Table 18.4.1 Violation of Environmental Protection Regulation in Heritage Area

Incident	Measure
Destruction of stalactite in Dong Tien Lake (Fairy Cave)	200,000 VND fine
Destruction of stalactite in Thien Cung Cave	500,000 VND charged
Tree cutting, rock destruction in Bu Xam Cave	Report and picture appeared in newspaper and radio for public awareness
Violation of environmental protection in aquaculture	Temporary seizure of aquaculture certificate
Trading corals near Tam Cung cave	Confiscation
Violation of environmental protection, decision on administrative penalties issued by QNPC	1 million VND fine + 5 million VND compensation
Destruction of corals near Ba Ham	Confiscation
Oil leakage from boats (3 cases)	20 million VND fine
Dynamite fishing (numerous cases)	Several hundred thousands VND fine

Source: Ha Long Bay Management Board, 1998

Table 18.4.2 Estimated Costs & Schedule (Development of Environmental Plan for Tourism)

Schedule

Type	Category	Work	Unit	Year 2000	Year 2001	Year 2002	Year 2003	Year 2004	Year 2005	Year 2006	Year 2007	Year 2008	Year 2009	Year 2010	Total (2000-2010)
Design	1. Design	Preliminary Investigation	person/month	240	0	0	0	0	0	120	0	0	0	0	360
		Project Design	person/month	120	0	0	0	0	0	60	0	0	0	0	180

Cost

Type	Category	Work	Unit Cost (US$)	Year 2000	Year 2001	Year 2002	Year 2003	Year 2004	Year 2005	Year 2006	Year 2007	Year 2008	Year 2009	Year 2010	Total (2000-2010)
Design	1. Design	Preliminary Investigation	100/pers./month	24,000	0	0	0	0	0	12,000	0	0	0	0	36,000
		Project Design	150/pers./month	18,000	0	0	0	0	0	9,000	0	0	0	0	27,000
		Contingency (20%)		8,000	0	0	0	0	0	4,000	0	0	0	0	12,000
		Subtotal		50,000	0	0	0	0	0	25,000	0	0	0	0	75,000
	Total			50,000	0	0	0	0	0	25,000	0	0	0	0	75,000
Total				50,000	0	0	0	0	0	25,000	0	0	0	0	75,000

Note : Cost rounded to the order of 4th digit, before adjustment of discount rate.

Table 18.4.3 Estimated Costs & Schedule (Improvement of Sanitation Condition - Phase 1)

Schedule

Type	Category	Work	Unit	Year 2000	Year 2001	Year 2002	Year 2003	Year 2004	Year 2005	Year 2006	Year 2007	Year 2008	Year 2009	Year 2010	Total (2000-2010)
Construction	1. Design	Design	person/month	240	0	0	0	0	0	0	0	0	0	0	240
	2. Collection System	Mobile Station	boat	0	2	2	0	0	0	0	0	0	0	0	4
		Stationary Station	facility	0	1	1	0	0	0	0	0	0	0	0	2
		Boat (Wastewater : Island)	boat	0	1	1	0	0	0	0	0	0	0	0	2
		Boat (Solid Waste : Island)	boat	0	1	1	0	0	0	0	0	0	0	0	2
		Toilet	facility	0	4	4	0	0	0	0	0	0	0	0	8
O&M	O&M	Labor	person/month	0	0	0	600	600	600	600	600	600	600	600	4,800
		Fuel & Other	boat/year	0	0	0	10	10	10	10	10	10	10	10	80
		Other	facility/year	0	0	0	8	8	8	8	8	8	8	8	64

Cost

Type	Category	Work	Unit Cost (US$)	Year 2000	Year 2001	Year 2002	Year 2003	Year 2004	Year 2005	Year 2006	Year 2007	Year 2008	Year 2009	Year 2010	Total (2000-2010)
Construction	1. Design	Design	100/pers./month	24,000	0	0	0	0	0	0	0	0	0	0	24,000
		Contingency (20%)		5,000	0	0	0	0	0	0	0	0	0	0	5,000
		Subtotal		29,000	0	0	0	0	0	0	0	0	0	0	29,000
	2. Collection Boat	Mobile Station	27,000/boat/year	0	54,000	54,000	0	0	0	0	0	0	0	0	108,000
		Stationary Station	13,000/facil./year	0	13,000	13,000	0	0	0	0	0	0	0	0	26,000
		Boat (Wastewater : Island)	27,000/boat/year	0	27,000	27,000	0	0	0	0	0	0	0	0	54,000
		Boat (Solid Waste : Island)	27,000/boat/year	0	27,000	27,000	0	0	0	0	0	0	0	0	54,000
		Toilet	20,000/facil./year	0	80,000	80,000	0	0	0	0	0	0	0	0	160,000
		Contingency (20%)		0	40,000	40,000	0	0	0	0	0	0	0	0	80,000
		Subtotal		0	241,000	241,000	0	0	0	0	0	0	0	0	482,000
	Total			29,000	241,000	241,000	0	0	0	0	0	0	0	0	511,000
O&M	O&M	Labor	80/pers./month	0	0	0	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	384,000
		Fuel & Other	5,000/boat/year	0	0	0	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	320,000
		Other	2,000/facil./year	0	0	0	16,000	16,000	16,000	16,000	16,000	16,000	16,000	16,000	128,000
		Contingency (20%)		0	0	0	21,000	21,000	21,000	21,000	21,000	21,000	21,000	21,000	168,000
		Subtotal		0	0	0	125,000	125,000	125,000	125,000	125,000	125,000	125,000	125,000	1,000,000
	Total			0	0	0	125,000	125,000	125,000	125,000	125,000	125,000	125,000	125,000	1,000,000
Grand Total				29,000	241,000	241,000	125,000	125,000	125,000	125,000	125,000	125,000	125,000	125,000	1,511,000

Note : Cost rounded to 4th digit, before adjustment of discount rate.

Table 18.4.4 Estimated Costs & Schedule (Improvement of Sanitation Condition - Phase 2)

Schedule

Type	Category	Work	Unit	Year 2000	Year 2001	Year 2002	Year 2003	Year 2004	Year 2005	Year 2006	Year 2007	Year 2008	Year 2009	Year 2010	Total (2000-2010)
Construction	1. Design	Design	person/month	0	0	0	120	0	0	0	0	0	0	0	120
	2. Collection System	Mobile Station	boat	0	0	0	0	1	1	1	0	0	0	0	3
		Stationary Station	facility	0	0	0	0	0	1	1	0	0	0	0	2
		Boat (Wastewater : Island)	boat	0	0	0	0	0	0	1	0	0	0	0	1
		Boat (Solid Waste : Island)	boat	0	0	0	0	0	1	1	0	0	0	0	2
		Toilet	facility	0	0	0	0	4	4	4	0	0	0	0	12
O&M	O&M	Labor	person/month	0	0	0	0	0	0	0	80	80	80	80	320
		Fuel & Other	boat/year	0	0	0	0	0	0	0	8 0	8 0	8 0	8 0	32
		Other	facility/year	0	0	0	0	0	0	0	12	12	12	12	48

