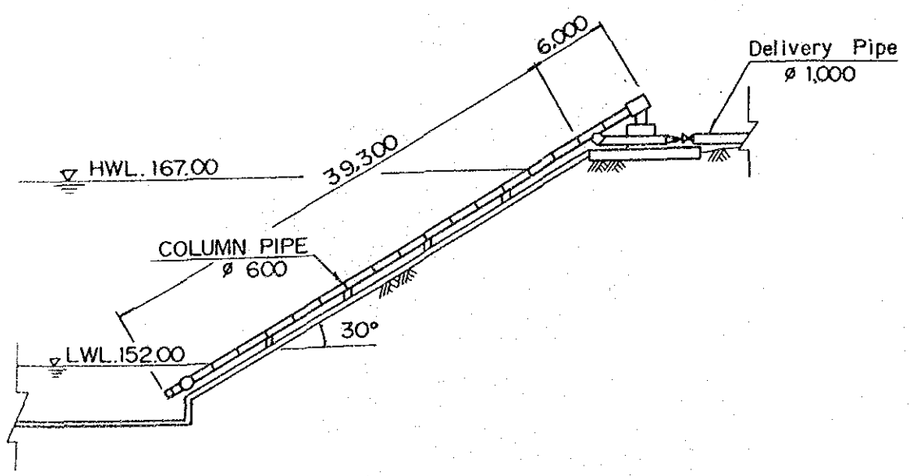
⑤ FLOATING PUMP STATION



Design Data

· Diameter	600 mm
· Total head	28.2 m
· Capacity	48.6 m³/min
· Speed	1000 rpm
· Motor	350 kw
· No. of pump	8

(2 UNITS)



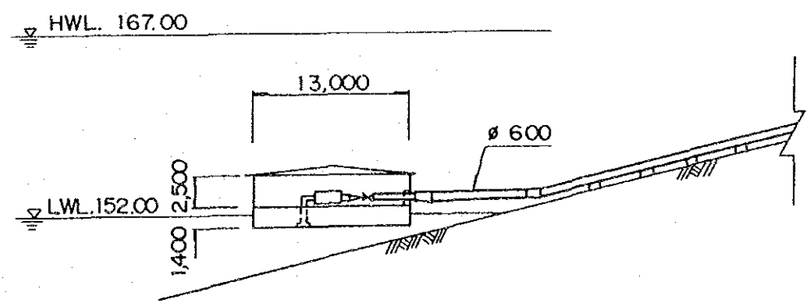


Fig. VIII-3 MAIN PUMP STATION FOR ALTERNATIVE STUDY (2/2)

