Appendix L

Van Phong Weir and Irrigation & Drainage System

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Appendix L Van Phong Weir and Irrigation & Drainage System

1 GENERAL

1.1 Project Area for Irrigation Development

The project area is selected in the master plan as the irrigation development area under the Binh Dinh reservoir. The project area covers 37,400 ha of net irrigation area, consisting of:

i) 17,112 ha commanded by Van Phong Weir, and
ii) 20,245 ha commanded by the other schemes under Dinh Binh Reservoir along the Kone River.

The project area is further divided into the following 6 schemes:

Irrigation Schemes under Feasibility Study

Name of Schemes	Total Area	Irrigated	Rainfed
1. Van Phong Weir	**17,112 ha**	**3,299 ha**	**13,813 ha**
1.1 Van Phong Area	10,815 ha	299 ha	10,516 ha
1.2 Van Phong Extension Area	3,297 ha	0 ha	3,297 ha
1.3 Hoi Son Reservoir Area (La Tinh Basin)	3,000 ha	3,000 ha	0 ha
2. Other Schemes under Binh Dinh Reservoir	**20,245 ha**	**12,413 ha**	**7,912 ha**
2.1 Tan An – Dap Da	14,532 ha	12,413 ha	2,199 ha
2.2 Vinh Thanh etc. (along Kone river)	3,674 ha	0 ha	3,674 ha
2.3 Tan An Extension (Lower Ha Thanh Basin)	2,039 ha	0 ha	2,039 ha
Total	**37,357 ha**	**15,712 ha**	**21,725 ha**

1.2 Demographic Condition of the Project Area

Such statistical information as population, land and agriculture are compiled at the level of local administration units: wards, sub-towns and communes through identifying these units covering the project area.

Administratively, the project area falls under 57 units of wards, sub-towns and communes in Qui Nhon City and 6 districts of Phu My, Vinh Thanh, Phu Cat, Tay Son, An Nhon, Tuy Phuoc. The administrative area of the 57 units can be called as "the gross project area", and its total area is 1,630 km^2. The gross project area includes not only the project area of 37,400 ha in net irrigation area, but also the other lands of 125,600 ha surrounding the project area in the same administrative units.

According to the Population Census 1999, total population in the project area is estimated at 665,100 persons in 145,000 households at average family size of 4.6 members, as shown in Table L.1. Average population density is about 409 persons/km^2, consisting of

1,737 persons/km^2 in urban area and 352 persons/km^2 in rural area. The main demographic feature in the project area is shown below:

Present Demographic Condition of the Project Area (Population Census 1999)

District	Area (km^2)	Total	Male	Female	House-hold	Family Size	Density
Qui Nhon	24.49	34,700	16,800	17,800	7,000	5.0	1,417
Phu My	170.36	71,000	34,000	37,100	15,600	4.6	417
Vinh Thanh	128.52	10,600	5,200	5,400	2,300	4.6	82
Phu Cat	508.43	114,900	70,100	74,700	31,800	4.6	285
Tay Son	453.33	84,600	40,700	43,900	18,500	4.6	187
An Nhon	125.88	143,400	69,300	74,100	32,000	4.5	1,139
Tuy Phuoc	216.77	176,000	85,600	90,400	37,800	4.7	812
Total	**1,627.78**	**665,100**	**321,700**	**343,400**	**145,000**	**4.6**	**409**
Urban	66.16	114,900	55,600	59,300	24,700	4.7	1,737
Rural	1,561.62	550,200	266,100	284,100	120,300	4.6	352

Source: Population Census 1999, Binh Dinh Province.

The demographic feature in the project area shows the higher population density since about 45% of the provincial population and 27% of the provincial area are located in the project area. Qui Nhon City, the capital of Binh Dinh Province, is located in the project area and its main economic sector is industry and service sector, however, 96% of the project area falls in rural area, and the main economic activities of population is crop production sector.

1.3 Present Land Use

The present land use of the administrative units over the project area is presented in Table L.2 and summarized below:

Present Land Use of the Project Area (2000)

District	Agriculture Land	Forest Land	Special Use Land	Residence Area	Unused Land	Total
Qui Nhon	1,500 ha	100 ha	300 ha	100 ha	800 ha	2,800 ha
Phu My	7,400 ha	800 ha	1,700 ha	300 ha	6,800 ha	17,000 ha
Vinh Thanh	1,400 ha	5,400 ha	200 ha	100 ha	5,700 ha	12,800 ha
Phu Cat	16,600 ha	12,700 ha	4,600 ha	700 ha	16,400 ha	50,900 ha
Tay Son	11,000 ha	11,600 ha	2,100 ha	500 ha	20,200 ha	45,400 ha
An Nhon	7,800 ha	100 ha	1,800 ha	600 ha	2,400 ha	12,700 ha
Tuy Phuoc	11,100 ha	500 ha	3,400 ha	700 ha	6,000 ha	21,700 ha
Project Area	56,700 ha	31,200 ha	14,100 ha	3,000 ha	58,300 ha	163,100 ha
(Proportion)	34.8%	19.0%	8.7%	1.8%	35.7%	100.0%
Province	116,900 ha	193,700 ha	29,400 ha	6,400 ha	256,200 ha	602,600 ha
(Proportion)	19.4%	32.1%	4.9%	1.1%	42.5%	100.0%

Source: Data Set of Binh Dinh Land Use General Inventory in 2000, Land Office.

Unused land is the largest land use, representing 58,300 ha or 36% of the total area, situated on mountainous area, water surface, river & stream and rocky hills. Agricultural land is 56,700 ha (35%) extending on flat land to gentle slopes. Forest land is 31,200 ha (19%) is situated on slopes.

The land in the project area has been rather intensively utilized than the total province, since proportion in agriculture, special use and residence area is far higher than the province. On the contrary, proportion of such extensive use of forest and unused land is 55% in the project area far lower than 75% in the province. This tendency is also supported by the proportion in each land use of the project area against the province, as shown below:

Proportion of Each Land Use Item against Province (2000)

Area	Agriculture Land	Forest Land	Special Use Land	Residence Area	Unused Land	Total
Province	116,900 ha	193,700 ha	29,400 ha	6,400 ha	256,200 ha	602,600 ha
Project Area	56,700 ha	31,200 ha	14,100 ha	3,000 ha	58,300 ha	163,100 ha
(Proportion)	48.5%	16.1%	48.0%	46.9%	22.8%	27.1%

Source: Data Set of Binh Dinh Land Use General Inventory in 2000, Land Office.

Details of agricultural land use are summarized below:

Agriculture Land in the Project Area (2000)

River Basin	Annual Crops	Misc. Garden	Perennial Crops	Aqua-culture	Total
Qui Nhon	900 ha	100 ha	0 ha	400 ha	1,400 ha
Phu My	5,600 ha	1,100 ha	400 ha	400 ha	7,500 ha
Vinh Thanh	900 ha	100 ha	400 ha	0 ha	1,400 ha
Phu Cat	10,200 ha	2,200 ha	4,100 ha	100 ha	16,600 ha
Tay Son	8,400 ha	1,400 ha	1,100 ha	0 ha	10,900 ha
An Nhon	6,400 ha	1,200 ha	200 ha	0 ha	7,800 ha
Tuy Phuoc	8,900 ha	1,000 ha	200 ha	1,000 ha	11,100 ha
Total	**41,300 ha**	**7,100 ha**	**6,400 ha**	**1,900 ha**	**56,700 ha**
(Proportion)	72.8%	12.5%	11.3%	3.4%	100.0%

Note: Grassland is 4 ha in the project area, and not presented above.
Source: Data Set of Binh Dinh Land Use General Inventory in 2000, Land Office.

Out of 56,700 ha of total agricultural land, annual crop land is 41,300 ha or 73% of total agricultural land, of which paddy field is 29,400 ha and upland crops fields is 11,300 ha as shown below:

Annual Crop Land in the Project Area (2000)

River Basin	Paddy Field	Shifting Culture	Upland Field	Total
Qui Nhon	800 ha	0 ha	100 ha	900 ha
Phu My	3,300 ha	0 ha	2,300 ha	5,600 ha
Vinh Thanh	300 ha	0 ha	600 ha	900 ha
Phu Cat	7,300 ha	0 ha	4,100 ha	10,200 ha
Tay Son	4,400 ha	600 ha	3,400 ha	8,400 ha
An Nhon	5,400 ha	0 ha	1,000 ha	6,400 ha
Tuy Phuoc	7,900 ha	0 ha	1,000 ha	8,900 ha
Total	**29,400 ha**	**600 ha**	**11,300 ha**	**41,300 ha**

Source: Data Set of Binh Dinh Land Use General Inventory in 2000, Land Office.

The project area, 37,400 ha of net irrigation area, are mostly located within the existing paddy field and upland field of annual crop land. According to the list of irrigation schemes prepared by DARD, 15,700 ha of paddy field are presently irrigated within the available water sources. The remaining 21,700 ha are cultivated under the rainfed condition.

1.4 Cropping Season

Agro-climatic condition in the project area is illustrated in Figure L.1. Crop cultivation is carried out in thee cropping seasons, namely, i) winter-spring season (December to March), ii) summer-autumn season (April to June) and iii) third season (July to October).

The period from September to November is the rainy season, and more than 70% of annual rainfall is concentrated in this period. In October to November, more than 50% of annual rainfall occurs and causes the major flood in low-lying area along the rivers and the lower reaches in the Tan An – Dap Da area. Therefore, no crops are planted in these area during the two months.

Such agro-climatic condition as air temperature, rainfall and solar radiation in each crop season is presented below:

Agro-Climatic Feature in Each Crop Season (2000)

Crop Season	Winter – Spring	Summer – Autumn	Third Season
Temperature	Min. temp. in Dec. to Jan. sometimes recorded below 20°C. Crop growth suffers from the low temp.	Max. temp. during May to July is nearly 40°C. Due to hot wind in this period, unit yield of paddy decrease by 10%.	No particular problem identified.
Rainfall	Utilization of residual moisture after rainy season. Risk of late flood in low-lying area.	Risk of minor and early flood in low-lying area.	Harvest suffers from heavy rainfall. Flood damages in low-lying area
Solar Radiation	Solar radiation is low from Nov. to Jan. Maturity period should be late Feb onward.	High solar radiation is preferable for photo-synthesis.	Low solar radiation in Oct. and Nov. is to be avoided for grain maturing stage.

1.5 Cropped Area and Production

Tables L.3 to L.6 present the cropped area, production and unit yield of crops. The total cropped area is estimated at 95,300 ha, consisting of 89,600 ha of annual crops and 5,700 ha of perennial crops. Total cropped area corresponds to 48% of the province, as shown below:

Planted Area of Crops in the Project Area

	Paddy	Other Food Crops	Vegetables & Beans	Industrial Crop	Industrial Tree Crops	Fruit Trees	Total
Province	127,300 ha	14,100 ha	9,400 ha	19,700 ha	24,800 ha	4,100 ha	199,400 ha
(Proportion)	63.8%	7.0%	4.7%	9.9%	12.4%	2.0%	100.0%
Study Area	69,600 ha	6,000 ha	4,900 ha	9,100 ha	4,200 ha	1,500 ha	95,300 ha
(Proportion)	73.0%	6.3%	5.1%	9.5%	4.4%	1.6%	100.0%

Source: Estimation based on the Statistical Yearbook 2001, Binh Dinh Province and districts.

The project area is characterized as annual crop dominant area, particularly, paddy. This is due to topographic position that the project mainly located in low-lying area and alluvial plains along the Kone River and its tributaries.

Paddy cropped area in the project area is 69,600 ha, 55% of the province of 127,300 ha. Unit yield is 4.36 ton/ha, about 6% higher than 4.12 ton/ha of the provincial average. Accordingly, paddy production in the project area is 303,600 ton, 58% of the province (524,900 ton), as summarized below:

Paddy Production in the Project Area (average during 1999 to 2001)

Cropping Season	Winter-Spring	Summer-Autumn	3rd Crop	Total
Cropped Area	25,900 ha	22,300 ha	21,400 ha	69,600 ha
Unit Yield (range at district level)	4.36 ton/ha (3.65 – 5.78)	4.39 ton/ha (3.77 – 4.53)	3.44 ton/ha (2.56 – 3.90)	4.36 ton/ha (3.11 – 4.72)
Production	131,900 ton	98,000 ton	73,700 ton	303,600 ton

Source: Statistical Yearbook 2001, Binh Dinh Province and each District.

Based on the paddy cropped area and land use described in the preceding Section 1.3, the cropping intensity is estimated at 237% for paddy crops and 167% for upland crops. The total cropping intensity including perennial crops is 201% on average, as shown below.

Cropping Intensity of the Province (2000)

Crop / Season		Physical Area (A)	Cropped Area (B)	Intensity (A / B)
Paddy:	Winter-Spring Crop	29,400 ha	25,900 ha	88%
Paddy:	Summer-Autumn	- do -	22,300 ha	76%
Paddy:	Third Crop	- do -	21,400 ha	73%
Paddy:	Annual Total	- do -	69,600 ha	237%
Upland Crop:	Annual Total	11,900 ha	19,900 ha	167%
Perennial crop:	Annual Total	6,400 ha	5,700 ha	89%
Total		**47,100 ha**	**95,200 ha**	**202%**

Source: Estimation by the JICA Study Team using the statistical data mentioned in the preceding section.

The above table shows that cropping intensity of paddy field is less than 100% in each season. This indicates other annual crops have been planted in the paddy field. If it is assumed that 24% of paddy field (7,100ha) in Summer-Autumn season is planted for upland crops, the cropping intensity of upland field decreases to 108%.

Crop production for subsidiary crops and perennial crops in the project area is estimated according to the proportion of land use against the provincial total. Most of the annual crops are produced at more than 60% of the province except cassava and sweet potatoes, as shown in the following table along with the large production districts:

Production of Annual Crops in the Study Area

	Province	Project Area	Proportion	Main Districts of Production
Paddy	524,900 ton	303,600 ton	57%	An Nhon, Tuy Phuoc, Phu Cat
Maize	9,700 ton	6,300 ton	65%	An Hhon, Phu Cat, Tay Son
Cassava	100,700 ton	42,800 ton	43%	Phu Cat, Tay Son, Phu My
Sweet Potato	5,000 ton	1,600 ton	32%	Phu Cat, Phu My
Vegetables	89,100 ton	48,700 ton	55%	Tuy Phuoc, Phu My, Tay Son,
Groundnuts	12,400 ton	6,800 ton	54%	Phu My, Phu Cat
Soybeans	2,700 ton	1,900 ton	70%	An Nhon, Tuy Phuoc, Tay Son
Sesame	400 ton	220 ton	55%	Phu My, Phu Cat
Sugarcane	364,200 ton	129,300 ton	36%	Tay Son, Phu Cat, Phu My
Tobacco	300 ton	230 ton	77%	Tay Son, Phu Cat

Source: Estimation based on the Statistical Yearbook 2001, Binh Dinh Province and districts.

For perennial crops, coffee, cashew and mango, more than 60% of the provincial production is produced in the project area, as shown in the following table:

Production of Perennial Crops in the Study Area

	Province	Study Area	Proportion	Production Districts
Coffee	250 ton	100 ton	40%	Vinh Thanh
Cashew	1,020 ton	320 ton	31%	Tay Son, Vinh Thanh
Coconuts	66,300 ton	28,500 ton	43%	Phu My, Phu Cat
Pineapple	1,930 ton	510 ton	26%	Vinh Thanh,
Banana	6,070 ton	2,300 ton	38%	Tuy Phuoc, Vinh Thanh
Mango	1,430 ton	1,090 ton	76%	Tuy Phuoc, Tay Son, Phu Cat,

Source: Estimation based on the Statistical Yearbook 2001, Binh Dinh Province and districts.

1.6 Livestock and Fishery

(1) Livestock

Number of livestock in the project area is roughly estimated based on the proportion of households against the province as shown in Table L.7, and summarized below:

Livestock Production in the Project Area

(unit: head)

Livestock	1995	1999	2000	2001
Buffaloes	6,100	6,100	7,500	6,600
- Plough buffaloes	3,900	3,800	4,500	4,100
Cattle	121,200	121,500	98,300	113,700
- Plough cattle	44,800	55,600	35,600	41,700
Pig	169,100	178,900	248,200	198,700
- Pork	132,900	140,800	202,200	158,500

Source: Statistical Yearbook 2001, Binh Dinh Province, refer to Table L.7.

Proportion in the project area against the province is estimated at 33% for buffalo, 51% for cattle, and 44% for pig. Number of pig for pork shows a remarkable increase as

same as observed in the province. Although no data is available for estimation, interview to farmers and livestock personnel indicated that poultry has been expanding its production. Livestock statistics in each district are shown in Tables L.8 and L.9 for reference, however, not used due to discrepancy with the provincial statistics.

(2) Fishery

The main fishery activities in the project area is shrimp culture in the brackish water, mainly conducted in the Thi Nai Swamp and the Nuoc Ngoi Swamp. Administratively, the Thi Nai Swamp is under Qui Nhon City and Tuy Phuoc District, and the Nuoc Ngoi Swamp under Phu Cat and Phu My Districts. About 1,900 ha of shrimp aquaculture is located in the project area and its production is estimated at about 1,200 ton, as shown blow:

Shrimp Aquaculture Production in the Project Area

Description	Qui Nhon	Phu My	Phu Cat	Tuy Phuoc	Total
Culture Area	400 ha	360 ha	110 ha	1,000 ha	1,870
Culture Production	260 ton	220 ton	70 ton	640 ton	1,190 ton

Source: Statistical Yearbook 2001, Binh Dinh Province.

In the area surrounding the shrimp culture, salt field is widely extending to produce salt. However, the salt field is not able to be converted to shrimp culture due to short of fresh water to dilute sea water in the summer season.

1.7 Basic Concept of Agricultural Development Plan

The agricultural development plan in the project area follows the basic concept of irrigation development formulated in the master plan. In the irrigation development plan, the future agriculture land is to be provided with the following conditions under the project works:

(1) Irrigation water will be adequately supplied within the available water resources.
(2) Cultivated land will be protected from the minor, early and late floods except major floods.
(3) Drainage condition will be improved to remove internal excessive water from the cultivated land.

The above conditions will enable to expand the cropped area and increase unit yield and cropping intensity along with technical improvement of farming practices like introduction. For formulation of cropping pattern, land position is taken into account as the flood condition on cropped land, as same in the master plan. Accordingly, the project area is classified into three categories, namely, higher, middle and lower positions, as presented below:

Land Position and Flood Condition in the Project Area

Position	Higher	Meddle	Lower	Total
Area	**20,500 ha**	**13,600 ha**	**3,300 ha**	**37,400 ha**
Irrigated	3,000 ha	10,100 ha	2,600 ha	15,700 ha
Rainfed	17,500 ha	3,500 ha	700 ha	21,700 ha
Minor Flood	Not severe	Partially affected	Severely affected	-
Early Flood	Not severe	Partially affected	Severely affected	-
Major Flood	Not Severe	Severely affected	Severely affected	-
Late Flood	Not severe	Partially affected	Severely affected	-

1.8 Present Production in the Project Area

Taking into account (1) the above flood condition, (2) the agro-climatic condition, (3) the statistical data at districts/ communes levels, and (4) the previous studies, the present cropping patterns for each land position above are assumed. The present cropped area is shown in Table L.10 and summarized below:

Present Cropped Area in the Project Area

Land Position	Higher	Middle	Lower	Total
Cropping Pattern	**A**	**B**	**C**	**Combined**
Total Land	20,500 ha	13,600 ha	3,300 ha	37,400 ha
Paddy	14,700 ha	20,000 ha	5,600 ha	40,300 ha
Maize	5,200 ha	2,600 ha	400 ha	8,200 ha
Groundnuts/ Soybeans	3,300 ha	900 ha	300 ha	4,600 ha
Tobacco	200 ha	0 ha	0 ha	200 ha
Sugarcane	4,000 ha	0 ha	0 ha	4,000 ha
Cassava	3,300 ha	1,300 ha	0 ha	4,600 ha
Total Cropped Area	30,700 ha	24,800 ha	6,300 ha	61,800 ha
Cropping Intensity	**150%**	**182%**	**191%**	**165%**

Source: Estimation by the JICA Study Team based on the Statistics and previous studies.

In the project area, the present cropped area is estimated at about 61,800 ha in total. This corresponds to the average cropping intensity of 165%, consisting of 211% in 15,700 ha of irrigation area and 132% in 21,700 ha of rainfed area. The low cropping intensity in the rainfed area is mainly due to short supply of irrigation water, therefore, irrigation and drainage improvement will increase crop production through expansion of cropped area and raise of unit yield.

1.9 Future Production under the Project

Based on the conditions mentioned above, the future cropping pattern and cropped area is formulated as shown Figure L.1 and Table L.11 and summarized below:

Proposed Cropped Area in the Project Area

Land Position Cropping Pattern	Higher A	Middle B	Lower C	Total Combined
Future Irrigation Area	20,500 ha	13,600 ha	3,300 ha	37,400 ha
Paddy	35,000 ha	20,500 ha	5,300 ha	60,800 ha
Maize	6,600 ha	5,400 ha	700 ha	12,700 ha
Groundnuts/ Soybeans	2,900 ha	4,100 ha	6000 ha	7,600 ha
Tobacco	400 ha	0 ha	0 ha	400 ha
Sugarcane	3,000 ha	0 ha	0 ha	3,000 ha
Pineapple	300 ha	0 ha	0 ha	300 ha
Total Cropped Area	48,200 ha	30,400 ha	6,600 ha	84,800 ha
Cropping Intensity	**235%**	**220%**	**200%**	**227%**

1.10 Incremental Production under the Project

Incremental cropped area by the project from the present condition is shown as summarized below:

Increment of Cropped Area

	Present	Project	Increment	Increase Rate
Irrigation Area	15,700 ha	37,400 ha	21,700 ha	138%
Non-Irrigation Area	21,700 ha	0 ha	-21,700 ha	-100%
Total	37,400 ha	37,400 ha	0 ha	0%
Paddy	40,300 ha	60,800 ha	+20,500 ha	+51%
Maize	8,200 ha	12,700 ha	+4,500 ha	+54%
Groundnuts/ Soybeans	4,500 ha	7,600 ha	+3,100 ha	+69%
Tobacco	200 ha	400 ha	+200 ha	+100%
Sugarcane	4,000 ha	3,000 ha	-1,000 ha	-25%
Pineapple	0 ha	300 ha	+300 ha	100%
Cassava	4,600 ha	0 ha	-4,600 ha	-100%
Total Cropped Area	61,800 ha	84,800 ha	23,000 ha	+37%
Cropping Intensity	**165%**	**227%**	+62%	+38%

As shown in the above table, the future cropped area will increase by 23,000 ha to 84,800 ha from the present cropped area of 61,800 ha. Improvement of drainage condition will cause the expansion of paddy crops in the rainy season, but not for other subsidiary crop due to high soil moisture condition.

The anticipated yield of crops is estimated based on the present unit yield and the conditions improved under the project such sufficient irrigation water supply, proper drainage, improved farming practices, and adequate input dosage. Based on the future cropping area and the anticipated unit yields, the crop production is estimated as shown in Table L.12 and summarized below:

Production Increment in the Project Area

	Present			Project under Project			Incre-ment (ton)
	Area (ha)	Unit Yield (ton/ha)	Produc-tion (ton)	Area (ha)	Unit Yield (ton/ha)	Produc-tion (ton)	
Paddy	40,300	2.2-4.3	152,700	60,800	4.7	289,100	136,400
Maize	8,200	1.4-3.3	13,400	12,700	4.5	57,200	43,800
Groundnuts/Soybeans	4,500	0.7-1.5	3,800	7,600	1.9	14,400	10,600
Tobacco	200	0.9-1.5	200	400	1.7	700	500
Sugarcane	4,000	34.1-49.7	136,400	3,000	60.0	180,000	43,600
Pineapple	0	-	0	300	20.0	6,000	6,000
Cassava	4,600	6.5	29,900	0	-	0	-29,900
Total Cropped Area	61,800		336,400	84,800		547,400	211,000

Total crop production will increase by 211,000 to 547,400 ton from the present production of 336,400 ton by 63%.

2 COMPARATIVE STUDY AND SELECTION OF WEIR SITE AND WEIR TYPE

2.1 Alternative Weir Sites

The comparative study about the alternative weir sites has been made for the following two (2) alternative sites.

Through the study hereinafter and in consideration of no meaningful difference in the geological condition as mentioned below, Site-II (JICA Team) has been selected as the proposed site of the Van Phong Weir.

Geology of both weir sites is very similar. The proposed concrete fixed spread foundation type weir can be constructed in both sites without any noticeable difficulty from the geological point of view. However, Site-II (JICA Team) is regarded as the optimum site and selected as the weir site in this feasibility study on the basis of the sediment distribution in the present river valley.

(1) Site-I (HEC-1)

Site-I in this Study is the same as Site-I proposed by HEC-1 in the Feasibility Study report (No.444C-05-TT2, June 2000). It is located about 5 km upstream from Phu Phong Town in Tay Son District. The site is near the Cay Muong Hydrological Monitoring Station and at foot of Nui Mot Hill.

(a) Geological condition

Site-I lies between the Hanh Son range and the Nui Mot hill in the downstream course of the Kone River, about 38 km downstream of the Dinah Binh damsite. The river at the site, U-shaped, has a width of 455 m more at elevation 25 meters. The present river channel in dry season flows along the right margin, while on the left margin, underlies the alluvial sand cone of about 200 m width.

The geology of the site is Mesozoic granite and the overlying recent deposits (Layers 1 and 3a). Layer 1, 6 to 11 m thick, covers the valley bottom and Layer 3a, 2 to 6 m thick, exists mainly on the natural slopes of both sides. The granite has undergone less deep weathering. The thickness of the completely and strongly weathered rocks varies from 1 to 6 meters. The moderately rock has a medium compressive strength.

(b) Meandering and sedimentation

The water route of the Kone River forms the meandering in the reaches near the alternative sites. The curve of meandering around Site-I is leftwards and the peak of the curve is positioned about 500 m upstream from Site-I. The curve changing

point to the right side is about 200 m downstream from Site-I. It means that the intake structure is to be positioned at inside of the curve where the sedimentation of sand has been caused in about 200 m width. This sedimentation was caused at floods in the past, and it would continue even after the proposed weir is constructed because the water route is formed at floods and its route would be the same as the original one.

Therefore, the common design criteria prescribe that the intake facilities site should be selected at the outside of meandering curve and at a little downstream point of the peak of the curve.

It would be better to shift the weir site to avoid the sedimentation to be caused in front of the intake facilities.

(c) Weir width

The river width at Site-I is the narrowest among the alternative sites. The proposed weir width excluding the scouring sluice part is 470 m.

(2) Site-II (JICA Team)

Site-II (JICA Team) used in this Study is located between Site-I and Site-II proposed by HEC-1 in the Feasibility Study report. It is located about 1 km upstream from Site-I and about 1.3 km downstream from Site-II (HEC-1).

(a) Geological condition

Site-II (JICA Team) is surrounded by the Hanh Son range at the left side and by the Nui Ngang Mountain at the right side. The river around the site shows U-shaped valley and has a valley width of 550 meters at elevation 25 meters. In contrast to Site-I, the present river channel in dry season flows along the left margin and the alluvial sand cone of about 300 m width occupies the right margin of the valley.

Geology of Site-II (JICA Team) is considered to be the same as that at Site-I, and underlain by granite and the overlying recent deposits.

(b) Meandering and sedimentation

The curve of meandering around Site-II (JICA Team) is rightwards and the peak of the curve is positioned about 200 m upstream from Site-II (JICA Team). The curve changing point to the left side is about 400 m downstream from Site-II (JICA Team). It was confirmed that no sedimentation had been caused and the no change of the water route of the Kone had been experienced since the time enough long before.

(c) Weir width

The river width at Site-II (JICA Team) is a little wider than it at Site-I. The

proposed weir width excluding the scouring sluice part is 525 m.

2.2 Alternative Weir Types

The following four (4) alternative types at Site-II (JICA Team) have been selected for the comparative study.

(i) Concrete fixed spread foundation type
(ii) Concrete fixed floating type
(iii) Concrete spread foundation type with rubber weir
(iv) Concrete floating type with rubber weir

General features of the above alternative types are shown in Figure L.2.

(1) Concrete Fixed Spread Foundation Type

The concrete fixed spread foundation type was proposed by HEC-1 in the Feasibility Study report.

(a) Foundation

The geological condition of the proposed weir is described below. The assumed rock foundation surface would range from EL.7.0 m at the deepest to EL.18.0 m at the shallowest.

All the weir part would be with the direct foundation on the weathered rock with grouting. This foundation rock would have the uniaxial compressive strength of 400 to 200 kgf/cm^2.

(b) Weir Crest Elevation

The required crest has been set at EL.25.50 m in consideration of the head loss for the settling basin and the discharge measurement device for the water level at BP. of the main canal WL. 24.70 m. The flood protection dike against the backwater has been designed for the water level WL. 28.90 m of 1% probability of occurrence.

The downstream water level of the weir at Site-II has been estimated with use of the manning formula with reference to H-Q curve at the Cay Muong Gauging Station as shown in Table L.13. A calculation sheet of the overflow water level of the weir is presented in Table L.14 (1/2).

(c) Apron

The upstream apron has not been designed. The downstream apron with 5.0 m length has been designed after the bucket on the foundation rock for protection of the connection part (the downstream slope toe part) between the weir body concrete and the foundation rock.

To examine the safety of the connection part of the downstream apron and the

foundation rock, the collision velocity of overflow water to the bottom of the downstream basin has roughly been calculated with the Aki's formula. Though it is for the free overfall, the formula has been used for the practical purpose to roughly know the degree of impact of the overflow water to the apron and the base rock. The maximum velocity on the bottom would be 6.5 m/s at a unit width discharge of 3.5 m^3/s (or 1,830 m^3/s in whole width) in a place where the downstream water depth is 3.0 m that varies depending on the base rock depth. It would be low enough for the safety the rock foundation. The calculation process is shown in Table L.15.

(2) Concrete Fixed Floating Type

The concrete fixed floating type was considered as an alternative for the comparative study.

(a) Foundation

The pile foundation has been designed for the weir body and the aprons to the assumed rock foundation surface at EL.7.0 m at the deepest. As the bottom elevation of the weir has been determined at EL.17.00 m for the river bed elevation of EL.19.5 m at the deepest, the longest pile length would be about 10 m.

(b) Weir Crest Elevation

As for the weir crest, the consideration is the same as the concrete fixed spread foundation type as mentioned above.

(c) Apron and cut-off

The upstream and downstream aprons have been designed to secure the required creep length against the water head of 6.0 m. In addition, the sheet piles have been designed at two (2) rows.

The upstream apron is of 20.0 m in length and the downstream one is 40.0 m. The total horizontal length including the weir part is 68.7 m. The cut-off sheet piles are of 6.0 m at the front and 4.5 m at the rear, respectively.

The necessary creep length has been estimated with reference to the both values obtained from the Bligh's Method and the Lane's Method. A calculation sheet of the creep length is presented in Table L.16.

On the other hand, the required lengths of the apron and the rip rap have been estimated to be 16.0 m and 22.0 m, respectively as shown in Table L.17.

As the required length of apron from the required creep length is 40.0 m as mentioned above and it is much longer than it from the protection viewpoint, the downstream apron would be 40.0 m. As for the riprap, it would be 20.0 m, which

would be enough for the protection against the change in roughness between the apron and the river bed.

(3) Concrete Spread Foundation Type with Rubber Weir

The concrete spread foundation type with rubber weir was considered as an alternative for the comparative study to decrease the flood backwater level.

(a) Foundation

As for the foundation, the consideration is the same as the concrete fixed spread foundation type as mentioned above.

(b) Rubber Weir on Concrete Body

The required crest has been set at EL.25.50 m, which is the same as the concrete fixed spread foundation type.

The rubber weir of 2.50 m height would be constructed on the concrete body of 3.50 m height. The crest elevation of the concrete weir is EL.23.0 m.

The flood protection dike against the backwater has been designed for the water level WL. 28.03 m of 1% probability occurrence. A calculation sheet for the rubber weir under the deflated condition is presented in Table L.14 (2/2).

(c) Apron

As for the apron, the consideration is the same as the concrete fixed spread foundation type as mentioned above.

(4) Concrete Floating Type with Rubber Weir

The concrete floating type with rubber weir was also considered as an alternative for the comparative study.

(a) Foundation

As for the foundation, the consideration is the same as the concrete fixed floating type as mentioned above.

(b) Rubber Weir on Concrete Body

The rubber weir on the concrete body is the same as it of the concrete spread foundation weir with rubber weir mentioned above.

(c) Apron and cut-off

As for the apron and cut-off, the consideration is the same as the concrete fixed floating type.

The upstream apron is of 20.0 m in length and the downstream one is 40.0 m. The

total horizontal length including the weir part is 68.7 m. The cut-off sheet piles are of 6.0 m at the upstream and 4.5 m at the downstream, respectively.

2.3 Comparative Study and Selection

At first, the technical comparison has been made for such two (2) points as the fixed or rubber type and the foundation type, as mentioned below.

Secondly, the cost comparison has also been made taking such major work items as the earth, the concrete, the pile, etc. for the five (5) comparative parts of the weir body, the apron, the foundation, the side wall and the flood dike, which costs would vary depending upon the weir type. As a result, it has been known that the concrete fixed spread foundation type shows the lowest.

Then, the concrete fixed spread foundation type has finally been selected from not only the technical viewpoint but also the economical one.

(1) Technical Comparison

The technical comparison has been made for the following points.

(a) Fixed weir and rubber weir

Information of the rubber weir has been obtained from the South Institute of Water Resources. There exist 15 rubber weirs at present in Vietnam. Seven (7) are of made-in-China, six (6) are made-in-Vietnam and two (2) made-in-Japan. All are of the water type. The rubber weirs of made-in- Vietnam have been constructed since 1997.

Generally speaking, in comparison between the gated weir and the rubber weir, the rubber weir has advantages such as the more reliable and easier inflation/deflation operation, the smaller scale foundation works, the easier construction works, and the lower construction cost. However, in this case, such comparison as between the steel gate and the rubber is not the matter of discussion.

The comparison should be made between the fixed weir and the rubber (fabric) weir. From this viewpoint, the fixed weir has an advantage in less operation and maintenance. On the other hand, the rubber weir has an advantage in lowering the flood backwater level.

Taking into account the fact that the combination of the fixed weir and the flood protection dike was adopted in the HEC-1's F/S, an advantage has been put on the fixed weir that is based on the same concept as HEC-1 putting stress on the convenience of less operation and maintenance.

(b) Spread foundation type and floating type

As mentioned hereinafter in a section of the site geology, the layer 3a of well-graded GRAVEL, which occasionally contains boulders, exists in some range at the both sides of the river bed under the layer 1 of SAND.

It means that the floating type with is not preferable for the parts of the layer 3a, because the cut-off sheet pile works would be difficult. Therefore, the spread foundation type would be more preferable than the floating one.

In relation to the foundation type of the weir body, the structure of apron has been studied as well as its necessity. For the spread foundation type weir, the upstream apron is not considered because the foundation is sound and the creep length to be secured in case of the floating type is not necessary to be considered. The downstream apron for the spread foundation type is considered to be constructed on the base rock in connection with the bucket at the slope toe of the weir body.

As for the floating type, both the upstream and downstream aprons would be constructed with required pile foundation.

Taking into consideration the matter of the sheet pile difficulty discussed above, an advantage from the technical viewpoint has been put on the spread foundation type.

(2) Cost Comparison

The cost comparison has been made for such major work items as the earth, the concrete, the pile, etc. for the five (5) parts mentioned above, which costs would vary depending upon the weir type. The result of the cost comparison is summarized below. More details are shown in Table L.18. As known from the table, the concrete fixed spread foundation weir shows the lowest cost.

Cost Comparison by Weir Type

(unit: million VND)

Work Item	1A. Fixed, Spread Foundation	1B. Fixed, Floating	2A. Rubber, Spread	2B. Rubber, Floating
Earth works	5,328	6,045	5,575	6,069
Concrete works	97,108	149,615	93,068	144,408
Sheet pile works	0	8,377	0	8,377
Foundation pile works	0	3,746	0	3,370
Foundation grouting work	7,081	0	7,081	0
Rubber weir	0	0	13,448	13,448
River dike works	5,885	5,885	4,059	4,059
Total	115,402	173,668	123,231	179,731

(3) Selection of Concrete Fixed Spread Foundation Type

Through the above comparative study, the concrete fixed spread foundation type weir has finally been selected from the technical and economical viewpoints.

2.4 Design of Major Structures

General features of the major structures such as the weir body, the scouring sluice, the apron and the intake facilities are as mentioned below and shown in Figure L.3. Those of the flood protection dike are shown in Figure L.4.

(1) Weir Body

The weir body is made of the concrete. The cross-section is the trapezoid-shape with the vertical upstream surface, 3.0 m crest length with overflow stream line and the inclined downstream surface with a slope of 1:0.7. The bottom is the spread foundation on the base rock. The downstream slope toe forms the bucket to smoothly connect with the downstream apron. The weir height would vary from 18.5 m to 7.5 m depending upon the base rock depth.

The stability calculation of the downstream slope of 1:0.7 has been made as shown in Table L.19. As the uniaxial compressive strength of the foundation rock is estimated at 400 to 200 kgf/cm^2, the bearing capacity would be large enough. Therefore, the safety against the overturning and the sliding has been examined and it for the both has been confirmed to be within the required conditions.

(2) Scouring Sluice

The scouring sluice would be constructed at the left side end in connection with the fixed weir. The scouring sluice part would be separated from the fixed weir part with the guide wall. This part would also have the spread foundation on the base rock, of which the rock surface might be assumed to exist at about EL.18.0 m. The floor elevation would be at the same elevation of the base rock surface that is EL.18.0 m, too.

The upstream water level at the dry season would be at WL. 25.5 m and the downstream one at WL.20.0 m. Therefore, the scouring sluice would be of the type using the stored energy of water head. The scouring sluice gates would be two (2) steel slide gates of B 2.75 m x H 2.75 m with the four-side water tightness.

(3) Apron

The upstream apron would not be considered. The downstream apron would be constructed on the base rock foundation in connection with the bucket at the downstream slope toe of the weir body. The floor level of the apron would be the same as the downstream base rock surface level. The length of the apron would be 5.0 m and the thickness 1.0 m. The same concept would be applied for the apron of the scouring sluice.

(4) Intake Facilities

The intake facilities would be constructed through the left side wall at just upstream point of the scouring sluice gate. The intake surface would be set on the same surface as the side wall so that the unnecessary space might not be made, where the sediments would remain even after the scouring activity. The intake flow direction would be perpendicular to it of the scouring sluice.

(a) Intake Gate

The intake gates would be two (2) steel slide gates of B 3.00 m x H 3.00 m with the four-side water tightness.

(b) Settling Basin

The settling basin of natural flushing type would be constructed with required dimensions in connection with the downstream end of the intake box culvert after the intake gates. The flow direction would be changed rightwards at 90 degrees in angle in the box culvert portion. Then, it would be in parallel with the flow direction of the weir. The settling basin would be constructed in parallel with the flow direction.

(c) Discharge Measurement Device

The discharge measurement device would be constructed between the end of the settling basin and the beginning point of the Van Phong Main Canal. The broad-crested overflow measuring weir would be installed in the rectangular concrete flume portion. The broad-crested weir would be preferable from such advantages as the easy measurement way and its sound structure.

3 GEOLOGY AND ENGINEERING GEOLOGY OF WEIR SITE

3.1 Site Geology

(1) Topographical features

The Van Phong weir site (Site II) is located near the Phu Phong town in the downstream course of the Kone river, about 38 km downstream of the Dinh Binh damsite and 30 km north of Quy Nhon City. The weir site is the start of the main alluvial plains encompassing most of the project irrigation areas (Van Phong, Tan An-Dap Da and Ha Thanh).

Around the site, the Hanh Son range at the left side and the Nui Ngang Mountain at the right side converge on the river, longitudinally forming a bottleneck-shaped valley. The range on the left side, about 300 meters in elevation along the Kone river, has a gradient slope of about 15 degrees and joints the riverbed through a narrow and rather flat river terrace (about 10 m wide) at elevation 25 meters. The mountain on the right side joints the riverbed through a narrow river terrace (about 15 m at elevation 25 meters) where National Highway 19 runs.

The river at the site shows a U-shaped valley and has a valley width of about 420 m wide at elevation of 20 meters. The reservoir area is about 650 meters wide on average and about 5,000 meters long at maximum water level (+ 30 m). The riverbed slope of the reservoir area is about 0.5/1000.

(2) Geological features

The bedrock is mainly medium-grained granitic rock (Deo Ca complex) of Mesozoic age. The rock is less jointed and weathered, with a weathering thickness of 2 to 8 meters. Overlying the rock are the recent deposits of alluvial and colluvial origins. These deposits consist mainly of gravels, sands and silty clay, and are generally 1 to 10 meters thick, depending on their distribution. These deposits are subdivided, in terms of the sedimentary processes, origins and compose, into the following 4 layers:

- **Layer 1**: Coarse to medium SAND (SP) with some coarse sub-rounded gravels. This layer is loose and poorly graded, having a high permeability. It originates mainly from alluvium and overlies on the riverbed. Its thickness is 6.0 to 11.0 meters.
- **Layer 2**: Medium-grained silty SAND (SM) with a little fine-grained gravel, yellowish gray. This layer, 1 to 3 meters thick, is of alluvial and colluvial origins and is distributed mainly on the lower part of the hillsides.
- **Layer 2a**: Clayey SAND (SC), yellowish gray. The layer, firm, is of alluvial origin and is beneath Layer 2. Its thickness is 2 to 4 meters.
- **Layer 3**: Well-graded GRAVEL with some sand and silt (GM), of non-dividable elluvium-deluvium (deQ), gray to brown, loose to medium dense. The size of gravel

and boulder is generally 2 cm to 5 cm, occasionally up to 10 cm. This layer is distributed mainly along the flanks of the valley. Its thickness is 4 to 6 meters.

3.2 Engineering Geology

(1) Rock mass classification

The foundation rocks at the Van Phong weir site have been partially subjected to weathering, with a weathering depth of 2 to 8 meters at drilled depth. These rocks were divided, similar to those at the Dinh Binh damsite, into completely weathered, strongly weathered and moderately weathered zones in view of their weathering degree, hardness, joint distribution and discoloration. The completely weathered rock (IV), yellowish gray to brown, is highly jointed and partly weathered into sandy soil especially along joints and crack. The thickness of the strongly weathered zone is 1.0 to 2.0 meters on the lower part of the left bank slope, while, 4.0 to 5.0 meters on the right bank terrace and the right hillside. The strongly weathered rock (III), generally 1.0 to 4.0 meters thick, yellowish gray to white gray, is rather solid, but can be broken along fissures or joints with hammer. Some joints or fissures are filled with clay. In the slightly weathered rock (II), however, only joints and cracks are rather solid and only slightly oxidized, the rock remains the original dark color.

The following table gives the rock classification of the Van Phong weir site, and its correspondence to the Rock Classification of Japanese Standard.

Van Phong weir site		Thickness (m)	Japanese Standard	Remarks
Slightly to Fresh	I	-	$A - C_H$	
Moderately Weathered	II	1.0 –5.0	C_M	Partially C_H
Strongly weathered	III	1.0 – 4.0	C_L	Partially C_M
Completely weathered	IV	-	D	

(2) Engineering properties

Unconfined compressive tests of rock samples were carried out by JICA Study Team and the test results are given in the following table.

