PART IV FEASIBILITY STUDY FOR THE PRIORITY PROJECTS

CHAPTER IV-1 THE PRIORITY AREAS

IV-1.1 Natural Condition

IV-1.1.1 Topography

(1) Upper Slakou River Irrigation Reconstruction Plan (USP)

The USP area (3,500 ha) is located on the right bank of the Slakou River between 104°30' to 104°40' east longitude, and 11°00' to 11°05' north latitude. The elevation of the area ranges from 15 m to 35 m with a slope of 1/200 to 1/1000 from west to east. The approximate distance to Takeo town from the area is about 15 to 35 km.

To the west of the area, two reservoir sites are located, i.e. Tumnup Lok and Kpob Trobek reservoirs. The elevation and location of the area inside the reservoir are as follow:

Items	Tumnup Lok Reservoir	Kpob Trobek Reservoir
Elevation in meter	36 m to 43.3 m	32.5 m to 39 m
North Latitude	11°07'	11°05'
East Longitude	104°28'	104°32'

(2) Small Reservoir Rehabilitation Plan (SRP)

Ang 160 SRP area (25ha) is located between 104°33' east longitude, and 11°01' north latitude. The elevation of the area inside the small reservoir ranges from 43 m to 46.5 m, while that of the irrigation area ranges from 40 m to 44 m with a slope of 1/100 from west to east. The distance from Takeo town is about 30 km.

Kim Sei SRP area (27 ha) is located between 104°38' east longitude, and 10°55' north latitude. The elevation of the area inside the small reservoir ranges from 12.5 m to 13.8 m, while that of the irrigation area ranges from 11 m to 12.5 m with a slope of 1/500-1/350 from west to east. The distance from Takeo town is about 25 km.

(3) Small Pond Development Plan (PDP)

The model area for Small Pond Development Plan (PDP) is Trapeang Snao village in Nhaeng Nhang Commune with an area of 298 ha. The village is located just east side of Kime Sei SRP area. The elevation of the area ranges from 9.0 m to 11.0 m with a slope of 1/500-1/350 from west to east.

IV-1.1.2 Geology and Soil Mechanics

(1) Tumnup Lok Reservoir

The geological formation inside the reservoir below 2 to 7 m from the ground surface is silty sand, and sandy silt and has N value of 10 to 37 (rather dense). The geological formation below such layer is clay layer with a thickness of 3 to 4 m, and its N value is 10 to 50. Below this layer, weathered rock (silty stone) exists, of which the N value is more than 50. The clay layer and weathered rock have a high enough bearing capacity for 5 m high embankment and ordinary concrete irrigation structure.

The existing dike of Tumnup Lok reservoir has the following soil mechanical nature:

- The main material is clayey sand (SC) and silty sand (SM) having a plasticity index of less than 10.
- Dry density of the dike material is 1.84 to 1.91 g/cm3 on average and the compaction degree is rather high.
- Internal friction angle and cohesion of the material are estimated at 20 to 30 degrees and 1.0 to 3.0 tf/cm2, respectively.
- Permeability of the material is 3x10-5cm/sec which is classified as impervious to semi-impervious.
- Based on the above considerations, the dike seems safe against slope failure, but it has a possibility of piping by water seepage and erosion by rainfall and waves in the reservoir that could result in collapse of dike. Therefore, the existing dike should be protected by laterite on the inner surface of the dike and filter material on the toe of the outer surface. River bed materials near the proposed reservoir will be collected and utilized as the filter material.

(2) Kpob Trobek Reservoir

The geological formation inside the reservoir is alternating layers of silty sand (SM), and sandy clay (CL) with a thickness of 6 to 10 m and N value of 10 on average. Below such layers, a firm sandy clay exists which has N value of more than 50. The material of the existing dike is silty sand and sandy clay which have N value of 20 to 50. The material of existing dike has the same soil mechanical nature as that of Tumnup Lok reservoir dike:

(3) Main and Secondary Canals of the USP

The existing canals of the USP were constructed mainly by clay (CL) and silty sand (SM). The silty sand includes 40 % fine material, but the plasticity is very low. The compaction was done well. Internal friction angle and cohesion of the material are estimated at 25 degrees and 1.0 to 4.0 tf/cm^2, respectively. Permeability of the clay is

$1x10^{-6}$cm/sec which is classified as impervious, and that of the silty sand is $3x10^{-5}$ cm/sec. The cut portion of the canals (SM and SC) are very weak against erosion by rainfall and water flow in the canal.

(4) Embankment Materials for Rehabilitation of the USP and the SRP

The soils of the irrigation areas of the USP and the SRP are mainly silty sand, clayey sand, sandy clay, and clay. The embankment materials of rehabilitation of dikes and canals of the USP and the SRP should be laterite, clayey gravel, excavated material of the existing dikes, and excavated materials in the area inside the reservoirs and project areas. The laterite and clayey gravel available from the borrow pit adjacent to Prey Kduch village proposed in Sub-Section II-1.2, will have high cohesion (unconfined compression strength of 4 to 14 tf/cm^2) and impervious nature ($1x10^{-6}$ to $1x10^{-7}$ cm/sec), and are rather strong against erosion. Therefore, the laterite and clayey gravel should be used for slope and surface protection of dike and canals, and surface pavement of roads.

The other materials will have difficulty of compaction, be weak against erosion by rainfall during construction, and be of low trafficability. When such materials are used for embankment, they must be well compacted at a water content within ± 3 % of the optimum water content.

The materials available from the borrow pit adjacent to Mt. Kraol is good for road materials, but is not recommendable for embankment materials of dike and canals in due consideration of the soil mechanical nature and long hauling distance.

The test pits and boring sites for the above investigation are shown in Fig.IV-1.1.1. The quarry sites and borrow-pit areas are also shown in Fig. IV-1.1.1.

For pond development, soils available near the pond should be used.

IV-1.1.3 Water Resources and Flood Discharge

(1) Water Resources

1) Upper Slakou River Irrigation Reconstruction Plan (USP) Area

The USP area of 3,500 ha net irrigation area will be served with water conveyed from the Tras Stream (Tumnup Lok Reservoir) and the Don Phe Stream (Kpob Trobek Reservoir). As explained in Sub-Section II-1.3, runoff for these streams was estimated on a monthly basis at Kpob Trobek Reservoir and Tumnup Lok Reservoir, respectively.

2) Small Reservoir Rehabilitation Plan (SRP) Area

(a) Ang160 Reservoir

Ang 160 reservoir is located at the eastern foot of the mountains that form the administrative boundary between Takeo and Kampot Provinces. The catchment area of Ang 160 reservoir is 2 km^2. Two small streams originating from the mountains serve Ang 160 reservoir. The dike of Ang 160 reservoir is made by earth. The dike consists of north-south dike of about 350 m in length and west-east dike of about 150 m in length. The crest elevation of the dike is around 46.5 m and the dike height is 3 m at the maximum. The dike collapsed about 20 m in length at the northeast corner and at present, water is flowing out through the broken portion.

One stream dries up in the dry season. The other stream is almost perennial and supplies a small amount of water even in the dry season. From June to August, flow gradually increases as rainfall increases. September and October are the peak rainy season. When heavy rainfall comes, big flow occurs. November and December are recession period. Occurrence of big flow decreases considerably in this season.

Based on the interview survey and the runoff estimated for the Slakou River tributaries, runoff to Ang 160 reservoir was assumed as shown below.

Assumed Runoff to Ang 160 Reservoir

Unit: l/sec

Probability	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
80%	0	0	0	0	0	0	5	7	33	27	17	4
50%	2	1	1	0	0	7	9	17	47	67	27	8

(b) Kim Sei Reservoir

Kim Sei reservoir lies along the southern side of National Road No.3 in the flat plain of paddy fields. The catchment area is 5.2 km^2, mostly covered with rain-fed paddy fields. There are three culverts crossing the road. Water from the catchment area flows into the reservoir passing through these culverts. The biggest culvert, which has two circular barrels of 1.2 m diameter, was provided on Canal 8.

The reservoir consists of earthen dikes on three sides such as north side, east side and south side. The east dike is a main dike. The main dike lies about 450 m long on the ground surface elevation of about 12 m in parallel to contour line. The dike top elevation is around EL 13.8 m. The dike height is about 1.7 m to 2.0 m. The reservoir area has been utilized for paddy cultivation in the rainy season except depressions of a few thousands m^2 located along the main dike.

According to interview survey, Canal 8 flows from July to December in an average year, but in the drought year, the starting time of flow is one to two months late. In September and October, water flows constantly. At the other two culvert points, water flows only when heavy rainfall comes, especially in September and October.

Based on the above-mentioned information and results of runoff analyses for the Slakou river tributaries, runoff flowing into Kim Sei reservoir was assumed as shown in the following table.

Assumed Runoff to Kim Sei Reservoir

Unit: l/sec

Probability	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
80%	0	0	0	0	0	0	4	12	76	63	40	5
50%	0	0	0	0	0	0	9	36	115	165	67	8

3) Small Pond Development Plan (PDP)

Small ponds proposed for developing a small scale irrigated agriculture will be located on the plain where paddy is planted in the rainy season. This situation is the same as Kim Sei reservoir. Stable flow cannot be expected until the paddy plots in the catchment area of the pond are filled with water. Thus the proposed pond should be located where water is easily collected and/or the groundwater level is high.

(2) Flood

1) Flood for Three Tributaries

There are no actual flood data for the Slakou River. Therefore, floods, including a 100 year probable flood were estimated by a general method recommended in the Irrigation Rehabilitation Study in Cambodia, 1994 (Mekong Secretariat) and the Unit Hydrograph method using annual maximum daily rainfall data of Kampong Spueu station. The past biggest flood experienced near the Tumnup Lok reservoir site was also estimated by the non-uniform flow calculation method.

The catchment areas used and estimated flood discharge at each reservoir site are as follows:

100-Year Probable Flood (Q100) and Past Biggest Flood

Name of Stream	Name of Reservoir	Catchment Area (km^2)	Method of I.Rehabili. Study (m^3/sec)	Unit Hydrograph Method (m^3/sec)	Non-Uniform Calculation Method (m^3/sec)
Don Phe	Kpob Trobek	137	184	190	
Krouch	O Saray	51	76	87	
Tras	Tumnup Lok	332	409	408	300 - 350

The past biggest flood at Tumnup Lok reservoir site seems to be the largest in the last 30 years in consideration of the ages of people interviewed.

Based on these estimates and considering the base flow of three tributaries, design discharges for rehabilitation and reconstruction of the three reservoirs are recommended as follows:

Kpob Trobek Reservoir: 195 m^3/sec
O Saray Reservoir: 90 m^3/sec
Tumnup Lok Reservoir: 420 m^3/sec

2) Flood for Ang 160 Reservoir and Kim Sei Reservoir

The Rational Formula was employed for estimating floods for both Ang 160 and Kim Sei reservoirs. Floods were calculated from probable daily rainfall estimated for return periods of 20 years and 100 years from the annual maximum daily rainfall data of Kompong Spueu station.

Results of peak flood estimate are shown in the following table.

Estimated Peak Flood Discharge of Ang 160 and Kim Sei Reservoirs

Name of Reservoir	Catchment Area ($km^{2)}$	Probable Flood (m^3/sec)	
		20 year	100 year
Ang 160 Reservoir	2.0	6.0	7.8
Kim Sei Reservoir	5.2	11.4	14.8

For both reservoirs, the flood scale and the reservoir scale are small, and the downstream areas of the reservoirs are mostly paddy fields with no valuable properties. Thus, the 20 year probable flood is recommended as a design flood, but a spillway to be provided on the reservoir should be checked for whether the 100-year probable flood can be drained within the freeboard of the reservoir dike or not.

IV-1.1.4 Soil and Land Suitability

Three (3) types of soils occupy the priority areas as shown in the following table:

Soils in the Priority Areas

Priority Projects	Soil type		Area (ha)	
			Gross	Net area of paddy
USP	D2	Grey lessive soils	700	530
	D3	Grey lessive soils	3,900	2,970
		Total	4,600	3,500
Ang160 SRP	B	Old alluvial gray soils	30	25
Kim Sei SRP	D2	Grey lessive soils	32	27
PDP (Tr. Snao)	D2	Grey lessive soils	6.2	5.8

Note: Grey lessive soils are classified into Tropical Podzol by FAO's soil classification system. Grey lessive soils are divided into 2 sub-groups, D2 and D3 by parent materials of alkali or acidic, respectively.

Surface soils of the above types have a sandy texture, are structureless or have a weak structure, poor soil-moisture, poor nutrient, and acidity of pH 5.3 to 5.7. Due to the sandy texture, the soils have a low nutrient-holding capacity and the soil fertility is generally poor. Despite the sandy texture, the permeability is generally low due to the existence of structureless subsoil and plow-pan layer. The soils can be plowed easily by draft animal under wet conditions. The lands in the priority areas are suitable for the cultivation of paddy and diversified crops. However, in order to increase the land productivity, irrigation is necessary, especially, during the early rainy season and dry season because of poor soil-moisture and unstable rainfall.

For the improvement of soil fertility, it is proposed to apply farm manure from livestock animal husbandry, to plow deeply by tractor if available, and to plant green manure. It is, also, recommendable to apply lime in order to improve the soil pH for vegetable cultivation.

IV-1.1.5 Land Use

(1) Land Use in Irrigation Area

Land use of four (4) priority areas are shown in the following table. The gross area of USP is estimated at about 4,600 ha, consisting of 3,500 ha of paddy field, 210 ha of secondary crop field, and 890 ha of other land. There is no secondary crop field in both areas of SRP. Targeted area of PDP is dotted in Trapeang Snao village, which consists of 30 sites with area of 0.05 to 0.82 ha per site.

Land Use of the Priority Areas

(Unit: ha)

Priority Projects	Paddy field *1	Secondary crop field *1	Residential area	Other lands *2	Total
USP	3,500	210	240	650	4,600
Ang 160 SRP	25	0	1	4	30
Kim Sei SRP	27	0	1	4	32
Tr. Snao PDP	5.8	0	0	0.4	6.2

Note *1: Net cultivated area
*2: Road, canal, stream, farm ridge, etc.
Source: Estimated on the basis of the village data and map of 1/10,000 scale.

(2) Paddy Cultivation inside the Reservoirs

Four (4) reservoirs, Tumnup Lok and Kpob Trabek reservoirs for USP, and Kim Sei and Ang160 reservoirs of both SRPs, will be rehabilitated under the Project. Lands inside the above reservoirs are the property of MOWRAM, and no farmers have rights to use the land. However, farmers around the reservoirs are cultivating paddy inside the reservoirs, mostly during the rainy season and partly in the beginning of the dry season as receding paddy cultivation. They recognize that the land belongs to MOWRAM. After reconstruction of the reservoirs, most of the lands will be submerged. But, the farmers want to continue paddy cultivation inside the reservoir at their own risk if MOWRAM permits the cultivation.

The following table shows land areas that will be submerged at the high water level of the reservoirs after rehabilitation. The submerged areas will be about 373 ha in total. In about 65 - 85 % of the submerged land, paddy is currently planted every year. The gross area of planted paddy is estimated at 280 ha in total: 130 ha for Tumnup Lok reservoir, 140 ha for Kpob Trabek reservoir, 3 ha for Ang160 reservoir, and 7 ha for Kim Sei reservoir.

Present Land Use of Reservoir Areas Submerged by Rehabilitation

(Unit: ha)

Priority Projects	Name of reservoir	Area at HWL	Area of paddy cultivation
USP	Tumnup Lok	150	130
	Kpob Trabek	210	140
Ang 160 SRP	Ang 160	4.3	3
Kim Sei SRP	Kim Sei	8.8	7

For the cultivation inside the above reservoirs, MOWRAM explained to farmers the objectives of the priority project, the necessity for land inside the reservoir and the ownership of land inside the reservoirs. The farmers understand that they have no land-use right, but they requested MOWRAM to permit such cultivation inside the reservoir.

Paddy cultivation inside the reservoirs after the reconstruction /rehabilitation will be possible, however, the cultivation system will be changed as follows:

i) In the land with the water depth of less than 25 cm (at the high water level of reservoir), local paddy can be planted in the rainy season, and
ii) In the land with the water depth of more than 25 cm, rainy season paddy cannot be planted due to deep water. Early maturing varieties (such as IR65) can be planted in the early dry season using receding water depth, and the receding paddy will be irrigated by portable pump during half-to-one month in the late growing season.

By applying the above cropping system, the planted area inside the reservoirs could be maintained at the present level, and the yield may increase by supplemental irrigation. The estimated area by cropping systems is shown in the following table:

Cultivable Area in Reservoirs by Cropping Type

(Unit: ha)

Name of Reservoir	Rainy season paddy *1	Receding paddy *2	Total
Tumnup Lok	40	90	130
Kpob Trabek	70	70	140
Ang 160	0.8	2.2	3.0
Kim Sei	5.0	2.0	7.0

Note *1: Area of deepest water depth less than 25 cm
*2: Area of deepest water depth more than 25 cm

IV-1.2 Socio-Economic Condition

(1) Administration

The three priority projects, namely USP, SRP and PDP are located in Tram Kak District (Takeo Province). The total number of Communes where the priority projects are located is 7, and that of villages is 35. The administration of the priority areas is summarized below, and the details are shown in Table IV-1.2.1.

Related Communes and Villages in the Priority Areas

Projects	Nos. of Communes	Nos. of Villages	Total Village Area (ha)
USP	5	32	5,464
SRP	2	2	569
PDP	1	1	298
Total	7*	35	6,331

Note: One Commune (Nhaeng Nhang) is included in SRP and PDP in the number of commune.
Source: Hearing Survey to Village Chiefs

(2) Demography

The total population and households (HHs) of the related 35 villages in the priority areas are about 23,100 persons and about 4,400 HHs, respectively. Average family

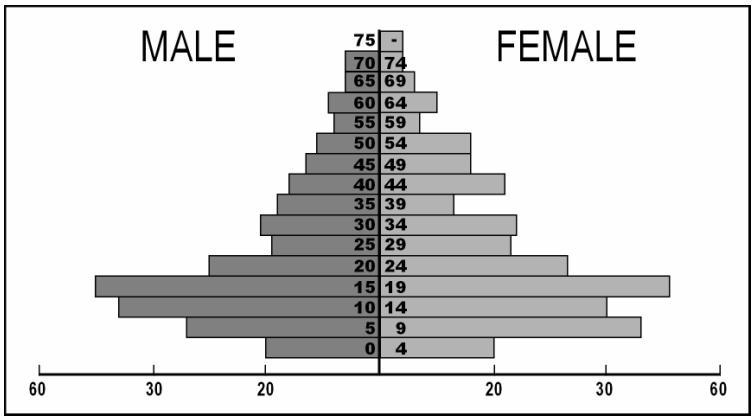
size is 5.2-person/HH. The details are shown in Table IV-1.2.1. According to the results of social environmental baseline survey[9], and the hearing survey to village chiefs of the related villages in the priority areas, almost all the households in the priority areas have their own agricultural land.

Population and Households of Related Villages in the Priority Areas

Projects	Population	Nos. of Households	Average Family Size
USP	21,163	4,063	5.21
SRP	1,372	258	5.32
PDP	583	111	5.25
Total	23,118	4,432	5.22

Source: Hearing Survey to Village Chiefs

Age distribution based on the social environmental baseline survey for related communes in the priority areas is graphed below. Sex ratio (% of male/female) is 90.5 %. Pattern of the age distribution in the priority areas is almost the same as that of the whole country.



Source: Social Environmental Baseline Survey (Feb. and Sep., 2001)

Age Distribution in the Priority Area

(3) Economic Activity

The major economic activity other than agriculture in the priority areas is observed in the two public markets in the USP area. The others are only stands, bike-taxi, cow-trailer, selling of imported goods, selling and collecting of firewood or palm leaves for house roof, house buildings and small scale rice mills.

The average annual cash income in the priority areas is about Riel 600,000 /HH. About 65 % of the cash income is agricultural income. The average percentage of the

[9] Additional survey was conducted by the Study Team in Sep. 2001 for 20 HHs of each in Trapeang Thhuk village, Kim Sei village and Trapeang Snao village.

agricultural cash income to the total cash income of the USP area is about 73 %, which is higher than that of SRP and PDP.

Annual Cash Income in the Priority Areas

Plans	Total Cash Income	Agricultural Cash Income	Other than Agricultural Cash Income
USP	Riel 503,600 100 %	Riel 365,700 72.6 %	Riel 137,900 27.4 %
SRP	Riel 743,000 100 %	Riel 475,400 64.0 %	Riel 267,600 36.0 %
PDP	Riel 598,100 100 %	Riel 353,900 59.2 %	Riel 244,200 40.8 %
Average	Riel 600,400 100 %	Riel 393,500 65.5 %	Riel 206,900 34.5 %

Source: Social Environmental Baseline Survey (Feb. and Sep., 2001)

As shown in the below table, about 51 % of the non-agricultural income is salary on the average in the priority areas. About 56 % of such income in the USP area is wages, while about 70 % and 52 % of the non-agricultural income in the SRP and PDP areas is salary. Salary is an income of public servants (teachers, soldiers and so on). Wage is income for work as temporary construction worker. Private business income comes from motorbike-taxi, selling goods imported from Vietnam, etc. Fishery income is earned by casting net in ponds and reservoirs. The caught fish is sold at local market and some is used for home consumption. The sales amount is negligibly small and scarcely any fish culture[10] is undertaken in the priority areas.

Annual Non-Agricultural Cash Income in the Priority Areas

Plans	Non- Agricultural Income = (1)+(2)+…+(5)	Salary (1)	Wages (2)	Private Business (3)	Fishery (4)	Others (5)
USP	Riel 137,900 100 %	Riel 26,100 18.9 %	Riel 77,600 56.3 %	Riel 27,800 20.2 %	-	Riel 6,400 4.6 %
SRP	Riel 267,600 100 %	Riel 186,900 69.8 %	Riel 50,700 19.0 %	Riel 17,000 6.4 %	Riel 7,000 2.6 %	Riel 6,000 2.2 %
PDP	Riel 244,200 100 %	Riel 126,500 51.8 %	Riel 77,500 31.7 %	Riel 40,300 16.5 %		-
Total	Riel 206,900 100 %	Riel 105,700 51.1 %	Riel 67,400 32.6 %	Riel 26,100 12.6 %	Riel 2,600 1.3 %	Riel 5,100 2.5 %

Source: Social Environmental Baseline Survey (Feb. and Sep., 2001)

IV-1.3 Agriculture

(1) Land Tenure and Landholding

Tenant and landless farmers are very limited in the priority areas, and tenant / landless farmers ratio to the whole farm households is estimated at less than 3 %. In general, a tenant farmer pays a land fee by crop sharing system: a landowner

10 Some villagers are raising tilapia in small ponds around houses.

provides inputs to tenant, and a tenant pays 50% of the products to the landowner.

The average size of paddy field per household is 0.87 ha for USP, 1.10 ha for Ang160 SRP, 1.33 ha for Kim Sei SRP, and 1.15 ha for Trapeang Snao PDP. The largest farm in each priority area is around 2.5 ha. The USP beneficiaries' paddy field will be mostly irrigable, but for the SRP and PDP beneficiaries' paddy field, irrigable area will be only a portion: 17% for Ang160, 55% for Kim Sei, and 6% for PDP. The average operating farm size and irrigable area of beneficiaries of each priority area are shown in Table IV-1.3.1.

Land registration of land-use right has not been implemented in the priority areas. Some villages keep the record of land allotment in 1989, but neither cadaster nor cadastral map is available in any village. Farmers recognize boundaries of respective farmlands of one another in a village community.

(2) Agricultural Labor Force

The agricultural labor force was estimated at 2.3 to 3.3 persons per family, or 1.6 to 3.0 persons per ha on the basis of the social environmental baseline survey shown in Table IV-1.3.2. During the idle period of farm work, some farmers go out of their village to earn cash income.

(3) Crop Production and Food Balance

1) Present Crop Production

Paddy rice is a major crop in each priority area. Diversified crops are minor and they are planted on less than several percents of their farmland.

Most of the paddy field is rain-fed during several months in the rainy season. In a part of paddy field, double cropping paddy combined with early maturing varieties of HYVs is undertaken. Double cropping of paddy in Ang160 is observed with higher cropping intensity than others project areas using stream water from the mountains. The cropping intensity of Ang160 is estimated at 120% currently. Diversified crops such as vegetables, corn, groundnut and mung-bean are planted in the early rainy season before paddy cultivation, or in the dry season after the harvest of paddy by supplemental irrigation using residual water. Table IV-1.3.3 shows the present planted area of the priority areas.

The average yield of crops is almost the same among all the priority areas. But, paddy yield by villages in the USP area widely ranges from 700 kg/ha to 2,000 kg/ha according to the interview survey with 32 village chiefs: 700 - 1,000 kg/ha in O Saray Commune, 1,000 - 2,000 kg/ha in T.T.K Cheung Commune, 1,200 - 2,000 kg/ha in Cheang Tong Commune, and 700 - 1,500 kg/ha in Ta Phem Commune.

Yields of both local and high yielding varieties are almost the same among all the priority areas, because HYVs are usually planted under severe conditions, such as at the early rainy season for double cropping of paddy or at the delayed season for planting due to water shortage, and at low application level of fertilizer. Present unit yield and production are shown in Tables IV-1.3.4 and IV-1.3.5.

2) Food Balance

Priority areas are basically deficit in food. Food balance analysis on the basis of MAFF' indicators reveals that shortage of food in USP, Ang160 and PDP areas are 30%, 10% and 3% against the demand, respectively, and Kim Sei SRP area produces a surplus of 22%. According to the social environmental baseline survey, 76% of the respondents in USP area said that the amount of paddy production was deficit even for their home consumption, and 65% of them bought it. Other crops are produced for home consumption and selling at local markets.

(4) Prices of Inputs and Outputs

Prices of inputs and outputs are shown in Table VI-1.3.6. The price of HYVs has fallen recently in Cambodia due to surplus production, low quality, and undesired taste to Cambodian people.