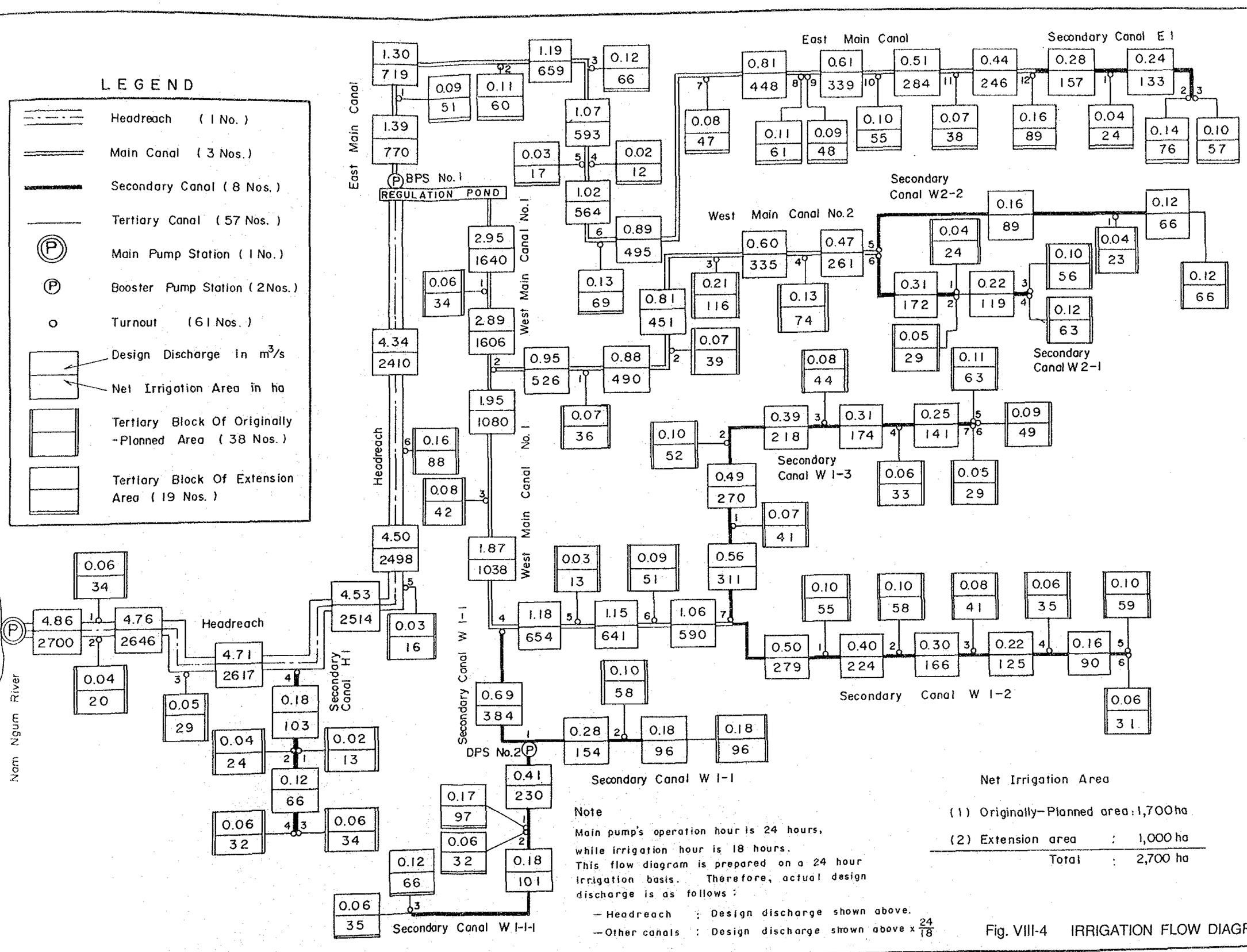
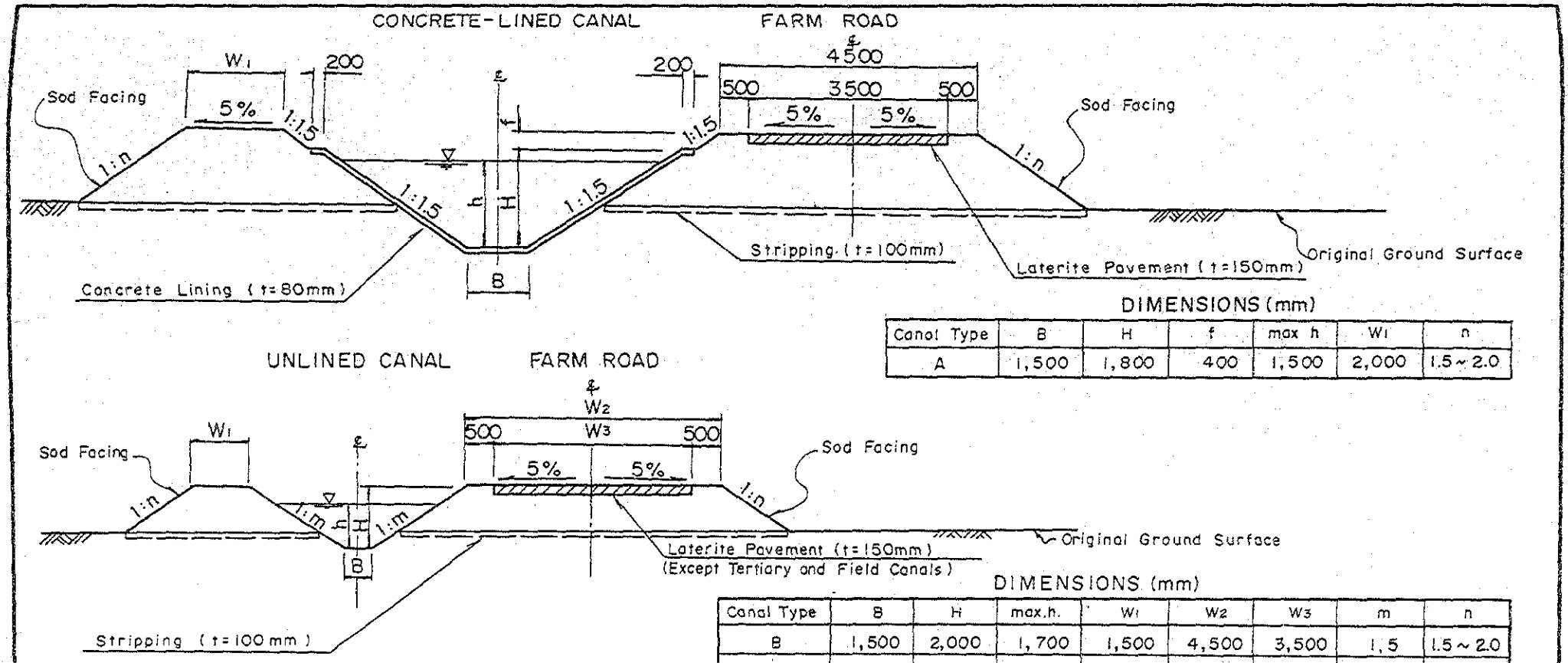


Fig. VIII-4 IRRIGATION FLOW DIAGRAM



DIMENSIONS (mm)

Canal Type	B	H	f	max h	W1	n
A	1,500	1,800	400	1,500	2,000	1.5~2.0

DIMENSIONS (mm)

Canal Type	B	H	max.h.	W1	W2	W3	m	n
B	1,500	2,000	1,700	1,500	4,500	3,500	1.5	1.5~2.0
C	1,300	2,000	1,700	1,500	4,500	3,500	1.5	1.5~2.0
D	1,000	1,800	1,500	1,500	4,500	3,500	1.5	1.5~2.0
E	800	1,600	1,100	1,500	4,500	3,500	1.5	1.5~2.0
F	700	1,400	800	1,500	4,500	3,500	1.5	1.5~2.0
G	500	1,100	800	1,100	4,500	3,500	1.5	1.5~2.0
H	400	900	600	1,000	4,500	3,500	1.5	1.5~2.0
I	400	800	600	400	3,000	—	1.0	1.5
J	300	600	400	400	3,000	—	1.0	1.5
K	300	500	300	300	3,000	—	1.0	1.5