Summary of rock unconfined compressive strength at theVan Phong weir

Sample No.	Depth (m)	Compressive strength (kgf/cm^2)	Remarks
BW1/1	18.4 – 19.6	841.9	C_L grade rock
BW1/2	20.3 – 21.0	1024.8	C_L to C_H grade rock
BW1/3	21.6 – 22.4	998.3	C_L to C_H grade rock
Average		955.0	

The above compressive strengths are much larger than the empirical values as shown in the following table. Also, because the unconfined compressive tests were done on small samples, the bearing capacity of the foundation rocks should be determined on the basis of the following experienced estimation.

Rock classification and rock parameters

Rock Grade	qu (kgf/cm^2)	Es (kgf/cm^2)	Ed (kgf/cm^2)	ϕ (degree)	c (kgf/cm^2)
A - B	Over 800	Over 80,000	Over 50,000	55 – 65	Over 40
C_H	800 - 400	80,000 - 40,000	50,000 - 20,000	40 – 55	40 - 20
C_M	800 - 200	40,000 - 15,000	20,000 - 5,000	30 – 45	20 - 10
C_L	400 - 200	Below 15,000	Below 5,000	15 - 38	Below 10
D	Below 200	Below 15,000	Below 5,000	15 - 38	Below 10

Source: Rock classification and its application, K. Yoshinaka, et al., Japanese Society of Civil Engineering, 1989.
qu = Uniaxial compressive strength, Es = Modulus of elasticity, Ed = Modulus of deformation, c = Cohesion, 1 kgf/cm^2 = 100 kN/m^2, ϕ = Internal friction angle.

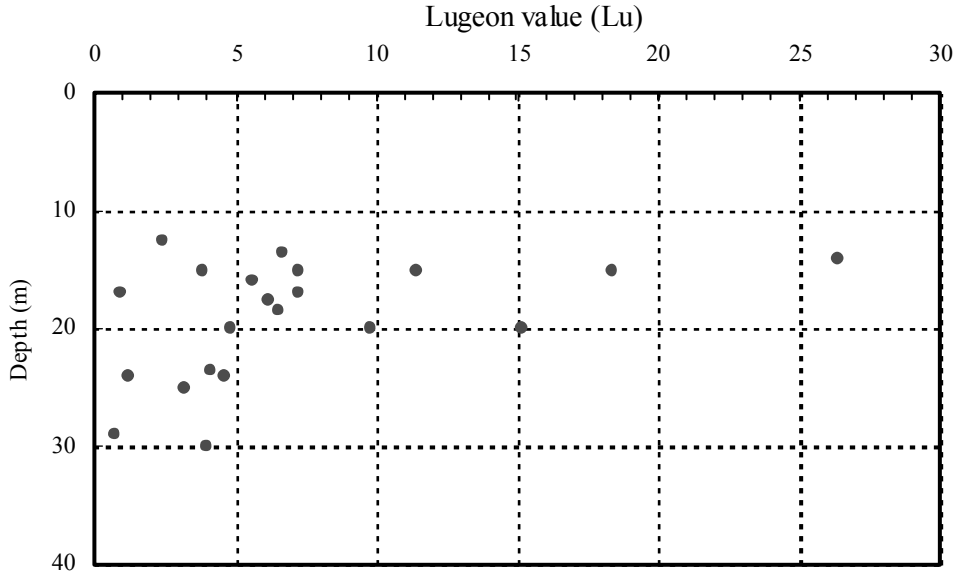
Lugeon tests were carried out mostly in the weathered rocks (II to III) at the weir site. The test results are summarized in the following table and figure.

Summary of lugeon test results at Van Phong weir site (21 Nos.)

lugeon value	Numbers	Percentage (%)	Remarks
0 - 5	10	47.7	
5 - 10	7	33.3	
10 - 20	3	14.3	
>20	1	4.7	

Source: Data from Report on Engineering Geology of Van Phong Weir done by HEC-1, March 1999, and from the present investigation.

These results show that the permeability of the weathered rocks is generally less than 10 Lugeon (over 80% Nos.), indicating that the weathered granitic rock has a low permeability and is groutable.



Relationship between Lugeon value and depth

In addition, some laboratory tests of the overlying deposits were made and the test results are summarized in the table below.

Summary of physical and mechanical properties of these layers

Properties	Symbol	Unit	Layer 1	Layer 2	Layer 2a	Layer 3a
Clay (< 0,005 mm)		%	0.0	8.0	20.0	4.0
Silt (0,005 to 0,05 mm)		%	0.0	11.0	20.0	5.0
Sand (0,05 to 2 mm)		%	61.0	69.0	57.0	21.0
Gravel (2 to 20 mm)		%	37.0	12.0	3.0	70.0
Fragment (20 to 40 mm)		%	2.0	0.0	0.0	0.0
Liquid limit	LL	%	-	-	34.2	-
Plastic limit	PL	%	-	-	19.2	-
Plasticity index	PI	%	-	-	14.5	-
Unit weight	γ	g/cm^3	-	1.65	1.73	1.79
Dry unit weight	γ_d	g/cm^3	-	1.50	1.50	1.65
Specific gravity	ρ	-	2.64	2.69	2.71	2.68
In-situ water content	w	%	-	11.0	15.2	4.1
Degree of saturation	S	%	-	35.9	51.8	-
Porosity	n	%	-	44.8	44.8	38.6
Void ratio	e	-	-	0.81	0.81	0.63
Cohesion	c	kg/cm^2	0.00	0.08	0.18	0.06
Internal friction angle	ϕ'	°	36	17	14	18
Permeability coefficient	K	cm/s	5×10^{-2}	5×10^{-4}	4×10^{-5}	5×10^{-2}

Source: Modified from Report on Engineering Geology of Van Phong Weir done by HEC-1, March 1999.

3.3 Construction Materials

In the feasibility study, some borrow areas were investigated by HEC-1. These areas comprise fine-grained sand to gravel and contain a little clay and silt. The various layers of the borrow areas were classified as follows:

- Layer 2a: Clayey SAND (SC) with silt, originating from alluvium
- Layer 3: Gravelly SAND with silt and clay (SG), originating from weathered granite

The quantities and engineering properties of various layers of the construction materials were summarized in the following tables.

Summary of the construction materials volume exploitable at these areas

Area	Distance from weir site	Area (10^3 m^2)	Soil Layer	Thickness (m)		Quantity (10^3 m^3)	
				Removed	Exploited	Removed	Exploited
CSII	0.5 km left downstream	48	-	0.0	2.0	0	96
CSIII	0.5 km right downstream	162	-	0.0	2.0	0	320
C	0.3 km left downstream	30	3	0.5	1.5	15	45
		10	2a	0.5	1.5	5	15
D	0.5 km left downstream	60	3	0.5	1.5	30	90
		56	2a	0.5	1.5	28	84
E	1.5 km left downstream	32	2a	0.5	2.0	16	64

Source: Modified from Report on Engineering Geology of Van Phong Weir done by HEC-1, March 1999.

Summary of physical and mechanical properties of these areas

Properties	Symbol	Unit	C Site		D Site		E Site
			Layer 2a	Layer 3	Layer 2a	Layer 3	Layer 2a
Clay (< 0,005 mm)		%	28	13	29	13	24
Silt (0,005 to 0,05 mm)		%	32	10	32	9	33
Sand (0,05 to 2 mm)		%	40	43	34	40	43
Gravel (2 to 20 mm)		%	0	34	5	38	0
Fragment (20 to 40 mm)		%	0	0	0	0	0
Liquid limit	LL	%	35.7	33.3	37.5	34.0	35.8
Plastic limit	PL	%	18.3	17.5	19.0	17.5	19.0
Plasticity index	PI	%	17.3	15.8	18.5	16.5	16.8
In-situ water content	w	%	22.5	-	15.0	-	15.2
Optimum water content	w_{opt}	%	19.0	11.0	18.0	11.0	17.5
Maximum dry unit weight	$\gamma_{d,max}$	g/cm^3	1.58	1.75	1.60	1.75	1.58
Cohesion	c	kg/cm^2	0.20	0.15	0.20	0.15	0.20
Internal friction angle	ϕ'	°	16	20	16	20	16
Permeability coefficient	K	10^{-5}cm/s	0.5	5.0	0.1	5.0	0.1

Source: Modified from Report on Engineering Geology of Van Phong Weir done by HEC-1, March 1999.

3.4 Geological Conditions and Geotechnical Parameters for Weir Design

The foundation rock of the Van Phong weir site is Mesozoic granite. The rock, having a low permeability and a medium compressive strength, provides a good foundation. Geologically, the site is thus considered to be an ideal location for the construction of the weir.

On the valley of the site, the recent deposits (Layer 3a) overlying the bedrock, approximately 8.0 to 10.0 meters thick, contain a large amount of gravel of 2 cm to 10 cm in grain size, and therefore, the driving of piles or sheet piles is considered to be impossible or of considerable difficulty.

In the more detailed design phase, although further geological investigations are necessary to evaluate the distribution of soil layers and the engineering strength properties

of the foundation rocks, for this feasibility study, the geological conditions and the geotechnical parameters for the Van Phong weir are considered to be the same as those for the Dinh Binh dam and are summarized as follows:

- Strongly to moderately weathered granite (C_L to C_M) as the foundation rock of the weir.
- Lugeon value less than 10 (of over 75%).
- Compressive strength over 20,000 kN/m^2.
- Cohesion c = 10 kgf/cm^2=1,000 kN/m^2 (C_L grade rock).
- Internal friction angle ϕ = 30 degrees.
- Horizontal seismic coefficient K_h = 0.12.

4 IRRIGATION AND DRAINAGE SYSTEM

4.1 General

The objective area of irrigation, drainage and farm road system development in this Feasibility Study has been selected through the Master Plan Study. The selected area has in principle been limited to the irrigable area with the water from the proposed Dinh Binh Reservoir. The following irrigation systems would receive the water from the Dinh Binh. Details are shown in Table L.20.

Irrigation Systems under Dinh Binh Reservoir (Unit: ha)

	Irrigation System	Category	Net Area
(i)	Van Phong Proper	R&I, N	10,815
(ii)	Van Phong Extension (La Tinh)	N	3,297
(iii)	Tan An - Dap Da	R&I, I, N	14,532
(iv)	Tan An Extension (Lower Ha Thanh)	I, N	2,039
(v)	Vinh Thanh	R&I, N	1,017
(vi)	South West Kone	N	2,657
	Total		34,357

Note. R: Rehabilitation, I: Improvement, N: New Development

The Van Phong Extension (La Tinh) System would partly use the existing canals of the Cay Gai System and the Cay Ke System in the La Tinh area. Therefore, the existing La Tinh areas of 3,000 ha, which are irrigated with the water from the Hoi Son Reservoir, would be added to the above as the rehabilitation and improvement area. Including this, the total project area becomes about 37,400 ha in net.

(1) Objective of Irrigation Development

The major objectives of the irrigation development would be summarized as follows:

(i) Improvement of irrigation efficiency to save the water
(ii) Improvement of efficiency in operation and maintenance to create the time for improvement of the living standard

(2) Premise of Project

The major premise of the irrigation development project would be the realization of the proposed Dinh Binh Reservoir because of the present water shortage in the existing irrigation schemes of the Tan An – Dap Da.

(3) Development Concept

The development concept has been formulated with the three (3) categories in consideration of the economical effectiveness of the project. The general plan of the irrigation project is shown in Figure L.5.

Irrigation System's Area by Category

(Unit: ha)

	Category	Net Area
(i)	Improvement of existing functioning systems	16,200
(ii)	Rehabilitation and improvement of non-functioning systems	3,400
(iii)	Development of new systems	17,800
	Total	37,400

Note. Above areas are based on the on-farm system's level including 500 ha in Tan An Extensic where on-farm systems could be used only with improvement and without rehabilitation.

(a) Improvement of existing functioning system

The existing functioning irrigation systems would fully be utilized for the project with priority. The area is about 16,200 ha consisting of 12,400 ha in the Tan An – Dap Da, 3,000 ha of the La Tinh and 500 ha in the Tan An Extension (Lower Ha Thanh) and 300 ha in the others.

The major project components would be (i) canal concrete lining up to the on-farm canal commanding 50 ha or more, and (ii) installation of discharge measurement devices at turnouts in the main to secondary system (the double orifice or the overflow weir if head is available) and at division boxes (using the crest of outlet notch in the wall of box) in the on-farm system.

(b) Rehabilitation and improvement of non-functioning system

The no-functioning irrigation systems due to the superannuation and the water shortage would be rehabilitated and simultaneously improved with the priority, too. The area is about 3,400 ha consisting of 1,600 ha in the Tan An – Dap Da, 1,500 ha in the Van Phong Proper and 300 ha in the others.

The rehabilitation works are to recover the original function of the system and the improvement works are such additional works as mentioned above.

(c) Development of new system

The present rainfed area would be newly developed at the above-mentioned improved level. The area is about 17,800 ha consisting of 9,000 ha of the Van Phong Proper, 3,300 ha of the Van Phong Extension (La Tinh), 2,700 ha of the Southwest Kone, 1,500 ha of the Tan An Extension (Lower Ha Thanh), 800 ha of the Vinh Thanh and 500 ha in the Dap Da (Lao Tam New). The above new development areas are classified at the on-farm system's level.

The new main canals would pass not only the rainfed area but also parts of the improvement area or the rehabilitation and improvement area. In this sense, the new development areas classified at the main system's level are to be 20,000 ha

consisting of 10,500 ha of Van Phong Proper excluding 300 ha of the two (2) existing pumping systems, 3,300 ha of the Van Phong Extension (La Tinh), 2,700 ha of the Southwest Kone, 2,000 ha of the Tan An Extension (Lower Ha Thanh), 1,000 ha of the Vinh Thanh and 500 ha in the Tan An - Dap Da (Lao Tam New).

(d) Integration of systems in Tan An – Dap Da

Several existing irrigation systems in the Tan An – Dap Da have the supplementary water sources such as weirs or pumping stations. These systems were initially constructed as parts of the parent irrigation systems. However, the water supply from the parent irrigation systems was not enough due to mainly water shortage at the water sources or the intake points. To cope with such situation, supplementary water source facilities were constructed to additionally supply the water to canals of the parent irrigation systems. Those systems such as the Van Kham, the Bo Ngo, the Dap Cat, the Nha Phu, etc. are shown in Figure L.6.

Those irrigation systems would in principle be returned to the original parent irrigation systems to save the operation and maintenance cost presently caused for those water source facilities. The irrigation systems after the integration or the intake unification are shown in Figure L.7.

By the way, it is noted that all the existing weirs located in the lower Tan An – Dap Da are functioning to prevent the areas from salinity intrusion. Therefore, those weirs would be used even after the project.

4.2 Irrigation System

The following six (6) irrigation systems (34,400 ha) would be executed in the direct relation to the proposed Dinh Binh Reservoir.

(i) Van Phong Proper Irrigation System
(ii) Van Phong Extension (La Tinh) Irrigation System
(iii) Tan An – Dap Da Irrigation System
(iv) Tan An Extension (Lower Ha Thanh) Irrigation System
(v) Vinh Thanh Irrigation System
(vi) Southwest Kone Irrigation System

Irrigation diagrams of those systems are shown in Figure L.8.

In addition to the above, the existing irrigation systems under the Hoi Son Reservoir (3,000 ha) in La Tinh would be improved for convenience in execution of the Van Phong Extension (La Tinh) System.

Lengths of the major canals with section distances are shown in Table L.21.

General features of the respective projects for the above-mentioned irrigation systems are

as follows:

(1) Van Phong Irrigation System

The proposed Van Phong Irrigation System of 10,815 ha would be grouped into two (2) areas. One is the area of 10,484 ha to be irrigated by gravity with the water from the proposed Van Phong Weir. The other is the area of 331 ha to be irrigated by the existing three (3) pumping stations namely the Dai Binh (45 ha), the Thi Lua (226 ha) and the Ngai Chanh (60 ha).

(a) Beginning Point (BP.) of Van Phong Main Canal

The beginning point (BP.) of the proposed Van Phong Canal has been set out at 1 km upstream from the alternative Site-I (HEC-1). The naming system putting the zero point at Site-I (Hec-1) would be used as it is for convenience in the course of the design works. Therefore, the station name of the proposed BP. of the Van Phong Main Canal has been given as "– 1k+000".

(b) Van Phong Main Canal

Almost of all section of the Van Phong Main Canal downstream from the original BP. at Site-I (HEC-1) would function as the original design by HEC-1. The design water level has been set as the same as it of the original one that is shown in the canal longitudinal drawing prepared in the Feasibility Study (HEC-1). The total canal length has become 1.0 km longer than it of the original design, and so the new one is 34.4 km.

The canal has been designed as the concrete lining canal with 10 cm in thickness, while the original design was of the partial lining. The canal depth and the base width have been changed from those of the original design. Major dimensions at BP. are such as the canal bottom width of 7.00 m, the water depth of 2.34 m and the canal height (or canal depth including the freeboard) of 3.05 m.

(c) Van Phong N1 Canal

The N1 Canal would branch at 23.8 km point (named 22k+820) to the left bank side (northwards) from the Van Phong Main Canal. The N1 Canal would convey the water for 4, 090 ha consisting of 790 ha of a northern part in the Van Phong Proper System and 3,300 ha of the Van Phong Extension (La Tinh) System.

At the boundary between the Van Phong Proper and the Van Phong Extension (La Tinh), the water level of the N1 Canal has been calculated to be WL.17.80 m at 4.1 km from BP.

(2) Van Phong Extension (La Tinh) Irrigation System

The Van Phong N1 Canal would function like a main canal for the Van Phong Extension (La Tinh) System. Therefore, for discussion of the Van Phong Extension (La Tinh) System, the point of the boundary that is positioned at 4.1 km from BP. of the N1 Canal would be considered to be BP. of the portion in the Extension System of the N1 Canal (Van Phong N1 Extension Canal). The water level at this BP. would be WL.17.80 m as mentioned above.

(a) Water supply to Cay Gai Right Main Canal

The N1 Canal would cross under the Cay Gai Right Main Canal at 1.8 km point from the boundary (BP. of Van Phong N1 Extension Canal). A supply canal would branch at just upstream point of the siphon to the right bank side (eastwards) to connect the Cay Gai Main Canal at 1.2 km downstream where the water level of the Cay Gai Main Canal becomes low enough to receive the water from the N1 Canal. The design water level at the connection point would be WL.17.10 m.

(b) Water supply to La Tinh River

The Van Phong N1 Extension Canal would cross under the La Tinh River at 2.3 km point with a siphon. A diversion structure from the Van Phong N1 Extension Canal to the La Tinh River would be constructed at just upstream point of the siphon. The design water level at the diversion structure would be WL.17.40 m.

The diverted water would be used for the new development area of 480 ha in the Cay Ke System. The Cay Ke Weir would intake the water for the new development area together with it for the existing system's area.

(c) Pumping station for Phu My irrigation area

After crossing the La Tinh, the Van Phong N1 Extension Canal would run northwards and turn to eastwards at meeting with the Cay Gai Left Main Canal. Then, it would run in parallel along the right side of the Cay Gai Left Main Canal. until crossing under the national railway, the National Road 1A and the Cay Gai Left Main Canal itself with siphons.

Then, the Van Phong N1 Extension Canal would run northwards more 3.4 km and reach the proposed pumping station site at 8.4 km point, where the design water level would be WL.14.90 m. The irrigable area has been set at EL.21.0 m at the highest in the northern part. Taking into consideration of this field elevation and its location, the required water level at the outlet of the pumping station would be WL.22.50 m. Therefore, the required head of this pumping station would be 7.60 m.

(3) Tan An – Dap Da Irrigation System

The Tan An – Dap Da Irrigation System would be composed of 10 irrigation systems after the project. Out of the 10 systems, five (5) systems would take the water from the Dap Da River, three (3) are from the Go Cham River and two (2) are from the Tan An River.

Major systems are as follows:

Major Irrigation Systems in Tan An - Da Da after Project (Unit: ha)

	Irrigation System	Net Area
(i)	Tach De Right (Gravity) from Dap Da River	3,800
(ii)	Lao Tam Left from Dap Da River	750
(iii)	Thap Mao Right (Gravity) from Go Cham River	1,670
(iv)	Thanh Hoa Right from Tan An with Thanh Hoa I & II	6,650

Details of the integration or the intake unification are shown in Figures L.6 and L.7. Irrigation areas of the respective systems are schematically shown with the irrigation diagrams in Figure L.8.

(4) Tan An Extension (Lower Ha Thanh) Irrigation System

The Tan An Extension (Lower Ha Thanh) Irrigation system would be composed of two (2) irrigation systems. The canals would be connected with downstream ends of the Thanh Hoa I canal and Thanh Hoa II canal, respectively.

Irrigation Systems in Tan An Extension (lower Ha Thanh) (Unit: ha)

	Irrigation System	Net Area
(i)	Thanh Hoa I Right from Tan An River	1,580
(ii)	Than Hoa II from Tan An River	460
	Total	2,040

One is the eastern system that would receive water from the Thanh Hoa N2 Canal under the Thanh Hoa I Weir. The existing gravity and pumping system would be integrated into the new network from the Thanh Hoa I Weir.

The other is western one that would receive the water from a branch stream of the Thanh Hoa II main stream at about 2.0 km downstream point of the Thanh Hoa II Weir, which functions as a regulating gate. The intake water at the diversion point would be regulated with the existing Thong Chin Weir located at about 1.5 km downstream point in the Thanh Hoa II main stream. In the downstream reaches of the branch stream, there is one more branching point to a drainage stream. The water at this branching point would be regulated with the existing Ben Nhi Weir located at about 1.3 km downstream point in this drainage stream.

The Tan An Extension System composed of the above two (2) systems would all become

the gravity system with the project.

(5) Vinh Thanh Irrigation System

The Vinh Thanh Irrigation System would receive the water directly from the proposed Din Binh Reservoir. The irrigation area would be the sloping right bank field of the Kone River. The irrigation area would be 1,020 ha.

The Vinh Thanh Main Canal would run with rather gentle longitudinal gradient from 1:4,000 to 1:2,000. The main canal would cross under the Suoi Xem River with siphon at 9k+980 point. The branching canals from the main canal would run in perpendicular to the counter lines. The field slope in a range of 300 m to 400 m from the main canal is rather steep (1:20 to 1:50), and so many drop structures would be required for the branching canals.

(6) Southwest Kone Irrigation System

The Southwest Kone Irrigation System would be composed of six (6) pumping irrigation systems along the Kone River.

Irrigation Systems of Southwest Kone (Unit: ha)

Irrigation System	Net Area
(i) Huu Giang	350
(ii) Huong Giang	310
(iii) Binh Hoa	350
(iv) Binh Ke	1,320
(v) Hoa Lac	150
(vi) Hon Gach	180
Total	2,660

Only the Hon Gach Irrigation System would be located on the left bank side of the Kone River and others be on the right side.

The Binh Ke Irrigation System would have two (2) pumping stations. One is the intake pump on the river side. The other is the booster pump for the southern higher area. The river water level would be WL.19.0 at the lowest. The field elevation of lower area would be EL.30.0 m and it of the higher area be EL.40.0 m. Therefore, the required head would be 10.0 m each.

(7) Irrigation Facilities Design

Preliminary design of the irrigation facilities such as canals and related structures has been made with reference to “Irrigation Canal Scheme – Design Criteria (TCVN 4118-85)” and HEC-1’s design drawings.

The design gross unit irrigation water requirement to determine the capacity of the irrigation facilities has been estimated to be 1.62 l/s/ha that is the peak requirement with

75% dependability for the cropping pattern B and at 2010 year irrigation efficiency level. The irrigation efficiency at 2010 year level has been set at 0.65, which is lower than it of 0.70 of the year 2020. By the way, it for the cropping pattern A has been estimated to be 1.47 l/s/ha and it for the cropping pattern C be 1.62 l/s/ha from the 10-day basis calculation for 24 years from 1978 to 2001.

Consequently, taking a safety allowance for the future condition into account, this 1.62 l/s/ha has finally been selected to be applied for all the areas of this feasibility study.

4.3 Drainage System

(1) Tan An – Dap Da and Lower Ha Thanh

The drainage system in the Tan An – Dap Da and the Lower Ha Thanh would be closely related to the flood protection system in those areas. A period of the major floods that has been set to be two (2) and half months from the beginning of September to the middle of December have been excluded for the agricultural field drainage plan and design.

Drainage systems in the area are classified into the following five (5) groups by places where the water is drained to.

Dainage Systems in Tan An - Da Da and Ha Thanh (Unit: nos.)

Groupe by Place of Drain's BP.	System
(i) Dap Da River	10
(ii) Nam Yang River	1
(iii) Tan An River	9
(iv) Ha Thanh River	3
(v) Thi Nai Swamp	11
Total	34

More details of the drainage systems are presented in Table L.22. Drainage routes of these systems are shown in Figure L.7.

(2) Drainage System in Other Areas

Natural streams and rivers would in principle be used as main drains in the other areas. The artificial drains would convey the water to those main drains. Therefore, the drainage systems in the other areas would be developed in the on-farm systems.

(3) Drainage Facilities Design

Preliminary design of the drainage facilities such as drains and related structures has been made with reference to “Drainage Coefficient for Paddy Fields – Design Criteria (14TCN.60-88)”.

(a) Tan An – Dap Da and Lower Ha Thanh

The design drainage water requirement to determine the capacity of the drainage

facilities has been estimated to be 11.6 l/s/ha for the Tan An - Dap Da and the Lower Ha Thanh that is the requirement for 5-day drainage of 3-day consecutive rainfall with 10% probability of occurrence using the data at Quy Nhon. In these areas, the water level in the rivers such as the Dap Da, the Tan An and the Ha Thanh would continue for about three (3) days. It means that actual situation would be the same as it of 2-day drainage of 3-day rainfall. If it were converted into 5-day real drainage, it would become 4.6 l/s/ha.

(b) Other areas

The design drainage water requirement has been estimated to be 8.8 l/s/ha for the other areas that is the requirement for 5-day drainage of 3-day consecutive rainfall with 10% probability of occurrence using the data in the whole year from January to December at Cay Muong (Binh Tuong).

4.4 Farm Road System

The farm road system is considered as the road network formed with a combination of the canal inspection road and the farm road. This network would be connected with the public road network composed of the commune road, district roads, etc. with certain density. In the project area, such public roads have been well developed and the connection points from the farm road network would be expected many enough for smooth transportation for the farming activities.

Therefore, the stress has been put on the inside of the farm road network. Several link roads would newly be constructed to connect the end of the canal inspection road to the other road in a short distance for short-cut the distance. This kind of linkage would in many cases need the construction of stream crossing structures such as the bridge and the drainage culvert.

The ends of several primary and secondary canals would be linked in the new development areas such as the Van Phong Proper, the Van Phong Extension (La Tinh), etc.

5 GEOLOGY AND ENGINEERING GEOLOGY OF IRRIGATION AREAS

In this feasibility study, 3 main irrigation canals, Van Phong main canal, Vinh Thanh main canal and Ha Thanh main canal, were proposed. In order to obtain the geological conditions of the canal foundations, field reconnaissance was made for all three canal areas, and two core drilling (BC-1, BC-2) including standard penetration tests (SPT) and soil sampling were done along the Van Phong main canal, where relatively larger siphons were likely to be proposed. The locations of the core drilling are shown in Figure J.1of Appendix J, while more detailed geological logs are given in Figure J.3 of Appendix J and the test results summarized in Table J.2 of Appendix J.

5.1 Van Phong main canal

(1) Site Geology

The Van Phong main canal, 33.5 km long, originates from the Van Phong weir on the left bank. The canal first runs eastward along the foot of the hills and then northeastward through the highland of the South Binh Dinh plain, and finally stops several kilometers after crossing the National Road No. 1.

Geology of the Van Phong main canal area consists mainly of Mesozoic granite and the overlying recent deposits. The granite is barely exposed in the area and has been found to be highly weathered at the drilled depth (20 m depth). The overlying recent deposits, generally below 10 m thick, is mainly of alluvial and colluvial origins. These deposits consist mainly of gravels, sands and silty clay, and are subdivided, in terms of the sedimentary processes, origins and composition, into the following sex layers:

- **Layer 1**: Fine to coarse SAND (SP) with some coarse sub-rounded gravel and boulder. This layer, 1 to 4 m thick, loose, is scattered along the main canal and on the river terrace.
- **Layer 2**: Medium-grained silty SAND (SM) with a little fine-grained gravel, yellowish brown to greenish gray. This layer, 0.5 to 1.5 meters thick and medium dense to dense, has a limited distribution only on the lower part of the hillsides.
- **Layer 2a**: Fine to coarse-grained (2-5 mm in grain size) gravelly SAND (SG), gray to yellowish gray, 1 to 4 m thick and loose to medium dense. The layer is of alluvial origin and is below Layer 2.
- **Layer 2b**: Clayey SAND (SC), reddish brown to yellowish gray, 2 to 3 m thick and medium dense to dense. The layer, generally beneath Layer 2 is mostly found along the main canal.
- **Layer 2c**: Clayey SAND (SC) with occasional laterite gravel, brown to yellowish gray and dense to hard. The layer is occasionally found along the canal sections in thickness of 1 to 2 meters.

- **Layer 3a**: Sandy/silty GRAVEL (GM), 2 to 4 m thick, brown to gray, non-dividable elluvium-deluvium (deQ), medium dense to hard locally. This layer is distributed mainly along the hillside in the right side of the main canal.

(2) Geotechnical investigation

Soil samples were taken from boring cores and test pits along these canal layouts. Laboratory soil tests were made to obtain the geotechnical properties of the foundation soil and thereby suggest design parameters for the canal structures. The laboratory test results are summarized in the following tables.

Summary of geotechnical properties of the Van Phong main canal areas

Properties	Symbol	Unit	Layer 1	Layer 2	Layer 2a		Layer 2b		Layer 2c
			No.1	No.1	No.1	No.2	No.1	No.2	No.1
Clay (< 0.005 mm)		%	4	20	6	9	16	19	31
Silt (0,005 to 0,05 mm)		%	5	8	6	7	7	6	14
Sand (0,05 to 2 mm)		%	83	68	78	37	64	41	52
Gravel (2 to 20 mm)		%	8	4	10	46	13	34	3
Fragment (over 20 mm)		%	0	0	0	1	0	0	0
Liquid limit	LL	%	-	29.4	18.4	34.0	31.6	34.0	41.2
Plastic limit	PL	%	-	16.8	11.6	20.0	18.0	20.0	23.5
Plasticity index	PI	%	-	12.6	6.8	14.0	13.6	14.0	17.7
Natural water content	w	%	-	16.2	11.2	10.1	16.7	16.7	23.0
Degree of saturation	S	%	-	79.2	67.9	67.9	79.6	77.4	86.7
Void ratio	e	-	-	0.54	0.43	0.49	0.56	0.58	0.71
Porosity	n	%	-	35.15	29.88	32.73	35.41	36.3	41.2
Specific gravity		-	2.65	2.66	2.65	2.65	2.66	2.66	2.67
Natural unit weight	γ_t	kg/cm^3	-	2.00	2.06	1.95	2.00	1.98	1.93
Dry density	γ_d	kg/cm^3	-	1.72	1.86	1.78	1.72	1.70	1.57
Cohesion	c	kg/cm^2	0.00	0.20	0.10	0.12	0.18	0.23	0.22
Internal friction angle	ϕ'	°	25	14	23	21	18	18	14
Permeability coefficient	K	10^{-5}cm/s	800	0.1	300	50	1	1	0.1

Source: Modified from Geological Investigation Report of the Van Phong canal done by Hydraulic Investigation and Survey Company 4, May 1999.

Summary of laboratory test results conducted by JICA Study Team

Properties	Symbol	Unit	Layer 2			
			1.2 – 1.4 m	1.3 – 1.5 m	3.8 – 4.0 m	4.5 – 4.7 m
Clay (< 0.005 mm)		%	8	19	20	15
Silt (0.005 to 0,05 mm)		%	16	17	25	27
Sand (0,05 to 2 mm)		%	74	64	55	57
Gravel (2 to 20 mm)		%	2	0	0	1
Fragment (over 20 mm)		%	0	0	0	0
Liquid limit	LL	%	30.5	45.7	52.2	41.0
Plastic limit	PL	%	17.3	25.0	28.5	21.8
Plasticity index	PI	%	13.2	20.7	23.7	19.2
Natural water content	w	%	24.3	16.0	25.3	19.2
Degree of saturation	S	%	91.1	64.4	76.8	74.0
Void ratio			0.71	0.67	0.88	0.69
Porosity	n	%	41.4	40.1	46.8	74.0
Specific gravity	-	-	2.65	2.69	2.67	2.67
Natural unit weight	γ_t	kg/cm^3	1.93	1.87	1.78	1.88
Dry density	γ_d	kg/cm^3	1.55	0.20	1.42	1.58
Unconfined compressive	qu	kg/cm^2	2.04	1.82	1.20	0.93
Remarks (N value)	N	-	8	7	12	14

Note: 1 kgf/cm^2 = 10 tf/m^2 = 100 kN/m^2, 1 kgf/cm^3 = 1,000 tf/m^3 = 10,000 kN/m^3

As the above tables show, all samples for these layers had a sand content (larger than 0.05mm) of more than 50% and were thus classified as Clayey SAND (SC) to Gravelly SAND (SG) by the Unified Soil Classification System (USCA) of ASTM. Their natural unit weight and specific gravity ranged from 1.78 to 2.06 kgf/cm^3 and from 2.65 to 2.67 respectively. Its void ratio averaged 0.62. The natural water content and the liquid limit were in the range of 10% to 25% and 30% to 50%, respectively. These properties indicated that there soil layers were medium dense sand with a low to moderate plasticity.

Moreover, the shear strength of soil can be also determined from the following empirical relationship with N value:

For COHESIVE soil c_u = (0.6 to 1.0) 10N (kPa)

For SANDY soil $\phi = \sqrt{12N} + 15 \leq 45$ (degree)

As described above, Layer 2, corresponding to Sandy soil, therefore, the shear strength of each layer was estimated on the basis of the above relationship and the N value (7 – 14) of Layer 2, as follows:

$$\phi = \sqrt{12N} + 15 \leq 45 = 24 \text{ to } 29 \text{ degrees}$$

In order to determine the shear strengths of each layer, a comparison of the shear strengths obtained from the different methods was made and thereby the proper values were suggested in view of soil composition and hardness.

Comparison of shear strengths obtained from different methods

Layer No.		Soil Classification	Laboratory Test	Estimation by N value	Suggested values
1	c (kN/m^2)	SM	0	—	0
	ϕ (degree)		25	—	25
2	c (kN/m^2)	SC	20	—	0
	ϕ (degree)		14	24 – 29	25
2a	c (kN/m^2)	SG	11	—	0
	ϕ (degree)		22		25
2b	c (kN/m^2)	SC	20	—	0
	ϕ (degree)		18	—	30
2c	c (kN/m^2)	SC	22	—	0
	ϕ (degree)		14	—	30

Note: Laboratory test is the averaged testing results done by Hydraulic Investigation and Survey Company 4, May 1999.

Experienced estimate of internal friction angle cohesion for natural deposits

Material	Condition	Unit Weight (kN/m3)	Internal friction angle (Degree)	Cohesion (kN/m^2)
Rock block	Broken as common	18	40	-
Rock block	Broken as brittle	16	35	-
Gravel	Crushed	18	30	-
Cobble		18	35	-
Gravel & boulder		17	35	-
Sand		18	30	-
Soil	Common	18	30	-

Source: Manual for Slope Protection (1984), by Japan Road Association.

Layer 2 had an average unconfined compressive strength of 150kN/m^2 and an average N value of 10. Therefore, the allowable bearing capacity was estimated to be about 100 kN/m^2 on the basis of the following empirical estimate. Expect Layer 1, the other layers (Layer 2a, 2b, 2c and 3), underlying Layer 2 and generally being denser and harder than Layer 2, would be expected to have an allowable bearing capacity of more than 100 kN/m^2.

Empirical estimate of allowable bearing capacity of ground foundation

GROUND		Allowable bearing capacity (kN/m^2)	N-value	Unconfined compressive strength ($kN/m^{2)}$
Rock		1000	Over 100	—
Sandstone		500	Over 50	—
Mudstone		300	Over 30	—
Gravelly Soil	Very dense	600	—	—
	Dense	300	—	—
Sandy Soil	Very dense	300	30 - 50	—
	Dense	200	20 - 30	—
	Medium dense	100	10 - 20	—
	Loose**	50	5 - 10	—
	Very loose*	0	Less than 5	—
Cohesive Soil	Very stiff	200	15 - 30	Over 250
	Stiff	100	8 - 15	100 - 250
	Medium stiff	50	4 - 8	50 - 100
	Soft	20	2 - 4	25 - 50
	Very soft*	0	0 - 2	Less than 25
Loam	Stiff		Over 5	Over 150
	Slightly stiff		3 - 5	100 - 150
	Soft		Less than 3	Less than 100

Note) *: unsuitable for foundation, **: necessary for liquefaction consideration.
Source: Manual for Slope Protection (1984), by Japan Road Association.

(3) Geological conditions and geotechnical parameters

Ground conditions along the Van Phong main canal comprise:

Layer 1: Gravelly SAND (SG), 1.0 to 4.0m thick, loose
Layer 2: Silty SAND (SM), 0.5 to 1.5m thick, medium dense to dense
Layer 2a: Gravelly SAND (SG), 1.0 to 4.0m thick, loose to medium dense
Layer 2b: Clayey SAND (SC), 2.0 to 3.0m thick, medium dense to dense
Layer 2c: Clayey SAND (SC), 1.0 to 2.0m thick, dense to very dense
Layer 3a: Silty GRAVEL (GM), 2.0 to 4.0m thick, dense to very dense

Layers 1 and 2a, being loose, were unsuitable for the foundation of the canal. The others were considered to be hard enough to support the related structures of the proposed canal. The design parameters for the canal design are summarized in following table. The parameters of shear strength in these layers were determined by comparing these values obtained from the different methods. In addition, for clay layer, internal friction angle was assumed to be zero, while for sand layer, cohesion was assumed to be zero. Similarly, physical properties such as the unit weight and void ratio were determined by averaging the test results. Moreover, in the case of normal soil, unit weights, γ =18 kN/m^3, and buoyant unit weight, γ '=10 kN/m^3 are usually used. These conventional parameters may also be applied in this feasibility study.

Summary of the suggested design parameters for the soil foundation

Soil Layer		Recommended Design Parameters	
Layer 2 Silty SAND	**0.5 to 1.5m thick**	Natural water content (%)	20.0
		Unit weight (kN/m^3)	18.9
		Specific gravity	2.67
		Void ratio (dec)	0.70
		Allowable bearing capacity (kN/m^2)	100
		Cohesion (kN/m^2)	0
		Internal friction angle (degree)	25
Layer 2b Clayey SAND	**2.0 to 3.0m thick**	Natural water content (%)	16.7
		Unit weight (kN/m^3)	19.9
		Specific gravity	2.66
		Void ratio (dec)	0.57
		Allowable bearing capacity (kN/m^2)	100
		Cohesion (kN/m^2)	0
		Internal friction angle (degree)	30
Layer 2c Clayey SAND	**1.0 to 2.0m thick**	Natural water content (%)	23.0
		Unit weight (kN/m^3)	1.93
		Specific gravity	2.67
		Void ratio (dec)	0.71
		Allowable bearing capacity (kN/m^2)	100
		Cohesion (kN/m^2)	0
		Internal friction angle (degree)	30
Layer 3a Silty GRAVEL	**2.0 to 4.0m thick**	Natural water content (%)	-
		Unit weight (kN/m^3)	18.0
		Specific gravity	-
		Void ratio (dec)	-
		Allowable bearing capacity (kN/m^2)	100
		Cohesion (kN/m^2)	0
		Internal friction angle (degree)	30

5.2 Vinh Thanh main canal

(1) Site Geology

The Vinh Thanh main canal, 18.8 km long, comes from the Dinh Binh dam and runs along the mountainside and the toes of hill slopes parallel to the Kone River.

The Vinh Thanh main canal area, geologically similar to others, is underlain chiefly by granite and recent deposits. Some granite outcrops show the granite has undergone less weathering. The overlying recent deposits consist mainly of Layer 3a with a scattered distribution of Layers 1, 2 and 2a, as follows:

- **Layer 1**: Fine to coarse SAND (SG) with some coarse gravel, 1 to 2 m thick, loose. The layer is scattered on the riverbed of some small mountain streams.
- **Layer 2**: Medium to coarse-grained silty SAND (SM), about 1.0 m thick, medium dense, covering the small mountain river terrace.
- **Layer 2a**: Coarse sandy GRAVEL (GS), 1 to 2 m thick and loose to medium dense. The layer is of alluvial origin and is distributed along the riverbed and river terrace of

the small mountain river.

- **Layer 3a**: Sandy/silty GRAVEL (GM), generally less than 5 m thick, brown to gray, non-dividable elluvium-deluvium (deQ), medium dense to hard. This layer is found in most parts of the canal foundation.

(2) Geotechnical investigation

Soil samples were taken from boring cores and test pits along these canal layouts. Laboratory soil tests were made to obtain of the geotechnical properties of the foundation soil and thereby suggest design parameters for the canal structures. The laboratory test results are summarized in the following table.

The test results show that these layers can be classified as poorly-graded, gravel-clay sand mixtures (SG to SC) by the unified soil classification criteria of ASTM. Their natural unit weight and natural water content were 18.8 kN/m^3 and 18.8 % on average, respectively. The specific gravity varied from 2.56 to 2.67. These properties indicated it was a normal medium-dense sandy soil.

Similar to those layers along the Van Phong main canal area, these layers (Layers 1, 2, 2a, 3a and 3) would be expected to have an internal friction angle of 25 to 30 degrees and an allowable bearing capacity of 100 kN/m^2 or more.

Summary of geotechnical properties of the Vinh Thanh main canal areas

Properties	Symbol	Unit	Layer 1	Layer 2	Layer 2a	Layer 3a	Layer 3
Clay (< 0,005 mm)		%	0	21	0	14	27
Silt (0,005 to 0,05 mm)		%	0	11	0	6	9
Sand (0,05 to 2 mm)		%	68	64	13	41	52
Gravel (2 to 20 mm)		%	32	4	14	38	12
Fragment (over 20 mm)		%	0	0	73	1	0
Liquid limit	LL	%	-	31.13	-	36.56	40.59
Plastic limit	PL	%	-	19.61	-	21.13	22.73
Plasticity index	PI	%	-	12.51	-	15.44	17.86
Natural water content	w	%	-	-	-	20.56	17.1
Degree of saturation	S	%	-	78.1	-	48.4	67.9
Void ratio	e	-	-	0.70	-	0.58	0.67
Porosity	n	%	-	40.9	-	36.7	40.0
Specific gravity		-	2.65	2.67	2.66	2.56	2.67
Natural unit weight	γ_t	kg/cm^3	-	1.90	-	1.86	1.87
Dry density	γ_d	kg/cm^3	-	1.58	-	1.68	1.60
Cohesion	c	kg/cm^2	0	0.18	0	0.15	0.20
Internal friction angle	ϕ'	°	36	13	38	21	16
Permeability coefficient	K	10^{-5}cm/s	1000	2	8000	100	30

Source: Geological Investigation Report of the Vinh Thanh canal done by Hydraulic Investigation and Survey Company 4,-4, May 1999.

(3) Geological conditions and geotechnical parameters

Ground conditions along the Vinh Thanh main canal comprise:

Layer 1: Gravelly SAND (SG), 1.0 to 2.0m thick, loose

Layer 2: Silty SAND (SM), about 1.0m thick, medium dense

Layer 2a: Sandy GRAVEL (GS), 1.0 to 2.0m thick, loose to medium dense

Layer 3a: Silty GRAVEL (GM), over 5.0m thick, dense to very dense

Layers 1 and 2a were loose and were thus unsuitable for the foundation of the canal. Prior to the construction of the canal, these layers should be removed or improved.