(5) Livestock

Pigs and poultry are a major cash income source of farm households, and cattle are the main draft animal for land preparation and transportation. According to the social environmental baseline survey, most of the farmers raise cattle 2.5 - 3.5 heads per household on average in each priority area. The number of cattle is 0.47 - 0.65 pairs of draft animals per ha of paddy field. Livestock animals in each priority area are shown in Table IV-1.3.7.

(6) Farm Household's Economy

Present economic situation of the beneficiaries in each priority areas is shown in Table IV-1.3.8 based on the social environmental baseline survey.

Household gross income including production value of home-consumed products ranges between Riel 0.92 million for USP, Riel 1.16 million for Ang 160 SRP and Riel 1.62 million for Kim Sei SRP area. Farm income from crop and livestock occupies around 80% of the total income in each priority area. As most of the crop products are consumed at home, the cash income source depends on livestock income. Cash income from livestock occupies around 50% of the total cash income: 62% for USP, 50% for Ang160 SRP, 57 % for Kim Sei SRP, and 42% for PDP. The farm household economy is shown in Table IV-1.3.8, and summarized below:

Farm Household's Economy in Priority Areas

(Unit: 1000 Riel)

	USP	Ang160 SRP	Kim Sei SRP	PDP
1) Gross Income *	919.3	1,161.2	1,618.3	1,112.8
Farm Income *	781.4	967.3	1,277.0	868.6
Crop *	452.1	676.0	772.0	602.2
Livestock *	329.3	291.3	505.0	266.4
Off-farm Income	137.9	193.9	341.3	244.2
2) Gross Outgoing *	937.5	1,122.1	1,577.3	1,145.5
Production Cost	258.2	186.9	294.1	267.0
Living Expenses *	679.4	935.2	1,283.1	878.6
Food *	484.4	663.7	767.5	583.1
Health	25.3	47.6	41.3	45.2
Education	33.8	19.9	67.7	28.0
Others	135.9	204.0	406.6	222.3
3) Balance	-18.2	39.1	41.0	-32.7

Note *: The figures include production value of self-consumed products.

IV-1.4 Agricultural Production Infrastructures

IV-1.4.1 USP Area

Water resources and diversion facilities of USP area are; Tumnup Lok reservoir on the upstream of the Slakou River (Tras Stream), Kpob Trobek reservoir on the Don Phe Stream, which is a tributary of the Slakou River, and a diversion canal from Tumnup Lok reservoir to Kpob Trobek reservoir.

The target irrigation area of this feasibility study on the USP totals 3,500 ha, consisting of 3,485 ha commanded by Main Canal 33 (7.3 km), Canal 24 and five secondary canals which originate from Main Canal 33 (44.7 km in total of the secondary canals), and 15 ha commanded directly by Tumnup Lok reservoir. The existing irrigation facilities, major roads and the proposed irrigation area are shown in Fig. IV-1.4.1.

(1) Tumnup Lok Reservoir

Tumnup Lok reservoir on the Slakou River was constructed in 1976 under the Pol Pot Regime. The main dike runs north-to-south at about 1.3 km across the Slakou River, along which three gate-type spillways exist and an intake facility to the diversion canal exist on the right bank at 600 m from the existing river course. The dike was damaged by floods that occurred in the1980s and at the beginning of the 1990s, then was finally flushed away for about 180 m in length beside the northern-most spillway on the left. Since then, the reservoir has lost its function as a reservoir and also as a diversion facility. The existing river bed level lies at about EL 36 m, while the dike top level lies at about EL 43.5 m. The spillways and the intake facilities are not being used at all. Another part of the main dike was also flushed

away for about 120 m in length at about 480 m on the left bank from the river course.

(2) Diversion Canal

The diversion canal starting at Tumnup Lok reservoir runs southward for about five kilometers into O Saray reservoir. Then, another canal starts at O Saray reservoir and runs for about five kilometers toward Kpob Trobek reservoir. Even having slight sedimentation, the canal section has been maintained and the canals could be utilized through certain rehabilitation works. However, for a stretch of three kilometers at O Saray reservoir, a new canal connecting the existing diversion canals should be constructed to make a detour around the reservoir. The diversion canal does not currently have the function of "diversion from the Slakou River", but it works as a drain to catch the surface water from the western part of the area and to drain it to the Slakou River via O Saray Reservoir and the Ou Krouch Stream.

(3) Kpob Trobek Reservoir

Kpob Trobek reservoir is located on the Don Phe Stream, a tributary of the Slakou River. The main dike runs from west to east for 2.9 km, and two sub-dikes about 600 m in length were constructed southward on both ends of the main dike. The diversion canal was connected at the west-side sub-dike, and two gate-type spillways were constructed along the main dike. An intake structure with a pipe culvert to Canal 24 was constructed at 350 m from the east end of the main dike. Another intake structure for Main Canal 33 exists at the eastern end of the main dike, while another intake for Koh Kaek Main Canal is located 150 m along the eastern sub-dike. The gates of all intake structures are damaged and do not function. Water flow into and out the reservoir is being controlled with stop-logs. In the center of the main dike, the dike was breached and flushed away for about 180 m by a flood that occurred in the 1990s. The damaged portion was repaired but the dike top elevation remains lower by two meters than that of the adjacent part of the main dike. However, as a whole, the main and sub-dikes remain in good condition, and they could be utilized after some rehabilitation works. According to the result of survey conducted during Phase-1, the storage volume of the reservoir amounts to 2.8 million m^3 (hereinafter referred to as "MCM") at EL 37.3 m. The storage volume would be 1.0 MCM more than that of Tumnup Lok reservoir even maintaining the existing dike elevation of EL 39.0 m. Even in the midst of the rainy season, water from either the Don Phe Stream or the diversion canal reaches the intake structures of Canal 33 or Canal 24, but surface water from the eastern or southern catchments flows through the eastern end of the reservoir into Canal 33 and Canal 24.

(4) Main Canal 33

Main Canal 33 starts at Kpob Trobek reservoir, and runs eastward beside Road 33 for about 16 km to National Road No.3, then joins Canal 17. Of 16 km, a 7,3 km stretch of the canal is used for USP from the beginning point to Ta Phem Commune. The canal has deteriorated to some extent particularly on the right slope. The related structures have malfunctioned due to deterioration of gates, erosion of surrounding slopes, etc., which requires either rehabilitation or reconstruction. Most of the canal sections have a capacity of 5.0 m^3/s or more at present. However, due to the low elevation of the canal bed, the water can not be diverted to the irrigation area located north of the Road 33 without control structures. Most of the existing canal section seems to be used for draining of water from the southern or western catchment of Canal 33. Such capacity as a drain should also be taken into account in the rehabilitation design of Canal 33.

(5) Canal 24

Canal 24 which starts at Kpob Trobek reservoir at 350 m from the eastern end of the main dike, is a secondary canal having an original gross command area of about 1,800 ha. The intake structure consists of a line of pipe culvert of 800 mm and diversion was controlled with stop logs. The 19 m long culvert has little sediment and keeps its function. Top width of the canal is about seven meters and paddy rice is being cultivated within the canal section at many locations.

(6) Other Secondary Canals

Six other existing secondary canals beside Canal 24 will also be utilized for USP. They are Canal 23 (gross command area is 1,360 ha[11]), Canal 22 (ditto, 1,120 ha), Canal 21(ditto, 1,480 ha), Canal 20 (ditto, 720 ha) and Canal 3 (opposite side of Canal 33 along Road 33). These canals run eastward at an interval of one kilometer from north to south. The width of the canals ranges from five to ten meters. In the rainy season, the canals collect and drain water from the surrounding area, and the water is utilized for irrigation. Most of the canal related structures such as diversion and off-take structures have deteriorated and should be replaced.

(7) Tertiary Canals

There are no systematic tertiary canal systems and even the secondary canals have malfunctioned. Canals constructed at an interval of one kilometer as grid lines from north to south and west to east, have the function of secondary canals and the areas of 100 ha surrounded by canals are irrigated by field-to-field irrigation. Such

irrigation practice requires longer time for irrigating the tail-end than irrigation through tertiary canal system, and makes irrigation efficiency lower.

(8) Drainage Facilities

In USP area, most of the existing canals are used for both irrigation and drainage. The irrigation canal has the same cross-section (capacity) from the beginning to the tail end, probably for draining inflow from the surrounding field to the downstream area. The drained water is re-used as "return flow" on the downstream. The main drainage river is the Slakou River in the USP Area, but the river itself has insufficient draining capacity under present conditions. The excess water in the midst of the rainy season backs up for certain periods in the area and is drained through the river as the water level of the river goes down. Therefore, it is suggested that drainage of the area should be considered taking certain allowable inundation period and depth into account. Moreover, it is necessary to estimate and maintain the existing drainage capacity, particularly for Canal 33 and secondary canals running from west to east.

IV-1.4.2 SRP Area

(1) Ang 160 SRP Area

Ang 160 reservoir was constructed in 1975 under the Pol Pot Regime. The reservoir has "L-shape" dike with the main dike of 360 m running from north to south and a sub-dike of 150 m from east to west starting from the northern end of the main dike (Figure II-4.3.2). There are two intake structures, which are composed of concrete pipes of 200 mm, and a spillway. These structures have deteriorated due to floods and poor maintenance and are not functioning. The main dike is damaged at the northern end around the intake pipes, and the sub-dike near-by was washed away by the floods. Inflow to the reservoir flows through that point without being stored. A seasonal stream which originates from the Noreay Mountain Range flows into the reservoir. The discharge of the stream in/around the rainy season ranges from 10 to 100 l/s and the water is being utilized partly for cultivation of paddy rice.

There is no irrigation channel at present, but it was confirmed that the area on the downstream of the reservoir was irrigated by field-to-field irrigation. Drainage condition of the command area is good having a natural stream flowing through the midst of the command area and steep topography.

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[11] Area was measured on the 1 in 50,000 scale map.

(2) Kim Sei SRP Area

Kim Sei Reservoir was also constructed in 1975 under the Pol Pot Regime. The reservoir diverts and stores water from Canal 8 which is one of the secondary canals of Koh Kaek Main Canal. The reservoir has "U-shape" dikes with the main dike running from north to south and sub-dikes on the north (near National Road No.3) and on the south along Canal 8 (Figure II-4.3.3). The total length of the dike is 1,500 m, and the height of the dike is low at 2.0 to 2.5 m. Water depth in the reservoir is very shallow. The main dike is stable with sufficient height, while the sub-dikes require additional embankment of 0.5 m to 1.0m in height. The diversion structure from Canal 8 was originally composed of a concrete pipe of 600 mm in diameter, which has already been removed. A spillway is located in the center of the main dike and four intake structures (only with a 200 mm single concrete pipe per location) exist along the main dike. The intake structures are functioning at present. Four lines of field channels were constructed on the downstream of the intake structures and are being used during the rainy season.

A part of the northern sub-dike was washed away by floods and the storage function of the reservoir was reduced, but water from the upstream catchment is collected and drained through the existing intake in the midst of the rainy season. A natural drain exists on the downstream of the spillway and the drainage condition in the command area is maintained well. The drain could be used as the main drain for the command area.

IV-1.4.3 PDP Area

The target village of the PDP is Trapeang Snao, which is located in Nhaeng Nhang Commune immidiately downstream (or east) of the Kim Sei SRP Area. Canal 8, a secondary canal of Koh Kaek Man Canal runs eastward in the center of the village. However, Koh Kaek Main Canal itself is playing no role as the main canal and the village can not expect any stable irrigation water through the canal. They use only water drained from the surrounding area through Canal 8 and return flow through Kim Sei SRP Area. No other irrigation facilities exist in the area.

IV-1.5 Farmer Water User Community

As mentioned in Sub-Section II-1.7, no legally authorized FWUC exists in the Study Area, although several FWUCs exist outside the Study Area. Based on the results of investigation of the existing FWUCs and the characteristics of the Study Area, the major constraints and problems that would occur during and after organizing FWUCs,

especially with respect to USP, are summarized as follows:

Problems in existing FWUCs

1) The organization of existing FWUCs seems to be very weak in technical and financial aspects. They have statutes, but no detailed regulations and manuals.
2) Very few personnel have technical knowledge in irrigation water management and operation and maintenance of irrigation facilities.
3) Personnel who have administrative knowledge in office management, accounting, documentation, and logistic operation are also very limited.
4) Cadaster and/or cadastral map are not available. Boundaries on farmers' land use rights are mutually understood only at the site level among farmers.
5) Staff of the FWUCs have little salary and allowance and their services for FWUC are almost voluntary work. With such low income, it seems that their motivation has been lowered.
6) It seems that member farmers have little trust in and are suspicious of board members and management staff of FWUC, especially in treating ISF.
7) Irrigation service fee (ISF) of existing FWUCs ranges from Riel 8,700 /ha to Riel 40,600 /ha, which is equivalent to 30 kg/ha to 140 kg/ha of paddy. The collection rate of ISF is 68 % on average among FWUCs. This amount of IFS and the low collection rate makes the activities of FWUC shrink. Actually, FWUC's financial status is always very weak, and budget for maintenance work is negligibly small every year. Increase in ISF is hard for the members of FWUCs, because of low price of paddy.
8) Maintenance of irrigation facilities is executed at minimum requirements and relies on voluntary labor.

Problems in Farmers of the Study Area

9) Cadaster and/or cadastral map are not available. Lists of farmer's name and acreage managed are available in some villages. Boundaries on farmers' land use rights are mutually understood only at the site level among farmers.
10) Most farmers have little knowledge on how to establish a FWUC or how to manage it by themselves. They have to fully understand the process, procedure, and works for forming a FWUC, if they are to establish one.
11) Most farmers have little knowledge on how to operate and maintain reservoirs and irrigation canal systems. They have to learn management of FWUC, irrigation water management, regular maintenance and repair, collection of ISF, accounting, etc. for operation of a sustainable FWUC.

    Most farmers can read. The literacy rate is estimated to be around 85 %. Thus it is judged that they have foundations to learn the required techniques.

12) Many farmers are not accustomed to a large-scale farmers' organization. It would be necessary to take a long time for them to recognize a FWUC and organize it.

Problems in MOWRAM Side

13) DWRAM, Takeo has little capacity to supervise and assist farmers in establishing FWUC of USP and managing it in due consideration of the present work volume, number and capacity of staff and equipment, and budgets.
14) Qualified personnel for both engineering and administration are very limited in DWRAM Takeo. It is, therefore, hard for DWRAM to guide farmers to establish and manage FWUC of USP.
15) References and materials such as criteria, guidelines, manuals, and various kinds of forms for all the subjects such as the training, forming FWUC, FWUC office management, irrigation water management, and O&M of irrigation facilities are little available in MOWRAM.

Anticipated Problems in the Formation of FWUC and Operation of FWUC at Initial Stage

16) Many farmers are poor at present and their economic situation would not be drastically changed within a short period. This would make it hard to establish a FWUC and manage it at the initial stage in terms of financial aspect because FWUCs need funds for their operation.
17) The Government allows FWUC to set up gradual increase in ISF, namely 20%, 40%, 60%, 80 % and 100% of O & M costs of the FWUC, but the necessary subsidy is not always guaranteed by the Government due to very tight budgeting situation of the Government. Further, FWUCs are in principle, required to be managed without financial and technical support of MOWRAM from the 5th year of the operation in accordance with the MOWRAM's policy.
18) Farmers can participate in small maintenance works by voluntary labor, but it is difficult for them to participate in construction works or large scale maintenance works under such no-cost arrangements.

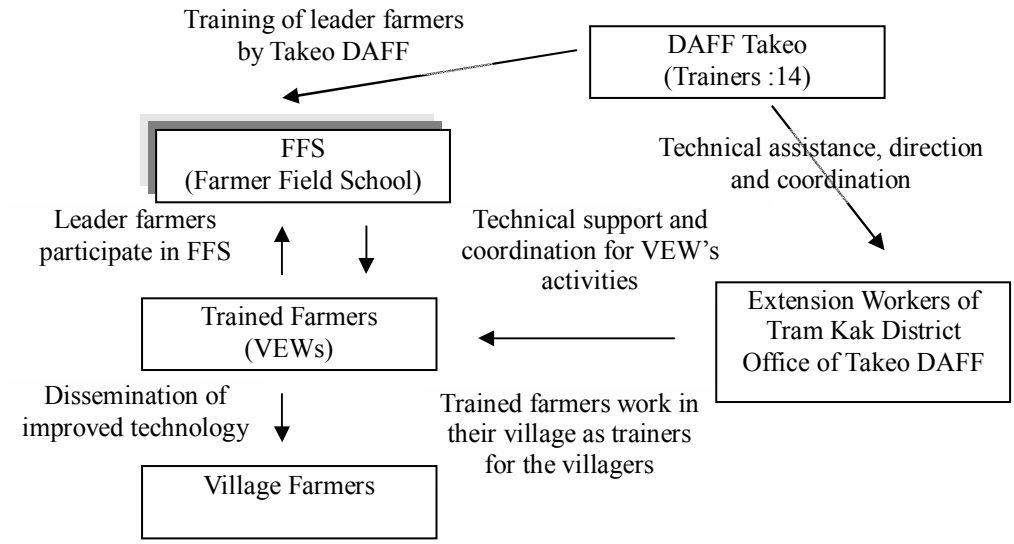
IV-1.6 Agriculture Support Services

IV-1.6.1 Agricultural Extension Services

Extension services in Tram Kak District are provided by District Office of DAFF under control of the head office of DAFF Takeo. Nine (9) staff in total are assigned in the district office, of which three (3) people are in charge of agricultural extension.

DAFF Takeo runs a Farmer Field School (FFS) for training of leader farmers aiming at activation of extension by the trained farmers (Village Extension Workers: VEWs).

The trained leader farmer performs as a VEW in his/her village to disseminate improved farming technology to the villagers. The framework of the extension system by FFS and VEW is shown below:



Framework of Present Extension System

DAFF has provided 46 sessions of FFSs in total in Tram Kak District during four (4) years from 1998 to 2001: 24 sessions for paddy, 9 sessions for vegetables and 13 sessions for livestock shown in the following table. More than 1,000 leader farmers have been trained as VEWs in the district. The FFS has been provided for four (4) of the seven (7) communes in the priority areas.

Achievement of FFS in Tram Kak District

(No. of FFS sessions)

Year	FFS for Paddy	FFS for Vegetable	FFS for Livestock
1998	3 (2)	-	2 (0)
1999	8 (4)	4 (2)	2 (2)
2000	6 (0)	5 (3)	3 (1)
2001	7 (2)	-	6 (3)
Total	24 (8)	9 (5)	13 (6)
Targeted communes related with priority areas	TTK Cheung, Cheng Tong, Ta Phem, and TTK Tbung	TTK Cheung, Cheng Tong, TTK Tbung	TTK Cheung, Cheng Tong, TTK Tbung

Note: Figures in ( ) show sessions of FFS in the communes concerned with priority plans.
Source: DAFF Takeo

It is evaluated that FFS system has been quite well implemented. However, the trained farmers (VEWs) have not always performed in the village due to a lack of group activity in the village community, lack of field plots to demonstrate the farming technology acquired at FFS, and lack of support and monitoring to VEWs

from DAFF.

IV-1.6.2 Credit Service

Living standard of farmers in the priority areas is too low to buy farm inputs. In the priority areas, farmers groups (FGs) under Village Development Committees (VDCs) are implementing a group credit for input purchase to the members. The credit FGs have covered 30 villages except five (5) villages in O Saray and Trapeang Kranhung Communes in USP area. The VDCs of the remaining five (5) villages will be set up in 2001 under SEILA program by DRD Takeo.

During the period from 1997 to 1999, VDCs received US$200 to 2,300 per village for credit fund of the VDC members from UNICEF and RD&RP of JICA. Some of the VDCs were given additional fund from UNICEF. The monthly interest rate in the credit service is 2 %. The capital fund, with interest, is repeatedly used for cash credit service for fertilizer purchase of VDC members. The general conditions of the credit and the system are shown in Fig IV-1.6.1.

Table IV-1.6.1 shows the present situation of the VDC credit in 30 villages concerned with the priority area. UNICEF and RD&RP provided about US$ 20,000 in total to 30 villages during the period from 1997 to 1999. The credit users repaid to the VDC at nearly 100% repayment ratio with interest every season. All villages have not used the accrued interest for village development. As a result, the amount of fund has increased to US$29,000 in total including the accrued interest as of October 2001.

In 2001, 51% of farm households used the credit service with the average credited amount per user of US$14.8. The amount is approximately equivalent to the average of the present farm input cost per farm household.

Besides the VDC credit, micro-credit has been relatively well developed by NGOs in the priority areas. However, in general, farmers do not like to use such micro-credit service due to the high interest rate (usually 4% per month). In addition to the micro-credit, there is a way to borrow money for buying fertilizer. In the priority areas, 20 to 30 % of farmers who need to buy fertilizer but have no fund for it through form of credit from paddy traders. The traders supply fertilizer to the farmers in the planting season, and collect the debt equivalent in paddy or cash after the harvest, but the debt value of fertilizer to be repaid is always higher than market price of fertilizer by 15 to 20 % as interest.

IV-1.7 Rural Infrastructures

(1) Rural Road

The Main road of the USP area is Road 33 which starts at National Road No.3 at Ang Ta Saom. A 12 km section of Road 33 from National Road No.3 to Trapeang Thum Khang Cheung Commune was rehabilitated by an ADB project in 1999 and is being kept in good condition with a laterite pavement of 11 m width. However, the 13 km from the end point of the rehabilitation to Trapeang Kranhung Commune via Kpob Trobek reservoir and O Saray Commune, is in extremely bad condition due to heavy traffic and vehicles. In particular, two bridges over O Saray reservoir and a drain nearby are in poor condition. Temporary repair was made with trunks of coconut trees for securing the minimum traffic through the points. See Fig. IV-1.4.1.

Roads to the northern command area of USP that are in good condition are the road from Angk Roka to Moeng Char via the commune office of Cheung Tong (improved by WFP program), and the road from Road 33 near the beginning point of Canal 23 to Pou Dou village. Along these roads, warehouses (depots) for USP supporting programs are proposed. The density of other existing road is low and their condition is also bad. However, road network improvement is being undertaken by various programs such as Food for Work Program by WFP.

(2) Other Infrastructures

In the USP area, various projects and programs on infrastructure development are being conducted consisting of construction of school building, wells, sanitary, health facilities, etc. Electrification has not yet been started in the command area, but people rent charged car batteries for lighting at night, and for electric appliances such as TV set, radio, etc. There are a provincial hospital and a health center at Angk Roka in the center of the command area. Another health center is also operated in Ta Phem Commune. As for drinking water, people in the USP area mostly utilize rain water stored in concrete jars connected with pipes from the roof. Wells of about fifty meter deep with hand pumps have also been constructed by UNICEF and ADB in many sites in the area, but some local people prefer surface water in ponds and/or canals to groundwater.

IV-1.8 Rural Society

IV-1-8.1 Farmers' Groups

(1) Establishment of CRDC and VDC

The Commune Rural Development Committees (CRDCs) and the VDCs in the

priority areas are shown in Table IV-1.8.1. Although CRDCs and VDCs were not established in the two Communes at the beginning of 2001, all the Communes in the priority areas have now established CRDCs and VDCs. The new CRDCs and VDCs have been established by the SEILA Program, while the other CRDCs and VDCs have been established by UNICEF and RD&RP. The SEILA Program was started at 5 Communes in Tramkak District in 2001, and all Communes (100 in total) in this district are scheduled to be covered by the SEILA Program until 2004 as tabulated below.

Commune Development Program by SEILA

Year	2001	2002	2003	2004
Nos. of Commune	5	30	35	30
(Accumulated Nos.)	5	35	70	100
%	5 %	35 %	70 %	100 %

Funds for commune development by the SEILA Program will be allocated to each Commune in 2001 as shown in the following table. USD 7,732 for Trapeang Kranhung Commune and USD 9,614 for O Saray Commune will be allocated based on the needs of each village. Each village has to establish FGs before the allocation of funds is started by the SEILA Program.

Allocated Fund for Commune Development by SEILA, 2001

Commune	Trapeang Kranhung	O Saray	Nhaeng Nhang
Allocated Fund (USD)	7,732	9,614	7,883

If the above funds are divided by related population, the funds per person of Khpob Svay village (Trapeang Kranhung Commune) are about USD 590, and that of 6 villages in O Saray Commune are about USD 400 to 1,430.

The SEILA Program will promote i) to establish CRDCs and VDCs for FGs, ii) to allocate fund for FGs' activities, and iii) to activate District Development Facility Committee (DDFC) and Provincial Rural Development Committee (PRDC), which have responsibility for management of CRDCs and VDCs. The DDFC of Tramkak District was established in October 2001.

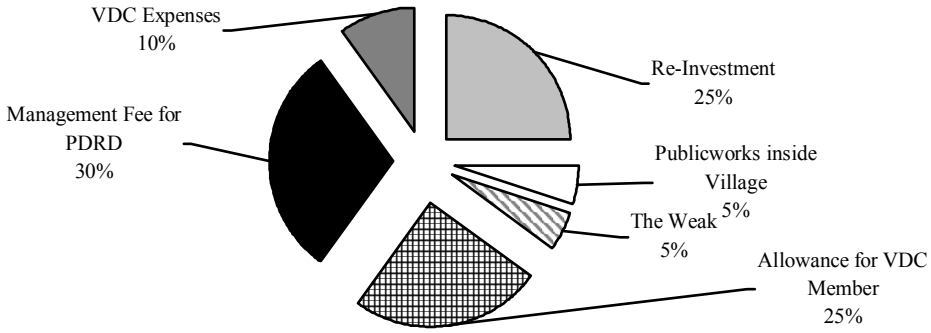
(2) FGs' Activities

FGs have been organized in the priority areas as shown in Table IV-1.8.1. All the villages in the priority areas have VDCs, and the funds will be allocated to them for VDC activities by the SEILA Program. As Trapeang Kranhung Commune and O Saray Commune only just established their CRDC and VDCs in 2001, the FGs are still being organized at the time of preparing this report. All the villages (30 in total)

other than Trapeang Kranhung Commune and O Saray Commune have FGs for fertilizer credit service. About 77 % of the VDCs have FGs for cash credit service and about 70 % have FGs for rice bank.