Cost

Type	Category	Work	Unit Cost (US$)	Year 2000	Year 2001	Year 2002	Year 2003	Year 2004	Year 2005	Year 2006	Year 2007	Year 2008	Year 2009	Year 2010	Total (2000-2010)
Construction	1. Design	Design	100/pers./month	0	0	0	12,000	0	0	0	0	0	0	0	12,000
		Contingency (20%)		0	0	0	2,000	0	0	0	0	0	0	0	2,000
		Subtotal		0	0	0	14,000	0	0	0	0	0	0	0	14,000
	2. Collection Boat	Mobile Station	27,000/boat/year	0	0	0	0	27,000	27,000	27,000	0	0	0	0	81,000
		Stationary Station	13,000/facil./year	0	0	0	0	0	13,000	13,000	0	0	0	0	26,000
		Boat (Wastewater : Island)	27,000/boat/year	0	0	0	0	0	0	27,000	0	0	0	0	27,000
		Boat (Solid Waste : Island)	27,000/boat/year	0	0	0	0	0	27,000	27,000	0	0	0	0	54,000
		Toilet	30,000/facil./year	0	0	0	0	120,000	120,000	120,000	0	0	0	0	360,000
		Contingency (20%)		0	0	0	0	29,000	37,000	43,000	0	0	0	0	109,000
		Subtotal		0	0	0	0	176,000	224,000	257,000	0	0	0	0	657,000
	Total			0	0	0	14,000	176,000	224,000	257,000	0	0	0	0	671,000
O&M	O&M	Labor	80/pers./month	0	0	0	0	0	0	0	6,000	6,000	6,000	6,000	24,000
		Fuel & Other	5,000/boat/year	0	0	0	0	0	0	0	60,000	60,000	60,000	60,000	240,000
		Other	2,000/facil./year	0	0	0	0	0	0	0	24,000	24,000	24,000	24,000	96,000
		Contingency (20%)		0	0	0	0	0	0	0	18,000	18,000	18,000	18,000	72,000
		Subtotal		0	0	0	0	0	0	0	108,000	108,000	108,000	108,000	432,000
	Total			0	0	0	0	0	0	0	108,000	108,000	108,000	108,000	432,000
Grand Total				0	0	0	14,000	176,000	224,000	257,000	108,000	108,000	108,000	108,000	1,103,000

Note : Cost rounded to 4th digit, before adjustment of discount rate

Table 18.4.5 Estimated Costs & Schedule (Reinforcement of Patrolling Capability for Tourism Activities)

Schedule

Type	Category	Work	Unit	Year 2000	Year 2001	Year 2002	Year 2003	Year 2004	Year 2005	Year 2006	Year 2007	Year 2008	Year 2009	Year 2010	Total (2000-2010)
Construction	1. Design	Design	person/month	0	0	24	0	0	12	0	0	0	0	0	36
	2. Boat	Boat	boat	0	0	2	0	1	0	1	0	1	0	1	6
O&M	O&M	Labor	person/month	0	0	0	200	230	260	290	320	350	380	410	2,440
		Fuel & Other	boat/year	0	0	0	2	3	3	4	4	5	5	6	30

Cost

Type	Category	Work	Unit Cost (US$)	Year 2000	Year 2001	Year 2002	Year 2003	Year 2004	Year 2005	Year 2006	Year 2007	Year 2008	Year 2009	Year 2010	Total (2000-2010)
Construction	1. Design	Design	100/pers./month	0	0	2,000	0	0	1,000	0	0	0	0	0	3,000
		Contingency (20%)		0	0	0	0	0	0	0	0	0	0	0	0
		Subtotal		0	0	2,000	0	0	1,000	0	0	0	0	0	3,000
	2. Boat	Boat	27,000/boat	0	0	54,000	0	27,000	0	27,000	0	27,000	0	27,000	162,000
		Contingency (20%)		0	0	11,000	0	5,000	0	5,000	0	5,000	0	5,000	31,000
		Subtotal		0	0	65,000	0	32,000	0	32,000	0	32,000	0	32,000	193,000
	Total			0	0	67,000	0	32,000	1,000	32,000	0	32,000	0	32,000	196,000
O&M	O&M	Labor	100/pers./month	0	0	0	20,000	23,000	26,000	29,000	32,000	35,000	38,000	41,000	244,000
		Fuel & Other	15,000/boat/year	0	0	0	30,000	38,000	45,000	53,000	60,000	68,000	75,000	83,000	452,000
		Contingency (20%)		0	0	0	10,000	12,000	14,000	16,000	18,000	21,000	23,000	25,000	139,000
		Subtotal		0	0	0	60,000	73,000	85,000	98,000	110,000	124,000	136,000	149,000	835,000
	Total			0	0	0	60,000	73,000	85,000	98,000	110,000	124,000	136,000	149,000	835,000
Grand Total				0	0	67,000	60,000	105,000	86,000	130,000	110,000	156,000	136,000	181,000	1,031,000

Note : Cost rounded to 4th digit, before adjustment of discount rate.

Table 18.5.1 Estimated Costs & Schedule (Reforestation in Bare Areas)

Schedule

Type	Category	Work	Unit	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total (2000-2010)
Design & Construction	1. Design	Preliminary Investigation	person/month	0	36	36	0	0	0	24	18	0	0	0	114
		Project Design	person/month	0	48	48	0	0	0	24	24	0	0	0	144
	2. Bed Preparation	Bed Preparation	ha	0	240	250	300	300	300	300	300	300	300	300	2,890
	3. Reforestation	Seedlings (Trees)	each	0	250,000	250,000	250,000	250,000	250,000	375,000	375,000	375,000	375,000	375,000	3,125,000
		Revegetation with Grass	ha	0	100	100	100	100	100	150	150	150	150	150	1,250
		Tree Planting	ha	0	100	100	100	100	100	150	150	150	150	150	1,250
O&M	4.O&M	Vegetation	ha	0	0	0	300	400	650	700	900	1,000	1,100	1,200	6,250
		Personnel (Staff of FPA)	person/month	0	0	0	36	36	36	36	36	36	36	36	288

Cost

Type	Category	Work	Unit Cost (US$)	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total (2000-2010)
Design & Construction	1. Design	Preliminary Investigation	100/pers./mo.	0	4,000	4,000	0	0	0	2,000	2,000	0	0	0	12,000
		Project Design	100/pers./mo.	0	5,000	5,000	0	0	0	2,000	2,000	0	0	0	14,000
		Contingency (20%)		0	2,000	2,000	0	0	0	1,000	1,000	0	0	0	6,000
		Sub-total		0	11,000	11,000	0	0	0	5,000	5,000	0	0	0	32,000
	2. Bed Preparation	Bed Preparation	200/ha	0	48,000	50,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	578,000
		Contingency (20%)		0	10,000	10,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	116,000
		Sub-total		0	58,000	60,000	72,000	72,000	72,000	72,000	72,000	72,000	72,000	72,000	694,000
	3. Reforestation	Seedlings (Trees)	.08 each	0	20,000	20,000	20,000	20,000	20,000	30,000	30,000	30,000	30,000	30,000	250,000
		Revegetation with Grass	80/ha	0	8,000	8,000	8,000	8,000	8,000	12,000	12,000	12,000	12,000	12,000	100,000
		Tree Planting	155/ha	0	16,000	16,000	16,000	16,000	16,000	23,000	23,000	23,000	23,000	23,000	195,000
		Contingency (20%)		0	9,000	9,000	9,000	9,000	9,000	13,000	13,000	13,000	13,000	13,000	110,000
		Sub-total		0	53,000	53,000	53,000	53,000	53,000	78,000	78,000	78,000	78,000	78,000	655,000
	Total			0	122,000	124,000	125,000	125,000	125,000	155,000	155,000	150,000	150,000	150,000	1,381,000
O&M	4.O&M	Vegetation	10/ha	0	0	0	3,000	4,000	7,000	7,000	9,000	10,000	11,000	12,000	63,000
		Personnel (Staff of FPA)	40/pers./month	0	0	0	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	8,000
		Contingency (20%)		0	0	0	1,000	1,000	2,000	2,000	2,000	2,000	2,000	3,000	15,000
		Sub-total		0	0	0	5,000	6,000	10,000	10,000	12,000	13,000	14,000	16,000	86,000
	Total			0	0	0	5,000	6,000	10,000	10,000	12,000	13,000	14,000	16,000	86,000
Grand Total				0	122,000	124,000	130,000	131,000	135,000	165,000	167,000	163,000	164,000	166,000	1,467,000

Note : Cost rounded to the order of 4th digit, before adjustment of discount rate.