Layers 2 and 3a, having an allowable bearing capacity of more than 100 kN/m^2, were considered to meet the stability requirements of the proposed canal. The design parameters for the canal design are summarized in following table.

Summary of the suggested design parameters for the soil foundation

Soil Layer		Recommended Design Parameters	
Layer 2 Silty SAND	**1.0m thick**	Natural water content (%)	-
		Unit weight (kN/m^3)	19.0
		Specific gravity	2.67
		Void ratio (dec)	0.70
		Allowable bearing capacity (kN/m^2)	100
		Cohesion (kN/m^2)	0
		Internal friction angle (degree)	25
Layer 3a Silty GRAVEL	**Over 5.0m thick**	Natural water content (%)	-
		Unit weight (kN/m^3)	18.0
		Specific gravity	-
		Void ratio (dec)	-
		Allowable bearing capacity (kN/m^2)	100
		Cohesion (kN/m^2)	0
		Internal friction angle (degree)	30

5.3 Ha Thanh main canal

(1) Site Geology

The Ha Thanh main canal runs mainly on the plains and occasionally along the hillsides in the downstream of the Kone River. The main canal is divided into the East and the West canals by the national road 1A. Most part of these canals already exists. Only 2.9 km of new canal system was proposed to complete the East canal in this feasibility study.

The East canal lies in the left side of the national road 1A and starts at the Thach Hoa weir on the Tan An river, a tributary of the Kone River. Along the first 10 km, the old canal, which currently under exploitation, would be used and a new canal of 2.9 km cutting across the Ha Thanh river would complete the East canal. This canal runs through the districts of Tuy Phuoc and Qui Nhon City.

The West canal originates from the Ganh river, also a tributary of the Kone River and uses an old canal to supply water to the irrigation areas in the Tuy Phuoc district.

The newly proposed canal is on the plains, which are covered by the thick recent deposits of alluvial origin. These recent deposits are summarized as follows:

- **Layer 2a**: Clayey/Silty SAND (SC) with some gravel of 2 to 5 mm in grain size, light gray to greenish gray and loose to very loose.
- **Layer 2b**: Clayey SAND (SC) with small gravel, reddish brown to yellowish gray, medium dense to dense, and generally more than 5.0 m thick.
- **Layer 2c**: Clayey SAND (SC) with occasional laterite gravel, brown to yellowish gray, dense to hard, more than 5.0 m thick.
- **Layer 2d**: Sandy/silty CLAY (CS), yellowish brown to yellow, Firm to stiff, more than 5.0 thick.

(2) Geotechnical investigation

No testing results were available to evaluate the geotechnical properties of the soil foundation for the Ha Thanh main canal. However, as stated before, these soil layers to support the canal were generally medium dense to hard (Layers 2b and 2c) or firm to stiff (Layer 2d), except Layer 2a that was in the loose to very loose state. Therefore, Layers 2b, 2c and 2d could be used as the soil foundation of the Ha Thanh main canal and would be expected to have an allowable bearing capacity of more than 100 kN/m^2 (for Layers 2b and 2c) or 50-100 kN/m^2 (for Layer 2d), following the empirical estimate of allowable bearing capacity of ground foundation shown before.

(3) Geological conditions and geotechnical parameters

Ground conditions along the Ha Thanh main canal comprise:

Layer 2a: Clayey SAND (SC), 2.0 to 5.0m thick, very loose to loose
Layer 2b: Clayey SAND (SC), over 5.0m thick, medium dense to dense
Layer 2c: Clayey SAND (SC), over 5.0m thick, dense to very dense
Layer 2d: Sandy CLAY (CS), over 5.0m thick, firm to stiff

Except Layer 2a, the other soil layers were medium dense to very dense or firm to stiff and were thus considered to be suitable for the foundation of the proposed canal. The design parameters for the canal design are summarized in following table.

Summary of the suggested design parameters for the soil foundation

Soil Layer		Recommended Design Parameters	
Layer 2b Clayey SAND	**Over 5.0m thick**	Natural water content (%)	-
		Unit weight (kN/m^3)	18.0
		Specific gravity	-
		Void ratio (dec)	-
		Allowable bearing capacity (kN/m^2)	100
		Cohesion (kN/m^2)	0
		Internal friction angle (degree)	25
Layer 2c Clayey SAND	**over 5.0m thick**	Natural water content (%)	-
		Unit weight (kN/m^3)	18.0
		Specific gravity	-
		Void ratio (dec)	-
		Allowable bearing capacity (kN/m^2)	100
		Cohesion (kN/m^2)	0
		Internal friction angle (degree)	30
Layer 2d Sandy CLAY	**Over 5.0m thick**	Natural water content (%)	-
		Unit weight (kN/m^3)	18.0
		Specific gravity	-
		Void ratio (dec)	-
		Allowable bearing capacity (kN/m^2)	50
		Cohesion (kN/m^2)	50
		Internal friction angle (degree)	0

6 CONSTRUCTION PLAN AND SCHEDULE FOR VAN PHONG WEIR AND IRRIGATION AND DRAINAGE SYSTEM

Basic conditions and consideration for implementation program are mentioned in Sections 1.1 and 1.2 of Appendix G.

6.1 Construction Plan

(1) Outline of Van Phong Weir and Irrigation and Drainage System

Based on the supply of irrigation water for the southern cultivated land of Binh Dinh Province and recommendation to rehabilitate and modernize the irrigation and drainage system, the following facilities are contemplated as the priority plan.

(i) Van Phong Weir
  (a) Weir
    - Total length: 525.0 m
    - Crest elevation: 25.5 m
  (b) Scouring sluice
    - Dimension: 2.75 m (W) x 2.75 m (H) x 2 nos
  (c) Intake facilities
    - Dimension: 2.75 m(W) x 2.75 m (H) x 2 nos

(ii) Rehabilitation Works of Existing Weirs (7 weirs)

(iii) Construction Works of New Pumping Station (6 places)

(iv) Improvement of Existing Function (16,200 ha)
  (a) Concrete Lining
  (b) Measuring Devices

(v) Rehabilitation and Improvement for Non-Function Area (3,400 ha)
  (a) Earthworks
  (b) Concrete Works
  (c) Gate Structures

(vi) Construction of New Development Area (17,800 ha)
  (a) Main Canal
  (b) Primary Canal
  (c) Secondary Canal
  (d) Tertiary Canal
  (e) Related Works
    - Turnout
    - Check Gate
    - Cross Drainage Culvert
    - Road Culvert
    - Siphon

- Aqueducts
- Vehicle Bridge
- Foot Bridge
- Side Spillway
- Drop Structure

(2) Implementation Plan

Major works comprise preparatory works, Van Phong weir, rehabilitation works of existing weirs, Construction works of new pumping station, improvement of existing function, rehabilitation and improvement for non-function area and construction of new development area.

(i) Preparatory Works

Preparatory works such as accommodation, site offices, motor pool, repair shop, warehouse, power supply system, water supply system, telecommunication system, temporary access road, concrete plant, cement silo, aggregate plant, etc. will be made before the works

(ii) Van Phong Weir

(a) River Diversion Works

The river diversion works will be carried out in two (2) stages as given below:

First Stage River Diversion;

The left bank is enclosed by cofferdam, and the river flows in the right side, and the Block No. 1 to 10, scouring sluice and intake facilities will be constructed.

The construction period for 1st stage is assumed to be about 1.9 years.

Second Stage River Diversion;

Before second stage river diversion, the first stage cofferdam will be removed, then the remaining right bank is enclosed by cofferdam, the river flows into the scouring sluice.

The Block No. 11 to 24 will be constructed. Construction period for 2nd stage is also assumed to be about 2.3 years.

(b) Cofferdams

The Van Phong weir will be constructed by two (2) stages coffer system.

The cofferdam materials for each stage will be obtained from river deposit material located upstream of weir.

The construction of cofferdams will be done using 5.4 m3 wheel loader, 32 ton

bulldozers, 32 ton dump trucks and 10 ton vibration roller.

After the cofferdam is completed, the steel sheet piles with a length of about 19 m and type IV will be driven along the cofferdam crest to protect the seepage water from river bed.

The surface of cofferdam will be protected by the concrete with a thickness of 0.1 m.

The stagnant water inside the cofferdam will be drained using Dia. 200 mm submersible pumps.

The cofferdams will be removed after completion of 1st stage works using same equipment.

(c) Excavation of Weir

The excavation works will be carried out using 5.4 m3 wheel loader, 1.2 m3 backhoes, 32 ton bulldozers with ripper and 32 ton dump trucks.

The materials excavated will be hauled to the stockpile and these materials will be used for 2nd stage cofferdam.

(d) Reinforced Concrete and Interior Mass Concrete of Weir

A total concrete volume is about 96,000 m3.

The reinforced concrete and mass concrete will be placed during 2.9 years.

The transverse joints of concrete block is assumed to be a 20 m.

The full lift of concrete is 1.5 m and 0.75 m of half lift is applied for weir foundation.

A cycle of full lift and half lift is assumed to be at least 5 days and 3 days respectively.

1 no. of 50 ton (1.5 m3 concrete bucket) crawler crane are planned as the concrete placing equipment considering the site conditions.

After the completion of excavation, the assembling of forms and reinforcement bar is performed, then the concrete will be placed using 1 no of 50 ton crawler crane with 1.5 m3 concrete bucket.

The weir construction facilities are planned as follows:

<u>During 1st Stage Construction (critical works)</u>

Volume: about:	48,000 m3
Construction Period:	17 months

Hourly Required Placing Capacity: 48,000m3/(17m*18.2d*10h)=15.5m3/h

- Concrete placing: 50 ton (1.5 m3 concrete bucket) crawler cranes
  Q =60*q*E/Cm = 60*1.5*0.55/2.8 = 17.6 m3/h >
  15.5 m3/h, 1 no
- Aggregate plant: 15.5 m3*2.1 t*1.5(peak)=50 t/h
- Concrete plant: 0.75 m3 x 2 =1.5 m3
  Q=60*q*2*E/2.7=60*0.75*2*0.9/2.7=30 m3/h
- Cement silo: 15.5 m3*10 h*1.5*210 kg*3days*1.1/1,000 kg
  = 200 t
- Transportation: 1.5 m3 transfer car
  Q=60*1.5m3/Cm=60*1.5/15.3=5.9 m3/h
  N=15.5m3/5.9m3=3 units
- Compaction: Concrete vibrator D130 mm x 3 nos

(e) Scouring Sluice and Intake Facilities

The foundation excavation will be carried out using 0.6 m3 backhoe and 10 ton dump trucks, and the excavated materials will be hauled to the stockpile area.

Succeeding the assembling of forms and reinforcing bar is carried out, then the concrete will be placed using 40-45 m3 concrete pump car, 4.5 m3 agitator trucks and Dia. 60 mm concrete vibrators.

After completion of concrete works, the gate installation works will be done using 10 ton truck crane.

The hydromechanical works will be designed and fabricated at the contractor's and/or subcontractor's factory.

Inland transportation will be done using 10 ton trucks. For the installation of hydromechanical works, 10 ton class truck crane will be used.

Installation period of scouring and intake gates is estimated at approximately 2 months respectively.

The work sequence of gate structure is (a) survey of setting out, (b) erection of guide frame, (c) assembly of gate leaf, (d) erection of hoist and wire rope, (e) repair painting and adjustment and (f) test operation.

The backfill materials will be excavated and hauled from the stockpile, and the materials will be compacted using 0.6 m3 backhoe, 60-100 kg tampers and 1 ton vibration roller.

(iii) Rehabilitation Works of Existing Weirs

Rehabilitation works of existing weirs comprise the strengthening of weir body,

foundation treatment, stoplog guide frames, etc.

Before starting the works, the cofferdam will be provided surrounding working area of rehabilitation works.

(a) Strengthening of Weir Body

The surface of weir body is picked and broken by using 7 kg pick hammers and 20 kg concrete breakers.

After the cleaning of debris, the form is assembled, and the mortar concrete is poured and spread on the surface of existing weir. Succeeding the weir concrete is placed on the mortar concrete by using 50 ton crawler crane equipped with 1.5 m3 concrete bucket and vibrators.

(b) Foundation Treatment

In order to consolidate of weir foundation, the consolidation grout will be carried out in the all weir foundation.

(c) Stoplog Guide Frames

Demolishing of guide frames will be carried out by using 7 kg pick hammers and 20 kg concrete breakers.

After removing guide frame and debris, the form works and 1st stage concrete works are performed, then the new guide frames are installed. Finally the 2nd stage concrete will be pourd.

(iv) New Pumping Station

The main component of new pumping station is pumping station building with suction pits, pumps, valves, pipes and powerline.

The foundation concrete is provided for each pump.

For the operation and maintenance works, the chain block with a trolley will be provided in the pumping station.

(v) Improvement of Existing Function

Main works is to provide the concrete lining in the existing canals and the measuring devices.

The three (3) faces concrete lining works will be planned each 200 m canal length. The coffer dike made by sand bags will be provided temporarily at the upstream and downstream portions.

After completion of foundation trimming, the concrete lining is planned to be about 4 m span interval. The concrete will be produced by 0.4 m3 portable concrete mixer with

manpower material delivery and transported to the placing site using one wheel buggy, and then the concrete is unloaded on the canal slope through chute.

The concrete placement will be done with scoop by manpower and pocked and squeezed by trowel.

The construction period of 200 m long three (3) faces concrete lining section is estimated at about 1.5 months.

The measuring device made by the small concrete weir is planned between sluice gate and canal.

These works will be done by manpower.

(vi) Rehabilitation and Improvement for Non-Function Area

Main works is the earthworks, concrete and gate structures in the existing canal.

The majority of earthworks is re-shaping of dike. To assure the uniformity between the existing dike and embankment of re-shaping, the slope on the existing dike forms in step shape by manpower, then the embankment of re-shaping will be carried out using 100 kg class soil compactors.

The major works of concrete works is three (3) faces concrete lining.

The construction method of three (3) faces concrete lining works is similar to paragraph (v).

Gate structure works is the replacement of sluice gate due to deteriorate the function and its life.

Hoists, wire rope, stoplogs and gate leafs are removed, and the civil structure and guide frames will be demolished using 7 kg pick hammers and 20 kg concrete breakers. After cleaning the concrete debris, the construction of new sluice gates will be conducted.

The construction method of hydromechanical works is similar to paragraph (ii).(e).

(vii) Construction for New Development Area

Major works consist of main canal, primary canal, secondary canal and tertiary canal.

(a) Cofferdam for Intake Structure

The cofferdam surrounding intake structure will be provided by utilizing of river deposit materials.

The works will be carried out using 1.2 m3 backhoe, 21 ton bulldozer, 11 ton bulldozer and 10 ton dump trucks.

(b) Intake Structure

The foundation excavation will be carried out using 0.6 m3 backhoe and 10 ton dump trucks, and the excavated materials will be hauled to the stockpile area.

Succeeding the assembling of forms and reinforcing bar is carried out, then the concrete will be placed using 40-45 m3 concrete pump car, 4.5 m3 agitator trucks and Dia. 60 mm concrete vibrators.

After completion of concrete works, the gate installation works will be done using 10 ton truck crane.

The backfill materials will be excavated and hauled from the stockpile, and the materials will be compacted using 0.6 m3 backhoe, 60-100 kg tampers and 1 ton vibration roller.

The construction method of hydromechanical works is similar to paragraph (ii).(e).

(c) Main Canal, Primary Canal and Secondary Canal

The works consist of stripping top soil, excavation of canal, embankment of dike, three (3) faces concrete lining inside canal and wet masonry. These works will be carried out in dry season.

The stripping top soil will be made using 11 ton bulldozers, 0.6 m3 backhoe and 10 ton dump trucks.

The excavation of canal will be done by a combination of 0.6 m3 backhoe, 0.35 m3 backhoe (slope work) and 10 ton dump trucks, and the excavated materials will be stockpiled along canal route for the purpose of embankment works. The surplus material will be hauled to the spoil bank.

The stockpiled materials along canal will be loaded and hauled to the embankment site using 1.5 m3 class tractor shovel, then the unloaded materials are spread and compacted with a thickness of about 0.2 m by 11 ton class bulldozer.

The construction method of three (3) faces concrete lining works is similar to paragraph (v).

The slope protection is made by rock masonry. The stone materials are obtained from the mountain quarry site.

Before commencement of slope protection works, the coffer will be provided along the slope protection. The foundation works of canal bed will be firstly constructed, and the side slope of dike is thoroughly trimmed by manpower, then the rock masonry works will be conducted by manpower and equipment.

(d) Tertiary Canal and Under Canal System

The main works are construction of gate structures, excavation and concrete lining

of tertiary canal and drain and excavation of on-firm works. These works will be carried out in dry season.

Construction works of gate structures consist of excavation of structure, foundation works, concrete works and gate installation.

The excavation of gate structures will be done using 0.35 m3 class backhoe, and the gravel is spread on the foundation by manpower. After assembly of forms and reinforcement, the concrete will be placed and compacted using Dia. 60 mm concrete vibrators. Succeeding the gate installation will be made using 4.5 ton truck crane. The construction period is estimated at 0.5 months.

The excavation of tertiary canal and drain will be made by 0.35 m3 class backhoe. The materials excavated are used as the embankment materials as much as possible.

A U-type precast concrete flumes are planned as the concrete lining of tertiary canal.

The precast U- type flume supplied by contractors will be installed in the designated position using 10-25 ton class truck crane.

The manufacturing of U-type flume is planned to be about 2 m length. The construction period for 200 m long U-type flume is assumed to be 1.0 months

The excavation of on-farm works will be done by manpower.

(e) Related Works

i) Turnout and Check gate

The works will be done during dry season. The foundation excavation will be carried out by a combination of 0.6 m^3 backhoe, 10 ton dump truck and 11 ton bulldozer.

To secure the dry conditions in the foundation, the drain pit and a D100 mm submersible pump will be provided.

The leveling concrete will be hauled by 3.0 m^3 agitator truck and placed by means of chute method.

Subsequently the assembling of form and reinforcing bar will be made on the leveling concrete, then the structural concrete will be placed by a fleet of 3.0 m^3 agitator truck and ϕ 60 mm concrete vibrators. Wet rubble masonry is set on the specified level and slope.

After the curing of structural concrete, the installation of gate and hoist will be done by 10 ton truck crane.

Embankment and backfill materials will be utilized from the excavated materials to be stocked in the temporary stockyard.

Excavation for embankment and backfill materials will be done by using 0.6 m^3 backhoe and hauled to the embankment and backfill sites. The embankment materials is spread by manpower compacted with a thickness of about 0.2 m by 100 Kg class soil compactors. The backfill material will be performed by using 0.6 m^3 backhoe and 80 Kg tamper.

ii) Cross Drainage Culvert, Road Culvert and Siphon

The works are carried out during dry season.

The steel sheet pile with a length of 10.0 m and type IV will be driven in the upstream and downstream of working area by using 45 Kw vibratory hammer with 40 ton crawler crane, 20 ton truck crane and 150 KVA diesel generator as a temporary ground support and protection of seepage water.

The foundation excavation will be carried out by a combination of 0.6 m^3 backhoe, 10 ton dump truck and 11 ton bulldozer.

To secure the dry conditions in the working area, the drain pit and a D100 mm submersible pump will be provided.

After foundation excavation, the leveling concrete for the structure will be hauled by 3.0 m^3 agitator truck and placed by means of chute method.

Succeeding the assembling of form and reinforcing bar will be made on the leveling concrete, then the structural concrete will be placed by a fleet of 3.0 m^3 agitator truck and ϕ 60 mm concrete vibrators.

Embankment and backfill materials will be utilized from the excavated materials to be stocked in the temporary stockyard.

Excavation for embankment and backfill materials will be done by using 0.6 m^3 backhoe and hauled to the embankment and backfill sites. The embankment materials is spread by 4 ton bulldozer and compacted with a thickness of about 0.2 m by using 0.5 – 1 ton vibratory roller.

The backfill materials will be performed by using 0.6 m^3 backhoe and 80 Kg tamper.

iii) Aqueducts, Vehicle Bridges and Foot Bridges

The works of these structures are carried out during dry season. Rough excavation of these structures will be made until level of reinforced concrete piles by using 0.6 m^3 backhoe and the excavated materials is hauled to the temporary stockyard by

using 10 ton dump trucks.

To secure the dry conditions in these structure foundations, the drain pit and a D100 mm submersible pump will be provided.

Considering narrow working area, the concrete pile works will be firstly constructed. The reinforced concrete piles (RC Pile) with a square of 250 x 250 mm will be driven in the foundation of these structures by a fleet of 1.3 ton diesel pile hammer with base machine together with a pile follower and 35 ton crawler crane. The RC piles will be procured from the pile manufacturer and supplier.

The cofferdams will be provided in the upstream and downstream working area of these structures by using 0.6 m3 backhoe, 11 ton bulldozer and 10 ton dump trucks.

Succeeding the treatment of pile head will be made and leveling concrete will be thoroughly placed on the piling head.

After assembling of form and reinforcement, concrete will be placed by using conventional equipment such as 3.0 m^3 agitator truck, 40 – 45 m^3 concrete pump and ϕ 60 mm concrete vibrators.

After finishing the concrete works, the embankment works will be carried out by using 0.6 m^3 backhoe, 10 ton dump truck, 80 Kg tamper and 80 Kg plate compactor.

An installation works of railing for vehicle and foot bridges will be done by manpower.

The erection works of steel pipes for aqueducts will be performed using 30 ton class truck crane.

iv) Side Spillway and Drop Structure

To secure the dry conditions in the working area, the drain pit and a D100 mm submersible pump will be provided.

Succeeding the leveling concrete will be hauled by 3.0 m^3 agitator truck and placed by means of chute method.

Subsequently the assembling of form and reinforcing bar will be made on the leveling concrete, then the structural concrete will be placed by a fleet of 3.0 m^3 agitator truck and ϕ 60 mm concrete vibrators.

Wet cobble masonry is set on the specified level and slope.

Minor earthworks are included, and these works are performed by manpower.

6.2 Construction Time Schedule

The construction period for Van Phong weir and irrigation and drainage system is

estimated at 5.0 years in the feasibility report, HEC-1.

While, the construction period for the proposed Van Phong weir and irrigation and drainage system is examined and also assumed to be 5.0 years.

The construction works will be performed by the contractor to be selected by international tendering process and its commencement year is scheduled at beginning of year 2007 for preparatory works and main works.

The construction time schedule include mobilization, preparatory works, civil works and building works..

The proposed construction time schedule for Van Phong weir and irrigation and drainage system is shown in Figure L.9.

7 COST ESTIMATE OF VAN PHONG WEIR AND IRRIGATION AND DRAINAGE SYSTEM

7.1 Basic Conditions

(1) Price Level and Exchange Rate

The construction cost is estimated based on the price level of December, 2001 and the applied foreign exchange rates are as shown below:

- US$ 1.00 = VND 15,068
- J. Yen 100 = VND 12,212
- As of December 3, 2001

(2) Foreign and Local Currencies

The estimated cost is composed of foreign currency portion and local currency portion and both currencies are expressed in Vietnamese Dong. The total amount is converted into US dollars.

(3) Physical Contingency

The physical contingency is provided to cope with the unforeseen physical conditions. The physical contingency is assumed to be 10 % for the sum of construction cost, resettlement cost, engineering service cost and administration cost.

(4) Price Contingency

The price escalation is given with the rate of 4.9 % per annum for the local currency portion and 1.6 % per annum for the foreign currency portion considering of the consumer price index in Vietnam in 2002 and recent JBIC financed projects.

(5) Value Added Tax

Value Added Tax (VAT) is estimated at 5 % of total construction cost, engineering cost, administration cost and price escalation.

(6) Local Currency Component and Foreign Currency Component

The local currency component covers the costs of locally available materials, including cement, reinforcement bars, fuel, local labors and local equipment.

The costs of imported associated mechanical works, associated electrical works, technical guidance engineers and technicians are allocated into the foreign currency component. The ratio for foreign and local currency portions is assumed to be 50.3 % and 49.7 % respectively reflecting on-going JBIC Projects.

(7) Engineering Services

Scope of engineering services for the Project will cover the whole works, including the

detailed design, preparation of bidding documents, tendering process and supervisory works during construction and until the end of completion of the Project.

7.2 Direct Construction Cost

(1) General Items

General items consist of insurance and contractor's preparatory works. Insurance include insurance of works and contractor's equipment, third party insurance and insurance for accident or injury to workmen. Contractor's preparatory works comprise providing engineer's temporary offices, first-aid station, providing accommodations and vehicles for engineer, contractor's temporary buildings, water supply system, electric power supply system, telecommunication system, sewerage and drainage system, temporary access roads and contractor's testing laboratory.

General cost is estimated at 5 % of total construction cost.

(2) Unit Prices

The unit prices for the major work items are prepared referring to the collected cost data from the completed project or on-going project or feasibility study report on Dinh Binh Reservoir Project (No. 444C-10-T1, June 2000, HEC-1).

The unit prices for each work item consist of labor cost, material cost, equipment cost and contractor's overhead expenses and profit.

7.3 Indirect Construction Cost

(1) Resettlement Cost

Resettlement cost for Van Phong weir and canal systems is reported in the feasibility report, HEC-1.

Total number of affected household is 713 households.

Total resettlement cost is estimated at 79,294 million VND on the basis of the feasibility report comprising Van Phong weir, Van Phong canal, Vinh Thanh canal, Ha Thanh canal and La Tin.

Unit average investment cost per household is 111.2 million VND.

(2) Engineering Service Cost

The engineering service cost is estimated to be 10 % of total construction cost comprising 5 % of detailed design and 5 % of construction supervision.

(3) Administration Cost

The cost for the project administration by the Government office is assumed to be 3 % of total construction and resettlement cost.

7.4 Project Cost

The project cost consists of direct cost and indirect cost. The direct construction cost comprises the general items, civil works, building works, mechanical and electrical works. The indirect cost includes the resettlement, engineering service, administration, price contingency and physical contingency. The total project cost is estimated at 740,893 million VND equivalent to 49.2 million US$ in foreign currency portion and 1,147,302 million VND equivalent to 76.1 million US$ in local currency portion, in total 1,888,195 million VND equivalent to 125.3 million US$.

Breakdown of the overall project cost are shown in Table L.23 and summarized as follows:

Overall Project Cost (Unit: Million VND, Million US$)

Description	F.C. Portion	L.C. Portion	Total
1. Direct Construction Cost			
1.1 General Items	25,741	25,434	51,175
1.2 Van Phong Weir			
(1) Weir	83,171	82,179	165,350
(2) Scouring Sluice	2,021	1,997	4,018
(3) Intake Facilities	3,838	3,792	7,631
(4) Flood Dike	4,939	4,880	9,819
Sub-total	93,969	92,848	186,817
1.3 Rehabilitation Works of Existing Weirs	36,544	36,108	72,652
1.4 New Pumping Station	14,746	14,570	29,316
1.5 Main Irrigation System	153,914	152,078	305,992
1.6 Primary and Secondary Irrigation System	142,656	140,955	283,611
1.7 Drainage System	34,177	33,769	67,946
1.8 Farm Road Network	4,147	4,097	8,244
1.9 On-farm System (Irrigation, Drainage and			
Farm Road facilities)	34,668	34,254	68,923
Total of 1	540,562	534,114	1,074,676
Equivalent to US$	35.9	35.4	71.3
2. Indirect Construction Cost			
2.1 Resettlement Cost	0	79,294	79,294
2.2 Engineering Cost	54,056	53,411	107,468
2.3 Administration	0	34,619	34,619
2.4 Price Escalation (F.C: 1.6 %, L.C: 4.9%)	78,921	294,563	373,484
2.5 Physical Contingency (10 %)	67,354	99,600	166,954
Total of 2	200,331	561,487	761,818
Equivalent to US$	13.3	37.3	50.6
Total of 1 & 2	740,893	1,095,601	1,836,494
Equivalent to US$	49.2	72.7	121.9
3. VAT (5 %)	0	78,838	78,838
Equivalent to US$	0	5.2	5.2
4. Total of 1 to 3	740,893	1,174,439	1,915,332
Equivalent to US$	49.2	77.9	127.1

7.5 Disbursement Schedule

The disbursement schedule of the project cost is estimated taking into account of the

construction time schedule. The annual disbursement schedule of the project cost is shown in Table L.24 and summarized below.

Disbursement Schedule of Overall Project Cost (Unit : Million VND)

Year	F.C. Portion	L.C. Portion	Total
2003	0	33,091	33,091
2004	0	34,253	34,253
2005	10,138	48,293	58,431
2006	9,012	31,298	40,310
2007	149,886	200,211	350,097
2008	147,640	203,585	351,225
2009	142,685	203,245	345,930
2010	144,968	212,990	357,958
2011	136,564	207,473	344,037
Total	740,893	1,174,439	1,915,332

Table L.1 List of Communes and Demographic Condition in the Study Area of Feasibility Study

	District or City	Ward/ Subtown/ Commune	Local Administration				Area (sq. km)	Population Sensus 1999						Population 2001					
			Ward	Sub-Town	Commune	Total		Total	Male	Female	House-hold	Family size	Density	Total	Male	Female	House-hold	Family size	Density
1	Qui Nhon	City	2	0	0	2	24.49	34,700	16,800	17,800	7,000	5.0	1,417	36,100	17,500	18,600	7,300	5.0	1,474
2	An Lao	District	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-
3	Hoai Nhon	District	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-
4	Hoai An	District	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-
5	Phu My	District	0	1	5	6	170.36	71,000	34,000	37,100	15,600	4.6	417	73,100	35,000	38,200	16,100	4.6	429
6	Vinh Thanh	District	0	0	2	2	128.52	10,600	5,200	5,400	2,300	4.6	82	10,800	5,200	5,500	2,400	4.6	84
7	Phu Cat	District	0	1	12	13	508.43	144,900	70,100	74,700	31,800	4.6	285	148,900	71,800	77,100	32,700	4.6	293
8	Tay Son	District	0	0	10	10	453.33	84,600	40,700	43,900	18,500	4.6	187	86,500	41,600	44,800	18,900	4.6	191
9	An Nhon	District	0	2	9	11	125.88	143,400	69,300	74,100	32,000	4.5	1,139	147,600	71,400	76,200	33,000	4.5	1,173
10	Tuy Phuoc	District	0	2	11	13	216.77	176,000	85,600	90,400	37,800	4.7	812	181,500	87,900	93,600	39,000	4.7	837
11	Van Canh	District	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-
Total of Province			**2**	**6**	**49**	**57**	**1,627.78**	**665,100**	**321,700**	**343,400**	**145,000**	**4.6**	**409**	**684,500**	**330,400**	**354,000**	**149,400**	**4.6**	**421**
14	Qui Nhon	Hai Cang	1	-	-	-	9.81	19,166	9,226	9,940	3,995	4.8	1,954	20,064	9,660	10,410	4,182	4.8	2,045
15	Qui Nhon	Nhon Binh	1	-	-	-	14.68	15,489	7,599	7,890	3,035	5.1	1,055	16,044	7,870	8,170	3,144	5.1	1,093
Total of Qui Nhon City			**2**	**0**	**0**	**2**	**24.49**	**34,655**	**16,825**	**17,830**	**7,030**	**4.9**	**1,415**	36,108	17,530	18,580	7,326	4.9	1,474
1	Phu My	Phu My	-	1	-	-	11.10	11,326	5,382	5,944	2,499	4.5	1,020	11,800	5,610	6,190	2,604	4.5	1,063
14	Phu My	My Chanh	-	-	1	-	46.19	19,370	9,277	10,093	3,886	5.0	419	19,800	9,480	10,320	3,972	5.0	429
16	Phu My	My Quang	-	-	1	-	20.28	7,225	3,442	3,783	1,581	4.6	356	7,436	3,540	3,890	1,627	4.6	367
17	Phu My	My Hiep	-	-	1	-	55.46	14,466	6,889	7,577	3,587	4.0	261	14,997	7,140	7,860	3,719	4.0	270
18	Phu My	My Tai	-	-	1	-	28.62	11,629	5,528	6,101	2,614	4.4	406	11,910	5,660	6,250	2,677	4.4	416
19	Phu My	My Cat	-	-	1	-	8.71	7,013	3,442	3,571	1,441	4.9	805	7,200	3,530	3,670	1,479	4.9	827
Total of Phu My District			**0**	**1**	**5**	**6**	**170.36**	**71,029**	**33,960**	**37,069**	**15,608**	**4.6**	**417**	73,143	34,960	38,180	16,078	4.6	429
5	Vinh Thanh	Vinh Hao	-	-	1	-	60.17	2,746	1,389	1,357	630	4.4	46	2,588	1,310	1,280	594	4.4	43
6	Vinh Thanh	Vinh Quang	-	-	1	-	68.35	7,884	3,798	4,086	1,704	4.6	115	8,165	3,930	4,230	1,765	4.6	119
Total of Vinh Thanh District			**0**	**0**	**2**	**2**	**128.52**	**10,630**	**5,187**	**5,443**	**2,334**	**4.6**	**83**	10,753	5,240	5,510	2,358	4.6	84
1	Phu Cat	Ngo May	-	1	-	-	7.55	10,672	5,105	5,567	2,471	4.3	1,414	11,172	5,345	5,827	2,587	4.3	1,480
2	Phu Cat	Cat Son	-	-	1	-	113.40	4,633	2,260	2,373	1,039	4.5	41	4,780	2,331	2,449	1,072	4.5	42
3	Phu Cat	Cat Minh	-	-	1	-	25.05	15,800	7,580	8,220	3,130	5.0	631	16,090	7,605	8,485	3,187	5.0	642
4	Phu Cat	Cat Tai	-	-	1	-	38.70	10,532	4,998	5,534	2,539	4.1	272	10,799	5,105	5,694	2,603	4.1	279
6	Phu Cat	Cat Lam	-	-	1	-	69.42	6,900	3,307	3,593	1,512	4.6	99	7,113	3,418	3,695	1,559	4.6	102
7	Phu Cat	Cat Hanh	-	-	1	-	44.16	14,922	7,213	7,709	3,569	4.2	338	15,228	7,245	7,983	3,642	4.2	345
10	Phu Cat	Cat Hiep	-	-	1	-	41.02	7,221	3,513	3,708	1,650	4.4	176	7,415	3,602	3,813	1,694	4.4	181
11	Phu Cat	Cat Trinh	-	-	1	-	47.55	12,630	6,124	6,506	2,820	4.5	266	13,011	6,311	6,700	2,905	4.5	274
12	Phu Cat	Cat Nhon	-	-	1	-	38.55	10,274	4,913	5,361	2,221	4.6	267	10,569	5,044	5,525	2,285	4.6	274
14	Phu Cat	Cat Tuong	-	-	1	-	29.14	16,255	7,944	8,311	3,349	4.9	558	16,685	8,142	8,543	3,438	4.9	573
15	Phu Cat	Cat Tan	-	-	1	-	28.02	15,745	7,880	7,865	3,564	4.4	562	16,226	8,125	8,101	3,673	4.4	579
16	Phu Cat	Cat Tien	-	-	1	-	17.34	10,662	5,152	5,510	2,133	5.0	615	10,972	5,291	5,681	2,195	5.0	633
17	Phu Cat	Cat Thang	-	-	1	-	8.53	8,612	4,124	4,488	1,791	4.8	1,010	8,863	4,285	4,578	1,843	4.8	1,039
Total of Phu Cat District			**0**	**1**	**12**	**13**	**508.43**	**144,858**	**70,113**	**74,745**	**31,788**	**4.6**	**285**	148,923	71,849	77,074	32,683	4.6	293
2	Tay Son	Binh Tan	-	-	1	-	110.30	5,940	2,849	3,091	1,337	4.4	54	6,066	2,910	3,160	1,365	4.4	55
3	Tay Son	Tay Thuan	-	-	1	-	97.19	7,629	3,674	3,955	1,586	4.8	78	7,838	3,770	4,060	1,629	4.8	81
4	Tay Son	Binh Thuan	-	-	1	-	40.80	7,775	3,731	4,044	1,748	4.4	191	7,972	3,830	4,150	1,792	4.4	195
5	Tay Son	Tay Giang	-	-	1	-	73.52	12,396	5,970	6,426	2,529	4.9	169	12,630	6,080	6,550	2,577	4.9	172
6	Tay Son	Binh Thanh	-	-	1	-	55.32	10,953	5,237	5,716	2,510	4.4	198	11,254	5,380	5,870	2,579	4.4	203
7	Tay Son	Tay An	-	-	1	-	10.40	5,482	2,643	2,839	1,296	4.2	527	5,521	2,660	2,860	1,305	4.2	531
8	Tay Son	Binh Hoa	-	-	1	-	13.80	8,475	4,112	4,363	1,916	4.4	614	8,650	4,200	4,450	1,956	4.4	627
9	Tay Son	Binh Tuong	-	-	1	-	37.70	12,565	6,131	6,434	2,480	5.1	333	12,831	6,260	6,570	2,533	5.1	340
10	Tay Son	Tay Vinh	-	-	1	-	7.10	7,209	3,435	3,774	1,669	4.3	1,015	7,376	3,510	3,860	1,708	4.3	1,039
11	Tay Son	Tay Binh	-	-	1	-	7.20	6,184	2,958	3,226	1,408	4.4	859	6,331	3,030	3,300	1,441	4.4	879
Total of Tay Son District			**0**	**0**	**10**	**10**	**453.33**	**84,608**	**40,740**	**43,868**	**18,479**	**4.6**	**187**	86,469	41,630	44,830	18,885	4.6	191
1	An Nhon	Binh Dinh	-	1	-	-	6.12	16,884	8,053	8,831	3,900	4.3	2,759	17,585	8,375	9,210	4,062	4.3	2,873
2	An Nhon	Dap Da	-	1	-	-	5.07	17,762	8,689	9,073	3,728	4.8	3,503	18,508	9,051	9,457	3,885	4.8	3,650
3	An Nhon	Nhon Thanh	-	-	1	-	12.66	15,641	7,673	7,968	3,413	4.6	1,235	15,955	7,777	8,178	3,482	4.6	1,260
4	An Nhon	Nhon My	-	-	1	-	17.15	12,239	5,880	6,359	2,841	4.3	714	12,511	6,010	6,501	2,904	4.3	730
5	An Nhon	Nhon Hanh	-	-	1	-	10.88	10,921	5,155	5,766	2,561	4.3	1,004	11,143	5,235	5,908	2,613	4.3	1,024
6	An Nhon	Nhon Phong	-	-	1	-	8.25	8,675	4,146	4,529	1,960	4.4	1,052	8,869	4,213	4,656	2,004	4.4	1,075
7	An Nhon	Nhon Hau	-	-	1	-	12.25	13,303	6,473	6,830	2,965	4.5	1,086	13,612	6,660	6,952	3,034	4.5	1,111
8	An Nhon	Nhon An	-	-	1	-	8.76	9,919	4,809	5,110	2,099	4.7	1,132	10,180	4,901	5,279	2,154	4.7	1,162
9	An Nhon	Nhon Hung	-	-	1	-	8.33	11,916	5,736	6,180	2,577	4.6	1,430	12,492	6,153	6,339	2,702	4.6	1,500
11	An Nhon	Nhon Khanh	-	-	1	-	8.58	8,890	4,219	4,671	2,090	4.3	1,036	9,113	4,345	4,768	2,142	4.3	1,062
13	An Nhon	Nhon Hoa	-	-	1	-	27.83	17,266	8,459	8,807	3,891	4.4	620	17,661	8,687	8,974	3,980	4.4	635
Total of An Nhon District			**0**	**2**	**9**	**11**	**125.88**	**143,416**	**69,292**	**74,124**	**32,025**	**4.5**	**1,139**	147,629	71,407	76,222	32,961	4.5	1,173
1	Tuy Phuoc	Tuy Phuoc	-	1	-	-	6.36	11,994	5,856	6,138	2,593	4.6	1,886	12,551	6,164	6,387	2,713	4.6	1,973
2	Tuy Phuoc	Dieu Tri	-	1	-	-	5.47	11,671	5,694	5,977	2,472	4.7	2,134	12,215	5,915	6,300	2,587	4.7	2,233
3	Tuy Phuoc	Phuoc Thang	-	-	1	-	13.79	10,349	5,058	5,291	2,198	4.7	750	10,550	5,075	5,475	2,241	4.7	765
4	Tuy Phuoc	Phuoc Hung	-	-	1	-	10.15	13,009	6,253	6,756	2,861	4.5	1,282	13,327	6,375	6,952	2,931	4.5	1,313
5	Tuy Phuoc	Phuoc Hoa	-	-	1	-	19.99	15,297	7,421	7,876	3,277	4.7	765	15,712	7,671	8,041	3,366	4.7	786
6	Tuy Phuoc	Phuoc Quang	-	-	1	-	10.81	12,865	6,166	6,699	2,770	4.6	1,190	13,219	6,315	6,904	2,846	4.6	1,223
7	Tuy Phuoc	Phuoc Son	-	-	1	-	25.84	22,889	11,128	11,761	4,832	4.7	886	23,613	11,245	12,368	4,985	4.7	914
8	Tuy Phuoc	Phuoc Hiep	-	-	1	-	15.72	15,995	7,751	8,244	3,572	4.5	1,017	16,471	7,956	8,515	3,678	4.5	1,048
9	Tuy Phuoc	Phuoc Loc	-	-	1	-	11.65	14,073	6,883	7,190	2,970	4.7	1,208	14,537	7,160	7,377	3,068	4.7	1,248
10	Tuy Phuoc	Phuoc Thuan	-	-	1	-	21.63	15,800	7,663	8,137	3,325	4.8	730	16,288	7,883	8,405	3,428	4.8	753
11	Tuy Phuoc	Phuoc Nghia	-	-	1	-	6.80	4,544	2,172	2,372	1,040	4.4	668	4,675	2,242	2,433	1,070	4.4	688
12	Tuy Phuoc	Phuoc An	-	-	1	-	33.51	17,883	8,778	9,105	3,744	4.8	534	18,467	8,999	9,468	3,866	4.8	551
13	Tuy Phuoc	Phuoc Thanh	-	-	1	-	35.05	9,592	4,736	4,856	2,132	4.5	274	9,876	4,903	4,973	2,195	4.5	282
Total of Tuy Phuoc District			**0**	**2**	**11**	**13**	**216.77**	**175,961**	**85,559**	**90,402**	**37,786**	**4.7**	**812**	181,501	87,903	93,598	38,975	4.7	837

Source: Population Census 1999 and Statistical Year Book 2001, Binh Dinh Province.