Fig. VIII-5 TYPICAL CROSS SECTIONS OF CANALS AND FARM ROADS

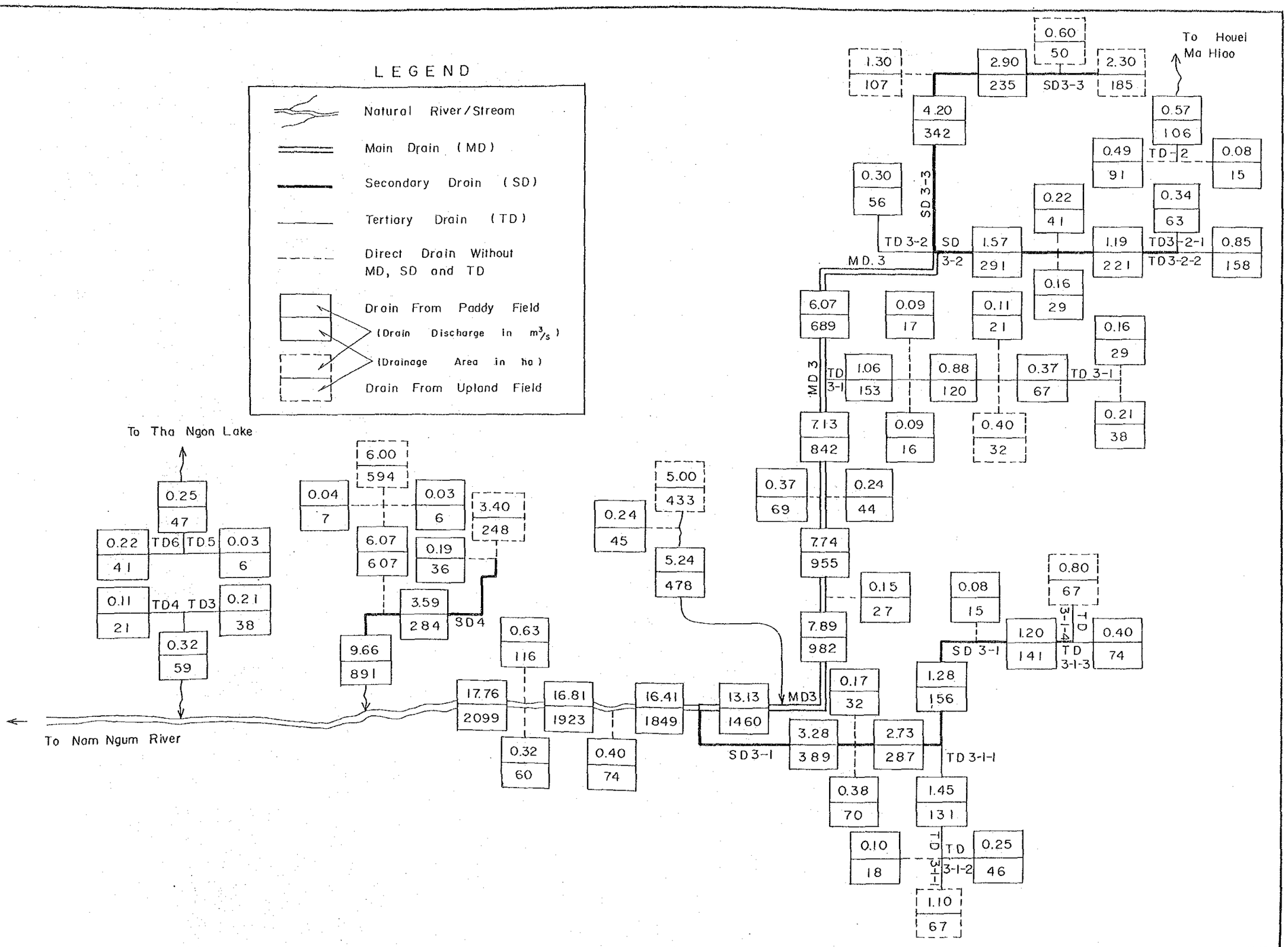


Fig. VIII-6 DRAINAGE FLOW DIAGRAM (1/2)