Table 18.5.2 Estimated Costs & Schedule (Rehabilitation of Mangrove Swamps)

Schedule

Type	Category	Work	Unit	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total (2000-2010)
Design & Construction	1. Design	Preliminary Investigation	person/month	36	0	0	24	0	0	0	24	0	0	0	84
		Project Design	person/month	48	0	0	36	0	0	0	36	0	0	0	120
	2. Bed Preparation	Bed Preparation	ha	120	120	120	120	120	120	120	120	120	120	120	1,320
	3. Reforestation	Seedlings (Trees)	each	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	3,300,000
		Tree Planting	ha	120	120	120	120	120	120	120	120	120	120	120	1,320
O&M	4.O&M	Vegetation	ha	0	0	0	360	480	600	720	840	960	1,080	1,200	6,240
		Personnel (Staff of TFMU)	person/month	0	0	0	80	80	80	80	80	80	80	80	640

Cost

Type	Category	Work	Unit Cost (US$)	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total (2000-2010)
Design & Construction	1. Design	Preliminary Investigation	100/pers./mo.	4,000	0	0	2,000	0	0	0	2,000	0	0	0	8,000
		Project Design	100/pers./mo.	5,000	0	0	4,000	0	0	0	4,000	0	0	0	13,000
		Contingency (20%)		2,000	0	0	1,000	0	0	0	1,000	0	0	0	4,000
		Sub-total		11,000	0	0	7,000	0	0	0	7,000	0	0	0	25,000
	2. Bed Preparation	Bed Preparation	200/ha	24,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000	264,000
		Contingency (20%)		5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	55,000
		Sub-total		29,000	29,000	29,000	29,000	29,000	29,000	29,000	29,000	29,000	29,000	29,000	319,000
	3. Reforestation	Seedlings (Trees)	.08 each	24,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000	264,000
		Tree Planting	155/ha	19,000	19,000	19,000	19,000	19,000	19,000	19,000	19,000	19,000	19,000	19,000	209,000
		Contingency (20%)		9,000	9,000	9,000	9,000	9,000	9,000	9,000	9,000	9,000	9,000	9,000	99,000
		Sub-total		52,000	52,000	52,000	52,000	52,000	52,000	52,000	52,000	52,000	52,000	52,000	572,000
	Total			92,000	81,000	81,000	88,000	81,000	81,000	81,000	88,000	81,000	81,000	81,000	916,000
O&M	4.O&M	Vegetation	10/ha	0	0	0	4,000	5,000	6,000	7,000	8,000	10,000	11,000	12,000	63,000
		Personnel (Staff of TFMU)	40/pers./month	0	0	0	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	24,000
		Contingency (20%)		0	0	0	1,000	2,000	2,000	2,000	2,000	3,000	3,000	3,000	18,000
		Sub-total		0	0	0	8,000	10,000	11,000	12,000	13,000	16,000	17,000	18,000	105,000
	Total			0	0	0	8,000	10,000	11,000	12,000	13,000	16,000	17,000	18,000	105,000
Grand Total				92,000	81,000	81,000	96,000	91,000	92,000	93,000	101,000	97,000	98,000	99,000	1,021,000

Note : Cost rounded to the order of 4th digit, before adjustment of discount rate.

Table 18.5.3 Estimated Costs & Schedule (Fishing Activity Management Program)

Schedule

Category	Work	Unit	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total (2000-2010)
1. Boat	Boat	boat	0	1	0	0	0	0	0	0	0	0	0	1
2.O&M	Personnel (patrol)	person/month	0	24	24	36	36	36	36	36	36	36	36	336
	Personnel (Envl Educ.)	person/month	0	12	12	24	24	24	24	24	24	24	24	216
	Personnel (data survey)	person/month	0	48	48	40	40	40	40	40	40	40	40	416
	Fuel & Other	boat/year	0	1	1	1	1	1	1	1	1	1	1	10

Cost

Category	Work	Unit Cost (US$)	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total (2000-2010)
1. Boat	Boat	27,000/boat	0	27,000	0	0	0	0	0	0	0	0	0	27,000
	Contingency (20%)		0	5,000	0	0	0	0	0	0	0	0	0	5,000
	Sub-total		0	32,000	0	0	0	0	0	0	0	0	0	32,000
2.O&M	Personnel (patrol)	40/pers./month	0	1,000	1,000	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	13,200
	Personnel (Envl Educ.)	40/pers./month	0	500	500	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	9,000
	Personnel (data survey)	40/pers./month	0	1,900	1,900	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	16,600
	Fuel & Other	1,500/boat/year	0	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	15,000
	Contingency (20%)		0	1,000	1,000	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	10,800
	Sub-total		0	5,900	5,900	6,600	6,600	6,600	6,600	6,600	6,600	6,600	6,600	65,000
Total			0	37,900	5,900	6,600	6,600	6,600	6,600	6,600	6,600	6,600	6,600	97,000

Note : Cost rounded to 3rd digit, before adjustment of discount rate.

Table 18.5.4 Estimated Costs & Schedule (Preparation of Landscape Management Guideline)

Schedule

Category	Work	Unit	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total (2000-2010)
landscape	Preliminary Investigation	person/month	0	240	0	0	0	0	0	120	0	0	0	360
	Preparation of Guideline	person/month	0	120	0	0	0	0	0	60	0	0	0	180

Cost

Category	Work	Unit Cost (US$)	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total (2000-2010)
Landscape	Preliminary Investigation	100/pers./month	0	24,000	0	0	0	0	0	12,000	0	0	0	36,000
	Preparation of Guideline	150/pers./month	0	18,000	0	0	0	0	0	9,000	0	0	0	27,000
	Contingency (20%)		0	8,000	0	0	0	0	0	4,000	0	0	0	12,000
	Su-btotal		0	50,000	0	0	0	0	0	25,000	0	0	0	75,000
Total			0	50,000	0	0	0	0	0	25,000	0	0	0	75,000

Note : Cost rounded to 4th digit, before adjustment of discount rate.

Table 18.5.5 Estimated Costs & Schedule (Reinforcement of Patrolling Capability for Shipping Activities)

Schedule

Category	Work	Unit	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total (2000-2010)
1. Boat	Boat	boat	0	0	0	1	0	0	0	0	0	0	0	1
2.O&M	Personnel	person/month	0	0	0	60	60	60	60	60	60	60	60	480
	Fuel & Other	boat/year	0	0	0	1	1	1	1	1	1	1	1	8

Cost

Category	Work	Unit Cost (US$)	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total (2000-2010)
1. Boat	Boat	27,000/boat	0	0	0	27,000	0	0	0	0	0	0	0	27,000
	Contingency (20%)		0	0	0	5,000	0	0	0	0	0	0	0	5,000
	Sub-total		0	0	0	32,000	0	0	0	0	0	0	0	32,000
2.O&M	Personnel	40/pers./month	0	0	0	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	19,200
	Fuel & Other	1,500/boat/year	0	0	0	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	12,000
	Contingency (20%)		0	0	0	800	800	800	800	800	800	800	800	6,400
	Sub-total		0	0	0	4,700	4,700	4,700	4,700	4,700	4,700	4,700	4,700	38,000
Total			0	0	0	36,700	4,700	4,700	4,700	4,700	4,700	4,700	4,700	70,000

Note : Cost rounded to 3rd digit, before adjustment of discount rate.