Table L.2 Land Use by Commune in the Study Area of Feasibility Study

(unit: ha)

	District or City	Ward/ Subtown/ Commune	Land Use												Agricultural Land								
			Total		Agriculture Land		Forest Land		Specialized Land		Housing Land		Unused Land		Annual Crop Land				Misc. garden	Perenni-al crop	Grass land	Aqua-culture	Total
															Paddy	Shifting	Upland	Total					
1	**Qui Nhon**	2 units	2,700	100%	1,400	52%	100	4%	300	11%	100	4%	800	30%	800	0	100	900	100	0	0	400	1,400
2	**An Lao**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-
3	**Hoai Nhon**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-
4	**Hoai An**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-
5	**Phu My**	6 units	17,100	100%	7,500	44%	800	5%	1,700	10%	300	2%	6,800	40%	3,300	0	2,300	5,600	1,100	400	0	400	7,500
6	**Vinh Thanh**	2 units	12,800	100%	1,400	11%	5,400	42%	200	2%	100	1%	5,700	45%	300	0	600	900	100	400	0	0	1,400
7	**Phu Cat**	13 units	50,900	100%	16,600	33%	12,700	25%	*4,500*	9%	700	1%	16,400	32%	7,300	0	2,900	10,200	2,200	4,100	0	100	16,600
8	**Tay Son**	10 units	45,200	100%	10,900	24%	*11,500*	25%	2,100	5%	500	1%	20,200	45%	4,400	600	3,400	8,400	1,400	1,100	0	0	10,900
9	**An Nhon**	11 units	12,700	100%	7,800	61%	100	1%	1,800	14%	600	5%	2,400	19%	5,400	0	1,000	6,400	1,200	200	0	0	7,800
10	**Tuy Phuoc**	13 units	21,700	100%	11,100	51%	500	2%	3,400	16%	700	3%	6,000	28%	7,900	0	*1,000*	8,900	1,000	200	0	1,000	11,100
11	**Van Canh**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-
	Total	**57 units**	163,100	100%	56,700	34.8%	31,100	19.1%	14,000	8.6%	3,000	1.8%	58,300	35.7%	29,400	600	11,300	41,300	7,100	6,400	0	1,900	56,700
15	**Qui Nhon**	Nhon Binh	1,468	100%	838	57%	8	1%	126	9%	48	3%	449	31%	489	0	20	509	50	0	0	278	838
16	**Qui Nhon**	Nhon Phu	1,319	100%	633	48%	56	4%	185	14%	84	6%	361	27%	338	1	98	437	68	10	0	118	633
	Total of Qui Nhon	**2 units**	2,787	100%	1,471	53%	64	2%	311	11%	132	5%	809	29%	827	1	119	946	118	10	0	396	1,471
1	**Phu My**	Phu My	1,110	100%	567	51%	13	1%	272	24%	48	4%	211	19%	309	0	93	402	126	38	0	0	567
14	**Phu My**	My Chanh	4,619	100%	1,639	35%	168	4%	275	6%	71	2%	2,466	53%	646	0	443	1,089	194	38	0	317	1,639
16	**Phu My**	My Quang	2,028	100%	877	43%	288	14%	193	10%	31	2%	639	32%	385	0	237	622	137	118	0	0	877
17	**Phu My**	My Hiep	5,546	100%	2,123	38%	361	7%	634	11%	69	1%	2,359	43%	1,147	0	572	1,720	261	142	0	0	2,123
18	**Phu My**	My Tai	2,862	100%	1,704	60%	0	0%	255	9%	54	2%	848	30%	519	0	897	1,417	273	15	0	0	1,704
19	**Phu My**	My Cat	871	100%	493	57%	0	0%	97	11%	29	3%	252	29%	284	0	70	354	92	4	0	44	493
	Total of Phu My	**6 units**	17,036	100%	7,402	43%	830	5%	1,726	10%	302	2%	6,775	40%	3,291	0	2,313	5,604	1,083	355	0	361	7,402
5	**Vinh Thanh**	Vinh Hao	6,017	100%	312	5%	3,820	63%	63	1%	15	0%	1,806	30%	14	35	63	113	30	169	0	0	312
6	**Vinh Thanh**	Vinh Quang	6,835	100%	1,125	16%	1,588	23%	180	3%	51	1%	3,891	57%	253	0	580	833	71	220	0	1	1,125
	Total of Vinh Than	**2 units**	12,852	100%	1,437	11%	5,408	42%	243	2%	67	1%	5,697	44%	267	35	643	946	102	389	0	1	1,437
1	**Phu Cat**	Ngo May	755	100%	426	56%	0	0%	148	20%	33	4%	148	20%	169	0	96	265	137	24	0	0	426
2	**Phu Cat**	Cat Son	11,340	100%	789	7%	6,608	58%	770	7%	31	0%	3,142	28%	257	0	44	301	109	380	0	0	789
3	**Phu Cat**	Cat Minh	2,505	100%	975	39%	49	2%	218	9%	63	3%	1,201	48%	568	0	139	707	150	11	0	108	975
4	**Phu Cat**	Cat Tai	3,870	100%	1,187	31%	486	13%	164	4%	52	1%	1,981	51%	692	0	356	1,047	130	10	0	0	1,187
6	**Phu Cat**	Cat Lam	6,942	100%	2,370	34%	2,377	34%	226	3%	38	1%	1,931	28%	372	0	492	864	232	1,275	0	0	2,370
7	**Phu Cat**	Cat Hanh	4,416	100%	2,063	47%	438	10%	486	11%	80	2%	1,350	31%	878	0	286	1,164	328	571	0	0	2,063
10	**Phu Cat**	Cat Hiep	4,102	100%	2,290	56%	558	14%	243	6%	51	1%	960	23%	532	0	389	921	265	1,103	0	0	2,290
11	**Phu Cat**	Cat Trinh	4,755	100%	1,910	40%	761	16%	390	8%	63	1%	1,630	34%	687	0	466	1,153	274	483	0	0	1,910
12	**Phu Cat**	Cat Nhon	3,855	100%	976	25%	1,057	27%	284	7%	64	2%	1,474	38%	648	0	132	781	88	107	0	0	976
14	**Phu Cat**	Cat Tuong	2,914	100%	1,303	45%	129	4%	297	10%	62	2%	1,124	39%	707	0	301	1,009	219	75	0	0	1,303
15	**Phu Cat**	Cat Tan	2,802	100%	1,039	37%	138	5%	1,178	42%	61	2%	386	14%	667	0	136	803	199	38	0	0	1,039
16	**Phu Cat**	Cat Tien	1,734	100%	555	32%	75	4%	90	5%	49	3%	965	56%	485	0	35	520	35	0	0	0	555
17	**Phu Cat**	Cat Thang	853	100%	629	74%	0	0%	99	12%	33	4%	92	11%	567	0	11	579	51	0	0	0	629
	Total of Phu Cat	**13 units**	50,843	100%	16,511	32%	12,676	25%	4,592	9%	679	1%	16,385	32%	7,228	0	2,884	10,112	2,217	4,075	0	108	16,512
2	**Tay Son**	Binh Tan	11,028	100%	998	9%	4,843	0.44	616	6%	35	0%	4,537	41%	319	0	284	603	192	203	0	0	998
3	**Tay Son**	Tay Thuan	9,719	100%	1,351	14%	2,887	30%	145	1%	51	1%	5,285	54%	371	0	852	1,224	126	1	0	0	1,351
4	**Tay Son**	Binh Thuan	4,084	100%	1,868	46%	423	10%	188	5%	37	1%	1,568	38%	600	0	578	1,178	381	309	0	0	1,868
5	**Tay Son**	Tay Giang	7,352	100%	1,889	26%	1,686	23%	177	2%	84	1%	3,517	48%	352	616	769	1,737	113	39	0	0	1,889
6	**Tay Son**	Binh Thanh	5,532	100%	1,529	28%	1,565	28%	300	5%	52	1%	2,086	38%	504	0	392	896	233	401	0	0	1,529
7	**Tay Son**	Tay An	1,044	100%	576	55%	4	0%	138	13%	26	2%	300	29%	479	0	10	489	85	2	0	0	576
8	**Tay Son**	Binh Hoa	1,380	100%	670	49%	90	6%	148	11%	47	3%	426	31%	496	0	60	556	78	36	0	0	670
9	**Tay Son**	Binh Tuong	3,770	100%	1,187	31%	44	1%	220	6%	73	2%	2,245	60%	642	0	357	999	86	102	0	0	1,187
10	**Tay Son**	Tay Vinh	706	100%	469	66%	0	0%	142	20%	34	5%	60	9%	331	0	71	402	65	2	0	0	469
11	**Tay Son**	Tay Binh	723	100%	414	57%	27	4%	58	8%	28	4%	195	27%	285	0	72	357	51	6	0	0	414
	Total of Tay Son	**10 units**	45,338	100%	10,952	24%	11,568	26%	2,132	5%	467	1%	20,219	45%	4,380	616	3,444	8,441	1,412	1,099	0	0	10,952
1	**An Nhon**	Binh Dinh	612	100%	382	62%		0%	136	22%	53	9%	41	7%	292	0	33	325	53	4	0	0	382
2	**An Nhon**	Dap Da	507	100%	335	66%		0%	87	17%	53	10%	33	6%	234	0	28	262	70	3	0	0	335
3	**An Nhon**	Nhon Thanh	1,266	100%	708	56%		0%	140	11%	57	5%	361	29%	454	0	139	593	105	10	0	0	708
4	**An Nhon**	Nhon My	1,715	100%	1,079	63%	14	1%	230	13%	58	3%	334	19%	676	0	60	735	194	149	0	0	1,079
5	**An Nhon**	Nhon Hanh	1,088	100%	877	81%		0%	140	13%	46	4%	25	2%	788	0	24	812	65	0	0	0	877
6	**An Nhon**	Nhon Phong	825	100%	635	77%		0%	117	14%	39	5%	34	4%	543	0	27	570	65	1	0	0	635
7	**An Nhon**	Nhon Hau	1,225	100%	788	64%		0%	187	15%	55	5%	195	16%	409	0	181	590	176	21	0	0	788
8	**An Nhon**	Nhon An	876	100%	697	80%		0%	118	14%	40	5%	21	2%	557	0	51	608	89	0	0	0	697
9	**An Nhon**	Nhon Hung	833	100%	601	72%		0%	139	17%	42	5%	51	6%	407	0	98	505	95	0	0	0	601
11	**An Nhon**	Nhon Khanh	858	100%	606	71%		0%	117	14%	37	4%	99	11%	372	0	151	523	74	0	4	4	606
13	**An Nhon**	Nhon Hoa	2,783	100%	1,104	40%	50	2%	382	14%	70	3%	1,177	42%	717	0	188	904	165	34	0	0	1,104
	Total of An Nhon	**11 units**	12,588	100%	7,810	62%	63	1%	1,795	14%	550	4%	2,370	19%	5,447	0	981	6,428	1,152	222	4	4	7,810
1	**Tuy Phuoc**	Tuy Phuoc	636	100%	398	63%	12	2%	102	16%	33	5%	91	14%	333	0	17	350	45	3	0	0	398
2	**Tuy Phuoc**	Dieu Tri	547	100%	281	51%	3	1%	95	17%	45	8%	123	22%	217	0	28	246	35	0	0	0	281
3	**Tuy Phuoc**	Phuoc Thang	1,379	100%	1,003	73%		0%	124	9%	37	3%	215	16%	889	0	13	902	50	0	0	50	1,003
4	**Tuy Phuoc**	Phuoc Hung	1,015	100%	790	78%		0%	130	13%	50	5%	45	4%	675	0	40	715	75	0	0	0	790
5	**Tuy Phuoc**	Phuoc Hoa	1,999	100%	1,048	52%	76	4%	223	11%	49	2%	603	30%	547	0	49	596	72	5	0	376	1,048
6	**Tuy Phuoc**	Phuoc Quang	1,081	100%	788	73%		0%	190	18%	50	5%	53	5%	665	0	40	705	80	3	0	0	788
7	**Tuy Phuoc**	Phuoc Son	2,584	100%	1,682	65%	16	1%	272	11%	79	3%	535	21%	1,208	0	27	1,235	124	8	0	315	1,682
8	**Tuy Phuoc**	Phuoc Hiep	1,572	100%	978	62%	38	2%	302	19%	66	4%	187	12%	710	0	158	868	107	3	0	0	978
9	**Tuy Phuoc**	Phuoc Loc	1,165	100%	671	58%	40	3%	210	18%	48	4%	197	17%	510	0	61	571	93	6	0	0	671
10	**Tuy Phuoc**	Phuoc Thuan	2,163	100%	950	44%	27	1%	176	8%	52	2%	959	44%	619	0	14	633	54	3	0	259	950
11	**Tuy Phuoc**	Phuoc Nghia	680	100%	324	48%	17	3%	94	14%	27	4%	218	32%	271	0	8	279	43	2	0	0	324
12	**Tuy Phuoc**	Phuoc An	3,351	100%	1,328	40%	81	2%	625	19%	98	3%	1,218	36%	849	0	264	1,113	152	63	0	0	1,328
13	**Tuy Phuoc**	Phuoc Thanh	3,505	100%	885	25%	148	4%	870	25%	59	2%	1,543	44%	396	0	231	627	107	151	0	0	885
	Total of Tuy Phuoc	**13 units**	21,677	100%	11,125	51%	457	2%	3,412	16%	695	3%	5,988	28%	7,890	0	950	8,840	1,037	247	0	1,001	11,124

Source: Data Set of Binh Dinh Land Use General Inventory in 2000 and Land Use Maps of Qui Nhon City and 10 Districts, Land Office, Binh Dinh Province.

Table L.3 Planted Area, Production and Yield of Paddy (Average of 1999 to 2001)

District/ City	Ward/ Subtown/ Commune	Average of 3 Years (1999 to 2001)											
		Total			Winter-Spring			Summer-Autumn			Third crop		
		Area ha	Prod. ton	Yield ton/ha	Area ha	Prod. ton	Yield ton/ha	Area ha	Prod. ton	Yield ton/ha	Area ha	Prod. ton	Yield ton/ha
1 Qui Nhon		1,900	8,200	4.32	800	3,700	4.63	700	3,200	4.57	400	1,300	3.25
2 An Lao		-	-	-	-	-	-	-	-	-	-	-	-
3 Hoai Nhon		-	-	-	-	-	-	-	-	-	-	-	-
4 Hoai An		-	-	-	-	-	-	-	-	-	-	-	-
5 Phu My		7,900	31,800	4.03	2,800	12,000	4.29	2,200	9,900	4.50	2,900	9,900	3.41
6 Vinh Thanh		500	1,600	3.20	100	500	5.00	100	400	4.00	300	700	2.33
7 Phu Cat		15,300	59,200	3.87	5,900	25,900	4.39	4,300	18,900	4.40	5,100	14,400	2.82
8 Tay Son		9,500	40,200	4.23	3,200	15,500	4.84	2,600	11,900	4.58	3,700	12,800	3.46
9 An Nhon		14,800	69,600	4.70	5,300	29,500	5.57	5,000	22,400	4.48	4,500	17,700	3.93
10 Tuy Phuoc		19,400	91,400	4.71	7,500	43,200	5.76	7,400	31,300	4.23	4,500	16,900	3.76
11 Van Canh		-	-	-	-	-	-	-	-	-	-	-	-
Total		**69,300**	**302,000**	**4.36**	**25,600**	**130,300**	**5.09**	**22,300**	**98,000**	**4.39**	**21,400**	**73,700**	**3.44**
Whole Province		**127,300**	**524,700**	**4.12**	**46,700**	**219,900**	**4.71**	**40,600**	**172,700**	**4.25**	**40,000**	**132,100**	**3.30**
Proportion in Province		**54%**	**58%**	**106%**	**55%**	**59%**	**108%**	**55%**	**57%**	**103%**	**54%**	**56%**	**104%**
15 Qui Nhon	Nhon Binh	1,013	4,540	4.48	473	2,234	4.72	449	1,965	4.38	91	340	3.74
16 Qui Nhon	Nhon Phu	879	3,640	4.14	315	1,438	4.57	298	1,245	4.17	265	957	3.61
Total of Qui Nhon City		**1,892**	**8,179**	**4.32**	**788**	**3,672**	**4.66**	**747**	**3,210**	**4.29**	**356**	**1,297**	**3.64**
1 Phu My	Phu My	843	3,469	4.11	272	1,197	4.41	270	1,230	4.55	301	1,041	3.46
14 Phu My	My Chanh	1,404	5,389	3.84	588	2,462	4.19	315	1,395	4.43	502	1,531	3.05
16 Phu My	My Quang	886	3,573	4.03	273	1,184	4.33	241	1,088	4.52	372	1,301	3.50
17 Phu My	My Hiep	2,712	11,235	4.14	943	4,169	4.42	805	3,665	4.55	964	3,402	3.53
18 Phu My	My Tai	1,199	4,431	3.69	421	1,722	4.09	285	1,173	4.12	493	1,537	3.11
19 Phu My	My Cat	835	3,804	4.56	278	1,306	4.70	279	1,398	5.02	278	1,101	3.95
Total of Phu My District		**7,880**	**31,900**	**4.05**	**2,776**	**12,039**	**4.34**	**2,193**	**9,948**	**4.54**	**2,911**	**9,913**	**3.40**
5 Vinh Thanh	Vinh Hao	76	259	3.41	23	84	3.66	25	95	3.80	28	80	2.86
6 Vinh Thanh	Vinh Quang	434	1,325	3.06	117	425	3.65	81	305	3.76	236	596	2.52
Total of Vinh Thanh District		**510**	**1,585**	**3.11**	**140**	**509**	**3.65**	**106**	**400**	**3.77**	**264**	**676**	**2.56**
1 Phu Cat	Ngo May	317	681	2.14	103	270	2.63	35	87	2.51	180	323	1.80
2 Phu Cat	Cat Son	567	1,888	3.33	202	813	4.03	121	511	4.23	245	564	2.30
3 Phu Cat	Cat Minh	1,557	6,697	4.30	555	2,490	4.48	483	2,030	4.20	518	2,177	4.20
4 Phu Cat	Cat Tai	1,819	7,219	3.97	651	2,791	4.29	509	2,201	4.33	660	2,228	3.38
6 Phu Cat	Cat Lam	652	1,869	2.87	213	812	3.81	123	395	3.20	315	662	2.10
7 Phu Cat	Cat Hanh	2,298	9,268	4.03	777	3,510	4.52	654	2,815	4.30	866	2,943	3.40
10 Phu Cat	Cat Hiep	600	1,205	2.01	114	305	2.67	70	151	2.16	416	749	1.80
11 Phu Cat	Cat Trinh	1,250	3,750	3.00	453	1,676	3.70	150	555	3.71	648	1,519	2.34
12 Phu Cat	Cat Nhon	1,540	6,444	4.18	630	2,985	4.74	521	2,206	4.24	389	1,253	3.22
14 Phu Cat	Cat Tuong	1,511	5,559	3.68	683	2,982	4.37	433	1,792	4.14	394	784	1.99
15 Phu Cat	Cat Tan	1,190	3,850	3.24	476	1,827	3.83	257	943	3.68	457	1,080	2.36
16 Phu Cat	Cat Tien	891	4,551	5.11	460	2,454	5.33	430	2,093	4.86	1	4	4.00
17 Phu Cat	Cat Thang	1,173	6,198	5.29	560	2,967	5.30	563	3,095	5.50	50	136	2.71
Total of Phu Cat District		**15,365**	**59,177**	**3.85**	**5,878**	**25,883**	**4.40**	**4,348**	**18,874**	**4.34**	**5,139**	**14,421**	**2.81**
2 Tay Son	Binh Tan	730	2,973	4.07	234	1,052	4.50	240	947	3.94	256	974	3.81
3 Tay Son	Tay Thuan	544	1,913	3.52	162	721	4.44	73	285	3.88	308	907	2.94
4 Tay Son	Binh Thuan	829	2,325	2.81	209	828	3.96	123	448	3.65	497	1,049	2.11
5 Tay Son	Tay Giang	675	2,610	3.87	264	1,226	4.65	136	586	4.32	275	799	2.90
6 Tay Son	Binh Thanh	1,184	5,326	4.50	387	1,847	4.77	395	1,841	4.66	402	1,638	4.08
7 Tay Son	Tay An	1,111	5,170	4.66	426	2,136	5.02	337	1,558	4.63	348	1,477	4.24
8 Tay Son	Binh Hoa	1,472	7,383	5.02	491	2,709	5.52	491	2,435	4.96	491	2,239	4.56
9 Tay Son	Binh Tuong	1,067	4,041	3.79	389	1,791	4.60	227	982	4.33	451	1,268	2.81
10 Tay Son	Tay Vinh	1,056	4,781	4.53	345	1,785	5.17	344	1,601	4.66	367	1,395	3.80
11 Tay Son	Tay Binh	840	3,680	4.38	284	1,412	4.97	260	1,192	4.59	296	1,076	3.63
Total of Tay Son District		**9,507**	**40,202**	**4.23**	**3,192**	**15,506**	**4.86**	**2,624**	**11,874**	**4.53**	**3,691**	**12,822**	**3.47**
1 An Nhon	Binh Dinh	807	4,126	5.11	278	1,706	6.13	269	1,321	4.90	259	1,099	4.24
2 An Nhon	Dap Da	455	2,738	6.02	227	1,473	6.48	222	1,243	5.60	6	23	4.10
3 An Nhon	Nhon Thanh	1,157	5,128	4.43	442	2,228	5.04	422	1,802	4.27	293	1,098	3.75
4 An Nhon	Nhon My	1,919	8,677	4.52	667	3,525	5.28	591	2,554	4.32	661	2,598	3.93
5 An Nhon	Nhon Hanh	2,224	10,507	4.72	795	4,644	5.84	772	3,289	4.26	657	2,574	3.92
6 An Nhon	Nhon Phong	1,275	6,311	4.95	514	2,904	5.65	457	2,098	4.59	303	1,309	4.32
7 An Nhon	Nhon Hau	1,068	4,729	4.43	370	1,981	5.35	347	1,513	4.36	351	1,235	3.52
8 An Nhon	Nhon An	1,591	7,601	4.78	550	3,140	5.71	508	2,291	4.51	533	2,170	4.07
9 An Nhon	Nhon Hung	1,189	5,298	4.46	400	2,180	5.46	391	1,664	4.26	398	1,454	3.65
11 An Nhon	Nhon Khanh	1,128	5,138	4.55	377	2,055	5.46	370	1,568	4.24	382	1,514	3.97
13 An Nhon	Nhon Hoa	2,103	9,317	4.43	716	3,646	5.10	698	3,064	4.39	690	2,607	3.78
Total of An Nhon District		**14,914**	**69,569**	**4.66**	**5,336**	**29,482**	**5.53**	**5,046**	**22,406**	**4.44**	**4,532**	**17,681**	**3.90**
1 Tuy Phuoc	Tuy Phuoc	891	3,970	4.46	309	1,708	5.53	326	1,291	3.97	257	971	3.78
2 Tuy Phuoc	Dieu Tri	595	2,776	4.67	219	1,248	5.70	219	920	4.20	157	608	3.88
3 Tuy Phuoc	Phuoc Thang	1,824	9,390	5.15	850	5,186	6.10	826	3,657	4.43	148	546	3.68
4 Tuy Phuoc	Phuoc Hung	2,010	9,732	4.84	677	4,127	6.10	675	3,058	4.53	658	2,547	3.87
5 Tuy Phuoc	Phuoc Hoa	1,110	5,394	4.86	525	3,046	5.80	527	2,143	4.07	57	205	3.58
6 Tuy Phuoc	Phuoc Quang	1,831	8,843	4.83	664	3,940	5.93	665	2,925	4.40	502	1,978	3.94
7 Tuy Phuoc	Phuoc Son	2,883	14,580	5.06	1,179	7,312	6.20	1,227	5,481	4.47	477	1,787	3.75
8 Tuy Phuoc	Phuoc Hiep	1,997	9,259	4.64	699	4,055	5.80	678	2,847	4.20	620	2,357	3.80
9 Tuy Phuoc	Phuoc Loc	1,501	6,800	4.53	499	2,810	5.63	502	2,059	4.10	499	1,931	3.87
10 Tuy Phuoc	Phuoc Thuan	1,440	6,718	4.67	587	3,424	5.83	586	2,384	4.07	267	910	3.41
11 Tuy Phuoc	Phuoc Nghia	725	3,395	4.68	281	1,620	5.77	280	1,149	4.10	164	626	3.82
12 Tuy Phuoc	Phuoc An	1,850	7,938	4.29	715	3,573	5.00	686	2,656	3.87	449	1,709	3.80
13 Tuy Phuoc	Phuoc Thanh	715	2,591	3.62	268	1,134	4.23	224	771	3.43	223	687	3.08
Total of Tuy Phuoc District		**19,371**	**91,388**	**4.72**	**7,472**	**43,184**	**5.78**	**7,421**	**31,343**	**4.22**	**4,478**	**16,861**	**3.76**

Table L.4 Crpped Area of Subsidiary and Other Crops (1/2)

Ward/Subtown/Commune	Cassava				Maize				Sweet potato				Vegetables				Sugarcane			
	1999	2000	2001	Ave.	1999	2000	2001	Ave.	1999	2000	2001	Ave.	1999	2000	2001	Ave.	1999	2000	2001	Ave.
1 **Qui Nhon**	0	0	0	**0**	-	-	-	**-**	2	2	0	**1**	564	567	585	**572**	0	0	0	**0**
2 **An Lao**	-	-	-	**-**	-	-	-	**-**	-	-	-	**-**	-	-	-	**-**	-	-	-	**-**
3 **Hoai Nhon**	-	-	-	**-**	-	-	-	**-**	-	-	-	**-**	-	-	-	**-**	-	-	-	**-**
4 **Hoai An**	-	-	-	**-**	-	-	-	**-**	-	-	-	**-**	-	-	-	**-**	-	-	-	**-**
5 **Phu My**	1,060	1,011	1,114	**1,062**	56	133	174	**121**	37	15	48	**33**	754	910	932	**865**	895	647	679	**740**
6 **Vinh Thanh**	-	90	95	**93**	-	62	41	**52**	-	20	13	**16**	-	32	33	**32**	-	459	341	**400**
7 **Phu Cat**	1,603	1,781	2,106	**1,830**	7	125	503	**212**	213	345	185	**248**	546	569	438	**518**	1,233	1,233	858	**1,108**
8 **Tay Son**	1,065	926	1,091	**1,027**	166	317	374	**285**	24	14	15	**17**	945	646	768	**786**	1,870	2,253	1,805	**1,976**
9 **An Nhon**	27	29	4	**20**	448	574	485	**502**	-	-	-	**-**	257	348	433	**346**	21	6	3	**10**
10 **Tuy Phuoc**	-	293	270	**282**	220	268	311	**266**	268	259	236	**254**	1,015	1,466	1,463	**1,315**	66	64	28	**53**
11 **Van Canh**	-	-	-	**-**	-	-	-	**-**	-	-	-	**-**	-	-	-	**-**	-	-	-	**-**
Total in Project Area	3,754	4,130	4,680	**4,188**	895	1,479	1,887	**1,420**	543	654	496	**564**	4,081	4,537	4,652	**4,423**	4,084	4,662	3,714	**4,153**
Total in Province	10,520	10,076	10,146	**10,247**	1,857	2,840	3,702	**2,800**	1,135	1,185	855	**1,058**	7,872	8,975	9,405	**8,751**	8,342	10,023	6,592	**8,319**
Propotion of Project Area	36%	41%	46%	**41%**	48%	52%	51%	**51%**	48%	55%	58%	**53%**	52%	51%	49%	**51%**	49%	47%	56%	**50%**
15 **Qui Nhon** Nhon Binh	-	-	-	**-**	-	-	-	**-**	0	0	0	**0**	68	69	70	**69**	-	-	-	**-**
16 **Qui Nhon** Nhon Phu	-	-	-	**-**	-	-	-	**-**	2	2	0	**1**	496	499	515	**503**	-	-	-	**-**
Total of Qui Nhon	**0**	**0**	**0**	**0**	**-**	**-**	**-**	**-**	**2**	**2**	**0**	**1**	**564**	**567**	**585**	**572**	**0**	**0**	**0**	**0**
1 **Phu My** Phu My	20	25	20	**22**	3	9	20	**11**	0	0	0	**0**	175	174	162	**170**	0	0	0	**0**
14 **Phu My** My Chanh	185	176	204	**188**	9	8	8	**8**	30	8	30	**23**	65	110	122	**99**	225	150	171	**182**
16 **Phu My** My Quang	145	145	175	**155**	4	9	10	**8**	0	0	2	**1**	147	186	159	**164**	45	35	5	**28**
17 **Phu My** My Hiep	220	200	205	**208**	11	34	60	**35**	0	4	4	**3**	186	218	259	**221**	220	172	203	**198**
18 **Phu My** My Tai	480	465	500	**482**	21	61	50	**44**	3	2	10	**5**	138	173	177	**163**	380	280	290	**317**
19 **Phu My** My Cat	10	0	10	**7**	8	12	26	**15**	4	1	2	**2**	43	49	53	**48**	25	10	10	**15**
Total of Phu My	**1,060**	**1,011**	**1,114**	**1,062**	**56**	**133**	**174**	**121**	**37**	**15**	**48**	**33**	**754**	**910**	**932**	**865**	**895**	**647**	**679**	**740**
5 **Vinh Thanh** Vinh Hao	n.a.	45	45	**45**	n.a.	41	32	**37**	n.a.	8	7	**7**	n.a.	9	10	**9**	n.a.	50	14	**32**
6 **Vinh Thanh** Vinh Quang	n.a.	45	50	**48**	n.a.	21	9	**15**	n.a.	13	6	**9**	n.a.	23	24	**23**	n.a.	409	327	**368**
Total of Vinh Thanh	**-**	**90**	**95**	**93**	**-**	**62**	**41**	**52**	**-**	**20**	**13**	**16**	**-**	**32**	**33**	**32**	**-**	**459**	**341**	**400**
1 **Phu Cat** Ngo May	70	70	70	**70**	0	0	2	**1**	25	20	20	**22**	15	20	10	**15**	0	0	0	**0**
2 **Phu Cat** Cat Son	250	225	301	**259**	0	0	8	**3**	0	15	5	**7**	24	25	20	**23**	164	164	150	**159**
3 **Phu Cat** Cat Minh	60	50	50	**53**	0	1	10	**4**	25	50	10	**28**	31	35	35	**34**	50	50	50	**50**
4 **Phu Cat** Cat Tai	20	30	30	**27**	7	120	422	**183**	0	25	15	**13**	60	60	50	**57**	70	70	30	**57**
6 **Phu Cat** Cat Lam	150	255	331	**245**	0	0	8	**3**	0	11	5	**5**	25	25	20	**23**	210	210	190	**203**
7 **Phu Cat** Cat Hanh	210	210	210	**210**	0	1	20	**7**	20	35	15	**23**	80	80	70	**77**	45	45	5	**32**
10 **Phu Cat** Cat Hiep	310	333	416	**353**	0	2	6	**3**	15	20	20	**18**	43	43	33	**40**	284	284	220	**263**
11 **Phu Cat** Cat Trinh	363	365	435	**388**	0	0	8	**3**	0	20	15	**12**	50	60	50	**53**	170	170	30	**123**
12 **Phu Cat** Cat Nhon	43	43	43	**43**	0	1	8	**3**	67	69	30	**55**	66	66	40	**57**	115	115	88	**106**
14 **Phu Cat** Cat Tuong	80	90	110	**93**	0	0	4	**1**	20	20	20	**20**	50	50	35	**45**	110	110	80	**100**
15 **Phu Cat** Cat Tan	47	110	110	**89**	0	0	4	**1**	36	60	30	**42**	42	45	35	**41**	15	15	15	**15**
16 **Phu Cat** Cat Tien	0	0	0	**0**	0	0	1	**0**	5	0	0	**2**	40	40	30	**37**	0	0	0	**0**
17 **Phu Cat** Cat Thang	0	0	0	**0**	0	0	2	**1**	0	0	0	**0**	20	20	10	**17**	0	0	0	**0**
Total of Phu Cat	**1,603**	**1,781**	**2,106**	**1,830**	**7**	**125**	**503**	**212**	**213**	**345**	**185**	**248**	**546**	**569**	**438**	**518**	**1,233**	**1,233**	**858**	**1,108**
2 **Tay Son** Binh Tan	120	120	100	**113**	11	24	42	**26**	0	0	0	**0**	19	17	54	**30**	130	180	180	**163**
3 **Tay Son** Tay Thuan	160	100	180	**147**	17	12	25	**18**	4	5	7	**5**	32	24	27	**28**	640	700	650	**663**
4 **Tay Son** Binh Thuan	466	322	378	**389**	0	0	0	**0**	0	0	0	**0**	200	60	60	**107**	234	279	199	**238**
5 **Tay Son** Tay Giang	121	60	130	**104**	31	81	79	**64**	7	0	0	**2**	150	67	132	**116**	464	633	504	**533**
6 **Tay Son** Binh Thanh	143	207	185	**178**	9	22	17	**16**	0	0	0	**0**	159	162	185	**169**	42	73	50	**55**
7 **Tay Son** Tay An	15	18	16	**16**	1	2	9	**4**	6	8	8	**7**	36	51	75	**54**	7	21	17	**15**
8 **Tay Son** Binh Hoa	3	35	35	**24**	40	46	55	**47**	6	0	0	**2**	240	164	138	**181**	2	0	0	**1**
9 **Tay Son** Binh Tuong	35	60	60	**52**	7	23	38	**23**	0	0	0	**0**	50	53	61	**55**	279	315	158	**251**
10 **Tay Son** Tay Vinh	1	0	0	**0**	45	97	97	**80**	0	0	0	**0**	31	15	12	**19**	20	1	2	**7**
11 **Tay Son** Tay Binh	2	4	7	**4**	6	11	13	**10**	1	1	0	**1**	28	32	24	**28**	53	53	45	**50**
Total of Tay Son	**1,065**	**926**	**1,091**	**1,027**	**166**	**317**	**374**	**285**	**24**	**14**	**15**	**17**	**945**	**646**	**768**	**786**	**1,870**	**2,253**	**1,805**	**1,976**
1 **An Nhon** Binh Dinh	0	0	0	**0**	15	15	8	**13**	n.a.	n.a.	n.a.	**-**	44	54	45	**47**	0	0	0	**0**
2 **An Nhon** Dap Da	0	0	0	**0**	35	33	25	**31**	n.a.	n.a.	n.a.	**-**	7	7	9	**7**	0	0	0	**0**
3 **An Nhon** Nhon Thanh	18	20	0	**13**	35	19	8	**21**	n.a.	n.a.	n.a.	**-**	14	34	28	**25**	0	0	0	**0**
4 **An Nhon** Nhon My	4	4	4	**4**	68	81	75	**75**	n.a.	n.a.	n.a.	**-**	74	76	85	**78**	0	0	0	**0**
5 **An Nhon** Nhon Hanh	0	0	0	**0**	0	0	0	**0**	n.a.	n.a.	n.a.	**-**	6	13	58	**26**	0	0	0	**0**
6 **An Nhon** Nhon Phong	0	0	0	**0**	0	6	0	**2**	n.a.	n.a.	n.a.	**-**	8	6	15	**10**	0	0	0	**0**
7 **An Nhon** Nhon Hau	5	5	0	**3**	29	73	75	**59**	n.a.	n.a.	n.a.	**-**	41	85	91	**72**	0	0	0	**0**
8 **An Nhon** Nhon An	0	0	0	**0**	31	63	37	**43**	n.a.	n.a.	n.a.	**-**	4	4	22	**10**	0	0	0	**0**
9 **An Nhon** Nhon Hung	0	0	0	**0**	84	84	70	**79**	n.a.	n.a.	n.a.	**-**	9	11	18	**13**	0	0	0	**0**
11 **An Nhon** Nhon Khanh	0	0	0	**0**	40	55	25	**40**	n.a.	n.a.	n.a.	**-**	13	26	31	**23**	5	2	0	**2**
13 **An Nhon** Nhon Hoa	0	0	0	**0**	112	146	162	**140**	n.a.	n.a.	n.a.	**-**	38	34	33	**35**	16	4	3	**7**
Total of An Nhon	**27**	**29**	**4**	**20**	**448**	**574**	**485**	**502**	**-**	**-**	**-**	**-**	**257**	**348**	**433**	**346**	**21**	**6**	**3**	**10**
1 **Tuy Phuoc** Tuy Phuoc	n.a.	n.a.	n.a.	**-**	2	3	4	**3**	0	0	0	**0**	51	63	52	**55**	0	0	0	**0**
2 **Tuy Phuoc** Dieu Tri	n.a.	n.a.	n.a.	**-**	0	0	0	**0**	0	0	0	**0**	97	108	91	**99**	0	0	0	**0**
3 **Tuy Phuoc** Phuoc Thang	n.a.	n.a.	n.a.	**-**	0	0	0	**0**	0	0	0	**0**	5	9	7	**7**	0	0	0	**0**
4 **Tuy Phuoc** Phuoc Hung	n.a.	n.a.	n.a.	**-**	10	10	44	**21**	0	0	0	**0**	94	169	156	**140**	0	0	0	**0**
5 **Tuy Phuoc** Phuoc Hoa	n.a.	n.a.	n.a.	**-**	26	48	39	**38**	0	0	0	**0**	48	48	69	**55**	0	0	0	**0**
6 **Tuy Phuoc** Phuoc Quang	n.a.	n.a.	n.a.	**-**	1	0	1	**1**	0	0	0	**0**	50	78	98	**75**	1	0	0	**0**
7 **Tuy Phuoc** Phuoc Son	n.a.	n.a.	n.a.	**-**	0	0	0	**0**	0	0	0	**0**	66	73	39	**59**	0	0	0	**0**
8 **Tuy Phuoc** Phuoc Hiep	n.a.	n.a.	n.a.	**-**	62	79	90	**77**	0	0	0	**0**	126	227	236	**196**	40	20	0	**20**
9 **Tuy Phuoc** Phuoc Loc	n.a.	n.a.	n.a.	**-**	14	42	14	**24**	0	0	0	**0**	99	98	110	**102**	0	0	0	**0**
10 **Tuy Phuoc** Phuoc Thuan	n.a.	n.a.	n.a.	**-**	0	0	0	**0**	0	0	0	**0**	23	52	53	**42**	0	0	0	**0**
11 **Tuy Phuoc** Phuoc Nghia	n.a.	n.a.	n.a.	**-**	8	0	0	**3**	0	0	0	**0**	23	39	59	**40**	0	0	0	**0**
12 **Tuy Phuoc** Phuoc An	n.a.	n.a.	n.a.	**-**	69	87	70	**75**	138	155	148	**147**	150	197	195	**181**	25	24	18	**22**
13 **Tuy Phuoc** Phuoc Thanh	n.a.	n.a.	n.a.	**-**	28	0	50	**26**	130	104	88	**107**	184	305	298	**262**	0	20	10	**10**
Total of Tuy Phuoc	**-**	**-**	**-**	**-**	**220**	**268**	**311**	**266**	**268**	**259**	**236**	**254**	**1,015**	**1,466**	**1,463**	**1,315**	**66**	**64**	**28**	**53**

Table L.4 Crpped Area of Subsidiary and Other Crops (2/2)