(3) Benefit

UNICEF has proposed to use benefits earned from FGs' activities as shown in the following graph. The graph says that 25 % of the total benefits should be used for reinvestment, such as credit service. Many VDCs have reinvested much more benefit (coming from interests of loan) to credit service than the proposed ratio by UNICEF. Although some of the villages use it for small public works inside their village, and operational expense for the VDC (stationery etc.), the amount of such reinvestment is very small.



Proposed Expenditure of Benefits Earned by FGs' Activities by UNICEF

IV-1.8.2 Rural Society

(1) Rural Society

Hearing Survey to village chiefs in the priority areas was conducted to obtain beneficiaries opinions and comments on subjects which may occur in the course of implementation of the priority projects.

It seems that most of the villagers in the priority areas have more sense of belonging to their village than to their commune. It is said that village chiefs, teachers and monks are usually trusted by villagers and are deemed to have leadership in rural society. The relationship between village chief and villagers is much stronger than that between Commune chief and villagers now. The commune chief, who is appointed by Provincial Governor, has a vertical relationship with villagers through the village chief.

It is expected that the number of Commune chiefs trusted by villagers increases when the Commune chief begins to be appointed by election beginning in 2002.

About 74 %[12] of the village chiefs were elected, but mostly only from candidates whom Commune chiefs had already nominated.

(2) Illegal Cultivation

1) Inside Reservoirs

Present illegal cultivation in the reservoirs including small reservoirs is summarized below and the details are shown in Table IV-1.8.2.

Illegal Cultivation inside the Reservoirs

Plan	USP		SRP	
Reservoir	Tumnup Lok	Kpob Trobek	Ang 160	Kim Sei
Households	140	156	13	44
Area (ha)	130.0	140.0	4.3	8.8

Source: Hearing Survey to Village Chiefs

The Kim Sei villagers have recognized their illegality. But all of them hoped to be beneficiaries. However, since the area to be irrigated is only 20 % of the agricultural land in the village, the farmers who cultivate inside the reservoir and have no agricultural land in Kim Sei SRP area, objected to the SRP. But, they finally requested rehabilitation of Kim Sei reservoir as village consensus.

The present land-users inside the reservoir wish to plant paddy as the water level decreases inside the reservoir. The MOWRAM should consider the present land-users' request if receding cultivation is undertaken at their own risk.

2) Inside Canals

Some farmers plant paddy inside canals as shown in Table IV-1.8.3, and summarized in the following table. All of them have recognized that present land-use is illegal. They agreed to give up the present land-use if canal rehabilitation starts. They also promised not to plant crops inside the canals for operation and maintenance of canals.

Illegal Cultivation inside Canals

	Main Canal	Secondary Canal				
	No. 33	No. 20	No. 21	No. 22	No. 23	No. 24
Households	0	50	13	33	94	76
Area (ha)	0	2.03	0.14	0.93	2.30	2.66

Source: Hearing Survey to Village Chiefs

[12] Commune chiefs nominated other 26 % of village chiefs.

MOWRAM insists that lands for canals and reservoirs belong to the nation, whereas it tacitly permits the cultivation within canals and reservoirs which have deteriorated and are not functioning.

3) Land Compensation

Basically, any compensation for land inside reservoir and canals is not required because such land-use is illegal as mentioned above. Most village chiefs agreed to render farmers' land for canals if such land is less than about 10 % of their land, but nobody agreed to render 50 % of their land. It should be considered in tertiary canal and watercourse alignment to minimize the land. All village chiefs agreed that land necessary for tertiary canal and watercourses should be rendered by beneficiaries. If unfair land rendering is required, they have to solve this subject inside their community.

As no land substitute is available within the village, compensation by money will be necessary to secure land necessary for reservoirs, main canal and secondary canals.

4) Temporary Land Use for Construction Works

Temporary land use for construction will be necessary. All village chiefs think it will be possible to allow a contractor to use beneficiaries' land as access road or road for construction without any compensation, if the land occupation will be only during dry season (land in fallow). Farmers will restore their land at their own expense after the construction is finished.

5) Participation in Construction Works and O&M Work

Farmers' demand for rehabilitation of reservoirs and canals is very high. Most of the participants to PRA workshop clarified their intention to offer their contribution to construction works and O & M works.

(i) Rehabilitation Work of USP

Beneficiaries agreed to participate in construction work of tertiary canals and watercourses. They need wages for rehabilitation of reservoirs, main and secondary canals, and construction of tertiary canal, while they do not need wage for construction of watercourses since the work will be less than one week.

(ii) Construction Works of SRP and PDP

Beneficiaries agreed to participate in construction works of SRP and PDP. If the work continues for more than one week, they demand wage, but for less than one week, they will work at no cost.

(iii) Operation and Maintenance Works

Village chiefs in USP, SRP and PDP areas agreed to participate in O&M works of irrigation facilities by beneficiaries without wage.

6) Irrigation Area of SRP

Under irrigation planning with 80 % dependability, the irrigation areas of Ang 160 SRP and Kim Sei SRP are 25 ha and 27 ha, respectively. Both Trapeang Chhuk and and Kim Sei village chiefs of these SRPs said that a larger irrigation area with lower dependability is preferable. It was, however, explained to village chiefs that lower dependability causes lower sustainability. They agreed to maintain the proposed irrigation plan.

7) Establishment of FWUC

Participants for the PRA Workshops and village chiefs in the priority areas agreed to establish FWUC and to be members of FWUC, to pay ISF determined by FWUC, and also to participate in maintenance work for reservoirs and canals without wage.

8) Countermeasures to the Weak

According to the social environmental baseline survey, about 5.8 % of households will not be able to join the construction works and O&M works because of the following reasons:

(i) Widow-headed household: There is no male of 16 to 60 years old in the household,
(ii) Household without work force: There is no male of 16 to 60 years old who can live in the household for more than 6 months, and
(iii) Old person-headed household: There is no male of 16 to 60 years old in the household.

Villagers generally have understanding that the above persons should be released from the construction works and O& M work.

CHAPTER IV-2 THE UPPER SLAKOU RIVER IRRIGATION RECONSTRUCTION PLAN (USP)

IV-2.1 Outline of the Plan

The Upper Slakou River Irrigation Reconstruction Plan (USP), which was selected as a high priority project for feasibility study, will divert irrigation water of 3.5 m^3/s from Tumnup Lok reservoir (effective storage volume; 100 MCM) on the Slakou River, through the diversion canal. The diverted water will be stored and regulated at Kpob Trobek reservoir (effective storage volume; 263 MCM) and will irrigate about 3,500 ha through Main Canal 33 and Canal 24. A conceptual diagram of the irrigation facilities is shown in Fig. IV-2.1.1. The basic features of the proposed irrigation facilities are given in the following table.

Proposed Irrigation Facilities

Item		Outline
Irrigation Command Area		32 villages in 5 communes in Tram Kak District Net irrigation area = 3,500 ha
Unit irrigation water requirement		1.1 lit/s/ha□water saving irrigation method□
Reservoir and Diversion	Tumnup Lok Reservoir □Tras Stream, Slakou River□	Catchment area=332 km^2, Effective storage□20yeras□ =1.00MCM Dike top EL=43.3 m, Design flood (100 years)=420 m^3/s, Flood water level=EL42.4 m, High water level=EL41.3 m, Low water level=EL40.4 m, L=2.5 km
	Kpob Trobek Reservoir □Don Phe Stream□	Catchment area=137 km^2, Effective storage□20yeras□ =2.63 MCM Dike top EL=39.0 m, Design flood (100 years) =195 m^3/s, Flood water level=EL38.1 m, High water level=EL37.3 m, Low water level=EL34.2 m, L=3.3 km
	Diversion Canal	Starts at Tumnup Lok Res., Ends at Kpob Trobek Res., Total length=9.4 km, Canal bed width=2.0 m, Design discharge=3.5 m^3/s, Laterite lining
Main& Secondary	Main Canal 33	Total length=7.3 km, Net irrigation area= 2,924 ha, Design discharge=3.2 m^3/s
	Canal 24	Total length=5.7 km, Net irrigation area=561 ha, Design discharge=0.6 m^3/s
	Other secondary canals	6 lines in total, Total length=39.0 km.
On-farm	Tertiary block	106 blocks□average irrigation area= 33.0 ha□
	Watercourse	5 ha per block (construction by beneficiaries' responsibility)

IV-2.2 Target Level of the Plan

(1) Basic Policy

Most of the existing irrigation facilities were constructed in the mid1970s during the Pol Pot Regime, and they now require significant rehabilitation and/or reconstruction. The basic policy of reconstruction of these facilities is to make both initial construction cost and O&M cost as low as possible with due

consideration to maintain sufficient function, safety and durability. To meet this, the purpose of the plan would not be to seek the "perfect" outcome, but to recover the minimum function required for increasing agricultural production as a model plan for similar irrigation developments in Cambodia. The target level of the plan is mentioned in the following.

(2) Irrigation Plan

Water saving irrigation method will be applied for irrigation. Reliability level is set at 4 in 5 years or 80 %, i.e., the proposed irrigation water supply would be guaranteed 4 times (seasons) out of 5 times (seasons). 24-hour water conveyance will be applied for diversion, main and secondary systems, while rotational irrigation will be applied for on-farm water distribution through tertiary canals and watercourses.

(3) Reservoir

The design flood discharge of 1-in-100-year recurrence period is adopted. Freeboard of the dikes of the reservoirs is set at 0.90 m. The existing dikes would be utilized as much as possible, and the embankment slopes of the dike would be 1:2.5 inside, and 1:2.0 outside[13]. Intake gates would be operated by manpower, and their dimensions and numbers are determined taking maneuverability into consideration. The designed sedimentation rate is set at 0.1 mm/km^2/year.

(4) Irrigation Canal

Irrigation canals will consist of main canal, secondary canal, tertiary canal and watercourse. The size of the tertiary block would primarily be set at 50 ha on average, but the tertiary block should exist within one village. The existing canals will have dual purposes for irrigation and drainage, and a certain capacity should be maintained up to the tail end. The existing canal section should be utilized, and hydraulic calculation should be done taking condition of the existing canal into account. Lining would not be considered except for the new canal or unless the minimum allowable current speed could be maintained. Inspection roads for the main and diversion canals would be set at 4 m, while those of the secondary canals would be 2 m taking O&M works by manpower without machines into consideration.

(5) Related Structures

Related structures of the canal, both in terms of structure and materials, would be

[13] The design slope was determined according to the soil mechanical test of existing dike and proposed embankment materials.

designed to conform with those that DWRAM and DRD generally design and construct in Takeo Province. As for structures, reinforced concrete and wet masonry will be generally used, and materials such as cement, sand and gravels will be easily procured. Steel gates will also be obtained in Phnom Penh, while concrete pipes will be fabricated at DWRAM Takeo office and the private sector as well. As for structures across the canals, cross-drain would be basically with pipe culvert, but box culvert and bridges would also be considered as required. River crossing structure would be determined to have a section (capacity) to discharge 1-in-50-year flood, also taking into account the previous floods and the capacity of the existing structures.

(6) Drainage

The basic concept of drainage in USP is "maintenance of status quo", considering insufficient drainage capacity of the Slakou River, and the main drainage river of USP Area. Accordingly, it would be primarily considered to maintain capacity to drain the irrigation water smoothly outside the area.

However, in utilizing existing canals, unit design drainage requirement of 1.6 l/s/ha as mentioned in IV-2.3 (7), would be adopted to determine the drainage capacity to be maintained. As for upland crops, inundation will not be allowed, and high ridge cultivation would be proposed.

The target level of the planning is mentioned in detail in "Planning Guideline for Rehabilitation and Reconstruction of Irrigation Systems in the Kingdom of Cambodia", which was prepared in the course of this Study.

IV-2.3 Plan of Irrigation Facilities

(1) Tumnup Lok Reservoir

1) Rehabilitation of Dike

According to the results of soil mechanical test, there is a sandy soil layer of 2~7 m on the surface, which is well compacted with N-values ranging from 10 to 37. Clayey layer under the surface layer has a thickness of 3~4 m with higher N-values of 10 to 50. Both layers would provide sufficient bearing capacity either for concrete structures or embankment of about 5 m in height. According to the results of the soil mechanical test of the embankment materials of the existing dike, it was judged that the dike has sufficient stability against sliding. However, without any countermeasures, collapse of the dike by infiltration leading to piping might occur. These is also a risk that erosion of the slope by rain water or waves inside the reservoir might affect the stability of the dike. Thus, re-shaping of the

existing dike, protection of the slope on the reservoir side with impervious materials such as laterite, and laying filter materials (mixture of sand and gravel) on the opposite slope of the dike would be required. The dike top elevation is set at EL 43.3 m and the width of the dike top is set at 5 m. The general layout plan of the reservoir is given in Fig. IV-2.3.1.

2) Spillway

An overflow-type fixed weir is proposed for preventing damage to the dike due to operational failure. The spillway will be constructed at the damaged portion that was flushed away for 180 m across the existing river course. The overflow length is set at 215 m for an overflow depth of 1.1 m. Rock spillway type which is generally constructed in Cambodia was adopted after due analysis on stability and hydraulics.

3) Maintenance Gate

A maintenance gate facility with two sluice gates of 1.5 m x 1.5 m is proposed on the right side of the spillway. The sluice gates would be used for reservoir maintenance, discharge of river maintenance flow, and removal of some sediment on the upstream of the spillway. The gates would be operated manually.

4) Intake Gate to the Diversion Canal

The existing intake structure at 600 m on the right bank of the existing river course would be replaced. Two steel gates of 1.2 m x1.2 m will be installed. Intake capacity would be 3.5 m^3/s with an intake water level of EL. 40.4 m.

5) Intake Gate for Tertiary Blocks

Out of the three existing spillways, the two farthest from the river course will be replaced by intake structures for tertiary blocks (15 ha for two blocks) immediately downstream of the dike. A line of concrete pipe of 600 mm diameter and a steel gate of 0.6 m x 0.6 m would be installed for each intake structure.

A general layout plan of Tumnup Lok Reservoir is given in Fig. IV-2.3.1.

(2) Kpob Trobek Reservoir

1) Rehabilitation of Dike

According to the results of soil mechanical tests, there is an alternate layer of silty-sand and sandy clay for 6~10 m from the surface, under which a well compacted sandy clay layer with N-values of over 50 lies. The layers would provide sufficient support either for concrete structures or the dike about 5 m in height. It is judged that the existing dike has sufficient stability against sliding. However, it is recommended to make the same countermeasures as proposed for

Tumnup Lok reservoir for maintaining the stability of the dike. The dike top elevation is set at EL 39.0 m and the width of the dike top is set at 5 m.

2) Spillway

An overflow-type fixed weir (rock spillway) similar to that of Tumnup Lok reservoir, was proposed. The spillway would be located at the center of the main dike where 180 m of embankment was washed out by flood. The overflow length of the spillway is set at 160 m for the overflow depth of 0.80 m.

3) Maintenance Sluice Gate

Two maintenance gate structures consisting of a sluice gate of 1.5 m x 1.5 m each are proposed at the locations of the existing spillways. The sluice gates would be used for reservoir maintenance and discharge of river maintenance flow. The gates would be operated manually.

4) Intake Gate for Canal 33

The existing intake gate structure at the eastern end of the main dike on the south of Road 33 would be replaced with two gates of 1.2 m by 1.2 m with an intake capacity of 3.2 m^3/s.

5) Intake Gate for Canal 24

The existing intake structure located at 350 m from the eastern end of the main dike would be replaced with two lines of concrete pipe culverts of 800 mm. Two steel gates of 0.8 m by 0.8 m would be installed at the inlet. The intake capacity of the structure is 0.62 m^3/s.

6) Intake Structure of Koh Kaek Main Canal

The existing intake gate structure of Koh Kaek Main Canal was constructed with six gates. The structure itself would not be used for USP, and it might be removed. However, certain amount of water is flowing into the reservoir through the structure at present and it would also be used for USP. The existing structure will be utilized for controlling such water flow.

A general layout plan of Kpob Trobek reservoir is given in Fig. IV-2.3.2.

(3) Diversion Canal

1) Canal Structure

According to the results of soil mechanical test, soils on the cut slopes of existing canals are silty-sand (SM), clayey sand (SC) or clay (CL), which are subject to erosion. Thus the design canal sections are proposed to have side slopes of 1:1.5 to 1:2.5 both for the cut and embankment portion. Excavated materials could be

used for the embankment with sufficient compaction.

2) Alignment of Canal and Hydraulic Design

According to the route determined in the Master Plan Study, the diversion canal would make a detour around O Saray reservoir passing the Krouch Stream by a siphon structure, then connects the existing diversion canal to Kpob Trobek reservoir (Fig. IV-1.4.1). The total length of the diversion canal is 9.4 km. The longitudinal gradient of the canal is 1 in 4,400. The canal bed width is 2.0 m and the side slope is set at 1:2.0. The water depth is 1.4 m for the designed discharge of 3.5 m^3/s. The section would be lined with laterite. The water level at the end point at Kpob Trobek reservoir is EL 37.85 m which is 0.25 m lower than the flood water level of the reservoir. Thus, the freeboard of the diversion canal at the end point would be increased.

3) Siphon

The siphon structure across the Krouch Stream will be proposed to have a 2-barrel reinforced concrete box culvert of 1.3 m by 1.3 m for easier performance of O&M and to maintain sufficient velocity even during low discharge period, by using a single cell. The length of the siphon is 32 m and a clearance of 2 m would be taken below the river bed. A side spillway is proposed on the upstream of the inlet.

(4) Main Canal 33

1) Design Discharge

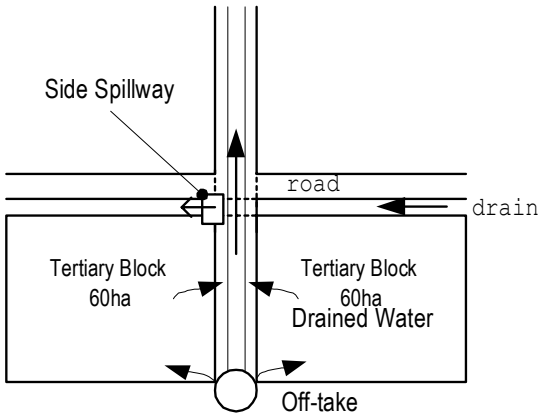
The design discharge of Canal 33 at the beginning point is 3.2 m^3/s, which reduces to 1.0 m^3/s by the end point (diversion point to Canal 21). However, as mentioned above, Canal 33 will also have function as a drain, and the existing canal section has the capacity to serve as a drain at the bottom part of the section. According to the unit drainage requirement of 1.6 l/s/ha as mentioned in "(7) Drainage" of this sub-section, the drainage capacity for a catchment of 12 km^2, i.e., 2.0 m^3/s is regarded as the minimum capacity of Canal 33.

2) Canal Section

The existing capacity of the canal is sufficient for discharging the required irrigation water. In the planning of rehabilitation, the minimum capacity for drainage would be maintained, and check structures would be arranged to divert the water at a certain water level to the secondary canals.

(5) Secondary Canal

The capacity of the existing secondary canals would also be maintained to drain the water flowing from the surrounding fields. Assuming that the area of tertiary blocks along a stretch of the secondary canal is 120 ha, a capacity of about 200 l/s (120 ha x 1.6 l/s/ha= 200 l/s) would be maintained for the stretch. The drained water (200 l/s) would be discharged through a side spillway constructed at the end of the stretch into a lateral drain (See figure on the right).



Setting of Capacity of Secondary Canals

(6) Tertiary Block

The number of tertiary blocks in the USP Area totals 106, and the average area is 33 ha. In each tertiary block, watercourses are proposed for commanding 5 ha per watercourse. Construction of the tertiary canal is supposed to be contracted to local contractors [14], while the watercourses would be constructed by the beneficiaries themselves. Alignment of the tertiary canals would be determined by FWUC members with technical guidance by the project office. Land required for the tertiary canals and watercourses would be provided by the beneficiaries. FWUC members would participate in the construction works as hired labor as a sort of training of maintenance works. Location and proposed irrigation area of each tertiary block are shown in Fig.IV-2.3.3.

(7) Drainage

As mentioned in "Target Level", substantial drainage improvement would not be undertaken, but the capacity of the existing canals would be maintained setting a unit drainage requirement as follows:

Most paddy rice cultivated in the area is categorized into local varieties, and they are more resistant against inundation. Assuming allowable inundation depth on the paddy field at 150 mm for an allowable inundation period of three days, the unit drainage requirement for draining 1-in-10-year 3-day rainstorm (173 mm for Takeo) up to the water level below the allowable inundation depth was estimated. Then, as shown in Fig. IV-2.3.4, a unit drainage requirement of 1.6 l/s/ha was obtained.

[14] Construction of diversion system, the main canal and secondary system would be contracted through international competitive bidding.

Vegetables will get fatal damage by the inundation even for a short period. However, considering the existing capacity of the main drains and economic viability, it is not practical to improve the drainage facilities to protect the vegetables from inundation. Accordingly, adoption of high ridge cultivation method into farming practice would be proposed. As shown in Fig. IV-2.3.4, the vegetables would be protected from the inundation caused by 1-in-10-year 24-hour rainstorm (114 mm in Takeo) provided that they are cultivated on a ridge of 125 mm or higher. Taking inundation in the root zone into account, the high-ridge cultivation of 150 mm is recommended.

IV-2.4 Water Management and Operation of Irrigation Facilities

(1) Operation

The MOWRAM staff and beneficiaries are not accustomed to irrigation operation. Reservoir and irrigation facilities should be designed so that the facilities can be easily operated and the operation of facilities should be as simple as possible.

1) Operation of Reservoir System

Reservoirs incorporated into USP are Tumnup Lok and Kpob Trobek reservoirs. An existing diversion canal running from Tumnup Lok reservoir to Kpob Trobek reservoir will be reconstructed as well. The principles for the operation rule of the reservoir system are itemized as follows:

(i) Operation for the reservoirs should be simple.
(ii) Head gates of the diversion canal should be operated so that the diverted flow does not exceed the design conveyance capacity of the diversion canal.
(iii) During the time that the Kpob Trobek reservoir is full of water and excess water overflows the spillway, the head gates of the diversion canal should be closed.
(iv) Close communication should be kept between Don Phe reservoir and Kpob Trobek reservoir, especially during large storms and droughts.

2) Operation of Canal System for Irrigation Water Supply and Distribution

The irrigation canal system consists of one main canal, secondary canals, and tertiary canals. The main canal originates from Kpob Trobek reservoir. The secondary canals branch off from the main canal except one secondary canal, namely, Canal 24 originating directly from Kpob Trobek reservoir. Each secondary canal commands a few hundred hectares that are divided into 10 to 30 tertiary blocks. Every tertiary block is served by a respective tertiary canal.

The principles and fundamental operation rules for irrigation water supply are

suggested as follows.

(i) The operation rules for water supply should be kept simple.

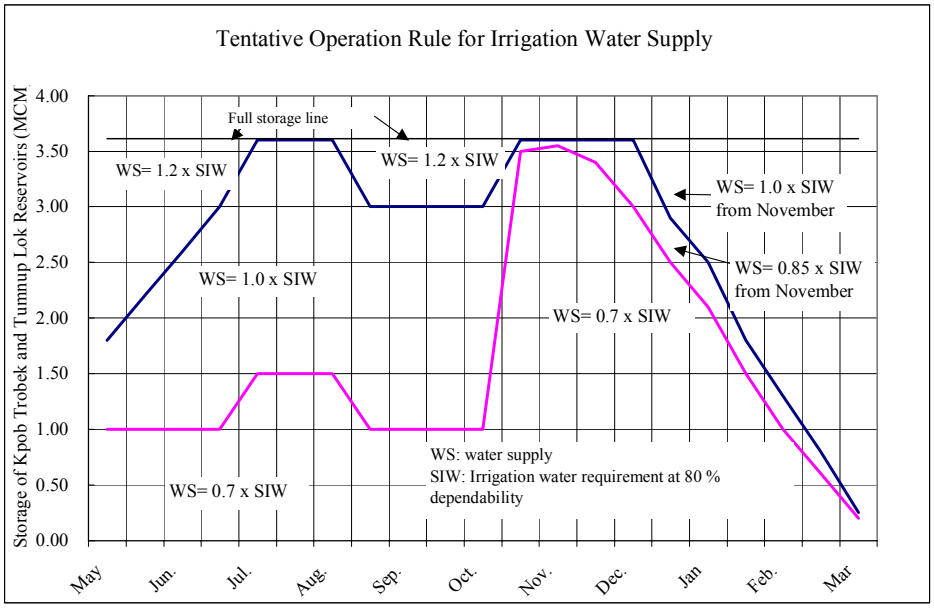
(ii) Rainfall factor is not taken into account for the operation of irrigation water supply in principle.

Rainfall is very erratic and so water supply based on the amount of rainfall is not practically possible.

(iii) The operation rule will be based on the irrigation water requirements estimated at a recurrence period of five years.

(iv) Operation will be carried out on half a monthly basis in the canal system.

(v) Only actual reservoir storage volume should be taken into account for the irrigation water supply from Kpob Trobek reservoir. It is proposed that the irrigation water supply is made in accordance with the following tentative operation rule, which was developed to mitigate irrigation water deficit during droughts as well as to increase water supply during the high water season.



Irrigation Water Requirement (SIW)

Unit : m^3/sec

May		June		July		August		September		October		November		December		January		February		March	
1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
0.00	0.11	0.22	0.31	0.33	1.41	1.71	1.89	3.06	3.28	1.99	2.27	3.39	2.36	1.36	0.70	0.38	0.44	0.54	0.41	0.30	0.12

For example, at the beginning of August, the actual water storage is more than the reservoir storage capacity (water spills out through the reservoir spillway), 1.71 m^3/s x 1.2 = 2.05 m^3/s will be released to the main canal. If the storage is less than 1.5 MCM, then 1.71 m^3/s x 0.7 = 1.20 m^3/s should be released.

During flooding of almost the entire paddy field area, the intake gate of the main canal should be closed.

This rule should be reviewed and revised on a realistic basis at any necessary time during the actual operation stage.

