Table D.7.5 Economic Net Return per Hectar Under With Project (1/4)

			Arroz - Invierno (CR)		Arroz - Verano (CR)		Maiz - Invierno/ Verano (CR)		Algodon (CR)	
I. PRODUCTION VALUE										
1) Unit yield		(t/ha)	4.5	(t/ha)	4.5	(t/ha)	4.5	(t/ha)	2.0	
2) Unit price		(S/./t)	273,000	(S/./t)	273,000	(S/./t)	193,000	(S/./t)	614,000	
3) Production value		(S/.)	1,228,500	(S/.)	1,228,500	(S/.)	868,500	(S/.)	1,228,000	
II. TOTAL EXPENSE	Unit	Unit cost (S/.)	Quantity	Total (S/.)	Quantity	Total (S/.)	Quantity	Total (S/.)	Quantity	Total (S/.)
1. Production cost										
1) Labor	(day's wage)									
- Preparacion de suelo		1,400	10	14,000	10	14,000		0	10	14,000
- Arreglo de suelo		1,400		0		0		0		0
- Control de maleza - Quimico		1,750	3	5,250	3	5,250	2	3,500	2	3,500
- Manual		1,400		0		0	6	8,400	12	16,800
- Siembra		1,400	10	14,000	10	14,000	8	11,200	10	14,000
- Fertilizacion		1,400	6	8,400	6	8,400	4	5,600	10	14,000
- Control fitosanitario		1,750	12	21,000	12	21,000	4	7,000	16	28,000
- Riego		1,400	10	14,000	20	28,000	6	8,400	10	14,000
- Cosecha		1,400		0		0		0	40	56,000
- Cosecha corte y trillado		1,400	32	44,800	32	44,800		0		0
- Corte y acarreo		1,400		0		0	15	21,000		0
- Desgranada		1,400		0		0	5	7,000		0
2) Materials										
- Semilla (Arroz)	(kg)	490	100	49,000	100	49,000		0		0
- Semilla (Maiz)	(kg)	590		0		0	15	8,850		0
- Semilla (Algodon)	(kg)	1,400		0		0		0	7	9,800
- Urea	(kg)	277	181	50,137	181	50,137	91	25,207	181	50,137
- Abono completo	(kg)	264	91	24,024	91	24,024		0	91	24,024
- Propanil 36%	(kg)	7,000	3.8	26,600	3.8	26,600		0		0
- Lazo	(lt)	6,900		0		0	2	13,800	2	13,800
- Gessagaro	(kg)	19,800		0		0		0	1	19,800
- Monitor	(lt)	13,600	2	27,200	2	27,200		0		0
- Lannate	(kg)	52,000	0.4	20,800	0.4	20,800		0		0
- Larvin	(lt)	31,400		0		0	0.2	6,280	0.2	6,280
- Afalon	(kg)	13,300		0		0	0.7	9,310		0
- Lorsban	(lt)	19,800		0		0	2	39,600	1.5	29,700
- Nuvacron	(lt)	13,100		0		0		0	1.5	19,650
- Karate	(lt)	35,000		0		0		0	1	35,000
- Agua	(Riego)	90	5	450	10	900	3	270	10	900
3) Equipments										
- Preparacion de suelo	(ha)	40,000	1	40,000	1	40,000	1	40,000	1	40,000
- Desgranada (Maiz)	(t)	13,200		0		0	4.5	59,400		0
- Transporte (Algodon)	(t)	12,500		0		0		0	2	25,000
Total of 1),2) and 3)				359,661		374,111		274,817		434,391
2. Unexpected Expense										
1) Imprevistos y Gastos de Administracion *1				35,966		37,411		27,482		43,439
Total of 1 & 2				395,627		411,522		302,299		477,830
III. NET RETURN				832,873		816,978		566,201		750,170

*1 10% of production cost

Note: SR = Without irrigation, CR = With irrigation

Table D.7.5 Economic Net Return per Hectar Under With Project (2/4)

			Mani - Verano (CR)		Soya - Verano (CR)		Melon - Invierno/ Verano (CR)		Pimiento-Invierno/ Verano (CR)	
I. PRODUCTION VALUE										
1) Unit yield			(t/ha)	1.8	(t/ha)	1.8	(t/ha)	13.0	(t/ha)	6.0
2) Unit price			(S/./t)	331,000	(S/./t)	303,000	(S/./t)	100,000	(S/./t)	205,000
3) Production value			(S/.)	595,800	(S/.)	545,400	(S/.)	1,300,000	(S/.)	1,230,000
II. TOTAL EXPENSE	Unit	Unit cost (S/.)	Quantity	Total (S/.)	Quantity	Total (S/.)	Quantity	Total (S/.)	Quantity	Total (S/.)
1. Production cost										
1) Labor	(day's wage)									
- Arreglo de surco		1,400	3	4,200		0	4	5,600	4	5,600
- Prep. densif. y siem.		1,400		0		0		0	6	8,400
- Transplante		1,400		0		0		0	30	42,000
- Aplic. pest. semillero		1,750		0		0		0	1	1,750
- Control de maleza	- Quimico	1,750	2	3,500	2	3,500		0		0
	- Manual	1,400	10	14,000	4	5,600	15	21,000	25	35,000
- Aplic. pest. campo		1,750		0		0		0	20	35,000
- *Siembra*		*1,400*	*10*	*14,000*		*0*	*6*	*8,400*		*0*
- Siembra y resiembre		1,400		0	22	30,800		0		0
- Fertilizacion		1,400		0		0	8	11,200	8	11,200
- Control fitosanitario		1,750	8	14,000	6	10,500	20	35,000		0
- Riego		1,400	16	22,400	18	25,200	20	28,000		0
- Riegos semillero		1,400		0		0		0	2	2,800
- Riegos campo		1,400		0		0		0	30	42,000
- Cosecha		1,400	38	53,200		0		0		0
- Corte, amontanada y acarr		1,400		0	20	28,000		0		0
- Cosecha y acarreo		1,400		0		0	25	35,000		0
- Cosecha, acarreo y empac.		1,400		0		0		0	120	168,000
- Trillada y limpieza		1,400		0	2	2,800		0		0
2) Materials										
- Semilla (Mani)	(kg)	1,200	60	72,000		0		0		0
- Semilla (Soya)	(kg)	830		0	45	37,350		0		0
- Semilla (Melon)	(kg)	17,600		0		0	0.45	7,920		0
- Semilla (Pimiento)	(kg)	37,400		0		0		0	0.91	34,034
- Urea	(kg)	277		0		0	136	37,672	181	50,137
- Abono completo	(kg)	264		0		0	136	35,904		0
- Lazo	(lt)	6,900	2	13,800	2	13,800		0		0
- Gessagaro	(kg)	19,800	1	19,800	1	19,800		0		0
- Oxiclor	(kg)	4,800		0		0	3.6	17,280		0
- Nuvacron	(lt)	13,100	1	13,100	1	13,100	2	26,200		0
- Mavrik	(lt)	40,000	0.4	16,000		0	0.5	20,000	1	40,000
- *Incolante*	*(kg)*	*8,000*		*0*	*0.45*	*3,600*		*0*		*0*
- Ambush	(lt)	87,300		0	0.3	26,190		0		0
- Karate	(lt)	35,000		0		0	1	35,000		0
- Temik	(kg)	12,300		0		0	15	184,500		0
- Morestan	(kg)	26,300		0		0	1	26,300		0
- Topsin	(kg)	21,600		0		0	3	64,800		0
- Pillaron	(lt)	13,600		0		0		0	1	13,600
- Dimecron	(lt)	9,400		0		0		0	3	28,200
- Cuprosan	(kg)	4,700		0		0		0	2.72	12,784
- Tricarbamix	(kg)	8,400		0		0		0	3.63	30,492
- Vitavax	(kg)	20,500	0	9,225		0		0	1.82	37,310
- Terractor	(kg)	19,000		0		0		0	1.82	34,580
- Monitor	(lt)	13,600		0		0		0	2	27,200
- Lorsban	(lt)	19,800	1	19,800		0		0		0
- Agua	(Riego)	90	8	720	8	720	10	900	15	1,350
3) Equipments										
- Preparacion de suelo (ha)		40,000	1	40,000	1	40,000	1	40,000	1	40,000
- Desgranada	(t)	10,000	1.8	18,000		0		0		0
- Trillada y limpieza	(t)	11,110		0	1.8	19,998		0		0
Total of 1),2) and 3)				347,745		280,958		640,676		701,437
2. Unexpected Expense										
1) Imprevistos y Gastos de Administracion *1				34,775		28,096		64,068		70,144
Total of 1 & 2				382,520		309,054		704,744		771,581
III. NET RETURN				213,281		236,346		595,256		458,419

*1 10% of production cost

Note: SR = Without irrigation, CR = With irrigation

Table D.7.5 Economic Net Return per Hectar Under With Project (3/4)

			Sandia-Invierno/ Verano (CR)		Tomate - Invierno/ Verano (CR)		Platano (CR)		Zpallo-Invierno/ Verano (CR)	
I. PRODUCTION VALUE										
1) Unit yield			(t/ha)	15.0	(t/ha)	25.0	(t/ha)	25.0	(t/ha)	20.0
2) Unit price			(S/./t)	125,000	(S/./t)	99,000	(S/./t)	59,000	(S/./t)	50,000
3) Production value			(S/.)	1,875,000	(S/.)	2,475,000	(S/.)	1,475,000	(S/.)	1,000,000
II. TOTAL EXPENSE	Unit	Unit cost (S/.)	Quantity	Total (S/.)	Quantity	Total (S/.)	Quantity	Total (S/.)	Quantity	Total (S/.)
1. Production cost										
1) Labor	(day's wage)									
- Arreglo de surco		1,400	2	2,800	4	5,600		0	2	2,800
- Siembra semillero y riego		1,400		0	3	4,200		0		0
- Prep. vivero y siemb.		1,400	4	5,600	2	2,800		0		0
- Transplante		1,400	8	11,200	14	19,600		0		0
- Control de maleza	- Quimico	1,750	4	7,000		0		0	4	7,000
	- Manual	1,400	14	19,600		0	10	14,000	8	11,200
- Siembra		1,400		0		0		0		0
- Fertilizacion		1,400	8	11,200		0	6	8,400	6	8,400
- Fertilizacion y aporque		1,400		0	12	16,800		0		0
- Control fitosanitario		1,750	24	42,000	30	52,500	6	10,500	8	14,000
- Deshierba		1,400		0	30	42,000	40	56,000		0
- Tutoreo		1,400		0	12	16,800		0		0
- Amarre		1,400		0	150	210,000		0		0
- Riegos		1,400	26	36,400	30	42,000	8	11,200	12	16,800
- Cosecha y acarreo		1,400	60	84,000	140	196,000	77	107,800	20	28,000
2) Materials										
- Semilla (Sandia)	(kg)	250,000	0.45	112,500		0		0		0
- Semilla (Tomate)	(kg)	90,000		0	0.14	12,600		0		0
- Semilla (Zapallo)	(kg)	6,000		0		0		0	1	6,000
- Fundas de polietileno	(millar)	1,200	5	6,000		0		0		0
- Urea	(kg)	277	91	25,207	136	37,672		0	91	25,207
- Abono completo	(kg)	264	136	35,904	136	35,904	181	47,784	91	24,024
- Sulfato de Amonio	(kg)	127	136	17,272		0		0	136	17,272
- Dual	(lt)	17,500	1	17,500		0		0	1	17,500
- Oxiclor	(kg)	4,800	3.6	17,280	6.8	32,640		0	3.6	17,280
- Nuvacron	(lt)	13,100	3	39,300	2	26,200		0	3	39,300
- Mavrik	(lt)	40,000	1.2	48,000		0		0	1	40,000
- Karate	(lt)	35,000	1	35,000		0		0		0
- Temik	(kg)	12,300	15	184,500		0		0		0
- Morestan	(kg)	26,300	1.5	39,450		0		0	1.5	39,450
- Topsin	(kg)	21,600	5	108,000		0		0		0
- Terraclor	(kg)	19,000	0.91	17,290		0		0	0.91	17,290
- Vitavax	(kg)	20,500	0.91	18,655		0		0	0.91	18,655
- Mancozeb	(kg)	6,000	5.4	32,400	4.5	27,000		0	5.4	32,400
- Furadan 5%	(kg)	3,000		0	1	3,000	15	45,000		0
- Orthocide	(kg)	5,900		0	0.45	2,655		0		0
- Evicel	(kg)	54,000		0	1.5	81,000		0		0
- Desis	(lt)	35,000		0	1	35,000		0		0
- Lorsban	(lt)	19,800		0	1.8	35,640		0		0
- Triciman	(kg)	6,600		0	4.5	29,700		0		0
- Fenon	(lt)	33,600		0	1.5	50,400		0		0
- Tricarbamix	(kg)	8,400		0	4.5	37,800		0		0
- Piola	(kg)	6,000		0	4	24,000		0		0
- Alambre	(kg)	280		0	25	7,000		0		0
- Estaca	(Unidad)	30		0	1,250	37,500		0		0
- Agua	(Riego)	90	13	1,170	15	1,350	4	360	6	540
3) Equipments										
- Preparacion de suelo (ha)		40,000	1	40,000	1	40,000		0	1	40,000
Total of 1),2) and 3)				1,015,228		1,165,361		301,044		423,118
2. Unexpected Expense										
1) Imprevistos y Gastos de Administracion *1				101,523		116,536		30,104		42,312
Total of 1 & 2				1,116,751		1,281,897		331,148		465,430
III. NET RETURN				758,249		1,193,103		1,143,852		534,570

*1 10% of production cost

Note: SR = Without irrigation, CR = With irrigation

Table D.7.5 Economic Net Return per Hectar Under With Project (4/4)

			Pasto de Corte (CR)		Citricos (CR)		Pepino (CR)		Cebolla Bulbo (CR)	
I. PRODUCTION VALUE										
1) Unit yield			(t/ha)	100.0	(t/ha)	30.0	(U/ha)	60,000	(t/ha)	15.0
2) Unit price			(S/./t)	-	(S/./t)	60,000	(S/./U)	12	(S/./t)	120,000
3) Production value			(S/.)	-	(S/.)	1,800,000	(S/.)	720,000	(S/.)	1,800,000
II. TOTAL EXPENSE	Unit	Unit cost (S/.)	Quantity	Total (S/.)	Quantity	Total (S/.)	Quantity	Total (S/.)	Quantity	Total (S/.)
1. Production cost										
1) Labor	(daily wage)									
- Arreglo de surco		1,400		0		0	4	5,600		0
- Limpieza y mantenimiento canales, surco y corona		1,400		0	16	22,400		0		0
- Prep. semillero y siembra		1,400		0		0		0	10	14,000
- Transplante		1,400		0		0		0	100	140,000
- Control de maleza	- Quimico	1,750		0		0	2	3,500	4	7,000
	- Manual	1,400	6	8,400	35	49,000	8	11,200	60	84,000
- Siembra		1,400		0		0	8	11,200		0
- Fertilizacion		1,400	8	11,200	12	16,800	6	8,400	5	7,000
- Control fitosanitario		1,750		0	30	52,500	16	28,000	20	35,000
- Poda		5,000		0	6	30,000		0		0
- Riego		1,400	8	11,200	12	16,800	18	25,200	20	28,000
- Corte y acarreo		1,400	40	56,000		0		0	66	92,400
- Cosecha y acarreo		1,400		0		0	20	28,000		0
- Cosecha, acarreo y cargada		1,400		0	150	210,000		0		0
2) Materials										
- Semilla (Pepino)	(kg)	20,900		0		0	0.91	19,019		0
- Semilla (Cebolla)	(kg)	39,600		0		0		0	1	39,600
- Urea	(kg)	277	363	100,551		0	91	25,207	68	18,836
- Sulfato de Amonio	(kg)	127		0	454	57,658		0	91	11,557
- Abono completo	(kg)	264		0	680	179,520	136	35,904	181	47,784
- Sulfamag	(kg)	277		0		0		0	91	25,207
- Sup.triple	(kg)	266	185	49,210		0		0	136	36,176
- Mureato potacio	(kg)	184	140	25,760		0		0	45	8,280
- Goal	(lt)	24,000		0		0		0	1.5	36,000
- Supracio	(lt)	29,000		0	4	116,000		0		0
- Lorsban	(lt)	19,800		0	4	79,200		0		0
- *Pillaron*	(lt)	*13,600*		*0*	*4*	*54,400*		*0*	*1*	*13,600*
- Oxiclor	(kg)	4,800		0	9.1	43,680		0		0
- Lonzin	(kg)	6,000		0	9.1	54,600		0		0
- Dual	(lt)	17,500		0		0	2	35,000		0
- Nuvacron	(lt)	13,100		0		0	2	26,200	1	13,100
- Mavrik	(lt)	40,000		0		0	0.5	20,000		0
- Topsin	(kg)	21,600		0		0	1	21,600		0
- Daconil	(kg)	21,500		0		0	2	43,000		0
- Monitor	(lt)	13,600		0		0		0	1.5	20,400
- *Malathion 57*	*(lt)*	*5,200*		*0*		*0*		*0*	*1*	*5,200*
- Mitac 20	(lt)	15,200		0		0		0	2	30,400
- Antracol	(kg)	9,200		0		0		0	2	18,400
- Daconil	(kg)	21,500		0		0		0	2	43,000
- Ridomil	(kg)	13,500		0		0		0	2.5	33,750
- Aceite agr.	(lt)	2,100		0	20	42,000		0		0
- Agral 90	(lt)	5,800		0	3	17,400		0		0
- Agua	(Riego)	90	8	720	6	540	9	810	10	900
3) Equipments										
- Preparacion de suelo (ha)		40,000	0.25	10,000		0	1	40,000	1	40,000
Total of 1),2) and 3)				273,041		1,042,498		387,840		849,590
2. Unexpected Expense										
1) *Imprevistos y Gastos de Administracion* *1				27,304		104,250		38,784		84,959
Total of 1 & 2				300,345		1,146,748		426,624		934,549
III. NET RETURN				-		653,252		293,376		865,451

*1 10% of production cost

Note: SR = Without irrigation, CR = With irrigation

Table D.7.6 Farming Practices and Net Income of Milk Cow Raising

1. FARMING PRACTICES OF MILD COW AND PASTURE

1) Raising of Milk Cow

Raising method: Pasturing

Raising of milk cow is done basically by the pasturing method, and part of pasture is supplied by manual. Milking is carried out in barn, which consists of two times per day.

Live weight:	500 kg/head	Milk yield:	4,000 lt
Calving interval:	18 months	Nursing quantity:	1,000 lt
Lactation period:	10 months	Milk fat percentage:	3.5 %
Labor requirement of milking and raising:		0.1 person/head	

2) Pasture Cultivation

Varieties: Napier grass, guinea grass, etc.

Yield: 100 t/ha

In general, about 120 t/ha is possible under the irrigated condition. but, most pasture land is located at the lands of Class VI and VII which not suitable for cultivation of annual crops and fruits. Anticipated yield will therefore be estimated at 80% of its normal yield.

Fertilizer: N 170kg, P205 85kg, K20 85kg

Replacement interval of pasture: 3-4 years

2. RAISING HEAD PER HECTARE

1) Nutrient Requirement per Head

	Period (day)	Unit Requirement of TDN*1 (kg/day)	Total Requirement of TDN (kg)	Contin-gency (%)	Annual Requirement of TDN (kg)
Basic nutrient	540	4.0	2,160	+10	1,606
Nutrient for milk yield	300	4.1	1,230	+10	915
Nutrient for gestation period	90	2.2	198	+10	147
Total	540		3,588		2,668

*1 TDN : Total Degestible Nutrient

*2 Requirement per calving interval

2) Annual Production of TDN per Hectare

- Annual production of pasture	100,000 kg/ha
- TDN content (Average figure of napier grass and guinea grass)	8.5 %
- Efficiency	80 %
- Production of TDN per ha	6,800 kg/year

3) Raising Head per Ha 2.5 head

3. ANNUAL MILK PRODUCTION

- Gross yield	4,000 x 12 months/18 months x 2.5 head =	6,670 lt/year
- Nursing quantity	1,000 x 12 months/18 months x 2.5 head =	1,670 lt/year
- Net yield		5,000 lt/year

4. GROSS INCOME PER HECTARE

5,000 l/year x S/.250/lt = S/. 1,250,000 /year

5. GROSS OUTGOINGS

- Production cost of pasture	S/.	300,000
- Raising cost		
Permanent labor: 2.5 head x 0.1 persons x S/.480,000 =	S/.	120,000
Miscellaneous and replacement cost	S/.	10,000
Total	S/.	430,000

6. NET INCOME

S/. 820,000

Table D.7.7 Irrigation Benefits (1/3)

	Carrizal-Chone			Amarillos			Guarango		
	Area (ha)	Net Return (S/.1000/ha)	Total (S/.Million)	Area (ha)	Net Return (S/.1000/ha)	Total (S/.Million)	Area (ha)	Net Return (S/.1000/ha)	Total (S/.Million)
LAND USE - WITHOUT PROJECT									
Annual Crops	1,500			250			1,500		
Perenial Crops	1,800			250			0		
Pasture	1,800			500			0		
Natural Vegetation	9,900			0			0		
WITHOUT PROJECT									
Maiz	1,010	53	54	170	53	9	1,010	53	54
Arroz	60	231	14	10	231	2	60	231	14
Melon	20	482	10	0	482	0	20	482	10
Sandia	80	828	66	10	828	8	80	828	66
Pepino dulce	10	82	1	0	82	0	10	82	1
Pimiento	10	409	4	0	409	0	10	409	4
Tomate	20	6	0	0	6	0	20	6	0
Algodon	30	424	13	10	424	4	30	424	13
Manì	20	107	2	0	107	0	20	107	2
Frejol	20	115	2	0	115	0	20	115	2
Haba	10	432	4	0	432	0	10	432	4
Yuca	200	18	4	30	18	1	200	18	4
Cacao	1,430	279	399	200	279	56	0	279	0
Citricos	120	268	32	20	268	5	0	268	0
Platano	120	453	54	20	453	9	0	453	0
Frutales	30	209	6	0	209	0	0	209	0
Higuerilla	70	2	0	10	2	0	0	2	0
Coco	20	692	14	0	692	0	0	692	0
Pastos *1	1,800	83	149	500	83	42	0	83	0
Sub-Total	5,080		828	980		136	1,490		174
WITH PROJECT									
Cultivos	15,000			1,000			1,500		
Pastos	0			0			0		
Maiz	1,480	566	838	100	566	57	150	566	85
Arroz	11,940	825	9,851	800	825	660	1,190	825	982
Melon	180	595	107	10	595	6	20	595	12
Pimiento	420	458	192	20	458	9	40	458	18
Sandia	1,180	758	894	80	758	61	120	758	91
Tomate	40	1,193	48	0	1,193	0	0	1,193	0
Sapallo	360	535	193	20	535	11	40	535	21
Algodon	2,320	750	1,740	150	750	113	230	750	173
Mani	1,160	213	247	80	213	17	120	213	26
Soya	120	236	28	10	236	2	10	236	2
Citricos	2,220	653	1,450	150	653	98	220	653	144
Platano	3,010	1,144	3,443	200	1,144	229	300	1,144	343
Otros Cultivos *2	340	579	197	30	579	17	40	579	23
Pastos	0	820	0	0	820	0	0	820	0
Sub-Total	24,770		19,228	1,650		1,280	2,480		1,920
Benefit			18,400			1,144			1,746
(US$1.0 = S/.1150)	(US$/ha)		(1,067)			(995)			(1,012)

*1 Net return of pasture under without project was estimated as follows, based on the avarage yields in the whole country.