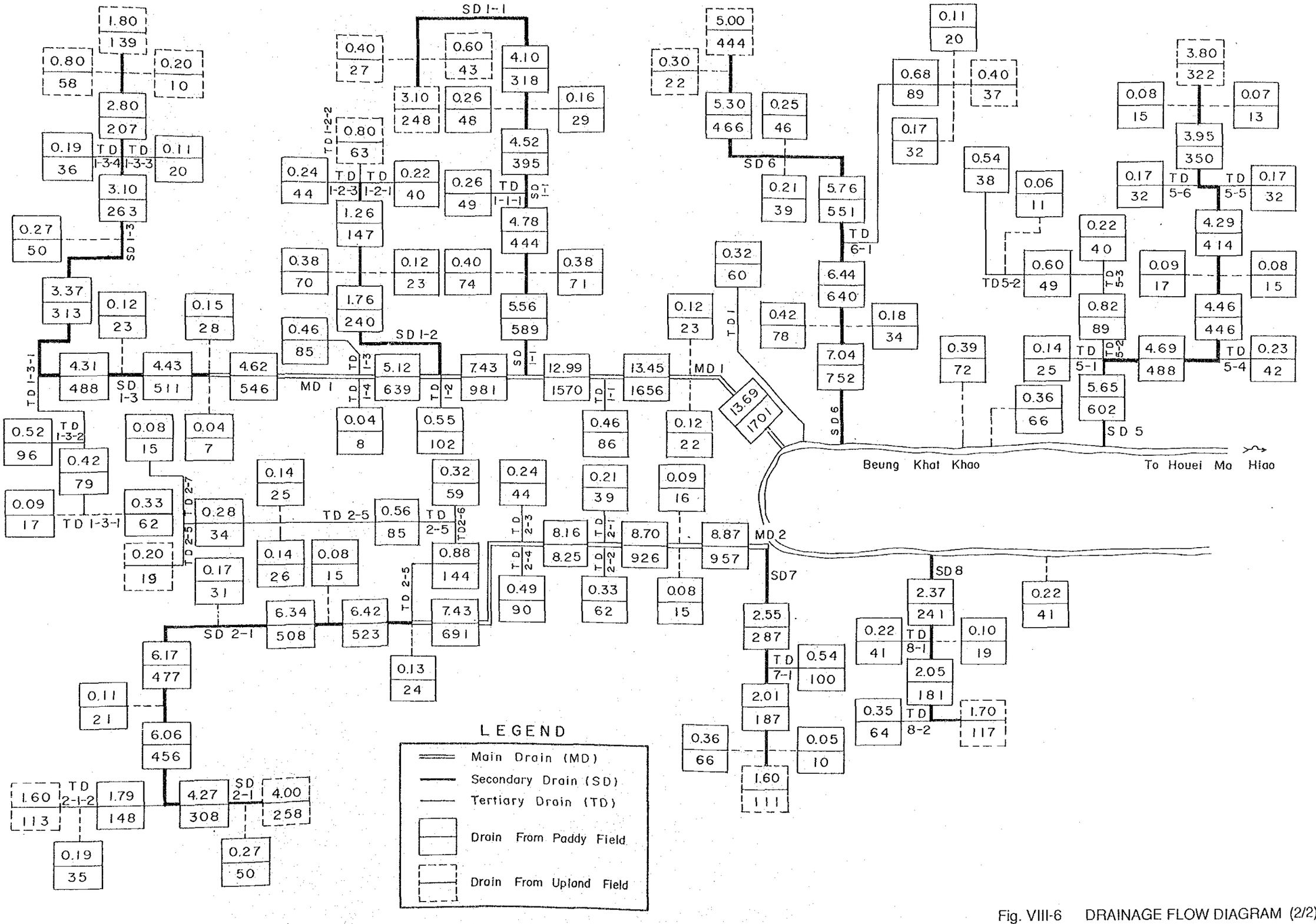
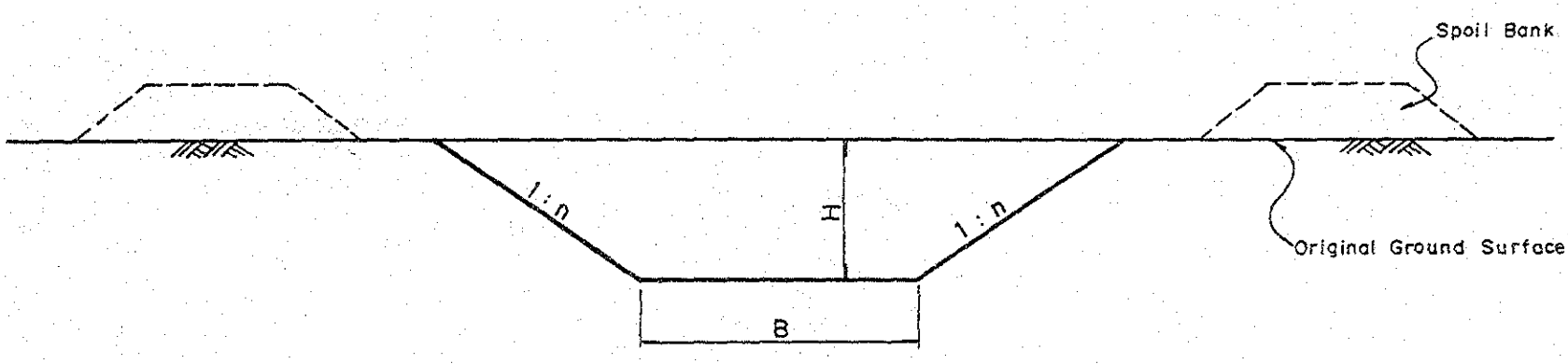


Fig. VIII-6 DRAINAGE FLOW DIAGRAM (2/2)



DIMENSIONS (mm)

Drain Type	B	H	n
A	5,000	2,000	1.5
B	4,000	2,000	1.5
C	3,500	1,800	1.5
D	3,000	1,500	1.5
E	2,500	1,200	1.5
F	2,000	800	1.5
G	500	500	1.0