(vi) The irrigation season is divided into three seasons in accordance with cropping pattern or irrigation water demands. The first season is two and a half months from May to early July when upland crops are planted. In this season, irrigation water demands are as small as the range from 0.11 m^3/s to 0.33 m^3/s. The middle season is the period from late July to late December when paddy is planted. The irrigation water demands are the largest in this season. Then third season is from January to March when upland crops are planted. The irrigation water demands in this season ranges from 0.12 m^3/s to 0.54 m^3/s.

The main canal and the secondary canals will apply 24 hours continuous conveyance of water throughout the irrigation seasons. In these first and third seasons when irrigation water demands are very small, check gates on the main canal and/or secondary canals will be fully closed and side overflow sections furnished on check structures will be utilized for water conveyance.

(vii) Tertiary canals will be operated so as to supply water on a 24-hour continuous conveyance basis during the middle season except small tertiary canals having an irrigation area less than 30 ha. For the first and third seasons, rotational supply will be applied among all the tertiary canals in each secondary canal. Small tertiary canals will be supplied water in accordance with rotational supply schedule among the small tertiary canals even in the middle season.

3) Irrigation Water Supply to Paddy Fields under Water-Saving Irrigation Method

In order to maintain high irrigation application efficiency, irrigation water to paddy fields should be distributed at a certain large discharge. Considering that irrigation water is distributed from a tertiary canal to fields and from a paddy plot to a plot, a flow of 10 l/s to 20 l/s is desirable. With this discharge, water supply for land preparation of one hectare of paddy field takes half a day to one day. During the ordinary peak irrigation season, paddy fields of 10 to 20 ha can be irrigated every day.

Puddling works and transplanting works should be carried out immediate after a plot is filled with water.

In the water saving irrigation method, water corresponding to the amount deducting effective rainfall from the consumptive use of water is supplied during the period after transplanting until the end of tillering and the period of yield formation. In this method, standing water gradually runs out and the ground

surface gradually become dry, because no water corresponding to percolation loss is supplied. In such a situation, if water is supplied as a small discharge, a large amount of water is wasted and water does not carry a long distance. Water should be supplied at rather large discharge through no water standing plots. Also, paddy plots should be provided with watercourses so as to smoothly convey water to the downstream paddy plots.

It is desirable to keep soil water content in the root depth at not less than 75 % of full saturation in order to maintain good yields of paddy. In order to attain this requirement at a certain level, irrigation application should be made once a week.

During a period of 30 days starting at head initiation till the end of flowering that is the most sensitive period against water deficit, additional water should be supplied so as to keep moderate submergence.

IV-2.5 Maintenance of Irrigation Facilities

(1) Setting-up for Maintenance of Irrigation Facilities

Maintenance of the irrigation facilities would be conducted substantially by FWUC after completion of the construction works and taking over of the facilities. FWUC Apex will be set up in the Project Office. MOWRAM and other related government offices will dispatch two senior engineers and a senior expert to the FWUC Apex for four years after completion of the construction for supporting its activities on O&M.

Maintenance of Tumnup Lok and Kpob Trobek reservoirs, diversion canal and main canal (Canal 33) would be planned by FWUC Apex, while that of secondary canals would be managed by six SC FWUCs. The maintenance procedures for facilities are described in detail in the following sub-section.

(2) Maintenance Plan of Facilities

1) Category of Maintenance

Maintenance works would be conducted by four categories of; reservoir, diversion and main canals, secondary canals and on-farm canals (tertiary canal and watercourses). The frequency and magnitude of maintenance works are; 1) routine inspection and maintenance (every day to once a week as required), 2) periodical inspection and repair (once a year before rainy season), and 3) periodical rehabilitation (once every five years). Labor for routine maintenance and periodical repair would be provided by FWUC as contribution, while for the periodical rehabilitation, which requires larger work volume, FWUC members will be hired as labor on a piece work basis.

2) Maintenance of Reservoir

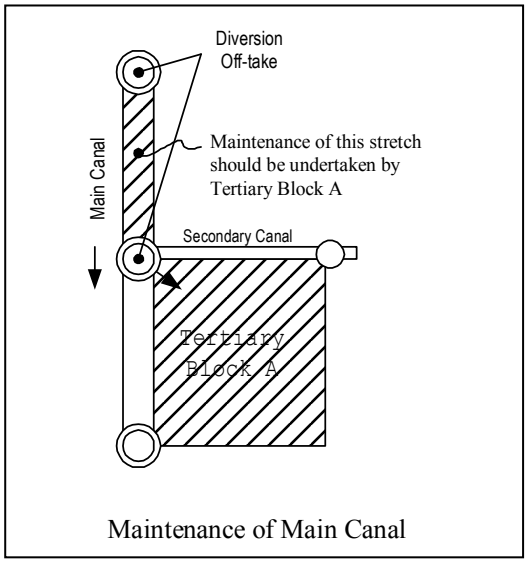
A scheme organizer (SO) in charge of the reservoirs would take responsibility of management of maintenance of Tumnup Lok and Kpob Trobek reservoirs. The scheme organizer would operate the intake gates and maintenance gates of the reservoirs according to the operation and maintenance plan prepared by FWUC Apex every year. He would also inspect damage to the gates, existence of debris, leakage, and keep maintenance and inspection record that would be reported and explained to FWUC Apex periodically as part of routine inspection and maintenance.

As for the periodical inspection and repair, confirmation of gate function, painting of rust preventive paint, removal of debris, minor repair works of the dike and other facilities by man power would be conducted.

The periodical rehabilitation would involve major repair works of the dike and facilities, removal of sediment in front of the intake and maintenance gates so that smooth water flow to the gates can be secured.

3) Diversion and Main Canals

Maintenance of the diversion canal would be conducted by the system organizer of FWUC Apex in charge of the main canal. In case that trouble such as damage to the structures, blockage of a canal section, or illegal extraction or diversion is confirmed, he should keep records and report to FWUC Apex so that FWUC should call a meeting and solve the problems.



Maintenance of Main Canal

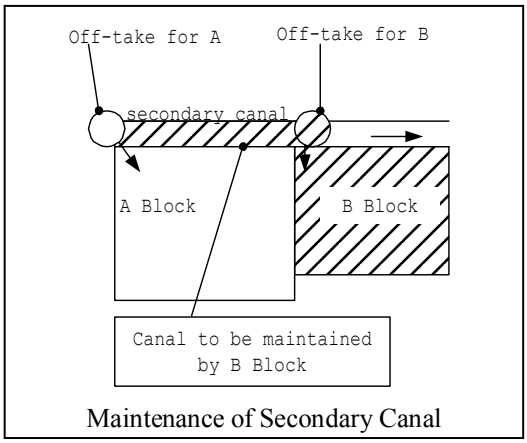
As for periodical inspection and repair, inspection and repair of intake facilities, crossing structures, such as removal of sediment, painting of the gates, and manual repair of the canals should be done.

The periodical rehabilitation would include rehabilitation of the dike and inspection roads, removal of sediment and debris from the canal, and major repair works to the structures. Necessary costs should be borne by part of ISF.

The routine and periodical inspection and maintenance of the main canal would be conducted by FWUC members of the upper most tertiary block of each secondary canal for a stretch between its diversion structure (beginning point of the

secondary canal) and the upper diversion structure as shown on the right. Items of the inspection and maintenance would be similar to those of the diversion canal.

4) Secondary Canal



Maintenance of Secondary Canal

The inspection and repair for the periodical and routine maintenance would be carried out by man power. The routine inspection and repair would basically be conducted by SC FWUC, but actual works such as grass cutting and/or sediment removal will be carried out by FWUC members adjacent to the canal. FWUC members of a tertiary block should be responsible for the maintenance works between their off-take structure and the upper off-take as shown on the right.

Repair of minor damages to the secondary canals that would affect several tertiary blocks would be repaired as part of periodical maintenance. The works should be substantially organized by SC FWUCs. For the repair works, all the tertiary blocks commanded by the secondary canals should provide labor, whilst the necessary materials and equipment would be procured by SC FWUCs by using part of ISF.

The periodical rehabilitation (every five years) would be conducted for major repair of the canals and structures on the piece work basis by using reserved ISF.

5) Tertiary Canal and Watercourses

The routine inspection of tertiary canals and watercourses would be done by FOs and maintenance works would be done by FWUC members. The periodical repair should be done before the rainy season requiring about 10 days by each of the members. Major works would consist of removal of sediment, painting of gates, etc. and materials or funds for purchase them would be claimed by FOs to SC FWUC.

CHAPTER IV-3 THE SMALL RESERVOIR REHABILITATION PLAN (SRP)

IV-3.1 Water Balance Study – Estimate of Irrigable Area

In order to estimate irrigable area, water balance calculation was made between irrigation water requirements and assumed available water resources.

(1) Ang 160 Reservoir

1) Unit Irrigation Water Requirements

The estimates of unit irrigation water requirements for the area to be benefited by Ang 160 Reservoir were based on the same cropping pattern as USP and on the same condition as USP that the water saving irrigation method would be applied for paddy cultivation. The irrigation efficiency was set at 0.7 for paddy cultivation and 0.6 for upland crop cultivation in due consideration that the anticipated irrigable area is small and that accurate operation can be practiced.

2) Feature of Ang 160 Reservoir

The elevation of the dike top level is to be kept as at present.

Primary Features of Ang 160 Reservoir

Elevation of Dike Top (m)	Design Flood W.L (m)	H.W.L (m)	L.W.L (m)	Gross Storage Capacity (m^3)	Effective Storage Capacity (m^3)	Dead Storage (m^3)
46.5	45.9	45.3	44.0	36,300	29,300	7,000

3) Irrigable area and irrigation water requirements

The area benefit with this development was estimated at 25 ha at 80 % dependability.

Medium paddy:	17.0 ha
Short Paddy:	8.0 ha
Diversified crop 1:	2.0 ha
Diversified crop 2:	3.0 ha

Irrigation water requirements are shown below.

Irrigation Water Requirements

Unit : l/sec

Recurrence Period	Jan.		Feb.		March		April		May		June		July		August		Sep.		Oct.		Nov.		Dec.	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
5years	1.9	2.2	2.7	2.1	1.5	0.6	0.0	0.0	0.0	0.4	0.8	1.1	1.3	7.9	9.9	11.3	18.8	20.1	12.2	14.0	20.8	14.3	8.1	4.0
2 years	1.9	2.2	2.7	2.1	1.5	0.6	0.0	0.0	0.0	0.1	0.2	0.2	0.8	7.1	8.3	9.1	16.1	11.2	4.2	6.4	14.5	9.2	7.8	4.0

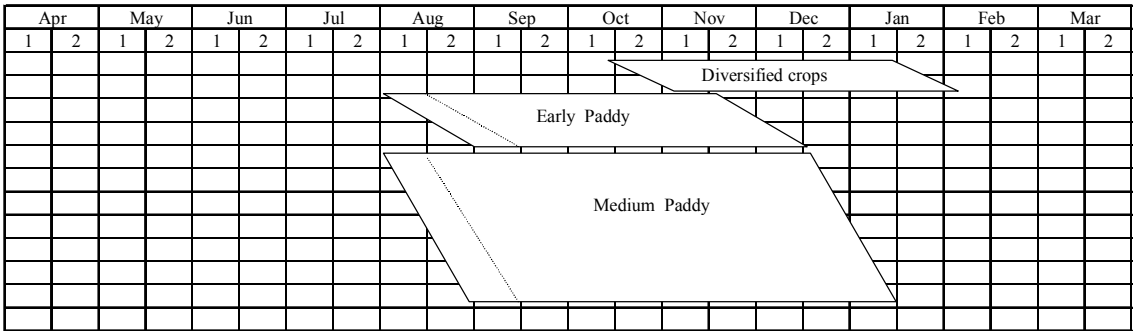
Taking some margin for changes in the cropping pattern, the unit water requirement for design is set at 1.0 l/s/ha for Ang 160 SRP.

(2) Kim Sei Reservoir

1) Unit Irrigation Water Requirements

The estimates of unit irrigation water requirements for the benefited area of Kim Sei reservoir were based on the following cropping pattern on the same condition as USP that the water saving irrigation method would be applied for paddy cultivation.

Proposed Cropping Pattern



The starting date for transplanting paddy is set at the middle of August, which is one month late than in the current cropping pattern. The irrigation efficiency was assumed to be 0.7 for paddy cultivation and 0.6 for diversified crops.

2) Feature of Kim Sei Reservoir

The elevation of the dike top level will not be changed from the prepsent.

Primary Features of Kim Sei Reservoir

Elevation of Dike Top (m)	Design Flood W.L (m)	H.W.L (m)	L.W.L (m)	Gross Storage Capacity (m^3)	Effective Storage Capacity (m^3)	Dead Storage (m^3)
13.8	13.2	12.6	12.0	27,500	19,700	7,800

3) Irrigable area and irrigation water requirements

The area benefit from the reservoir rehabilitation was estimated at 27 ha at 80 % dependability.

Medium paddy: 18.0 ha

Short Paddy: 9.0 ha

Instead of a few hectares of paddy cultivation, vegetables are also recommendable

at a scale of a few hectares during a period from October to January.

Irrigation water requirements are as follows.

Irrigation Water Requirements

Unit : l/sec

Recurrence Period	Jan.		Feb.		March		April		May		June		July		August		Sep.		Oct.		Nov.		Dec.	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
5years	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	14.3	25.0	16.4	9.0	15.3	30.9	21.2	7.1	0.0
2 years	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	12.5	21.6	6.2	1.8	7.8	22.5	13.5	6.8	0.0

Taking some margin for changes in the cropping pattern, unit water requirement for design is set at 1.2 l/s/ha for Kim Sei SRP.

IV-3.2 Rehabilitation Plan of Facilities

The irrigation area of a small reservoir is generally about 20 ha, which is similar or less than that of a tertiary block of USP. Irrigation canals are similar to watercourses. The number of beneficiaries differs by reservoir, and the prototype alignment of canals does not always fit the individual command area. For instance, Ang 160 Reservoir (irrigation area 25 ha) has 130 beneficiary households, while Kim Sei Reservoir has only 37, and the actual canal alignments would also need to differ. Accordingly, it is proposed that on-farm development would be undertaken by the beneficiaries themselves and the project would be responsible for the rehabilitation works on the reservoir, dike and their related structures only. Construction works are expected to be contracted by MOWRAM to local contractors.

(1) Ang 160 Reservoir

1) Dike

The existing dike has been washed out for a stretch of 10 m on the east-west sub-dike. The northern end of the main dike is damaged around the intake pipes due to piping. Some portions of the embankment slopes on the reservoir side are eroded, but the dike itself remains stable as a whole. The proposed section of the dike would have an inside slope of 1:2.0 and outside slope of 1:1.5. Embankment materials at the toe of the inside slope would be replaced, and the embankment would be reshaped in some portions. Embankment should be at least 0.5 m thick, assuming the embankment is formed with machines. The dike top width would be 3.0 m, which would be protected with a laterite layer of 0.30 m.

Embankment materials would be excavated materials inside the reservoir, laterite materials taken at Prey Kdouch Village and existing embankment materials, which

are classified into silty-sand (SM), clayey sand (SC) and/or clay (CL). They all show sufficient shear strength with sufficient compaction. The total length of the dike would be 500 m.

2) Spillway

A design flood discharge of recurrence period of 20 years is adopted for the small reservoir. The design flood discharge for Ang 160 Reservoir whose catchment area is 2.0 km^2 was estimated at 6.0 m^3/s. Location of the spillway would be 90 m from the northern end of the main dike near the existing stream on the downstream of the reservoir. The spillway would be of rock with an overflow crest width and overflow water depth of 7.6 m and 0.6 m, respectively.

3) Intake Structure

Intake structures are proposed at two locations on the both sides of the spillway. The pipe culvert should be of RC pipe with 400 mm diameter. A steel gate of 0.6 m by 0.6 m would be installed at the inlet. A concrete box would be installed at the outlet to dissipate the water flow energy, from where it would flow into the irrigation canal.

4) Access Road

Ang 160 Reservoir is located on the foot of the Noreay Mountain Range at 2.8 km to the west from ADB Road on which the center of Trapeang Chhuk Village exists. The access road to the reservoir is passable by vehicle but requires improvement for construction machines. Prior to construction of the reservoir, an access road of 4.0 m width with laterite pavement of 0.15 m thickness would be constructed.

A general layout plan of Ang 160 Reservoir is given in Fig. IV-3.2.1.

(2) Kim Sei Reservoir

1) Dike

The existing dike has collapsed for 10 m within the northern sub-dike near the National Road No.3. Besides, the northern sub-dike requires additional embankment thickness of 0.5 to 1.0 m throughout the stretch. The main dike on the east has sufficient height and stability, and little rehabilitation work is required. The slopes of the proposed dike are the same as those of Ang 160 except the outside slope along Canal 8, which would have a slope of 1:2.0. Embankment materials would be similar to those of Ang 160.

2) Spillway

The design flood discharge with a recurrence period of 20 years for Kim Sei Reservoir is 11.4 m^3/s for a catchment area of 5.2 km^2. The existing spillway in

the center of the main dike would be replaced. The spillway would be of rock with an overflow depth and width of 0.6 m and 14.3 m, respectively.

3) Intake Structure

The existing intake structures in four locations would be replaced to connect the existing watercourses. Taking into account the low water pressure because of the shallow water depth in the reservoir, a steel plate gate with a pull-up handle would be installed at each inlet. A concrete box would be installed at the outlet to dissipate the water flow energy, before it flows into the existing watercourses. A general layout plan of Kim Sei Reservoir is shown in Fig. IV-3.2.2.

IV-3.3 Water Management, Operation and Maintenance

(1) Water Management

The storage capacities of both Ang 160 Reservoir and Kim Sei Reservoir are small. If water were easily released without a definite irrigation schedule, water stored in these reservoirs would be run out in an instant without efficient utilization. Especially during nighttime, no one would manage the irrigation system and a large amount of water would often be wasted. In order to efficiently utilize the limited water resources, daytime operation is proposed. The water would be released from the reservoir and distributed to the fields through small canals in accordance with a definite irrigation schedule.

(2) Operation and Maintenance of Facilities

Operation and maintenance of the small reservoirs should be conducted by Farmer Water User Group (FWUG). The water depth of the reservoirs is generally shallow and subject to the influence of sediment. However no particular facilities for flushing the sediment are considered, and removal of sediment around the intake structures should be undertaken periodically.

As for the dike, routine inspection and maintenance should be done on the erosion of the slope by wave and rain water. Rust preventive material should be painted every year and removal of sediment in the pipe culvert should also be done periodically. It is desirable to fix the timing of annual period of intensive maintenance and all the FWUG members should be ready to participate in the works.

CHAPTER IV-4 THE SMALL POND DEVELOPMENT PLAN (PDP)

IV-4.1 Basic Plan

(1) Basic Concept

As a priority project of the Master Plan, the small pond development plan consisting of three types of pond by village in the Study Area was proposed as mentioned in the following.

1) Group Pond Operated by Farmers Group

For small individual farm holders, group pond is proposed to be utilized by several small holders around the pond for irrigation purpose (Fig. II-4.4.2).

2) Individual Pond

This type of pond would be constructed within a single owner's land to irrigate his(her) land around the pond (Fig. II-4.4.3).

3) Canal Pond

By utilizing the existing irrigation canal network constructed during the Pol Pot Regime, ponds would be excavated in the canal for irrigating farm lands along the canal (Fig. II-4.4.4). The land for pond (canal) belongs to MOWRAM. It is, therefore, proposed that the pond user groups should register with MOWRAM.

In the Master Plan, 60 individual ponds and 12 group ponds including the canal ponds were proposed to be constructed in each village in the Study Area within 10 years, so that all the farm households in the Area could utilize the ponds.

In this feasibility study, Trapeang Snao Village in Nhaeng Nhang Commune was selected as a model village, then the development model of PDP and economic viability were examined through the actual planning of 30 ponds in the village.

(2) Development Approach

Development approach of PDP is shown in Fig. IV-4.1.1. Necessary fund for implementing PDP would be kept as "PDP Fund", which would be procured and handled by MOWRAM. The fund would be lent to members of Pond Users Group (PUG) for construction of the proposed ponds. PUG would be situated under VDC and five village level extension workers who would be trained in the course of the implementation of PDP would play roles of "board members" in collecting repayment, identification of other candidate ponds, and coordination on technical support from MOWRAM (DWRAM). Training on accounting would be done for

two of five board members of PUG or village level extension workers. Survey and design would be done by PUG or VDC or DWRAM conforming to formats for the survey and design that were used in the course of this Study[15]. As for construction, excavation of the pond itself would be contracted to contractors, while spreading of excavated soils, fencing, catch drains would be constructed by the beneficiaries.

(3) Irrigation Plan

According to the cropping pattern for PDP, proposed in the Sub-Section IV-5.1.1 "Prospective Crop Production", irrigation with pond water for two cropping periods, i.e., August to October (pre-rainy-season crops including nursery of paddy rice), and November to January (post-rainy-season diversified crops) was proposed. Gross irrigation water requirements were estimated, assuming irrigation efficiency of 0.8, at 250 mm per season for the first season, and 550 mm per season for the second season. Manual irrigation with bucket or watering pot, or irrigation with small engine pump is assumed. Drained water from catchment area should be collected into the pond through collecting channels, side drain of roads and existing canals so that one third of the pond capacity should be stored at the end of the first month of the growing period. The proposed irrigation area of the identified 30 ponds totaled 5.8 ha for the first season (0.27 ha for group pond on the average, and 0.1 ha for the individual pond), while for the second season, it totaled 2.6 ha (0.12 ha for the group pond, and 0.04 ha for the individual pond).

IV-4.2 Trapeang Snao Small Pond Development Plan

(1) Orientation

The Study Team visited Trapeang Snao Village and explained the development concept, approach and component of PDP to the village chief. The team also collected basic information on socio-economic condition, natural condition, location and condition of existing infrastructures (road, canal, location of residential area and sub-village, school, temple, etc.). Then the team called or visited sub-village (Khrom) leaders to explain the plan and procedure of planning.

(2) Identification of Candidate Ponds

Candidate ponds were identified after holding several discussion and explanation meetings with each household by the leaders. Consequently, 30 candidate ponds were identified at seven sub-villages as shown in Table IV-4.1.1 and Fig. IV-4.1.2. The 30 ponds were composed of 14 group ponds on private land, three (3) canal

[15] The forms are compiled in the "Planning Guideline"

ponds and 13 individual ponds. In total, 88 households and 409 villagers were covered by the candidate ponds, which occupied about 80 % of the total households (111) and 70 % of the total population (583). New ponds and existing ponds occupy half in the number, respectively.

(3) Survey and Investigation of the Candidate Ponds

A survey of the proposed ponds and irrigation fields was conducted in the presence of the group members. Dimensions of land for pond or existing pond, proposed irrigation field, distance from the proposed pond to the main road, members' houses, canals and proposed irrigation field, were measured.

(4) Design and Cost Estimate

According to the standard design of the model pond (depth, slope, structure), design and cost estimate were conducted by pond. Manual excavation was assumed for the ponds with poor access, while excavation with machine was assumed for the ponds near the main (good) roads. The quantity of excavation, slope finishing, embankment (small dike) around the pond, fence, excavation of collecting channel, etc. were estimated using a "Form for Design and Cost Estimate" prepared by the Study Team.

IV-4.3 Operation and Maintenance of Pond

Operation and maintenance of the pond would be done by individual farmers or the group members. In actual practices, removal of sediment and reshaping of the slope would be the major maintenance works in a year.

The water level and water use of actual ponds observed in the Study Area show that some water is stored even in the midst of the dry season, particularly at deep ponds. In March or April, the pond water is eliminated in order to catch fish, and after transplanting of paddy rice, the pond water is used for emergency irrigation during drought period. On these occasions, the pond water is exhausted.

Most farmers are likely to use small engine pumps, but from the viewpoint of "water use according to the available storage", the application of pumps for routine irrigation is not suitable. The pumps should be used only for emergency extraction on a rental basis. By keeping the water at certain level, the stability of the excavated slope is maintained allowing the pond to be used for longer period between maintenance. Installation of a fence is considered important from the viewpoint of safety, but it could be substituted by fruit trees or acacias that serve other purposes such as shade or fuel wood.

CHAPTER IV-5 SUPPORT PROGRAMS

IV-5.1 Agriculture Production Program

IV-5.1.1 Prospective Crop Production

(1) Proposed Cropping Pattern and Planted Area

Target crops and the cropping pattern to be applied under irrigation are proposed according to the basic concept mentioned in the Master Plan Study. Paddy-based cropping system will be applied to USP and SRP for the improvement of food security in the priority areas. Crop diversification will be encouraged within the availability of irrigation water to increase farmers' income in each priority project. Intensive crop diversification will be introduced as part of the PDP.

1) USP

The USP will distribute irrigation water to 3,500 ha of paddy field. The rainy season paddy of the whole area will be irrigated and the water will additionally irrigate 500 ha and 550 ha of diversified crops before and after the paddy cultivation, respectively. For planting season of paddy, about one (1) month delay from the present practice is proposed for the purpose of effective use of rainfall in the heavy rainy season for the puddling, and the availability of irrigation water from the reservoirs during the late growing season. For paddy of local variety or HYV, one time cropping during the rainy season is proposed. Planting area of HYV paddy will be limited to about 30% (1,100 ha) of the paddy field because of the following reasons:

(i) As HYVs grow during 90 - 120 days (early maturing), the water requirement is considerably smaller than that of local varieties (120 - 150 days of growing period). It saves irrigation water, and contributes to expand the area planted to diversified crop after the paddy cultivation,

(ii) HYVs will improve the food balance in and around the project areas because of the higher yield, and

(iii) The market price of HYVs has fallen recently due to the surplus production of HYVs, un-favored taste to Cambodian people, and low quality.

Diversified crops including vegetables will increase the cash income of farm households. However, it is necessary to support them in marketing of products.

2) Ang160 SRP

A cropping pattern similar to that of USP will be applied to Ang160 SRP considering the availability of irrigation water. The rehabilitated reservoir will irrigate 25 ha of paddy in the rainy season: 17 ha of local paddy and 8 ha of HYV

paddy. Additionally, 2 ha and 3 ha of diversified crops will be irrigated before and after paddy cultivation, respectively.