- Production of beef per ha	65 kg x S/.1283/kg	=S/.	83,400 /ha
- Production of mild per ha	140 lt x S/.250/lt	=S/.	35,000 /ha
Gross income		S/.	118,400 /ha
- Production cost (30%)		S/.	35,500 /ha
Net return		S/.	82,900 /ha

*2 Average of Pepino and Cebolla

Table D.7.7 Irrigation Benefits (2/3)

	Rio Chico			Pechiche - Pasaje		
	Area (ha)	Net Return (S/.1000/ha)	Total (S/.Million)	Area (ha)	Net Return (S/.1000/ha)	Total (S/.Million)
LAND USE - WITHOUT PROJECT						
Annual Crops	430			170		
Perenial Crops	430			470		
Pasture	840			210		
Natural Vegetation	0			0		
WITHOUT PROJECT						
Maiz	210	53	11	-	-	-
Arroz	50	231	12	-	-	-
Melon	0	482	0	-	-	-
Sandia	20	828	17	-	-	-
Pepino dulce	0	82	0	-	-	-
Pimiento	0	409	0	-	-	-
Tomate	10	6	0	10	6	0
Algodon	40	424	17	-	-	-
Mani	40	107	4	-	-	-
Frejol	0	115	0	-	-	-
Haba	10	432	4	-	-	-
Yuca	40	18	1	-	-	-
Cacao	150	279	42	60	279	17
Citricos	100	268	27	110	268	29
Platano	70	453	32	40	453	18
Frutales	40	209	8	-	-	-
Higuerilla	60	2	0	-	-	-
Coco	10	692	7	400	692	277
Pastos	840	83	70	270	83	22
Sub-Total	1,690		252	890		363
WITH PROJECT						
Cultivos	1,700			850		
Pastos	0			0		
Maiz	180	566	102	80	566	45
Arroz	1,360	825	1,122	680	825	561
Melon	20	595	12	10	595	6
Pimiento	50	458	23	20	458	9
Sandia	130	758	99	60	758	45
Tomate	0	1,193	0	0	1,193	0
Zapallo	40	535	21	20	535	11
Algodon	260	750	195	130	750	98
Mani	130	213	28	80	213	17
Soya	10	236	2	10	236	2
Citricos	250	653	163	130	653	85
Pl·tano	340	1,144	389	170	1,144	194
Otros Cultivos	40	579	23	20	579	12
Pastos	0	820	0	0	820	0
Sub-Total	2,810		2,179	1,410		1,085
Benefit			1,927			722
(US$ = S/.1150)	(US$/ha)		(986)			(739)

Table D.7.7 Irrigation Benefits (3/3)

	Santa Ana			Mejia			Ceibal - Guayaba		
	Area (ha)	Net Return (S/.1000/ha)	Total (S/.Million)	Area (ha)	Net Return (S/.1000/ha)	Total (S/.Million)	Area (ha)	Net Return (S/.1000/ha)	Total (S/.Million)
LAND USE - WITHOUT PROJECT									
Annual Crops	2,600			990			3,660		
Perenial Crops	150			50			200		
Pasture	550			210			790		
Natural Vegetation	0			0			0		
WITHOUT PROJECT									
Irrigated Field *1									
Maiz	190	368	70	70	368	26	260	368	96
Arroz	380	496	188	150	496	74	540	496	268
Sandia	30	802	24	10	802	8	50	802	40
Tomate	90	1,477	133	40	1,477	59	130	1,477	192
Mani	100	213	21	40	213	9	140	213	30
Otros Cultivos *2	340	291	99	120	291	35	480	291	140
Perennes *3	130	361	47	40	361	14	170	361	61
Pastos *4	490	574	281	190	574	109	700	574	402
Rainfed Field									
Algodon	160	424	68	60	424	25	220	424	93
Maiz	90	53	5	30	53	2	130	53	7
Mani	30	107	3	10	107	1	50	107	5
Otros Cultivos *5	220	175	39	90	175	16	290	175	51
Perenne *6	20	279	6	10	279	3	30	279	8
Pastos	60	83	5	20	83	2	90	83	7
Sub-Total	2,330		989	880		383	3,280		1,400
WITH PROJECT									
Cultivos	3,300			1,250			4,650		
Pastos	0			0			0		
Maiz	330	566	187	120	566	68	460	566	260
Arroz	2,620	825	2,162	1,000	825	825	3,700	825	3,053
Melon	35	595	21	20	595	12	60	595	36
Pimiento	90	458	41	30	458	14	130	458	60
Sandia	260	758	197	100	758	76	360	758	273
Tomate	10	1,193	12	0	1,193	0	10	1,193	12
Zapallo	80	535	43	30	535	16	110	535	59
Algodon	510	750	383	190	750	143	720	750	540
Mani	260	213	55	100	213	21	360	213	77
Soya	30	236	7	10	236	2	40	236	9
Citricos	490	653	320	180	653	118	690	653	451
Platano	660	1,144	755	250	1,144	286	930	1,144	1,064
Otros Cultivos	75	579	43	30	579	17	110	579	64
Pastos	0	820	0	0	820	0	0	820	0
Sub-Total	5,450		4,226	2,060		1,598	7,680		5,958
Benefit			3,237			1,215			4,558
(US$1.0 = S/.1150)	(US$/ha)		(853)			(845)			(852)

*1 Poza Honda irrigation system

*2 Average of haba, frejor, pepino and pimiento

*3 Average of platano and citricos

*4 The data of gross and net incomes is not available. Therefore, net return under without project condition was assumed at 70 % of with project condition.

*5 Average of camote, yuca and pimiento

*6 Cacao

FIGURES

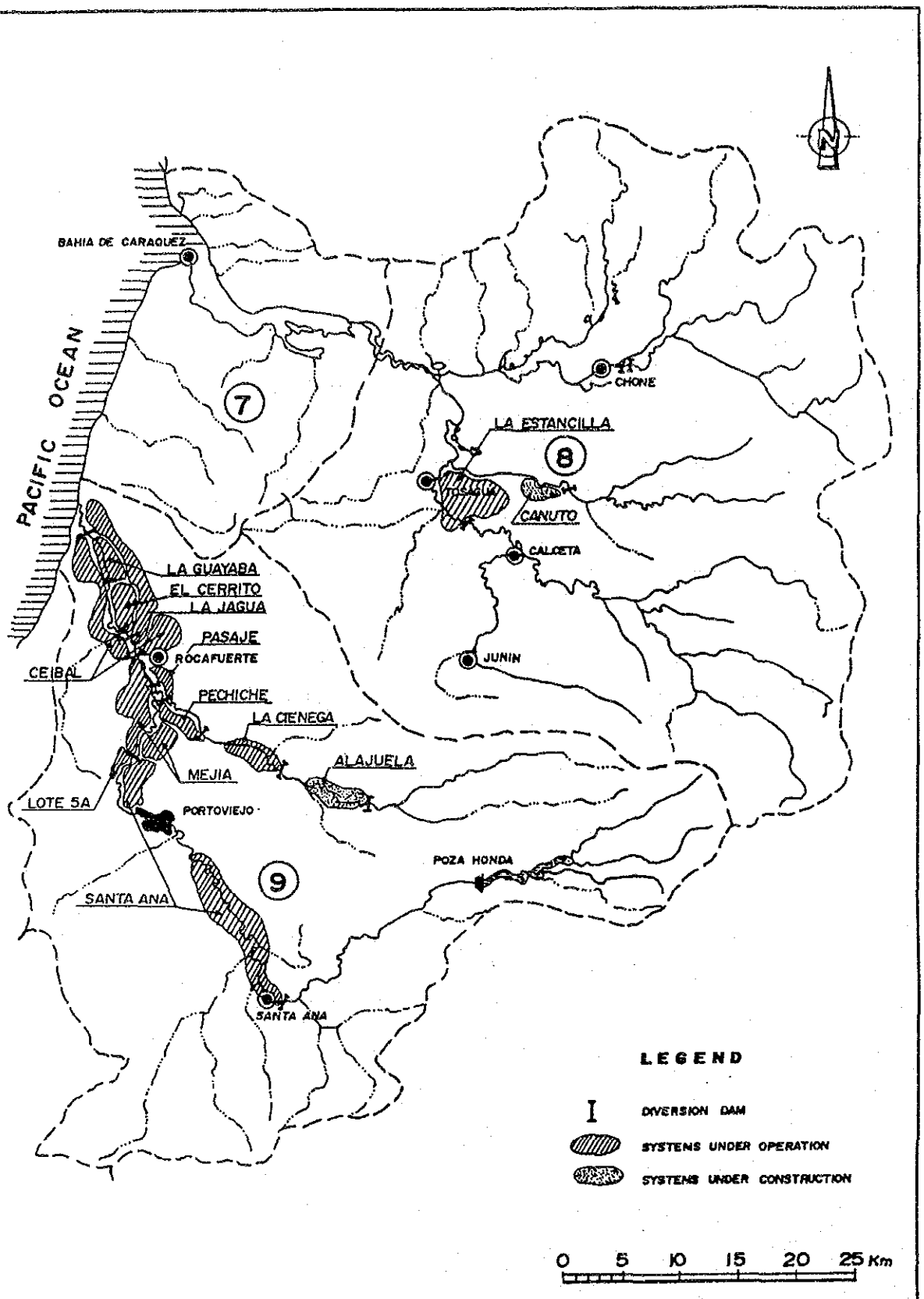
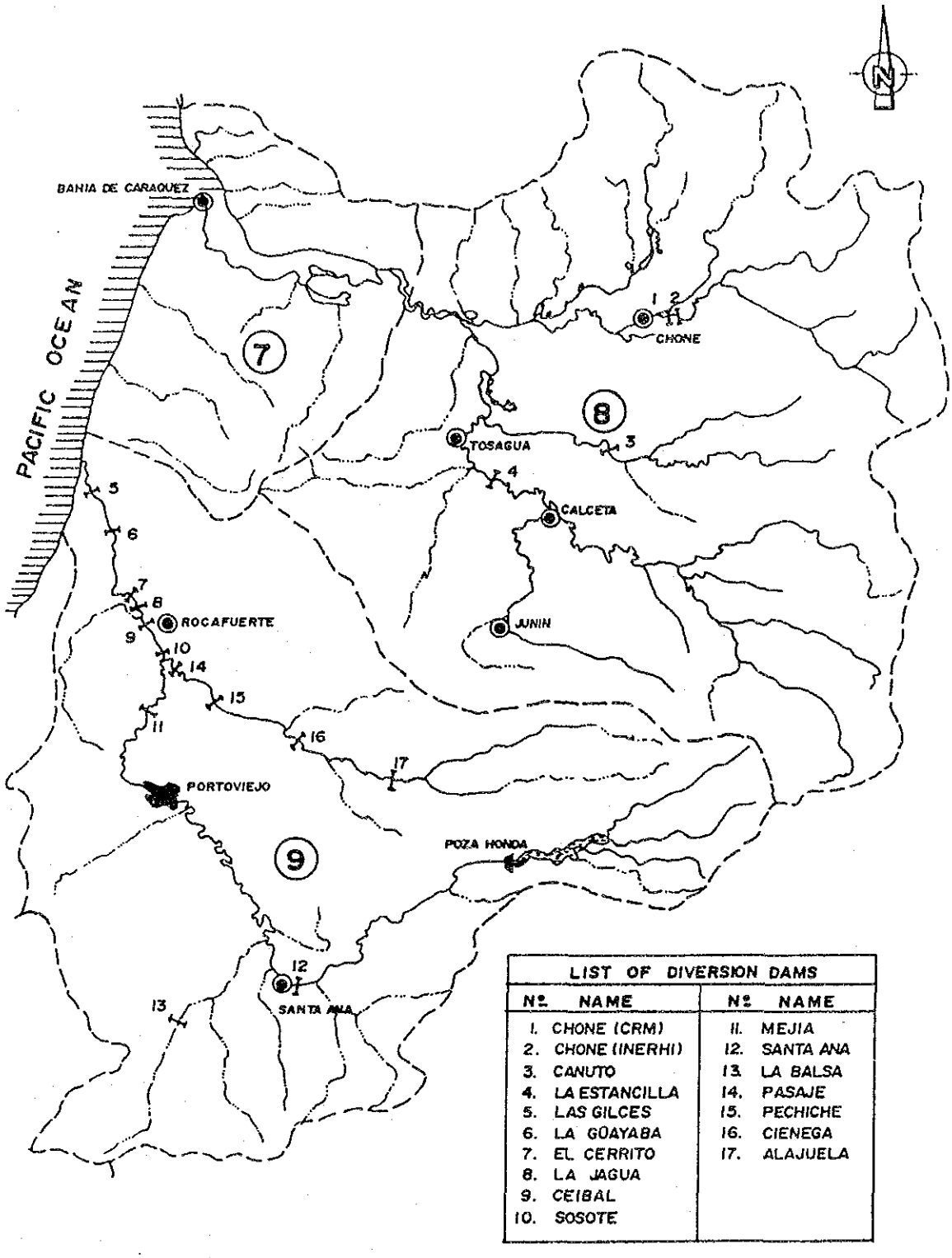


Fig.D.2.1 Location of Existing Irrigation Systems

GOVERNMENT OF THE REPUBLIC OF ECUADOR
CENTRO DE REHABILITACION DE MANABI (CRM)
THE FEASIBILITY STUDY ON THE WATER RESOURCES DEVELOPMENT FOR CHONE-PORTOVIEJO RIVER BASINS
JAPAN INTERNATIONAL COOPERATION AGENCY



LIST OF DIVERSION DAMS			
Nº	NAME	Nº	NAME
1.	CHONE (CRM)	11.	MEJIA
2.	CHONE (INERHI)	12.	SANTA ANA
3.	CANUTO	13.	LA BALSA
4.	LA ESTANCILLA	14.	PASAJE
5.	LAS GILCES	15.	PECHICHE
6.	LA GUAYABA	16.	CIENEGA
7.	EL CERRITO	17.	ALAJUELA
8.	LA JAGUA		
9.	CEIBAL		
10.	SOSOTE		

Fig.D.2.2 Location of Existing Diversion Dams

GOVERNMENT OF THE REPUBLIC OF ECUADOR
CENTRO DE REHABILITACION DE MANABI (CRM)
THE FEASIBILITY STUDY ON THE WATER RESOURCES DEVELOPMENT FOR CHONE-PORTOVIEJO RIVER BASINS
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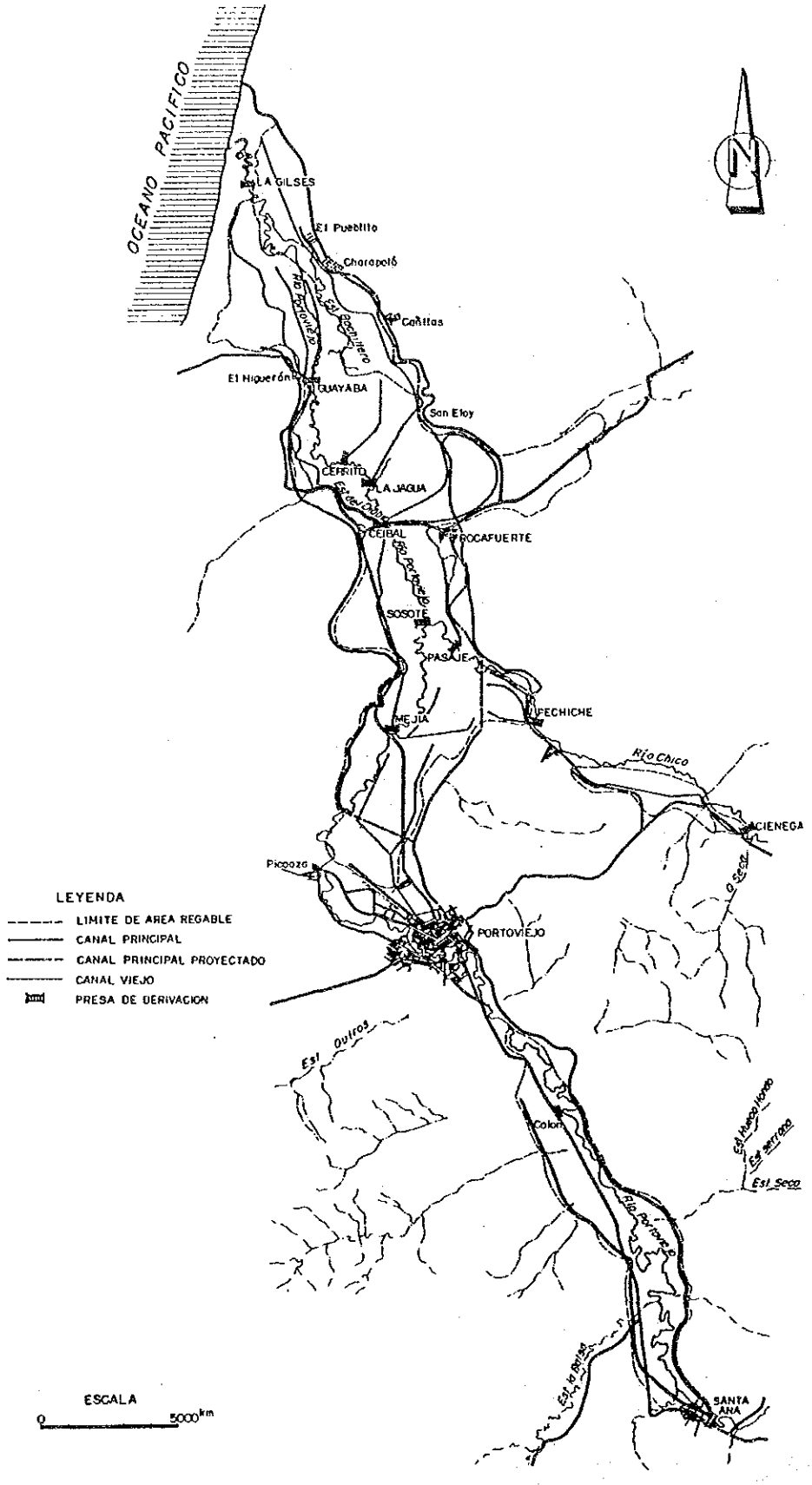

Fig.D.2.3 General Layout of Poza Honda Irrigation System

GOVERNMENT OF THE REPUBLIC OF ECUADOR
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THE FEASIBILITY STUDY ON THE WATER RESOURCES DEVELOPMENT FOR CHONE-PORTOVIEJO RIVER BASINS
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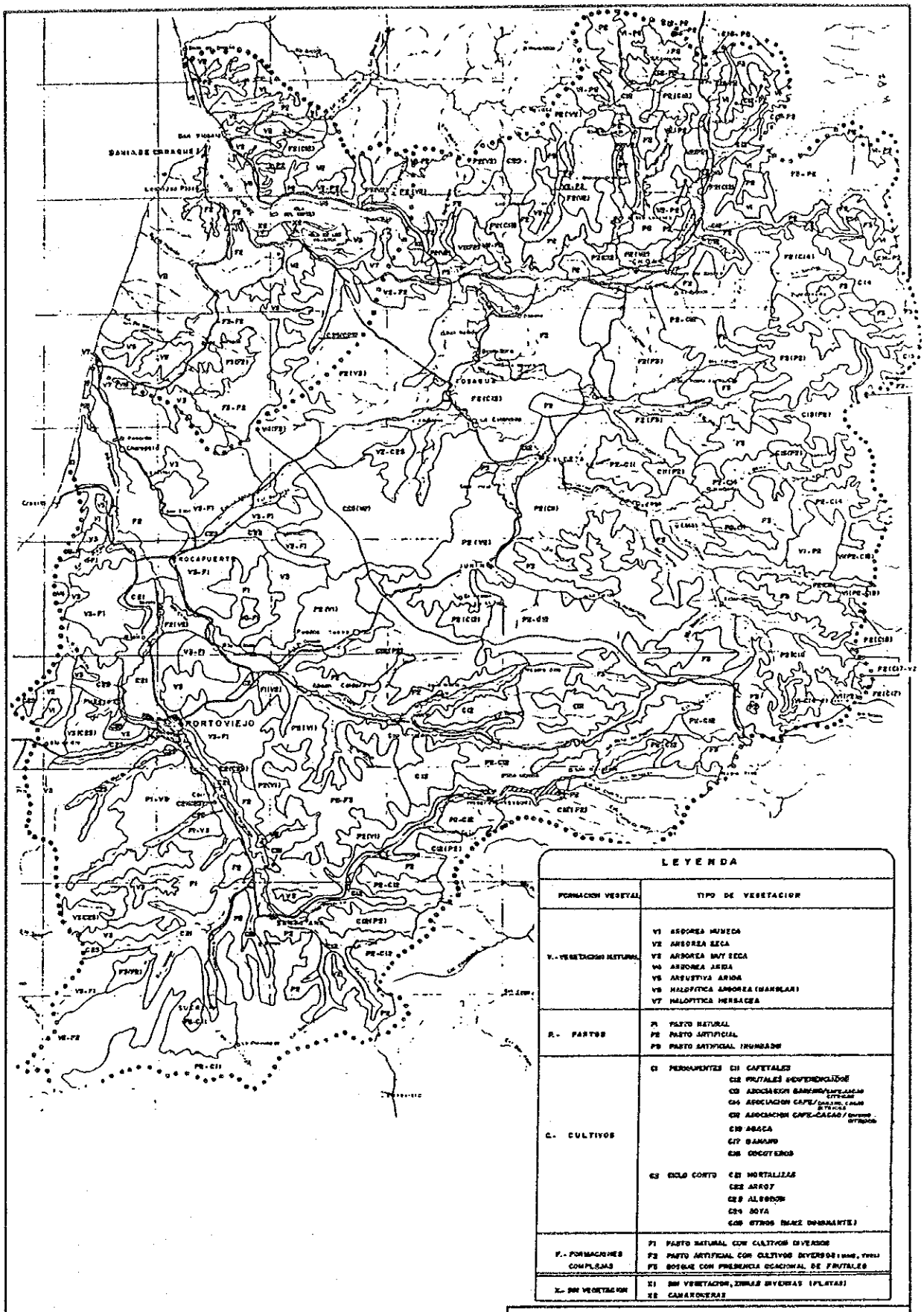