Fig. VIII-7 TYPICAL CROSS SECTIONS OF DRAINS

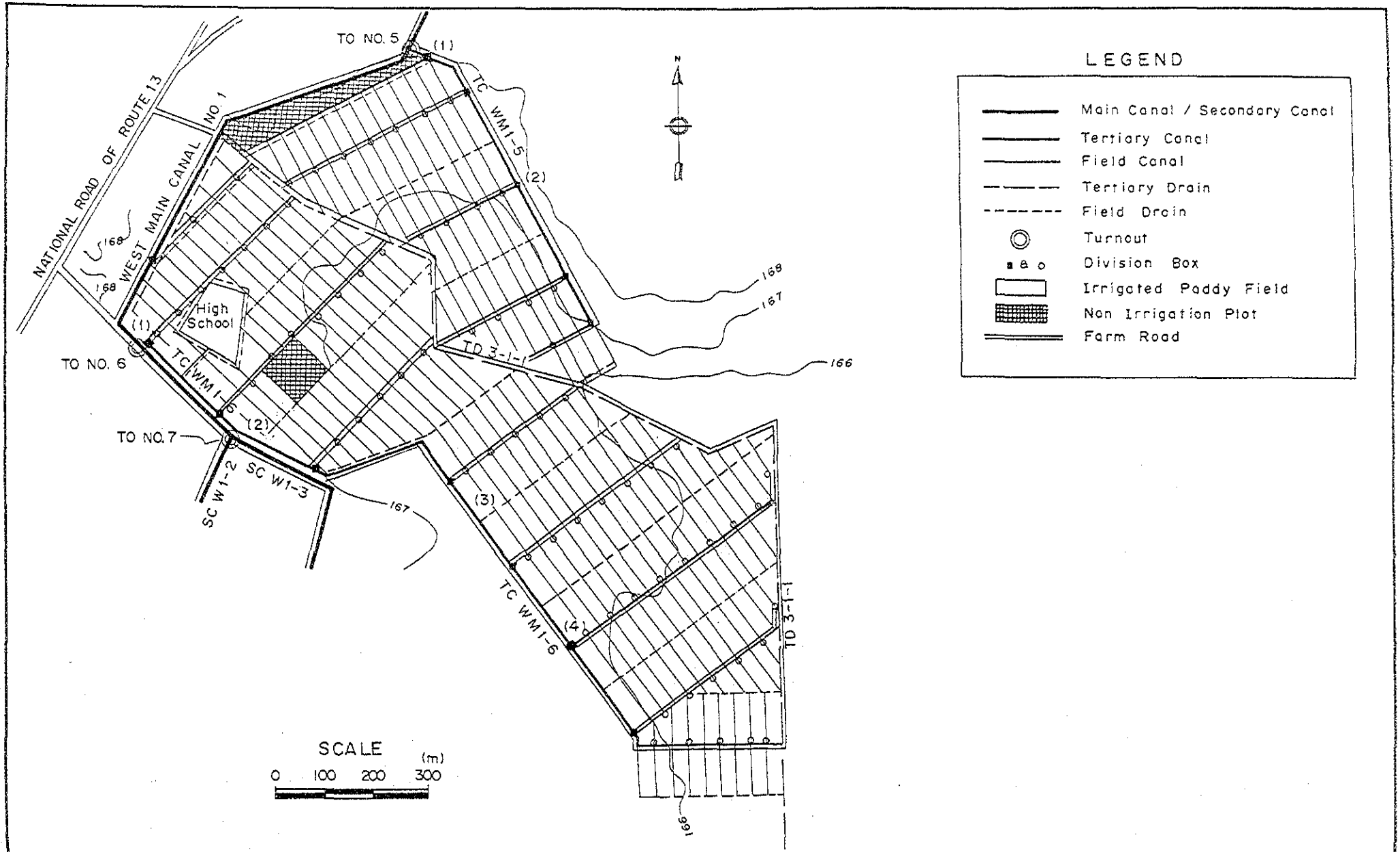


Fig. VIII-8 GENERAL LAYOUT OF DEMONSTRATION FARM

ANNEX IX

CONSTRUCTION PLAN AND COST ESTIMATE

ANNEX IX

CONSTRUCTION PLAN AND COST ESTIMATE

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1. Construction Plan

1.1 Construction Work

The civil works to be constructed under the Project are broadly divided into two categories; irrigation and drainage facilities, and rural infrastructures. The irrigation and drainage facilities are further divided into two categories; major irrigation and drainage facilities, and on-farm development works. Main works for each category are as follows:

(1) Major irrigation and drainage facilities
- Headreach with related structures
- Main and secondary canals with related structures
- Main pump station
- Booster pump stations
- Regulation pond
- Main and secondary drains with related structures
- Farm roads to be provided alongside headreach, and main and secondary canals

(2) On-farm development work
- Tertiary and field canals with related structures
- Tertiary and field drains with related structures
- Farm roads to be provided alongside tertiary and field canals
- Land clearing and land levelling work for present forest land
- Land levelling and land consolidation for the demonstration farm

(3) Rural infrastructures
- Village roads
- Extension of municipal water supply pipe line
- Tubewells and distribution pipe line

1.2 Construction Schedule

The construction schedule of the Project is prepared as shown in Fig. IX-1 on the following conditions:

i) Orderly implementation of the Project is essential for obtaining the Project benefit as early as possible. In this view and also taking into account the

scale of the Project, it is proposed to implement the Project in two stages. Stage-I will include the whole works related to the originally-planned area of 1,700 ha, while Stage-II will cover the works for the extension area of 1,000 ha. The rural infrastructures are proposed to be included in Stage-I, since their implementation is urgently needed. Major works to be implemented in each stage as itemized below:

Stage-I
- Main irrigation and drainage facilities for the originally-planned area
- On-farm development work for the originally-planned area including land leveling and consolidation for the demonstration work
- Rural infrastructures for the entire Project area

Stage-II
- Main irrigation and drainage facilities for the extension area
- On-farm development work for the extension area

ii) All the construction works will be executed by qualified international contractor(s) selected through international competitive tendering, except for the extension of municipal water supply pipe line. This work only will be made by Lao Water Supply Company (Bo Ly Sath Nam Papa Lao) under the supervision of the Project office.

iii) Since the construction work includes a large volume of earth work, the mechanized construction method will be employed.

iv) Major construction equipment and machinery needed for the work is shown in Table IX-1. Most of it will be available in Lao PDR.

v) Construction work for main irrigation and drainage facilities, and on-farm development work will be carried out almost simultaneously so that the Project benefits may accrue immediately after the completion of the construction works.

vi) Competent foreign consultant(s) will be engaged in detailed design, preparation of tender documents, technical guidance for prequalification and tendering works, and supervision of the construction works.

vii) Acquisition of lands necessary for the construction work will be made by the Project office timely.

viii) Equipment and machinery necessary for supervision of the construction works and for operation and maintenance of the Project facilities as well as for the demonstration farm will be procured by the Project office.

ix) Annual workable days for the construction works are estimated at 269 days excluding suspension days due to rainfall, national holidays and Sundays as shown in Table IX-2.

As shown in Fig.IX-1, the construction work for stage-I will commence in May 1990 and end in October 1992, taking a period of 2.5 years. The construction work for Stage-II will commence in May 1991 and end in April 1993. Consequently, total construction period will be three years.

The irrigation to the demonstration farm of 64 ha is scheduled to commence from November 1991. The irrigation to the originally-planned area of 1,700 ha will commence from May 1992. The irrigation to the entire area of 2,700 ha will commence from May 1993.

1.3 Construction

(1) Major irrigation and drainage facilities

Construction of the main pump station will be mainly executed during the dry season when water level of the Nam Ngum river is low. A temporary closing dike will be firstly constructed and, this will be immediately followed by foundation excavation and concreting for sub-structure.