3) Kim Sei SRP

Kim Sei SRP is limited to water resources due to the reservoir's capacity. Irrigation will start in early August. Only one crop will be irrigable during the rainy season. It is proposed that three (3) ha of diversified crops will be planted after paddy nursery, 16 ha for local paddy, and 8 ha of HYV paddy. Irrigation for paddy nursery will improve the production yield of rain-fed paddy.

4) Trapeang Snao PDP

PDP in Trapeang Snao village is a model project of pond-based irrigation. PDP will consist of group-use ponds and individual ponds. Land use of the target areas will be changed from paddy field to diversified crop field. Diversified crop production using pond water will be a major income source for farm households.

The proposed cropping pattern and planted area of each project are shown in Fig. IV-5.1.1 and Table IV-5.1.1, respectively. Beneficiaries of USP and SRP should apply the respective cropping patterns: kinds of crops and cropping season (four categories: i) local paddy, ii) HYV paddy, iii) rainy season diversified crop, and iv) dry season diversified crop), and the planted areas.

(2) Anticipated Unit Yields

Target unit yield of paddy was estimated at 2,800 kg/ha for local variety, 3,300 kg/ha for HYV through examination of the yields in existing irrigation areas in and around the priority areas. The unit yields of target crops are shown in Table IV-5.1.2.

(3) Prospective Crop Production

Table IV-5.1.3 shows prospective crop production in the target year of production (5th year after the completion of irrigation facility). The paddy production will be 10,350 ton in USP area, 74 ton in Ang160 SRP, and 71 ton in Kim Sei SRP. The incremental productions will be 6,050 ton, 37 ton, and 37 ton, in the respective projects. The diversified crops, especially, vegetables in USP area, will become a major cash crop income source for the beneficiaries. The diversified crops in PDP will also contribute to income increase for the beneficiaries.

(4) Food Balance and Marketable Surplus

Food balance in the USP and the SRP areas will be improved by the increase of paddy production shown in Table IV-5.1.4. Surplus paddy of each project will be 4,200 ton in USP, 20 ton in Ang160 SRP, and 47 ton in Kim Sei SRP. The average

surplus paddy per household will be 1,050 kg in USP, 150 kg in Ang160 SRP, and 1,280 kg in Kim Sei SRP. Paddy production in PDP may decrease due to the decrease of planted area of paddy, but the beneficiaries will obtain more cash income from the diversified crops. The marketable surplus paddy will contribute to improve the food balance in Tram Kak District and villages adjacent to the project area.

About 10 to 20% of vegetables produced in USP area will be consumed at home and sold in the local market. The remaining 80 - 90% will be marketable to populated area, such as Phnom Penh and Takeo Town. A support program for vegetable marketing is, therefore, necessary. Vegetables produced in SRP and PDP will be consumed in respective villages and the surplus will be marketed to the local markets, such as Angk Ta Saom, Tram Kak, and Angk Roka. Maize will be consumed mainly by livestock animals (pig and chicken) in the households. Most of the other diversified crops (groundnut, soybean, mung-bean and sesame) will be sold at market, except for a small amount for home consumption.

IV-5.1.2 Proposed Crop Budget

Crop budgets of present condition (without-project) and proposed plan (with-project) are shown in Table IV-5.1.5. The by-product was valued as livestock feed such as rice straw, stalk and waste vegetable fruits. The costs of farm manure and draft animal were estimated by farm-gate price and actual contract base cost, respectively. Most of the households raise livestock animals: pigs, cattle and draft cattle. These households will have to cover the costs for animal raising. Labor requirement was estimated as man-days, of which hired labor was estimated at 10% of the total for paddy cultivation, and no-hired labor for diversified crops cultivation. The cost of credit interest was estimated on the assumption that 50% of fertilizer would be bought by loan at 10% interest per cropping season. The gross income, production cost and net return of each crop in the proposed plan are summarized below:

Crop Budget of Proposed Plan

(Unit: 1000 Riel/ha)

Crop	Gross income	Production cost			Net return
		Inputs	Others	Total	
Paddy Local	1,081	253	120	373	707
Paddy HYV	1,035	264	122	386	649
Vegetables	5,118	440	102	542	4,576
Maize	1,238	185	70	256	983
Groundnut	1,119	301	79	380	739
Soybean	1,216	254	74	328	888
Mung-bean	1,416	246	73	319	1,097
Sesame	1,453	145	63	208	1,245

Note: Refer to Table IV-5.1.5 in detail

IV-5.1.3 Input Requirement and Labor Balance

(1) Requirement and Distribution of Inputs

Fertilizer requirements according to the proposed plan will increase by three times of the present application volume per ha of paddy cultivation, and that for all the crops will also increase nearly four times. Chemical fertilizer will have to be timely and sufficiently available in the markets around the priority areas to meet the demand. Since farmers' financial situation is still at low level for purchase of fertilizer, utilization of a credit service is required.

Farm manure will be produced through livestock animal husbandry. Improved seed of paddy for both local varieties and HYVs will be produced by the seed production farmers group that is proposed for the USP agricultural support program. The requirement for paddy seed was estimated at about 50 - 60 ton in total on the assumption that seed renewal be conducted every four years. Kbalkoh Vegetable Research Station in Kandal Province is producing vegetable seed for extension activity of MAFF, but the capacity of seed production is too small. Vegetable seed will be mainly supplied through traders from Thailand and Taiwan. The input requirement is shown below:

Input Requirement

(Unit: ton)

	USP	Ang160 SRP	Kim Sei SRP	PDP
Seed				
Local paddy	156	1.1	1.0	-
HYV Paddy	55	0.4	0.4	-
Vegetables	4	0.0	0.0	0.03
Other diversified crops	18	0.1	0.1	0.15
Chemical fertilizer				
Urea	390	2.5	2.3	0.58
DAP	238	1.4	1.3	0.57
KCL	139	0.8	0.7	0.35
Farm manure/Compost	12,700	79	76	15

(2) Labor and Draft Animal Balance

Labor force requirements for farming will increase because of irrigation farming and the increase in cropping intensity. According to the examination on labor force balance by month, it will be sufficient even in the busiest season (August, September, November and December) for the proposed plan in each project area.

At present, available draft animas per ha are 0.65 pairs cattle in USP, 0.47 pairs in Kim Sei SRP, 0.63 pairs in Ang 160 SRP and 0.63 pairs in PDP. The number of draft animals is sufficient for land preparation and transportation of inputs and products in each project.

IV-5.1.4 Prospective Production Value and Net Return

Table IV-5.1.6 shows the production value, net return and incremental net return of each project according to the proposed crop production plan. The summary is shown as follows:

Production Value and Net Return

	USP	Ang160 SRP	Kim Sei SRP	PDP
Total (Riel million)				
Production value	7,191	37.0	33.0	24.0
Production cost	1,768	11.1	10.2	3.2
Net return	5,423	25.9	22.8	20.8
Incremental net return	4,318	15.0	14.9	19.0
Per household (Riel 1000)				
Production value	1,789	285	893	272
Production cost	440	86	277	36
Net return	1,349	199	616	236
Incremental net return	1,074	115	404	216

Note: Refer to Table IV-5.1.6

The total production value of USP project will increase to 4 times the present value, 2.2 times for Ang 160, 2.5 times for Kim Sei, and 8 times for PDP.

IV-5.1.5 Monitoring and Evaluation (M&E) Plan of Agriculture Production

Monitoring and Evaluation (M&E) should be carried out by the FWUC every year and the results will be reported in the annual report of FWUC. Besides the O&M of irrigation facilities, crop production and the supporting programs should be monitored and evaluated every year and the output should be reported at a meeting of Apex and the 6 SC FWUCs.

M&E on agriculture production should be conducted for the following items:

- Planted area, actual irrigated area, unit yield and production by crops and season,
- Selling of products including volume, price, quality and marketing channel,
- Input supply of fertilizer and seeds,
- Achievement of farmer field school (FFS),
- Extension activities of DAFF and village extension worker (VEW),
- Number and activity of demonstration plots, and
- Loan amount, repayment, and number of credit users.

IV-5.2 Agriculture Support Programs

IV-5.2.1 Farmers Groups (FGs)

VDCs and CRDCs are supported by District Development Facility Committee (DDFC) and Provincial Rural Development Committee (PRDC) under the SEILA Program. Under VDCs, organizing FGs for credit service, agricultural extension and paddy seed production is proposed.

When FGs are newly organized under the priority projects, the following principles and lessons learnt from the past NGOs and international aid projects should be taken into accounts:

1) All the FGs should produce benefit for members of FGs.
2) Member fee of FGs should be minimum.
3) Well-organized and -operated VDC's know-how should be utilized.
4) Training should be provided to members of FGs in order to create a sense of solidarity and mutual aid, and avoid violation of rules.
5) Management persons of FGs should get a reasonable allowance in proportion to the profits of their FG activity.

IV-5.2.2 Extension Services

The proposed agricultural extension plan consists of three (3) components, i.e. i) strengthening plan of extension service, ii) paddy seed production plan, and iii) distribution plan of farm inputs.

(1) Strengthening Plan of Agricultural Extension Service

Dissemination of improved farming practices and irrigation farming will be done by the extension service activities of DAFF Takeo through VDC and FWUC. DRD will support the establishment and activation of VDC. The relationship of governmental institutions and farmers' communities is illustrated in Fig. IV-5.2.1.

The extension plan basically conforms to the present framework of the DAFF extension system, and is proposed to strengthen the present system, especially on activities in the field of Village Extension Workers (VEWs). For this purpose, it is proposed as an agriculture support program that extension FGs including VEWs should be organized under VDCs, and demonstration plot (Demo-plots) should be set up in farmers' fields. The proposed extension system is illustrated in Fig. IV-5.2.2.

1) Farmer Field School (FFS)

FFS aims at training of leader farmers who disseminate the trained farming practice

to farmers in their villages as VEWs. A session of FFS will be held one day every week during 16 weeks according to the cropping season of the target crop. The venue of FFS will be commune office, pagoda or school in and around the priority areas. The curriculum of FFS covers all farming practices from land preparation to post-harvesting, and Integrated Pest Management (IPM). Two (2) kinds of FFS courses will be provided for the target crops, i.e. paddy and diversified crops including vegetables. The FFS trains participants by seminar, workshop and field tour. In addition, the FFS trains paddy seed production farmers to produce and distribute improved paddy seed to priority areas.

About 30 farmers will participate in a session of FFS. They are selected from VDC of each village. The number of trained leader farmers (VEWs) should be determined based on the following criteria:

- 3 to 4 VEWs / village,
- 1 to 2 VEWs / Farmer Water User Group (FWUG) of tertiary irrigation unit,
- one VEW / 30 to 40 farm households, or
- one VEW / 1 to 3 sub-villages

The number of VEWs and FFS's sessions for training is shown in Table IV-5.2.1.

2) Demonstration Plots in Farmers' Field

Demonstration plots (Demo-plots) aim to demonstrate improved farming technology and improved varieties for beneficiaries in the field. Demo-plots will be set up at farmers' field with 0.1 ha per plot in the priority areas. Seeds and fertilizer required will be supplied free of charge from DAFF. The owner farmers will provide other inputs, pay other production expense, such as labor force and draft animal, and operate the Demo-plot under technical supervision of the extension worker and VEWs. The owner farmers receive the products as incentive. Usually, Demo-plots will be set up in VEWs' farm land, and the location will be basically changed every year or every season.

Eight (8) Demo-plots to each SC FWUC will be set up every year during the four (4) years after the irrigation service is started: two (2) plots each for i) local paddy, ii) HYV paddy, iii) rainy season diversified crops, and iv) dry season diversified crops. The proposed number of Demo-plots is shown in Table IV-5.2.2.

SC FWUCs and FOs (Farm Organizers) of FWUGs of tertiary irrigation units will support the operation and coordination of Demo-plots every season with extension FGs. The Technical Supervision and Assistance Unit of Apex FWUC will also support the operation of Demo-plots and assist coordination with DAFF.

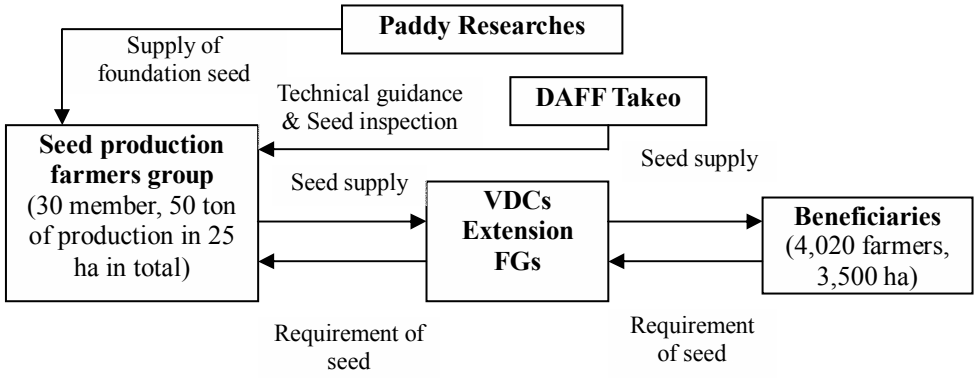
3) Extension Activities of VEWs

VEWs trained in FFS will come from extension FG under VDC. VEW will disseminate improved farming technology into villagers. Extension officers and District Office of DAFF Takeo will support and monitor the VEW activities. VEWs will have to effectively use Demo-plots for dissemination of improved technology.

(2) Paddy Seed Production Plan

Distribution of improved paddy seed of both local and high yielding varieties (HYVs) is indispensable for increasing of the production and improvement of the quality. It is proposed to multiply paddy seed by FGs of seed production in the priority areas. Required paddy seed was estimated at about 50 - 60 ton per year to 3,500 ha of paddy field on the assumption that the sowing rate is 50 - 60 kg/ha, and renewal is done every four (4) cropping seasons. The required paddy seed will be produced in 25 - 30 ha of paddy field or by about 30 farm households.

The produced seed will have to be inspected by DAFF. The certified seed after the inspection will be distributed to farmers through extension FGs. The seed price was estimated at Riel 600 to 700/kg. Price of the foundation seed supplied from researchers is Riel 2,400/kg. The seed producers will receive a higher net return than the common paddy producers.



Proposed Plan of Paddy Seed Production

(3) Distribution Plan of Farm Input

Most of the fertilizer and seeds of diversified crops are currently supplied by the private sector. They are imported from foreign countries: Thailand, Vietnam and Philippines for fertilizer, and Thailand and Taiwan for vegetable seed. Under the free market policy, these requirements will have to be supplied through the markets by dealers.

Due to the small farming size of the beneficiaries, the input requirement per household is very small. The transportation cost is high from market, (Ang Roka, or Angk Ta Saom) to village. The farm-gate price of fertilizer is generally 5 - 7% higher than that in Takeo and Angk Ta Saom market. It is, therefore, recommended that the extension FGs undertake group purchase of inputs including paddy seed produced by the seed production farmers group. Farmers would obtain the inputs at a cheaper price and higher quality through the group purchase.

It is also recommended that extension FGs take a few percent as a handling charge from farmers to fund for activities such as VEWs work and Demo-plots. The implementation schedule and estimated cost of the extension activities are shown in Table IV-5.2.3.

IV-5.2.3 Credit Service

(1) Credit System

The input cost of fertilizer and seed in the proposed plan of USP was estimated at Riel 810 million in total, which is equivalent to about 3.4 times the Riel 240 million at present. The average cost per household will increase from Riel 60,000 at present to Riel 200,000 in total, consisting of paddy (Riel 135,000) and diversified crops (Riel 65,000). Farmers will need cash credit to buy the inputs. The following three (3) credit systems will be available to farmers for input purchase:

1) Credit by FGs under VDCs

Fertilizer credit service by FGs under VDC is operated in 30 villages, and in the remaining five (5) villages, the same credit service will be started in 2002.

2) Credit by NGOs

One commercial bank and several local NGOs work for micro-credit service in the priority area. The interest rate is generally 4% per month.

3) Credit by FWUC's Reserves

FWUC will reserve capital for the replacement of irrigation facilities from collected ISF. The capital will be accumulated. It is proposed that a part of the reserve be used for a credit service, but only to the financially weak for input purchases subject to the approval of the Apex board of FWUC and 6 SC FWUCs committees. It will be managed under 6 SC-FWUCs. The interest rate is proposed to be 2% per month, the same as that of VDC credit service.

Farmers, who cannot access the above credit services, have to buy farm input from

traders as a debt. In order to avoid an increase in trader's price and interest rates, the VDC and FWUC should monitor the price. Meanwhile, the farmers will gradually reserve the capital for farm input through their own savings.

IV-5.2.4 Marketing Assistance Program

(1) Development Strategies

After 6 SC FWUCs are organized, paddy will be collected as ISF from the member farmers, while there are no storage facilities suitable for collection, cleaning and storage before selling to buyers. The USP area will produce diversified crops, such as maize, beans, groundnuts, vegetables both in the rainy season (500 ha) and dry season (550 ha) which will be too much for farmers to trade them by themselves in the area. In addition, there are no markets for assembling a large volume of products near the project area.

As a support program for the selected priority irrigation projects, specifically for USP's area due to its magnitude of products in the future, the following marketing assistance programs will be crucial for the project sustainability:

- Storage and sales of paddy collected as ISF
- Assembling and marketing assistance

The SC FWUCs and their Apex as a part of their activities will implement both programs.

(2) Program of Storage and Sales of Paddy

1) Objectives and Activities

ISF collection will be one of the fundamental activities under 6 SC FWUCs that will be organized by respective secondary canal command area. ISF is usually collected as in-kind paddy and sold to buyers or at markets to provide funds for O&M activities. In the USP area, there are no suitable places and facilities for ISF collection and storage. It is indispensable to establish storage facilities at the respective secondary canal area under SC FWUCs. The program objectives and activities are summarized as follows:

Objectives	Activities
To promote ISF collection, to increase quality of paddy and SC FWUCs' income by storage, cleaning and sales of paddy collected.	To clean and store the ISF paddy collected, and sell them in lean harvesting season.

Input	Implementing organization	Requirement
• Warehouse (Depots) with SC FWUCs' offices (6 no.) • Platform scale	• 6 SC FWUCs under coordination of Apex. • Apex Marketing unit coordinates among SC FWUCs.	• Technical assistance for the staff of Marketing Unit of Apex and warehouse manager of SC FWUCs.

2) Facility and Operation Plan

The storage facility (depot) plan was formulated as follows:

1. Number of depots — Six (6) for respective SC FWUCs. SC-24 and 3U shall be integrated due to the small storage requirement and location of the areas.
2. Location — Selected at six places accessible both by the farmer members and buyers.
3. Collection of ISF paddy and storage capacity — Around 392 ton of paddy in total (80% of ISF collection rate, i.e. 490 ton of paddy, 140 kg/ha of ISF from 3,500 ha), Around 65 ton per each depot on average.
4. Operation plan — Collection (Dec.-Feb.), Sales (Dec.-March, Jul.-Oct, excluding Apr. -Jun.)
5. Facility requirement — Building and yard

	Drying Floor	Storage	Office
Floor Area (m2)	108	252	252

Platform scale (200 kg) ; 6 numbers

3) Storage and Sales Revenue to be Expected

Through the storage and sales of ISF paddy, additional revenue will accrue from the difference of sales prices at around Riel 15.68 million as follows:

Revenue from ISF Storage and Sales

Quantity	Prices (Riel/kg)			Income
	Harvesting Season	Lean Season	Difference	
(ton)				(Riel Milion)
392	290	330	40	15.68

(3) Assembling and Marketing Assistance Program

1) Objectives and Activities

Assembling and marketing assistance program aims at:

- Provision of a public trading place to the member farmers of SC FWUCs,
- Giving opportunities to the members to negotiate prices with buyers,
- Dissemination to the members on market price determined by quality and quantity,
- Getting information on markets and prices in the big terminal market, and
- Giving chance to increase the members' income through marketing assistance.

Assembling market facility will be constructed as one of the components of USP. The marketing unit (MU) under the Apex of FWUC will operate the facilities. The program objectives and activities are summarized as follows:

Objectives	Activities
1) Stage I • Provision of wholesale trading place in the area. • Developing trading opportunities at better condition.	• Assembling the marketable products by using the market facility. • Promoting trade with local and regional traders.
2) Stage II • Establishing wholesale trade function at the area. • Joint shipping to the terminal markets by producers' groups. • Establishing the area-specific products with a high value at the market.	• Organizing producers' groups. • Introducing the transport equipment and storage facility. • Developing the buyers at the terminal markets in Phnom Penh. • Disseminating group collection, sales and quality control activities. • Promoting scheduled production, assembling and shipping by producers' group according to the market situation.

Input	Implementing Organization	Requirement
<Facility and Equipment> 1) Stage I Assembling market facility (Trapeang Svey village) 2) Stage II Two trucks, storage facility <Training> 1) Stage I Facility management, accounting, marketing, & quality control 2) Stage II Business management &marketing	1) Stage I Marketing unit (MU) with 7 staff under Apex of FWUC 2) Stage II Deploying 2 drivers to the market unit additionally.	• Technical assistance for the staff of Marketing Unit of Apex by the Project Office/Technical Supervi. & Assist. Unit • Marketing assistant for Apex by providing marketing opportunities by the government agencies concerned.

2) Operation Plan

The assembling and marketing assistance comprises i) wholesale trade assistance by using the assembling market facilities, and ii) joint shipping assistance for producers groups. The wholesale trade assistance will be initiated in the first year after completion of the facility construction. The joint shipping assistance will be implemented after the 5th year. The operation plan is summarized below:

(i) Wholesale trade assistance

- Promoting the farmer members to trade their products at the assembling market.
- Inviting traders to trade the products at the assembling market.
- The products brought by the farmers are registered by the inspectors based on the weight and quality, and assembled and packed according to quality grade.
- The farmers negotiate and settle the trade prices with buyers under the assistance of the MU of Apex.
- After completion of trade negotiation, the buyers pay the amount adding 2 % of the traded amount as a market charge to the accountant of MU. The farmers receive the amount deducting 1 (one) % from the traded amount. (The Apex will collect the market charge 2 % of the traded amount from the buyers and 1 % from the farmers that will be a fund for O&M and replacement of the facilities including the irrigation facilities).
- The MU presents the traded quantity and prices by quality grade on the blackboard at the assembling market.
- The assumed trade volume of wholesale trade assistance is conservatively set at 40% of paddy, vegetables and other products out of the marketable surplus.

(ii) Joint Shipping Assistance

- After experience in the assembling market, some farmers will have an interest to sell their products in the terminal markets, i.e. Phnom Penh in order to get higher income. The MU promotes organizing such farmers as producers' groups for joint shipping to the terminal markets.
- The MU develops buyers proving better trading conditions at the terminal markets.
- Under the assistance of MU, the producers' groups assemble and pack their products in the assembling market, and ship the products for sale at the terminal markets by using two trucks of the Apex.
- Of the balance between the trade amount at the terminal markets and the estimated value in case of trading at the assembling market, 10% will be given to the farmers and 90% to the Apex. The sharing rate will be adjusted based on the actual expenditure for shipping and saving fund necessary for O&M and replacement cost.
- The MU collects the market information and finds out market demand, requirements, and better trade opportunities. Based on the market situation, planned cultivation and increase in quality of products will be promoted by MU, if farmers agree to this plan.
- The assumed trade volume of joint shipping assistance is conservatively set at

10% of products out of the marketable surplus.

3) Facility Plan for the Assembling Market

Based on the trade volume and their seasonal variation, the following facilities and equipment will be required for the marketing assistance activities:

Facility Plan for the Assembling Market

Item	Stage	Number	Area (m2)	Function
Assembling yard	I	1	263	Receiving, grading, packing, shipping, etc.
Well	I	1	-	Domestic and washing the products
Office	I	1	36	Recording, accounting, administration work
Warehouse	II	1	80	Storage of rice and cereals
Equipment				
Platform scale	I	2	-	Weighting
Table scale	I	2	-	Weighting
Blackboard	I	1	-	Presentation on market information
PC, Printer, Fax	II	1	-	Recording, assessment, collection of information
Truck	II	2	-	Shipping products to the terminal markets

4) Marketing Assistance Revenue and Expenditure

The gross revenue accrued from the assembling and marketing assistance by the MU of Apex was estimated at Riel 54 million from the wholesale trade assistance and Riel 128 million from the joint shipping assistance. The revenue from the joint shipping assistance will be accrued from the 5th year after the commencement of the MU. The expenditure for the assistance comprises the personnel expense of MU staff, O&M cost for the marketing facilities and equipment, and equipment cost procured in the stage II. The revenue and expenditure for marketing assistance were estimated as follows:

Cash Flow of Marketing Support Activities

(Unit: Riel Million)

Year	Revenue			Expenditure				Annual Balance
	Market Charge	Trade Income	Total	Personnel	O&M	Others	Total	
2006	18.2		18.2	7.4	5.9		13.3	4.9
2007	30.2		30.2	7.4	5.9		13.3	16.9
2008	42.1		42.1	7.4	5.9		13.3	28.8
2009	48.1		48.1	7.4	5.9		13.3	34.8
2010	54.1	128.3	182.4	9.4	20.0	117.2	146.6	35.8
2011	54.1	128.3	182.4	9.4	20.0	80.0	109.4	73.0
In and after 2012*	54.1	128.3	182.4	9.4	20.0	0	29.4	153.0

Note *□After 2012, the values of the annual revenue and expenditure are the same as those of 2012 except years of replacement of facilities and equipment.

IV-5.3 Rural Road Improvement Program (RIP)

(1) Proposed Roads

Feasibility study was conducted on the following road sections prioritized in the Master Plan (Fig. IV-1.4.1).

1) Road 33 (Trapeang Thum Khang Cheung ~ Trapeang Kranhung (Road-A)

Road 33 is the main road of USP Area. A stretch of 13.3 km between the end point of ADB road improvement at Trapeang Thum Khang Cheung Commune and Trapeang Kranhung Commune via Kpob Trobek and O Saray Reservoirs is the target section as "Road-A".

2) O Saray ~ Slakou River (Road-B)

Out of the district road between Basedth of Kampong Supue Province and Chum Kiri of Kampot Province, a stretch of 4.1 km from Road-A at O Saray to the Slakou River is proposed as Road-B.