Fig.D.3.1 Land Use Map

GOVERNMENT OF THE REPUBLIC OF ECUADOR
CENTRO DE REHABILITACION DE MANABI (CRM)
THE FEASIBILITY STUDY ON THE WATER RESOURCES DEVELOPMENT FOR CHONE-PORTOVIEJO RIVER BASINS

JAPAN INTERNATIONAL COOPERATION AGENCY

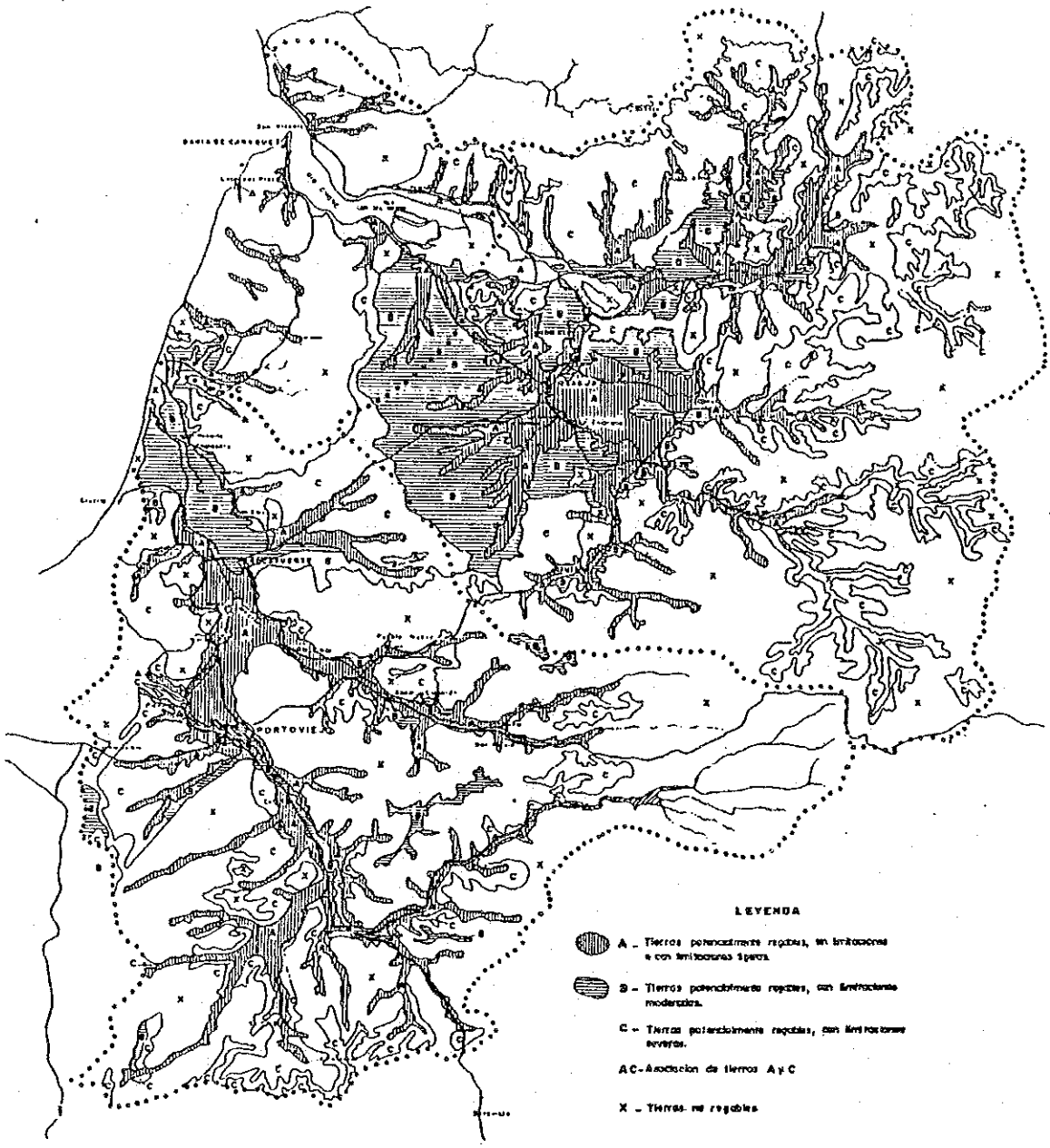


Fig.D.3.2 Land Suitability Map for Irrigation

GOVERNMENT OF THE REPUBLIC OF ECUADOR
CENTRO DE REHABILITACION DE MANABI (CRM)
THE FEASIBILITY STUDY ON THE WATER RESOURCES DEVELOPMENT FOR CHONE-PORTOVIEJO RIVER BASINS
JAPAN INTERNATIONAL COOPERATION AGENCY

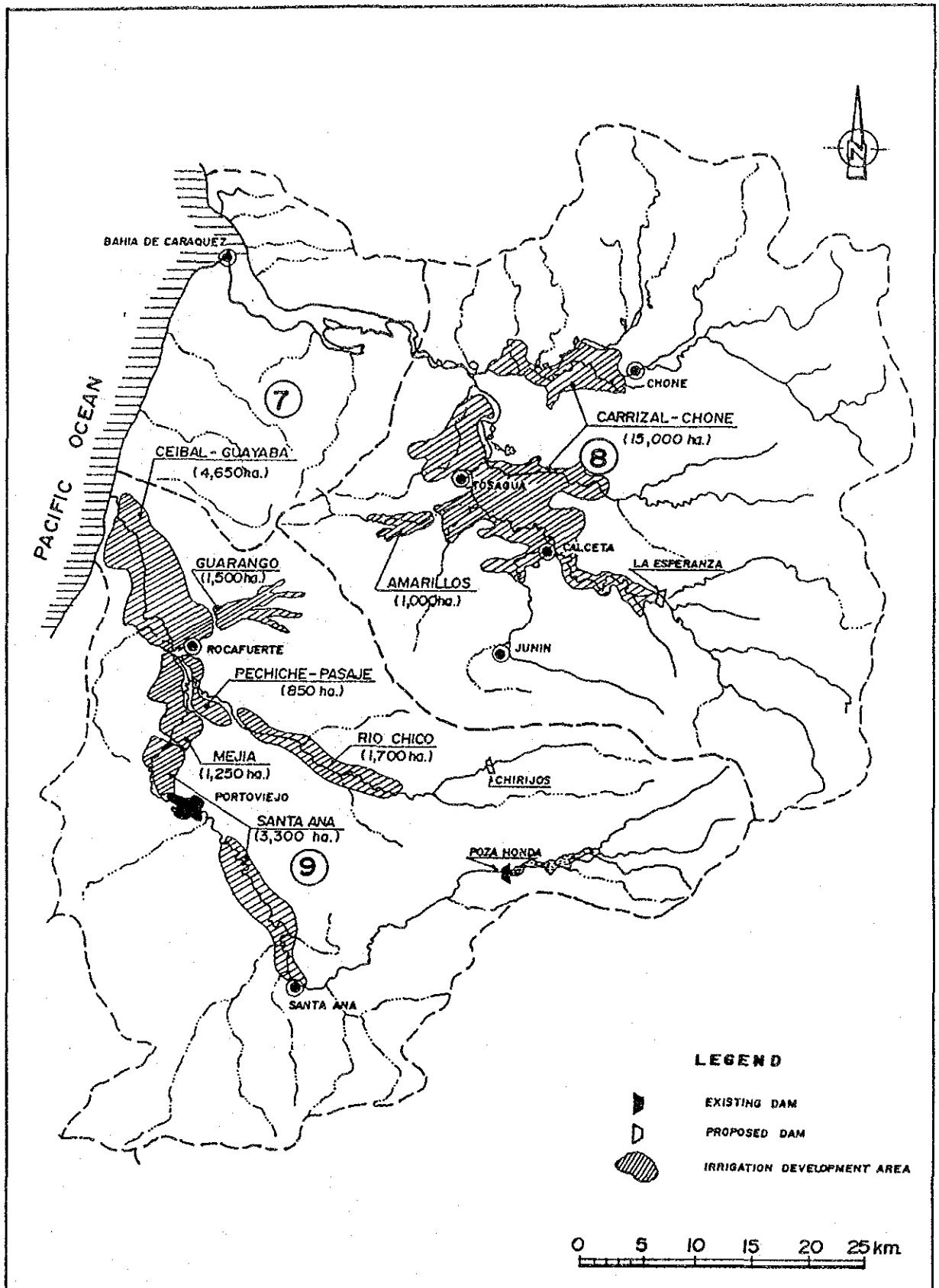


Fig.D.3.3 Location of Irrigation Development Area

GOVERNMENT OF THE REPUBLIC OF ECUADOR
CENTRO DE REHABILITACION DE MANABI (CRM)
THE FEASIBILITY STUDY ON THE WATER RESOURCES DEVELOPMENT FOR CHONE-PORTOVIEJO RIVER BASINS
JAPAN INTERNATIONAL COOPERATION AGENCY

Crops	Days	Carrizal - Chone	Amarillos	Guarango	Río Chico	Pechiche - Pasaje	Santa Ana	Mejía	Ceibal - Guayaba
		(ha.)	(ha.)	(ha.)	(ha.)	(ha.)	(ha.)	(ha.)	(ha.)
Rice	135	5,970	400	595	680	340	1,310	500	1,850
Rice	135	5,970	400	595	680	340	1,310	500	1,850
Maize	120	740	50	75	90	40	165	60	230
Maize	120	740	50	75	90	40	165	60	230
Vegetables	120	740	50	80	80	40	165	60	230
Vegetables	120	1,780	110	180	200	90	385	150	550
Cotton	150	2,320	150	230	260	130	510	190	720
Peanut/Soybean	120	1,280	90	130	140	80	290	110	400
Citrus	365	2,220	150	220	250	130	490	180	690
Platano	365	3,010	200	300	340	170	660	250	930
Total		24,770	1,650	2,480	2,810	1,400	5,450	2,060	7,680

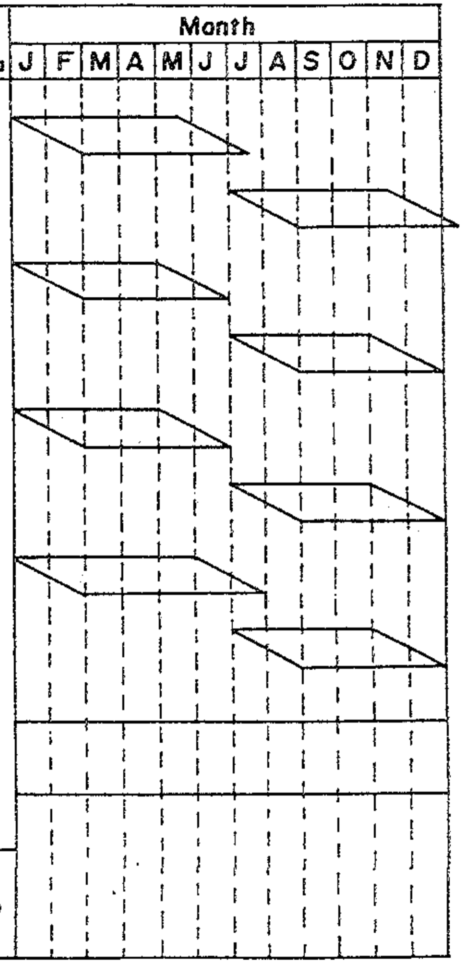
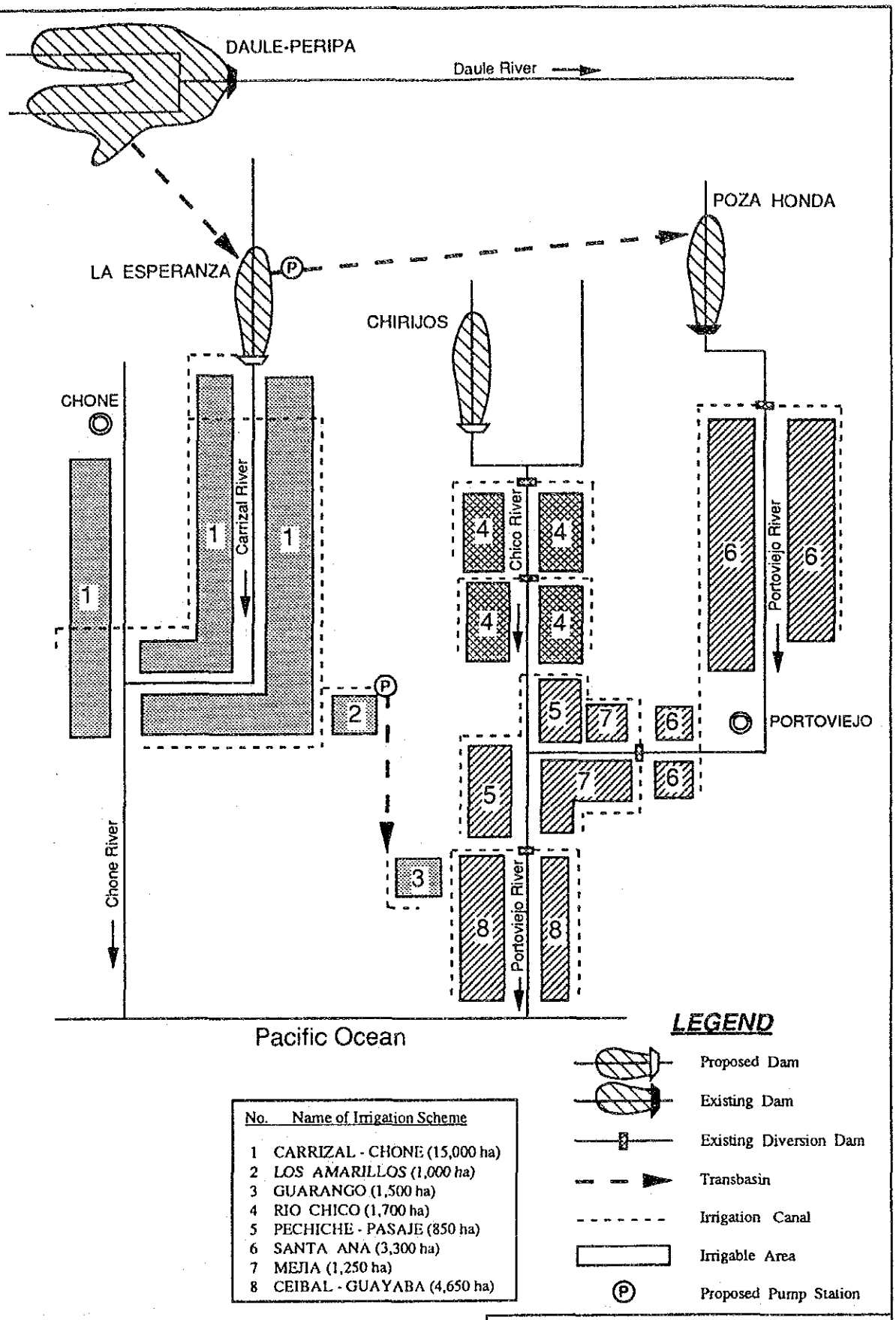


Fig.D.4.1 Proposed Cropping Pattern

GOVERNMENT OF THE REPUBLIC OF ECUADOR
CENTRO DE REHABILITACION DE MANABI (CRM)
THE FEASIBILITY STUDY ON THE WATER RESOURCES DEVELOPMENT FOR CHONE-PORTOVIEJO RIVER BASINS
JAPAN INTERNATIONAL COOPERATION AGENCY



No.	Name of Irrigation Scheme
1	CARRIZAL - CHONE (15,000 ha)
2	LOS AMARILLOS (1,000 ha)
3	GUARANGO (1,500 ha)
4	RIO CHICO (1,700 ha)
5	PECHICHE - PASAJE (850 ha)
6	SANTA ANA (3,300 ha)
7	MEJIA (1,250 ha)
8	CEIBAL - GUAYABA (4,650 ha)

Fig. D.5.1 Irrigation Development Plan (Alternative-1)

GOVERNMENT OF THE REPUBLIC OF ECUADOR
CENTRO DE REHABILITACION DE MANABI (CRM)
THE FEASIBILITY STUDY ON THE WATER RESOURCES DEVELOPMENT FOR CHONE-PORTOVIEJO RIVER BASINS
JAPAN INTERNATIONAL COOPERATION AGENCY

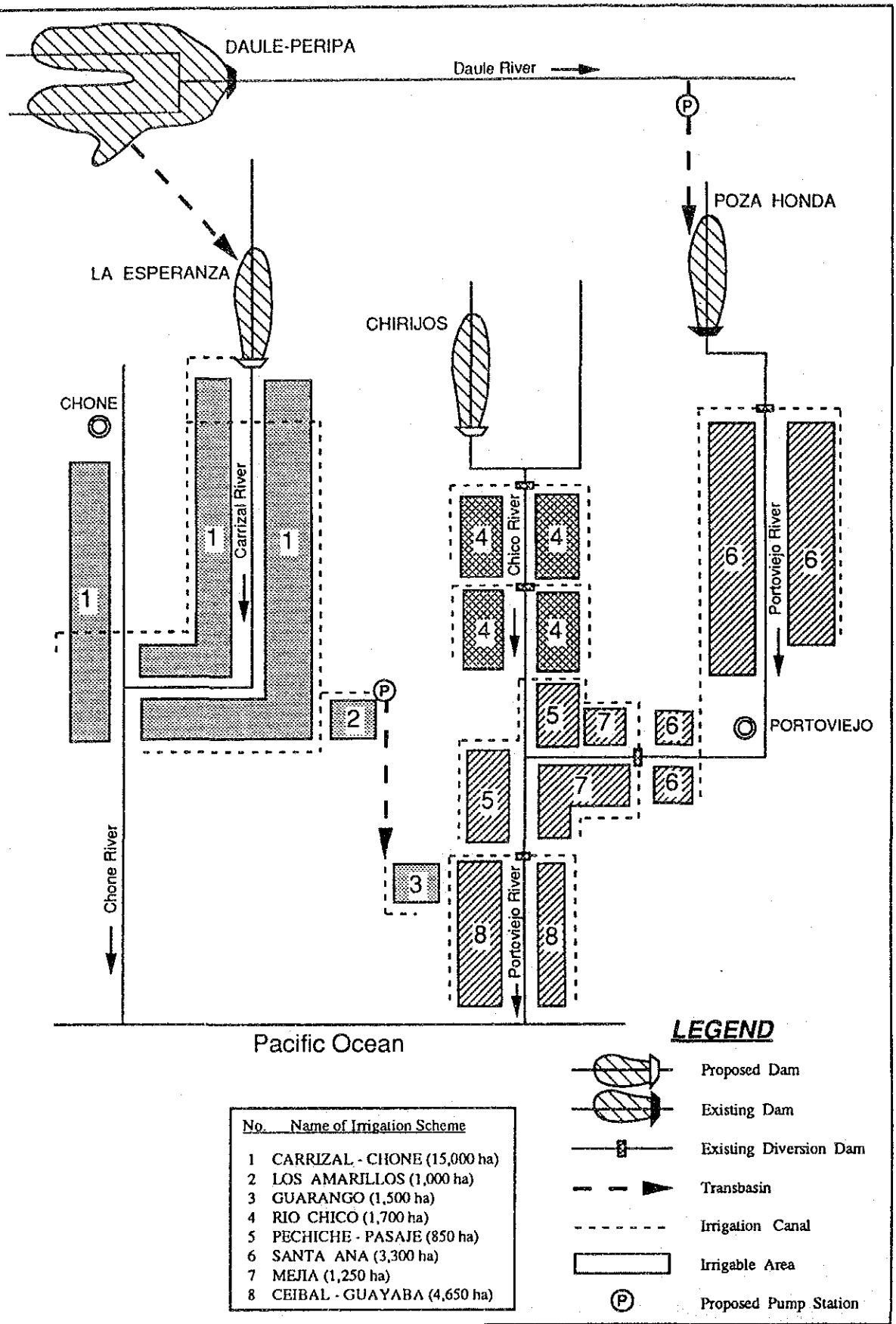
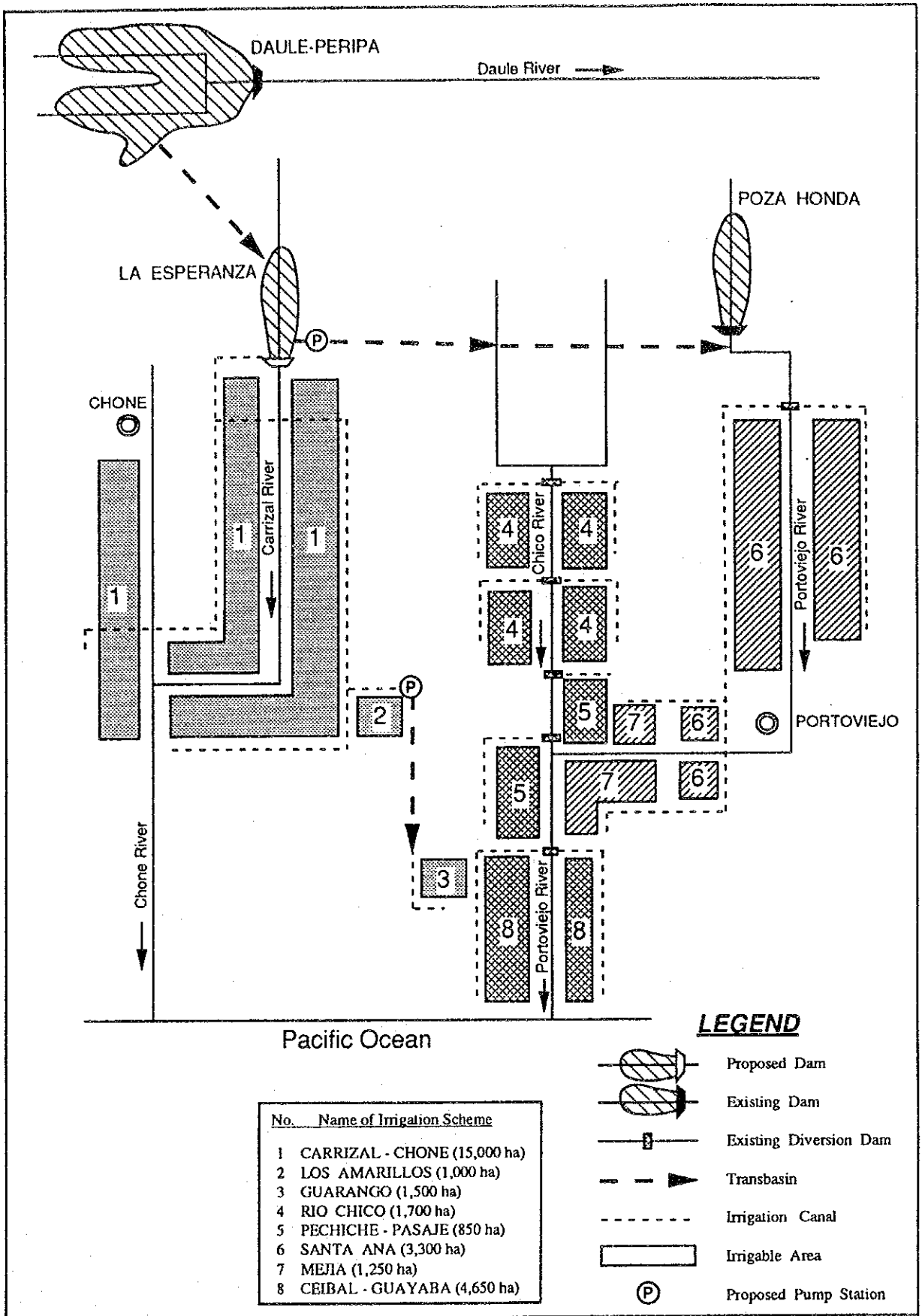