FIGURES

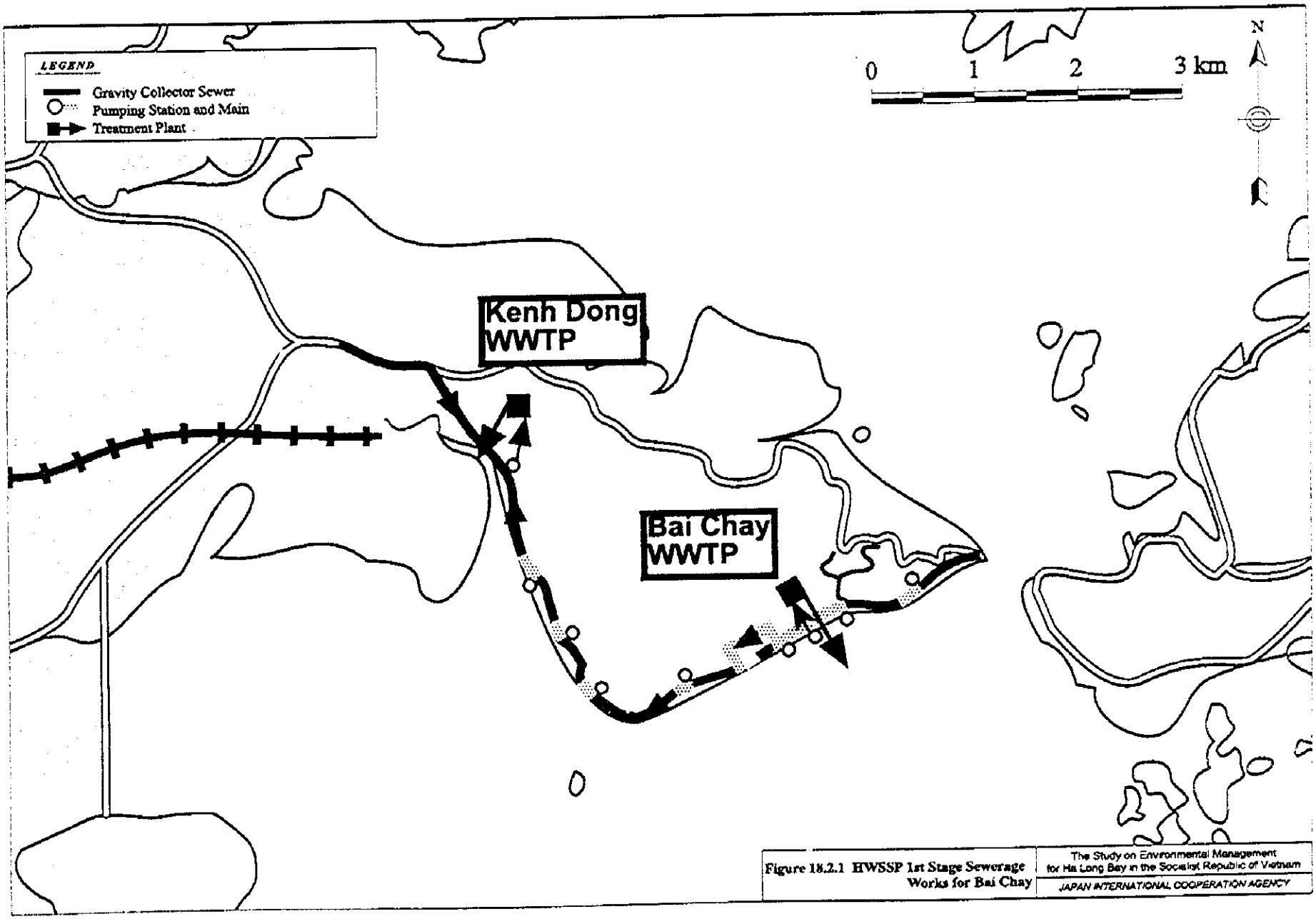

Figure 18.2.1 HWSSP 1st Stage Sewerage Works for Bai Chay

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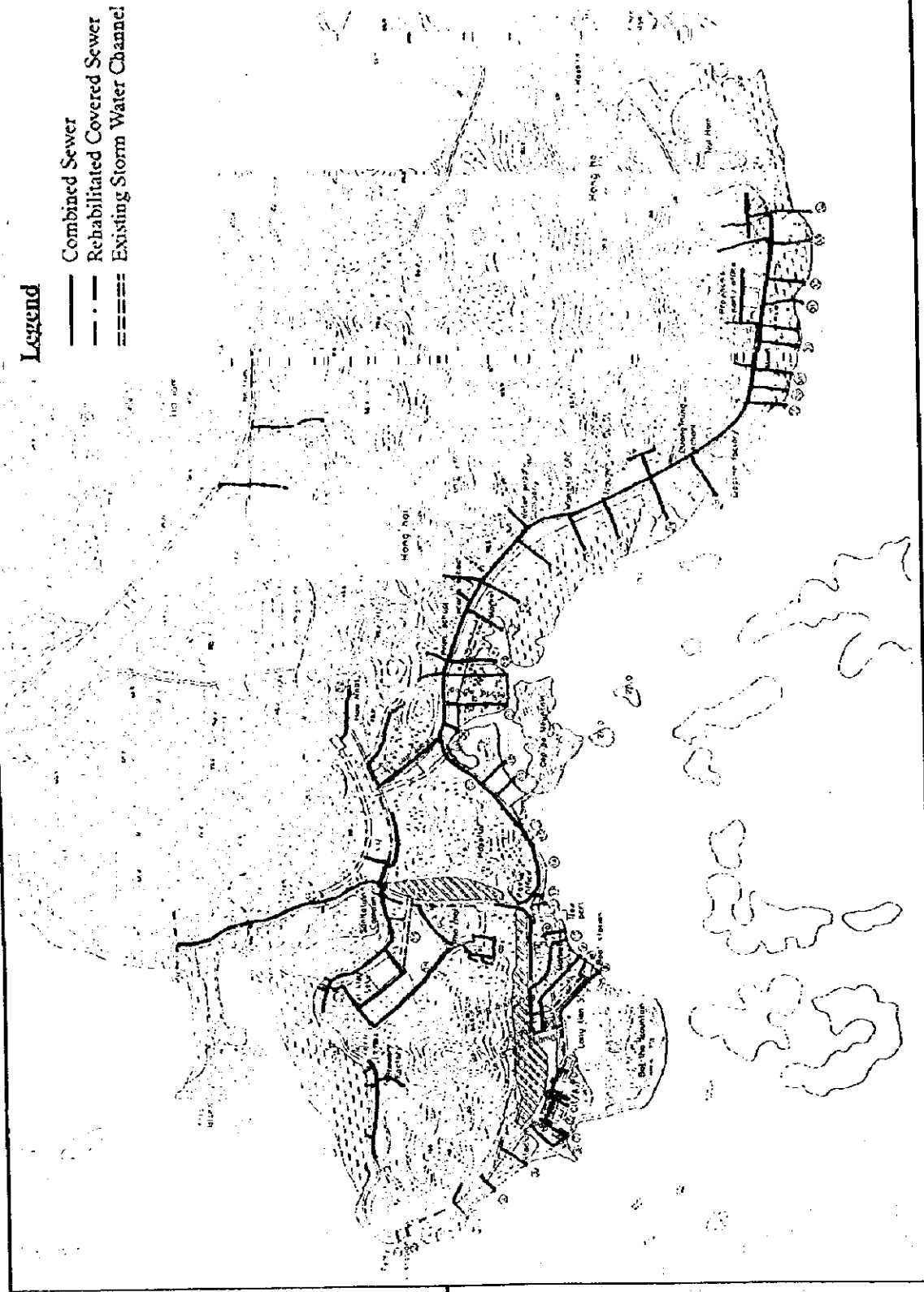
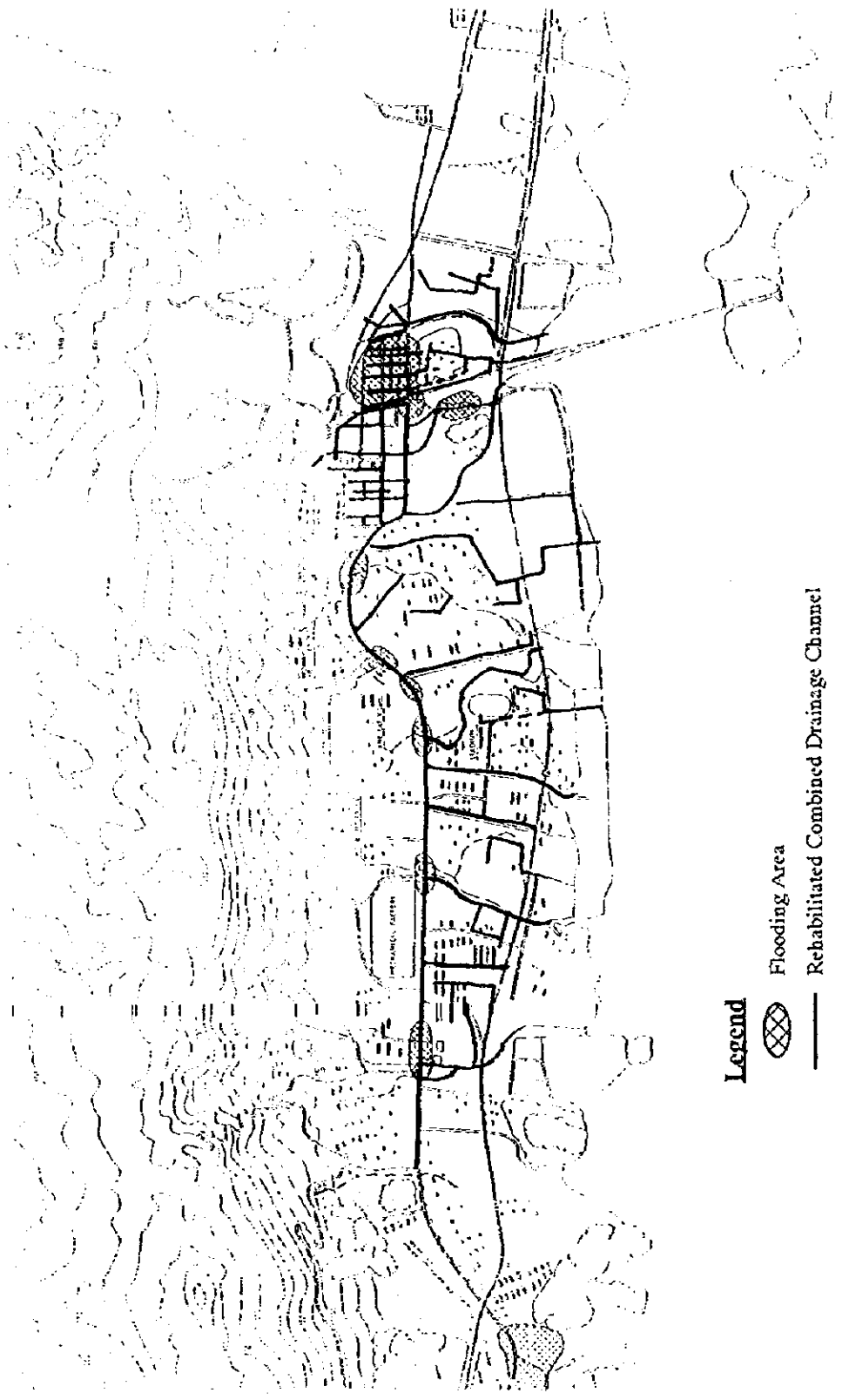