Ward/Subtown/Commune	Groundnuts				Soyabean				Beans				Tobaco				Total of Annual Crops			
	1999	2000	2001	Ave.	1999	2000	2001	Ave.	1999	2000	2001	Ave.	1999	2000	2001	Ave.	1999	2000	2001	Ave.
1 **Qui Nhon**	125	108	49	**94**	-	-	-	-	30	30	32	**30**	-	-	-	-	721	706	665	**697**
2 **An Lao**	-	-	-	**-**	-	-	-	**-**	-	-	-	**-**	-	-	-	**-**	-	-	-	**0**
3 **Hoai Nhon**	-	-	-	**-**	-	-	-	**-**	-	-	-	**-**	-	-	-	**-**	-	-	-	**0**
4 **Hoai An**	-	-	-	**-**	-	-	-	**-**	-	-	-	**-**	-	-	-	**-**	-	-	-	**0**
5 **Phu My**	757	770	769	**765**	-	-	7	**7**	207	234	255	**232**	23	21	16	**20**	3,788	3,740	3,987	**3,845**
6 **Vinh Thanh**	-	19	65	**42**	-	54	16	**35**	-	17	33	**25**	-	3	3	**3**	-	756	640	**698**
7 **Phu Cat**	1,636	1,489	1,339	**1,488**	13	30	17	**20**	43	73	43	**53**	-	30	51	**41**	5,293	5,645	5,489	**5,516**
8 **Tay Son**	428	413	449	**430**	91	125	177	**131**	124	152	220	**165**	102	27	103	**77**	4,812	4,873	5,000	**4,895**
9 **An Nhon**	475	558	508	**513**	1,148	802	1,082	**1,011**	162	104	103	**123**	-	-	-	**-**	2,537	2,419	2,617	**2,524**
10 **Tuy Phuoc**	567	570	493	**543**	576	281	360	**405**	136	78	78	**97**	-	-	-	**-**	2,847	2,985	2,970	**3,215**
11 **Van Canh**	-	-	-	**-**	-	-	-	**-**	-	-	-	**-**	-	-	-	**-**	-	-	-	**0**
Total in Project Area	3,987	3,926	3,672	**3,861**	1,827	1,291	1,658	**1,592**	701	687	763	**717**	125	81	173	**126**	19,997	21,123	21,367	**20,829**
Total in Province	8,348	8,328	8,083	**8,253**	2,156	1,582	1,983	**1,907**	-	-	-	**-**	247	127	200	**191**	40,477	43,136	40,966	**41,526**
	48%	47%	45%	**47%**	85%	82%	84%	**83%**	-	-	-	**-**	51%	64%	87%	**66%**	49%	49%	52%	**50%**
15 **Qui Nhon** Nhon Binh	-	-	-	**-**	-	-	-	**-**	0	0	0	**0**	-	-	-	**-**	68	69	70	**69**
16 **Qui Nhon** Nhon Phu	125	108	49	**94**	-	-	-	**-**	30	30	32	**30**	-	-	-	**-**	653	638	596	**629**
Total of Qui Nhon	**125**	**108**	**49**	**94**	**-**	**-**	**-**	**-**	**30**	**30**	**32**	**30**	**-**	**-**	**-**	**-**	**721**	**706**	**665**	**697**
1 **Phu My** Phu My	94	98	76	**89**	n.a.	n.a.	n.a.	**-**	2	15	12	**10**	0	0	0	**0**	294	321	290	**302**
14 **Phu My** My Chanh	95	85	99	**93**	n.a.	n.a.	n.a.	**-**	14	7	15	**12**	23	20	15	**19**	646	564	664	**625**
16 **Phu My** My Quang	60	69	44	**58**	n.a.	n.a.	n.a.	**-**	21	27	27	**25**	0	0	0	**0**	422	471	422	**438**
17 **Phu My** My Hiep	355	355	365	**358**	n.a.	n.a.	n.a.	**-**	128	123	130	**127**	0	0	0	**0**	1,120	1,106	1,226	**1,151**
18 **Phu My** My Tai	130	120	140	**130**	n.a.	n.a.	n.a.	**-**	25	55	65	**48**	0	0	0	**0**	1,177	1,156	1,232	**1,188**
19 **Phu My** My Cat	23	43	45	**37**	n.a.	n.a.	n.a.	**-**	17	7	6	**10**	0	1	1	**1**	129	122	153	**135**
Total of Phu My	**757**	**770**	**769**	**765**	**-**	**-**	**-**	**-**	**207**	**234**	**255**	**232**	**23**	**21**	**16**	**20**	**3,788**	**3,740**	**3,987**	**3,838**
5 **Vinh Thanh** Vinh Hao	n.a.	6	19	**13**	n.a.	4	8	**6**	n.a.	2	16	**9**	n.a.	1	1	**1**	0	166	152	**159**
6 **Vinh Thanh** Vinh Quang	n.a.	13	46	**29**	n.a.	50	8	**29**	n.a.	15	17	**16**	n.a.	2	2	**2**	0	590	488	**539**
Total of Vinh Thanh	**-**	**19**	**65**	**42**	**-**	**54**	**16**	**35**	**-**	**17**	**33**	**25**	**-**	**3**	**3**	**3**	**-**	**756**	**640**	**698**
1 **Phu Cat** Ngo May	50	60	30	**47**	2	0	0	**1**	0	2	1	**1**	n.a.	n.a.	n.a.	**-**	162	172	133	**156**
2 **Phu Cat** Cat Son	80	125	80	**95**	0	0	0	**0**	0	5	5	**3**	n.a.	n.a.	n.a.	**-**	518	559	569	**549**
3 **Phu Cat** Cat Minh	50	30	30	**37**	0	0	0	**0**	0	5	3	**3**	n.a.	n.a.	n.a.	**-**	216	221	188	**208**
4 **Phu Cat** Cat Tai	280	210	210	**233**	0	15	11	**9**	6	5	5	**5**	n.a.	n.a.	n.a.	**-**	443	535	773	**583**
6 **Phu Cat** Cat Lam	160	167	150	**159**	1	1	1	**1**	2	0	0	**1**	n.a.	n.a.	n.a.	**-**	548	669	705	**640**
7 **Phu Cat** Cat Hanh	250	210	210	**223**	10	10	4	**8**	4	0	2	**2**	n.a.	n.a.	n.a.	**-**	619	591	536	**582**
10 **Phu Cat** Cat Hiep	235	233	250	**239**	0	0	0	**0**	5	16	10	**10**	n.a.	n.a.	n.a.	**-**	892	931	955	**926**
11 **Phu Cat** Cat Trinh	270	219	180	**223**	0	0	0	**0**	10	10	4	**8**	n.a.	n.a.	n.a.	**-**	863	844	722	**810**
12 **Phu Cat** Cat Nhon	66	39	30	**45**	0	5	2	**2**	0	10	2	**4**	n.a.	n.a.	n.a.	**-**	357	348	243	**316**
14 **Phu Cat** Cat Tuong	85	80	99	**88**	0	0	0	**0**	0	8	4	**4**	n.a.	n.a.	n.a.	**-**	345	358	352	**352**
15 **Phu Cat** Cat Tan	87	96	60	**81**	0	0	0	**0**	16	12	7	**12**	n.a.	n.a.	n.a.	**-**	243	338	261	**281**
16 **Phu Cat** Cat Tien	3	0	0	**1**	0	0	0	**0**	0	0	0	**0**	n.a.	n.a.	n.a.	**-**	48	40	31	**40**
17 **Phu Cat** Cat Thang	20	20	10	**17**	0	0	0	**0**	0	0	0	**0**	n.a.	n.a.	n.a.	**-**	40	40	22	**34**
Total of Phu Cat	**1,636**	**1,489**	**1,339**	**1,488**	**13**	**30**	**17**	**20**	**43**	**73**	**43**	**53**	**-**	**-**	**-**	**-**	**5,293**	**5,645**	**5,489**	**5,476**
2 **Tay Son** Binh Tan	19	33	36	**29**	0	0	0	**0**	2	5	23	**10**	0	0	0	**0**	301	379	434	**371**
3 **Tay Son** Tay Thuan	27	35	52	**38**	6	26	6	**13**	24	10	28	**21**	50	0	50	**33**	959	910	1,025	**965**
4 **Tay Son** Binh Thuan	110	100	70	**93**	0	0	0	**0**	10	42	15	**22**	0	0	0	**0**	1,020	803	722	**849**
5 **Tay Son** Tay Giang	109	106	126	**114**	23	22	60	**35**	32	46	42	**40**	52	27	53	**44**	988	1,043	1,126	**1,052**
6 **Tay Son** Binh Thanh	47	50	48	**48**	30	28	35	**31**	2	4	1	**2**	0	0	0	**0**	431	545	521	**499**
7 **Tay Son** Tay An	8	6	4	**6**	0	0	0	**0**	0	0	30	**10**	0	0	0	**0**	72	106	159	**112**
8 **Tay Son** Binh Hoa	33	25	30	**29**	15	36	31	**27**	20	0	15	**12**	0	0	0	**0**	357	306	303	**322**
9 **Tay Son** Binh Tuong	45	26	26	**32**	0	2	4	**2**	14	27	36	**26**	0	0	0	**0**	430	505	383	**439**
10 **Tay Son** Tay Vinh	20	24	40	**28**	15	12	34	**20**	10	10	19	**13**	0	0	0	**0**	142	160	204	**168**
11 **Tay Son** Tay Binh	11	8	17	**12**	1	0	7	**3**	10	7	10	**9**	0	0	0	**0**	110	116	123	**116**
Total of Tay Son	**428**	**413**	**449**	**430**	**91**	**125**	**177**	**131**	**124**	**152**	**220**	**165**	**102**	**27**	**103**	**77**	**4,812**	**4,873**	**5,000**	**4,895**
1 **An Nhon** Binh Dinh	5	7	5	**6**	37	24	47	**36**	0	0	0	**0**	n.a.	n.a.	n.a.	**-**	101	99	105	**102**
2 **An Nhon** Dap Da	17	15	15	**16**	15	12	24	**17**	0	0	0	**0**	n.a.	n.a.	n.a.	**-**	73	66	73	**70**
3 **An Nhon** Nhon Thanh	69	66	70	**68**	92	56	61	**69**	22	6	15	**14**	n.a.	n.a.	n.a.	**-**	250	200	182	**211**
4 **An Nhon** Nhon My	48	50	48	**49**	19	12	22	**17**	8	2	37	**15**	n.a.	n.a.	n.a.	**-**	220	224	271	**238**
5 **An Nhon** Nhon Hanh	0	0	0	**0**	29	15	43	**29**	0	0	0	**0**	n.a.	n.a.	n.a.	**-**	35	28	101	**55**
6 **An Nhon** Nhon Phong	7	18	5	**10**	161	120	148	**143**	0	0	0	**0**	n.a.	n.a.	n.a.	**-**	176	149	168	**164**
7 **An Nhon** Nhon Hau	99	101	92	**97**	267	225	262	**251**	91	65	0	**52**	n.a.	n.a.	n.a.	**-**	532	554	520	**535**
8 **An Nhon** Nhon An	32	38	32	**34**	101	41	94	**79**	5	3	2	**3**	n.a.	n.a.	n.a.	**-**	173	149	186	**169**
9 **An Nhon** Nhon Hung	68	57	57	**61**	74	65	70	**70**	7	0	3	**3**	n.a.	n.a.	n.a.	**-**	242	217	217	**225**
11 **An Nhon** Nhon Khanh	25	66	45	**45**	178	92	134	**134**	0	0	42	**14**	n.a.	n.a.	n.a.	**-**	260	241	276	**259**
13 **An Nhon** Nhon Hoa	105	140	139	**128**	176	140	178	**165**	30	29	4	**21**	n.a.	n.a.	n.a.	**-**	477	491	519	**496**
Total of An Nhon	**475**	**558**	**508**	**513**	**1,148**	**802**	**1,082**	**1,011**	**162**	**104**	**103**	**123**	**-**	**-**	**-**	**-**	**2,537**	**2,419**	**2,617**	**2,524**
1 **Tuy Phuoc** Tuy Phuoc	23	15	13	**17**	3	4	3	**3**	21	5	0	**9**	n.a.	n.a.	n.a.	**-**	99	90	72	**87**
2 **Tuy Phuoc** Dieu Tri	61	36	29	**42**	0	0	0	**0**	0	0	0	**0**	n.a.	n.a.	n.a.	**-**	158	144	120	**141**
3 **Tuy Phuoc** Phuoc Thang	0	0	5	**2**	0	0	0	**0**	0	0	0	**0**	n.a.	n.a.	n.a.	**-**	5	9	12	**9**
4 **Tuy Phuoc** Phuoc Hung	15	7	20	**14**	58	25	16	**33**	10	0	5	**5**	n.a.	n.a.	n.a.	**-**	187	211	241	**213**
5 **Tuy Phuoc** Phuoc Hoa	16	36	68	**40**	59	60	62	**60**	16	22	0	**13**	n.a.	n.a.	n.a.	**-**	165	214	238	**206**
6 **Tuy Phuoc** Phuoc Quang	26	20	10	**19**	21	20	13	**18**	8	0	17	**8**	n.a.	n.a.	n.a.	**-**	107	118	138	**121**
7 **Tuy Phuoc** Phuoc Son	0	0	0	**0**	0	0	0	**0**	0	0	0	**0**	n.a.	n.a.	n.a.	**-**	66	73	39	**59**
8 **Tuy Phuoc** Phuoc Hiep	150	93	90	**111**	283	116	152	**184**	35	29	45	**36**	n.a.	n.a.	n.a.	**-**	696	563	613	**624**
9 **Tuy Phuoc** Phuoc Loc	33	41	29	**34**	114	36	24	**58**	29	7	2	**13**	n.a.	n.a.	n.a.	**-**	289	223	179	**230**
10 **Tuy Phuoc** Phuoc Thuan	16	15	22	**18**	19	17	35	**24**	4	2	0	**2**	n.a.	n.a.	n.a.	**-**	61	85	110	**85**
11 **Tuy Phuoc** Phuoc Nghia	14	10	12	**12**	10	4	7	**7**	5	3	6	**5**	n.a.	n.a.	n.a.	**-**	60	55	84	**66**
12 **Tuy Phuoc** Phuoc An	104	212	131	**149**	8	0	19	**9**	0	0	3	**1**	n.a.	n.a.	n.a.	**-**	494	675	583	**584**
13 **Tuy Phuoc** Phuoc Thanh	111	87	64	**87**	0	0	30	**10**	8	10	0	**6**	n.a.	n.a.	n.a.	**-**	461	526	540	**509**
Total of Tuy Phuoc	**567**	**570**	**493**	**543**	**576**	**281**	**360**	**405**	**136**	**78**	**78**	**97**	**-**	**-**	**-**	**-**	**2,847**	**2,985**	**2,970**	**2,934**

Table L.5 Cropped Area, Unit Yield and Production of Other Annual Crops (2001)

City/District	Other Food Crops									Vegetable & Others					
	Maize			Cassava			Sweet Potatoes			Others			Vegetables		
	Area ha	Yield ton/ha	Prod. ton	Area ha	Yield ton/ha	Prod. ton	Area ha	Yield ton/ha	Prod. ton	Area ha	Yield ton/ha	Prod. ton	Area ha	Yield ton/ha	Prod. ton
Quy Nhon	-	-	-	22	7.16	158	8	4.50	36	10	-	-	178	12.81	2,279
An Lao	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hoai An	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hoai Nhon	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phu My	181	4.08	738	821	10.65	8,743	70	4.00	280	101	-	-	1,226	11.12	13,633
Vinh Thanh	31	2.21	68	63	10.05	633	4	5.07	20	-	-	-	18	8.64	155
Phu Cat	459	3.53	1,618	1,977	10.99	21,725	205	6.00	1,230	-	-	-	542	10.08	5,465
Tay Son	326	4.16	1,355	873	10.68	9,322	10	3.67	37	20	-	-	909	8.80	8,002
An Nhon	389	3.83	1,491	11	4.10	45	-	-	-	-	-	-	488	10.88	5,309
Tuy Phuoc	296	3.44	1,017	251	8.76	2,199	-	-	-	7	-	-	1,434	9.67	13,872
Van Canh	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	1,682	3.74	6,287	4,018	10.66	42,825	297	5.40	1,603	138	0.00	0	4,795	10.16	48,715
				Total of Other Food Crops			5,997	8.46	50,715	Total of Vegetables & Others			4,933	9.88	48,715

City/District	Industrial Crops														
	Peanuts			Soyabeans			Sesame			Sugarcane			Tobacco		
	Area ha	Yield ton/ha	Prod. ton	Area ha	Yield ton/ha	Prod. ton	Area ha	Yield ton/ha	Prod. ton	Area ha	Yield ton/ha	Prod. ton	Area ha	Yield ton/ha	Prod. ton
Quy Nhon	21	1.51	32	-	-	-	-	-	-	20	36.00	720	-	-	-
An Lao	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hoai An	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hoai Nhon	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phu My	1,159	1.65	1,910	3	1.57	5	334	0.40	133	436	38.10	16,612	8	1.59	13
Vinh Thanh	63	1.27	80	10	1.28	13	-	-	-	85	47.80	4,063	2	0.87	2
Phu Cat	1,439	1.65	2,377	15	1.41	21	250	0.20	50	779	40.92	31,875	46	1.80	83
Tay Son	499	1.69	843	173	1.80	312	12	0.59	7	1,461	45.00	65,745	72	1.80	129
An Nhon	390	1.81	706	624	1.79	1,118	26	0.41	11	153	49.70	7,604	-	-	-
Tuy Phuoc	537	1.60	861	334	1.29	430	40	0.58	23	72	38.00	2,736	-	-	-
Van Canh	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	4,108	1.66	6,809	1,159	1.64	1,899	662	0.34	224	3,006	43.03	129,355	128	1.77	227
				Total of Industrial Crops			9,063	15.28	138,514	Total of Subsidiary Crops			19,993	11.90	237,944

Table L.6 Cropped Area, Unit Yield and Production of Perennial Crops

City/District	Tea			Pepper			Coffee			Cashew			Coconut		
	Area ha	Yield ton/ha	Prod. ton	Area ha	Yield ton/ha	Prod. ton	Area ha	Yield ton/ha	Prod. ton	Area ha	Yield ton/ha	Prod. ton	Area ha	Yield ton/ha	Prod. ton
Quy Nhon	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
An Lao	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hoai An	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hoai Nhon	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phu My	-	-	-	1.3	0.25	0.3	-	-	-	382	0.07	28	560	4.05	12,540
Vinh Thanh	-	-	-	3.5	0.13	0.5	218	0.45	98.4	443	0.15	68	50	7.15	930
Phu Cat	7.0	0.03	0.2	-	-	-	-	-	-	237	0.08	18	174	6.14	10,925
Tay Son	-	-	-	-	-	-	-	-	-	1,248	0.13	156	344	4.94	1,700
An Nhon	-	-	-	-	-	-	-	-	-	90	0.15	14	71	3.99	1,260
Tuy Phuoc	-	-	-	-	-	-	-	-	-	171	0.19	32	151	3.80	1,179
Van Canh	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	7.0	0.03	0.2	4.8	0.16	0.8	218.0	0.45	98.4	2,571	0.12	316	1,350	21.14	28,534

City/District	Orange			Pineapple			Banana			Mango			Others		
	Area ha	Yield ton/ha	Prod. ton	Area ha	Yield ton/ha	Prod. ton	Area ha	Yield ton/ha	Prod. ton	Area ha	Yield ton/ha	Prod. ton	Area ha	Yield ton/ha	Prod. ton
Quy Nhon	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
An Lao	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hoai An	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hoai Nhon	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phu My	0.5	3.00	1.5	4.8	5.00	24.0	30.0	4.97	149.0	56.0	2.86	160.0	37.5	-	-
Vinh Thanh	7.6	2.22	16.9	64.0	4.59	294.0	120.0	4.46	535.0	129.8	0.59	76.7	17.5	-	-
Phu Cat	0.1	4.00	0.4	13.0	5.00	65.0	15.0	4.47	67.0	224.0	0.31	70.4	3.0	-	-
Tay Son	9.0	2.53	22.8	8.0	3.33	26.6	100.0	4.70	470.0	83.0	2.17	180.0	54.0	-	-
An Nhon	1.3	1.60	2.1	1.0	4.00	4.0	104.0	4.50	468.0	55.6	2.70	150.0	13.0	-	-
Tuy Phuoc	15.6	1.25	19.5	28.0	3.54	99.0	133.0	4.62	615.0	155.0	2.94	456.0	34.0	-	-
Van Canh	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	34.1	1.85	63.1	118.8	4.31	512.6	502.0	4.59	2,304.0	703.4	1.55	1,093.1	159.0	-	-

Table L.7 Livestock in the Project Area

(1) Buffalo (unit: head)

City/District	1995		1999		2000		2001		Average '99-'00	
	Total	Plough	Total	Plough	Total	Plough	Total	Plough	Total	Plough
1. Quy Nhon	30	20	30	10	30	10	20	10	27	10
2. An Lao	-	-	-	-	-	-	-	-	-	-
3. Hoai An	-	-	-	-	-	-	-	-	-	-
4. Hoai Nhon	-	-	-	-	-	-	-	-	-	-
5. Phu My	1,200	800	1,210	640	1,290	680	1,970	1,040	1,490	787
6. Vinh Thanh	260	60	360	130	360	130	300	110	340	123
7. Phu Cat	2,360	2,030	1,760	1,040	1,760	1,020	2,930	1,720	2,150	1,260
8. Tay Son	200	210	270	100	240	90	450	160	320	117
9. An Nhon	980	750	1,340	1,110	1,240	910	990	750	1,190	923
10. Tuy Phuoc	1,460	1,070	1,130	900	1,160	910	880	690	1,057	833
11. Van Canh	-	-	-	-	-	-	-	-	-	-
Total	6,490	4,940	6,100	3,930	6,080	3,750	7,540	4,480	6,573	4,053
Gowrh rate	-	-	-1.5%	-5.6%	-0.3%	-4.6%	24.0%	19.5%	0.2%	-3.2%
Province	18,480	12,530	19,480	12,750	18,590	11,800	20,720	12,420	19,600	12,320
Proportion	35.1%	39.4%	31.3%	30.8%	32.7%	31.8%	36.4%	36.1%	33.5%	32.9%

(2) Cattle (unit: head)

City/District	1995		1999		2000		2001		Average '99-'00	
	Total	Plough	Total	Plough	Total	Plough	Total	Plough	Total	Plough
1. Quy Nhon	810	270	920	280	850	240	740	210	840	240
2. An Lao	-	-	-	-	-	-	-	-	-	-
3. Hoai An	-	-	-	-	-	-	-	-	-	-
4. Hoai Nhon	-	-	-	-	-	-	-	-	-	-
5. Phu My	16,970	8,520	19,420	7,570	20,030	7,800	16,870	6,280	18,770	7,220
6. Vinh Thanh	4,490	1,530	5,480	1,670	4,690	1,410	3,880	1,160	4,680	1,410
7. Phu Cat	33,280	18,030	34,260	18,160	35,980	18,510	29,690	15,010	33,310	17,230
8. Tay Son	26,420	9,160	25,700	6,200	26,450	6,200	20,150	4,660	24,100	5,690
9. An Nhon	22,030	7,930	18,450	5,540	17,710	5,540	14,210	4,360	16,790	5,150
10. Tuy Phuoc	15,970	5,950	17,000	5,420	15,830	4,890	12,780	3,920	15,200	4,740
11. Van Canh	-	-	-	-	-	-	-	-	-	-
Total	119,970	51,390	121,230	44,840	121,540	44,590	98,320	35,600	113,690	41,680
Gowrh rate	-	-	0.3%	-3.4%	0.3%	-0.6%	-19.1%	-20.2%	-0.9%	-3.4%
Province	230,300	91,820	239,470	79,470	238,850	78,970	192,480	63,150	223,600	73,860
Proportion	52.1%	56.0%	50.6%	56.4%	50.9%	56.5%	51.1%	56.4%	50.8%	56.4%

(3) Pig (unit: head)

City/District	1995		1999		2000		2001		Average '99-'00	
	Total	Pork	Total	Pork	Total	Pork	Total	Pork	Total	Pork
1. Quy Nhon	2,700	2,400	3,200	3,000	3,100	2,900	3,100	2,900	3,100	2,900
2. An Lao	-	-	-	-	-	-	-	-	-	-
3. Hoai An	-	-	-	-	-	-	-	-	-	-
4. Hoai Nhon	-	-	-	-	-	-	-	-	-	-
5. Phu My	18,700	14,800	20,600	15,900	20,900	16,100	25,500	19,700	22,300	17,200
6. Vinh Thanh	3,900	3,600	5,400	5,100	6,700	6,300	5,300	4,600	5,800	5,300
7. Phu Cat	36,600	30,400	38,200	34,000	40,900	36,200	59,000	52,400	46,000	40,900
8. Tay Son	23,800	20,700	29,400	24,400	31,200	25,900	40,200	36,800	33,600	29,000
9. An Nhon	28,700	21,800	33,200	22,700	36,000	24,800	59,700	46,200	43,000	31,200
10. Tuy Phuoc	34,800	27,500	39,100	27,800	40,100	28,600	55,400	39,600	44,900	32,000
11. Van Canh	-	-	-	-	-	-	-	-	-	-
Total	149,200	121,200	169,100	132,900	178,900	140,800	248,200	202,200	198,700	158,500
Gowrh rate	-	-	3.2%	2.3%	5.8%	5.9%	38.7%	43.6%	4.9%	4.6%
Province	340,000	284,700	393,100	324,400	411,100	337,600	545,200	466,600	449,800	376,200
Proportion	43.9%	42.6%	43.0%	41.0%	43.5%	41.7%	45.5%	43.3%	44.2%	42.1%

Note: Livestock head is estimated based on the number of households located in the project area at the district level against total of the province.

Source: Estimation by JICA Study Team based on the Statistical Yearbook 2001, Binh Dinh Province.

Table L.8 Livestock in Each District in the Project Area

	Unit	Total				Qui Nhon				Phu My			
		1999	2000	2001	Ave.	1999	2000	2001	Ave.	1999	2000	2001	Ave.
1. Baffalo	head	8,200	9,800	10,500	10,200	230	230	158	210	2,909	3,083	4,710	3,570
for working		5,200	5,400	5,200	5,500	105	105	78	100	1,541	1,633	2,494	1,890
2. Cattle	head	176,500	179,600	163,000	214,700	6,691	6,155	6,052	6,300	46,511	47,872	40,415	44,900
for working		62,800	58,900	57,800	73,600	2,006	1,741	1,695	1,800	18,139	18,683	15,041	17,300
cross breading		20,300	9,600	19,600	36,500	356	532	698	530	4,124	5,549	3,376	4,350
3. Pig	head	248,800	287,700	347,000	347,500	23,340	22,290	22,463	22,700	49,404	49,997	61,175	53,500
Sow		50,700	50,000	71,800	65,200	1,267	1,220	1,288	1,300	11,124	11,251	13,764	12,000
Boar		416	438	493	500	30	30	35	0	130	134	135	100
Pork		197,700	181,000	274,700	273,700	22,043	21,040	21,140	21,400	38,150	38,612	47,276	41,300
Cross breed		200,000	174,600	278,700	281,200	20,547	16,759	18,124	18,500	34,079	34,364	44,255	37,600
4. Hourse	head	114	132	109	132	0	0	0	0	14	12	12	13
5. Goat	head	3,300	4,000	4,200	4,100	876	510	560	650	262	286	286	280
6. Chiken	head	893,100	1,137,700	1,349,000	1,152,900	60,990	71,978	71,885	68,300	180,454	194,908	247,429	207,600
7. Duck	head	963,600	967,100	750,100	925,300	108,703	118,492	117,765	115,000	130,326	149,166	107,498	129,000
8. Goose	head	4,600	12,900	3,300	8,700	270	290	304	290	3,464	3,617	2,950	3,340

	Unit	Vinh Thanh				Phu Cat				Tay Son			
		1999	2000	2001	Ave.	1999	2000	2001	Ave.	1999	2000	2001	Ave.
1. Baffalo	head	-	844	712	780	2,193	2,192	2,352	2,250	373	689	-	530
for working		-	312	263	290	1,294	1,268	1,368	1,310	136	-	-	140
2. Cattle	head	-	11,128	9,226	10,200	42,762	44,900	37,143	41,600	40,682	30,902	-	35,800
for working		-	3,338	2,767	3,100	22,664	23,097	19,314	21,700	9,531	-	-	9,500
cross breading		-	3,513	3,020	3,270				-	15,826	-	-	15,830
3. Pig	head	-	15,963	12,619	14,300	47,703	50,996	73,621	57,400	48,022	61,071	-	54,500
Sow		-	977	1,556	1,300	5,247	5,689	8,314	6,400	8,163	5,161	-	6,700
Boar		-	36	31	0	56	86	53	100	69	-	-	100
Pork		-	14,950	11,032	13,000	42,400	45,221	65,254	51,000	39,790	-	-	39,800
Cross breed		-	14,603	11,896	13,200	44,580	48,065	69,410	54,000	45,621	-	-	45,600
4. Hourse	head	-	20	-	20	12	12	9	11	-	-	-	-
5. Goat	head	-	910	621	770	1,380	1,528	1,830	1,580	-	-	-	-
6. Chiken	head	-	108,596	48,567	78,600	241,690	273,109	365,580	293,500	-	-	-	-
7. Duck	head	-	11,068	9,937	10,500	75,240	95,554	200,477	123,800	-	-	-	-
8. Goose	head	-	144	-	140	30	30	30	30	-	-	-	-

	Unit	An Nhon				Tuy Phuoc				Van Canh			
		1999	2000	2001	Ave.	1999	2000	2001	Ave.	1999	2000	2001	Ave.
1. Baffalo	head	1,302	1,565	1,252	1,370	1,157	1,186	902	1,080	-	-	420	420
for working		1,171	1,158	114	810	926	930	707	850	-	-	154	150
2. Cattle	head	22,373	22,436	17,546	20,800	17,438	16,235	13,104	15,600	-	-	39,535	39,500
for working		7,013	7,013	5,485	6,500	3,438	5,015	4,017	4,200	-	-	9,529	9,500
cross breading		-	-	-	-	-	-	-	-	-	-	12,476	12,480
3. Pig	head	40,203	45,589	75,119	53,600	40,130	41,806	56,821	46,300	-	-	45,219	45,200
Sow		13,317	14,025	23,110	16,800	11,595	11,647	16,166	13,100	-	-	7,626	7,600
Boar		91	91	150	100	40	61	65	100	-	-	24	0
Pork		26,795	31,473	51,859	36,700	28,495	29,738	40,590	32,900	-	-	37,569	37,600
Cross breed		26,795	31,473	51,859	36,700	28,357	29,290	40,184	32,600	-	-	42,950	43,000
4. Hourse	head	56	56	58	57	32	32	30	31	-	-	-	-
5. Goat	head	230	130	240	200	560	602	712	620	-	-	-	-
6. Chiken	head	261,088	307,012	302,100	290,100	148,834	182,087	313,421	214,800	-	-	-	-
7. Duck	head	169,053	175	-	84,600	480,230	592,597	314,412	462,400	-	-	-	-
8. Goose	head	-	-	-	-	864	8,856	-	4,860	-	-	-	-

Source: Statistical Year Book 2001 in each distict.

Table L.9 Livestock Production in Each District

		Total				Qui Nhon				Phu My			
	Unit	1999	2000	2001	Ave.	1999	2000	2001	Ave.	1999	2000	2001	Ave.
Livestock Production													
1. Buffalo	ton	72	85	111	80	0	2	3	2	44	32	57	44
2. Cow	ton	1,800	2,600	2,200	1,800	86	104	38	100	703	709	265	600
3. Pork	ton	9,900	11,100	12,600	7,600	1,428	1,478	1,714	1,500	2,741	2,826	3,278	2,900
4. Poultry	ton	885	1,803	2,148	1,600	324	354	385	400	120	148	156	100
5. Egg	1000 pcs.	67,500	72,000	78,600	72,300	10,863	13,958	13,796	12,900	9,110	9,931	10,131	9,700
6. Honey	ton	0.15	0.14	0.15	0.00	-	-	-	-	-	-	-	-

		Vinh Thanh				Phu Cat				Tay Son			
	Unit	1999	2000	2001	Ave.	1999	2000	2001	Ave.	1999	2000	2001	Ave.
Livestock Production													
1. Buffalo	ton	-	21	21	21	14	15	15	15	-	-	-	-
2. Cow	ton	-	503	564	500	537	691	571	600	-	-	-	-
3. Pork	ton	-	717	964	800	3,441	3,658	4,266	3,800	-	-	-	-
4. Poultry	ton	-	717	956	800	217	309	348	300	-	-	-	-
5. Egg	1000 pcs.	-	938	904	900	9,294	10,629	10,829	10,300	7,909	-	-	7,900
6. Honey	ton	-	-	-	-	0.15	0.14	0.15	0.15	-	-	-	-

		An Nhon				Tuy Phuoc				Van Canh			
	Unit	1999	2000	2001	Ave.	1999	2000	2001	Ave.	1999	2000	2001	Ave.
Livestock Production													
1. Buffalo	ton	-	-	-	-	14	15	15	15	-	-	-	-
2. Cow	ton	-	-	-	-	442	574	742	600	-	-	-	-
3. Pork	ton	-	-	-	-	2,333	2,466	2,417	2,400	-	-	-	-
4. Poultry	ton	-	-	-	-	224	275	303	300	-	-	-	-
5. Egg	1000 pcs.	-	-	-	-	30,345	36,584	36,572	34,500	-	-	6,408	6,400
6. Honey	ton	-	-	-	-	-	-	-	-	-	-	-	-

Table L.10 Present Cropping Area in the Project Area of Feasibility Study (2001)

	Cropping Pattern A					Cropping Pattern B					Cropping Pattern C					Total				
	Irrigated		Rainfed		Total	Irrigated		Rainfed		Total	Irrigated		Rainfed		Total	Irrigated		Rainfed		Total
I. Physical Area																				
Farm Land	**3,000**	14.6%	**17,500**	85.4%	**20,500**	**10,100**	74.3%	**3,500**	25.7%	**13,600**	**2,600**	78.8%	**700**	21.2%	**3,300**	**15,700**	42.0%	**21,700**	58.0%	**37,400**
II. by Cropping Season																				
1. Winter - Spring	**3,000**	15%	**10,200**	50%	**13,200**	**10,100**	74%	**2,200**	16%	**12,300**	**2,600**	79%	**700**	21%	**3,300**	**15,700**	42%	**13,100**	35%	**28,800**
Paddy (early)	3,000	15%	7,300	36%	10,300	1,700	13%	-	-	1,700	-	-	-	-	0	4,700	13%	7,300	20%	12,000
Paddy (late)	-	-	-	-	0	8,400	62%	1,000	7%	9,400	2,600	79%	700	21%	3,300	11,000	29%	1,700	5%	12,700
Maize	-	-	2,700	13%	2,700	-	-	1,200	9%	1,200	-	-	-	-	0	0	0%	3,900	10%	3,900
Groundnuts/ Soybeans	-	-	-	-	0	-	-	-	-	0	-	-	-	-	0	0	0%	0	0%	0
Tobacco	-	-	200	1%	200	-	-	-	-	0	-	-	-	-	0	0	0%	200	1%	200
2. Summer - Autumn	**3,000**	15%	**5,400**	26%	**8,400**	**8,300**	61%	**1,200**	9%	**9,500**	**2,600**	79%	**400**	12%	**3,000**	**13,900**	37%	**7,000**	19%	**20,900**
Paddy (early)	2,600	13%	-	-	2,600	1,700	13%	-	-	1,700	-	-	-	-	0	4,300	12%	0	0%	4,300
Paddy (late)	-	-	-	-	0	5,500	40%	-	-	5,500	2,300	70%	-	-	2,300	7,800	21%	0	0%	7,800
Maize	-	-	2,500	12%	2,500	800	6%	600	4%	1,400	200	6%	200	6%	400	1,000	3%	3,300	9%	4,300
Groundnuts/ Soybeans	400	2%	2,900	14%	3,300	300	2%	600	4%	900	100	3%	200	6%	300	800	2%	3,700	10%	4,500
Tobacco	-	-	-	-	0	-	-	-	-	0	-	-	-	-	0	0	0%	0	0%	0
3. 3rd Crop Season	**1,800**	9%	**0**	0%	**1,800**	**1,700**	13%	**0**	0%	**1,700**	**0**	0%	**0**	0%	**0**	**3,500**	9%	**0**	0%	**3,500**
Paddy (early)	1,800	9%	-	-	1,800	1,700	13%	-	-	1,700	-	-	-	-	0	3,500	9%	0	0%	3,500
Paddy (late)	-	-	-	-	0	-	-	-	-	0	-	-	-	-	0	0	0%	0	0%	0
Maize	-	-	-	-	0	-	-	-	-	0	-	-	-	-	0	0	0%	0	0%	0
Groundnuts/ Soybeans	-	-	-	-	0	-	-	-	-	0	-	-	-	-	0	0	0%	0	0%	0
Tobacco	-	-	-	-	0	-	-	-	-	0	-	-	-	-	0	0	0%	0	0%	0
4. Perennial Crops	**0**	0%	**7,300**	36%	**7,300**	**0**	0%	**1,300**	10%	**1,300**	**0**	0%	**0**	0%	**0**	**0**	0%	**8,600**	23%	**8,600**
Sugarecane	-	-	4,000	20%	4,000	-	-	-	-	0	-	-	-	-	0	0	0%	4,000	11%	4,000
Pinapple	-	-	-	-	0	-	-	-	-	0	-	-	-	-	0	0	0%	0	0%	0
Cassava	-	-	3,300	16%	3,300	-	-	1,300	10%	1,300	-	-	-	-	0	0	0%	4,600	12%	4,600
5. Total	**7,800**	38%	**22,900**	112%	**30,700**	**20,100**	148%	**4,700**	35%	**24,800**	**5,200**	158%	**1,100**	33%	**6,300**	**33,100**	89%	**28,700**	77%	**61,800**
(Cropping Intensity)	260%		131%		150%	199%		134%		182%	200%		157%		191%	211%		132%		165%
III. by Crops	**7,800**	38%	**22,900**	112%	**30,700**	**20,100**	148%	**4,700**	35%	**24,800**	**5,200**	158%	**1,100**	33%	**6,300**	**33,100**	89%	**28,700**	77%	**61,800**
Paddy	7,400	36%	7,300	36%	14,700	19,000	140%	1,000	7%	20,000	4,900	149%	700	21%	5,600	31,300	84%	9,000	24%	40,300
Maize	0	-	5,200	25%	5,200	800	6%	1,800	13%	2,600	200	6%	200	6%	400	1,000	3%	7,200	19%	8,200
Groundnuts/ Soybeans	400	2%	2,900	14%	3,300	300	2%	600	4%	900	100	3%	200	6%	300	800	2%	3,700	10%	4,500
Tobacco	0	-	200	1%	200	0	0%	0	0%	0	0	0%	0	0%	0	0	0%	200	1%	200
Sugarecane	-	-	4,000	20%	4,000	-	-	-	0%	0	-	-	-	-	0	0	0%	4,000	11%	4,000
Pinapple	-	-	-	-	0	-	-	-	0%	0	-	-	-	-	0	0	0%	0	0%	0
Cassava	-	-	3,300	16%	3,300	-	-	1,300	10%	1,300	-	-	-	-	0	0	0%	4,600	12%	4,600

Table L.11 Future Cropping Area in the Project Area of Feasibility Study (2020)

	Cropping Pattern A					Cropping Pattern B					Cropping Pattern C					Total				
	Irrigated		Rainfed		Total	Irrigated		Rainfed		Total	Irrigated		Rainfed		Total	Irrigated		Rainfed		Total
I. Physical Area																				
Farm Land	**20,500**	100%	**0**	0%	**20,500**	**13,600**	100%	**0**	0%	**13,600**	**3,300**	100%	**0**	0%	**3,300**	**37,400**	100%	**0**	0%	**37,400**
II. by Cropping Season																				
1. Winter - Spring	**17,300**	84%	**0**	0%	**17,300**	**13,600**	100%	**0**	0%	**13,600**	**3,300**	100%	**0**	0%	**3,300**	**34,200**	92%	**0**	0%	**34,200**
Paddy (early)	14,400	70%	-	-	14,400	2,800	21%	-	-	2,800	-	-	-	-	0	17,200	46%	-	-	17,200
Paddy (late)	-	-	-	-	0	8,100	60%	-	-	8,100	3,300	100%	-	-	3,300	11,400	31%	-	-	11,400
Maize	2,500	12%	-	-	2,500	2,700	20%	-	-	2,700	-	-	-	-	0	5,200	14%	-	-	5,200
Groundnuts/ Soybeans	-	-	-	-	0	-	-	-	-	0	-	-	-	-	0	0	0%	-	-	0
Tobacco	400	2%	-	-	400	-	-	-	-	0	-	-	-	-	0	400	1%	-	-	400
2. Summer - Autumn	**17,300**	84%	**0**	0%	**17,300**	**13,600**	100%	**0**	0%	**13,600**	**3,300**	100%	**0**	0%	**3,300**	**34,200**	92%	**0**	0%	**34,200**
Paddy (early)	10,300	50%	-	-	10,300	1,400	10%	-	-	1,400	-	-	-	-	0	11,700	31%	-	-	11,700
Paddy (late)	-	-	-	-	0	5,400	40%	-	-	5,400	2,000	61%	-	-	2,000	7,400	20%	-	-	7,400
Maize	4,100	20%	-	-	4,100	2,700	20%	-	-	2,700	700	21%	-	-	700	7,500	20%	-	-	7,500
Groundnuts/ Soybeans	2,900	14%	-	-	2,900	4,100	30%	-	-	4,100	600	18%	-	-	600	7,600	20%	-	-	7,600
Tobacco	-	-	-	-	0	-	-	-	-	0	-	-	-	-	0	0	0%	-	-	0
3. 3rd Crop Season	**10,300**	50%	**0**	0%	**10,300**	**2,800**	21%	**0**	0%	**2,800**	**0**	0%	**0**	0%	**0**	**13,100**	35%	**0**	0%	**13,100**
Paddy (early)	10,300	50%	-	-	10,300	2,800	21%	-	-	2,800	-	-	-	-	0	13,100	35%	-	-	13,100
Paddy (late)	-	-	-	-	0	-	-	-	-	0	-	-	-	-	0	0	0%	-	-	0
Maize	-	-	-	-	0	-	-	-	-	0	-	-	-	-	0	0	0%	-	-	0
Groundnuts/ Soybeans	-	-	-	-	0	-	-	-	-	0	-	-	-	-	0	0	0%	-	-	0
Tobacco	-	-	-	-	0	-	-	-	-	0	-	-	-	-	0	0	0%	-	-	0
4. Perennial Crops	**3,300**	16%	**0**	0%	**3,300**	**0**	0%	**0**	0%	**0**	**0**	0%	**0**	0%	**0**	**3,300**	9%	**0**	0%	**3,300**
Sugarecane	3,000	15%	-	-	3,000	-	-	-	-	0	-	-	-	-	0	3,000	8%	-	-	3,000
Pinapple	300	2%	-	-	300	-	-	-	-	0	-	-	-	-	0	300	1%	-	-	300
Cassava	-	-	-	-	0	-	-	-	-	0	-	-	-	-	0	0	0%	-	-	0
5. Total	**48,200**	235%	**0**	0%	**48,200**	**30,000**	221%	**0**	0%	**30,000**	**6,600**	200%	**0**	0%	**6,600**	**84,800**	227%	**0**	0%	**84,800**
(Cropping Intensity)	235%				235%	221%				221%	200%				200%	227%				227%
III. by Crops	**48,200**	235%	**0**	0%	**48,200**	**30,000**	221%	**0**	0%	**30,000**	**6,600**	200%	**0**	0%	**6,600**	**84,800**	227%	**0**	0%	**84,800**
Paddy	35,000	171%	-	-	35,000	20,500	151%	-	-	20,500	5,300	161%	-	-	5,300	60,800	163%	-	-	60,800
Maize	6,600	32%	-	-	6,600	5,400	40%	-	-	5,400	700	21%	-	-	700	12,700	34%	-	-	12,700
Groundnuts/ Soybeans	2,900	14%	-	-	2,900	4,100	30%	-	-	4,100	600	18%	-	-	600	7,600	20%	-	-	7,600
Tobacco	400	2%	-	-	400	0	0%	-	-	0	0	0%	-	-	0	400	1%	-	-	400
Sugarecane	3,000	15%	-	-	3,000	-	0%	-	-	0	-	0%	-	-	0	3,000	8%	-	-	3,000
Pinapple	300	2%	-	-	300	-	0%	-	-	0	-	-	-	-	0	300	1%	-	-	300
Cassava	-	-	-	-	0	-	-	-	-	0	-	-	-	-	0	0	0%	-	-	0

Table L.12 Incremental Production under the Project

A: Without Project Condition			
Crop & Season	**Area (ha)**	**Unit Yield (ton/ha)**	**Production (ton)**
Paddy			
Winter-Spring Season	24,700	2.6 - 6.5	110,000
Summer-Autum Season	12,100	2.2 - 5.6	53,200
3rd Crop Season	3,500	1.8 - 4.6	11,900
Sub-total	40,300	2.2 - 4.3	175,100
Maize	8,200	1.4 - 3.3	13,600
Groundnuts & Soybeans	4,500	0.7 - 1.5	4,500
Tobacco	200	0.9 - 1.5	200
Sugarcane	4,000	34.1 - 49.7	136,300
Pineapple	0	-	0
Cassava	4,600	7.00	32,200
Total	**61,800**	**-**	**361,900**

B: Future under the Project			
Crop	**Area (ha)**	**Unit Yield (ton/ha)**	**Produc-tion (ton)**
Paddy			
Winter-Spring Season	28,600	5.5	157,300
Summer-Autum Season	19,100	4.8	91,700
3rd Crop Season	13,100	4.3	56,300
Sub-total	60,800	5.0	305,300
Maize	12,700	4.5	57,200
Groundnuts & Soybeans	7,600	1.9	14,400
Tobacco	400	1.7	700
Sugarcane	3,000	60.0	180,000
Pineapple	300	20.0	6,000
Cassava	0	-	0
Total	**84,800**	**-**	**563,600**

Increment (A - B)					
Crop	**Area (ha)**		**Unit Yield (ton/ha)**	**Production (ton)**	
Paddy					
Winter-Spring Season	3,900	16%	1.05	47,300	43%
Summer-Autum Season	7,000	58%	0.40	38,500	72%
3rd Crop Season	9,600	274%	0.90	44,400	373%
Sub-total	20,500	51%	0.68	130,200	74%
Maize	4,500	55%	2.85	43,600	321%
Groundnuts & Soybeans	3,100	69%	0.89	9,900	220%
Tobacco	200	100%	0.75	500	250%
Sugarcane	-1,000	-25%	25.93	43,700	32%
Pineapple	300	100%	20.00	6,000	100%
Cassava	-4,600	-	-	-32,200	-
Total	**23,000**	**37%**	**-**	**201,700**	**56%**

Table L.13 Estimated Water Level at Downstream Side of Site-II (JICA Team)

River Bed Width B (converted)	Side Slope m (average)	River Bed EL (Converted)	Discharge Q	Water Depth h	Velocity V	Water Level WL	Remarks
(m)		(m)	(m^3/s)	(m)	(m/s)	(m)	
483	11.0	21.75	0	0.00	0.00	21.75	
483	11.0	21.75	50	0.34	0.30	22.09	
483	11.0	21.75	100	0.51	0.40	22.26	
483	11.0	21.75	150	0.65	0.47	22.40	
483	11.0	21.75	200	0.78	0.53	22.53	
483	11.0	21.75	300	0.99	0.62	22.74	
483	11.0	21.75	500	1.34	0.75	23.09	
483	11.0	21.75	1,000	2.02	0.98	23.77	
483	**11.0**	**21.75**	**1,829**	**2.90**	**1.23**	**24.65**	**Site II, P=10% with Dam**
483	11.0	21.75	2,000	3.05	1.27	24.80	
483	**11.0**	**21.75**	**2,397**	**3.40**	**1.36**	**25.15**	**Site II, P=5% with Dam**
483	11.0	21.75	3,000	3.88	1.47	25.63	
483	11.0	21.75	4,000	4.59	1.63	26.34	
483	11.0	21.75	5,000	5.23	1.77	26.98	
483	11.0	21.75	6,000	5.81	1.89	27.56	
483	**11.0**	**21.75**	**6,713**	**6.20**	**1.96**	**27.95**	**Site II, P=1% with Dam**
483	11.0	21.75	7,000	6.36	1.99	28.11	
483	11.0	21.75	8,000	6.87	2.09	28.62	

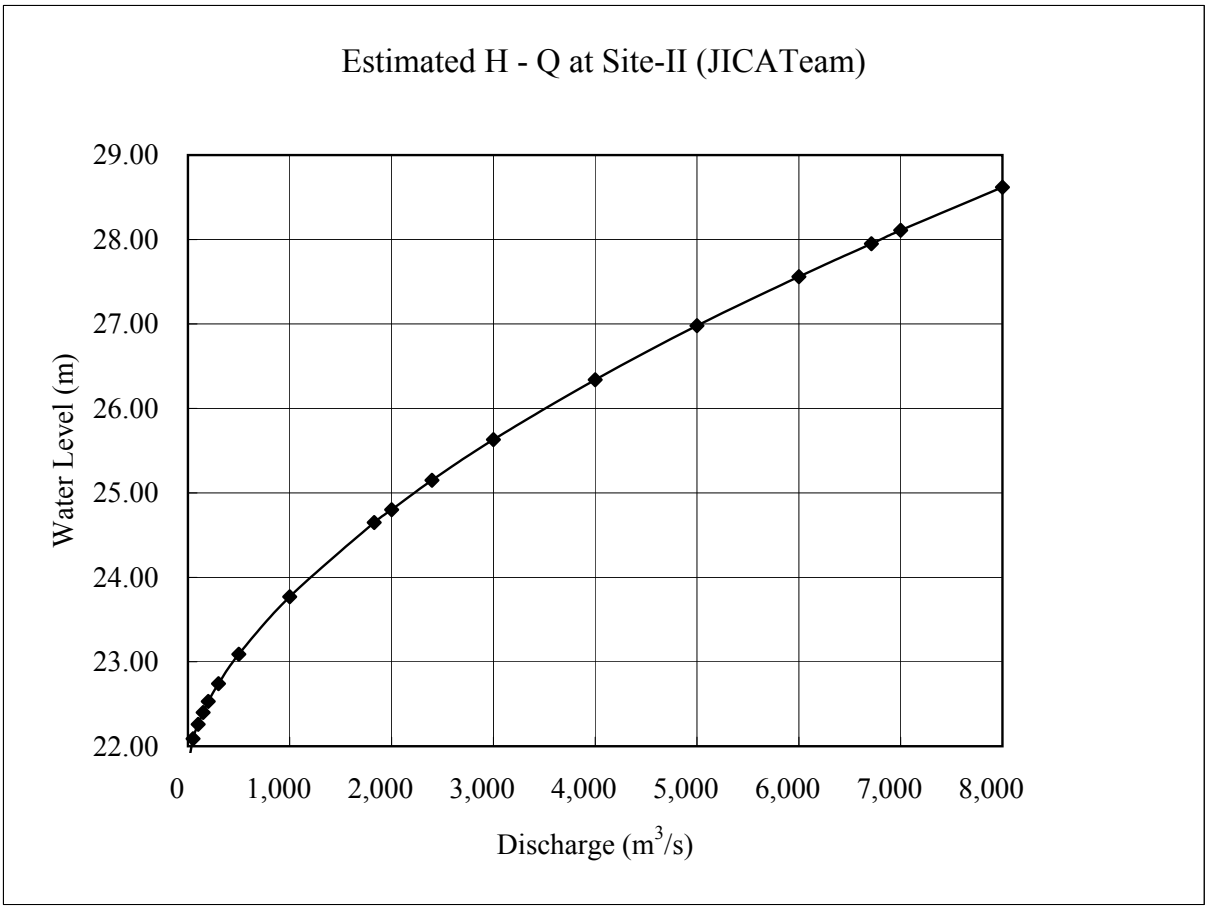


Table L.14 (1/2) Overflow Water Level on Fixed Weir at Site-II (JICA Team)

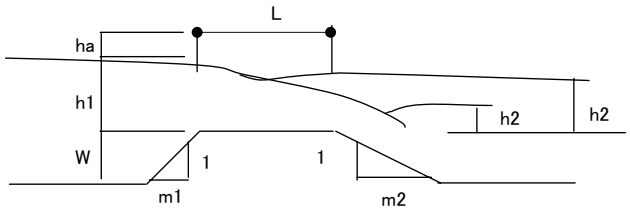
Honma's Formula

Perfect Overflow	Q=	Co･B･h1^(3/2)
Imperfect Overflow	Q=	C･B･h1^(3/2)
Submerged Overflow	Q=	C'･B･h2･(h1-h2)^(1/2)

	Downstream m2	Upstream m1	Perfect Co	Border h2/h1	Imperfect C/Co	Border h2/h1	Submerged C'/Co
Case1	>5/3	0~4/3	1.37+1.02(h1/W)	0.60	1.018-0.030 h2/h1	0.70	2.6
Case2	around 1/1	0~2/3	1.28+1.42(h1/W)	0.45	1.090-0.200 h2/h1	0.80	2.6
Case3	around 2/3	0~1/3	1.24+1.64(h1/W)	0.25	1.032-0.124 h2/h1	0.80	2.6
Case4	Rectangular, h1/L<1/2		1.55	2/3	-	2/3	2.6

Input

Discharge	Qi=	6,713	m^3/s
Downstream Depth	H2=W+h2=	8.45	m
Weir Width	B=	525	m
Weir Length	L=	3.0	m
Weir Height	W=	6.0	m
Down. Depth on Crest	h2=H2-W=	2.45	m, output
Down. Side Slope	m2, 1:	0.7	
Up. Side Slope	m1, 1:	0.0	
Up. Depth on Crest	h1=	3.40	m, Goal Seek (C)



Output

h2/h1=	0.722	check by each case !