Fig. D.5.2 Irrigation Development Plan (Alternative-2)

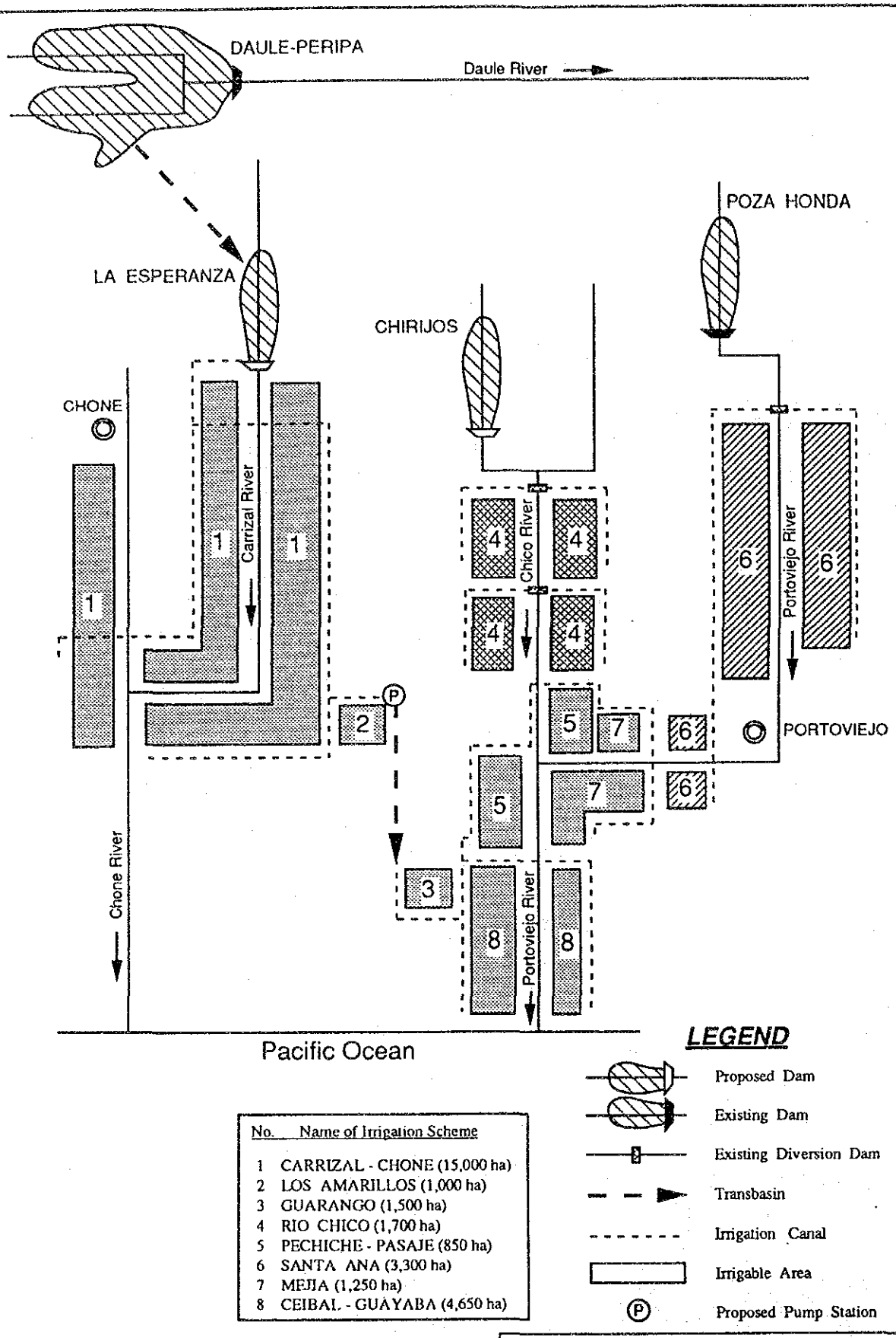
GOVERNMENT OF THE REPUBLIC OF ECUADOR
CENTRO DE REHABILITACION DE MANABI (CRM)
THE FEASIBILITY STUDY ON THE WATER RESOURCES DEVELOPMENT FOR CHONE-PORTOVIEJO RIVER BASINS
JAPAN INTERNATIONAL COOPERATION AGENCY



No.	Name of Irrigation Scheme
1	CARRIZAL - CHONE (15,000 ha)
2	LOS AMARILLOS (1,000 ha)
3	GUARANGO (1,500 ha)
4	RIO CHICO (1,700 ha)
5	PECHICHE - PASAJE (850 ha)
6	SANTA ANA (3,300 ha)
7	MEJIA (1,250 ha)
8	CEIBAL - GUAYABA (4,650 ha)

Fig. D.5.3 Irrigation Development Plan (Alternative-3)

GOVERNMENT OF THE REPUBLIC OF ECUADOR
CENTRO DE REHABILITACION DE MANABI (CRM)
THE FEASIBILITY STUDY ON THE WATER RESOURCES DEVELOPMENT FOR CHONE-PORTOVIEJO RIVER BASINS
JAPAN INTERNATIONAL COOPERATION AGENCY



No.	Name of Irrigation Scheme
1	CARRIZAL - CHONE (15,000 ha)
2	LOS AMARILLOS (1,000 ha)
3	GUARANGO (1,500 ha)
4	RIO CHICO (1,700 ha)
5	PECHICHE - PASAJE (850 ha)
6	SANTA ANA (3,300 ha)
7	MEJIA (1,250 ha)
8	CEIBAL - GUAYABA (4,650 ha)

Fig. D.5.4 Irrigation Development Plan
(Alternative-4)

GOVERNMENT OF THE REPUBLIC OF ECUADOR
CENTRO DE REHABILITACION DE MANABI (CRM)
THE FEASIBILITY STUDY ON THE WATER RESOURCES DEVELOPMENT FOR CHONE-PORTOVIEJO RIVER BASINS

JAPAN INTERNATIONAL COOPERATION AGENCY

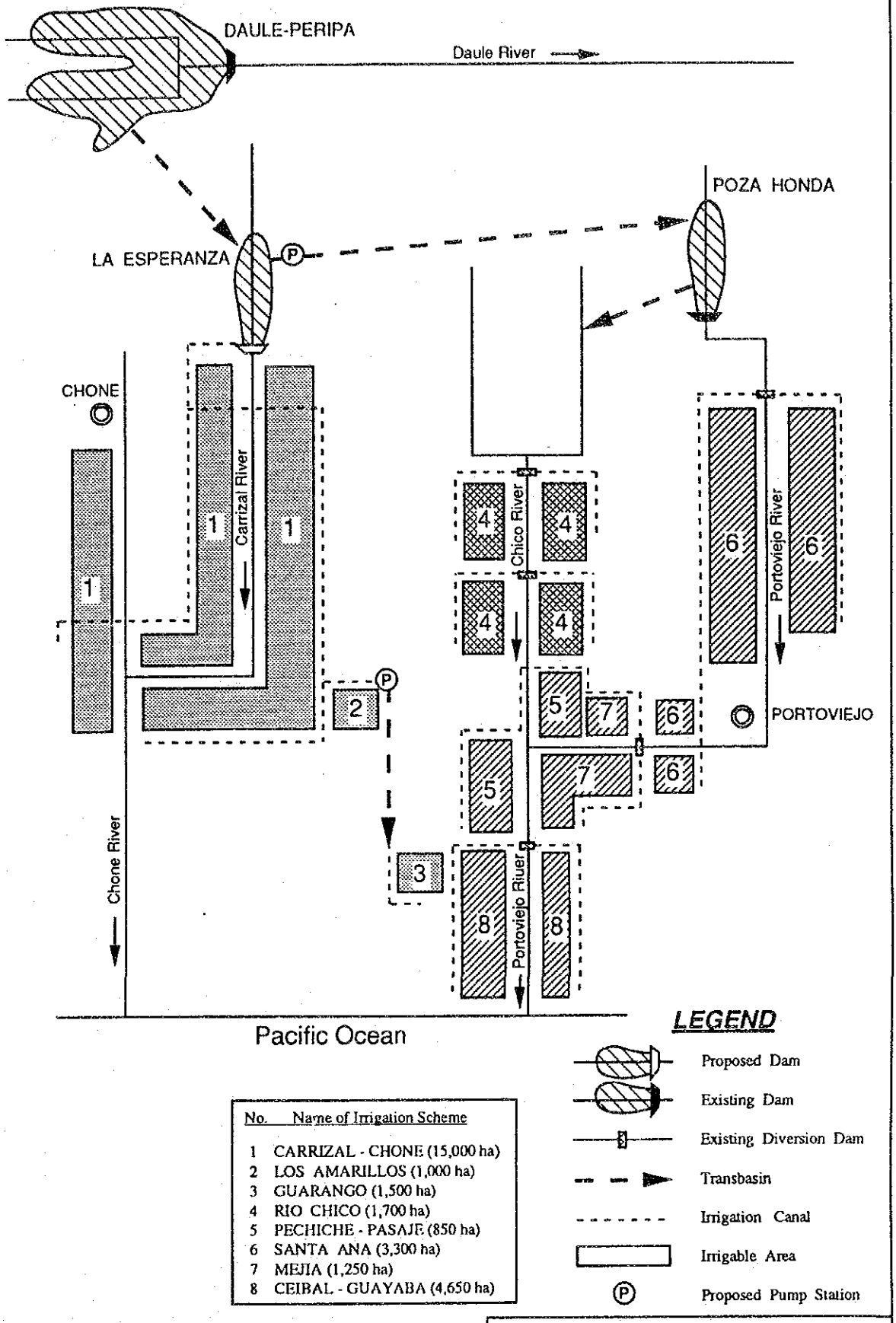


Fig. D.5.5 Irrigation Development Plan (Alternative-5)

GOVERNMENT OF THE REPUBLIC OF ECUADOR
CENTRO DE REHABILITACION DE MANABI (CRM)
THE FEASIBILITY STUDY ON THE WATER RESOURCES DEVELOPMENT FOR CHONE-PORTOVIEJO RIVER BASINS
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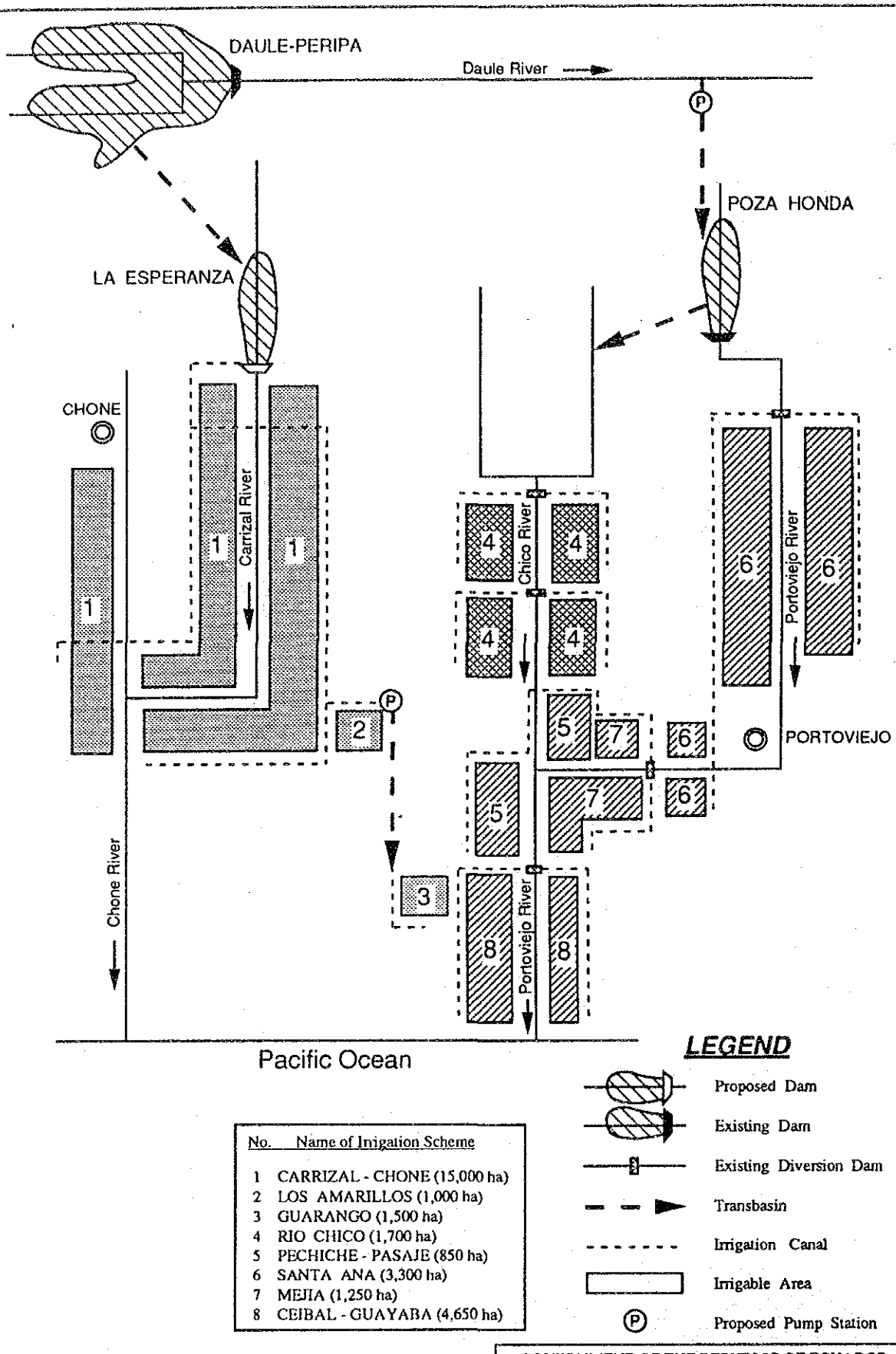
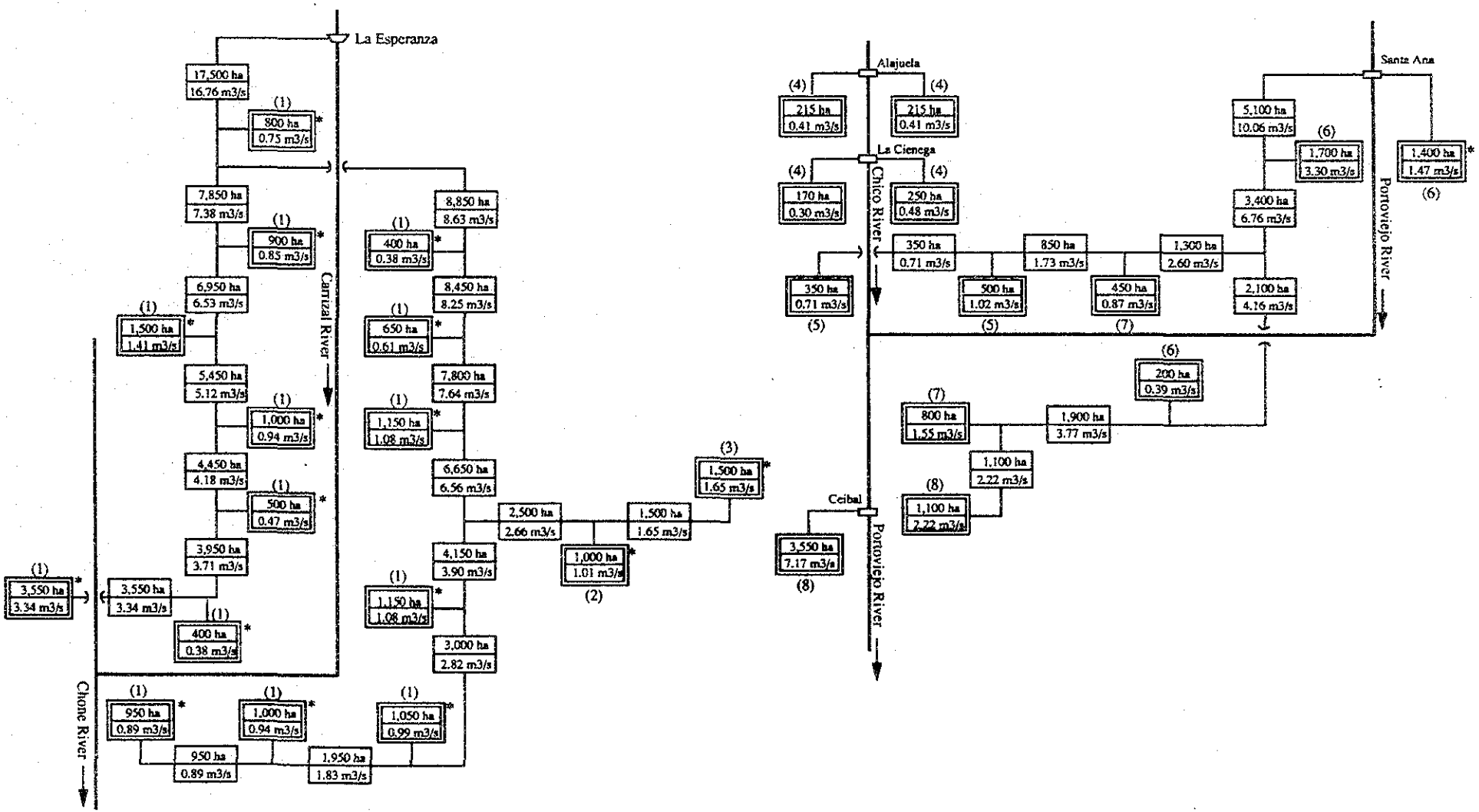


No.	Name of Irrigation Scheme
1	CARRIZAL - CHONE (15,000 ha)
2	LOS AMARILLOS (1,000 ha)
3	GUARANGO (1,500 ha)
4	RIO CHICO (1,700 ha)
5	PECHICHE - PASAJE (850 ha)
6	SANTA ANA (3,300 ha)
7	MEJIA (1,250 ha)
8	CEIBAL - GUAYABA (4,650 ha)

Fig. D.5.6 Irrigation Development Plan (Alternative-6)

GOVERNMENT OF THE REPUBLIC OF ECUADOR
CENTRO DE REHABILITACION DE MANABI (CRM)
THE FEASIBILITY STUDY ON THE WATER RESOURCES DEVELOPMENT FOR CHONE-PORTOVIEJO RIVER BASINS
JAPAN INTERNATIONAL COOPERATION AGENCY



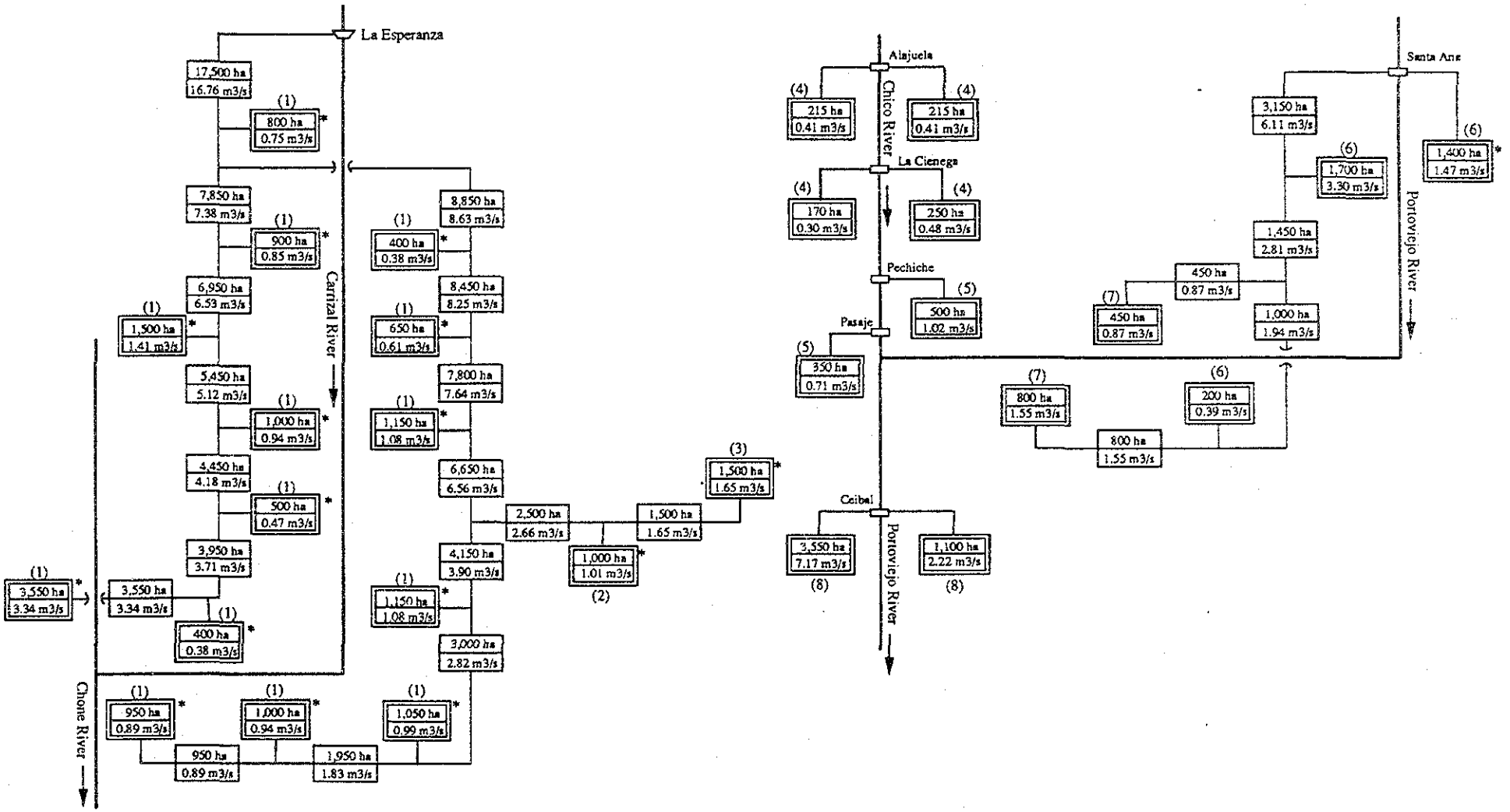
LEGEND

4,150 ha : Irrigable Area
3.90 m3/s : Design Discharge

Note; * 24 hours operation

Fig.D.5.7 Irrigation Diagram (Alternative-1, 2, 5 & 6)