The Study on Environmental Management for Ha Long Bay in the Socialist Republic of Vietnam	Figure 18.2.2 HWSSP First Stage Drainage Works for Hong Gai
Japan International Cooperation Agency	



The Study on Environmental Management for Ha Long Bay in the Socialist Republic of Vietnam	Figure 18.2.3 HWSSP First Stage Drainage Works for Cam Pha
Japan International Cooperation Agency	

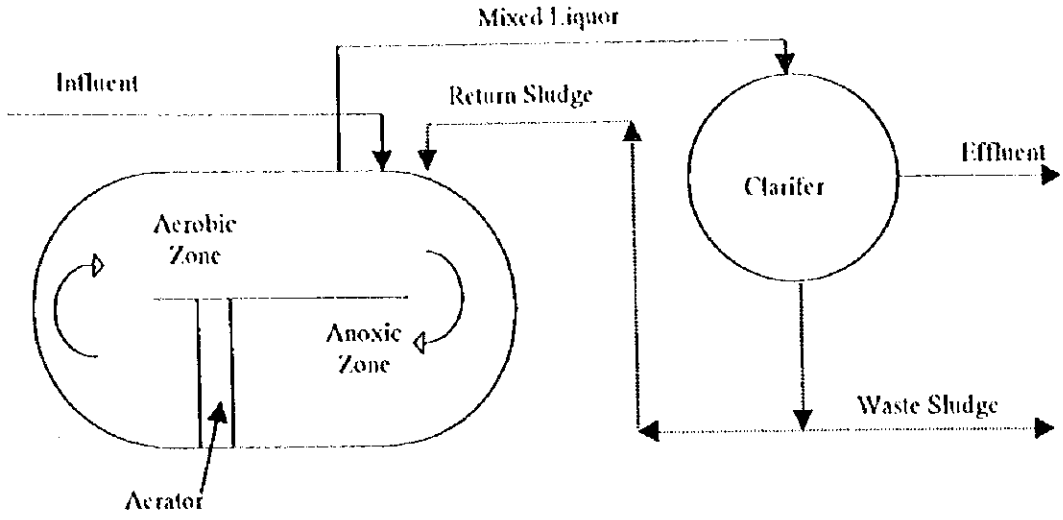


Figure 18.2.4 Combined Nitrification/Denitrification in an Oxidation Ditch

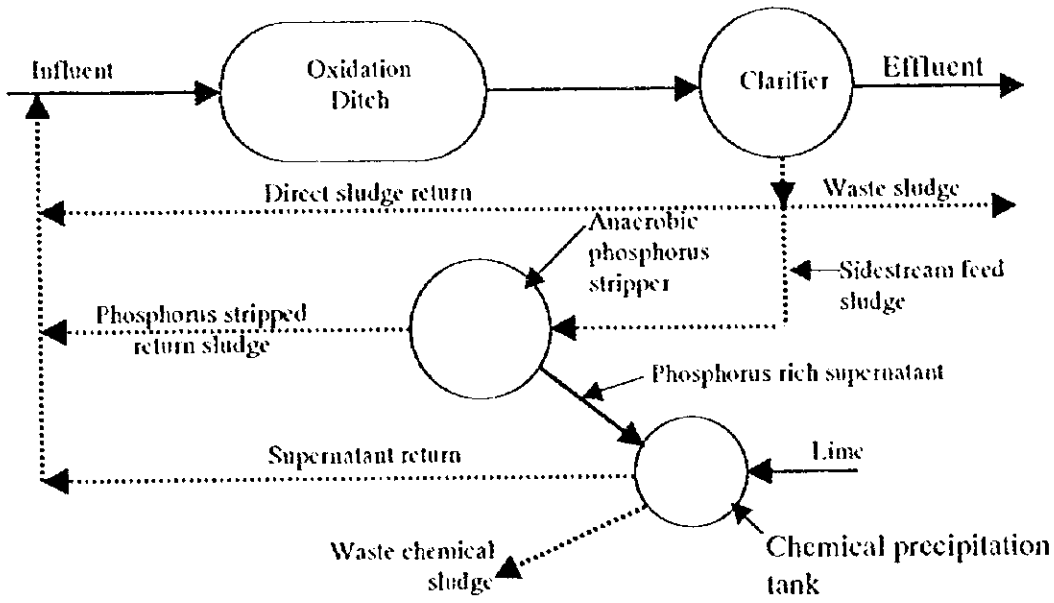