Perfect Overflow	Imperfect Overflow	Submerged Overflow
Case 3	Case 3	Case 3
Co= 2.168132076	C= 2.043532586	C'= 5.6371434
∴ Qc= 7,122	∴ Qc= 6,713	∴ Qc= 7,051
Qi-Qc= -409 Goal Seek (E)	Qi-Qc= 0	Qi-Qc= -338

Calculation Result, Case 3

Concrete Fixed Weir

Input B (m)	Input River Bed EL (m)	Input Weir Height W (m)	Output Crest EL (m)	Input Q (m3/s)	Input H2 (m)	Output h2 (m)	Output h1 (m)	Output WL1 (m)	h2/h1	Overflow Condition	Remarks
525.0	19.50	6.0	25.50	6,713	8.45	2.45	3.40	28.90	0.72	Case 3, Imperfect	**Site II, P=1%**

Table L.14 (2/2) Overflow Water Level on Rubber Weir at Site-II (JICA Team)

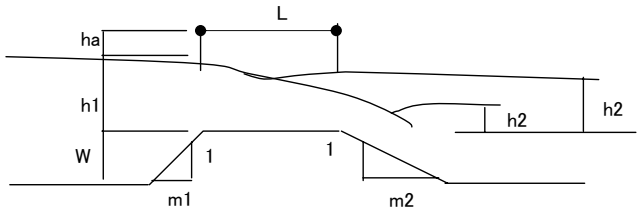
Honma's Formula

Perfect Overflow	Q=	Co･B･h1^(3/2)
Imperfect Overflow	Q=	C･B･h1^(3/2)
Submerged Overflow	Q=	C'･B･h2･(h1-h2)^(1/2)

	Downstream m2	Upstream m1	Perfect Co	Border h2/h1	Imperfect C/Co	Border h2/h1	Submerged C'/Co
Case1	>5/3	0~4/3	1.37+1.02(h1/W)	0.60	1.018-0.030 h2/h1	0.70	2.6
Case2	around 1/1	0~2/3	1.28+1.42(h1/W)	0.45	1.090-0.200 h2/h1	0.80	2.6
Case3	around 2/3	0~1/3	1.24+1.64(h1/W)	0.25	1.032-0.124 h2/h1	0.80	2.6
Case4	Rectangular, h1/L<1/2		1.55	2/3	-	2/3	2.6

Input

Discharge	Qi=	6,713	m^3/s
Downstream Depth	H2=W+h2=	8.45	m
Weir Width	B=	507.5	m
Weir Length	L=	5.5	m
Weir Height	W=	3.5	m
Down. Depth on Crest	h2=H2-W=	4.95	m, output
Down. Side Slope	m2, 1:	0.65	
Up. Side Slope	m1, 1:	0.0	
Up. Depth on Crest	h1=	5.03	m, Goal Seek (C)



Output

h2/h1=	0.984	check by each case !

Perfect Overflow	Imperfect Overflow	Submerged Overflow
Case 3	Case 3	Case 3
Co= 3.597670272	C= 3.273920584	C'= 9.35394271
∴ Qc= 20,607	∴ Qc= 18,753	∴ Qc= 6,713
Qi-Qc= -13,894 Goal Seek (E)	Qi-Qc= -12,040	Qi-Qc= -0

Calculation Result, Case 3

Rubber Weir, Deflated Condition

Input B (m)	Input River Bed EL (m)	Input Weir Height W (m)	Output Crest EL (m)	Input Q (m3/s)	Input WL2 (HQ) (m)	Output h2 (m)	Output h1 (m)	Output WL1 (m)	h2/h1	Overflow Condition	Remarks
507.5	19.50	3.50	23.00	6,713	8.45	4.95	5.03	28.03	0.98	Case 3, Submerged	**Site II, P=1%**

Table L.15 Collision Velocity on Bottom of Downstream Basin

Aki's Formula on Free Overfall into Basin
for Range III (hs ≥ 20 hd, hs: water depth in weir side, hd: water depth in downstream side)

$V_1/V_0 = k/(\xi/d_0)^{(1/2)}$ or $V_1 = V_0 * k/(\xi/d_0)^{(1/2)}$

1	**Unit Width Discharge q =**	**4.60**	**$m^3/s/m$**	**4.60**	**$m^3/s/m$**	**4.60**	**$m^3/s/m$**	**4.60**	**$m^3/s/m$**
	Upstream WL1 =	27.13	m	27.13	m	27.13	m	27.13	m
	Downstream WL2 =	25.15	m	25.15	m	25.15	m	25.15	m
	Depth on Crest h1 =	1.63	m	1.63	m	1.63	m	1.63	m
	H = (WL1-h2/2)-WL2 =	1.17	m	1.17	m	1.17	m	1.17	m
	Velocity at Water Surface V_0 =	(2*9.8*H)^(1/2)		(2*9.8*H)^(1/2)		(2*9.8*H)^(1/2)		(2*9.8*H)^(1/2)	
	V_0 =	4.78	m/s	4.78	m/s	4.78	m/s	4.78	m/s
	k =	2.50		2.50		2.50		2.50	
	Water Depth to Bottom ξ' =	**3.00**	**m**	**5.00**	**m**	**10.00**	**m**	**15.00**	**m**
	Slope 1:m, m =	0.70		0.70		0.70		0.70	
	Distance in Water ξ = ξ' / m =	4.29	m	7.14	m	14.29	m	21.43	m
	hc =	1.29	m	1.29	m	1.29	m	1.29	m
	$d_0 = q/V_0$ =	0.96	m	0.96	m	0.96	m	0.96	m
	V_1 =	**5.66**	**m/s**	**4.39**	**m/s**	**3.10**	**m/s**	**2.53**	**m/s**

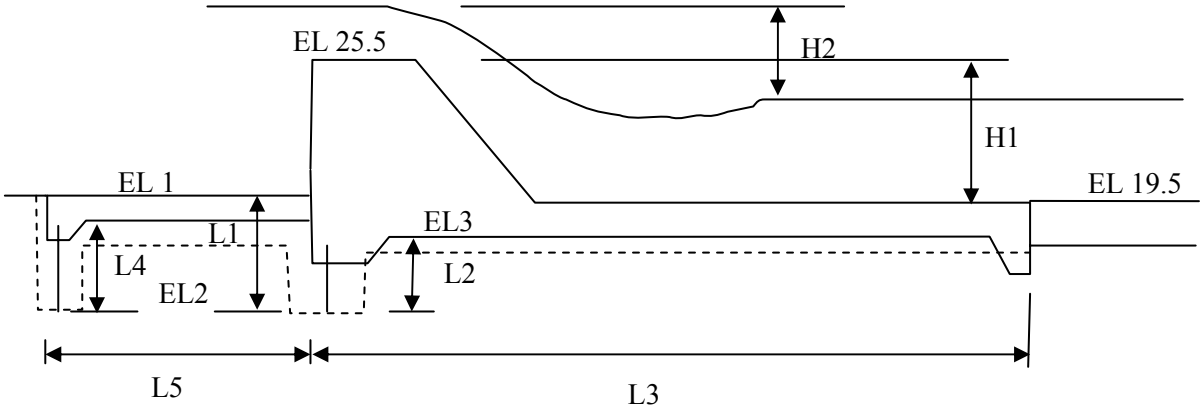
2	**Unit Width Discharge q =**	**3.50**	**$m^3/s/m$**	**3.50**	**$m^3/s/m$**	**3.50**	**$m^3/s/m$**	**3.50**	**$m^3/s/m$**
	Upstream WL1 =	28.86	m	28.86	m	28.86	m	28.86	m
	Downstream WL2 =	24.65	m	24.65	m	24.65	m	24.65	m
	Depth on Crest h1 =	1.36	m	1.36	m	1.36	m	1.36	m
	H = (WL1-h2/2)-WL2 =	3.53	m	3.53	m	3.53	m	3.53	m
	Velocity at Water Surface V_0 =	(2*9.8*H)^(1/2)		(2*9.8*H)^(1/2)		(2*9.8*H)^(1/2)		(2*9.8*H)^(1/2)	
	V_0 =	8.32	m/s	8.32	m/s	8.32	m/s	8.32	m/s
	k =	2.50		2.50		2.50		2.50	
	Water Depth to Bottom ξ' =	**3.00**	**m**	**5.00**	**m**	**10.00**	**m**	**15.00**	**m**
	Slope 1:m, m =	0.70		0.70		0.70		0.70	
	Distance in Water ξ = ξ' / m =	4.29	m	7.14	m	14.29	m	21.43	m
	hc =	1.07	m	1.07	m	1.07	m	1.07	m
	$d_0 = q/V_0$ =	0.42	m	0.42	m	0.42	m	0.42	m
	V_1 =	**6.52**	**m/s**	**5.05**	**m/s**	**3.57**	**m/s**	**2.91**	**m/s**

3	**Unit Width Discharge q =**	**1.00**	**$m^3/s/m$**	**1.00**	**$m^3/s/m$**	**1.00**	**$m^3/s/m$**	**1.00**	**$m^3/s/m$**
	Upstream WL1 =	26.09	m	26.09	m	26.09	m	26.09	m
	Downstream WL2 =	23.13	m	23.13	m	23.13	m	23.13	m
	Depth on Crest h1 =	0.59	m	0.59	m	0.59	m	0.59	m
	H = (WL1-h2/2)-WL2 =	2.67	m	2.67	m	2.67	m	2.67	m
	Velocity at Water Surface V_0 =	(2*9.8*H)^(1/2)		(2*9.8*H)^(1/2)		(2*9.8*H)^(1/2)		(2*9.8*H)^(1/2)	
	V_0 =	7.23	m/s	7.23	m/s	7.23	m/s	7.23	m/s
	k =	2.50		2.50		2.50		2.50	
	Water Depth to Bottom ξ' =	**3.00**	**m**	**5.00**	**m**	**10.00**	**m**	**15.00**	**m**
	Slope 1:m, m =	0.70		0.70		0.70		0.70	
	Distance in Water ξ = ξ' / m =	4.29	m	7.14	m	14.29	m	21.43	m
	hc =	0.47	m	0.47	m	0.47	m	0.47	m
	$d_0 = q/V_0$ =	0.14	m	0.14	m	0.14	m	0.14	m
	V_1 =	**3.25**	**m/s**	**2.51**	**m/s**	**1.78**	**m/s**	**1.45**	**m/s**

4	**Unit Width Discharge q =**	**0.10**	**$m^3/s/m$**	**0.10**	**$m^3/s/m$**	**0.10**	**$m^3/s/m$**	**0.10**	**$m^3/s/m$**
	Upstream WL1 =	25.63	m	25.63	m	25.63	m	25.63	m
	Downstream WL2 =	22.10	m	22.10	m	22.10	m	22.10	m
	Depth on Crest h1 =	0.13	m	0.13	m	0.13	m	0.13	m
	H = (WL1-h2/2)-WL2 =	3.47	m	3.47	m	3.47	m	3.47	m
	Velocity at Water Surface V_0 =	(2*9.8*H)^(1/2)		(2*9.8*H)^(1/2)		(2*9.8*H)^(1/2)		(2*9.8*H)^(1/2)	
	V_0 =	8.24	m/s	8.24	m/s	8.24	m/s	8.24	m/s
	k =	2.50		2.50		2.50		2.50	
	Water Depth to Bottom ξ' =	**3.00**	**m**	**5.00**	**m**	**10.00**	**m**	**15.00**	**m**
	Slope 1:m, m =	0.70		0.70		0.70		0.70	
	Distance in Water ξ = ξ' / m =	4.29	m	7.14	m	14.29	m	21.43	m
	hc =	0.47	m	0.47	m	0.47	m	0.47	m
	$d_0 = q/V_0$ =	0.01	m	0.01	m	0.01	m	0.01	m
	V_1 =	**1.10**	**m/s**	**0.85**	**m/s**	**0.60**	**m/s**	**0.49**	**m/s**

Table L.16 Creep Length for Alternative Floating Type Weir

Concrete Floating at Site-II (JICA Team)



(1) Min. Creep Length

(a) Bligh's Method

$S \geq C \cdot DH$

H1 =	6.0	m
H2 =	2.9	m
DH	6.0	m
C=	15	(Fine Sand)
S ≥	90	m

(b) Lane's Method

$L \geq C \cdot DH$

H1 =	6.0	m
H2 =	2.9	m
DH	6.0	m
C'=	7	(Fine Sand)
L ≥	42	m

(2) Trial

Fine Sand L1 ≥ 12 m

(a) 1 Raw

(b) 2 Raws

Interval ≥ L1+L4

Case	1	2	3	4	5	6
EL1	20.0	20.0		20.0	20.0	
EL2	6.0	6.0		6.0	12.5	
EL3	16.5	16.5		16.5	16.5	
L1	14.0	14.0		14.0	7.5	
L2	10.5	10.5		10.5	4.0	
L3	40.0	50.0		40.0	50.0	
L4	0.0	0.0		12.0	5.5	
L5	0.0	20.0		0.0	20.0	
S	64.5	94.5	0.0	88.5	92.5	0.0
Judge	no	OK		no	OK	
L	37.8	47.8	0.0	61.8	45.8	0.0
Judge	no	OK		OK	OK	

Table L.17 Downstream Apron and Riprap Lengths of Van Phong Weir

Apron

La = 0.6 * C * D^(1/2) La: Downstream apron length (m), C: Bligh's coefficient C=15 (Sand), D: Height from downstream apron to weor crest (m)

Riprap

1) Bligh's Method

Lr = Lb -La, Lb = 0.67 * C* ((D*q)^0.5) * f Lr: Riprap length (m), Lb: Total length of apron and riprap, q: Unit width discharge (m^3/s/m), f: Safety factor f=1.0 for fixed weir part)

2) Method with Hydraulic Calculation by Ranges

Range I (h2 > h3, h2: Conjugate depth, h3: Downstream depth)

Lr = L1 + L2 L1: Upstream portion length (m), L2: Downstream portion (m)

L1 = (1/nf^2) * { (3*α)/(4*9.8) * (H1^(4/3) - h0^(4/3)) - 3/(13*q^2) * (H1^(13/3) - h0^(13/3)) }

L2 = 6 * H2 nf: Roughness coefficient, α: Velocity distribution correction coefficient, H1: Water depth in upstream portion, H2: Water depth in downstream portion, h0: Water depth at the beginning point of upstream portion

Range II (h2 = h3) Lr = 6 * H2

Range III (h2 < h3) Lr = 3.5 * h3

BLd: Downstream river bed elevation

BLd= 23.00 m

Input				Input	Input		Apron		Riprap by Bligh		Input										Table 15.6 (or Goal Seek)			Riplap		
Q	B	q	hc	H2(=h2)	WL1	D	C	La	Lb	Lr	D+hc	WL2	h3	**h3-h2**	k	H2	L2	nf	H1	h0	F(h0)	L1	for Range I Lr =L1+L2	for Range II Lr =L1+L2	for Range III Lr =L1+L2
(m3/s)	(m)		(m)	(m)	(m)	(m)	Bligh	(m)	(m)	(m)	(m)	(m)	(m)	**(m)**	(m)	(m)	(m)		(m)	(m)	(m)	(m)	(m)	(m)	(m)
2,397	525	4.6	1.29	3.05	27.13	2.84	15	15.18	36.21	21.04	4.13	25.15	2.15	**-0.90**	0.5	2.65	15.9	0.035	0.51	0.4989	-0.0004	0.65	16.55		
1,829	525	3.5	1.07	2.70	26.86	2.79	15	15.02	31.31	16.29	3.86	24.65	1.65	**-1.05**	0.5	2.15	12.9	0.035	0.44	0.3931	0.0005	3.50	16.40		
525	525	1.0	0.47	1.40	26.09	2.62	15	14.58	16.28	1.70	3.09	23.13	0.13	**-1.27**	0.5	0.63	3.78	0.035	0.34	0.1272	-0.0007	11.63	15.41		

BLd= 22.50 m

Input				Input	Input		Apron		Riprap by Bligh		Input										Table 15.6 (or Goal Seek)			Riplap		
Q	B	q	hc	H2(=h2)	WL1	D	C	La	Lb	Lr	D+hc	WL2	h3	**h3-h2**	k	H2	L2	nf	H1	h0	F(h0)	L1	for Range I Lr =L1+L2	for Range II Lr =L1+L2	for Range III Lr =L1+L2
(m3/s)	(m)		(m)	(m)	(m)	(m)	Bligh	(m)	(m)	(m)	(m)	(m)	(m)	**(m)**	(m)	(m)	(m)		(m)	(m)	(m)	(m)	(m)	(m)	(m)
2,397	525	4.6	1.29	3.05	27.13	2.84	15	15.18	36.21	21.04	4.13	25.15	2.65	**-0.40**	0.5	3.15	18.9	0.035	0.38	0.4986	0.0010	-7.80	18.90		
1,829	525	3.5	1.07	2.7	26.86	2.79	15	15.02	31.31	16.29	3.86	24.65	2.15	**-0.55**	0.5	2.65	15.9	0.035	0.32	0.3931	0.0005	-5.05	15.90		
525	525	1.0	0.47	1.4	26.09	2.62	15	14.58	16.28	1.70	3.09	23.13	0.63	**-0.77**	0.5	1.13	6.78	0.035	0.14	0.1272	-0.0007	0.69	7.47		

BLd= 22.00 m

Input				Input	Input		Apron		Riprap by Bligh		Input										Table 15.6 (or Goal Seek)			Riplap		
Q	B	q	hc	H2(=h2)	WL1	D	C	La	Lb	Lr	D+hc	WL2	h3	**h3-h2**	k	H2	L2	nf	H1	h0	F(h0)	L1	for Range I Lr =L1+L2	for Range II Lr =L1+L2	for Range III Lr =L1+L2
(m3/s)	(m)		(m)	(m)	(m)	(m)	Bligh	(m)	(m)	(m)	(m)	(m)	(m)	**(m)**	(m)	(m)	(m)		(m)	(m)	(m)	(m)	(m)	(m)	(m)
2,397	525	4.6	1.29	3.05	27.13	2.84	15	15.18	36.21	21.04	4.13	25.15	3.15	**0.10**	0.5	3.65	21.9	0.035	0.30	999				18.90	11.03
1,829	525	3.5	1.07	2.7	26.86	2.79	15	15.02	31.31	16.29	3.86	24.65	2.65	**-0.05**	0.5	3.15	18.9	0.035	0.23	0.3931	0.0005	-9.97	18.90		
525	525	1.0	0.47	1.4	26.09	2.62	15	14.58	16.28	1.70	3.09	23.13	1.13	**-0.27**	0.5	1.63	9.78	0.035	0.07	0.1272	-0.0007	-2.28	9.78		
53	525	0.1	0.10	0.45	25.63	2.53	15	14.31	5.05	-9.26	2.63	22.1	0.10	**-0.35**	0.5	0.60	3.6	0.035	0.01	0.0165	-0.0002	-0.22	3.60		

BLd= 21.50 m

Input				Input	Input		Apron		Riprap by Bligh		Input										Table 15.6 (or Goal Seek)			Riplap		
Q	B	q	hc	H2(=h2)	WL1	D	C	La	Lb	Lr	D+hc	WL2	h3	**h3-h2**	k	H2	L2	nf	H1	h0	F(h0)	L1	for Range I Lr =L1+L2	for Range II Lr =L1+L2	for Range III Lr =L1+L2
(m3/s)	(m)		(m)	(m)	(m)	(m)	Bligh	(m)	(m)	(m)	(m)	(m)	(m)	**(m)**	(m)	(m)	(m)		(m)	(m)	(m)	(m)	(m)	(m)	(m)
2,397	525	4.6	1.29	3.05	27.13	2.84	15	15.18	36.21	21.04	4.13	25.15	3.65	**0.60**	0.5	4.15	24.9	0.035	0.23	999				21.90	12.78
1,829	525	3.5	1.07	2.7	26.86	2.79	15	15.02	31.31	16.29	3.86	24.65	3.15	**0.45**	0.5	3.65	21.9	0.035	0.18	999				12.78	11.03
525	525	1.0	0.47	1.4	26.09	2.62	15	14.58	16.28	1.70	3.09	23.13	1.63	**0.23**	0.5	2.13	12.78	0.035	0.04	999				6.60	5.71
53	525	0.1	0.10	0.45	25.63	2.53	15	14.31	5.05	-9.26	2.63	22.1	0.60	**0.15**	0.5	1.10	6.6	0.035	0.00	999				0.00	2.10

BLd= 21.00 m

Input				Input	Input		Apron		Riprap by Bligh		Input										Table 15.6 (or Goal Seek)			Riplap		
Q	B	q	hc	H2(=h2)	WL1	D	C	La	Lb	Lr	D+hc	WL2	h3	**h3-h2**	k	H2	L2	nf	H1	h0	F(h0)	L1	for Range I Lr =L1+L2	for Range II Lr =L1+L2	for Range III Lr =L1+L2
(m3/s)	(m)		(m)	(m)	(m)	(m)	Bligh	(m)	(m)	(m)	(m)	(m)	(m)	**(m)**	(m)	(m)	(m)		(m)	(m)	(m)	(m)	(m)	(m)	(m)
1,829	525	3.5	1.07	2.7	26.86	2.79	15	15.02	31.31	16.29	3.86	24.65	3.65	**0.95**	0.5	4.15	24.9	0.035	0.14	999				15.78	12.78
525	525	1.0	0.47	1.4	26.09	2.62	15	14.58	16.28	1.70	3.09	23.13	2.13	**0.73**	0.5	2.63	15.78	0.035	0.03	999				9.60	7.46
53	525	0.1	0.10	0.45	25.63	2.53	15	14.31	5.05	-9.26	2.63	22.1	1.10	**0.65**	0.5	1.60	9.6	0.035	0.00	999				0.00	3.85

Table L.18 Summary of Cost Comparison of Van Phong Weir (Site-II)

Item		1A. Fixed Weir, Spread Foundation (million VND)			1B. Fixed Weir, floating (million VND)			2A. Rubber Weir, Spread Foundation (million VND)			2B. Rubber Weir, Floating (million VND)		
		Q'ty	Cost	Ratio	Q'ty	Cost	Ratio	Q'ty	Cost	Ratio	Q'ty	Cost	Ratio
(a) Excavation													
Common	Exc =	268,543 m^3	4,364	4.0%	292,699 m^3	4,757	2.7%	269,994 m^3	4,388	3.8%	293,853 m^3	4,776	2.7%
Weatherd Rock	Exr =	29,838 m^3	681	0.6%	32,522 m^3	743	0.4%	29,999 m^3	685	0.6%	32,650 m^3	746	0.4%
(b) Earthhfilling													
Common Filling	Efb =	14,919 m^3	211	0.2%	16,261 m^3	230	0.1%	15,000 m^3	212	0.2%	16,325 m^3	231	0.1%
Backfilling	Efc =	2,984 m^3	72	0.1%	13,009 m^3	315	0.2%	12,000 m^3	290	0.2%	13,060 m^3	316	0.2%
(c) Concrete													
Class M250	Ca =	38,693 m^3	52,582	48.5%	85,798 m^3	116,596	67.1%	36,582 m^3	49,713	42.8%	84,193 m^3	114,414	63.7%
Class M150	Cb =	28,298 m^3	31,276	28.9%	4,180 m^3	4,620	2.7%	27,835 m^3	30,764	26.5%	1,943 m^3	2,147	1.2%
Class M100	Cc =	952 m^3	457	0.4%	3,606 m^3	1,731	1.0%	964 m^3	463	0.4%	3,624 m^3	1,740	1.0%
(d) Form													
	FM =	40,194 m^2	1,944	1.8%	53,987 m^2	2,611	1.5%	38,650 m^2	1,869	1.6%	51,681 m^2	2,500	1.4%
(e) Reinforcing Bar													
	RB =	1,935 ton	10,849	10.0%	4,290 ton	24,058	13.9%	1,829 ton	10,257	8.8%	4,210 ton	23,607	13.1%
(f) Sheet Pile													
U-Shape, t=13mm	SP =	0 m^2	0	0.0%	5,513 m^2	8,377	4.8%	0 m^2	0	0.0%	5,513 m^2	8,377	4.7%
(g) Fondation Pile													
B=H=400mm	FP =	0 m	0	0.0%	3,095 m	3,746	2.2%	0 m	0	0.0%	2,785 m	3,370	1.9%
(h) Rubber Weir													
	RW =	0 m^2	0	0.0%	0 m^2	0	0.0%	1,313 m^2	13,448	11.6%	1,313 m^2	13,448	7.5%
(i) River Dike													
Earthfilling	Efb =	415,716 m^3	5,885	5.4%	415,716 m^3	5,885	3.4%	286,752 m^3	4,059	3.5%	286,752 m^3	4,059	2.3%
			108,321	100.0%		173,668	100.0%		116,150	100.0%		179,731	100.0%

Note. The above costs are estimated on the direct construction cost basis.

Table L.19 Stability Calculation of Van Phong Weir

$1kg/m^2 = 9.8N/m^2$ $1tf/m^3 = 9.805kN/m^3$

$1kg/cm^2 = 98kN/m^2$

Conditions

- Dry season
- Upstream WL is the same as the weire crest EL. Downstream WL is the same as the River bed EL.
- At earthquake
- Separate structure
- Water pressures + Earthquake

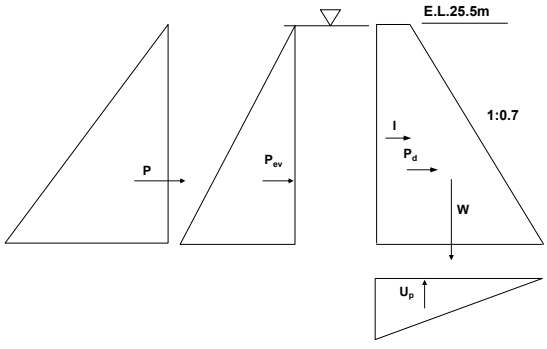
Water level WL	Upstream	25.5	m
	Downstream	19.5	m
Crest elevation		25.5	m
Bottom elevation		12.0	m
Weir height		13.5	m
Upstream sediments height		13.5	m
Upstream water head on bottom		13.5	m
Weir crest length		3.0	m
Upstream slope	n1	0.0	
Downstream slope	n2	0.7	
Weir bottom length	B	12.45	m
Earth pressure coeffi	Ce	0.6	
Uplift coefficient	μ	0.4	
Friction coefficient	f	0.6	
Design seismic coefficient		0.12	
Weir bottom foundation surface shear strength		100	tf/m^2

Unit weight

Water	1.0 tf/m^3
Concrete	2.3 tf/m^3
Sediments (submerged)	0.8 tf/m^3

			Distance x (m)	Distance y (m)	Height (m)	Thickness (m)	Width (m)	□/△ (m)	Unit Weight (tf/m^3)	Vx (tf)	Hy (tf)	Arm length x (m)	Arm length y (m)	Moment MV (tfm)	Moment MH (tfm)
Body Self: W															
	1	□	x	9.45		13.5	1	3.0	1	2.30	93.2	0.0	10.95		1020.0	
	2	◿	x	0		13.5	1	9.45	0.5	2.30	146.7	0	6.30		924.3	
Uplift: U_l	1	◸	x	0		5.4	1	12.45	0.5	-1.00	-33.6	0	8.30		-279.0	
Earth Pressure: Pev																
	1	◺	y		0	13.5	1	8.1	0.5	0.80	0.0	43.74		-4.50		-196.8
Water Pressure: P																
	1	◺	y		0	13.5	1	13.5	0.5	1.00	0.0	91.125		-4.50		-410.1
Earthquake Hydrodynamic Pressure: Pd																
	1	□	y		0					1.00	0.0	12.76		-5.40		-68.9
Earthquake Inertia Force: I																
	1	□	y	9.45		13.5	1	3	1	2.30		11.2		-6.75		-75.5
	2	◿	y		0	13.5	1	9.45	0.5	2.30		17.61		-4.50		-79.2
											206.2	176.4			1665.2	-830.5

ΣMV	1665.2	(tfm)
ΣMH	-830.5	(tfm)
ΣVx	206.2	(tf)
ΣHy	176.4	(tf)



Against Overturning

d =	(MV+MH)/V	4.05			
e =	B/2 - d =	2.18			
B/3=	4.15	>	2.18	= e	**OK**

Against Sliding

n = (ZoxB+fΣVx)/ΣH	7.76	>	4.0		**OK**

Table L.20 Irrigation Schemes as of 2012 in F/S

No.	Name of Irrigation Scheme			Irrigation Area in 2001		Irrigation Area in 2012			Irrigation Area in 2012								
									Van Phong Weir			Other Schemes under Dinh Binh Dam				Hoi Son Reser. (La Tinh)	Grand Total
				Constructed Area	Actual 2001	Rehabilitation as of 2012	New Development as of 2012	Actual 2012	Van Phong Area	Van Phong Ext. (La Tinh)	Total	Tan An Dap Da	Vinh Thanh, etc. (along Kone)	Tan An Ext. (Lower Ha Thanh)	Total		
A	**North of La Tinh River**			**1,614**	**1,614**	**0**	**3,297**	**4,911**	**0**	**3,297**	**3,297**	**0**	**0**	**0**	**0**	**1,614**	**4,911**
1	Cay Gay Left	W	La Tinh	1,162	1,162	0		1,162			0				0	1,162	1,162
2	Cay Ke Left	W	La Tinh	331	331	0		331			0				0	331	331
3	Cay Ke Right North	W	La Tinh	121	121	0		121			0				0	121	121
4	Van Phong Extension (La Tinh	W	La Tinh	0	0	0	3,297	3,297		3,297	3,297				0		3,297
B	**South of La Tinh Riv&North of Kone Riv.**			**1,717**	**1,685**	**32**	**10,484**	**12,201**	**10,815**	**0**	**10,815**	**0**	**0**	**0**	**0**	**1,386**	**12,201**
5	Hoi Son Upstream	R	La Tinh	118	118	0		118			0				0	118	118
6	Cay Gai Right	W	La Tinh	913	913	0		913			0				0	913	913
7	Cay Ke Right South	W	La Tinh	355	355	0		355			0				0	355	355
8	Dai Binh	P	Kone	45	40	5		45	45		45				0		45
9	Thi Lua	P	Kone	226	206	20		226	226		226				0		226
10	Ngai Chanh	P	Kone	60	53	7		60	60		60				0		60
11	Van Phong Proper	R		0	0	0	10,484	10,484	10,484		10,484				0		10,484
C	**Tan An - Dap Da**			**14,020**	**12,413**	**1,607**	**512**	**14,532**	**0**	**0**	**0**	**14,532**	**0**	**0**	**14,532**	**0**	**14,532**
12	Thanh Hoa I+II	W	Kone	4,120	4,055	65		4,120			0	4,120			4,120		4,120
13	Thach De	W	Kone	1,300	1,247	53		1,300			0	1,300			1,300		1,300
14	Thuan Hat	W	Kone	187	166	21		187			0	187			187		187
15	Thap Mao	W	Kone	1,800	1,782	18		1,800			0	1,800			1,800		1,800
16	**Lao Tam**	**W**	**Kone**	**702**	**688**	14		702			0	702			702		702
17	**Part of Lao Tam**	**W**	**Kone**			0		0									0
18	**Nha Phu**	**W**	**Kone**	**300**	**300**	0		300			0	300			300		300
19	**Ha Bac**	**W**	**Kone**	**300**	**300**	0		300			0	300			300		300
20	**Bo Ngo**	**W**	**Kone**	**588**	**523**	65		588			0	588			588		588
21	Bay Yen	P	Kone	247	220	27		247			0	247			247		247
22	Binh Thanh	P	Kone	170	170	0		170			0	170			170		170
23	Lao Tam Downstream	W	Kone	0		0	512	512			0	512			512		512
24	**Dap Cat**	**W**	**Kone**	**295**	**263**	32		295			0	295			295		295
25	**Van Kham**	**W**	**Kone**	**385**	**343**	42		385			0	385			385		385
26	**Van Moi**	**W**	**Kone**	**235**	**209**	26		235			0	235			235		235
27	Nhon Phong (Ban Nui)	W	Kone	695	619	76		695			0	695			695		695
28	Da Den	W	Kone	358	319	39		358			0	358			358		358
29	Ben Tranh	P	Kone	42	37	5		42			0	42			42		42
30	Thanh Danh	P	Kone	49	44	5		49			0	49			49		49
31	Ben Go	P	Kone		0	0		0			0	0			0		0
32	Thach De	P	Kone	67	60	7		67			0	67			67		67
33	An Loi	P	Kone	43	38	5		43			0	43			43		43
34	Trung Ly	P	Kone	15	13	2		15			0	15			15		15
35	An Hoa	P	Kone	34	30	4		34			0	34			34		34
36	An Thuan I+II	P	Kone	101	90	11		101			0	101			101		101
37	Long Quang	P	Kone	80	70	10		80			0	80			80		80
38	Unknown Minor Schemes		Kone	1,907	827	1,080		1,907			0	1,907			1,907		1,907
D	**South of Kone River Basin**			**0**	**0**	**0**	**2,657**	**2,657**	**0**	**0**	**0**	**0**	**2,657**	**0**	**2,657**	**0**	**2,657**
39	Huu Giang	P	Kone	0	0	0	351	351			0		351		351		351
40	Huong Giang	P	Kone	0	0	0	308	308			0		308		308		308
41	Binh Hoa	P	Kone	0	0	0	353	353			0		353		353		353
42	Binh Khe	P	Kone	0	0	0	1,319	1,319			0		1,319		1,319		1,319
43	Hoa Lac	P	Kone	0	0	0	150	150			0		150		150		150
44	Hon Gach	P	Kone	0	0	0	176	176			0		176		176		176
E	**Downstream Reaches of Ha Thanh River Ba**			**0**	**0**	**0**	**2,039**	**2,039**	**0**	**0**	**0**	**0**	**0**	**2,039**	**2,039**	**0**	**2,039**
45	Tan An Extention (Lower Ha Thanh)	Ha Thanh		0	0	0	2,039	2,039			0			2,039	2,039		2,039
G	**Vinh Thanh Region**			**0**	**0**	**0**	**1,017**	**1,017**	**0**	**0**	**0**	**0**	**1,017**	**0**	**1,017**	**0**	**1,017**
46	Vinh Thach (Dinh Binh) IR	R	Kone	0	0	0	**1,017**	1,017			0		1,017		1,017		1,017
Total of A to G				**17,351**	**15,712**	**1,639**	**20,006**	**37,357**	**10,815**	**3,297**	**14,112**	**14,532**	**3,674**	**2,039**	**20,245**	**3,000**	**37,357**

Table L.21 Irrigation Canal List (1/3)

No.	Name of Irrigation Canal	Headwork	Type of Headwork	Section	Length (cm)	Length (m)	Acumulated Length
A	**Tan An & Dap Da**						
1	TH-MC	Thanh Hoa	Weir			3,625	
2	TH-MC-N2	-	-	1	6	*1,500*	
3	TH-MC-N1	-	-	2	4	*1,000*	2,500
4	TH-MC-N3	-	-	3	4.5	*1,125*	**3,625**
5	TH.N1	-	-			9,750	
6	TH-N1-N1.2	-	-	1	11	*2,750*	
7	TH-N1-EP	-	-	2	28	*7,000*	**9,750**
8	TH.N2	-	-			13,750	
9	TH.N2-TH.N2-1	-	-	1	4	*1,000*	
10	TH.N2-TH.N2-2	-	-	2	18	*4,500*	5,500
11	TH.N2-EP	-	-	3	33	*8,250*	**13,750**
12	TH-N3	-	-	1	21	5,250	
13	TH-N4	-	-	1	23	5,750	
14	TH2-N1	-	-			7,500	
15	TH2-N1.1			1	4	*1,000*	
16	TH2-EP	-	-	2	26	*6,500*	**7,500**
17	BT-MC	Binh Thanh	Weir	1	21	5,250	
18	BT-N1	-	-	1	10	2,500	
19	BY-MC	Bay Yen	Pump	1	21	5,250	
20	BY-N1	-	-	1	19	4,750	
21	TM-MC	Thap Mao	Weir			9,250	
22	TM-MC-N3	-	-	1	26	*6,500*	
23	TM-MC-EP	-	-	2	11	*2,750*	**9,250**
24	TM-N1	-	-	1	26	6,500	
25	TM-N2	-	-	1	42	10,500	
26	TM-N3	-	-	1	18	4,500	
27	TL-MC	Thi Lua	Pump	1	10	2,500	
28	TL-N2	-	-	1	10	2,500	
29	NC-MC	Ngai Chanh	Pump	1	8	2,000	
30	TDP-MC	Thach De	Pump	1	11	2,750	
31	TD-MC	Thach De	Weir			13,750	
32	TD-MC-N1	-	-	1	9	*2,250*	
33	TD-MC-SP	-	-	2	23	*5,750*	8,000
34	TD-MC-EP	-	-	3	23	*5,750*	**13,750**
35	TD-N1	-	-			14,000	
36	TD-N1-N1.2	-	-	1	9	*2,250*	
37	TD-N1-LT	-	-	2	25	*6,250*	8,500
38	TD-N1-EP	-	-	3	22	*5,500*	**14,000**
39	TD-N2	-	-	1	22	5,500	
40	AL-MC	An Loi	Pump	1	4	1,000	
41	THa-MC	Thuan Hat	Weir	1	11	2,750	
42	LT-MC	Lao Tam	Weir	1	33	8,250	
43	LT-N1	-	-	1	8	2,000	
44	HB-MC	Ha Bac	Weir	1	11	2,750	
45	HB-N1	-	-	1	8	2,000	
46	HB-N2	-	-	1	10	2,500	
B	**La Tinh River**						
47	VP-N1	Van Phong	Weir			22,500	
48	VP-N1-T1	-	-	1	5	*1,250*	
49	VP-N1-T2	-	-	2	2	*500*	1,750
50	VP-N1-SP	-	-	3	12	*3,000*	4,750
51	VP-N1-P	-	-	4	15	*3,750*	8,500
52	VP-N1-EP	-	-	5	56	*14,000*	**22,500**
53	CG-MC-R	Cay Gai	Weir			15,750	
54	CG-MC-N2	-	-	1	1	*250*	
55	CG-MC-N4	-	-	2	4	*1,000*	1,250
56	CG-MC-N1	-	-	3	5	*1,250*	2,500
57	CG-MC-N8	-	-	4	3	*750*	3,250
58	CG-MC-N3	-	-	5	12	*3,000*	6,250
59	CG-MC-N5	-	-	6	15	*3,750*	10,000
60	CG-MC-EP	-	-	7	23	*5,750*	**15,750**

Note: MC: Main Canal (left and right), EP: Ending Point, S: Siphon, T: Turnout, P: Pump, Ext: Extension Area

Table L.21 Irrigation Canal List (2/3)