3) Road-B ~ Kpob Svay (Road-C)

A road of 6.2 km from Road-B to Kpob Svay Village on the right bank of the Slakou River in which Tumnup Lok Reservoir of USP is located is proposed as Road-C.

(2) Target Level of Road Improvement

Road-A and Road-B are classified into district roads, and have bigger traffic load as the main roads in the area. A bridge over the Slakou River on Road-B was washed away by floods and does not perform its original function, but it still plays a significant role to provide access to Road-A. Traffic itself is less for Road-C, but the road has a significant impact as a rural road to connect the up-most area of USP and the main road (Road-A). Taking into consideration present and future road conditions and requirements after completion of USP, the target level of road improvement was determined as summarized below:

Standard of Roads

Item	Road-A	Road-B	Road-C
Length (km)	13.32	4.14	6.16
Width (m)	Total 5m, effective□m	Total 5m, effective□m	Total 4m, effective 3m
Design speed	30km/h	30km/h	20km/h
Traffic Volume (heavy equipment)	15□40 nos. per day	15□40 nos. per day	Less than 15 nos.
Structure of surface and sub-base	Total height 0.65m □local material□ laterite10cm sand &gravel 20cm	Total height 0.65m □local material□ laterite10cm sand &gravel 20cm	Total height 0.65m □local material□ laterite15cm
Slope protection	reshape / sodding	reshape / sodding	reshape / sodding
Design CBR	3	3	2

(3) Improvement Plan

1) Road-A

Improvement incorporated with USP irrigation facilities, such as the dike of Kpob Trobek Reservoir and road crossing of the secondary canals, is considered as follows.

- The road crossing structure at the beginning point of each secondary canal is included in the construction of USP. If USP is not implemented, replacement or rehabilitation of the structure would not be included.
- Embankment for the dike of Kpob Trobek Reservoir is not included for RIP, but a laterite pavement of 10 cm and sub-base (sand and gravel) of 20 cm are accounted in RIP. (USP accounts laterite protection of 30 cm for the dike top of Kpob Trobek Reservoir).
- An RC bridge (length of 19.8 m with three spans) as shown in Fig. IV-1.4.1, is appropriated over the O Saray Reservoir in RIP, while a temporary bridge is appropriated as the temporary works of USP.

Other major structures for Road-A are a bridge (L=9.2 m) and four road crossing pipe culverts. The location of the bridge is shown in Fig. IV-1.4.1.

2) Road-B

Road improvement, replacement of three existing bridges and construction of new road crossing culverts are proposed. The bridges which could not be passed during the rainy season due to damages on the foundation, exist across the Krouch Stream and its tributaries. The location of bridges are shown in Fig. IV-1.4.1.

3) Road-C

The existing road width is narrow at 3 m, and vehicles cannot pass each other at most locations. The road itself is eroded due to a lack of cross-drains. Thus, the road width will be widened to 4 m and road crossing pipe culverts are proposed at 12 locations. Embankment materials are procured from the land beside the road as, is generally done for rural road improvement projects, and the road surface will be paved with laterite.

IV-5.4 Farmer Water User Community (FWUC)

There are three priority projects, namely USP, SRP and PDP. Since the irrigation area is only a few hectares and the number of beneficiaries of each PDP is a few, no FWUC is required. For SRP, two projects are proposed, namely Ang 160 (25 ha) and Kim Sei (27 ha), which are categorized into small-scale projects by MOWRAM. The irrigation areas for these two projects are less than a tertiary unit of USP (33 ha on

average). Therefore, formation of FWUC of SRP will be conducted more easily and quickly under the technical support of DWRAM than that of USP. In this Sub-Section, therefore, FWUC of USP is mainly described.

IV-5.4.1 FWUC

(1) The Objectives and Function of FWUC of USP

According to MOWRAM policy, FWUC is required to manage operation and maintenance (O & M) of irrigation facilities by itself in both technical and financial aspects after the facilities are ready to be operated and its capacity is deemed to be adequate by MOWRAM in terms of O & M. Behind the policy, there are two objectives that i) MOWRAM's financial burden for O & M of all the large and medium scale irrigation projects (more than 200 ha) in Cambodia should be reduced as much as possible, and ii) that farmers or beneficiaries should make efforts to manage O & M of irrigation facilities by themselves without MOWRAM's technical and financial assistance as a sustainable autonomous organization by self-reliance.

As mentioned in Sub-Section IV-1.5, present FWUCs existing outside the Study Area face many problems in technical and financial aspects.

For financial aspect, existing FWUCs suffer from fund shortage. Maintenance work of irrigation facilities can not be carried out due to shortage of operation funds. This is a very serious problem. The price of paddy, which is an external factor that can not be controlled has remained very low in recent years. It is, therefore, difficult for paddy cultivation farmers (farmers in the USP area are mostly paddy cultivation farmers) to raise the irrigation service fee (ISF). USP would be laid under the same situation. The preliminary financial analyses indicate that ISF can not cover all the expenses for operation of FWUC. Thus other sources have to be considered. In this Study, it is proposed that FWUC should have a function of marketing assistance in addition to its primary function of irrigation water management and O & M of irrigation facilities. It should provide a market place for member farmers to sell diversified crops to middle man and buyers and take a commission on the sale of crops from both farmers and buyers to supplement the lack of operation funds of FWUC.

For technical aspects, whenever a FWUC faces difficulty, it always relies on MOWRAM to solve the difficulty. However MOWRAM cannot respond to all the requests due to lack of financial resources and technical staff. This ends in the deterioration of irrigation facilities. In order to enhance spirit of self-reliance on

FWUC, change of farmers' mindset is very important, although this will take a long time. For this purpose and to finally realize a substantial increase in the self-reliance of FWUC in both technical and financial foundations, it is proposed that MOWRAM fully supports farmers. It should establish and reinforce the FWUC during the design, construction and initial operation stages of USP through its project office with qualified staff from MOWRAM, other concerned agencies, and local staff from DWRAM and/or local people.

(2) Proposed Organization and Staffing of FWUC of USP

The organization structure of FWUC was discussed with commune chiefs and some village chiefs. The proposed structure is shown in Fig. IV-5.4.1 and consists of a FWUG organized in every tertiary block, six FWUCs at the secondary canal level (SC FWUC) and a FWUC Apex Committee at the head. An Apex Board will be established. These functions are briefly described as follows:

1) Apex Board is a top decision-making organization of FWUC. Members are 14 members in total composed of one secretary, one accountant and chairmen and vice-chairmen of SC FWUCs. Chairman and vice-chairman of the Board are elected from among the chairmen and the vice-chairmen of the SC FWUCs. The chairman and vice-chairman of the Board also work as a chairman and vice-chairman of the Apex Committee. The Board will approve and determine its statutes, budget, ISF, dispute resolution, irrigation schedule, plans on water management and O & M work, etc.
2) The Apex Committee is a top management organization consisting of four units under chairman, vice-chairman and secretary, i.e. accounting/administration unit, marketing unit, O & M unit and dispute resolution unit. The O & M unit will directly manage the reservoirs and the main canal of USP and supervise scheme operators (SOs).
3) Each SC FWUC will manage its respective secondary canal. One SC FWUC consists of several farmer water user groups (FWUGs) that will manage tertiary canals and watercourses within one tertiary unit.

The duties of the staff of the organization are shown in Table IV-5.4.1.

(3) Proposed Organization and Staffing of FWUG of SRP

The organization and staffing of a FWUG is shown in Fig. IV-5.4.4. The FWUG committee is composed of a chairman cum dispute coordinator, an accountant and one FO. In addition, two representatives will be elected by farmers, when decision making on important subjects is required.

(4) Materials and Equipment for FWUC of USP

An Apex Committee office and six (6) SC FWUC offices will be built at convenient locations. Also, gatekeepers huts will be built at the beginning point of the diversion canal from Tumnup Lok Reservoir and the beginning point of the main canal from Kpob Trobek Reservoir.

References and materials such as criteria, guidelines, manuals, and various kinds of forms for all the subjects such as the training, forming FWUC, FWUC office management, irrigation water management, and O&M of irrigation facilities should be prepared.

Regulations to specify office management, accounts, logistics, personnel affairs and the rights and duties for members and staff of FWUC, etc. and manuals for irrigation water management and operation and maintenance of irrigation facilities should be furnished.

Originals of cadaster and/or cadastral maps should be kept in Apex Committee. Copies should be kept by each SC FWUC and FOs in each jurisdiction.

The Apex Committee Office should be furnished with computers and a generator with ordinary office equipment such as desks, chairs, and cabinets. The office needs one pick-up truck and several motorbikes as well. During the construction time, most of the equipment will be commonly used with the project office and then be handed over from the project office upon the completion of the project.

No construction equipment will be owned by FWUC. for major repair and maintenance work. FWUC should select a local contractor for such works in consultation with MOWRAM and DWRAM and should make a contract with the local contractor, for which the FWUC will meet the cost.

IV-5.4.2 Annual FWUC Works

Upon the completion of the formation of FWUC and the project works, the project office will be curtailed to a small advisory unit, so-called as “the Technical Supervision & Assistance Unit (TSAU)”. FWUC of USP will work under TSAU for the first 4 years as joint management. After the joint management, the FWUC should manage all the O & M work itself. The major annual works and organization units responsible for such works will be as follows:

Before the irrigation period:

1) Preparation of annual water distribution schedule by O & M unit.
2) Preparation of an annual maintenance schedule for reservoirs and all canals by O

& M unit.

3) Listing / confirmation of operation staff and operation rule for reservoirs and all canals by O & M unit.
4) Listing / confirmation of maintenance staff and maintenance methodology for reservoirs and all canals by O & M unit.
5) Assessment and determination of ISF by the Apex Board
6) Preparation of annual marketing work schedule by the marketing unit.
7) Preparation of an annual budget by the accounting unit.
   (The above subjects of item 1) to 7) should be approved by the Apex Board.)
8) Meetings of the Apex Board and Apex / SC FWUC Committees

<u>During irrigation period :</u>

1) Routine operation and patrol work by O & M unit and SC FWUCs
2) Monitoring and measuring discharge by O & M unit and SC FWUCs
3) Dispute resolution by dispute resolution unit
4) Preparation of marketing work

<u>After irrigation period :</u>

1) Routine maintenance work of reservoirs and all the canals by the O& M unit and SC FWUCs
2) Emergency repair work by the O & M unit and SC FWUCs
3) Assignment of farmers for the above 1) and 2) works as laborers and repair work by the O & M unit and SC FWUCs (If emergency repair is beyond the capacity of FWUC, the FWUC should consult with MOWRAM, and a local contractor should be deployed at the FWUC's expense.)
4) Collection of ISF by the accounting unit
5) Auditing by an authorized auditor
6) Rendering of accounting (revenue and expenses) to members of the FWUC by the accounting unit and Apex Committee
7) Monitoring and evaluation of crop yield, and ISF collection rate by Apex and SC FWUC Committee members
8) Assessment of salary of FWUC staff
9) Disclosure of all the information by Apex and SC FWUC Committee members
10) Election of Apex and SC FWUC Committee members, if necessary.

For the smooth management of FWUC and O & M of irrigation facilities, guidelines for management of FWUC and an O & M manual are very useful. Under institutional development and capacity building program, it is proposed that experts be deployed by MOWRAM to prepare them.

In addition, for agricultural extension, SC FWUC will prepare Demo plot

implementation program for the first four years and FOs will actually operate Demo plot works in collaboration with TSAU and DAFF Takeo. The SC FWUC will provide a credit service to assist the weak in buying farm inputs if the SC FWUC committee approves such credit. The accountant of SC FWUC will operate the credit service for the weak.

IV-5.4.3 Irrigation Service Fee and Initial Operation Fund

(1) Government Policy on ISF

According to the Government policy on O & M of irrigation systems, the Committee of FWUC registered to the Government must collect an ISF from water user farmers for irrigation services. FWUC has to decide the rate of ISF according to the following formula.

$$Y = \frac{X_1+X_2+X_3+X_4+X_5}{\text{Irrigation Service Area}} + 20\% \text{ of Increased Production}$$

Where, Y = ISF per ha

X_1 = expenditure on maintenance and repair
X_2 = expenditure on fuel in case of pumping
X_3 = expenditure on contribution to the Community Board
X_4 = expenditure on administration
X_5 = expenditure on contingency

As the O&M cost may vary from year to year, the ISF will vary accordingly. The 20 % of the increased production from the present condition shall remain in the bank account of the FWUC as a fund to cover the emergency repair and maintenance expenditure or the FWUC could spend it in the modernization of the irrigation system or in improvement works for farm water management.

Depending on the financial situation, the FWUC might reduce the percentage for the first 4 years but not less than 5% of the increased production. Upon the completion of construction, the responsibility for operation and maintenance and emergency repair shall be transferred to the FWUC progressively as follows:

Year 1: The Government shares 80% and the farmer members 20%
Year 2: The Government shares 60% and the farmer members 40%
Year 3: The Government shares 40% and the farmer members 60%
Year 4: The Government shares 20% and the farmer members 80%
Year 5: The Government shares 0% and the farmer members 100%

It is, however, noted that the Government share of the above ISF is not always guaranteed or subsidized by the Government. MOWRAM should review the present regulation on the ISF including some ambiguity and modify it from now on.

(2) Annual O&M Cost

In order to assess ISF for USP, the revenue and ordinary annual O & M costs excluding replacement costs, were estimated. The staff required for O&M of USP was estimated at 118 members (See Fig. IV-5.4.1). The annual FWUC O&M cost for proper water management of the system was estimated as shown in Table IV-5.4.2 and summarized below:

Personnel expenses:	Riel 99.2 million
Running costs:	Riel 64.4 million
Total	Riel 163.6 million

(3) Revenue

In order to cover the above annual O & M cost, the required FWUC ISF rates were estimated at 140 kg /ha for paddy or Riel 40,600/ha for both paddy and wet season diversified crops and Riel 76,500 /ha or 264 kg/ha of paddy equivalent for dry season diversified crops respectively based on the prevailing ISF of paddy in Takeo as shown in the following table:

Amount of ISF equivalent to O&M Cost

Crop	Unit	Area	ISF applicable Riel/ha	Total Million Riel	Paddy equivalent (Riel 290 /kg) Kg/ha
Paddy	ha	3,500	40,600	142.10	140
Wet S. Diversified Crop	ha	500	40,600	20.30	140
Dry S. Diversified Crop	ha	550	76,500	42.08	264
Total				204.48	
ISF Collection (80%)				163.58	

As shown above, the total revenue would amount to about Riel 204.5 million. Provided that an 80 % collection rate is achieved, the total revenue amounts to about Riel 163.6million, which would balance the annual O & M cost. Meanwhile, the 20 % increased production is calculated as follows:

Emergency Maintenance Rate (ISF by government's formula)

Item	Unit	Present (1)	Projected (2)	Increment (3)=(2)-(1)	20% of (3)
Paddy in rainy season	t/ha	1.32	2.96	1.64	**0.328**
Diversified crops	1,000 Riel/ha	0	2,869	2,869	**574**
				Paddy equivalent (**1,979kg/ha**)	

Provided that ISF rate proposed by the Government policy is applied for both paddy and diversified crops, the ISF for USP was estimated as follows:

Paddy cultivation : 140 kg/ha + 328 kg/ha = 468 kg/ha

Diversified crops (average): 205 kg/ha + 1,979 kg/ha =2,184 kg/ha

The ISF rate proposed by the Government is only applicable for paddy, not other crops. As a trial calculation, the above calculation was conducted. The estimated rate by the Government formula is considered to be extremely high and not applicable from the viewpoint of farmer's capacity to pay.

(4) Proposed ISF

Under such circumstances, it is proposed to tentatively apply 140 kg/ha for paddy cultivation, Riel 40,600 for paddy and wet season diversified crop and Riel 76,500 for dry season diversified crops for USP only to cover annual O & M cost. If the ISF covers the costs of periodical maintenance and replacement (gates, office equipment, etc.), then about 1.55 times the ISF (218 kg /ha of paddy equivalent) is needed. In other words, an additional ISF of 78 kg/ha for paddy cultivation, Riel 22,330 for wet season diversified crop, and Riel 42,075 for dry season diversified crops is required. Without introducing other financial sources, the FWUC will be unable to compensate its total O & M cost. In order to balance the above deficit, it is proposed to introduce the marketing activities of agricultural products into the operation of FWUC for USP.

(5) Marketing Activity

Details of marketing activities are explained in Sub-Section IV-5.2.4. Even if estimated conservatively, the marketing activities would substantially provide about Riel 182 million of their profits after 5 years of marketing activities started, from which USP is expected to be sustainable.

(6) Initial Operation Fund

Operation of FWUC needs some funds from the initial stage, however, FWUC can not get ISF in advance. Farmers have little capacity to pay especially at the initial stage of the project when no or little project benefits are brought from the agricultural production. Therefore, farmers and authorities relevant to the project should think about methods to make funds necessary for activities for initial operation of FWUC.

One of the most realistic measures to make initial operation funds is for farmers to participate in the construction works of USP. Farmers who are prospective members of an FWUC have to accept that the FWUC deposits a part of their earnings for initial operation of FWUC. In this participation, farmers will come to understand the USP and obtain basic knowledge on the operation and maintenance of the project

facilities. Since farmers have a sense of belonging to their village, but not their commune, the village chiefs or village leaders are expected to play an important role in securing the farmers' participation and providing the initial operating funds for the FWUC. This methodology is also proposed for SRP

IV-5.4.4 Formation of FWUC

(1) Formation of FWUC of USP

The FWUC of USP will consist of about 4,020 families in 32 villages. The formation process of FWUC was discussed with village chiefs based on the formation process mentioned in Prakas 306 and was provisionally concluded as below-mentioned 8 steps. The project office will assist farmers in the formation of the FWUC under the MOWRAM's technical and financial support. Many farmers are not accustomed to farmers' group organization. Therefore, it will take time for farmers to recognize FWUC and organize it. Steady efforts will be required during the period of formation of FWUC. The period necessary for the formation was estimated at 3 years.

Step-1: Farmers Awareness

Farmers do not know what a FWUC is, nor the details of formation. The jurisdiction of FWUC is put on the irrigation area of USP, and the boundary will be determined by irrigation planning and design. The project office should firstly explain to farmers i) the outline and objective of the project, ii) irrigation plan, iii) irrigation area and the boundary, iv) proposed organization of FWUC, v) formation process of FWUC and required activities, vi) right and obligation of FWUC, etc. For this, a series of meetings and forums should be conducted at a village level. Since the village is the basic unit of the farmer's life, village boundaries have been considered in preparation of irrigation canal layout of USP as far as technically possible. In order to conduct such meetings and forums, farmers should elect coordinators from all the villages. The project office should make arrangement with such coordinators.

Step-2: Setting Tertiary Units of FWUC

The terminal group of FWUC is the farmer water user groups (FWUGs) that will manage the tertiary units covered by one tertiary canal, say 33 ha. The coordinator and farmers in each FWUG will prepare a list of member farmers to form a FWUG. For this, the project office will have meetings/forums and confirm the location of tertiary unit with farmers and the coordinator through field reconnaissance considering the alignment of tertiary canals and watercourses. Then, the farmers who would form the FWUG finalize the tertiary unit. Farmers should prepare FWUG's

cadaster including acreage and land-use-right owners' name. Since they have neither cadaster nor cadastral map, it will take time to make it. It is noted, however, that farmers know the areas and boundaries of one another. At the same time, the project office should explain and obtain consensus on the land necessary for construction of tertiary canals and watercources**.** In addition, the layout of tertiary canals and watercourses should be investigated and finalized by farmers under the technical supervision of the project office.

Step-3: Election of Farmer Organizer (FO)

Each FWUG will have one representative who is called FO. The role of FO is to organize his FWUG into SC FWUC and collect opinion /information of farmers and record it. At this step, every FWUG should elect one FO. For the smooth election, the project office should assist coordinators and farmers in organizing meetings and electing FOs. The roles of coordinators elected at Step-1 will be over. The project office should provide training to groups of elected FOs on on-farm development, etc.

Step-4: Formation of SC FWUCs

There will be six SC FWUCs in total, which will be under one Apex Committee of FWUC of USP. SC FWUC will cover an irrigation area of about 580 ha on average, ranging from 770 ha to 295 ha. Each SC FWUC will have members consisting of one chairman, one vice-chairman, one accountant, one warehouse manager, one SO (Scheme Operator) and FOs. The SO is the person who will manage O & M of a secondary canal. At this step, FOs should elect these members through ballot to form a SC FWUC Committee. SC FWUC Committee should prepare a list of Committee members and member farmers including cadaster. Also SC FWUC Committee will issue provisional membership cards to all the prospective member farmers through FOs.

Step-5: Formation of Apex Committee and Start of Participation to Construction Works

Out of the 12 committee members who consist of six chairmen and six vice-chairmen of the six SC FWUCs, two will be elected as chairman and vice-chairman of the Apex Committee. Then, they will also elect a secretary and an accountant for Apex Committee.

Prospective member farmers will participate in the construction works of USP as a worker of a contractor on the condition that they pay or deposit a part of the earnings to the Apex Committee of the FWUC for providing funds for the initial operation of the FWUC.

Step-6: Preparation and Finalization of Draft FWUC Statute

In order to register a FWUC to the Government, the Apex Committee should draft the statute of FWUC in accordance with the draft sub-decree on FWUC prepared by MOWRAM. The draft should be discussed by each SC FWUC and finalized by the Apex Board based on the six SC FWUCs comments. The project office should assist the Apex Board in finalizing the statute.

Step-7: Final Ratification of FWUC Status

The Apex Board should draft documents for ratification of FWUC status. The project office will assist the Board in drafting and finalizing the documents.

Step-8: Registration of FWUC

With the above steps, the formation works of the FWUC will be finished. The Apex Committee should apply to MOWRAM for registration through the local DWRAM in order to establish the legal status of the FWUC. FWUC should secure recommendation from MOWRAM and make an agreement with MOWRAM after the project office reviews the statute and formation documents. DWRAM will transmit such documents to the District Authority and the Provincial Governor who will proceed to the formal approval and transmit them to MOWRAM. MOWRAM will provide the registration of the statute and transmit it to DWRAM. DWRAM will issue the approved statute and a certificate of registration.

The steps of formation and the schedule of formation are shown in Fig. IV-5.4.2 and Fig. IV-5.4.3, respectively.

(2) Formation of FWUC of SRP

Ang 160 SRP will irrigate about 25 ha of 130 families. Each farm plot size is about 0.19 ha on average. Kim Sei SRP will irrigate about 27 ha of 37 families. Each farm plot is about 0.73 ha. The irrigation area and type of canal is less than the minimum unit of FWUC of USP. The formation of a FWUG level committee for the two SRPs is proposed as follows:

Step 1: Meetings at village level should be held by DWRAM to launch the project. In the meetings, DWRAM should inform the farmers of, i) an outline and objectives of the project, ii) the irrigation plan, iii) the irrigation area and the boundary, iv) the formation process of FWUG and required activity, v) the rights and duties of FWUG, etc. At the same time, DWRAM should obtain consensus on the land necessary for construction of small canals, which will be provided by farmers for free.

Step 2: Prospective members of the FWUG should elect a chairman, an accountant

and farmer organizer (FO). The chairman and the accountant will also act as a dispute coordinator. They make a list of members of FWUG and cadaster.

Step 3: The formation process of FWUG is the same as that of FWUC of USP. FWUG of SRP should draft the statutes and documents for registration with DWRAM's support.

Step 4: In parallel with the formation, DWRAM should train members of FWUG on technical and administrative matters. The period necessary for the formation of FWUG will be 8 to10 months. The organization of FWUG is shown in Fig. IV-5.4.4.

IV-5.5 Institutional Development and Capacity Building Program

(1) General

There are three priority projects, i.e. USP, SRP and PDP. The USP will need institutional development and capacity building. the SRP and PDP also need it, but MOWRAM and DWRAM have the capacity to assist and advise farmers how to carry out institutional development and capacity building for SRP and PDP. Therefore, this Section mainly deals with institutional development and capacity building for USP.

In order i) to smoothly organize FWUC, ii) to conduct financially and technically sustainable operation of FWUC, and iii) to finally increase farm income, institutional development and capacity building program for USP is a must.

This program is to cope with the constraints and problems described in Section IV-1.5 and considering the present capacity of DRWAM. For this, it is proposed that MOWRAM deploys experts of institutional development and capacity building for six (6) years. Two steps are proposed for the implementation of the program. Firstly, the deployed experts will provide training to the project office staff. Secondly, the trained project office staff will give training to farmers and FWUC staff.

The program for the capacity building of the project office staff consists of the following two categories:

1) Planning and design for 1.5 years at design stage and construction supervision of irrigation facilities for 2.5 years at the construction stage.
2) FWUC and its related works, such as FWUC formation and its process, on-farm development necessary for USP, management of FWUC, O & M of irrigation facilities, marketing, farming practice, etc for six (6) years in total from design stage to initial operation stage.

The general concept of institutional development and capacity building is shown in

Fig. IV-5.5.1. The institutional development and capacity building schedule is shown in Fig. IV-5.5.2.

(2) Program to project office

For the institutional development and capacity building for project office staff, the following experts are proposed based on the anticipated constraints and problems described in Sub-Section IV-1.5, in due consideration of the difficulty of FWUC formation, on-farm-development, O & M of irrigation facilities and marketing:

- FWUC Expert (Foreign & Local)
- Irrigation OM Expert (Foreign)
- Participatory On-farm Development Expert (Foreign & Local)
- Farm to Market Organizer (Foreign)
- Accountant (Local)
- Legal Officer (Local)
- Marketing Expert (Local)
- Agronomist (Local)

The experts will provide training to the project office staff assisting them to prepare the following manuals and guidelines necessary for the training farmers and FWUC staff:

- Guideline for FWUC formation
- Management manual of FWUC
- Guideline for on-farm development
- Manual of O & M of irrigation facilities
- Manual of farming practices
- Guideline for marketing

In addition, the experts will prepare materials for farmer and FWUC training including the use of audio-visual equipment. The training subjects of the project office staff are shown in Table IV-5.5.1.