Figure 18.2.5 Oxidation Ditch with Side Stream Phosphorus Removal Process

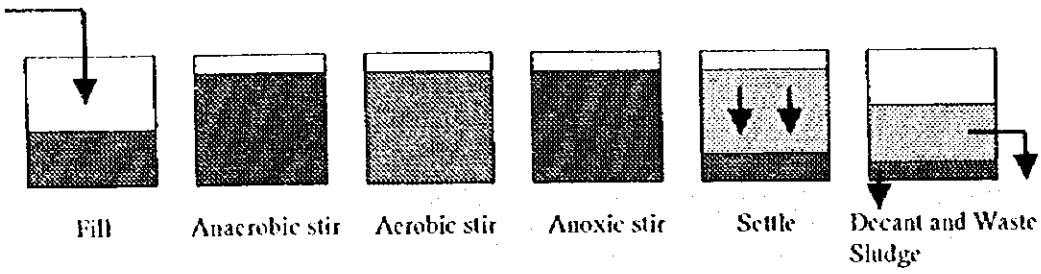


Figure 18.2.6 Sequencing Batch Reactor Operation for Carbon, Nitrogen, and Phosphorus Removal

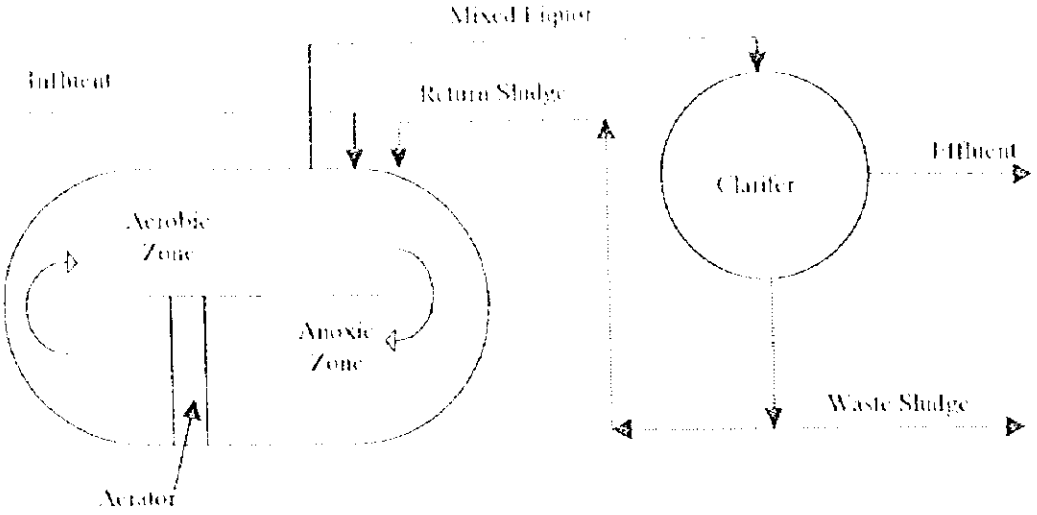


Figure 18.2.4 Combined Nitrification Denitrification in an Oxidation Ditch

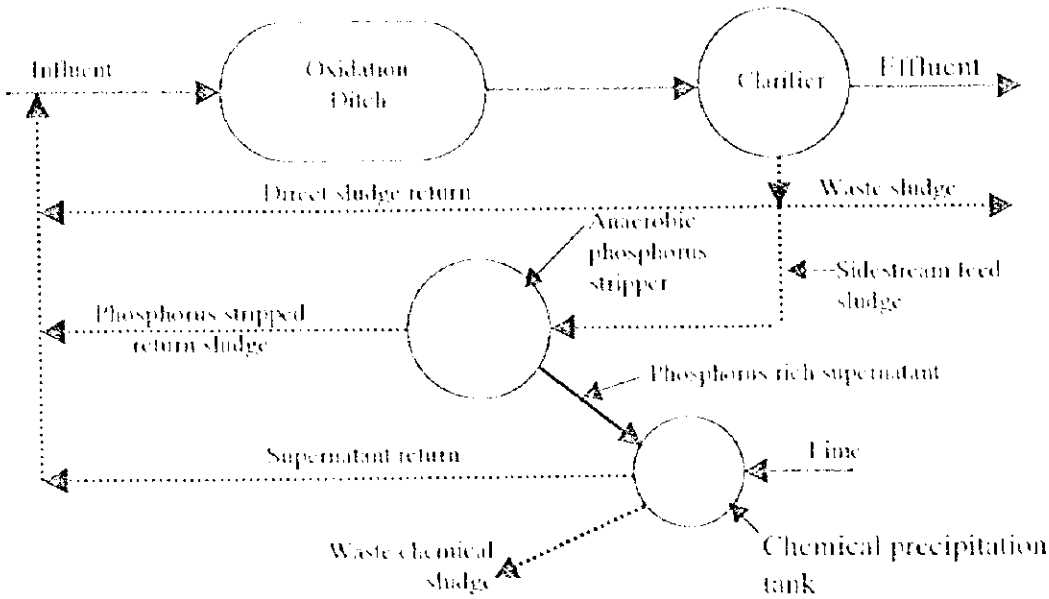


Figure 18.2.5 Oxidation Ditch with Side Stream Phosphorus Removal Process

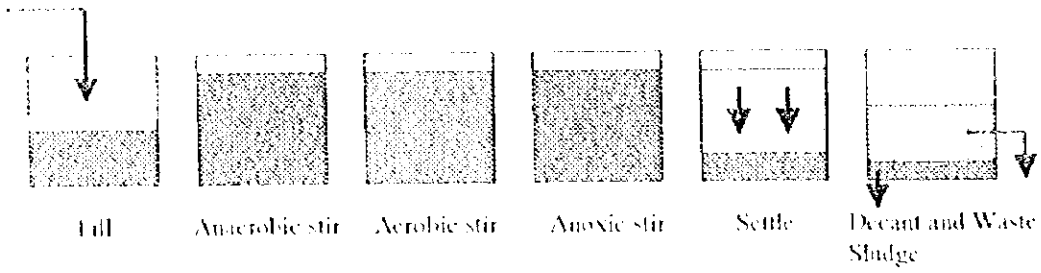
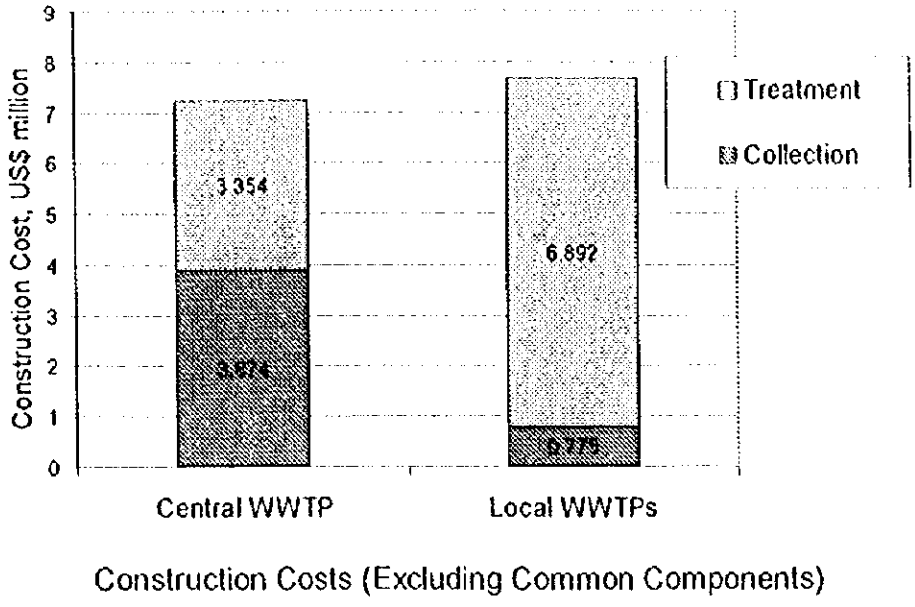
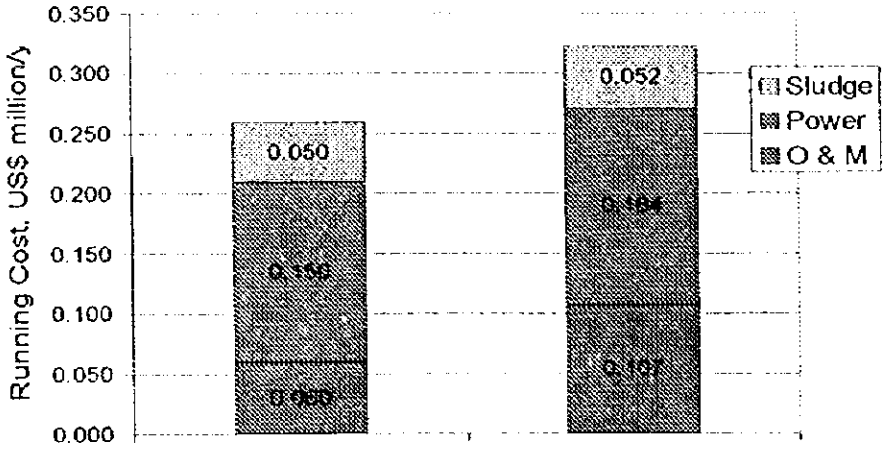