GOVERNMENT OF THE REPUBLIC OF ECUADOR
CENTRO DE REHABILITACION DE MANABI (CRM)
THE FEASIBILITY STUDY ON THE WATER RESOURCES DEVELOPMENT FOR CHONE-PORTOVIEJO RIVER BASINS
JAPAN INTERNATIONAL COOPERATION AGENCY



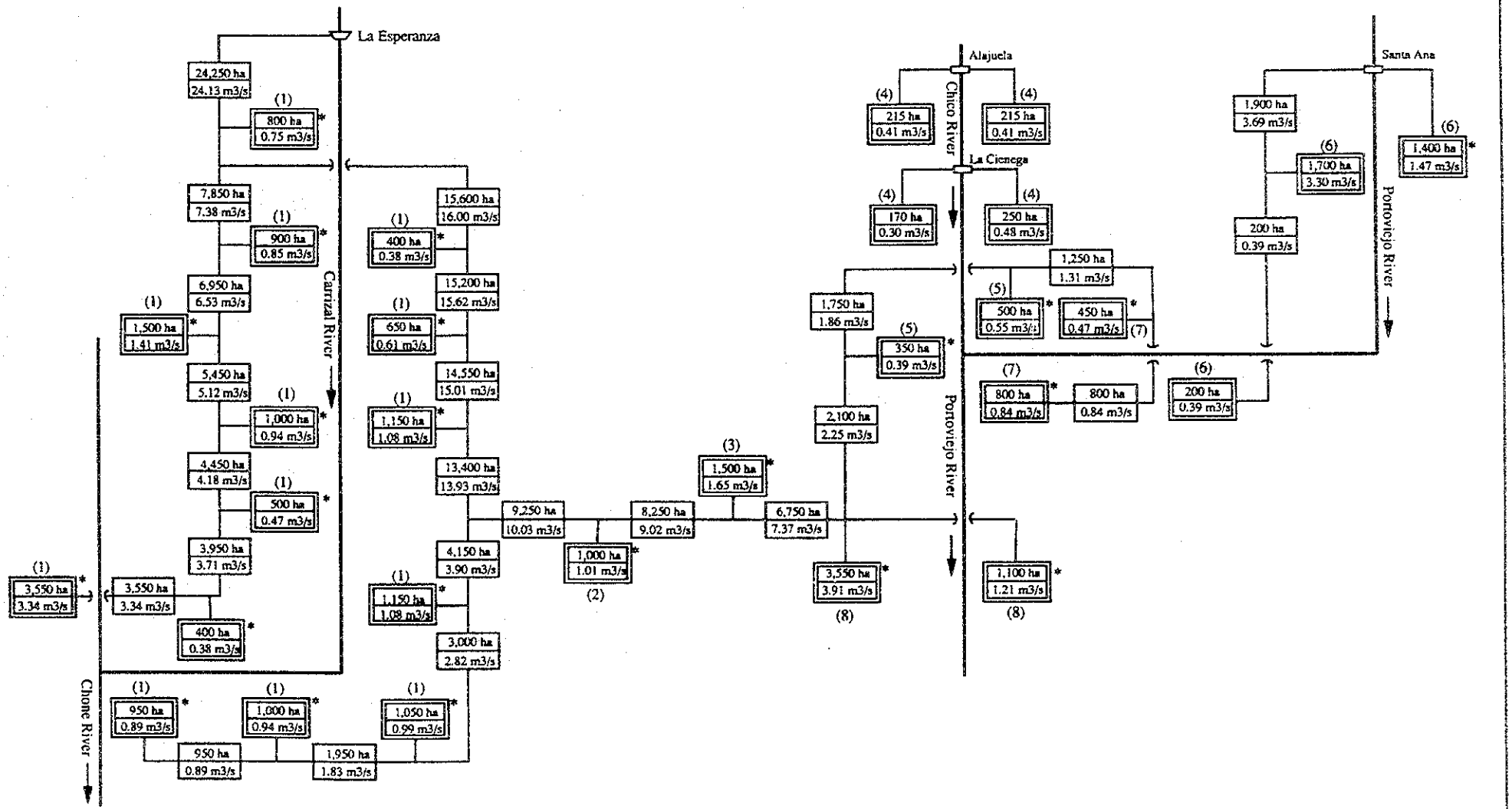
LEGEND

4,150 ha / 3.90 m3/s : Irrigable Area / Design Discharge

Note; * 24 hours operation

Fig.D.5.8 Irrigation Diagram (Alternative-3)

GOVERNMENT OF THE REPUBLIC OF ECUADOR
CENTRO DE REHABILITACION DE MANABI (CRM)
THE FEASIBILITY STUDY ON THE WATER RESOURCES DEVELOPMENT FOR CHONE-PORTOVIEJO RIVER BASINS
JAPAN INTERNATIONAL COOPERATION AGENCY



LEGEND

4,150 ha : Irrigable Area
3.90 m3/s : Design Discharge

Note; * 24 hours operation

Fig.D.5.9 Irrigation Diagram (Alternative-4)

GOVERNMENT OF THE REPUBLIC OF ECUADOR
CENTRO DE REHABILITACION DE MANABI (CRM)
THE FEASIBILITY STUDY ON THE WATER RESOURCES DEVELOPMENT FOR CHONE-PORTOVIEJO RIVER BASINS
JAPAN INTERNATIONAL COOPERATION AGENCY

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ANNEX E AQUACULTURE

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1. INTRODUCTION

Shrimp farming in the western hemisphere (the United States, the Caribbean and Central and South America) accounts for approximately 11 percent of world production, about 61,000 metric tons from approximately 90,000 hectares ponds (Reference 13). Of this total, Ecuador, the leader in the western hemisphere, produces 65 percent and its shrimp farming industry employs two percent of the total labour force. In terms of export earnings, in 1990 shrimp contributed approximately 78 percent of the fisheries sector which contributed about 16 percent of the country's export (Reference 3).

1.1 Shrimp Farming in Ecuador

1.1.1 Brief History of Shrimp Farming in Ecuador

The shrimp culture industry in Ecuador has developed through three phases. In the first phase (1968-1977), it grew slowly at first, mostly by trial and error, with rudimentary extensive culture system. In 1974, an estimated 600 hectares were in production. In the mid-1970s, the industry was concentrated in El Oro Province, and then spread northward to Guayas Province. In the second phase (1978-1987), commercial shrimp fishermen, and non-Ecuadorian were the next group to enter shrimp farming. In the late 1970s, they owned most of the shrimp farms in Ecuador. Foreign biologists and technicians came in and modern productive culture systems and methods were introduced. This phase was characterized by vigorous expansion, and this resulted in an indiscriminate use of land. The production which started with approximately 3,000 hectares in 1977, finished in 1988 with about 120, 000 hectares of shrimp ponds. At this time the industry began the transition from extensive to semi-intensive farming. Approximately 60 percent of the farms used extensive techniques, 35 percent were making transition from extensive to semi-intensive, and 5 percent were full-fledged semi-intensive farms. The current third phase, which started in 1988, is characterized as a test of survival because of lack of the essential inputs, increasing costs, technological barriers and decreasing revenues.

Initially the growth of the shrimp culture industry went rather smooth as the country was blessed with a favorable climate (warm temperatures which permitted year-round grow-out), ample land (salts flats and inter-tidal mangroves), water rich in nutrients and an abundant supply of wild postlarvae and juveniles. In addition, labour was cheap and demand from the world market was firm. However, changes in natural

conditions have clearly demonstrated the vulnerability of the sector; particularly the normal supply of wild post-larvae was interrupted in 1983, 1985 and 1989. In 1984, the growth of Ecuador's shrimp farming industry was slowed by a shortage of wild shrimp larvae, but when the wild larvae returned in August 1986, and coupled with plenty of rain and warm temperature, 1986 and 1987 were good years for Ecuador's shrimps. The industry grew to 1,300 farms and 100, 000 hectares of ponds. The larval shortage triggered a major effort to increase Ecuador's post-larval production from hatcheries.

1.1.2 Species Cultured

The species widely cultured is Penaeus vannamei, a white shrimp with good market acceptance around the world, and this species is one of the important commercial Penaeus shrimps in the Pacific coastal waters from Mexico to Peru, and it is locally called "Camaron blanco". This species accounts for about 90 percent of the production of farmed-raised shrimp in the western hemisphere. Wild stocks of Penaeus vannamei support shrimp farming industries on the Pacific coast of every country from Mexico to Peru. This shrimp has a reputation as a 'tough' animal during grow-out, and it has a low protein requirement. Another species, Penaeus stylirostris (camaron azul) accounts for about six percent of production.

The postlarvae or small juveniles come from two sources; the hatchery or the wild. Ecuador is blessed with an abundant supply of wild larvae particularly in rainy season which lasts approximately five months of the year. Penaeus vannamei is found as far as the inner estuaries, and it is a species with the greatest capacity for migration within the estuary. As rain increases, Penaeus vannamei becomes more abundant and this species is predominant from January to April/May during the rainy season. Hatchery-reared post-larvae are required especially during those months of dry season when the wild fry are in short supply. In 1989 there were 120 registered hatcheries, and only less than 50 percent are in operation (Reference 19).

It is estimated that 20 billion postlarvae a year would be needed by 1995. Currently, it uses 14 billion a year, with approximately 5 billion produced by hatcheries (Reference 17 and 19).

1.1.3 Current Status in Ecuador

Accurate data on the current number and size of shrimp farms in Ecuador are not available. Only the number of hectares authorized for cultivation by the government is known. It is likely that for much of the period through 1980, authorized hectares were considerably less than the actual area used in the shrimp farming. Since 1981, however, it appears that the actual area in farms was less than the authorized hectares (Reference 15). These data do not distinguish between land area of farms and land area in ponds. Also, it is not known how much of the stated area was idle in a given area. Therefore, the data on the number and areas of government concessions for shrimp farming by province over some period should be treated as indicative only, since government authorizations are not an accurate record of the actual amount of land cultivation.

The official statistics says there are 150,489 hectares of authorized ponds (Table E.1); however, during bad periods, like in 1989 and 1990, many ponds are taken out of production. Guayas Province has 71 percent of the authorizations, followed by El Oro with 18 percent, Manabi with 8 percent and Esmeraldas with 3 percent.

In Ecuador, 60 percent of the shrimp farms are between 1 and 50 hectares, 15 percent between 51 and 100 hectares and the rest between 101 and 250 hectares

In 1988, Ecuador produced approximately 45,600 metric tons of cultured shrimps (tails); with an increasing trend from about 818 metric tons in 1977 (Table E.2). In 1989, because of a fry shortage, production dropped to 32,600 metric tons. Ecuador has 1,500 shrimp farms, 75 packing plants, 25 feed mills, 120 hatcheries and 120 export companies. The industry employs 81,000 people, more than 2 percent of the labour force.

1.2 Shrimp Farming in Manabi Province

The shrimp culture practices in Manabi province where the project area is located, are similar to the other provinces. In 1990, there were 12,074 hectares of authorized shrimp farms in this province and this area amounted to approximately 8 percent of the country's total (Table E.1). The shrimp farms are spread over in locations such as Cojimies, Bahia, Jama, Portoviejo of the province. Most of the shrimp farms are concentrated in the estuary of Rio Chone (Bahia de Caraquez) where

about 4,967 ha (41 %) of the province total are located. In 1989, Manabi produced 7,458 tons of shrimps, equivalent to about 9 percent of the country's total (reference 18). In this study the estimated current production of the project area is about 4,061 metric tons (Table E.22) accounting for about 54 percent of the province.

There are about 50 registered hatcheries in Manabi, but there are known to be many un-registered hatcheries operating in the backyards, according to a hatchery operator in Manta who produces 15 million larvae a month.

2. OBJECTIVE

The objective of this study is to examine the present activity of shrimp farms mainly in the Rio Chone estuary and to determine the freshwater requirement for shrimp farming. The study was carried out for about two months including the field survey and interview survey.

3. DATA COLLECTION APPROACH/METHOD

Accurate data on the current number and size of shrimp farms in Ecuador, particularly in the project area are not available. Only the number of hectares authorized for shrimp farming by the government is known. Other data on the salinity, water temperature, etc. are also not available. In order to gather data and information, and to get an insight on the shrimp farming in Ecuador the following approach was adopted.

1) Field visits to Rio Chone estuary and Rio Portoviejo estuary. In the estuary of Rio Chone, where more than 90 percent of the shrimp farms in the project area are located, interview survey was carried out to gather information on culture practices such as stocking density, source of postlarvae and juveniles, water exchange, salinity control, productivity, etc.

2) Discussion with Chairman of Shrimp Farmers Association of Pedernales and Cojimies.

3) Visit to CLIRSEN office in Guayaquil and discussion on the latest map or picture available on the Bahia de Caraquez.

4) Visit to PMRC in Guayaquil and discussion on the coastal resource management, particularly on the mangroves.

5) Visit to Subsecretary of Fisheries Resources in Guayaquil, and discussion on the authorization of lands for shrimp cultivation by the government. Relevant data on the authorization were obtained.

6) Visit to Shrimp Farmers Association and discussion on the production and export of shrimps.

7) Discussion with a private hatchery owner (Exobio S.A) from Japan in Manta, who has more than 10 years experience in larvae production in Ecuador, to get an insight on the current status of larvae production in Manabi province.

8) Discussion with a progressive culturist (Biocultivos Manabitas S.A) from Canada with 160 ha of shrimp ponds in Zone B of Rio Chone estuary

9) Visit to CENAIM (ESPOL) in San Pedro of Manglaralto, shrimp research facilities provided by the government of Japan, to know the current research activities in shrimp.

10) Study and analysis of previous reports on shrimp culture of the project area prepared by PHIMA.

11) Visit to Daule-Peripa Dam and discussion on the status of reservoir fishery.

4. PROJECT AREA

4.1 The Project Area

The project area is in the central Manabi province, covering from Rio Chone in the north to Rio Portoviejo in the south. The Manabi province as a whole is an arid province with very sparse vegetation.

The rainy season is from January to May, and the rainfall varies from less than 500 mm in a year. The dry season is from June to December, and the annual mean

temperatures (from 24.4 to 27°C) vary little, and the evaporation is less than 2000 mm per year.

The two major rivers in the study area are Rio Chone in the north and Rio Portoviejo in the south. The Rio Chone with its main tributary, the Rio Carrizal, has a length about 160 km and drains an area of about 230, 000 hectares. The Rio Chone at the lower reaches with a vast estuary receives run-off from about six dead rivers that flow only during the rainy season into the Rio Chone estuary. The Rio Chone estuary extends to about 30 km from Bahia de Caraquez to the mouth of Rio Chone, and it is the major source of freshwater to the estuary, and the mean discharge is 43 m^3/s.

During the dry season, the river is blocked by a small temporary earth dam (Simbocal dam) located about 30 km upstream (east) of the coastal port of Bahia de Caraquez. Upstream of the dam (freshwater zone), the river has a width of 10-30 meters and is bordered by floating vegetation. Downward of the dam (estuarine zone) the river widens and is bordered by about 4,000 hectares of shrimp farms and fringes of mangrove swamps (Figure E.1).

4.2 The Aquatic Environment

The lower portion of the estuary of Rio Chone is relatively deep, up to 12 meters, decreasing towards upstream to about 4 meters at high tide. There are narrow fringes of mangroves alternating on both sides of the estuary. These mangroves provide favorable habitat for shrimp larvae and juveniles. The tide amplitude is about 3 meters, and the sea water intrusion is as far as 30 km upstream in dry season.

Salinities are influenced by the seasonality of rainfall and run-off. Surface waters on the upstream, freshened by rainfall and run-off from Rio Chone in the rainy season have salinities as low as 0 parts per thousand (ppt.). In dry season surface salinities are equal to or near that of seawater.

The annual range of salinities at high tide for both the estuaries of Rio Chone and Portoviejo are summarized from various source in Table E.3, although there are very few data available on the salinity of estuary. It is known, through interview survey, that the salinity reaches to more than 40 ppt. near the river mouth of Rio Chone in November and December.

These data on temperature, salinity and oxygen obtained from PHIMA report (reference 8) shows slight stratification in the rainy season in April and May from station 3 to station 6 (Table E.4.1). There seemed to be no stratification at stations 1 and 2 in May, and this may have been due to vertical mixing or some error in the measurement (no explanation was given in the report).

4.3 Shrimp Culture Activities/Practices

There are two types of shrimp farmers; one is large company based on large scale with more than 100 hectares of ponds, and another on small scale with 20 - 100 hectares of ponds.

Estimated area of shrimp farms based on CLIRSEN report is listed in Table E.5. Location of farms is shown in Figures E.1 and E.2, where the mangroves are shown are those that were present in the year 1977. Those mangroves are not to be seen at present except for some marginal ones, as the area was converted to shrimp farms.

Semi-extensive and semi-intensive shrimp farming are already underway in the estuaries of Rio Chone and Rio Portoviejo and coastal areas. Shrimp farms come in all shapes and sizes, and a typical layout of a shrimp farm is shown in Figure E.3. Shrimp farmimg is usually conducted above the high tide line, semi-intensive farming uses nursery ponds, carefully laid out grow-out ponds, feeding and pumping. Wild or hatchery-produced juveniles are stocked at high densities in the nursery ponds until large enough to be stocked at lower densities in grow-out ponds, which range from 1 to 50 hectares. The farmers harvest by draining the pond through a net.

The shrimp farms in Project area utilize diesel pumps to supply the ponds with water. Pumping stations are located close to the estuary. The diameter of the pumps varies between 12 and 36 inches, with a discharge capacity ranging from 2000 to 3000 gpm, at a discharge height of 2.0 to 3.5 m. The water goes directly from a pumping station to a reservoir or intake canal (distribution canal) that serves equally well either as a sedimentation pond or as the principal canal supplying the ponds.

Some salient information based on the interview survey is summarized in Table E.7. Water exchanges are daily during high tides and range from 5 percent to 10 percent of the total water volume. A few progressive culturists stocking more than 15 PL/m^2 exchange water at 15 percent to 25 percent. Depending on the elevation of the

pumping station with respect to tide, one may pump 10 to 12 hours a day during the two daily tides. Water depth of shrimp ponds is about 70 cm; stocking density varies from 7 PL/m^2 to 10 PL/m^2.

Shrimp culture is carried throughout the year because of the perennial supply or availability of postlarvae from the wild and hatcheries. However, not all the area of the farms are under cultivation. Shrimp farming is less extensive in the dry season than in the rainy season because of high salinity (more than 30 ppt.).

The average growing period is about three to four months, and it is not difficult to harvest two crops a year. The procured postlarvae are usually stocked in a nursery ponds for about three to four weeks before stocking in grow-out ponds. Based on the interview, the present productivity ranges from 425 to 900 kg/ha/crop. Each crop cycle is 3.5 to 4 months, therefore the number of crops a year is 2 to 2.5. The average productivity per crop is estimated to be 663 kg, and the average productivity a year in the project area is 1,656 kg. The size of shrimp varies from 16 to 18 grams.

Salinity at the water intake ranges as minimum 5 ppt. or less in the upstream in rainy season to maximum 40 ppt. in dry season. Since even in dry season, average salinity of 35 ppt. is observed, the shrimp farmers did not show any concern or desire for salinity control, and this may be due to non-availability of any freshwater source.

Under the present condition of salinity more than 30 ppt, the monthly average growth rate of a shrimp (cultivated for about four months to an average size of 18 g) is estimated at 4.5 g (1.13 g/week). In the optimum range of 15 ppt. to 25 ppt. the growth rate is known to increase to more than 1.5 g per week. Based on discussion with a non-Ecuadorian progressive culturist who keeps weekly record of essential data and information, growth curve of Penaeus vannamei was computed and is shown in Figure E.4. According to him the optimum range of salinity for good growth is from 15 to 25 ppt. (Approximately 3.0 g/week during the earlier phase of growth at optimum range, and with salinity above 30 ppt. the growth rate is on an average 1.3 g/week.). Therefore, under condition of lower salinity, the number of crops in a year can be increased from the present two crops to 3.5 crops with planned grow-out schedule. (The shrimp size required in the American and European market for the Ecuadorian shrimp ranges from 16 to 18 g with head-on.)

5. ESTIMATION OF WATER REQUIREMENT

5.1 Basic Consideration

The basic consideration is to examine and determine the requirement of freshwater for shrimp farming in dry season for areas under cultivation to increase the production through 3.5 crops a year instead of two crops practiced currently.

5.2 Shrimp Farm Under Cultivation and Future Expansion

The Rio Chone estuary is the major area for shrimp farms in the project area, and it has about 41 percent of the shrimp farms in the Manabi Province. As indicated earlier, accurate data on the current number and area of shrimp farms are not available for the project area. Therefore, the area of shrimp farms was extracted from PMRC report (Reference 1) and summarized in Table E.5. The major areas with shrimp farms are Bahia de Caraquez, Salinas de Bahia, Estero Ebano and San Antonio in Rio Chone estuary. There were 4,120 hectares and 4,827 hectares in 1984 and 1987, respectively, in the Rio Chone estuary; and an increase of 707 hectares in three years was noticed (Table E.5). In Las Gilces of Rio Portoviejo estuary, there were 103 hectares and 130 hectares in 1984 and 1987 respectively, and the increase was only 27 hectares because this area has not much mangroves or land for expansion. In Rio Chone estuary, between 1987 and 1990, there was an increase of about 140 hectares of shrimp farms, according to information provided by CLIRSEN to the JICA study team (October 23/24). Therefore, the current area of shrimp farms is estimated to 4,967 hectares in Rio Chone estuary. It also means that in the same period, about 140 hectares of mangroves were converted to shrimp farms.