No.	Name of Irrigation Canal	Headwork	Type of Headwork	Section	Length (cm)	Length (m)	Acumulated Length
61	CG-N2	-	-	1	9.5	2,375	
62	CG-N4	-	-	1	7	1,750	
63	CG-N1	-	-	1	15.5	3,875	
64	CG-N8	-	-	1	9	2,250	
65	CG-N3	-	-	1	24	6,000	
66	CG-N5	-	-	1	15	3,750	
67	CG-MC-L	-	-			9,500	
68	CG-MC-L-N1	-	-	1	11	*2,750*	
69	CG-MC-L-EP	-	-	2	27	*6,750*	**9,500**
70	CK-MC-R	Cay Ke	Weir	1	15.5	3,875	
71	CK-MC-L	-	-	1	25	6,250	
72	CK-N1			1	15	3,750	
C	**Upper Kone River**						
73	VP-MC	Van Phong	Weir			34,419	
74	VP-MC-N2	-	-	1		*3,440*	
75	VP-MC-N4	-	-	2		*1,487*	4,927
76	VP-MC-N6	-	-	3		*2,213*	7,140
77	VP-MC-N8	-	-	4		*2,652*	9,792
78	VP-MC-N10	-	-	5		*860*	10,652
79	VP-MC-N12	-	-	6		*1,595*	12,247
80	VP-MC-N14	-	-	7		*275*	12,522
81	VP-MC-N16	-	-	8		*470*	12,992
82	VP-MC-N18	-	-	9		*2,438*	15,430
83	VP-MC-N20	-	-	10		*2,130*	17,560
84	VP-MC-N22	-	-	11		*1,060*	18,620
85	VP-MC-N24	-	-	12		*950*	19,570
86	VP-MC-N26	-	-	13		*2,765*	22,335
87	VP-MC-N28	-	-	14		*865*	23,200
88	VP-MC-N1	-	-	15		*620*	23,820
89	VP-MC-N30	-	-	16		*1,495*	25,315
90	VP-MC-N32	-	-	17		*755*	26,070
91	VP-MC-N34	-	-	18		*3,195*	29,265
92	VP-MC-N36	-	-	19		*1,850*	31,115
93	VP-MC-N38	-	-	20		*690*	31,805
94	VP-MC-N40	-	-	21		*780*	32,585
95	VP-MC-N42	-	-	22		*680*	33,265
96	VP-MC-N44	-	-	23		*506*	33,771
97	VP-MC-N46	-	-	24		*648*	**34,419**
98	VP-N2	-	-	1	5.1	1,275	
99	VP-N4	-	-	1	6.5	1,625	
100	VP-N6	-	-	1	12	3,000	
101	VP-N8	-	-	1	11.2	2,800	
102	VP-N10	-	-	1	11.5	2,875	
103	VP-N12	-	-	1	32.5	8,125	
104	VP-N14	-	-	1	35	8,750	
105	VP-N16	-	-	1	28	7,000	
106	VP-N18	-	-	1	5	1,250	
107	VP-N20	-	-	1	53	13,250	
108	VP-N22	-	-	1	4.2	1,050	
109	VP-N24	-	-	1	21	5,250	
110	VP-N26	-	-	1	8.2	2,050	
111	VP-N28	-	-	1	5	1,250	
112	VP-N1	-	-	1	21	5,250	
113	VP-N30	-	-	1	25	6,250	
114	VP-N32	-	-	1	9	2,250	
115	VP-N34	-	-	1	24.5	6,125	
116	VP-N36	-	-	1	9	2,250	
117	VP-N38	-	-	1	9	2,250	
118	VP-N40	-	-	1	12.5	3,125	
119	VP-N42	-	-	1	16	4,000	
120	VP-N44	-	-	1	16	4,000	
121	VP-N46	-	-	1	29	7,250	

Note: MC: Main Canal (left and right), EP: Ending Point, S: Siphon, T: Turnout, P: Pump, Ext: Extension Area

Table L.21 Irrigation Canal List (3/3)

No.	Name of Irrigation Canal	Headwork	Type of Headwork	Section	Length (cm)	Length (m)	Acumulated Length
122	VT-MC	-	-			18,845	
123	VT-MC-N1	-	-	1		*7,140*	
124	VT-MC-N3	-	-	2		*1,915*	9,055
125	VT-MC-N5	-	-	3		*2,505*	11,560
126	VT-MC-N7	-	-	4		*2,865*	14,425
127	VT-MC-N9	-	-	5		*1,890*	16,315
128	VT-MC-N11	-	-	6		*940*	17,255
129	VT-MC-N13	-	-	7		*800*	18,055
130	VT-MC-N15	-	-	8		*790*	**18,845**
131	VT-N1	-	-	9	10	2,500	
132	VT-N3	-	-	10	21	5,250	
133	VT-N5	-	-	11	18	4,500	
134	VT-N7	-	-	12	20	5,000	
135	VT-N9	-	-	13	7.2	1,800	
136	VT-N11	-	-	14	22	5,500	
137	VT-N13	-	-	15	6	1,500	
138	VT-N15	-	-	16	32	8,000	
139	HUG-MC	Huu Giang	Pump	1	4	2,000	
140	HnG-MC	Hon Ganh	Pump	1	4	2,000	
141	BH-MC	Binh Hoa	Pump	1	9	4,500	
142	BK-MC	Binh Ke	Pump	1	15	7,500	
143	BK-N2			1	7	3,500	
144	HL-MC	Hoa Lac	Pump	1	6	3,000	
D	**Ha Thanh River**						
145	TH-N2.Ext	Thanh Hoa	Weir	1	22	11,000	
146	TH.N2-2.Ext	-	-	1	9	4,500	
147	TH2-N1.Ext	-	-	1	17	8,500	

Note: MC: Main Canal (left and right), EP: Ending Point, S: Siphon, T: Turnout, P: Pump, Ext: Extension Area

Table L.22 Drainage Systems

Drainage System		Location	Catchment Area		Discharge	Length	
		(Commune)	(cm2)	(ha)	(m3/s)	(cm)	(m)
A	**Dap Da River**						
1	DD1	Nhon My	56	348	4.03	10	2,500
2	DD2	Nhon Hau	38	238	2.76	11	2,750
3	DD3	Dap Da	64	400	4.64	14	3,500
4	DD4	Nhon Thanh	208	1,300	15.08	34	8,500
5	DD5L	Nhon Thanh	256	1,600	18.56	33	8,250
6	DD5R	Nhon Thanh	32	200	2.32	10	2,500
7	DD6	Nhon An	200	1,250	14.50	12	3,000
8	DD7	Cat Hung	15	94	1.09	5	1,250
9	DD8	Cat Hung	32	200	2.32	12	3,000
10	DD9	Cat Thang	64	400	4.64	12	3,000
B	**Nam Yang River**						
11	NYD1	Nhon Phong	42.5	266	3.08	11	2750
C	**Tan An River**						
12	TD1	Nhon Phuc	138	863	10.01	18	4,500
13	TD2	Nhon Loc	285	1,781	20.66	20	5,000
14	TD3	Nhon Loc	362	2,263	26.25	15	3,750
15	TD4L	Nhon Hoa	40	250	2.90	12	3,000
16	TD4R	Nhon Hoa	40	250	2.90	12	3,000
17	TD5	Nhon Khanh	40	250	2.90	7	1,750
18	TD6	Binh Dinh	165	1,031	11.96	25	6,250
19	TD7	Phuoc Quang	123	766	8.89	23	5,750
20	TD8	Phuoc Hoa	337	2,106	24.43	40	10,000
D	**Ha Thanh River**						
21	HD1	Tuy Phuoc	155	968.75	11.24	23	5750
22	HD2	Nhon Binh	263	1643.75	19.07	29	7250
23	HD3	Nhon Binh	138	862.5	10.01	11	2750
E	**Thi Lai Lagoon**						
24	TND1	Phuoc Thang (Lao Dong Outlet)	329	2,056	23.85	40	10,000
25	TND2	Phuoc Thang (Ha Gach Sluice)	516	3225	37.41	64	16000
26	TND3	Phuoc Hoa (Tan Giang Sluice)	70	437.5	5.08	20	5000
27	TND4	Phuoc Hoa (Kim Dong Sluice)	137	856.25	9.93	23	5750
28	TND5	Phuoc Son (Cai Son Sluice)	230	1437.5	16.68	22	5500
29	TND6	Phuoc Son (Cho Dinh Sluice)	62	387.5	4.50	22	5500
30	TND7	Phuoc Son (Ong Ba Sluice)	38	237.5	2.76	14	3500
31	TND8	Phuoc Thuan (Ong Ho Sluice)	84	525	6.09	10	2500
32	TND9	Phuoc Thuan (Cao Don Sluice)	78	487.5	5.66	15	3750
33	TND10	Nhon Phu (Dong Dinh Sluice)	202	1262.5	14.65	31	7750
34	TND11	Phuoc Thuan (Hung Thanh Sluice)	65	406.25	4.71	12	3000

Table L.23 Project Cost for Van Phong Weir and Irrigation and Drainage System

No.	Description	Unit	Quantity	Foreign Currency Portion		Local Currency Portion		Total
				Unit	Amount	Unit	Amount	
					Million VND		Million VND	Million VND
1	Direct Construction Cost							
1.1	General Items	L.S	1		25,741		25,434	51,175
1.2	Van Phong Weir							
1.2.1	Weir Part							
	(1) Site clearance	m2	43,265	1,830	79	1,809	78	157
	(2) Excavation, common	m3	641,210	8,175	5,242	8,077	5,179	10,421
	(3) Excavation, strongly weathered rock	m3	56,996	11,486	655	11,349	647	1,302
	(4) Excavation, moderately weathered rock	m3	10,687	22,509	241	22,241	238	478
	(5) Excavation, slightly weathered rock	m3	3,562	59,962	214	59,247	211	425
	(6) Earthfilling	m3	35,623	7,121	254	7,036	251	504
	(7) Backfilling	m3	28,498	12,166	347	12,021	343	689
	(8) Sod facing	m2	0	3,378	0	3,337	0	0
	(9) Wearing resistant concrete, M300	m3	1,050	669,995	703	662,003	695	1,399
	(10)Concrete, M250 for BTCT	m3	12,760	587,402	7,495	580,396	7,406	14,901
	(11)Concrete, M200 for BTCT	m3	51,041	559,620	28,564	552,945	28,223	56,786
	(12)Plain concrete, M150	m3	28,364	240,258	6,815	237,392	6,733	13,548
	(13)Lean concrete, M100	m3	2,809	235,232	661	232,426	653	1,314
	(14)Form	m2	55,300	27,105	1,499	26,781	1,481	2,980
	(15)Reinforcing bar	ton	3,190	2,972,236	9,481	2,936,781	9,368	18,850
	(16)Steel sheet pile, type III, t=13 mm	m2	3,150	1,514,088	4,769	1,496,027	4,712	9,482
	(17)Foundation pile, B=H=400 mm	m	315	480,903	151	475,166	150	301
	(18)Wet stone masonry	m3	3,511	155,828	547	153,970	541	1,088
	(19)Concrete block	m3	23,625	650,407	15,366	642,649	15,183	30,548
	(20)Gabion	m3	900	98,860	89	97,681	88	177
	(21)Dry riprap	m3	0	61,591	0	60,856	0	0
	Sub-total				83,171		82,179	165,350
1.2.2	Scouring Sluice Part							
	(1) Site clearance	m2	824	1,830	2	1,809	1	3
	(2) Excavation, common	m3	12,214	8,175	100	8,077	99	199
	(3) Excavation, strongly weathered rock	m3	1,086	11,486	12	11,349	12	25
	(4) Excavation, moderately weathered rock	m3	204	22,509	5	22,241	5	9
	(5) Excavation, slightly weathered rock	m3	68	59,962	4	59,247	4	8
	(6) Earthfilling	m3	679	7,121	5	7,036	5	10
	(7) Backfilling	m3	543	12,166	7	12,021	7	13
	(8) Sod facing	m2	0	3,378	0	3,337	0	0
	(9) Wearing resistant concrete, M300	m3	0	669,995	0	662,003	0	0
	(10)Concrete, M250 for BTCT	m3	243	587,402	143	580,396	141	284
	(11)Concrete, M200 for BTCT	m3	972	559,620	544	552,945	537	1,081
	(12)Concrete, M150	m3	0	240,258	0	237,392	0	0
	(13)Lean concrete, M100	m3	54	235,232	13	232,426	13	25
	(14)Form	m2	1,053	27,105	29	26,781	28	57
	(15)Reinforcing bar	ton	61	2,972,236	181	2,936,781	179	360
	(16)Steel slide gate, B=H=2.75 m	nos	2	276,708,378	553	273,407,682	547	1,100
	(17)Steel sheet pile, type III, t=13 mm	m2	60	1,514,088	91	1,496,027	90	181
	(18)Foundation pile, B=H=400 mm	m	60	480,903	29	475,166	29	57
	(19)Wet stone masonry	m3	67	155,828	10	153,970	10	21
	(20)Concrete block	m3	450	650,407	293	642,649	289	582
	(20)Gabion	m3	17	98,860	2	97,681	2	3
	(21)Dry riprap	m3	0	61,591	0	60,856	0	0
	Sub-total				2,021		1,997	4,018
1.2.3	Intake Facilities Part							
	(1) Site clearance	m2	2,472	1,830	5	1,809	4	9
	(2) Excavation, common	m3	36,641	8,175	300	8,077	296	595
	(3) Excavation, strongly weathered rock	m3	3,257	11,486	37	11,349	37	74
	(4) Excavation, moderately weathered rock	m3	611	22,509	14	22,241	14	27
	(5) Excavation, slightly weathered rock	m3	0	59,962	0	59,247	0	0
	(6) Earthfilling	m3	2,036	7,121	14	7,036	14	29
	(7) Backfilling	m3	1,628	12,166	20	12,021	20	39
	(8) Sod facing	m2	800	3,378	3	3,337	3	5
	(9) Wearing resistant concrete, M300	m3	0	669,995	0	662,003	0	0
	(10)Concrete, M250 for BTCT	m3	729	587,402	428	580,396	423	851
	(11)Concrete, M200 for BTCT	m3	2,917	559,620	1,632	552,945	1,613	3,245
	(12)Concrete, M150	m3	0	240,258	0	237,392	0	0
	(13)Lean concrete, M100	m3	161	235,232	38	232,426	37	75
	(14)Form	m2	3,160	27,105	86	26,781	85	170
	(15)Reinforcing bar	ton	182	2,972,236	541	2,936,781	534	1,075
	(16)Steel slide gate, B=H=3.0 m	nos	2	329,305,836	659	325,377,734	651	1,309
	(17)Steel sheet pile, type III, t=13 mm	m2	0	1,514,088	0	1,496,027	0	0
	(18)Foundation pile, B=H=250 mm	m	60	432,282	26	427,125	26	52
	(19)Wet stone masonry	m3	201	155,828	31	153,970	31	62
	(20)Concrete block	m3	0	650,407	0	642,649	0	0
	(20)Gabion	m3	51	98,860	5	97,681	5	10
	(21)Dry riprap	m3	0	61,591	0	60,856	0	0
	Sub-total				3,838		3,792	7,631
1.2.4	Flood Dike							
	(1) Site clearance	m2	99,600	1,830	182	1,809	180	362
	(2) Excavation, common	m3	62,357	8,175	510	8,077	504	1,013
	(3) Earthfilling	m3	415,716	7,121	2,960	7,036	2,925	5,885
	(4) Sod facing	m2	139,440	3,378	471	3,337	465	936
	(5) Wet stone masonry	m3	2,988	155,828	466	153,970	460	926
	(6) Concrete, M250 for BTCT	m3	50	587,402	29	580,396	29	58
	(7) Concrete, M200 for BTCT	m3	10	559,620	6	552,945	6	11
	(8) Concrete, M150	m3	0	240,258	0	237,392	0	0
	(9) Lean concrete, M100	m3	68	235,232	16	232,426	16	32
	(10)Form	m2	298	27,105	8	26,781	8	16
	(11)Reinforcing bar	ton	4	2,972,236	12	2,936,781	12	24
	(12)Steel slide gate, B=H=0.8 m	nos	9	31,012,168	279	30,642,241	276	555
	Sub-total				4,939		4,880	9,819
	Sub-total of 1.2				93,969		92,848	186,817
1.3	Rehabilitation Works of Existing Weirs							
	(1) Thanh Hoa	m	99	89,131,927	8,824	88,068,724	8,719	17,543
	(2) Bin Thanh	m	54	89,131,927	4,813	88,068,724	4,756	9,569
	(3) Ha Bac	m	20	89,131,927	1,783	88,068,724	1,761	3,544
	(4) Thuan Hat	m	60	89,131,927	5,348	88,068,724	5,284	10,632
	(5) Thap Mao	m	21	89,131,927	1,872	88,068,724	1,849	3,721
	(6) Lao Tam	m	83	89,131,927	7,398	88,068,724	7,310	14,708
	(7) Cay Gai	m	73	89,131,927	6,507	88,068,724	6,429	12,936
	Sub-total of 1.3				36,544		36,108	72,652

Table L.23 Project Cost for Van Phong Weir and Irrigation and Drainage System

No.	Description	Unit	Quantity	Foreign Currency Portion		Local Currency Portion		Total
				Unit	Amount	Unit	Amount	
					Million VND		Million VND	Million VND
1.4	New Pumping Station							
	(1) Pumping facilities and building works	place	6	2,457,621,598	14,746	2,428,306,032	14,570	29,316
	Sub-total of 1.4				14,746		14,570	29,316
1.5	Main Irrigation System							
1.5.1	Canal Works							
	(1) Site clearance	m2	1,164,620	1,830	2,132	1,809	2,106	4,238
	(2) Excavation, common	m3	1,246,474	8,175	10,190	8,077	10,068	20,258
	(3) Excavation, strongly weathered rock	m3	49,859	11,486	573	11,349	566	1,139
	(4) Excavation, moderately weathered rock	m3	24,929	22,509	561	22,241	554	1,116
	(5) Excavation, slightly weathered rock	m3	6,232	59,962	374	59,247	369	743
	(6) Earthfilling	m3	1,001,744	7,121	7,133	7,036	7,048	14,181
	(7) Sod facing	m2	390,763	3,378	1,320	3,337	1,304	2,624
	(8) Lining concrete, M150	m3	127,581	246,331	31,427	243,393	31,052	62,479
	(9) Pavement gravel	m3	194,075	130,794	25,384	129,234	25,081	50,465
	Sub-total				79,093		78,149	157,242
1.5.2	Related Structure Works							
	(1) Site clearance	m2	575,587	1,830	1,054	1,809	1,041	2,095
	(2) Excavation, common	m3	633,189	8,175	5,176	8,077	5,114	10,291
	(3) Excavation, strongly weathered rock	m3	25,328	11,486	291	11,349	287	578
	(4) Excavation, moderately weathered rock	m3	0	22,509	0	22,241	0	0
	(5) Excavation, slightly weathered rock	m3	0	59,962	0	59,247	0	0
	(6) Earthfilling	m3	446,036	7,121	3,176	7,036	3,138	6,314
	(7) Backfilling	m3	75,983	12,166	924	12,021	913	1,838
	(8) Sod facing	m2	2,137	3,378	7	3,337	7	14
	(9) Concrete, M250 for BTCT	m3	21,969	607,945	13,356	600,693	13,197	26,553
	(10)Concrete, M200 for BTCT	m3	337	545,638	184	539,130	182	366
	(11)Plain concrete, M150	m3	5,948	246,331	1,465	243,393	1,448	2,913
	(12)Lean concrete, M100	m3	3,276	199,648	654	197,267	646	1,300
	(13)Mortar, M100	m3	545	233,999	128	231,208	126	254
	(14)Form	m2	113,017	12,579	1,422	12,429	1,405	2,826
	(15)Reinforcing bar	ton	1,249	2,972,236	3,712	2,936,781	3,668	7,380
	(16)Steel slide gate, B=H=2.0 m	nos	51	193,826,060	9,885	191,514,020	9,767	19,652
	(17)Steel slide gate, B=H=0.6 m	nos	1,296	17,444,345	22,608	17,236,262	22,338	44,946
	(18)Foundation pile, B=H=250 mm	m	11,843	432,282	5,120	427,125	5,058	10,178
	(19)Wet stone masonry	m3	33,822	155,828	5,270	153,970	5,208	10,478
	(20)Gabion	m3	0	98,860	0	97,681	0	0
	(21)Sand and gravel	m3	2,980	130,794	390	129,234	385	775
	(22)Dry riprap	m3	0	61,591	0	60,856	0	0
	Sub-total				74,822		73,929	148,751
	Sub-total of 1.5				153,914		152,078	305,992
1.6	Primary and Secondary Irrigation System							
1.6.1	Canal Works							
	(1) Site clearance	m2	1,536,436	1,830	2,812	1,809	2,779	5,591
	(2) Excavation, common	m3	826,346	8,175	6,755	8,077	6,675	13,430
	(3) Excavation, strongly weathered rock	m3	16,527	11,486	190	11,349	188	377
	(4) Excavation, moderately weathered rock	m3	8,263	22,509	186	22,241	184	370
	(5) Excavation, slightly weathered rock	m3	1,653	59,962	99	59,247	98	197
	(6) Earthfilling	m3	990,934	7,121	7,056	7,036	6,972	14,028
	(7) Sod facing	m2	349,453	3,378	1,180	3,337	1,166	2,347
	(8) Lining concrete, M150	m3	108,555	246,331	26,740	243,393	26,421	53,162
	(9) Pavement gravel	m3	205,069	130,794	26,822	129,234	26,502	53,324
	Sub-total				71,841		70,984	142,825
1.6.2	Related Structure Works							
	(1) Site clearance	m2	29,398	1,830	54	1,809	53	107
	(2) Excavation, common	m3	64,458	8,175	527	8,077	521	1,048
	(3) Excavation, strongly weathered rock	m3	1,289	11,486	15	11,349	15	29
	(4) Excavation, moderately weathered rock	m3	0	22,509	0	22,241	0	0
	(5) Excavation, slightly weathered rock	m3	0	59,962	0	59,247	0	0
	(6) Earthfilling	m3	45,783	7,121	326	7,036	322	648
	(7) Backfilling	m3	3,867	12,166	47	12,021	46	94
	(8) Sod facing	m2	342	3,378	1	3,337	1	2
	(9) Concrete, M250 for BTCT	m3	3,825	607,945	2,325	600,693	2,298	4,623
	(10)Concrete, M200 for BTCT	m3	76	545,638	41	539,130	41	82
	(11)Plain concrete, M150	m3	1,311	246,331	323	243,393	319	642
	(12)Lean concrete, M100	m3	662	199,648	132	197,267	131	263
	(13)Mortar, M100	m3	77	233,999	18	231,208	18	36
	(14)Form	m2	10,425	12,579	131	12,429	130	261
	(15)Reinforcing bar	ton	109	2,972,236	324	2,936,781	320	644
	(16)Steel slide gate, B=H=2.0 m	nos	26	193,826,060	5,039	191,514,020	4,979	10,019
	(17)Steel slide gate, B=H=0.6 m	nos	3,270	17,444,345	57,043	17,236,262	56,363	113,406
	(18)Foundation pile, B=H=250 mm	m	1,400	432,282	605	427,125	598	1,203
	(19)Wet stone masonry	m3	8,584	155,828	1,338	153,970	1,322	2,659
	(20)Gabion	m3	0	98,860	0	97,681	0	0
	(21)Sand and gravel	m3	517	130,794	68	129,234	67	134
	(22)Dry riprap	m3	0	61,591	0	60,856	0	0
	(23)Pumping station	place	1	2,457,621,598	2,458	2,428,306,032	2,428	4,886
	Sub-total				70,815		69,971	140,786
	Sub-total of 1.6				142,656		140,955	283,611

Table L.23 Project Cost for Van Phong Weir and Irrigation and Drainage System

No.	Description	Unit	Quantity	Foreign Currency Portion		Local Currency Portion		Total
				Unit	Amount	Unit	Amount	
					Million VND		Million VND	Million VND
1.7	Drainage System							
1.7.1	Drain Works							
	(1) Site clearance	m2	197,505	1,830	362	1,809	357	719
	(2) Excavation, common	m3	2,666,321	8,175	21,796	8,077	21,536	43,333
	(3) Excavation, strongly weathered rock	m3	296,258	11,486	3,403	11,349	3,362	6,765
	(4) Excavation, moderately weathered rock	m3	0	22,509	0	22,241	0	0
	(5) Excavation, slightly weathered rock	m3	0	59,962	0	59,247	0	0
	(6) Earthfilling	m3	0	7,121	0	7,036	0	0
	(7) Sod facing	m2	0	3,378	0	3,337	0	0
	(8) Lining concrete, M150	m3	0	246,331	0	243,393	0	0
	(9) Pavement gravel	m3	0	130,794	0	129,234	0	0
	Sub-total				25,561		25,256	50,817
1.7.2	Related Structure Works							
	(1) Site clearance	m2	89,850	1,830	164	1,809	163	327
	(2) Excavation, common	m3	134,775	8,175	1,102	8,077	1,089	2,190
	(3) Excavation, strongly weathered rock	m3	17,970	11,486	206	11,349	204	410
	(4) Excavation, moderately weathered rock	m3	4,493	22,509	101	22,241	100	201
	(5) Excavation, slightly weathered rock	m3	0	59,962	0	59,247	0	0
	(6) Earthfilling	m3	44,925	7,121	320	7,036	316	636
	(7) Backfilling	m3	7,188	12,166	87	12,021	86	174
	(8) Sod facing	m2	1,872	3,378	6	3,337	6	13
	(9) Concrete, M250	m3	749	607,945	455	600,693	450	905
	(10)Concrete, M200	m3	2,995	545,638	1,634	539,130	1,615	3,249
	(11)Lining concrete, M150	m3	1,498	246,331	369	243,393	365	734
	(12)Lean concrete, M100	m3	599	199,648	120	197,267	118	238
	(13)Mortar, M100	m3	0	233,999	0	231,208	0	0
	(14)Form	m2	18,719	12,579	235	12,429	233	468
	(15)Reinforcing bar	ton	262	2,972,236	779	2,936,781	769	1,548
	(16)Steel slide gate, B=H=1.0 m	nos	15	48,456,515	727	47,878,504	718	1,445
	(17)Foundation pile, B=H=250 mm	m	1,498	432,282	648	427,125	640	1,287
	(18)Wet stone masonry	m3	4,493	155,828	700	153,970	692	1,392
	(19)Gabion	m3	7,488	98,860	740	97,681	731	1,472
	(20)Dry riprap	m3	3,594	61,591	221	60,856	219	440
	Sub-total				8,616		8,513	17,129
	Sub-total of 1.7				34,177		33,769	67,946
1.8	Farm Road Network							
1.8.1	Road Works							
	(1) Site clearance	m2	56,000	1,830	103	1,809	101	204
	(2) Excavation, common	m3	8,000	8,175	65	8,077	65	130
	(3) Excavation, strongly weathered rock	m3	200	11,486	2	11,349	2	5
	(4) Excavation, moderately weathered rock	m3	0	22,509	0	22,241	0	0
	(5) Excavation, slightly weathered rock	m3	0	59,962	0	59,247	0	0
	(6) Earthfilling	m3	20,000	7,121	142	7,036	141	283
	(7) Sod facing	m2	56,400	3,378	190	3,337	188	379
	(8) Pavement concrete, M200	m3	4,800	517,987	2,486	511,809	2,457	4,943
	(9) Pavement gravel	m3	6,000	130,794	785	129,234	775	1,560
	Sub-total				3,774		3,729	7,503
1.8.2	Related Structure Works							
	(1) Site clearance	m2	3,200	1,830	6	1,809	6	12
	(2) Excavation, common	m3	800	8,175	7	8,077	6	13
	(3) Excavation, strongly weathered rock	m3	40	11,486	0	11,349	0	1
	(4) Excavation, moderately weathered rock	m3	0	22,509	0	22,241	0	0
	(5) Excavation, slightly weathered rock	m3	0	59,962	0	59,247	0	0
	(6) Earthfilling	m3	1,200	7,121	9	7,036	8	17
	(7) Backfilling	m3	240	12,166	3	12,021	3	6
	(8) Sod facing	m2	865	3,378	3	3,337	3	6
	(9) Concrete, M250	m3	40	607,945	24	600,693	24	48
	(10)Concrete, M200	m3	200	545,638	109	539,130	108	217
	(11)Concrete, M150	m3	400	231,884	93	229,118	92	184
	(12)Lean concrete, M100	m3	80	199,648	16	197,267	16	32
	(13)Mortar, M100	m3	0	233,999	0	231,208	0	0
	(14)Form	m2	1,200	12,579	15	12,429	15	30
	(15)Reinforcing bar	ton	17	2,972,236	51	2,936,781	50	100
	(16)Steel slide gate, B=H=1.0 m	nos	0	48,456,515	0	47,878,504	0	0
	(17)Foundation pile, B=H=300 mm	m	0	0	0	0	0	0
	(18)Wet stone masonry	m3	240	155,828	37	153,970	37	74
	(19)Gabion	m3	0	98,860	0	97,681	0	0
	(20)Dry riprap	m3	0	61,591	0	60,856	0	0
	Sub-total				372		368	740
	Sub-total of 1.8				4,147		4,097	8,244
1.9	On-farm System (Irrigation, Drainage and							
	Farm Road Facilities)							
	(1) Improvement of existing facilities	ha	16,200	334,495	5,419	330,505	5,354	10,773
	(2) Rehabilitation and improvement of facilities	ha	3,400	597,313	2,031	590,188	2,007	4,038
	(3) New construction of facilities	ha	17,800	1,529,120	27,218	1,510,880	26,894	54,112
	Sub-total of 1.9				34,668		34,254	68,923
	Total of 1				540,562		534,114	1,074,676
	Equivalent to US$				35.9		35.4	71.3

Table L.23 Project Cost for Van Phong Weir and Irrigation and Drainage System

No.	Description	Unit	Quantity	Foreign Currency Portion		Local Currency Portion		Total
				Unit	Amount	Unit	Amount	
					Million VND		Million VND	Million VND
2	Indirect Construction Cost							
2.1	Resettlement Cost	L.S	1		0		79,294	79,294
2.2	Engineering Cost	L.S	1		54,056		53,411	107,468
2.3	Administration	L.S	1		0		34,619	34,619
2.4	Price escalation	L.S	1		78,921		294,563	373,484
2.5	Physical Contingency	L.S	1		67,354		99,600	166,954
	Total of 2				200,331		561,487	761,818
	Equivalent to US$				13.3		37.3	50.6
	Total of 1 & 2				740,893		1,095,601	1,836,494
	Equivalent to US$				49.2		72.7	121.9
3	VAT (5 %)	L.S	1		0		78,838	78,838
	Equivalent to US$				0		5.2	5.2
	Total of 1 to 3				740,893		1,174,439	1,915,332
	Equivalent to US$				49.2		77.9	127.1
	Note:							
	(1) Cost data sources; Feasibility study report, executive summary, Stage 2, No. 444C-05-TT2, General Explanation, No.444C-05-TM (HEC-1)							
	and Supplementary Study, No.444C-10-T1(HEC-1)							
	(2) Price level; As of Year 2001							
	(3) Exchange rate; US$ 1.0 = VND 15,068 = ￥ 123.39							
	(4) Price escalation; F.C : 1.6 % and L.C : 4.9 %							

Table L.24 Disbursement Schedule for Van Phong Weir and Irrigation and Drainage System

Unit: Million VND, Million US$

Description	Total(VND)			2003		2004		2005		2006		2007		2008		2009		2010		2011	
	F.C(VND)	L.C(VND)	Total(VND)	F.C(VND)	L.C(VND)	F.C(VND)	L.C(VND)	F.C(VND)	L.C(VND)	F.C(VND)	L.C(VND)	F.C(VND)	L.C(VND)	F.C(VND)	L.C(VND)	F.C(VND)	L.C(VND)	F.C(VND)	L.C(VND)	F.C(VND)	L.C(VND)
1. Direct Construction Cost																					
1.1 General Items	25,741	25,434	51,175									25,741	25,434								
1.2 Van Phong Weir																					
1.2.1 Weir	83,171	82,179	165,350									18,298	18,079	18,298	18,079	18,298	18,079	18,298	18,079	9,981	9,861
1.2.2 Scouring Sluice	2,021	1,997	4,018											2,021	1,997						
1.2.3 Intake Facilities	3,838	3,792	7,631											3,838	3,792						
1.2.4 Flood Dike	4,939	4,880	9,819									4,939	4,880								
Sub-total	93,969	92,848	186,817									23,236	22,959	24,157	23,869	18,298	18,079	18,298	18,079	9,981	9,861
1.3 Rehabilitation Works of Existing Weirs	36,544	36,108	72,652									5,847	5,777	7,674	7,583	7,674	7,583	7,674	7,583	7,674	7,583
1.4 New Pumping Station	14,746	14,570	29,316									2,359	2,331	3,097	3,060	3,097	3,060	3,097	3,060	3,097	3,060
1.5 Main Irrigation System	153,914	152,078	305,992									24,626	24,333	32,322	31,936	32,322	31,936	32,322	31,936	32,322	31,936
1.6 Primary and Secondary Irrigation System	142,656	140,955	283,611									22,825	22,553	29,958	29,600	29,958	29,600	29,958	29,600	29,958	29,600
1.7 Drainage System	34,177	33,769	67,946									5,468	5,403	7,177	7,092	7,177	7,092	7,177	7,092	7,177	7,092
1.8 Farm Road Network	4,147	4,097	8,244									663	656	871	860	871	860	871	860	871	860
1.9 On-farm System (Irrigation, Drainage and																					
Farm Road Facilities)	34,668	34,254	68,923									5,547	5,481	7,280	7,193	7,280	7,193	7,280	7,193	7,280	7,193
Total of 1	**540,562**	**534,114**	**1,074,676**									**116,314**	**114,926**	**112,536**	**111,193**	**106,677**	**105,404**	**106,677**	**105,404**	**98,359**	**97,186**
Equivalent to US$	35.9	35.4	71.3									7.7	7.6	7.5	7.4	7.1	7.0	7.1	7.0	6.5	6.4
2. Indirect Construction Cost																					
2.1 Resettlement Cost	0	79,294	79,294		22,995		22,995		22,995		10,308										
2.2 Engineering Cost	54,056	53,411	107,468					8,649	8,546	7,568	7,478	7,568	7,478	7,568	7,478	7,568	7,478	7,568	7,478	7,568	7,478
2.3 Administration	0	34,619	34,619		4,154		3,808		3,808		3,808		3,808		3,808		3,808		3,808		3,808
2.4 Price Escalation (F.C:1.6%, L.C:4.9%)	78,921	294,563	373,484	0	2,726	0	4,136	567	7,455	625	5,835	12,379	41,960	14,115	48,716	15,469	54,405	17,544	62,789	18,222	66,542
2.5 Physical Contingency (10%)	67,354	99,600	166,954	0	2,988	0	3,094	922	4,280	819	2,743	13,626	16,817	13,422	17,119	12,971	17,109	13,179	17,948	12,415	17,501
Total of 2	**200,331**	**561,487**	**761,818**	**0**	**32,863**	**0**	**34,034**	**10,138**	**47,084**	**9,012**	**30,172**	**33,573**	**70,063**	**35,105**	**77,121**	**36,008**	**82,800**	**38,291**	**92,022**	**38,205**	**95,329**
Equivalent to US$	13.3	37.3	50.6	0.0	2.2	0.0	2.3	0.7	3.1	0.6	2.0	2.2	4.6	2.3	5.1	2.4	5.5	2.5	6.1	2.5	6.3
Total of 1 & 2	**740,893**	**1,095,601**	**1,836,494**	**0**	**32,863**	**0**	**34,034**	**10,138**	**47,084**	**9,012**	**30,172**	**149,886**	**184,989**	**147,640**	**188,314**	**142,685**	**188,204**	**144,968**	**197,426**	**136,564**	**192,515**
Equivalent to US$	49.2	72.7	121.9	0.0	2.2	0.0	2.3	0.7	3.1	0.6	2.0	9.9	12.3	9.8	12.5	9.5	12.5	9.6	13.1	9.1	12.8
3. VAT (5 %)	**0**	**78,838**	**78,838**		**229**		**220**		**1,209**		**1,126**		**15,222**		**15,271**		**15,040**		**15,563**		**14,958**
Equivalent to US$	0.0	5.2	5.2		0.0		0.0		0.1		0.1		1.0		1.0		1.0		1.0		1.0
Total of 1 to 3	**740,893**	**1,174,439**	**1,915,332**	**0**	**33,091**	**0**	**34,253**	**10,138**	**48,293**	**9,012**	**31,298**	**149,886**	**200,211**	**147,640**	**203,585**	**142,685**	**203,245**	**144,968**	**212,990**	**136,564**	**207,473**
Equivalent to US$	49.2	77.9	127.1	0.0	2.2	0.0	2.3	0.7	3.2	0.6	2.1	9.9	13.3	9.8	13.5	9.5	13.5	9.6	14.1	9.1	13.8

Note:

(1) Cost data sources; Feasibility study report, executive summary, Stage 2, No. 444C-05-TT2, General Explanation, No.444C-05-TM (HEC-1) and Supplementary Study, No.444C-10-T1(HEC-1)

(2) Price level; As of Year 2001

(3) Exchange rate; US$ 1.0 = VND 15,068 = ¥ 123.39

(4) Price escalation; F.C 1.6 % and L.C 4.9 %

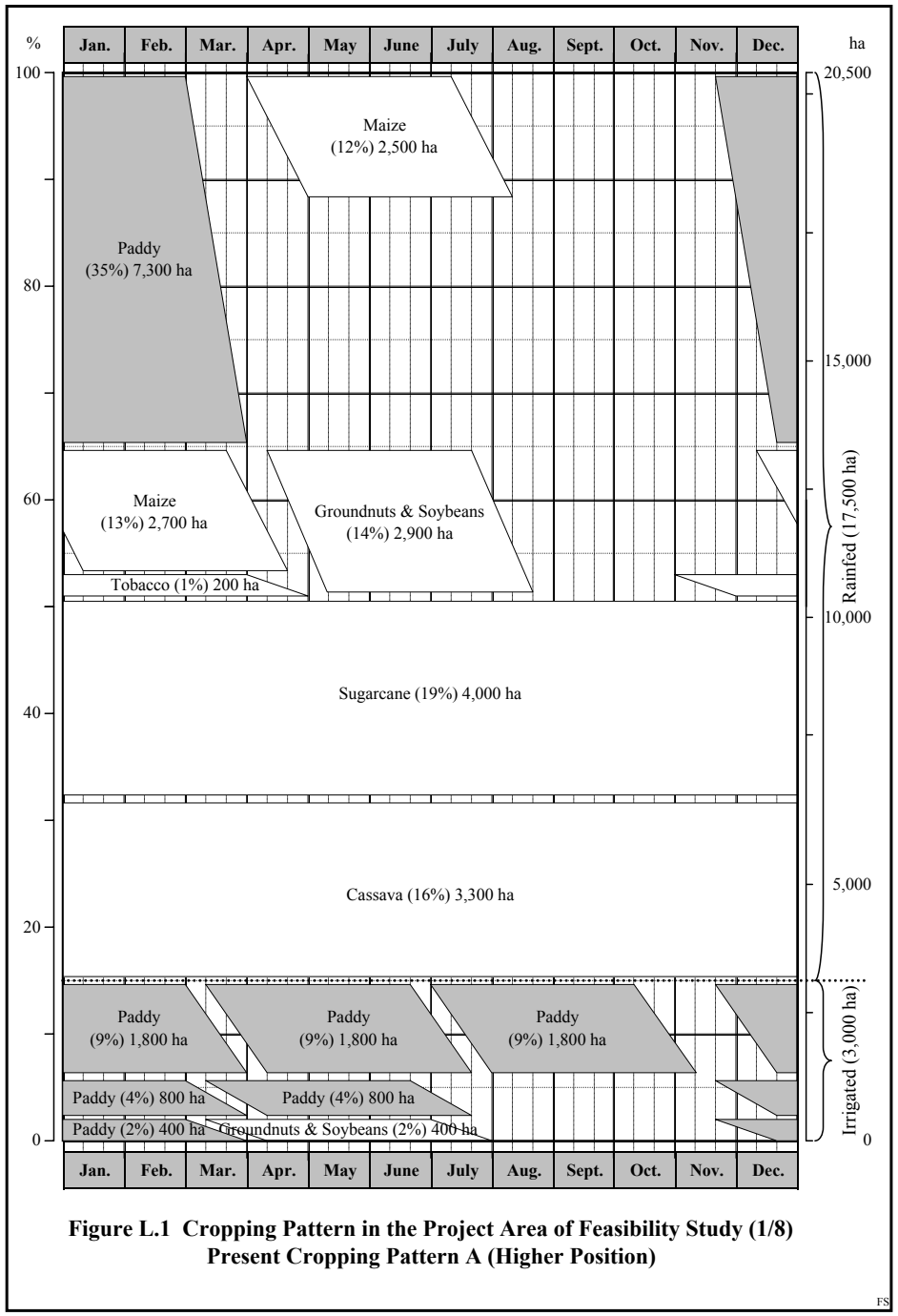


Figure L.1 Cropping Pattern in the Project Area of Feasibility Study (1/8)
Present Cropping Pattern A (Higher Position)

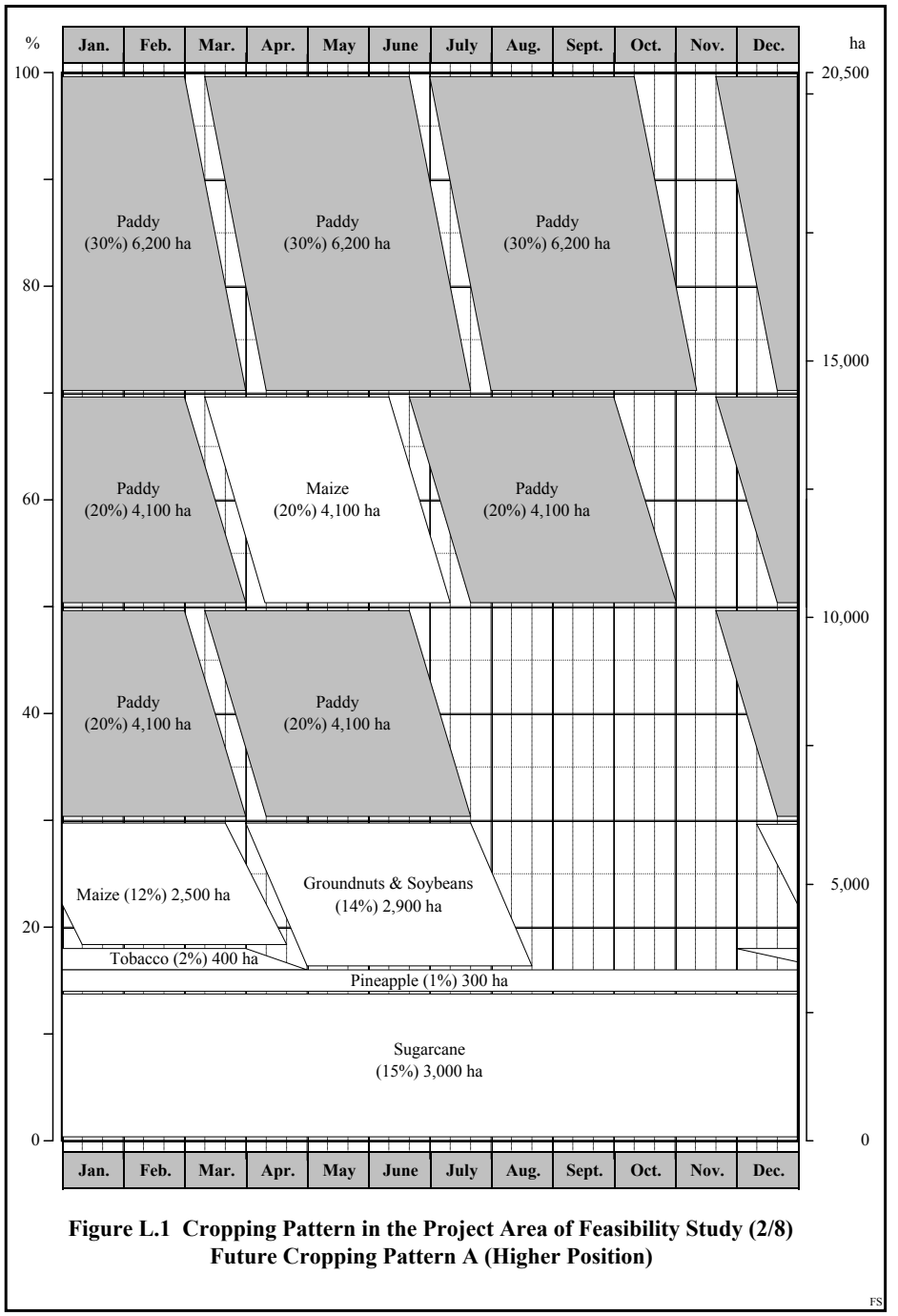


Figure L.1 Cropping Pattern in the Project Area of Feasibility Study (2/8)
Future Cropping Pattern A (Higher Position)