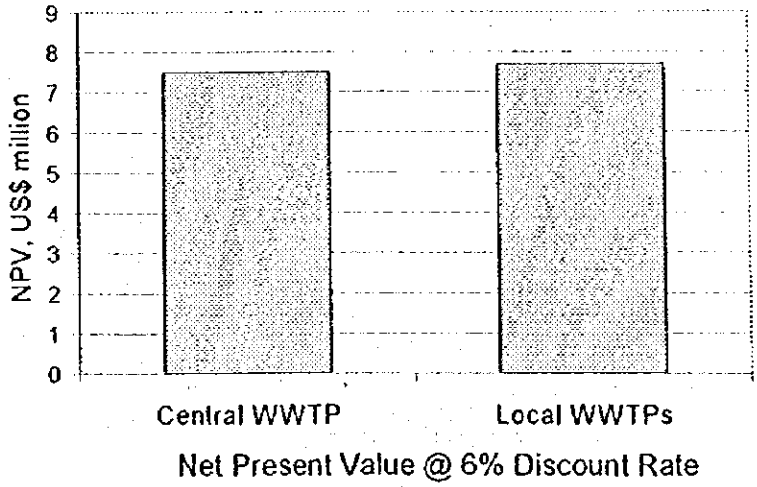
Figure 18.2.6 Sequencing Batch Reactor Operation for Carbon, Nitrogen, and Phosphorus Removal



Construction Costs (Excluding Common Components)

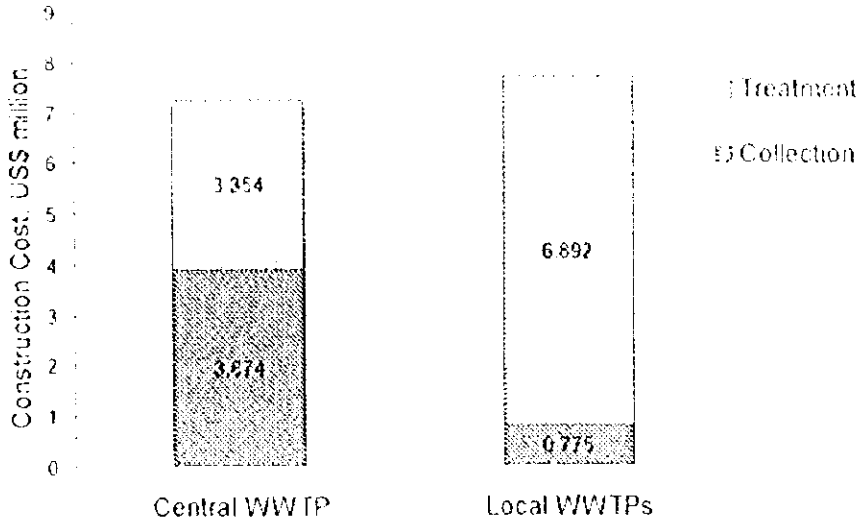


Running Costs

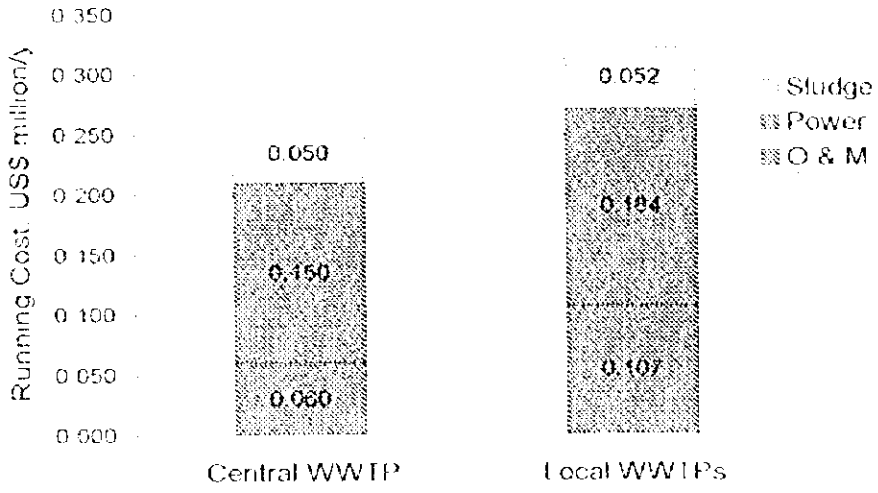


Net Present Value @ 6% Discount Rate

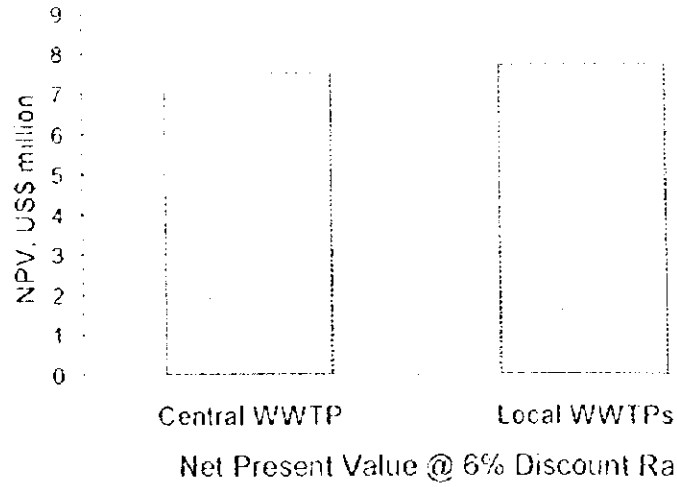
Figure 18.2.7 Cost Comparison of Central versus Local Treatment Schemes



Construction Costs (Excluding Common Components)