In this study, the shrimp farms in the Rio Chone estuary are zoned based on the seasonal salinity distribution of the estuary (Table E.3) as shown in Table E.6; 990 hectares in Zone A and 3,977 hectares in Zone B.

The estimation of future expansion of shrimp farms is based on the area of existing mangroves. Expansion is expected only in Zone B of Rio Chone estuary, as the mangroves in the Zone A have been almost destroyed. There are estimated to be about 900 hectares as indicated in Table E.5. If there is no pressure to conserve or ban the destruction of mangroves, it is estimated that by the year 1995, about 180 hectares, and by the year 2000, another 270 hectares of mangroves to be converted to shrimp farms. Based on this assumption, the total estimated area of shrimp farms is 5,277

hectares in 1995 and 5,547 hectares in 2000 and thereafter (Table E.14). However, according to personal communication with some large-scale shrimp farm owners in the area, they do not expect any more expansion because of the increasing costs of essential inputs, decreasing revenues and instability of the shrimp market of which they are already experiencing.

5.3 Estimation of Freshwater Requirement

Daily water exchange varies depending on the tide, water condition in shrimp ponds and stocking density. Daily water exchange rate is one of the important factor to increase production. Based on the interview survey, the shrimp farms in Rio Chone and Rio Portoviejo estuaries pump seawater two times a day based on two high tides; at each high tide the operation varies from five to six hours and it amounts to 10 to 12 hours of pumping daily. The water exchange rate varies from 5 to 10 percent of the pond water volume, and in some cases to 15 (stocking density: 8 PL/m^2) and also to 25 percent (stocking density: 12 PL/m^2). (PL = Postlarvae)

In this study the freshwater requirement is estimated on a monthly basis considering the water loss through seepage and evaporation, and water added through precipitation, and water exchange rate of 10 percent.

The salinity in the estuary varies depending on the location and season. The salinity range summarized from various sources for the two zones in Rio Chone estuary and Rio Portoviejo estuary, and the estimated average salinity during the dry season is shown in Table E.3.

The freshwater required to control salinity to optimum level is based on the following condition.

- The target species, Penaeus vannamei can grow in a wide range of salinity as 5 to 40 ppt, but for good growth rate the optimum salinity range is 15 to 25 ppt.

- The salinity in most of the shrimp ponds is known to increase to more than 40 ppt. due to evaporation based on interview survey. Currently, salinity control by dilution with freshwater is not considered because there is no freshwater source such as deep well or perennial rivers.

- The average salinity ranges from 23 to 25 ppt. in Zone A (January to June - rainy season), 5 to 25 ppt in Zone B (January to September - rainy and dry season) of Rio Chone estuary, and 25-26 ppt. in Rio Portoviejo estuary (January to June - rainy season) (Table E.3).

- The freshwater requirement is considered from July to December for both Rio Portoviejo estuary and Zone A of Rio Chone estuary, where the salinity is above 30 ppt., and from October to December in Zone B, where the salinity is above 35 ppt., of Rio Chone estuary.

5.3.1 Water Requirement for Maintenance of Shrimp Pond

The water volumes required for maintenance in one hectare of shrimp pond by month in the areas of Rio Chone and Rio Portoviejo estuaries considering the seepage, evaporation and precipitation are summarized in Tables E.8 and E.9. Monthly intake volumes for one hectare shrimp pond considering the maintenance water volume and water exchange rate (pond water depth is 70 cm and water exchange rate is 10 percent daily) are shown in Tables E.10 and E.11. The monthly water intake ranges from about 22,290 to 22,710 m^3/ha for both the Rio Chone and Portoviejo.

5.3.2 Freshwater Requirement at Different Salinity Level

The freshwater required to reduce the high salinity at water intake for farms at different levels of salinity in the optimum range of 15 to 25 ppt. in the project area is shown in Tables E.12, E.13 and E.14. The salinities considered at water intakes are on average 34 ppt. from August to December in Zone A, 38 ppt. from October to December in Zone B, and 33 ppt. in Rio Portoviejo estuary.

Monthly freshwater water required for shrimp farms (grow-out pond ratio is 80 percent) to control the salinity at different points in the optimum range; i.e. maximum requirement (15 ppt.), medium requirement (20 ppt.) and minimum requirement (25 ppt.) in dry season is summarized in Tables E.15, E.16 and E.17. The annual requirements in the project area are as follows:

Unit: MCM

	Annual Freshwater Requirement		
	Maximum	Medium	Minimum
At salinity (ppt.)	15	20	25
Rio Chone			
Zone A	138.28	76.27	39.23
Zone B	334.62	196.85	113.72
Rio Portoviejo			
Las Gilces	17.31	9.40	4.61
Total	491.21	282.52	157.56

The annual minimum requirements of freshwater for Zone A and Zone B of Rio Chone are estimated to be about 39 MCM and 114 MCM, respectively, and 5 MCM for Las Gilces in Rio Portoviejo, at optimum salinity of 25 ppt. amounting to 158 MCM in total. The annual maximum requirements are 138 MCM (Zone A) and 335 MCM (Zone B) of Rio Chone, and 17 MCM (Las Gilces), which amount to 491 MCM, at optimum point of 15 ppt. At the medium requirement, the annual total requirement is 282 MCM. Approximately 97 percent of the freshwater requirement is in Rio Chone estuary.

The future requirement of freshwater at three levels of salinity is estimated for Zone B of Rio Chone (Table E.18, E.19 and E.20). The possibility of expansion of shrimp farms is considered only for Zone B, as there are approximately 900 hectares of mangrove swamps (para 5.2). The future requirement considering the expansion of shrimp farms is summarized below.

Unit: MCM

	Annual Freshwater Requirement		
	Maximum	Medium	Minimum
At salinity (ppt.)	15	20	25
1995			
Without expansion	491.21	282.52	157.56
With expansion			
Zone B (180 ha)	15.15	8.91	5.15
Total	506.29	291.43	162.70

Unit: MCM

	Annual Freshwater Requirement		
	Maximum	Medium	Minimum
At salinity (ppt.)	15	20	25
2000 & thereafter			
With expansion			
Zone B (270 ha)	22.72	13.37	7.72
Total	529.01	304.80	170.42

The annual freshwater requirements in the optimum range for the 180 hectares of shrimp farms in 1995 are approximately 5 MCM at the minimum and 15 MCM at maximum levels. In the year 2000, with the expansion of another 270 hectares of shrimp farms, the freshwater required is about 8 MCM and 23 MCM at both levels. The total annual requirements of freshwater are 163 MCM and 171 MCM in 1995 and 2000 and thereafter, respectively, at the 25 ppt. (minimum level), and 506 MCM in 1995 and 529 MCM in 2000 and thereafter at 15 ppt (maximum level).

5.3.3 Freshwater Requirement Based on Effective Use of Shrimp Pond

The estimated freshwater requirement may be even less based on the effective use of the shrimp ponds. The effective use considered is about 60 percent (i.e. 60% of the shrimp ponds are put to shrimp cultivation) based on declining shrimp prices, high domestic inflation and interest rates, rising labour, fuel and feed costs. As indicated by some shrimp producers, they are already diversifying from shrimp farming.

The estimated freshwater requirement with 60 percent use of the shrimp ponds is shown below.

Unit: MCM/year

Freshwater	Without Expansion	---------- With Expansion ----------			
Requirement	1995-2020	1995	2000	2010	2020
Minimum	94.8	97.8	102.6	102.6	102.6
Medium	169.8	174.6	190.8	190.8	190.8
Maximum	294.6	303.6	317.4	317.4	317.4

For the shrimp farms in this project the annual minimum freshwater requirements, i.e. approximately 95 MCM (without expansion) in 1995-2020, and

with expansion 98 MCM in 1995 and 103 MCM in 2000-2020, are judged to be appropriate for the following reasons.

1) Water allocated for shrimp farms is about 100 MCM a year.

2) Water is scare in Manabi province and provision of water at higher level is not recommended for the reason that it is difficult to judge the effective use of the freshwater discharged in to the estuary.

3) Even at salinity control at 25 ppt. the growth is around 3.0 g per week during the initial phase of stocking, and thereafter it decreases and stabilizes (personal communication with owner of 160-ha shrimp farms and keeps detail records of water quality and production). The growing period can be reduced to three months, and also shrimps are grown to a small size in the range of 16-18 g per shrimp (Fig. E.4).

4) If water is required at medium or maximum level by some progressive shrimp farmers, the natural flow can compensate for the deficit.

5) Most of the shrimp ponds are in the semi-extensive (60%) and the increase in productivity is considered to be minimal under the maximum or medium level of water requirement.

5.4 Production with/without Project

The productivity of the shrimp ponds varies by farms due to location of farms and farming techniques. The average productivity is computed based on information obtained through interview survey in this study (Table E.7). In this study, the productivity of 830 kg/ha/crop is applied.

Production with and without project is estimated and shown in Table E.15. The estimated annual production of one hectare shrimp pond is 1,660 kg with two crops without the project; but with the project, it is estimated to be 2,905 kg with 3.5 crops with an increase of 1,245 kg (43 %).

Increase in shrimp production of farms in the project area is shown in Table E.16, and a summary is as follows.

	Without Expansion	With Expansion			
	1995-2000	1995	2000	2010	2020
Total area(ha)	5,097	5,277	5,547	5,547	5,547
(Effective area)	(2,447)	(2,533)	(2,663)	(2,663)	(2,663)
Net Production (ton/year)					
Without project	4,061	4,205	4,420	4,420	4,420
With project	7,107	7,357	7,734	7,734	7,734
Net Increase	3,046	3,152	3,314	3,314	3,314
Annual Freshwater Required					
Total (MCM)	94.80	97.80	102.60	102.60	102.60
For 1 ha. of pond (m^3)	38,741	38,610	38,528	38,528	38,528
For 1 kg increase of production (m^3)	31	31	31	31	31

The increase in annual net production in 1995 without expansion of shrimp farm is 3,046 tons with approximately 95 MCM of freshwater, and with expansion, that is if 180 hectares of shrimp farms are available, it is 3,152 tons (water required is 98 MCM); with an increase of 107 tons, from Zone B of Rio Chone. In the year 2000 and thereafter the increase in net production is 3,314 tons; an increase of 159 tons, mainly from the expansion of 270 hectares shrimp farms, and the freshwater required is about 103 MCM.

Therefore, annually for one hectare of shrimp pond, approximately 38,626 m^3 of freshwater is required, and for one kilogram of shrimp produced, about 31 m^3 of freshwater is required. At current water price of three cents per one cubic meter, the water charge for one kilogram of shrimp amounts to US$0.93.

The annual net production in terms of value is summarized in Table E.23. An average farmgate price, computed from interview survey, is about US$4.40/kg of shrimp (head-on); in which the production cost varies from 40 to 50 percent that includes cost of postlarvae, feed, fuel, fertilizer and labour. In the 1995-2000 without expansion; with the increase in production of 3,046 tons of shrimps, a profit of US$3.86 million is expected for the producers, i.e. 30 percent increase with the project. With the expansion, in the year 1995 and 2000, approximately US$4 million is expected. Approximately 30 percent increase in profit can be expected with the

project, i.e. with the use of approximately 100 MCM of freshwater annually. The average cost of freshwater and the profit for one hectare of shrimp pond vary very little over the years. The annual average cost of freshwater for one hectare of shrimp pond is US$1,150, and the annual average profit for one hectare of shrimp pond is US$1,577.

6. CONCLUSION

In the project area, the Bahia estuary of Rio Chone has a great potential for shrimp farming, whereas the Las Gilces in the Rio Portoviejo is minimal. The freshwater requirement is only for six months (July to December) in Zone A of Rio Chone estuary; while in Zone B, it is for three months (October to December). The requirement in the Las Gilces of Rio Portoviejo estuary is for six months from July to December.

The minimum monthly requirement of freshwater for one hectare shrimp pond, at 10 percent daily water exchange ratio, amounts to approximately 37 percent (8,000 m^3/ha) in Zone A and about 55 percent (11,900 m^3/ha) in Zone B of Rio Chone estuary, and about 33 percent (7,400 m^3) in the Las Gilces, of total water intake.

The required freshwater, if supplied, will definitely, increase the production of shrimps through three cycles of operation in a year. Based on discussion with some large shrimp farm operators, the supply of freshwater by this project, could be of great help to their shrimp culture business. However, there are problems in the supply of freshwater, and the effective use of the freshwater. There are the mixing of water at the water intake area or points to achieve the salinity required for culture and the timing of of release of the water.

In other countries (particularly in Taiwan), seawater is diluted by pumping freshwater from deep wells or rivers directly to lower the concentration of salinity artificially. Using this method of diluting seawater, it is easily possible to create the most suitable salinity for shrimp. By this method, the effective use of freshwater can be achieved. However, in the project area where water is scare, freshwater cannot be discharged into estuary under the supposition that there would be mixing at the water intake. Therefore, the effective use of the freshwater supplied into the estuaries can not be evaluated.

In order to solve this problem and to get maximum effective use of the freshwater is to supply through a separate canal. A canal of about 15 km may be required to cover Zone B of the Rio Chone estuary from Simbocal dam. The cost benefit has to be evaluated.

In order to reduce daily water exchange rate or consumption of freshwater, the following measures have to be taken into consideration; (1) to supply aeration by water paddle or jetblower (2) to secure higher water depth of pond (about one meter) (3) to conduct intensive culture in small size ponds

APPENDIX

(1) Note on the conversion of mangroves to shrimp farms

The decline in mangrove area in Ecuador is well documented by various sources. In the course of shrimp pond construction since 1976, large areas of mangrove have been destroyed, and that includes the Bahia de Caraquez, a large estuary in Rio Chone in Manabi. According to CLIRSEN, in 1980 there was a wide belt of mangroves, and these have been virtually replaced by ponds.

There is unfortunately no evidence that effective steps have been taken since 1986 to slow or stop the conversion of mangroves into shrimp ponds. In 1988 CLIRSEN, using 1987 data documented the conversion of mangroves. The average annual loss between 1969-1984 and the period of second survey, 1984-1987, were 1,434 and 2,618 ha/year, respectively. By late 1988 the destruction of mangrove habitat in some estuaries was virtually complete, particularly in Rio Chone estuary.

Many of the ponds are in mangrove zones which are very productive components of the estuarine ecosystem and contribute to both flora and fauna, including shrimp. The capability of estuarine mangrove areas to support major fisheries is widely acknowledged by scientists. The juveniles of many commercially important fishes migrate and congregate in shallow zones for feeding and refuge from predators. Such behavior makes these species more adaptable for mariculture operations. Shrimp, in particular, take advantage of favorable shallow water habitats during critical life cycle stages. Various studies have revealed that shrimp postlarvae are present virtually all year in mangrove waters, although numbers fluctuate seasonally in relation to the lunar, diurnal and tidal cycles.

Relevant authorities should make efforts to conserve the mangroves that are still existing, and to allow reforestration of mangroves in order to sustain the shrimp industry.

(2) Note on chame fishery in project area

A goby, Dormitator latifrons (Family: Eleotridae), locally known as Chame or Chalaco is a popular food fish in Manabi province. The chame fishery in Ecuador is centered in the Chone river system. The fish is considered as resident within the estuarine system and it is known to enter river to spawn on the flooded fringes in the

upstream. The peak spawning season is during rising floods in the Chone River but it also shows a continuation of breeding into the dry season (Reference 10). Pond culture is practiced in the Chone river by construction of ponds on the floodplains, either by dyking or by excavation. The wild young chame (5-15 cm) stocked into these ponds are grown-on through the dry season. It is the most common fish caught in the rivers and in adjacent floodplains, and is also a by-catch in shrimp farms located in the estuarine zone.

Based on the data from the Sub-secretary of Fisheries, there are about 780 hectares of chame ponds in the country; of which about 560 hectares are in Manabi Province. However, there is no data on the production. According to a survey conducted by CRM in 1986 in Chone, Tosagua, Calceta and Junin of Central Manabi, there were 773 hectares and 33 cultivators. The production yield reported in this survey was 329 kg/ha, and that amounted to about 254 metric tons in 1986.

CRM had initiated a chame programme in its Rural Development Department in 1980 with objective to produce chief source of protein in rural area. The programme has one senior staff with an assistant. In the first three year (1980-1983), the programme was on the ecological study of Chame. In 1984 to 1987, it started carrying out cultivation in five culture ponds (300 m^2 each) located in La Estancilla station. In 1985 it also successfully carried reproduction through hormone. The programme also involves technical training to rural farmers interested in chame cultivation.

There seems to be a local demand for chame but the problem in chame fishery is the availability of juveniles for culture. Currently culture is practiced by stocking small fish caught from the wild. There is a need to produce post-larvae or juveniles in hatchery, and this needs extensive research.

List of Reference

Number	Title	Source
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2	*Libro Blanco del Camaron, Mayo de 1898* (CPC-Camara de Productores de Camaron)	CPC
3	Profile of the Shrimp Industry for Foreign Investors	CPC
4	Unidad de Estudios Pesqueros y Estadisticas Criaderos de Camaron: 1976-1990 (Acumulado) Concesiones y Autorizaciones por Provincias y Tipos de Zonas, Segun Anos (SRP-Subsecretaria de Recursos Pesqueros)	SRP
5	Criaderos de Camaron: 1988 - 1990 Segun Provincias y Nombres	SRP
6	Cultivadores de Especies Bioacuaticas 1985 - 1988	SRP
7	Nihon no Ebi - Sekkai no Ebi (In Japanese) 1984	MARUZEN
8	Calidad del Agua en Los Estuarios del Los Rios Chone y Portoviejo, 1988 Plan Integral de Desarrollo de Los Recursos Hidricos de La Provincia de Manabi	PHIMA
9	Calidad de Las Aguas Superficiales Plan Integral de Desarrollo de Los Recursos Hidricos de La Provincia de Manabi	PHIMA
10	Seasonal variations in growth, condition and gonads of Dormitator latifrons (Richardson) in the Chone River Basin, Ecuador (1984) 24, 637-648, by B.D.Chang and W. Navas	J. Fish Biol.
11	Shrimp Report on Manabi Province	PHIMA
12	Proceedings of the First International Conference on the Culture of Penaeid Prawns/Shrimps (October 1985) (Southeast Asian Fisheries Development Center - Aquaculture Department)	SEAFDC
13	Technical and Economic Aspects of Shrimp Farming (June 1990) Editors: Michael B. New, Henri de Saram & Tarlochan Singh	INFOFISH/FAO

Number	Title	Source
14	Planning, Design and Construction of a Coastal Fish Farm (1976) Y.A. Tang, FAO, Rome	FAO
15	A Sustainable Shrimp Mariculture Industry for Ecuador (1989) Editors: Stephen Olsen Rhode Island and Luis Arriaga	Univer. of Rhode Island
16	Penaeus Shrimp Pond Grow-Out in Panama by Richard Pretto Malca (CRC Handbook of Mariculture pg.169-178)	Cruystacean Aquaculture
17	The Ecuadorean Shrimp Culture Industry by Yosuke Hirono and Sjef van Eys, April 1990	INFOFISH/FAO
18	Manabi Frente Al Pais Estadistica Basica 1989	Direccion de Planificacion Regional, CRM
19	Analisis de la industria camaronera ecuatoriana Special Newspaper Article) Edicion 28 October 1991	El Financiero Edicion Especial

TABLES

Table E.1 Shrimp Culturist and Shrimp Farm Area in Manabi Province (1976-1990)- Authorized by the Sub-Secretary of Fisheries

	MANABI PROVINCE					COUNTRY (TOTAL)
	Shrimp Culturist		Shrimp Farm (Ha)			Shrimp Farm
Year	Increase	Cumul	Increase	Cumul.	(%)	(Ha)
1976	1	1	20	20	(4.4)	459
1977	5	6	732	752	(32.1)	2,345
1978	2	8	52	804	(19.2)	178
1979	12	20	743	1,547	(21.7)	7,125
1980	8	28	225	1,772	(11.9)	14,887
1981	11	39	631	2,403	(6.8)	35,272
1982	14	53	739	3,142	(6.5)	48,458
1983	17	70	859	4,001	(6.4)	62,427
1984	27	97	1,124	5,125	(5.9)	86,626
1985	24	121	781	5,906	(5.8)	102,667
1986	110	231	2,957	8,863	(7.3)	121,679
1987	28	259	843	9,706	(7.5)	129,154
1988	48	307	1,048	10,754	(7.7)	139,052
1989	25	332	662	11,416	(7.9)	145,284
1990	54	386	658	12,074	(8.0)	150,489

Source: Subsecretaria de Recursos Pesqueros, Direccion General de Pesca

Table E.2 Shrimp Pond and Hatchery Operation, and Production in Ecuador (1977 - 1990)

Year	Total Area in Production (HA)	Production (Tons)	Number of Hatcheries	Production (Millions)
1977	3,000	818	-	-
1978	5,500	1,682	-	-
1979	8,200	2,545	-	-
1980	18,570	5,955	1	83
1981	27,000	9,091	1	405
1982	40,000	13,955	2	34
1983	55,000	23,227	3	652
1984	60,000	21,818	4	280
1985	70,000	21,636	14	488
1986	80,000	28,364	38	1,979
1987	91,000	42,525	70	2,566
1988	100,000	45,591	35	3,080
1989	75,000	32,600	60	4,000
1990	90,000	45,450	-	-

Remarks: 1) Production figures represent weight of tails (headless shrimps).
2) Number of hatcheries represents the registered ones, and it is reported that they are many more operating in the backyards.

Source: Focus of Aquaculture (Reference 17).

Table E.3 Salinity Distribution by Month in the Estuaries of Rio Chone and Rio Portoviejo at High Tide

Unit: ppt.

Month	RIO CHONE Zone A	RIO CHONE Zone B	RIO PORTVIEJO Las Gilses
January	25	20	
February	-	-	
March	23	-	
April	25	5 - 17.4	25
May	24	5 - 14.8	25
June	25	12	26
July	30	19	28
August	32	21	30
September	35 Ave.	25	32 Ave.
October	33 ->34	35 Ave.	34 ->33
November	34	38 ->38	34
December	40	40	34

Remarks: 1) Salinity data for Zone A from PHIMA report (Reference 8).
2) Salinity data for April and May in Zone B from PHIMA report (Reference 8) and the rest from Reference 10.
3) Rainy season is from January to May, and Dry season is from June to December.