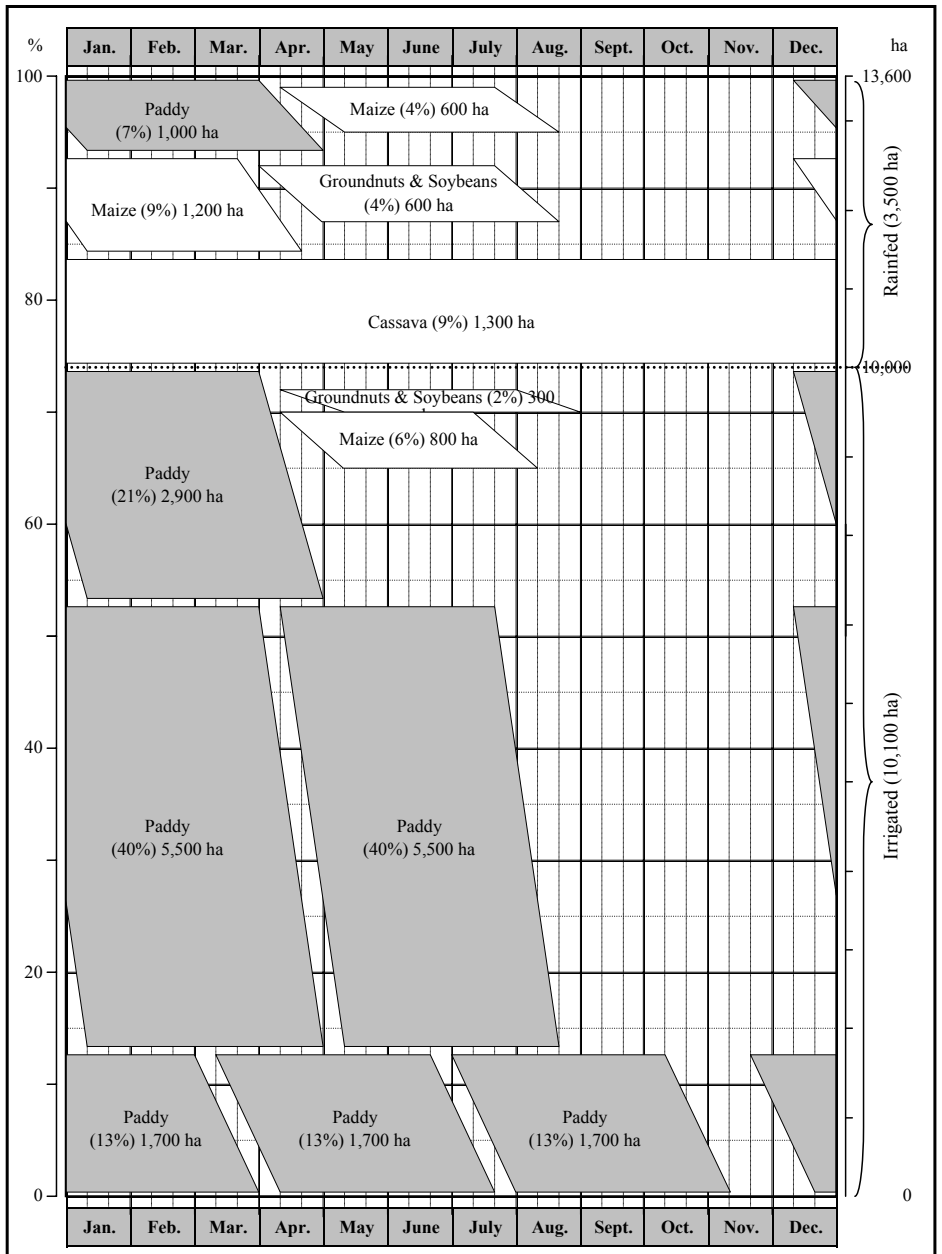


Figure L.1 Cropping Pattern in the Project Area of Feasibility Study (3/8)
Present Cropping Pattern B (Higher Position)

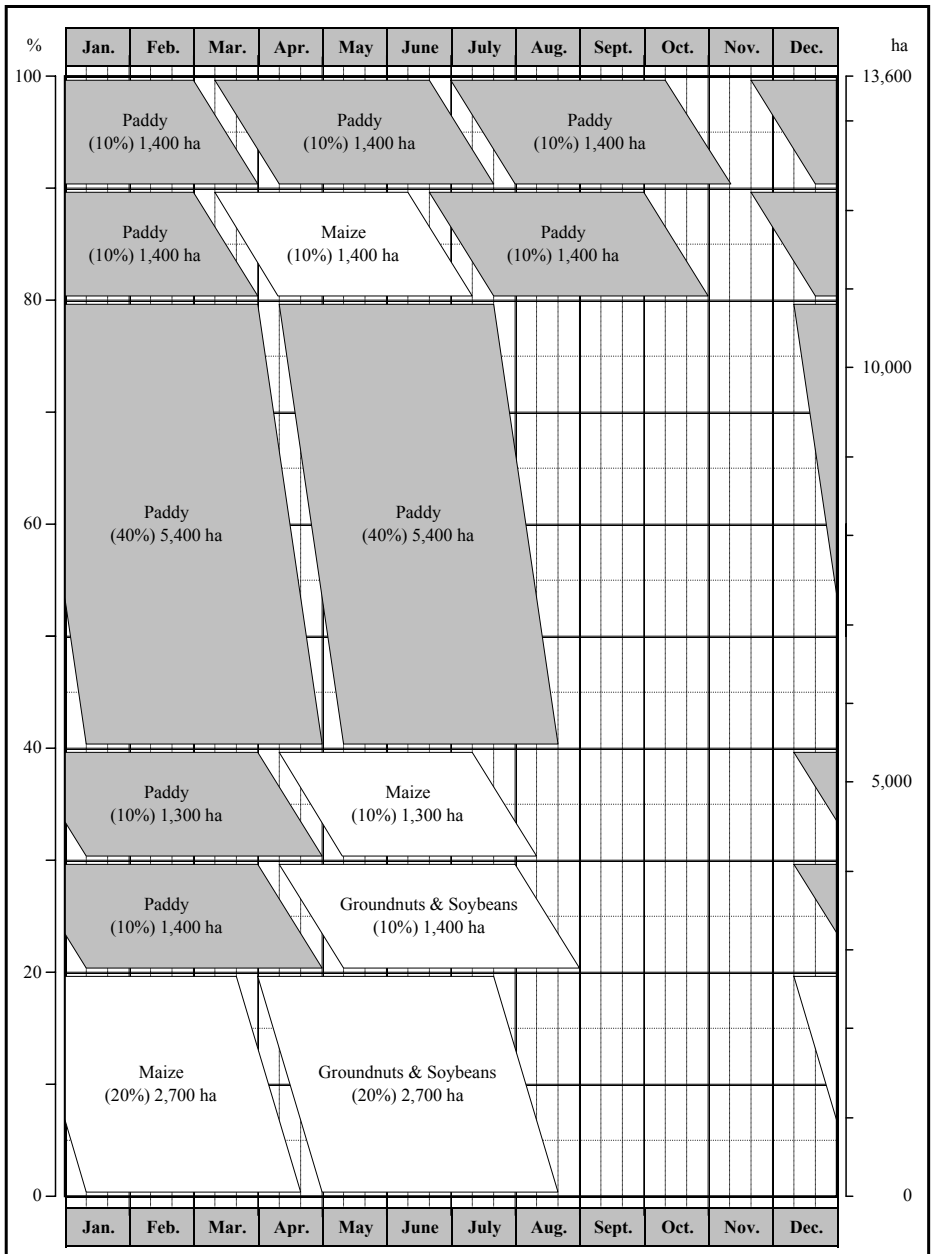


Figure L.1 Cropping Pattern in the Project Area of Feasibility Study (4/8)
Future Cropping Pattern B (Higher Position)

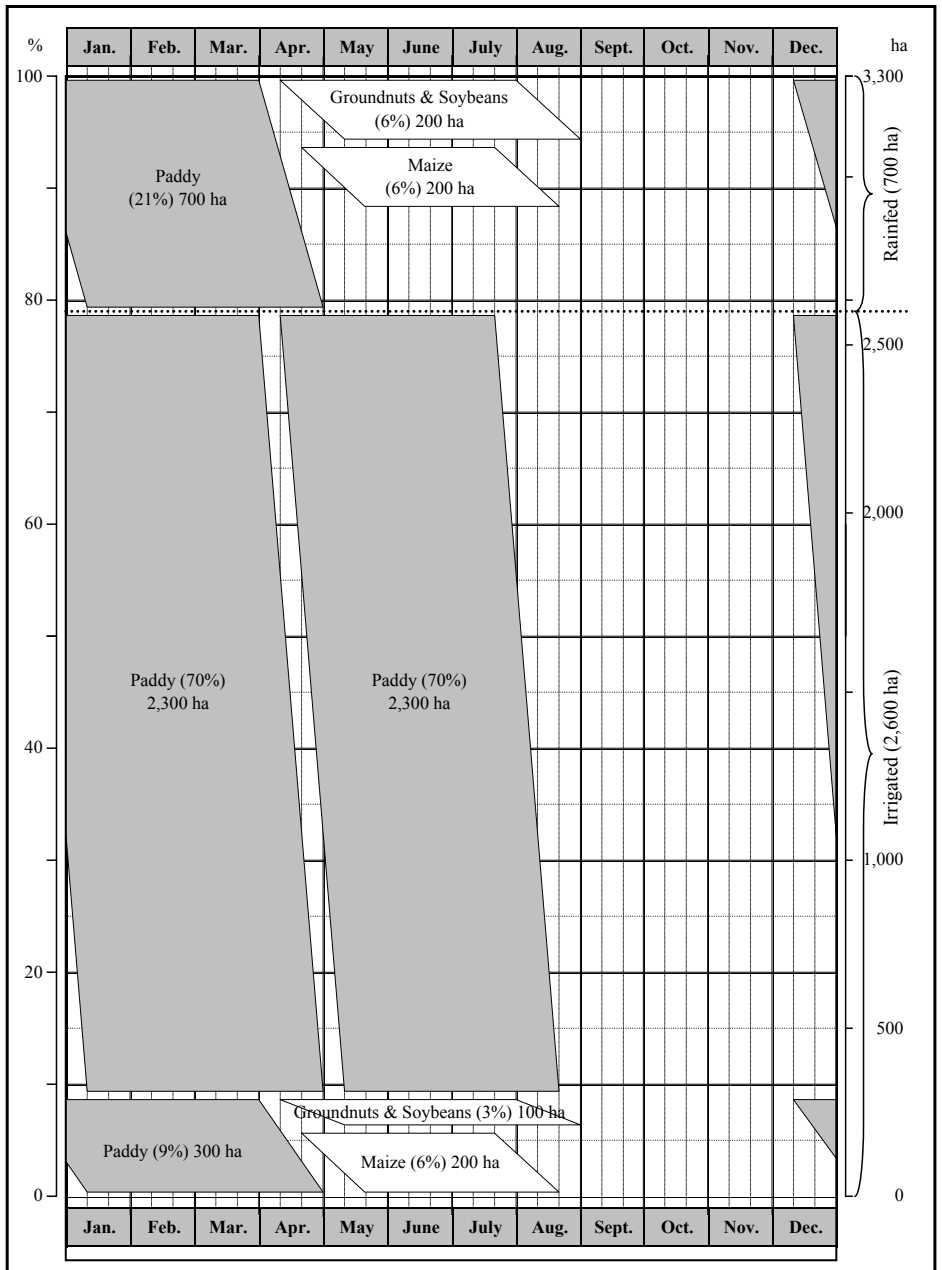


Figure L.1 Cropping Pattern in the Project Area of Feasibility Study (5/8)
Present Cropping Pattern C (Higher Position)

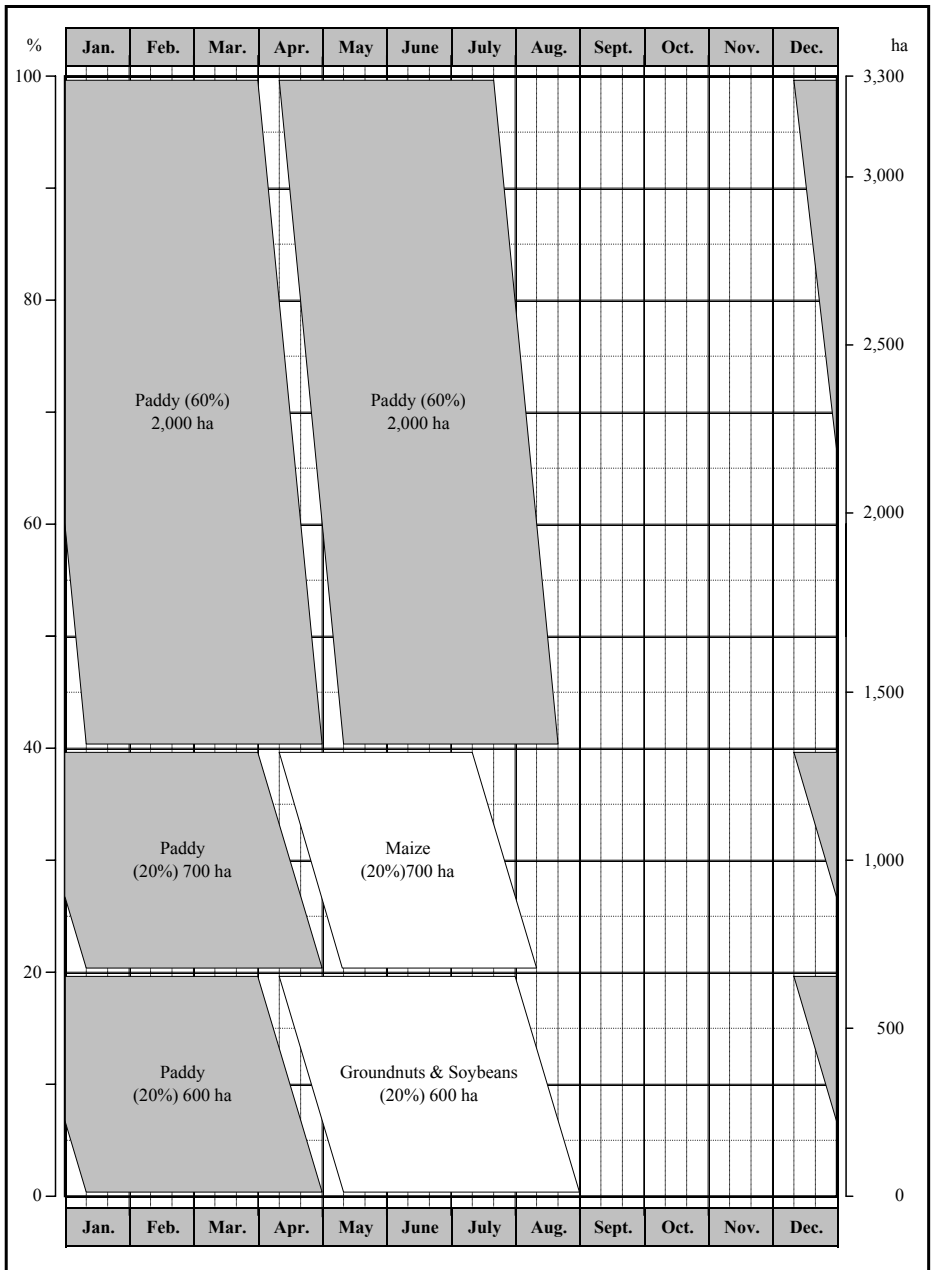


Figure L.1 Cropping Pattern in the Project Area of Feasibility Study (6/8)
Future Cropping Pattern C (Higher Position)

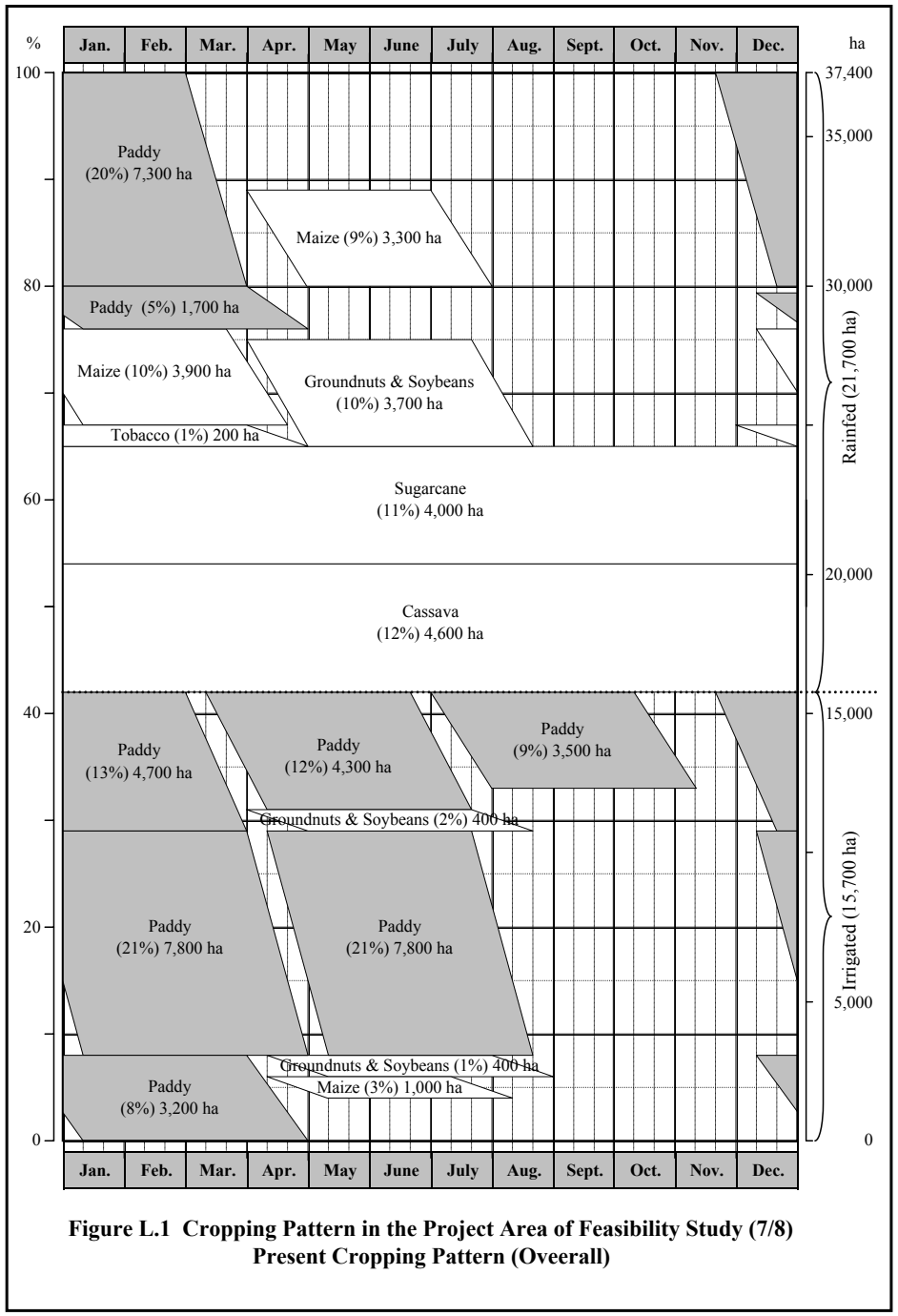


Figure L.1 Cropping Pattern in the Project Area of Feasibility Study (7/8)
Present Cropping Pattern (Oveerall)

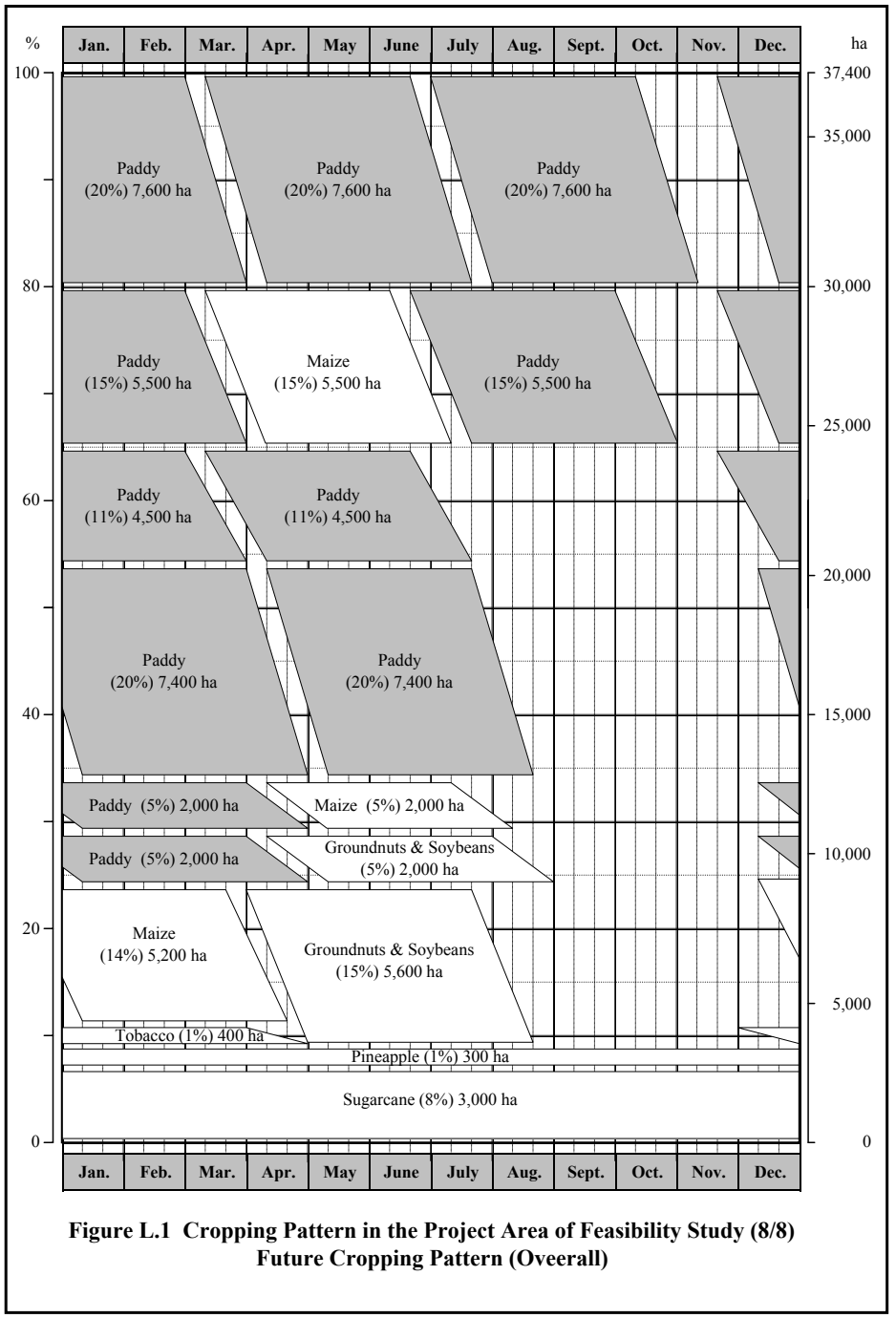
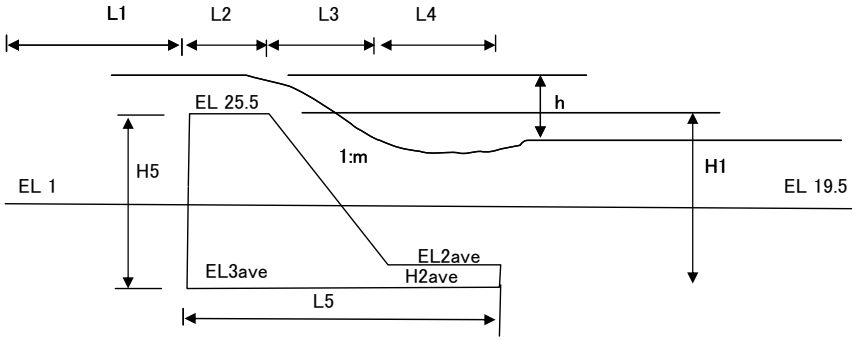


Figure L.1 Cropping Pattern in the Project Area of Feasibility Study (8/8)
Future Cropping Pattern (Oveerall)

(i) Case 1A Concrete Fixed at Site-II (1: Concrete) (A: Fixed)



(1) Dimensions

(a) Elevation

ELcrest =	25.5	m
EL1 =	20.0	m
EL2ave =	13.5	m
EL3ave =	12.5	m
EL d ap =	12.5	m
GL ave =	22.5	m

(b) Height/Thickness

H1 =	13.0	m
H2ave =	1.0	m
H3 =	0.0	m
H4 =	0.0	m
H5 =	14.0	m

(c) Length

L1 =	0.0	m
L2 =	3.0	m
L3 =	9.1	m
L4 =	5.0	m
L5 =	17.1	m

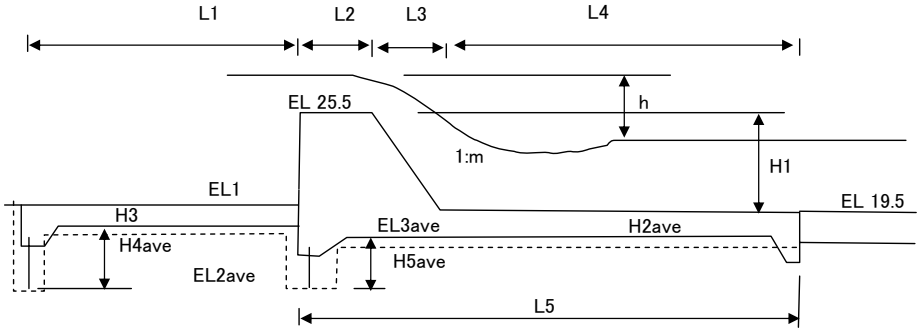
(d) Slope

m= 0.70

(e) Width

B = 525 m

(ii) Case 1B Concrete Floating at Site-II (1: Concrete) (B: Floating)



(1) Dimensions

(a) Elevation

ELcrest =	25.5	m
EL1 =	20.0	m
EL2ave =	12.5	m
EL3ave =	17.0	m
EL d ap =	19.0	m
GL ave =	22.5	m

(b) Height/Thickness

H1 =	6.5	m
H2ave =	2.0	m
H3 =	1.5	m
H4ave =	6.0	m
H5ave =	4.5	m

(c) Length

L1 =	20.0	m
L2 =	3.0	m
L3 =	4.6	m
L4 =	40.0	m
L5 =	47.6	m

(d) Slope

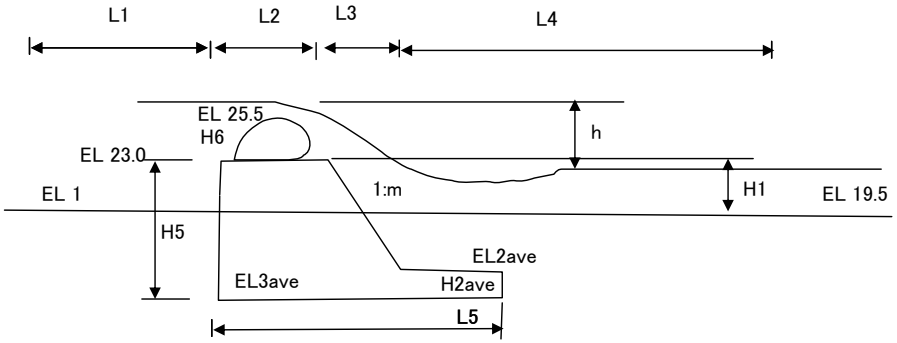
m= 0.70

(e) Width

B = 525 m

Figure L.2 (1/2) Alternative Weir Types (Concrete Weir)

(iii) Case 2A Rubber Fixed at Site-II (2: Rubber) (A: Fixed)



(1) Dimensions

(a) Elevation

ELRcrest =	25.5	m
ELCcrest =	23.0	m
EL1 =	20.0	m
EL2ave =	13.5	m
EL3ave =	12.5	m
EL d ap =	12.5	m
GL ave =	22.5	m

(b) Height/Thickness

H1 =	10.5	m
H2ave =	1.0	m
H3 =	0.0	m
H4 =	0.0	m
H5 =	11.5	m
H6 =	2.5	m

(c) Length

L1 =	0.0	m
L2 =	5.5	m
L3 =	6.8	m
L4 =	5.0	m
L5 =	17.3	m

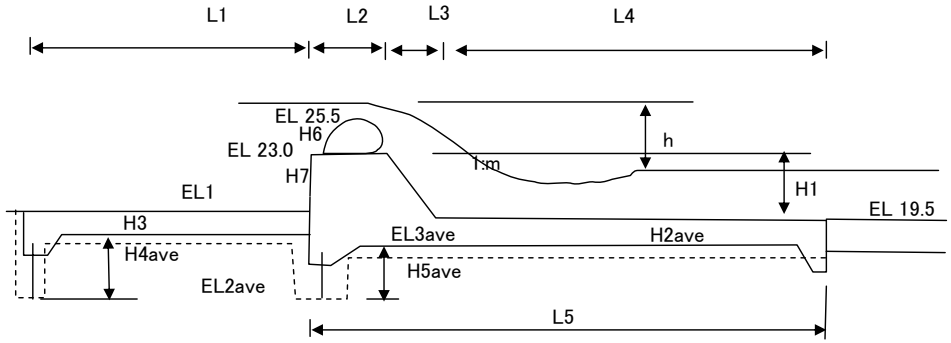
(d) Slope

m=	0.65	

Width

(e) B = 525 m

(iv) Case 2B Rubber Floating at Site-II (2: Rubber) (B: Floating)



(1) Dimensions

(a) Elevation

ELRcrest =	25.5	m
ELCcrest =	23.0	m
EL1 =	20.0	m
EL2ave =	12.5	m
EL3ave =	17.0	m
EL d ap =	19.0	m
GL ave =	22.5	m

(b) Height/Thickness

H1 =	4.0	m
H2ave =	2.0	m
H3 =	1.5	m
H4ave =	6.0	m
H5ave =	4.5	m
H6 =	2.5	m
H7 =	3.0	m

(c) Length

L1 =	20.0	m
L2 =	5.5	m
L3 =	2.4	m
L4 =	40.0	m
L5 =	47.9	m

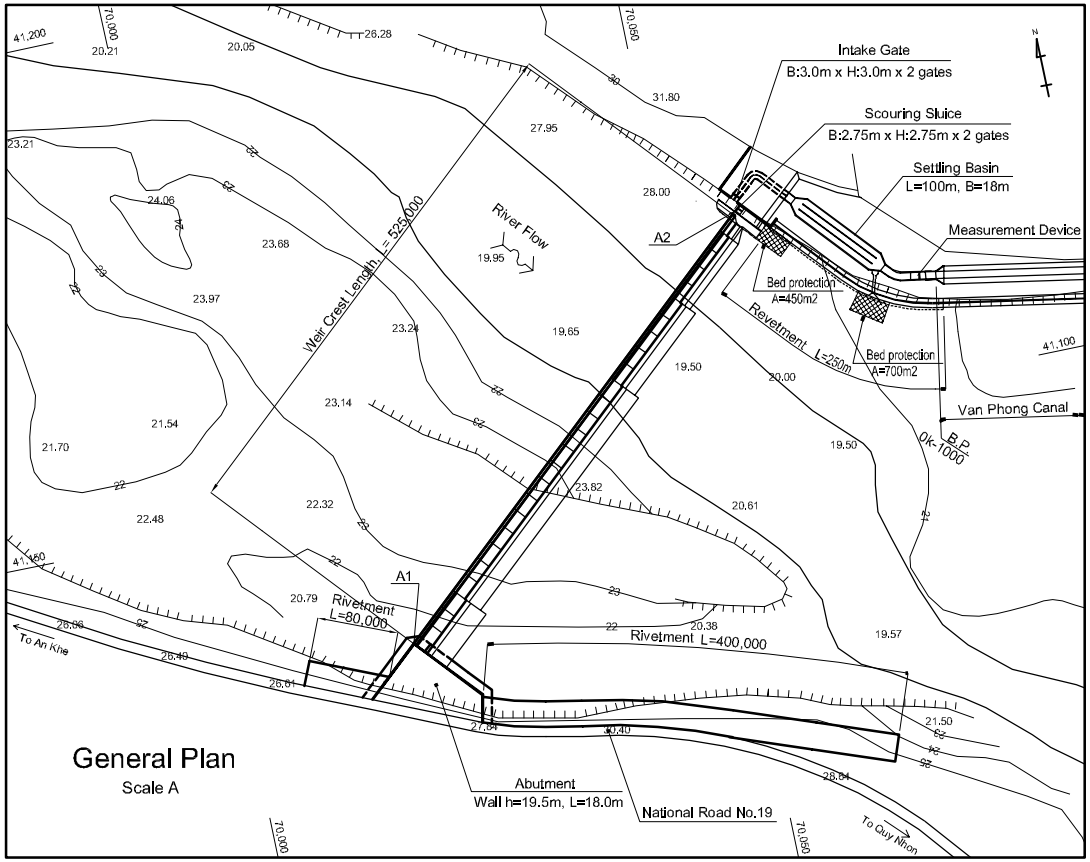
(d) Slope

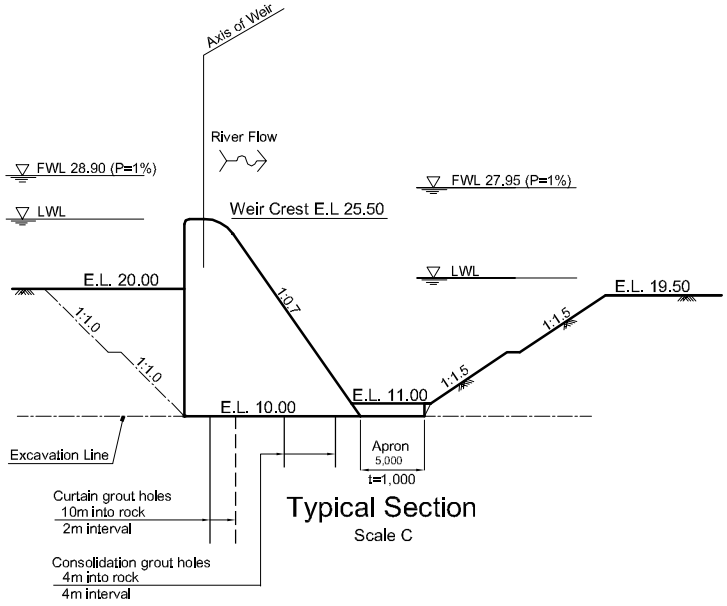
m=	0.60	

(e) Width

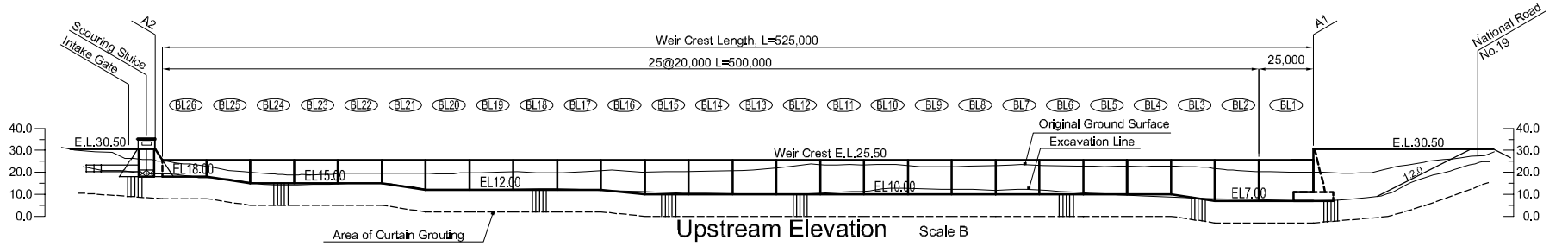
B = 525 m

Figure L.2 (2/2) Alternative Weir Types (Rubber Weir on Concrete Weir Body)





No.	X	Y
A1	41,134.93	70,017.38
A2	41,169.96	70,056.96

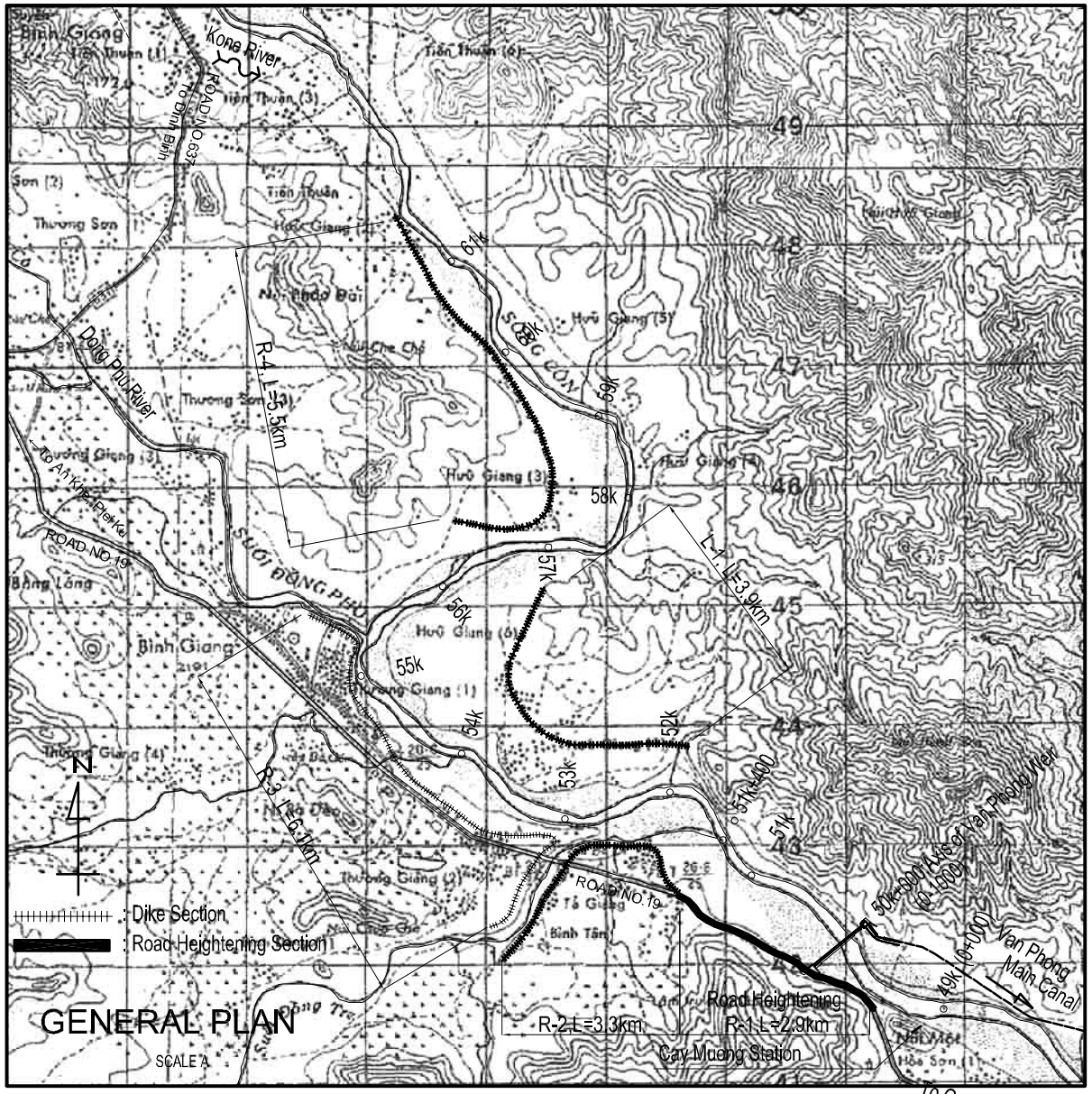


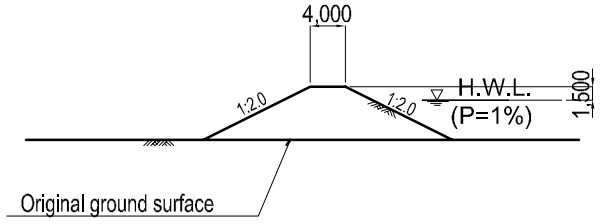
Scale A: 0 50 100 150 200 250m

Scale B: 0 50 100m

Scale C: 0 10 20m

The Study on Nationwide Water Resources Development and Management in the Socialist Republic of Vietnam	Figure L.3 General Layout of Van Phong Weir
JAPAN INTERNATIONAL COOPERATION AGENCY	

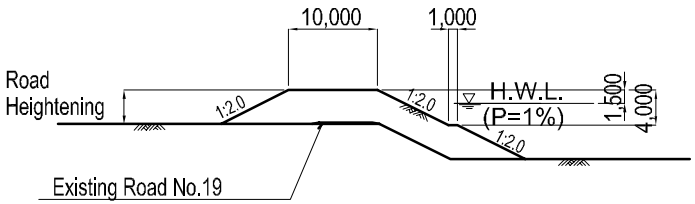




Dike SECTION

(R-2,3,4, L-1)

SCALE B



ROAD HIGHTENING SECTION

(R-1)

SCALE B

TYPICAL SECTION

Section	from to	Length (m)	Dike Crest (ELm)	H.W.L (ELm)	Remarks
R-1	49k+700 to 51k+400	2,900	30.50 to 31.50	29.50 to 30.00	Road Heightening
R-2	51k+400 to 52k+900	3,300	31.50 to 31.92	30.00 to 30.40	
R-3	53k+000 to 55k+400	6,100	31.96 to 32.85	30.46 to 31.35	
R-4	56k+500 to 61k+500	5,500	33.41 to 35.19	31.91 to 33.69	
L-1	52k+000 to 57k+000	3,900	31.71 to 33.51	30.21 to 32.01	

50k+000 in the above is measured distance from the sea.

SCALE A : 0 1000 2000m

SCALE B : 0 10 20 30m

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JAPAN INTERNATIONAL COOPERATION AGENCY

Figure L.4
Van Phong Weir
Flood Dike