Earth work for the headreach, and main and secondary canals will be carried out mainly by heavy equipment such as back-hoes and bulldozers. The trimming of canal side slopes will be made by manual labor or trimming machine. The compaction for canal embankment will be made by tamping roller after conditioning fill materials to have a moisture content in the required range. The embankment materials will be obtained from suitable excavated materials in canals and drains, and/or extracted from borrow-pits.

Concrete lining for the headreach will be executed by a longitudinally operating slip form. Concrete for canal lining and large structures will be produced in a central batching and mixing plant and transported by agitators, while that for small structures will be produced by potable concrete mixers to be installed at construction sites of respective structures.

(2) On-farm development work

Land levelling will be executed by bulldozers. Earth work for on-farm canals and drains will be made by both construction machinery and manual labor.

(3) Rural infrastructures

The existing road will be rehabilitated as village road by road construction equipment such as bulldozers, motor graders and road rollers. Deep tube-well will be constructed by drilling machine.

(4) Borrow-pit and concrete aggregates

The proposed borrow-pits are located near the junction of the national road of route 10 with the road to Ban Oudom Phon, and at the place about 1 km east from the regulation pond site. Concrete aggregates, i.e. sand and gravel will be obtained from the Mekong river between Thanaleng and Thadua located about 20 km southeast from the Project area.

Work quantities of the major construction works are presented in Tables IX-3, 4, 5 and 6. The required quantities of major construction materials are estimated in Table IX-7. Major equipment required for the construction works of the Project is listed in Table IX-1.

1.4 Operation and Maintenance

All the facilities constructed under the Project will be owned by the Government of Lao PDR. The operation and maintenance of the main irrigation and drainage facilities, village roads, and farm tractors for the demonstration farm will be carried out by the Project office, while that of the on-farm facilities will be entrusted to farmers concerned. The operation and maintenance of the potable water supply facilities will be entrusted to Lao Water Supply Company (Bo Ly Sath Nam Papa Lao) or the Project office.

2. Cost Estimate

2.1 General

The costs for the implementation of the Project are estimated on the following assumptions:

i) The exchange rate as of October 1988 used in the estimate is US$1 = Kip450 = ¥130.

ii) All the construction works except for extension of municipal water supply pipe line for rural development will be carried out by contractor(s) selected through international tendering. Most of the construction machinery and equipment needed for the construction works will be available in Lao PDR. The extension of municipal water supply pipe line will be made by Lao Water Supply Company.

iii) Taxes on construction materials, machinery and equipment to be imported from abroad are exempted.

iv) Unit costs of respective works are estimated at price and wage levels prevailing in Vientiane as of October 1988, due reference being made to the costs actually incurred in the implementation of the Tha Ngon Project. The unit costs are divided into foreign currency portion and local currency portion based on the following classification:

Local currency portion
- Labor force
- Wooden materials
- Sand and gravel
- Inland transportation
- Administration expenses

Foreign currency portion
- Reinforcing bar
- Depreciation of construction equipment and machinery
- Pumping plant and electrical facilities
- Steel gates

- Structural steel
- Cement
- Fuel
- International transportation
- General expense and profits for foreign contractor(s)
- Expenses and fees of engineering services by foreign consultant(s)

v) Physical contingency is taken as 8 % of direct construction cost.

vi) Price contingency is estimated based on a price escalation rate of 1% per annum for the foreign currency equivalent.

2.2 Cost Estimate

(1) Construction cost and annual disbursement schedule

The total construction cost for the Project is estimated at US$ 29.1 million equivalent, comprising US$ 26.1 million of foreign currency portion and US$3.0 million equivalent of local currency portion as summarized in Table IX-8. The annual disbursement schedule is worked out based on the construction schedule as shown in Table IX-22.

The breakdowns of the construction cost, procurement cost of O&M equipment, and other related cost are shown in Table IX-9 to Table IX-17. The prices of basic materials and labor wages used in the estimate and the unit prices for major work items are shown in Tables IX-18 and IX-19.

(2) Operation and maintenance costs

Operation and maintenance costs at the full operation stage of the Project is estimated at US$238,000 equivalent, including (i) operation and maintenance of the Project office and (ii) operation and maintenance of the Project facilities. These costs are shown in Table IX-20.

(3) Replacement cost of the Project facilities

Pumping equipment, electrical facilities and steel gates will have to be periodically replaced. The useful life and replacement cost are given in Table IX-21.

Table IX-1 Required Major Construction Equipment

Equipment	Originally-planned Area (Units)	Extension Area (Units)
- Bulldozer, 21 ton	4	8
- Bulldozer, 15 ton	8	8
- Swamp dozer, 15 ton	4	2
- Backhoe, 0.6 m^3	4	3
- Backhoe, 0.3 m^3	3	2
- Wheel loader, 2.3 m^3	2	1
- Whole loader, 1.0 m^3	3	1
- Tire roller, 8 ton	5	2
- Road roller, 10 ton	1	1
- Motor grader, 3.1 m	3	2
- Dump truck, 11 ton	15	4
- Dump truck, 8 ton	2	1
- Truck crane, 20 ton	1	1
- Water tanker, 5,500 lit	2	1
- Agitator truck, 1.6 m^3	5	1
- Trailer, 30 ton	1	1
- Cargo truck with crane, 6 ton	2	1
- Fork lift, 1 ton	2	1
- Microbus, 20 passengers	1	1
- Concrete batching and mixing plant, 0.5 m^3	1	1
- Concrete mixer, 0.2 m^3	3	2
- Tamper, 80 kg	7	6

Table IX-2 Work Day for Construction Work

1. Conditions for work day estimate

(1)	Daily rainfall (mm)	0-10	10-30	30-50	more than 50
(2)	Time needed for suspension (day)	0	0.5	1.0	2.0