Table E.4.1 Salinity, Water Temperature and Dissolved Oxygen Distribution at Six Stations in Rio Chone Estuary During High Tide

Date: May 12,1987
Time: 15:20-17:00

	Station - 1			Station - 2			Station - 3		
Depth (m)	Salinity (ppt)	Temp (C)	Oxygen (ppm)	Salinity (ppt)	Temp (C)	Oxygen (ppm)	Salinity (ppt)	Temp (C)	Oxygen (ppm)
0	30.4	28.5	7.3	23.2	29.0	6.8	19.2	29.6	7.2
1	30.4	28.5	7.4	-	28.9	6.8	-	29.5	7.3
2	30.4	28.4	7.3	23.2	28.7	6.7	19.2	29.2	7.0
3	30.4	28.3	7.3	-	28.6	6.7	-	28.6	6.0
4	30.4	28.4	7.3	24.7	28.4	6.6	21.9	28.4	6.0
5	30.4	28.3	7.1	-	28.3	6.6	-	28.4	5.5
6	30.4	28.3	7.1	26.3	28.3	6.6	21.9	28.2	5.1
7	30.4	28.3	6.9	-	28.3	6.6	-	28.7	5.0
8	30.4	28.3	6.9	25.3	28.3	6.6	22.0	28.2	5.5
9	30.4	28.3	7.3						
10	30.4	28.2	7.3						
11	30.4	28.2	7.3						
12	30.4	28.2	7.0						

	Station - 4			Station - 5			Station - 6		
Depth (m)	Salinity (ppt)	Temp (C)	Oxygen (ppm)	Salinity (ppt)	Temp (C)	Oxygen (ppm)	Salinity (ppt)	Temp (C)	Oxygen (ppm)
0	13.2	29.4	10.2	0.6	29.8	6.2	0.5	29.0	5.6
1	-	29.2	7.4	-	29.7	6.9	-	29.0	5.6
2	15.0	28.9	7.3	0.9	29.8	5.8	0.5	29.0	5.6
3	-	28.4	7.3	-	29.8	5.7	-	29.0	5.6
4	18.9	28.3	7.3	1.0	29.8	5.7	0.5	29.0	5.6
5	-	28.2	7.1	-	29.8	5.9			
6									

Remarks: 1) Location of stations is shown in Fig. E.1 (Rio Chone).
2) Stations 1 and 2 show no changes in salinity and temperature with increase in depth - indicating vertical mixing at the time measurement or error in the measurements (no explanation in the report).

Source: Reference 8

Table E.4.2 Salinity, Water Temperature and Dissolved Oxygen Distribution at Six tations in Rio Chone Estuary During High Tide

Date: April 7,1988
Time: 11:00-14:00

	Station - 1			Station - 2			Station - 3		
Depth (m)	Salinity (ppt)	Temp (C)	Oxygen (ppm)	Salinity (ppt)	Temp (C)	Oxygen (ppm)	Salinity (ppt)	Temp (C)	Oxygen (ppm)
0	27.1	30.0	12.4	26.0	30.0	11.8	20.2	31.0	11.4
1	27.5	29.5	11.0	26.2	29.5	10.5	20.5	31.0	11.2
2	28.0	29.5	10.6	27.8	29.0	8.8	21.5	30.0	10.5
3	28.8	29.0	10.6	(Fondo 2.2)			23.8	30.0	8.8
4	29.4	29.0	10.2				23.3	30.0	8.1
5	Profundidad						24.5	29.5	7.6
6							25.2	29.0	7.3
7							25.2	29.3	7.1
8							(Profundidad 6.7)		

	Station - 4			Station - 5			Station - 6		
Depth (m)	Salinity (ppt)	Temp (C)	Oxygen (ppm)	Salinity (ppt)	Temp (C)	Oxygen (ppm)	Salinity (ppt)	Temp (C)	Oxygen (ppm)
0	16.1	30.3	9.6	7.1	30.9	7.4			
1	18.1	29.5	7.9	8.1	30.5	6.4			
2	(Profundidad 1.1)			8.3	30.5	6.0			
3	-			(Profundidad 1.3)					

Remarks: 1) Location of stations is shown in Fig. E.1 (Rio Chone).

Source: Reference 8

Table E.4.3 Salinity, Water Temperature and Dissolved Oxygen Distribution at Six Stations in Rio Portoviejo Estuary During High Tide

Date: April 8,1988
Time: 10:45 - 13:00

	Station - 1			Station - 2			Station - 3		
Depth (m)	Salinity (ppt)	Temp (C)	Oxygen (ppm)	Salinity (ppt)	Temp (C)	Oxygen (ppm)	Salinity (ppt)	Temp (C)	Oxygen (ppm)
0	27.4	31.5	7.7	23.8	30.5	8.3	16.5	31.0	10.1
0.5	27.5	31.0	7.3	24.1	31.0	8.0	20.2	31.0	9.6
1.0	28.0	30.5	7.3	28.0	30.5	6.9	27.1	30.5	6.9
1.5	28.2	30.0	7.0	29.0	30.0	6.4	27.9	30.5	4.5
2.0	28.5	30.0	7.2	29.1	30.0	6.2	28.4	30.0	3.8
2.5				-	-	-	29.8	30.0	3.8
3.0				30.1	29.0	6.4	30.0	29.0	3.0
4.0				30.9	29.0	6.5			
5.0				30.5	29.0	5.7			
6.0									

	Station - 4			Station - 5			Station - 6		
Depth (m)	Salinity (ppt)	Temp (C)	Oxygen (ppm)	Salinity (ppt)	Temp (C)	Oxygen (ppm)	Salinity (ppt)	Temp (C)	Oxygen (ppm)
0	14.8	31.0	10.1	11.4	31.0	9.4	9.2	31.2	8.1
0.5	21.4	31.0	8.8	16.9	31.0	6.1	19.2	30.0	4.4
1.0	26.9	31.0	6.1	26.2	30.0	4.8	25.4	30.0	3.0
1.5	28.1	30.5	3.9	27.2	30.0	2.6	26.9	30.0	2.3
2.0	28.4	30.0	3.7	20.5	30.0	3.1	27.2	30.0	1.7
2.5							28.0	29.5	0.8
3.0							28.2	29.0	0.8

Remarks: 1) Location of stations is shown in Fig. E.2 (Rio Portoviejo).

Source: Reference 8

Table E.5 Distribution of Mangrove and Shrimp Farms in the Project Area During the Period of 1969-1984 and 1984-1987, and 1991

Unit: Ha

	1969	1984	1987	1991
MANGROVE				
Rio Chone				
1) Bahia de Caraquez	509	189	98	
2) Salinas de Bahia	1,884	852	476	900**
3) Estero Ebano	1,548	633	466	
4) San Antonio	32	-	-	
Rio Portoviejo				
1) Las Gilses	83	81	81	***
Project Area (Total)	4,056	1,755	1,121	
Province (Total)	12,416	7,992	6,401	

	1984	1987	1987-1990 (Increase)	1991
SHRIMP FARMS				
Rio Chone				
1) Bahia de Caraquez	375	466		
2) Salinas de Bahia	1,791	2,167	140*	
3) Estero Ebano	1,954	2,121		
4) San Antonio	68	73		
Sub-total	4,120	4,827		4,967
Rio Portoviejo				
1) Las Gilses	103	130	-***	130
Project Area (Total)	4,223	4,956		5,097
Province (Total)	8,377	10,238		

Remarks: * Based on information obtained from CLIRSEN (Guayaquil) during the survey (October 23/24). Based on the measurement of satellite map of Rio Chone estuary, that is about 140 ha of mangrove swamps have been converted to shrimp ponds from 1987 to 1990.

** Based on the estimation on the 140 ha of shrimp farms developed from mangroves (1,040 - 140 = 900 ha)

*** No land for expansion

Source: Reference 1

Table E.6 Shrimp Farm in the Zone A and Zone B of Rio Chone Estuary and Las Gilses in Rio Portoviejo in 1990

Unit: Ha

	RIO CHONE[1)]		RIO PORTOVIEJO[2]	
	Zone A	Zone B	Las Gilses	Total
Shrimp farms	990	3,977	130	5,097

Remarks: 1) Based on the salinity in the estuary (Table E.3), it is roughly divided into Zone A and Zone B (Fig. E.1).
Zone A - From the mouth of Rio Chone estuary to Punta Blanca & Islas de Los Aposentos and
Zone B - From Punta Blanca to Simbocal Dam 2) No more land and mangroves for development.

Source: Reference 1

Table E.7 Salient Information Summarized based on the Interview Survey

(1/2)

	Case 1	Case 2	Case 3
Total Pond Area (ha)	17	50 (38 in operation)	130
Pumping hours daily	4-5 hrs/tide 8-10 hrs/day	8-12 hrs/day	4-6 hrs/day
Salinity (ppt)	25 (rainy season)	5 (Feb & March) 30 (June - Jan)	32 (Oct.) 22 (Rainy)
Water exchange rate (%)	10-15	10-15	5-10
Water depth (cm)	70	70	70
Stocking density	1,200,000/13ha 9/m^2	780,000/11ha 7/m^2	1,000,000/12ha 8/m^2
Growout period (months)	3-4	4	3-4
Survival rate (%)	70	80	80
Harvest size (gm/shrimp)	16-17	16-18	16-18
Production (kg/cycle)	830	925	940
Number of cycles	2	2	2
Productivity (kg/ha/year)	1,660	1,900	1,880

	Case 4	Case 5 (La Gilses)	Case 6
Total Pond Area (ha)	72	15 (38 in operation)	160
Pumping hours daily	4-6 hrs/tide 8-12 hrs/day	12 hrs	12 hrs
Salinity (ppt) in pond	32-33 (Oct)	32	
Water exchange rate (%)	10-15	10-15	25
Water depth (cm)	70	70	70
Stocking density postlarvae (PL)	40,000/ha 4/m^2	100,000/ha 10/m^2	12/m^2
Growout period (months)	3.5-4	4	4
Survival rate (%)	85	80	65-80
Harvest size (gm/shrimp)	16-17	16-18	16-17
Production (kg/cycle)	425	450	1,420
Number of cycles	2.5-3	2	2
Productivity (kg/ha/year)	1,275	1,350	2,850

Remarks: 1) Case 1 to Case 4 & 6 are from Rio Chone estuary and Case 5 is from Rio Portoviejo estuary.

Source: Interview survey, October 1991.

Table E.8 Estimation of Water Volume Required for Maintenance in One Hectare of Shrimp Pond in Rio Chone Area by Month

Month	WATER LOSS (cm) Seepage A	Evaporation B	WATER ADDED(cm) Precipitation C	WATER REQUIRED m^3/ha/month (A+B-C)x 1 ha
January	10	8.6	15.7	290
February	10	8.0	19.5	-150
March	10	11.2	17.2	400
April	10	9.3	14.1	520
May	10	9.4	4.9	1450
June	10	7.9	2.6	1530
July	10	9.2	2.1	1710
August	10	10.7	0.6	2010
September	10	11.1	1.0	2010
October	10	10.5	0.8	1970
November	10	11.7	1.2	2050
December	10	10.4	3.2	1720

Remarks:
1) Seepage - Seepage is estimated to be 7.2 cm/month for clay loamy soil, however, for higher allowance 10 cm/month is considered (Reference 14).
2) Evaporation - Average data from 1964-1990 at La Estancilla station (Tank A x 0.8)- INHERI Report.
3) Precipitation - Average data from 1964-1990 at La Estancilla station - INHERI Report.
4) Rainy season is from January to May, and Dry season is from June to December.

Table E.9 *Estimation of Water Volume Required for Maintenance in One Hectare of Shrimp Pond in Rio Portoviejo Area by Month*

Month	WATER LOSS (cm) Seepage A	Evaporation B	WATER ADDED(cm) Precipitation C	WATER REQUIRED m^3/ha/month (A+B-C)x 1 ha
January	10	10.5	8.9	1160
February	10	9.1	11.1	800
March	10	10.7	10.9	980
April	10	10.6	5.8	1480
May	10	11.0	2.8	1820
June	10	9.3	2.2	1710
July	10	0.3	1.1	1920
August	10	11.9	0.2	2170
September	10	12.1	0.5	2160
October	10	12.0	0.3	2170
November	10	11.7	0.5	2120
December	10	11.9	1.7	2020

Remarks:
1) Seepage - Seepage is estimated to be 7.2 cm/month for clay loamy soil, however, for higher allowance 10 cm/month is considered (Reference 14).
2) Evaporation - Average data from 1964-1990 at Portoviejo station (Tank A x 0.8)- INEHRI Report.
3) Precipitation - Average data from 1964-1990 at Portoviejo station - INEHRI Report.
4) Rainy season is from January to May, and Dry season is from June to December.

Table E.10 Water Intake for One Hectare of Shrimp Pond in Rio Chone Estuary by Month

Unit: m^3/ha/month

Month	Maintenance of Water Level (M)	Water Exchange (E)	Total (M+E)
January	290	21,000	21,290
February	-150	21,000	20,850
March	400	21,000	21,400
April	520	21,000	21,520
May	1,450	21,000	22,450
June	1,530	21,000	22,530
July	1,710	21,000	22,710
August	2,010	21,000	23,010
September	2,010	21,000	23,010
October	,970	21,000	22,970
November	2,050	21,000	23,050
December	1,720	21,000	22,720

Remarks: 1) For water exchange (E), water depth considered is 70 cm and water exchange rate is 10 percent.
2) For maintenance of water level (M) refer Table E.8.

Table E.11 Water Intake for One Hectare of Shrimp Pond in Rio Portoviejo Estuary by Month

Unit: m^3/ha/month

Month	Maintenance of Water Level (M)	Water Exchange (E)	Total (M+E)
January	1,160	21,000	22,160
February	800	21,000	21,800
March	980	21,000	21,980
April	1,480	21,000	22,480
May	1,820	21,000	22,820
June	1,710	21,000	22,710
July	1,920	21,000	22,920
August	2,170	21,000	23,170
September	2,160	21,000	23,160
October	2,170	21,000	23,170
November	2,120	21,000	23,120
December	2,020	21,000	23,020

Remarks: 1) For water exchange (E), water depth considered is 70 cm and water exchange rate is 10 percent.
2) For maintenance of water level (M) refer Table E.9.

Table E.12 Monthly Freshwater Requirement of One Hectare of Shrimp Pond at Different Salinities in the Optimum Range in Dry Season in Rio Chone Estuary (Zone A)

Unit: m^3/ha/month

Month	ZONE-A OF RIO CHONE ESTUARY		
	Maximum 34 ppt -> 15 ppt	Medium 34 ppt -> 20 ppt	Minimum 34 ppt -> 25 ppt
January	-	-	-
February	-	-	-
March	-	-	-
April	-	-	-
May	-	-	-
June	-	-	-
July	28,842	15,897	8,176
August	29,223	16,107	8,284
September	29,223	16,107	8,284
October	29,172	16,079	8,270
November	29,274	16,135	8,298
December	28,854	15,904	8,179

Remarks: 1) Monthly freshwater requirement (RF) is estimated based on the following formula.
For maximum requirement : RF = (M + E) x (34 - 15)/15
For mean requirement : RF = (M + E) x (34 - 20)/20
For minimum requirement : RF = (M + E) x (34 - 25)/25
where M = Monthly water requirement for maintenance of water level (Refer Table E.10), and
E = Monthly water requirement for daily exchange of 10 percent (Refer Table E.10).

2) Freshwater is not considered from January to June in the Zone-A.

Table E.13 Monthly Freshwater Requirement of One Hectare of Shrimp Pond at Different Salinities in the Optimum Range in Dry Season in Rio Chone Estuary (Zone B)

Unit: m^3/ha/month

Month	ZONE-A OF RIO CHONE ESTUARY		
	Maximum 38 ppt -> 15 ppt	Medium 38 ppt -> 20 ppt	Minimum 38 ppt -> 25 ppt
January	-	-	-
February	-	-	-
March	-	-	-
April	-	-	-
May	-	-	-
June	-	-	-
July	-	-	-
August	-	-	-
September	-	-	-
October	35,144	20,673	1,944
November	35,267	20,745	11,986
December	34,762	20,448	11,814

Remarks: 1) Monthly freshwater requirement (RF) is estimated based on the following formula.
For maximum requirement : RF = (M + E) x (38 - 15)/15
For mean requirement : RF = (M + E) x (38 - 20)/20
For minimum requirement : RF = (M + E) x (38 - 25)/25
where M = Monthly water requirement for maintenance of water level (Refer Table E.10), and
E = Monthly water requirement for daily exchange of 10 percent (Refer Table E.10).

2) Freshwater is not considered from January to September in the Zone B.

Table E.14 Monthly Freshwater Requirement of One Hectare of Shrimp Pond at Different Salinities in the Optimum Range in Dry Season in Las Gilses of Rio Portoviejo Estuary

Unit: m^3/ha/month

Month	LAS GILSES OF RIO PORTOVIEJO ESTUARY		
	Maximum 33 ppt -> 15 ppt	Medium 33 ppt -> 20 ppt	Minimum 33 ppt -> 25 ppt
January	-	-	-
February	-	-	-
March	-	-	-
April	-	-	-
May	-	-	-
June	-	-	-
July	27,504	14,890	7,334
August	27,804	15,061	7,414
September	27,792	15,054	7,411
October	27,804	15,061	7,414
November	27,744	15,028	7,398
December	27,624	14,963	7,366

Remarks: 1) Monthly freshwater requirement (RF) is estimated based on the following formula.
For maximum requirement : RF = (M + E) x (33 - 15)/15
For mean requirement : RF = (M + E) x (33 - 20)/20
For minimum requirement : RF = (M + E) x (33 - 25)/25
where M = Monthly water requirement for maintenance of water level (Refer Table E.11), and
E = Monthly water requirement for daily exchange of 10 percent (Refer Table E.11).

2) Freshwater is not considered from January to June in the Rio Portoviejo.

Table E.15 Monthly Freshwater Requirement of Shrimp Farms in the Zone A of Rió Chone Estuary in Dry Season at Different Salinities in the Optimum Range

Shrimp area: 990 ha
Unit: MCM

Month	ZONE-A OF RIO CHONE ESTUARY		
	Maximum 33 ppt -> 15 ppt	Medium 33 ppt -> 20 ppt	Minimum 33 ppt -> 25 ppt
January	-	-	-
February	-	-	-
March	-	-	-
April	-	-	-
May	-	-	-
June	-	-	-
July	22.84	12.59	6.48
August	23.15	12.78	6.56
September	23.15	12.78	6.56
October	23.10	12.74	6.55
November	23.19	12.78	6.58
December	22.85	12.60	6.49
	138.28	76.27	39.23

Remarks: 1) Optimum salinity range is 15 to 25 ppt.
2) Monthly freshwater requirement (MFR) of shrimp farms is estimated as follows.
MFR = Water requirement/ha (Table E.12) x Shrimp farm area (990 ha) x 0.8 (grow-out pond ratio - water area available for shrimp production)

Table E.16 Monthly Freshwater Requirement of Shrimp Farms in the Zone B of Rio Chone Estuary in Dry Season at Different Salinities in the Optimum Range

Shrimp area: 3,977 ha
Unit: MCM

Month	ZONE-A OF RIO CHONE ESTUARY		
	Maximum 38 ppt -> 15 ppt	Medium 38 ppt -> 20 ppt	Minimum 38 ppt -> 25 ppt
January	-	-	-
February	-	-	-
March	-	-	-
April	-	-	-
May	-	-	-
June	-	-	-
July	-	-	-
August	-	-	-
September	-	-	-
October	111.81	65.79	38.00
November	112.21	66.00	38.14
December	110.60	65.06	37.58
	334.62	196.85	113.72

Remarks: 1) Optimum salinity range is 15 to 25 ppt.
2) Monthly freshwater requirement (MFR) of shrimp farms is estimated as follows.
MFR = Water requirement/ha (Table E.13) x Shrimp farm area (3,977 ha) x 0.8 (grow-out pond ratio - water area available for shrimp production)

Table E.17 Monthly Freshwater Requirement of Shrimp Farms in the Las Gilses of Rio Portoviejo Estuary in Dry Season at Different Salinities in the Optimum Range

Shrimp area: 130 ha
Unit: MCM

Month	LAS GILSES OF RIO PORTOVIEJO ESTUARY		
	Maximum 33 ppt -> 15 ppt	Medium 33 ppt -> 20 ppt	Minimum 33 ppt -> 25 ppt
January	-	-	-
February	-	-	-
March	-	-	-
April	-	-	-
May	-	-	-
June	-	-	-
July	2.86	1.55	0.76
August	2.89	1.57	0.77
September	2.89	1.57	0.77
October	2.89	1.57	0.77
November	2.89	1.57	0.77
	17.31	9.40	4.61

Remarks: 1) Optimum salinity range is 15 to 25 ppt.
MFR = Water requirement/ha (Table E.14) x Shrimp farm area (130 ha) x 0.8 (grow-out pond ratio - water area available for shrimp

Table E.18 Present and Future Freshwater Requirement of Shrimp Ponds in Project Area (Salinity = 25 ppt.)

Salinity: 25 ppt.

	Present	Future (1995, 2000 and 2020	
		Increase[1] 1991-1995	Increase[1] 1996-2000
Shrimp Farms (ha)	5097	180	270
Cumulative total		5,277	5,547
Freshwater Requirement (MCM)			
June	-	-	-
July	7.24	-	-
August	7.33	-	-
September	7.33	-	-
October	45.32	1.72	2.58
November	45.49	1.73	2.58
December	44.84	1.70	2.55
	157.55	5.15	7.72
Cumulative total		162.70	70.42

.Remarks: 1) From 1987 to 1990 (Table E.5), 140 ha of mangrove swamps had been converted to shrimp ponds, i.e. 45 ha per year. Currently there are about 900 ha of mangroves. At this rate, it is expected that by the year 1995 and 2000, approximately 180 and 270 ha of mangroves respectively, would be converted to shrimp farms. From the year 2001, only narrow fringes are expected to be left, therefore no increase in shrimp farms is expected. No more area for expansion of shrimp farms in the Zone A of Rio Chone estuary, and La Gilses of Rio Portoviejo.

2) Effective use of the shrimp ponds considered is 60 percent based on the assumption of international market situation and also timely availability of post larvae and labour. Therefore, the freshwater requirement is expected to be less.