(3) Program to Farmers and FWUC Staff

The training program to farmers and FWUC staff consists of the following six (6) courses and numbers of trainees:

- FWUC and its formation to farmers (about 4,020 households)
- On-farm development to FWUC staff (72 persons in total)
- Management of FWUC to FWUC staff (22 persons in total)
- O & M irrigation facilities to FWUC staff (82 persons in total)
- Marketing to FWUC staff (10 persons in total)
- Farming practice (120 leader-farmers)

The training subjects on the above courses, breakdown of trainees and training period are shown in Table IV-5.5.2. The project design matrix for institutional development and capacity building for formation and operation of FWUC is shown in Table IV-5.5.3. The costs for institutional development and capacity building are estimated at Riel 10,153 million in total.

IV-5.6 Environmental Conservation Program

An environmental conservation program was prepared based on i) the existing condition in and around the priority areas, ii) characteristics of the priority projects, and iii) the results of the environmental assessment as mentioned in Section IV-8. As a result, it is recommended that the two (2) programs described below be integrated into the priority projects.

IV-5.6.1 Environmental Monitoring against Human-health Hazard

The objective of the program is to monitor the primary factors that would directly present a human-health hazard to allow avoidance steps to be taken if required. This program is composed of i) water quality monitoring, and ii) monitoring of conditions of water-borne diseases and agricultural inputs.

(1) Water quality monitoring

Water quality analysis should be carried out from the viewpoint of applicability on drinking water by the following manners.

1) Parameters to be analyzed or measured

- Temperature of air/water, flow rate, color
- Physico-chemical properties (pH, EC, TDS)
- Organo-chemical substances (NO_3-N, NO_2-N, NH_4-N)
- Micro-organisms (bacteria, coliform group)
- Inorganic ions (Na, Mn, Fe, Zn, Cu, Cl)

2) Monitoring stations

Proposed Monitoring Stations for Water Quality Analysis

Target area	Nos. of sampling points and their locations	
Slakou River *	2	Upstream of Tumnup Lok reservoir, and river at the bridge of Route No.3
Proposed irrigation area of USP	2	Drain ditches from irrigation area
	2	Ponds within the irrigation area
	2	Wells within the irrigation area
Proposed irrigation areas of SRP	2	Each drain ditch from Ang 160 and Kim Sei irrigation areas
	2	Each pond within Ang 160 and Kim Sei irrigation areas
	2	Each well within Ang 160 and Kim Sei irrigation areas
PDP area (Nhaeng Nhang)	2	Pond and well one each
Total	16	

*: Monitoring is recommended for collecting the baseline data.

3) Monitoring period and frequency

The monitoring should be conducted at least twice a year during the construction stage (dry season and rainy season), and at least once a year after the construction (rainy season).

4) Evaluation

Monitored values should be evaluated with reference to the related standard (WHO standard for drinking water, etc.). If a serious problem is recognized, proper countermeasures should be developed and implemented.

(2) Monitoring of conditions of water-borne diseases and agricultural inputs

Monitoring of conditions of water-borne diseases and agricultural inputs should be carried out, to collect the basic information regarding the likely changes to the risks of a serious public health hazard occurring.

1) Items to be monitored

- Condition of change in the incidence of water-borne diseases and the number of out-patients
- Condition and change of fertilizer utilization
- Condition and change of agro-chemicals utilization, if any

2) Methodology

- Interviews with staff of concerned agencies and organizations such as DAFF, DOH, and health-related NGOs, and reports from the extension workers
- Literature review and statistical analysis on the data and information compiled by concerned agencies and organizations

- Hearing from VDCs, FGs, and local farmers which exist in the proposed irrigation areas and around the new/renewed water bodies

3) Areas to be monitored

The priority areas of USP, SRP and PDP, including vicinity of the water-source facilities, should be fully covered.

4) Monitoring frequency

The monitoring should be conducted at least once a year.

5) Evaluation

The outcomes of monitoring should be evaluated from the viewpoint both of changes from the pre-construction stage and of the annual trend. In case that serious problem would be recognized, proper countermeasures should be developed and implemented.

IV-5.6.2 Affected Households Assistance (AHA)

The objectives of the program are i) to minimize the negative impacts on the households whose houses will be relocated or whose land-use status will be changed, and ii) to support land-affected households for attaining their former living standards. There will be two types of land-affected households by the implementation of the priority projects. One is the affected households of 'users of entitled property', who use the lands for cultivation or for building houses under the legal land-use rights. Another is the affected households of 'users of non-entitled property', who illegally use the lands or other property, such as reservoir areas or dikes, for cultivation or for building houses.

(1) Program for 'users of entitled property'

The most preferable manner of compensation for the users of entitled property is land-for-land compensation. However, there are no available lands near the priority areas, such as public lands, with which to apply this approach. Therefore, cash compensation is necessary for land-affected households of users of entitled property.

An AHA committee should i) adequately identify and evaluate the entitled property affected by implementation of the priority projects, ii) determine the unit rate for compensation on some types of affected property, and iii) prepare compensation amount. The compensation amount should be provided before the commencement of construction works, and restoration progress of the compensated households should be observed continuously.

(2) Program for 'users of non-entitled property'

The users of non-entitled property, such as the households who have house inside the reservoir or who cultivate lands inside the reservoir, are not entitled to be compensated because of illegality. However, for maintaining their living standards, the support and assistance should be provided, for example:

- No prohibition on the cultivation in the reservoir areas under their own risk control,
- Provision of agricultural extension services on the cropping practices such as receding paddy in the reservoir areas,
- Provision of displacement allowance for house relocation (taking structure apart, movement of materials, and rebuilding structure at new site), and
- Provision of the priority for the employment opportunities during the construction stage.

(3) Establishment of AHA committee

In order to facilitate the implementation of the above AHA program, an AHA committee should be established before the commencement of construction works. The committee should be composed of: an official of MOF (as chairman); officials of MOWRAM and DWRAM; officials of related agencies such as MAFF and MOE; chiefs of concerned provinces, districts, communes, and VDCs; project office manager; and designated staff in the project office. The main tasks to be performed by the committee are described in Sub-Section II-4.9 and Table IV-8.1.

IV-5.6.3 Implementation of the Program and Estimated Costs

The project executing body should assign a professional engineer to the project office who will be responsible for implementing and managing the environmental conservation program. The program should be implemented in close cooperation with the concerned agencies such as MAFF and MOE, for ensuring the effectiveness of the program.

The costs for the implementation of the program were estimated at Riel 15 million /year (US$ 3,744 /year) during the construction stage, and at Riel 7.5 million/year (US$ 1,872 /year) after construction, as shown in Table IV-5.6.1. In addition, The cost for AHA program was estimated at Riel 200.3 million in total (US$ 49,800).

CHAPTER IV-6 PROJECT IMPLEMENTATION SCHEDULE AND COST ESTIMATE

IV-6.1 Implementing Organization

(1) USP

Implementing organization of USP at design and construction stages is shown in Fig. IV-6.1.1. Prior to the implementation, a project office will be constructed independently along Road 33 in the USP Area at Angk Roka, Ta Phem Commune. The project office will be established under the direct administration of MOWRAM, and the headquarters of MOWRAM will appoint the project manager.

The project office will consist of four units, namely, administration, technical, FWUC and task force, in which 11 technical staff and 2 administrative staff will be assigned. As for office and operational equipment, a four-wheel drive vehicle, eight motorcycles, three walky-talkies, one generator, etc. will be procured.

1) Administration Unit

The administration unit will be responsible for payment of staff, paying for expenditures on the project, coordination and arrangement with related organizations and other administrative works.

2) Technical Unit

The technical unit will be in charge of the design and construction supervision. It will have a work booth in the construction site office (probably in O Saray or Trapeang Kranhung Commune) and the staff will work for the routine supervision of the construction works. In addition, they will work for FWUC formation with FWUC unit, by assisting farmers in setting the tertiary units and preparation of cadaster.

3) FWUC Unit

The FWUC unit will have five staff to assist farmers to assist FWUC by awareness creation, training and technical guidance to FWUC and member farmers.

4) Task Force Unit

Staff required for executing the supporting programs of USP by processes, such as environmental evaluation and monitoring, agricultural extension, etc. will be assigned to this unit.

After completion of the construction works, the "Technical Supervision and Assistance Unit" (Fig. IV-5.4.1) will be in charge of supporting the operation and maintenance works of FWUC for four years. Two senior engineers of MOWRAM and a senior expert from MAFF or other related sectors are expected to be assigned to this unit.

(2) SRP and PDP

Considering the development scale and past experience, the implementation of the SRP is proposed to be managed by DWRAM, Takeo as part of its routine work. Technical guidance, extension and support will be conducted in collaboration and coordination with other line agencies.

The PDP will be conducted as shown in Fig. IV-4.1.2 with technical support to Pond User Group (PUG) and management of PDP Fund by DWRAM, Takeo.

IV-6.2 Implementation Schedule

(1) USP

Construction works of USP will take place over a period of two and half years or two dry seasons (Fig. IV-6.2.1). Construction of the diversion and main canals will be completed in the first year, then the reservoirs, secondary canals and tertiary development will be conducted for the whole construction period. The construction works of the reservoirs, diversion and main canals will be contracted through international competitive bidding, while that of tertiary development will be contracted through local competitive bidding.

As for institutional development and capacity building, the initial three years will be spent for the preparation and support on establishment of FWUC, then intensive training program will be implemented from the last year of the construction. FWUC will have to take over the responsibility of operation and management of the whole irrigation facilities after completion of the construction works even getting technical support and guidance by the Technical Supervision and Assistance Unit for four years through on-the-job training.

(2) SRP and PDP

The two reservoirs of SRP will be constructed within one year, respectively. The construction works will be contracted through local competitive bidding. Project component would consist of the construction of the reservoirs and related structures except for irrigation facilities in the command area, which will be undertaken by FWUGs. Institutional development such as preparation and support of the FWUGs will be conducted prior to the construction, then technical guidance

on the construction of irrigation facilities will be performed to FWUGs. DWRAM and DAFF are intended to support FWUGs on water management, operation and maintenance of facilities, and farming practices as part of their routine work for four years as USP would do.

PDP will be implemented in three stages as proposed in the Master Plan, namely, Pilot Development Stage (Stage-1), Intensive Development Stage (Stage-2) and Self-supportive Development Stage (Stage-3), which would be performed over 10 years. Establishment of PUG will be supported in the first year, then two village extension workers who are supposed to be members of its Board will be trained in its operation and management and accounting of its Fund. In the second stage, three more extension workers will be trained. These village extension workers will be in charge of arranging the construction of other ponds, coordination with DWRAM and refunding of PDP Fund. The implementation schedules for SRP and PDP are shown in Fig. IV-6.2.2.

(3) RIP

Three routes of RIP will be constructed over two years. The construction works will be contracted through local competitive bidding. Design and construction supervision will be carried out by MRD (DRD) in the course of routine work.

IV-6.3 Cost Estimate

(1) Conditions for Cost Estimate

The project cost of the three main plans and one support program, namely the Upper Slakou River Irrigation Reconstruction Plan (USP), Small Reservoir Rehabilitation Plan (SRP), Small Pond Development Plan (PDP), and Rural Road Improvement Program (RIP) was estimated on the basis of the following conditions and assumptions:

1) Project cost was estimated for the best alternative of USP, Kim Sei and Ang 160 Reservoirs for SRP, 30 small ponds in Trapeang Snao Village for PDP, and 3 rural roads (total 23.62 km) for RIP.
2) Cost estimate refers to the prices as of October 2001.
3) Unit prices of labor, construction materials, engineering works, etc., were collected from MOWRAM and MRD.
4) Construction mode is on contract basis, and bidding of contractor is judged from work volume and technical requirements.
5) Project cost comprises 1) preparatory work, 2) direct construction cost, 3) O&M equipment, 4) institutional development, 5) relocation and land

expropriation cost, 6) administration cost, 7) consulting service and 8) contingencies.

6) Contingencies comprises physical contingency and price escalation, physical contingency of 10% of the Project cost is included.
7) Price escalation was evaluated based upon 2.5% per annum for foreign currency portion and 3.0% per annum for local currency portion.
8) Construction equipment is used on a rental basis for the O&M works.
9) The institutional development cost includes the cost for training, extension, and other supporting services identified in the supporting programs.
10) Conversion rate among Cambodian Riel, US Dollars (US$) and Japanese Yen (¥) was assumed at US$ 1.0 = Riel 4,022.20 = ¥ 120.53 (as of October 5, 2001).

(2) Cost Estimation

1) USP

(a) Project Cost

Total amount of the Project cost of the Plan is Riel 76,624.6 million as shown in Table IV-6.3.1 and summarized below.

Project Cost of USP

(Unit : million Riel)

Work Item	F/C	L/C	Total
1) Preparatory Work	2,484.9	846.3	3,331.2
2) Direct Construction Cost	30,633.5	14,238.0	44,871.5
3) O&M Equipment	156.7	10.3	167.0
4) Institutional Development	666.9	1,760.8	2,427.7
5) Relocation and Land Compensation Cost	3.3	197.0	200.3
6) Administration Cost	155.7	824.3	980.0
7) Consulting Service	11,921.7	623.5	12,545.2
8) Contingencies	8,358.0	3,743.7	12,101.7
Total	54,380.7	22,243.9	76,624.6

(b) Annual Disbursement Schedule

The annual disbursement schedule is worked out as shown in Table IV-6.3.2, based on the project implementation program described in Sub-Section IV-6.2 and Fig. IV-6.2.1.

(c) Replacement Cost

Some project facilities and equipment have a shorter economic life than project life and will require replacement during the proposed 50 years of the project life. The following table shows the economic life times and

replacement cost of the materials and equipment to be replaced.

Replacement Cost of USP

(Unit : million Riel)

Description	Economic Life Time	Replacement Cost
Office / Facilities	30 years	411.2
Gates	25 years	1,726.0
Steel Plate	10 years	45.4
Transportation Equipment & Generator	10 years	290.3
Administrative Equipment	8 years	39.5
Marketing Equipment	8 years	3.1
Wooden Stoplog	5 years	11.7

(d) Annual Operation and Maintenance Cost

The annual operation and maintenance cost of the project facilities includes the salaries of the staff for the Project office, staff of FWUCs, staff of marketing unit, material and labor cost for annual maintenance, the cost of operation, repair and maintenance of transportation equipment, and large scale maintenance by contract basis every five years. The estimated cost is Riel 193.0 million.

2) SRP

(a) Project Cost

The Project cost for Ang 160 reservoir system is estimated at Riel 223,706,000 and for Kim Sei reservoir system at Riel 250,661,000, giving a total Project cost of Riel 474,367,000. The details are shown in Table IV-6.3.3.

(b) Annual Disbursement Schedule

The annual disbursement schedule is worked out as shown in Table IV-6.3.4, based on the project implementation program described in Sub-Section IV-6.2. and Fig. IV-6.2.2.

(c) Replacement Cost

For the SRP, the materials and equipment that are to be replaced are for the intake gates only. The economic life time and replacement cost of each small reservoir is as shown in the following table.

Replacement Cost of SRP

(Unit : Thousand Riel)

Description	Economic Life Time	Replacement Cost
Gates for Ang 160 Reservoir	25 years	8,120
Gates for Kim Sei Reservoir	25 years	272

(d) Annual Operation and Maintenance Cost

The annual operation and maintenance cost of the project facilities includes the salaries, equipment, and materials for annual maintenance. The estimated costs are Riel 2,630,000 per year for Ang 160, and Riel 2,430,000 per year for Kim Sei.

3) PDP

(a) Project Cost

Total amount of the Project cost of the Plan is Riel 180,549,000 as shown in Table IV-6.3.5.

(b) Annual Disbursement Schedule

The annual disbursement schedule is worked out as shown in Table IV-6.3.6, based on the project implementation program described in Sub-Section IV-6.2. and Fig. IV-6.2.2.

(c) Annual Operation and Maintenance Cost

The annual operation and maintenance cost of the project facilities is labor cost for pond maintenance only. The cost is estimated at Riel 1,600,000 per year.

4) RIP

(a) Project Cost

Total amount of the Project cost of the Program is Riel 4,175,162,000 as shown in Table IV-6.3.7.

(b) Annual Disbursement Schedule

The annual disbursement schedule is worked out as shown in Table IV-6.3.8, based on the project implementation program described in Sub-Section IV-6.2.

(c) Annual Operation and Maintenance Cost

The annual operation and maintenance cost of the project facilities is annual maintenance work on an contract basis only. The estimated cost is Riel 14,000,000 per year.

CHAPTER IV-7 PROJECT EVALUATION

IV-7.1 Economic Evaluation

(1) Evaluation Procedures

All prices were expressed in constant prices as of October, 2001 applying the official exchange rate of US$ 1.0 = Riel. 4,022.20 = ¥ 120.53. The economic life of the project is assumed to be 50 years for USP, SRP and RIP, and 30 years for PDP, beginning from the year 2002.

Economic farm gate prices of traded agricultural inputs and outputs based on their export or import parity prices were applied and the long-run projected prices in 2005 at 2001 constant price were used in the analysis. The financial construction costs estimated in the feasibility study were converted into economic values using the construction conversion factors (CCFs).

(2) Economic Benefit

Irrigation and drainage benefit will accrue from an increase in cropping areas and productivity of target crops comprised of paddy, maize, soybean, mungbean, groundnut, sesame, and vegetables based on the feasibility study. The irrigation and drainage benefit (increment of NPV) for USP, SRP, and PDP was estimated as follows:

Economic Irrigation and Drainage Benefit, Feasibility Study

Project	Project Area (ha)	Cropping Intensity (%)		Net Production Value (Riel Million)		
		Without Project	With Project	Without Project	With Project	Increment
1. USP	3,500	96	130	3,068.8	9,977.3	6,908.5
2. SRP						
Kim Sei	27	100	100	23.2	55.6	32.4
Ang 160	25	120	120	27.1	58.9	31.8
3. PDP	5.82	97	128	5.1	18.8	13.7

The increase in the volume of transportation will be different between with and without USP because of the increase in agricultural production and farm inputs. Based on the future traffic volume and number of passengers, and transportation cost savings, the rural road improvement benefit was estimated as follows:

Economic Rural Road Improvement Benefit, Feasibility Study

Year	Without USP		With USP	
	Goods (ton)	Passenger (persons)	Goods (ton)	Passenger (persons)
2005	14,130	140,560	14,130	140,560
2030	15,810	236,910	34,780	359,810
2050	17,950	359,700	40,580	546,310
Year	Transportation Cost Savings (Riel '000)			
	Financial	Economic*	Financial	Economic*
2005	618,510	439,140	618,510	439,140
2030	777,560	552,070	1,335,900	948,490
2050	980,380	696,070	1,689,570	1,199,590

Note : * Ajusted with CF of 0.71

Existing farmlands will be acquired and used for the construction of irrigation and drainage facilities. The agricultural production foregone, defined as the annual net production value without project, was accounted for as negative benefit in the evaluation as follows:

Negative Project Benefit for Irrigation and Drainage Project
Feasibility Study

Project	Farm Land (ha)	Forgone Amount (Riel Million)
1. USP	60.0	52.60
2. SRP		
Kim Sei	0.2	0.18
Ang 160	0.1	0.09
3. PDP	0.4	0.37

(3) Economic Cost

The economic project investment cost was estimated by applying relevant conversion factors to the components of financial foreign and local currency cost. The total economic project investment cost of the respective projects for USP, SRP, PDP and RIP was estimated as follows:

Economic Investment Cost, Feasibility Study

Project	Project Area (ha)	Investment Cost (Riel Million)	Cost Per ha (Riel '000)
1.USP	3,500	55,180.2	15,766
2.SRP			
Kim Sei	27.0	184.6	6,837
Ang 160	25.0	169.1	6,764
3.PDP	5.82	111.3	19,124
4. RIP	23.62 km	3,074.2	130,151/km

The financial O&M and replacement costs were converted to economic value, the same as the project investment costs, and accounted for in the project evaluation.

(4) Economic Evaluation

The economic cost and benefit stream comprising (i) the cost of project investment, O&M and replacement, and (ii) irrigation and drainage, road improvement, and negative benefit was prepared for the economic life of the respective projects for USP, SRP, PDP and RIP. The economic internal rate of return (EIRR) and other indicators were calculated as follows:

Economic Efficiency of the Projects, Feasibility Study

Item	USP	SRP		PDP	RIP
		Kim Sei	Ang 160		With USP
EIRR (%)	10.2	13.7	14.5	8.7	18.8
NPV (Riel Million) (6.5% discount rate)					
Benefit	73,660	410	404	105	11,551
Cost	47,535	207	196	87	2,773
B - C	26,125	203	208	18	8,778
B / C	1.5	2.0	2.1	1.2	4.2

The sensitivity of USP, SRP, PDP and RIP to adverse economic changes was tested. In general, USP and SRP are insensitive to increasing cost and decreasing benefit, while PDP is sensitive, especially to decreasing benefit. A decrease in benefit will affect the economic viability of all projects more than an increase in cost.

IV-7.2 Financial Evaluation

(1) Farm Budget Analysis

A farm budget analysis was made by assuming the change in income and expenditure for the respective average size of farm operation in the USP, SRP and PDP areas. The household income was estimated to increase by 99% for USP, 14 to 34% for SRP and 16% for PDP. The future net reserve of the farm households under with project condition is expected to increase, specifically at the USP area. Because SRP and PDP can irrigate a part of the agricultural land operated by farmers, the financial impact on the farm economy of those areas will be limited. The future livelihood situation under the without and with project conditions was summarized as follows:

Farm Budget Assessment, Feasibility Study

(Unit : Riel '000)

Item	USP	SRP		PDP
		Kim Sei	Ang 160	
Average Size(ha)	0.87	1.33	1.10	1.15
Without Project				
Income	875.5	1,502.2	1,034.7	1,065.6
Expenditure	866.2	1,330.2	983.7	961.7
Net Reserve	9.3	172.0	51.0	103.9
With Project				
Income	1,746.0	2,017.7	1,184.4	1,239.2
Expenditure	1,033.9	1,459.5	1,023.2	978.3
Net Reserve	712.1	558.2	161.2	260.9
Increase (%)				
Income	99	34	14	16
Expenditure	19	10	4	2
Net Reserve	7,557	225	216	151

(2) Capacity to Pay for O&M Cost

The annual requirement of O&M cost of the respective projects by the average scale of farm operation was estimated and compared to the respective increment of net income. The O&M cost requirement will be below 10% of the increment of net income for USP and PDP and below 15% for SRP as follows:

O&M Cost Requirement and Share to Net Reserve, Feasibility Study

Project	Average Size (ha/F.House)	Increment of Net Reserve (Riel '000 /F.House)	O&M Cost (Riel '000 /F.House)	Share to Increment of Net Reserve (%)
1.USP	0.87	702.8	48.1	7
2.SRP				
Kim Sei	1.33	386.2	47.0	12
Ang 160	1.10	110.2	13.4	12
3.PDP	1.15	157.0	12.1	8

(3) FWUCs' O&M Activities and Management of USP

After completion of the project construction works, FWUCs and their Apex organization will operate the facilities comprising the irrigation facilities, the FWUCs' depots and offices, the Apex office, and the assembling market. The income for FWUCs will be the irrigation service fee (ISF), income accrued from the storage of paddy paid as ISF, market charge paid by the farmers and buyers, and trade income from sales of the members' products at the terminal markets. The expenditure comprises the personnel cost of FWUCs, the operation and maintenance cost for the facilities, and their replacement cost.

Based on the ISF rates set at Riel 40,600/ha (equivalent to the value of 140 kg of paddy) for wet season paddy and diversified crops, and at Riel 76,500/ha (264 kg of paddy) for dry season diversified crops, the cash flow for irrigation O&M activities

was prepared and assessed. The annual O&M cost for the irrigation facilities could be covered by 80% of the ISF collected, while the replacement cost for irrigation facilities, offices and equipment need to be subsidized by the government from the 6th-year of operation. If the cost of replacement is paid by the beneficiaries, the ISF rates will be set as follows:

ISF Requirement for Replacement, Feasibility Study

Item	Original Rate		Replacement by ISF Savings			
	80% ISF Collection		100% ISF Collection		80% ISF Collection	
	Paddy (kg/ha)	Amount (Riel/ha)	Paddy (kg/ha)	Amount (Riel/ha)	Paddy (kg/ha)	Amount (Riel/ha)
Wet season						
Paddy	140	40,600	174	50,482	218	63,103
Div. Crops	140	40,600	174	50,482	218	63,103
Dry season						
Div. Crops	264	76,500	328	95,120	410	118,900

Taking the achievable ISF collection efficiency of 80% into consideration, the ISF rates of 218 kg of paddy/ha and 410 kg of paddy equivalent/ha for wet and dry season crops, respectively are considered as unrealistic for the USP management. The total ISF payment for 0.87 ha of average operation size will be around Riel 79,000/year, which accounts for 11% of the increment of net income under with project condition.

To supplement the deficit to cover the cost of replacement, the USP requires FWUCs' marketing services for the farmer beneficiaries. The cash flow for marketing services was independently prepared taking revenue from market charge and trade income, and all O&M expenditure for the activities. The marketing services are financially sustainable at around 30% of gross revenue reduction. The net income from the marketing services will be saved for the replacement of irrigation facilities and FWUCs could be financially sustained. Under the 80% of ISF collection efficiency at 140 kg and 264 kg of paddy for wet and dry season crops, respectively, around 15 % of gross revenue reduction in the marketing services will be breakeven for the entire management of FWUCs.

IV-7.3 Indirect Benefits and Socio-Economic Impacts

(1) Self-sufficiency of Rice in the Project Area

The annual increment of rice production by the USP, two SRPs and PDP projects will be around 6,100 ton of paddy and 4,000 ton of rice under with project condition. This increment of rice production will be an additional supply to reduce the deficit of local rice demand.

(2) Vegetable Production and Foreign Currency Savings

Vegetable in the project area is produced mainly for home and local consumption at present. After implementation of the projects, the annual increment of vegetable production will be around 3,500 ton, which is equivalent to Riel 2.4 billion (US$ 0.6 million) at the farm gate value. Future vegetable production by the projects will substitute vegetable importation from neighboring countries.