2. Estimate of work days (reference year of 1981)

		J	F	M	A	M	J	J	A	S	O	N	D
(1)	Rainfall days (day/month)												
	10-30 mm	-	-	1	4	2	6	8	3	1	2	1	-
	30-50 mm	-	-	-	-	1	-	2	1	3	1	-	-
	more than 50 mm	-	-	-	-	3	1	3	1	1	-	-	-
(2)	Time length to be suspended	-	-	0.5	2	8	5	6.5	4.5	5.5	2	0.5	-
(3)	Sundays & national holidays	6	4	4	7	6	4	5	4	4	5	4	5
	Total days: (2)+(3)	6	4	5	9	14	9	12	9	10	7	5	5
3.	Work days	25	25	26	21	17	21	17	22	20	24	25	26

= 269 days

Table IX-3 Work Quantity of Irrigation and Drainage Facilities (1/2)

Items	Embank-ment (m^3)	Back-fill (m^3)	Excava-tion (m^3)	Strip-ping (m^3)	Sod Facing (m^2)	Laterite Pavement (m^3)	Land Clearing (ha)	Land Levelling (ha)
1. Originally-planned Area (1,700 ha)								
- Headreach	428,000	4,300	274,000	15,300	117,000	5,800	14.9	-
- Main canals	100,000	800	27,800	9,400	33,400	4,900	7.9	-
- Secondary canals	123,000	1,000	17,300	15,700	45,400	9,000	2.2	-
- Tertiary canals	284,000	4,000	9,600	35,000	-	-	-	-
- Field canals	340,000	1,500	76,600	72,000	-	-	-	-
- Main drains	200	300	93,300	-	-	-	0.5	-
- Secondary drains	300	800	205,000	-	-	-	0.3	-
- Tertiary drains	200	300	61,700	-	-	-	-	-
- Field drains	-	-	61,000	-	-	-	-	-
- Main pump station	-	200	10,500	200	1,900	200	0.3	-
- Regulation pond	22,400	400	14,400	1,500	11,500	-	9.0	-
- Land clearing & levelling	-	-	-	-	-	-	170.0	170
- Demonstration farm	-	-	-	-	-	-	-	64
2. Extension Area (1,000 ha)								
- Main canals	88,200	200	46,400	9,100	35,000	5,400	13.0	-
- Secondary canals	22,700	100	2,200	3,500	9,000	2,100	1.3	-
- Tertiary canals	200,000	2,400	6,100	24,000	-	-	-	-
- Field canals	201,000	900	2,700	40,500	-	-	-	-
- Secondary drains	200	400	102,000	-	-	-	0.3	-
- Tertiary drains	100	200	53,400	-	-	-	-	-
- Field drains	-	-	36,000	-	-	-	-	-
- Main pump station	-	100	4,500	100	1,100	-	0.1	-
- Booster pump stations	-	100	200	100	-	-	-	-
- Land clearing & levelling	-	-	-	-	-	-	710.0	710

Table IX-3 Work Quantity of Irrigation and Drainage Facilities (2/2)

Items	Concrete Lining (m^2)	Concrete (1:2:4) (m^3)	Concrete (1:3:6) (m^3)	Form (m^2)	Reinforce. Bar & Steel (ton)	Gate (set)	Concrete pipe (ϕ<0.8m) (m)	Concrete pipe ($\phi \geqq 0.8$m) (m)
1. Originally-planned Area (1,700 ha)								
- Headreach	93,000	1,470	2,070	11,000	130	20	40	1,330
- Main canals	-	1,390	360	9,700	110	22	35	215
- Secondary canals	-	700	670	4,900	50	26	225	235
- Tertiary canals	-	2,080	3,010	14,300	220	-	4,020	1,760
- Field canals	-	1,220	1,220	8,500	90	-	6,790	-
- Main drains	-	300	180	2,100	22	-	-	130
- Secondary drains	-	830	570	5,800	55	-	-	470
- Tertiary drains	-	290	170	2,000	33	-	430	60
- Field drains	-	-	-	-	-	-	-	-
- Main pump station	-	920	260	2,100	63	-	-	-
- Regulation pond	-	150	10	1,100	11	4	-	40
2. Extension Area (1,000 ha)								
- Main canals	-	390	180	2,700	44	24	50	110
- Secondary canals	-	100	30	700	7	12	30	-
- Tertiary canals	-	1,220	1,770	8,400	128	-	2,340	1,270
- Field canals	-	720	720	5,000	54	-	4,020	-
- Secondary drains	-	380	180	2,700	21	-	-	110
- Tertiary drains	-	160	80	1,100	12	-	250	40
- Field drains	-	-	-	-	-	-	-	-
- Main pump station	-	300	80	2,100	27	-	-	-
- Booster pump stations	-	280	20	2,000	23	-	-	-

Table IX-4 Work Quantity for Rehabilitation of Village Road

Works	Unit	Q'ty
1. Reshaping	m^3	10,040
2. Embankment	m^3	5,020
3. Laterite pavement	m^3	5,020
4. Concrete work		
- Concrete (1:2:4)	m^3	25
- Concrete (1:3:6)	m^3	93
- Reinforcement bar	ton	2
- Form	m^2	520
5. Concrete pipe work		
- Dia. 600 mm	m	32
- Dia. 800 mm	m	50
- Dia. 1,000 mm	m	24
- Dia. 1,200 mm	m	60

Table IX-5 Work Quantity for Extension Work of Existing Water Supply Pipe Line

Works	Unit	Q'ty
1. PVC pipe work		
- Dia. 25 mm	m	500
- Dia. 50 mm	m	1,450
- Dia. 75 mm	m	1,450
- Dia. 100 mm	m	650
2. Valves		
- Dia. 25 mm	nos.	26
- Dia. 50 mm	nos.	1
- Dia. 75 mm	nos.	3
- Dia. 100 mm	nos.	2
3. Communal taps and washing place	place	26

Table IX-6 Work Quantity for Drilling Tubewells and Construction of Distribution Pipe Line