Present situation : 158 MCM x 0.6 = 94.8 MCM
Future
In 1995 : 163 MCM x 0.6 = 97.8 MCM
n 2000 : 171 MCM x 0.6 = 102.6 MCM

Table E.19 Present and Future Freshwater Requirement of Shrimp Ponds in Project Area (Salinity = 20 ppt.)

Salinity: 20 ppt.

	Present	Future (1995, 2000 and 2020	
		Increase[1)] 1991-1995	Increase[1)] 1996-2000
Shrimp Farms (ha)	5097	180	270
Cumulative total		5,277	5,547
Freshwater Requirement (MCM)			
June	-	-	-
July	14.14	-	-
August	14.35	-	-
September	14.35	-	-
October	80.10	2.98	4.47
November	80.35	2.99	4.48
December	79.23	2.94	4.42
	282.52	8.91	13.37
Cumulative total		291.43	318.17

Remarks: 1) From 1987 to 1990 (Table E.5), 140 ha of mangrove swamps had been converted to shrimp ponds, i.e. 45 ha per year. Currently there are about 900 ha of mangroves. At this rate, it is expected that by the year 1995 and 2000, approximately 180 and 270 ha of mangroves respectively, would be converted to shrimp farms. From the year 2001, only narrow fringes are expected to be left, therefore no increase in shrimp farms is expected. No more area for expansion of shrimp farms in the Zone A of Rio Chone estuary, and La Gilses of Rio Portoviejo.

2) Effective use of the shrimp ponds considered is 60 percent based on the assumption of international market situation and also timely availability of post larvae and labour. Therefore, the freshwater requirement is expected to be less.

Present situation : 283 MCM x 0.6 = 169.8 MCM
Future
In 1995 : 291 MCM x 0.6 = 174.6 MCM
In 2000 : 318 MCM x 0.6 = 190.8 MCM

Table E.20 Present and Future Freshwater Requirement of Shrimp Ponds in Project Area (Salinity = 15 ppt.)

Salinity: 15 ppt.

	Present	Future (1995, 2000 and 2020	
		Increase[1)] 1991-1995	Increase[1)] 1996-2000
Shrimp Farms (ha)	5097	180	270
Cumulative total		5,277	5,547
Freshwater Requirement (MCM)			
June	-	-	-
July	26.70	-	-
August	26.00	-	-
September	26.00	-	-
October	137.81	5.06	7.59
November	138.29	5.08	7.62
December	136.34	5.01	7.51
	491.14	15.15	22.72
Cumulative total		506.29	529.01

Remarks: 1) From 1987 to 1990 (Table E.5), 140 ha of mangrove swamps had been converted to shrimp ponds, i.e. 45 ha per year. Currently there are about 900 ha of mangroves. At this rate, it is expected that by the year 1995 and 2000, approximately 180 and 270 ha of mangroves respectively, would be converted to shrimp farms. From the year 2001, only narrow fringes are expected to be left, therefore no increase in shrimp farms is expected. No more area for expansion of shrimp farms in the Zone A of Rio Chone estuary, and La Gilses of Rio Portoviejo.

2) Effective use of the shrimp ponds considered is 60 percent based on the assumption of international market situation and also timely availability of post larvae and labour. Therefore, the freshwater requirement is expected to be less.

Present situation : 491 MCM x 0.6 = 294.6 MCM
Future
In 1995 : 506 MCM x 0.6 = 303.6 MCM
n 2000 : 529 MCM x 0.6 = 317.4 MCM

Table E.21 Estimated Productivity of Shrimp Farms With and Without Project

WITHOUT PROJECT			WITH PROJECT		Increase in
Number of	Productivity		Number of	Productivity	production
Crops/yr	kg/ha/crop	kg/ha/year	Crops/yr	kg/ha/year	kg/ha/year
2	830	1,660	3.5	2,905	1,245

Remarks: 1) Currently two crops of harvests are easily possible.
2) Estimated productivity is based on interview survey (Table E.6).
4) With the salinity control during dry season, the growout period is expected to be reduced from the current 3.5 - 4 months to 3 to 3.5 months, and thereby the number of crops can be increased to 3.5 crops per year.

Table E.22 Increase in Production of Shrimp Farms in Project Area WIth/Without Project

	Shrimp Farm Area (ha)	PRODUCTION (ton/year)[1] Without Project	With Project	Increase in Production (ton/year)
1995 (without expansion)				
Rio Chone				
Zone A	990	1,315	2,300	985
Zone B	3,977	5,281	9,243	3,962
Rio Portoviejo				
Las Gilses	130	173	302	129
Total	5,097	6,769	11,845	5,076
Net Production		4,061	7,107	3,045
1995 (with expansion)				
Rio Chone				
Zone A	990	1,315	2,300	985
Zone B	3,977+180	5,520	9,660	4,140
Rio Portoviejo				
Las Gilses	130	173	302	129
Total	5,277	7,008	12,262	5,254
Net Production		4,205	7,357	3,155
2000-2020 (with expansion)				
Rio Chone				
Zone A	990	1,315	2,300	985
Zone B	4,157+270	5,879	10,288	4,409
Rio Portoviejo				
Las Gilses	130	173	302	129
Total	5,547	7,367	12,890	5,523
Net Production		4,420	7,734	3,314

Remarks: 1) Production is calculated as shown below;
Production = Productivity (Refer Table E.21) x Shrimp Farm Area x 0.8 (Growout pond ratio - water area available for shrimp production).
2) Net production is 60 percent of gross production, where the assumption is about 60 percent of shrimp ponds are utilized due reasons cited in para. 5.1.

Table E.23 Net Profit With/Without Project

	Production (MT)	FW Demand (MCM)	FARMGATE PRICE (US$Million) Total	Production Cost Freshwater	Inputs	Profit (F)
	(A)	(B)	(C)	(D)	(E)	(C-D-E)
No expansion (2,447 ha)						
1995-2000						
With Project	7,107	94.8	31.271	2.844	15.636	12.791
W'out Project	4,061	-	17.870	-	8.935	8.935
Net increase	3,046	94.8	13.401	2.844	6.701	3.856
With Expansion						
1995 (2,533 ha)						
With Project	7,357	97.8	32.371	2.934	16.186	13.252
W'out Project	4,205	-	18.502	-	9.251	9.251
Net increase	3,152	97.8	13.869	2.934	6.935	4.001
2000 (2,663 ha)						
With Project	7,734	102.6	34.030	3.078	17.015	13.937
W'out Project	4,420	-	19.448	-	9.744	9.744
Net increase	3,314	102.6	14.582	3.078	7.271	4.193

Remarks: 1) (A) - Net production in metric tons (Table E.22).
(B) - Annual freshwater requirement in MCM (Table E.18).
(C) - Farmgate price of shrimp comprising production cost (essential inputs) & freshwater and profit (farmgate price applied is US$4.40/kg). Production cost is approximately 50 percent of the farmgate price.
(D) - Cost of freshwater estimated at US$0.03/$m^3$.
(E) - Costs of essential inputs which include larvae, feed, fertilizer, fuel, labour, and others

2) Figures parentheses indicate effective shrimp pond area.

3) Annual net profit/ha {(F)/shrimp pond area} is expected to be as follows.
Present situation : US$1,576
Future
1995 : US$1,580
2000 : US$1,575

4) Annual cost of freshwater/ha {(D)/shrimp pond area} is expected to be as follows.
Present situation : US$1,162
Future
1995 : US$1,158
2000 : US$1,156

FIGURES

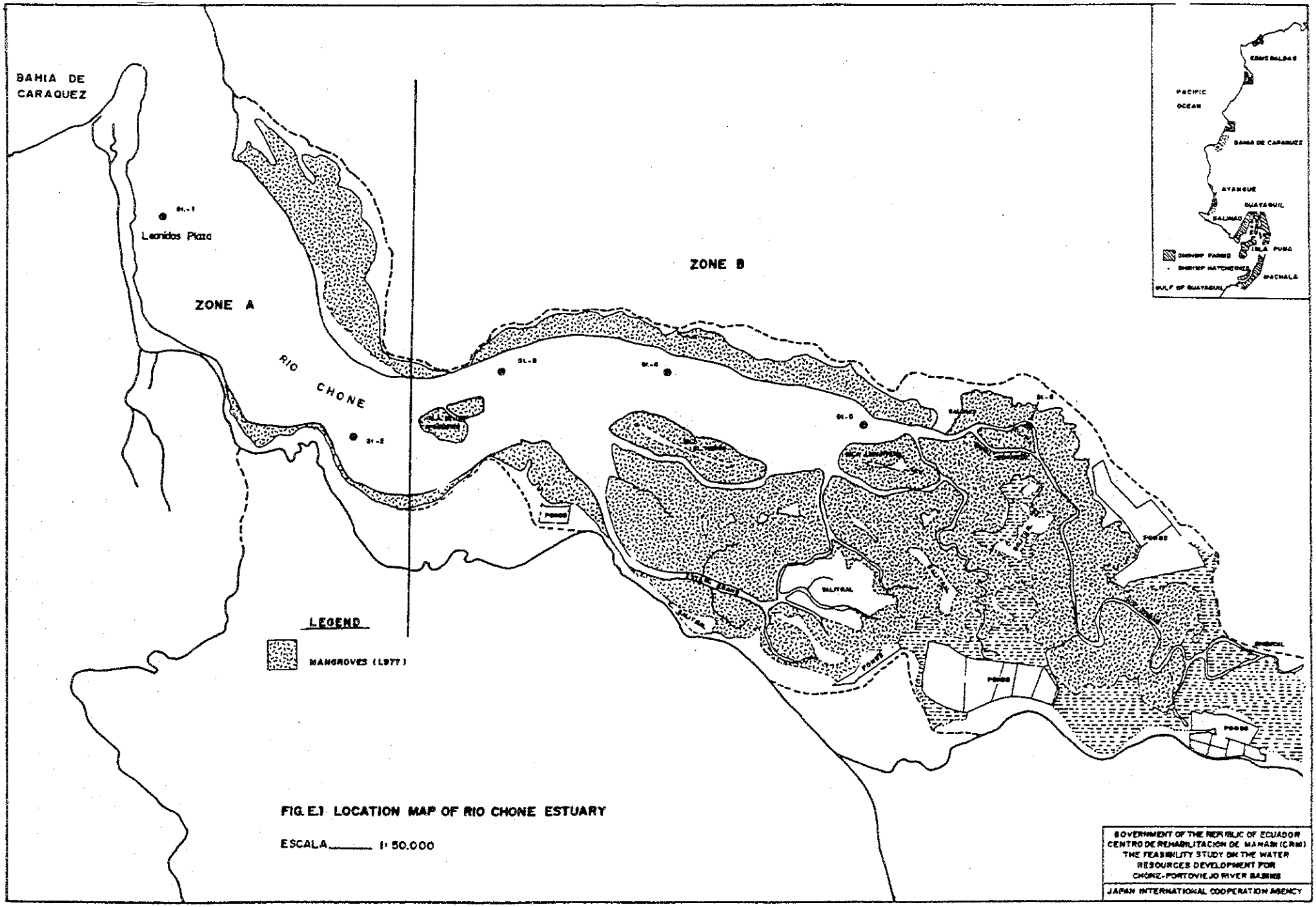

FIG. E.1 LOCATION MAP OF RIO CHONE ESTUARY

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GOVERNMENT OF THE REPUBLIC OF ECUADOR
CENTRO DE REHABILITACION DE MANABI (CRM)
THE FEASIBILITY STUDY ON THE WATER RESOURCES DEVELOPMENT FOR CHONE-PORTOVIEJO RIVER BASINS
JAPAN INTERNATIONAL COOPERATION AGENCY

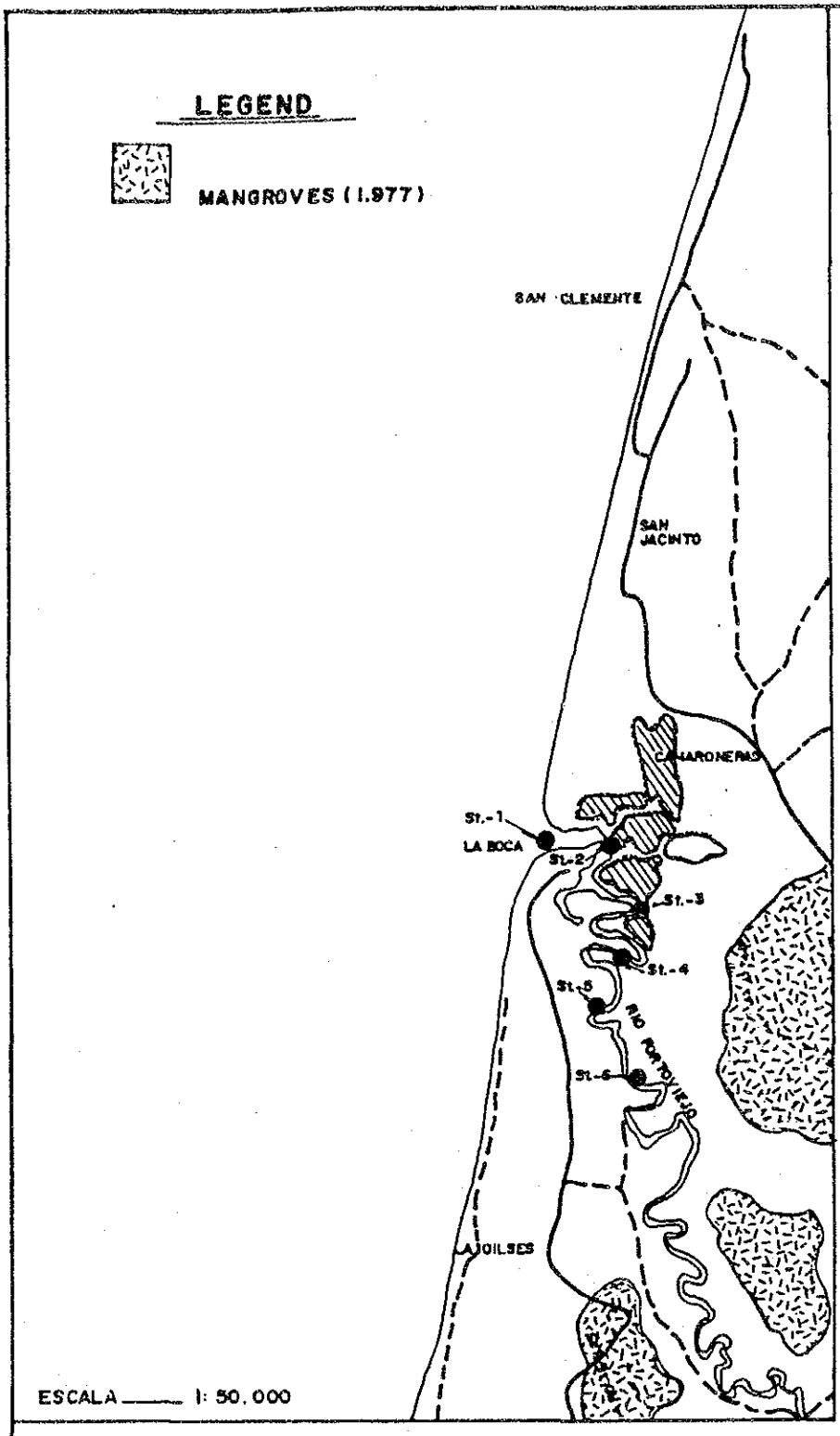

FIG. E.2 LOCATION MAP OF RIO PORTOVIEJO ESTUARY

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THE FEASIBILITY STUDY ON THE WATER RESOURCES DEVELOPMENT FOR CHONE-PORTOVIEJO RIVER BASINS

JAPAN INTERNATIONAL COOPERATION AGENCY

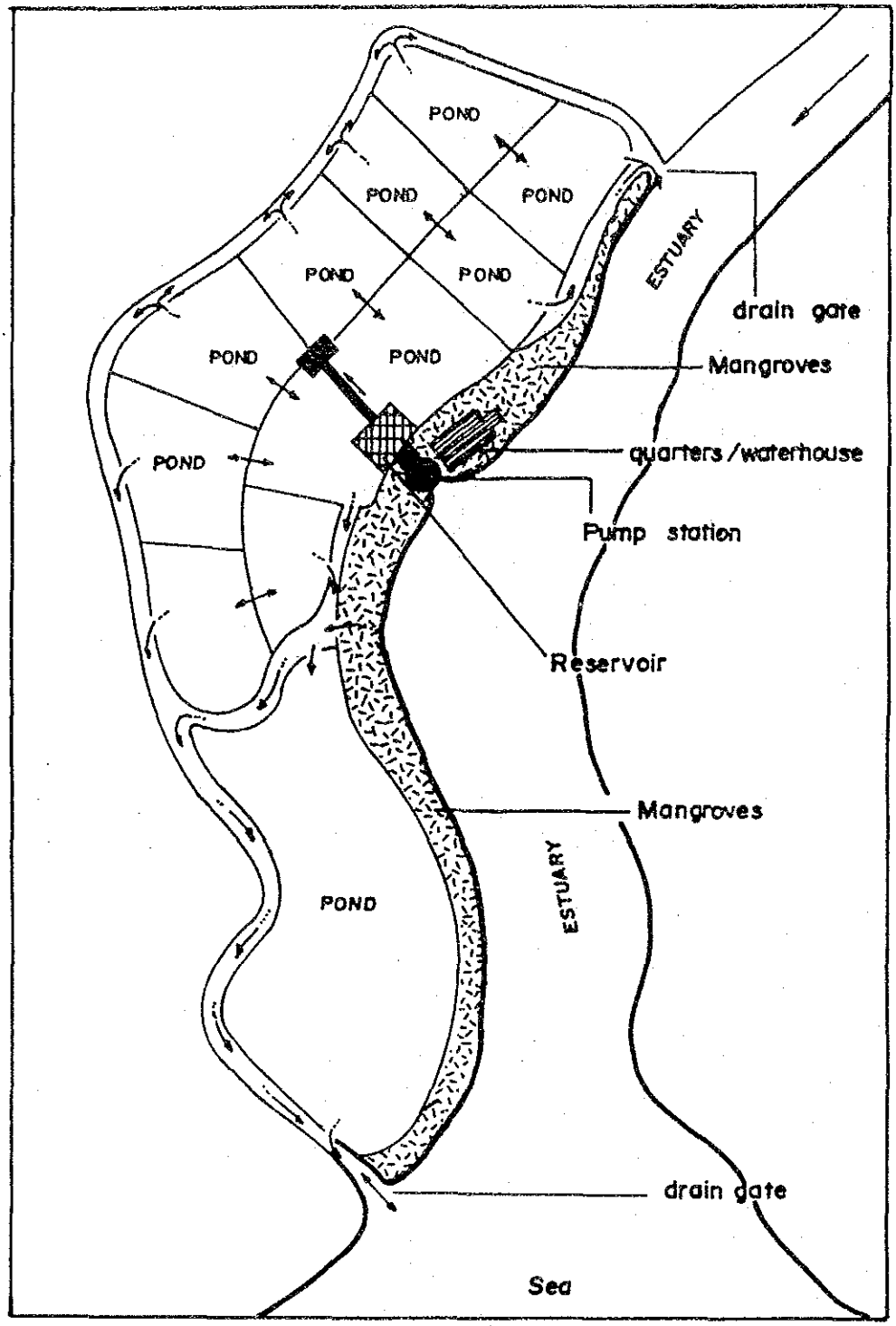

FIG. E.3. LAYOUT OF SHRIMP FARM IN PROJECT AREA

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THE FEASIBILITY STUDY ON THE WATER RESOURCES DEVELOPMENT FOR CHONE-PORTOVIEJO RIVER BASINS

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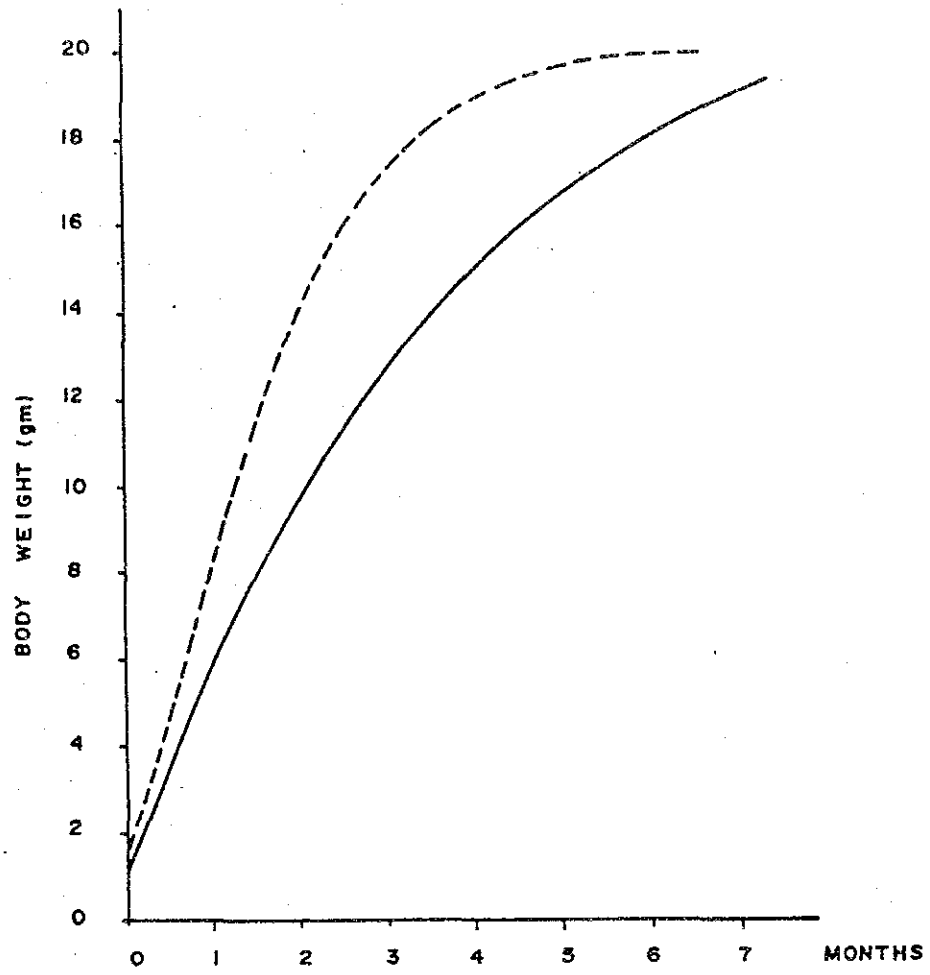

LEGEND

FIG. E.4. GROWTH CURVE OF PENAEUS VANNAMEI.

GOVERNMENT OF THE REPUBLIC OF ECUADOR
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