(3) Improvement of Rural Accessibility

The USP will provide 44.7 km of inspection road along the secondary canals. These roads will effect the local economy through directly by reducing the transportation cost and also by saving time for transportation and minimizing post harvest losses, etc.

(4) Increase in Employment Opportunity

The projects will generate additional employment of around 134 thousand person-days annually for the farming activities. In addition, construction labor for USP will be around 303.8 thousand person-days in total. During the construction period of 21 months from 2003 to 2005, around 580 persons will be deployed daily on average. These additional employment opportunities will reduce the present unemployment, especially in the lean production season. The labor for the project construction will be supplied mainly from the beneficiaries of the projects.

(5) Promoting Rural Industry

The agro-industry and agri-related service sectors will be activated by value adding to the crop products and enlarging the trade in farm inputs. The project effects on the local economy, including industry and services, are considered significant.

CHAPTER IV-8 ENVIRONMENTAL ASSESSMENT

IV-8.1 General

As concluded in Section II-5, the environmental impacts caused by implementation of the priority projects will not be serious as a whole. However, it is preferable to minimize the likely negative impacts in order to make the priority projects environmentally sound and sustainable. Thus, the environmental assessment of the priority projects was preliminarily conducted for integration of desirable mitigation measures and monitoring framework into the priority projects.

IV-8.2 Impact Prediction and Assessment

(1) Environmental Elements to be Assessed

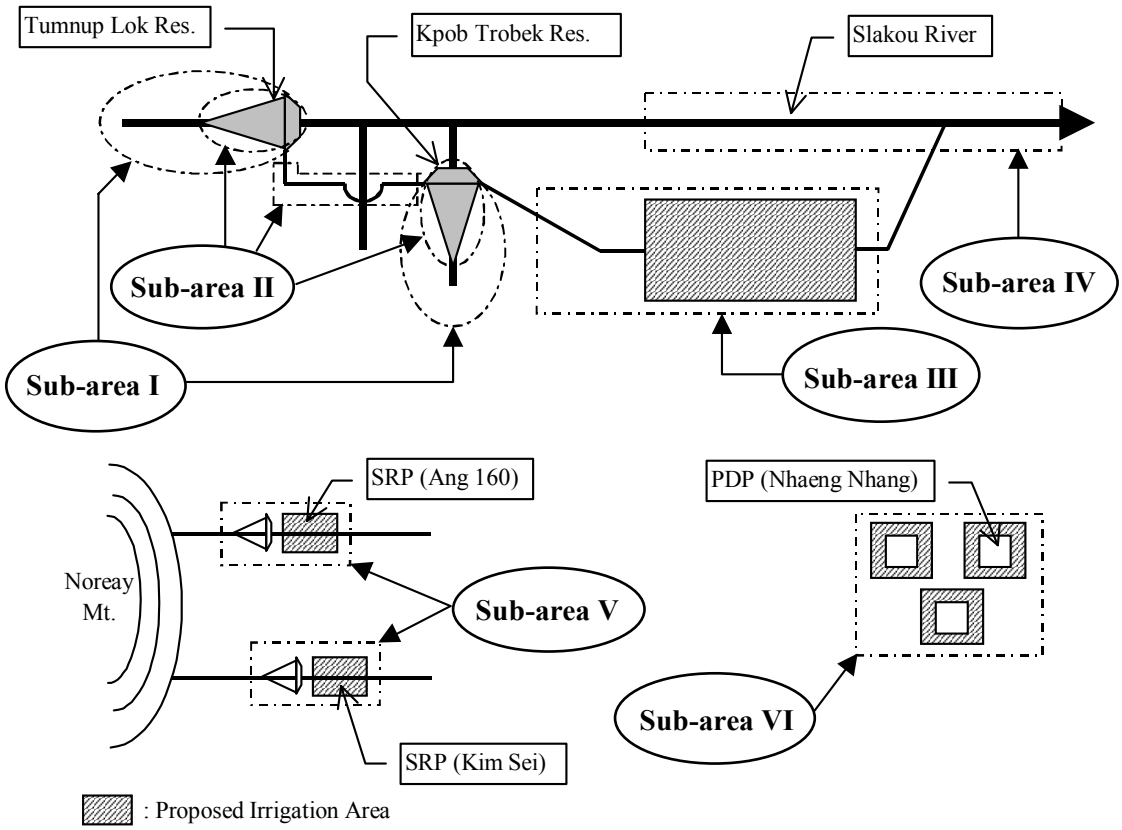
The following issues, which the IEE revealed as likely negative impacts, were studied from available data and information.

- Deterioration of the water-related environment
- Social impact of relocation and land expropriation
- Degradation of forest resources

(2) Environmental Sub-areas of the Priority Areas

Taking into consideration the general features of the priority projects and likely negative impacts recognized in Section II-5, the priority areas can be broadly divided into the following six sub-areas, in order to facilitate i) determination of the extent and magnitude of impacts, and ii) implementation of mitigation measures and monitoring framework.

- Sub-area I: Catchment areas of Tumnup Lok and Kpob Trobek reservoirs
- Sub-area II: Inundation areas including the proposed dam sites of Tumnup Lok and Kpob Trobek reservoirs, and diversion canal
- Sub-area III: Proposed irrigation area of USP including main and secondary canals
- Sub-area IV: Downstream of the Slakou River
- Sub-area V: SRP areas (Ang 160 and Kim Sei)
- Sub-area VI: PDP area (Nhaeng Nhang)



Environmental Sub-areas of the Priority Areas

(3) Impact Prediction and Assessment

1) Degradation of forest resources (Sub-area I)

It seems that dense tropical forests still widely cover the mountainous areas in the uppermost catchment areas of the reservoirs. On the other side, in the catchment area near the provincial boundary between Takeo and Kampot, and in Noreay Mountain, the exploitation of forests by local people is frequently observed, although the actual activities and their extent are unknown at present.

Implementing the priority projects without having completely secured access to the catchment areas would be risky because this might result in further encroachment into remaining forest areas. There would be potential risks of increased erosion and changes in the patterns of runoff to and sedimentation in the reservoirs.

2) Relocation of houses (Sub-area II, III, V)

Relocation of houses legally built by local people will be negligibly small, because of following reasons.

i) Regarding the reconstruction of the two reservoirs in Sub-area II, the toe ends of the dike slopes facing outside-reservoir will be designed to be within the existing lots.
ii) The rehabilitation and reconstruction of main / secondary canals in Sub-area III / V, will be within the existing lots.
iii) Improvement of rural roads will also be designed within the existing lots.

The above design policy for reconstruction/rehabilitation of existing facilities will minimize the magnitude of relocation of existing houses outside of reservoir areas. However, if any such houses should be relocated, adequate compensation and support should be provided for resettling and restoring the living conditions of land-affected households.

About 40 houses, which were built in the 1980's according to the local people, exist inside the Kpob Trobek Reservoir area. Although these houses are located at a higher elevation than HWL (37.3 m), it is preferable not to leave them there after the completion of the project, because there is a possibility of damage from an unexpected flood and because the area is State-owned. It is better to urge them to move the houses with some support for the expense of movement.

Seven (7) small shops are located on the west portion of the dike of Kpob Trobek Reservoir. These shops should be removed because of illegal occupancy. Although, according to the chief of O Saray commune, the owners of these shops have other permanent houses outside the reservoir area, some support towards the cost of moving should be provided if requested.

The reconstruction of Tumnup Lok Reservoir will cause the relocation of about 15~20 houses that are located in the reservoir area near the north-end of the dike. Some support for the cost of movement should be recommended for those who must relocate their houses, since the elevation at these houses are lower than the HWL (41.3 m).

3) Land expropriation (Sub-area II, III, V)

Expropriation of lands legally used by local people will be negligibly small for the same reasons mentioned in '2) Relocation of houses'. However, adequate compensation and support should be provided to the land-affected households, if any, in the same manner as for house relocation.

The cultivation activities inside the reservoir areas and canal bed in Sub-area II are observed in approximately 50 % of Kpob Trobek Reservoir area (about 90 ha) and approximate 80 % of Tumnup Lok Reservoir area (about 120 ha). In Sub-area V, 70~80 % of small reservoir areas are under cultivation. Since these cultivation

activities are illegal, they are not entitled to be compensated. However, some of households who cultivate lands inside the reservoir areas are recognized and most of them are the socially weak. For example, more than 10 households that use the Tumnup Lok Reservoir area are widow-headed according to the interview to chiefs of concerned communes. In the Kim Sei small reservoir, one household, at least, also has no choice but to utilize the reservoir area because of no possession of land outside. Therefore, proper countermeasures and/or support will be necessary to maintain their living standard.

4) Deterioration of the water-related environment (Sub-area II, III, IV, V, VI)

A quantitative assessment on probable water quality change is inappropriate due to a lack of data on the existing conditions. However the water quality contamination in Sub-area IV and its downstream caused by the priority projects will not be serious from the long-range viewpoint, because

- The cultivation in the priority areas will be conducted in the rainy season, as it is as present. It is expected that the water volume of the Slakou River and of the reservoirs located downstream of and outside the priority areas is enough to dilute the additional pollutant load produced from the priority areas in the rainy season; and
- The return flow from the proposed irrigation area in Sub-area III to the Slakou River is limited, since some portion of Sub-area III descends topographically southeastward.

On the other side, the water is generally used both for irrigation and for drinking or domestic purposes in the priority areas. Proposed irrigated agriculture is basically in the rainy season, and the rainfall in/around the proposed irrigation areas will contribute somewhat to the dilution of the additional pollutant load of agricultural inputs. However, there might be a possibility that the local people in/around the proposed irrigation areas would suffer from more contamination of drinking water than at present. For example, water with a high concentration of nitrogen is not suitable for drinking since it might cause health problems, particularly for infants. Therefore, attention should be paid to this aspect.

The risk of water-borne diseases might increase due to the appearance of new or renewed water bodies in Sub-area II, III, V, and VI. According to the information from AMDA – Ang Roka Health Project office, which covers the Tram Kak District as their jurisdiction area, malaria is very common but limited to the vicinity of the Noreay Mountain range. New/renewed water bodies would not cause a drastic increase in risk because of adequate separation in distance of the mountain range and

water bodies. However, the statistical data compiled by the AMDA Project from January to September in 2001 indicates that the number of out-patients of malaria in the rainy season is more than twice as many as in the dry season. This suggests that the expansion of water bodies would increase the risk of infection. Therefore, careful monitoring will be required.

II-8.3 Mitigation Measures and Monitoring Framework

Based on the Master Plan study and the environmental assessment mentioned in this chapter, the overall mitigation measures and monitoring framework are proposed in Table IV-8.1. Among these four (4) programs, the following programs and activities are recommended for implementation of the priority projects, taking into consideration their importance and urgency.

- Environmental monitoring against human-health hazard
- Land-affected households assistance

The other proposed programs and activities should be taken as a long-term scheme in close co-operation with related agencies and organizations to ensure environmentally sound development.

II-8.4 Conclusion

Some of likely negative impacts on environment were pointed out through the IEE and this environmental assessment. However, their magnitude is not serious and most of them can be mitigated/minimized by the proposed countermeasures. Therefore, the priority projects are judged to be acceptable from an environmental viewpoint.

CHAPTER IV-9 RESULTS OF PARTICIPATORY RURAL APPRAISAL WORKSHOPS

IV-9.1 General

"Participatory Rural Appraisal Workshops (PRA Workshops)" were conducted in the priority areas on a sub-contract basis. The purposes of the workshops were i) to explain the draft Feasibility Study Plan to beneficiaries, local government officers and NGOs, ii) listening to opinions of these same stakeholders groups, and iii) confirmation of acceptability of the Plan to stakeholders.

Ten (10) workshops were conducted during the period of two (2) days of December 5 and 6, 2001; nine (9) with farmers or beneficiaries including commune and village (vice-) chiefs, and one (1) with NGO and related local government officers. The workshops were operated by facilitators who were well-trained by the Study Team prior to the workshops. The Study Team members joined all the workshops as observers.

The farmers or beneficiaries and village (vice-) chiefs were selected from villages covered by the proposed three (3) plans (USP, SRP and PDP) of the draft Plan. The commune (vice-) chiefs were also selected from communes covered by the proposed three (3) plans.

IV-9.2 Participants

The participants for the workshops were 140 persons in total. The number of participants for each workshop was around 14 on average. The categories of participants are shown below.

Categories of Participants for the PRA Workshops

Categories of Participants	Nos. of Participants	Remarks
Beneficiaries	111	
Village chief*	48	Chief and vice-chief
VDC president*	31	President and vice-president
Farmer	53	
Commune chief	23	Chief, vice/third chief, and secretary
Local Government officer	7	DOWRAM, DAFF, PRDC and DOE
NGO	2	OXFAM
Total	140	

Note *: Some village chiefs are VDC presidents concurrently

Profiles of Participants for the PRA Workshops

Profiles		Remarks
Nos. of commune	6	All related communes are included.
Nos. of village	34	All related villages are included.

Note: All village chiefs in the priority areas participated in the workshops

Participants for the PRA workshop selected from local government offices, and related NGOs acting in the priority areas were PRDC, DAFF, and DOE (Department of Environment, Takeo), and OXFAM Australia.

IV-9.3 Beneficiaries' Opinions on the Draft Feasibility Study Plan

Participants of the workshops accepted the draft Feasibility Study Plan as a whole. Some requests and opinions were given at the workshops. The outstanding opinions which do not always mean the majority, are summarized below:

(1) Beneficiaries' Contribution to Construction Works

Facilitators asked participants whether or not they could participate in rehabilitation works of the reservoirs and canals (main, secondary and tertiary canals) without payment. All the participants understood that the rehabilitation of reservoirs and canals are indispensable to secure irrigation water and also that beneficiaries' contribution is significant. Finally, they agreed to work for the rehabilitation works on condition, and the following different conditions were given:

- Long-term engagement for rehabilitation works without payment is impossible because most of the farmers need to work to support their family even in the dry season.
- Short-term (2 to 5 days/month) engagement without payment will be possible.
- Payment to farmers is necessary if they work for long-term work.
- The wage proposed by farmers is about Riel 4,000 /day on daily basis, or Riel 2,500□3,000/m^3 according to work volume.
- Even for the short-term work without payment, some incentive to work is preferable, such as 2 kg of paddy/m^3 according to work volume.
- They agreed to deposit a part (around 10 %) of wages to FWUC and/or FWUG as initial working funds for the first year of management of the FWUC and/or FWUG (one year maximum).
- As all the participants think construction of watercourses will be a short-term exercise, they agree to construct them by themselves without payment. They wish technical advice from MOWRAM /DWRAM Takeo.

(2) Provision of Land for Canals and Roads

Facilitators asked participants whether or not they could provide a part of their land necessary for construction of canals and road.

- There is no substitute of agricultural land in the priority areas and neighboring area. Therefore, sharing of their land among beneficiaries will be necessary.
- It will be possible to compensate the land loss by substitute of their land or money. All the beneficiaries in the community will share such loss.
- Provision of land for construction without any compensation will be possible if the percentage of land loss is small.

(3) Inspection Road and Temporary Road for Construction

- They want to use inspection road as community road after rehabilitation and/or construction of canals. Laterite surfacing proposed by the draft Plan is appreciated.
- They will compensate the land loss by substitute of land or money within community.
- They agree to allow MOWRAM / DWRAM and/or contractor(s) to use their land as temporary road for construction and access road without any compensation if the usage is in dry season.

(4) Formation of FWUC/FWUG

- All the participants of USP agree to form a FWUC for USP, be members of FWUC, and obey decision of Apex Committee of FWUC.
- All the participants of SRP agree to form a FWUG under the present VDC, be members of FWUG and obey decision of FWUG.
- All the participants of PDP agree to form a FWUG under the present VDC, be members of FWUG and obey decision of FWUG. They expressed a need to get the agricultural extension service as VDC activities.

(5) ISF

- All the beneficiaries understand the necessity of ISF and its payment for irrigation to paddy and diversified crops.
- They agree to pay ISF proposed by the draft Plan.
- Most of them think that the proposed ISF rates are reasonable, namely 140 kg/ha of paddy for the rainy season, if the anticipated yield is attained.
- Some of them firstly disagree to pay ISF for dry season irrigation, because they use water in the canal at present. But, they finally decided to obey FWUC's decision.
- Some of them request that ISF for dry season irrigation should be the same price

or less than ISF for rainy season irrigation, because the volume of irrigation water for vegetable cultivation in the dry season is less than that for paddy cultivation in the rainy season.

(6) Agricultural Support Service

- All were pleased to hear that a credit service by FWUC at 2 %/month interest is proposed, because the interest rate is the same as that of the present VDC credit.
- Assembling and shipping of the diversified crops by the FWUC is indispensable because marketing of such crops by farmers is difficult.
- They need agricultural extension service, such as breed improvement, water management and fertilizer application for irrigated paddy and diversified crops cultivation.

(7) Cultivation inside the Reservoirs of USP

- All users of land inside the reservoirs of USP agreed to give up the present cultivation inside the reservoirs.
- One of owners of a grave inside the reservoir agreed to move it outside if the grave is submerged.
- One owner of a house located inside the reservoir thought it unnecessary to move his house because he was sure that it would not be submerged, since it is located higher than the water surface of the reservoir.

(8) SRP

- Some of them were, at first, worried that their neighbors might lose land located inside the small reservoir, as this would harm relationships among the villagers. They finally agreed to the rehabilitation work because it was shown that some area inside the reservoir is cultivable by delaying the cropping season.
- All of them agree to pay the proposed ISF because the proposed amount of ISF is reasonable if the anticipated yield is attained.
- Some of them requested that the proposed size of the small reservoir be increased by increasing the height of the dike by 1 to 2 m because they want to expand the irrigation area.

(9) PDP

- Some of them who have small land need a group pond and wanted to compensate the land for pond by cash to landowner(s).
- They cannot compensate the land for pond by substitute of land because member families' small lands are widely spread.
- Some of them request that the proposed capacity of group ponds should be bigger.

- They wish subsidy for PDP. Actual repayment by beneficiaries should be less than around 20 % of the construction costs.
- Some of them request wage (Riel 3,000□3,500 /m^3) if they have to work for pond construction because most of them are very poor and have to work to support their families even in the dry season.

(10) Opinions and Recommendations of Local Government Officers

- Some farmers may suffer from poverty during the construction period and in the first year of FWUC / FWUG operation if all the rehabilitation works and O & M of irrigation facilities are done by beneficiaries' labor without payment.
- No serious environmental negative impact is anticipated, but it is necessary as proposed in the draft Plan to conduct environmental monitoring and evaluation work during and after the construction works of the priority projects.
- The number of FWUC staff should be reduced to lower the ISF rate.
- Some beneficiaries may not agree to pay ISF for supplemental irrigation in the rainy season.
- One of the officers requested JICA to donate funds for PDP.
- Beneficiaries may prefer repayment of construction cost of PDP by labor to that by cash.

CHAPTER IV-10 CONCLUSIONS AND RECOMMENDATIONS

IV-10.1 Conclusions

The Master Plan Study aimed at formulation and selection of appropriate irrigation-based development plans in the area that will be model plans for other similar areas in Cambodia. The Study identified the following three irrigation-based development plans and five support programs from economic, financial, technical and environmental viewpoints at a preliminary level.

Irrigation Based Development Plans

1) Upper Slakou River Irrigation Reconstruction Plan (USP)
2) Small Reservoir Rehabilitation Plan (SRP)
3) Small Pond Development Plan (PDP)

Support Programs

4) Agriculture Production Program
5) Agriculture Support Programs
6) Rural Road Improvement Program (RIP)
7) Institutional Development Program
8) Environmental Conservation Program

The above support programs except for the rural road improvement program are closely related to the irrigation based development plans. Therefore, the following three irrigation development plans including the four support programs was selected as priority projects, and the Feasibility Study was conducted.

1) Upper Slakou River Irrigation Reconstruction Plan (USP: 3,500 ha)
2) Small Reservoir Rehabilitation Plan (SRP) at the following two sites;
   i) Kim Sei SRP (27 ha)
   ii) Ang 160 SRP (25 ha)
3) Small Pond Development Plan (PDP) in Trapeang Snao village, Nhaeng Nhang commune (5.82 ha)

The rural road improvement program (RIP) is characteristic of rather independence from three irrigation based development plans from viewpoint of economic and financial evaluation. Therefore, RIP was selected as priority projects in spite of support program and the Feasibility Study was conducted.

4) Rural Road Improvement Program (23.62 km) comprising;

i) Trapeang Thum Khang Cheung to Trapeang Kranhung (13.32 km),
ii) O Saray to Slakou river (4.14 km), and
iii) Kpob Svay road (6.16 km).

The USP covering the irrigation area of 3,500 ha has sufficient economic and financial viability. The magnitude of project impact to the local economy by increasing farm income and employment generation, creating paddy self-sufficiency in the area, and promoting rural industry is considered significant. The direct beneficiaries were estimated at more than 20,000 people, while indirect beneficiaries from the stable supply of paddy were estimated as more than the population of Tram Kak Distict, 144,000 people.

Kim Sei SRP and Ang 160 SRP indicated high economic viability. However the impact to farmer beneficiaries will be limited because the SRPs can irrigate only a part of the agricultural land, i.e. 27 ha for Kim Sei and 25 ha for Ang 160, operated by 37 and 130 farm households, respectively.

The PDP indicated affordable economic viability, but the magnitude of impact to the farm economy in terms of increment of net income was smaller than those of USP and SRP.

RIP has the highest economic viability. The economic impact to the upper area of the USP (1,477 ha of agricultural land) and outside area of influence (4,004 ha) covering the total households of around 4,400 in 2001 will be significant. The access road to Tumnup Lok reservoir of USP, one of the RIP routes, is very poor at present and needs to be rehabilitated for the effective implementation of USP. The development of the outside influencing area will also be accelerated by RIP. The direct beneficiaries were estimated at more than 20,000 people.

The above priority projects will not create any serious negative environmental impact except the requirement for relocation and land expropriation for USP, and slight deterioration of water-related environment mainly due to the increasing use of fertilizer in the future. The government efforts for reaching consensus among the affected people will solve this social environmental issue. The water quality deterioration needs periodical monitoring and evaluation by the concerned government agency.

Taking the above assessment into consideration, the priority project implementation needs to be initiated as early as possible. The early implementation is expected to promote early development of other similar potential areas in Cambodia, since the proposed priority project plans will serve as model plans. The implementation by

applying the model plans to other areas in Cambodia will contribute to increasing farm income and improving living standard, and ultimately to poverty alleviation in Cambodia, which is the final target of the Study.

IV-10.2 Recommendations

(1) Project Sustainability of USP

The project risk for USP will be the financial basis of O&M of the irrigation facilities as well as assurance of ISF collection. If the beneficiaries pay the cost of replacement, the ISF rates will be set unrealistically high. In order to minimize the beneficiaries' load to pay a high rate of ISF, FWUC needs to operate marketing assistance services to ensure markets of products and generate internal revenues through i) storage and sales of paddy collected as ISF, and ii) assembling and marketing assistance. The net income from the marketing services should be saved as a fund for the replacement of irrigation facilities, and FWUC could be financially sustained. The marketing assistance services will help RGC to reduce its financial burden for O & M of irrigation projects in Cambodia, once this approach is applied to other projects in Cambodia.

In addition to the project investment for direct construction cost, institutional development and capacity building for member farmers and staff of FWUC as well as that for the project office staff will be crucial. For this, it is proposed that MOWRAM deploys foreign and local experts for 6 years. Two steps are proposed. Firstly, the deployed experts will train the project office staff and secondly, the trained staff will train farmers and staff of FWUC. The assignment of such experts is a must for institutional development and capacity building.

The project office to be organized for USP will act as facilitator and supervisor to organize FWUC, to design the facilities and supervise the construction work by applying a participatory approach that will also transfer the technologies for O&M, farming and marketing to farmers and FWUC staff. The term of the project office will be initially limited to four years until the completion of construction work. From the 5th year, the project office will be transformed into the "Technical Supervision and Assistance Unit" in coordination with FWUCs' Apex Committee, and the Unit will assist FWUC in its management, O & M of the rehabilitated irrigation facilities, marketing assistance service and farming practice for the succeeding four years.

For institutional development and capacity building to farmers, and staff of FWUC, a participatory approach for the following subjects will be a key factor to encourage project ownership among the beneficiaries, and sustainable O&M participation :

- Participatory agricultural land registration and mapping for preparation of water users' list by tertiary canal,
- Participatory tertiary canal / watercourse alignment and layout of the facilities and coordination for agricultural land sharing and compensation among the tertiary canal users,
- FWUC formation and registration by member farmers,
- Management and accounting of FWUC by staff elected by member farmers,
- Participatory O&M of irrigation facilities, and
- Marketing assistance service for member farmers.

Without the above institutional development and capacity program, USP will not be a self-reliance system as a model project in Cambodia. Deployment of expert groups for i) design and construction supervision and ii) institutional development and capacity building is essential.

(2) Institutional Development Support to Beneficiaries of SRP

The technical and economical feasibility of Kim Sei and Ang 160 SRPs was verified and there are farmers' communities in the project areas. Early implementation of two SRPs was recommended. In order to ensure the SRP sustainability and prevent the same mistakes as previous investments, institutional assistance to the beneficiaries' communities by MOWRAM and DWRAM needs to be made in parallel with the construction investment.

(3) Creation of PDP Fund and System Formulation for Revolving Fund

The key issue for the implementation of the PDP was creation of an enabling fund and a system for formation for replication of capital investment to other villagers. An institutional system for a revolving fund collected from the individual and group beneficiaries needs to be prepared by the concerned agencies, such as DWRAM Takeo and DAFF Takeo. Both the PDP beneficiaries and other villagers need to be made aware of the government investment in the revolving fund created by beneficiaries prior to PDP implementation.

(4) Sustainability of SRP and PDP

Technical issues for O&M of the SRP and PDP schemes are limited to introducing new crops such as vegetables with farm guidance extension. Sustainability of SRP and PDP will fully depend on the beneficiaries' participation and performance in

meeting their obligations, such as payment of ISF and/or other charges. MOWRAM and DWRAM Takeo are expected to supervise beneficiaries of SRP and PDP and assist them in understanding project sustainability so that they can operate the projects by themselves.