	Works	Unit	Q'ty	
			Tubewell No.1	Tubewell No.2
1.	Drilling tubewell (30 m)	nos.	1	1
2.	Pumps and motors			
	- Submersible pump & motor (Q=160 lit/min, H=35 m, 2.2 kW)	set	1	-
	- Vertical turbine pump & motor (Q=320 lit/min, H=20 m, 2.2 kW)	set	1	-
	- Submersible pump & motor (Q=30 lit/min, H=35 m, 2.2 kW)	set	-	1
	- Vertical turbine pump &motor (Q=60 lit/min, H=10 m, 2.2 kW)	set	-	1
3.	Electrical work			
	- Distribution line	m	600	600
	- Service line	m	20	20
4.	Regulation tank	nos.	2	1
5.	Elevated tank	nos.	1	1
6.	PVC pipe work			
	- Dia. 25 mm	m	260	60
	- Dia. 50 mm	m	600	-
	- Dia. 75 mm	m	800	800
	- Dia. 100 mm	m	2,000	-
7.	Valves			
	- 75 mm	nos.	2	1
	- 100 mm	nos.	1	1
8.	Communal taps and washing place	place	14	3
9.	Fencing (h = 2 m)	m	88	76
10.	Painting	m^2	44	16

Table IX-7 Major Construction Materials
(Irrigation and Drainage Facilities)

Materials	Unit	Originally-planned Area	Extension Area	Total
- Ordinary portland cement	ton	8,700	1,800	10,500
- Reinforcement bar and structural steel	ton	790	320	1,200
- Gate with accessories	set	72	36	108
- Sand for concrete	m^3	13,600	3,500	17,100
- Gravel for concrete	m^3	26,900	7,000	33,900
- Laterite pavement	m^3	19,900	7,500	27,400
- Fuel	kl	2,310	840	3,150
- Lubricant	kl	170	60	230
- Concrete pipe				
$\phi < 800$ mm	m	10,380	6,000	16,380
$\phi \geqq 800$ mm	m	4,370	1,530	5,904

Table IX-8 Summary of Costruction Cost (1/2)

(Unit: US$ 1,000)

	Items	Originally-planned Area	Extension Area	Total
1.	Preparatory work	233	210	443
2.	Major irrigation and drainage facilities			
	- Headreach	5,600	-	5,600
	- Major canals	1,912	934	2,846
	- Major drains	975	288	1,263
	- Main pump station	2,118	1,516	3,634
	- Regulation pond	160	-	160
	- Booster pump stations	-	1,366	1,366
3.	On-farm development			
	- Tertiary canals	1,974	1,274	3,248
	- Tertiary drains	224	152	376
	- Field canals	1,385	764	2,149
	- Field drains	98	58	156
	- Land clearing and levelling	303	916	1,219
	Sub-total (1+2+3)	(14,982)	(7,478)	(22,460)
4.	Rural infrastructures			
	- Rehabilitation of village road	92	-	92
	- Extension of existing water supply pipe line	46	-	46
	- Drilling and construction of distribution pipe line	220	-	220
	Sub-total (4)	(358)	-	(358)
5.	Project office	154	-	154
6.	Demonstration farm			
	- Land consolidation	30	-	30
	- Warehouse	126	-	126
7.	O & M equipment	610	-	610
8.	Farm tractors for demonstration farm	91	-	91
9.	Engineering services and administration expenses	1,499	774	2,273
	Sub-total (5+6+7+8+9)	(2,510)	(774)	(3,284)
10.	Contingencies			
	- Physical contingency	1,428	660	2,088
	- Price contingency	540	347	887
	Sub-total (10)	(1,968)	(1,007)	(2,975)
	Total	19,818	9,259	29,077

Table IX-8 Summary of Costruction Cost (2/2)

(Unit: US$ 1,000)

Items	Originally-planned Area			Extension Area		
	FC	LC	Total	FC	LC	Total
1. Preparatory work	126	107	233	114	96	210
2. Major irrigation and drainage facilities						
- Headreach	4,915	685	5,600	-	-	-
- Major canals	1,732	180	1,912	881	53	934
- Major drains	873	102	975	257	31	288
- Main pump station	2,084	34	2,118	1,479	19	1,516
- Regulation pond	147	13	160	-	-	-
- Booster pump stations	-	-	-	1,346	20	1,366
3. On-farm development						
- Tertiary canals	1,762	212	1,974	1,146	128	1,274
- Tertiary drains	199	25	224	138	14	152
- Field canals	1,265	120	1,385	694	70	764
- Field drains	96	2	98	57	1	58
- Land clearing and levelling	296	7	303	895	21	916
Sub-total (1+2+3)	(13,495)	(1,487)	(14,982)	(7,025)	(458)	(7,478)
4. Rural infrastructures						
- Rehabilitation of village road	87	5	92	-	-	-
- Extension of existing water supply pipe line	43	3	46	-	-	-
- Drilling and construction of distribution pipe line	209	11	220	-	-	-
Sub-total (4)	(339)	(19)	(358)	-	-	-
5. Project office	-	154	154	-	-	-
6. Demonstration farm						
- Land consolidation	28	2	30	-	-	-
- Warehouse	38	88	126	-	-	-
7. O & M equipment	610	-	610	-	-	-
8. Farm tractors for demonstration farm	91	-	91	-	-	-
9. Engineering services and administration expenses	1,157	342	1,499	622	152	774
Sub-total (5+6+7+8+9)	(1,924)	(586)	(2,510)	(622)	(152)	(774)
10. Contingencies						
- Physical contingency	1,261	167	1,428	612	48	660
- Price contingency	473	67	540	328	19	347
Sub-total (10)	(1,734)	(234)	(1,968)	(940)	(67)	(1,007)
Total	17,492	2,326	19,818	8,587	672	9,259