Running Costs



Net Present Value @ 6% Discount Rate

Figure 18.2.7 Cost Comparison of Central versus Local Treatment Schemes

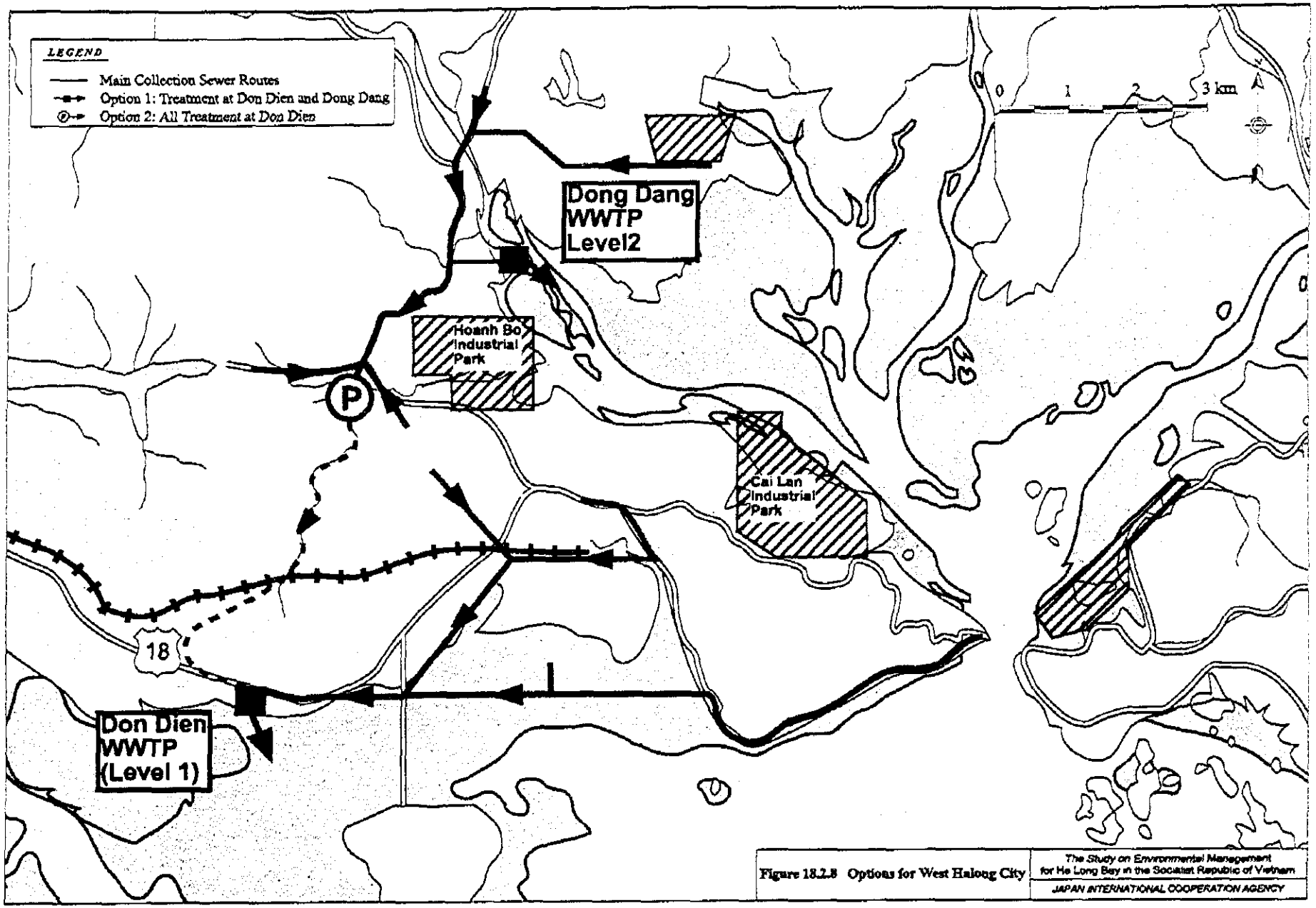


Figure 18.2.8 Options for West Halong City

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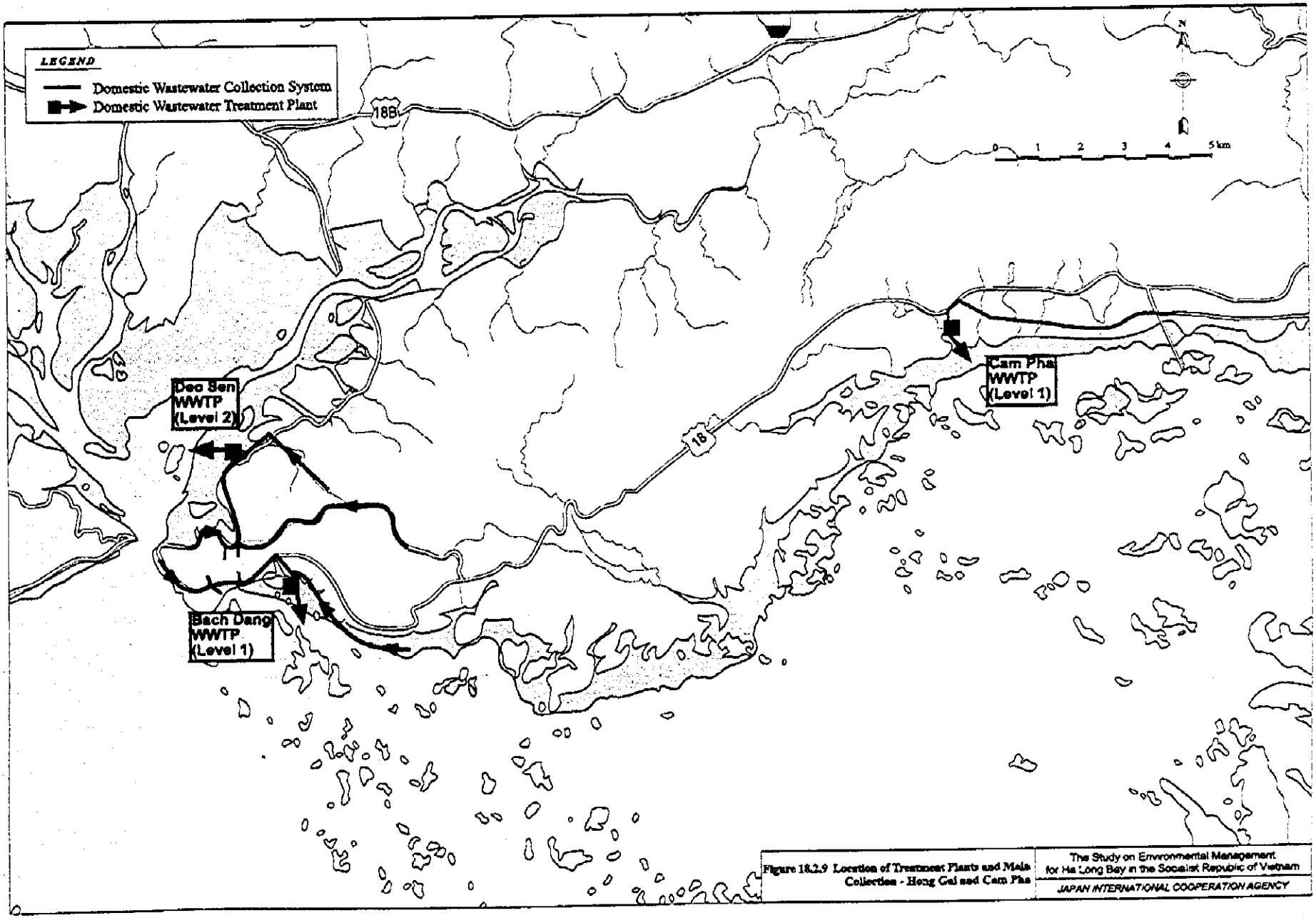

Figure 18.2.9 Location of Treatment Plants and Main Collection - Hong Gai and Cam Pha

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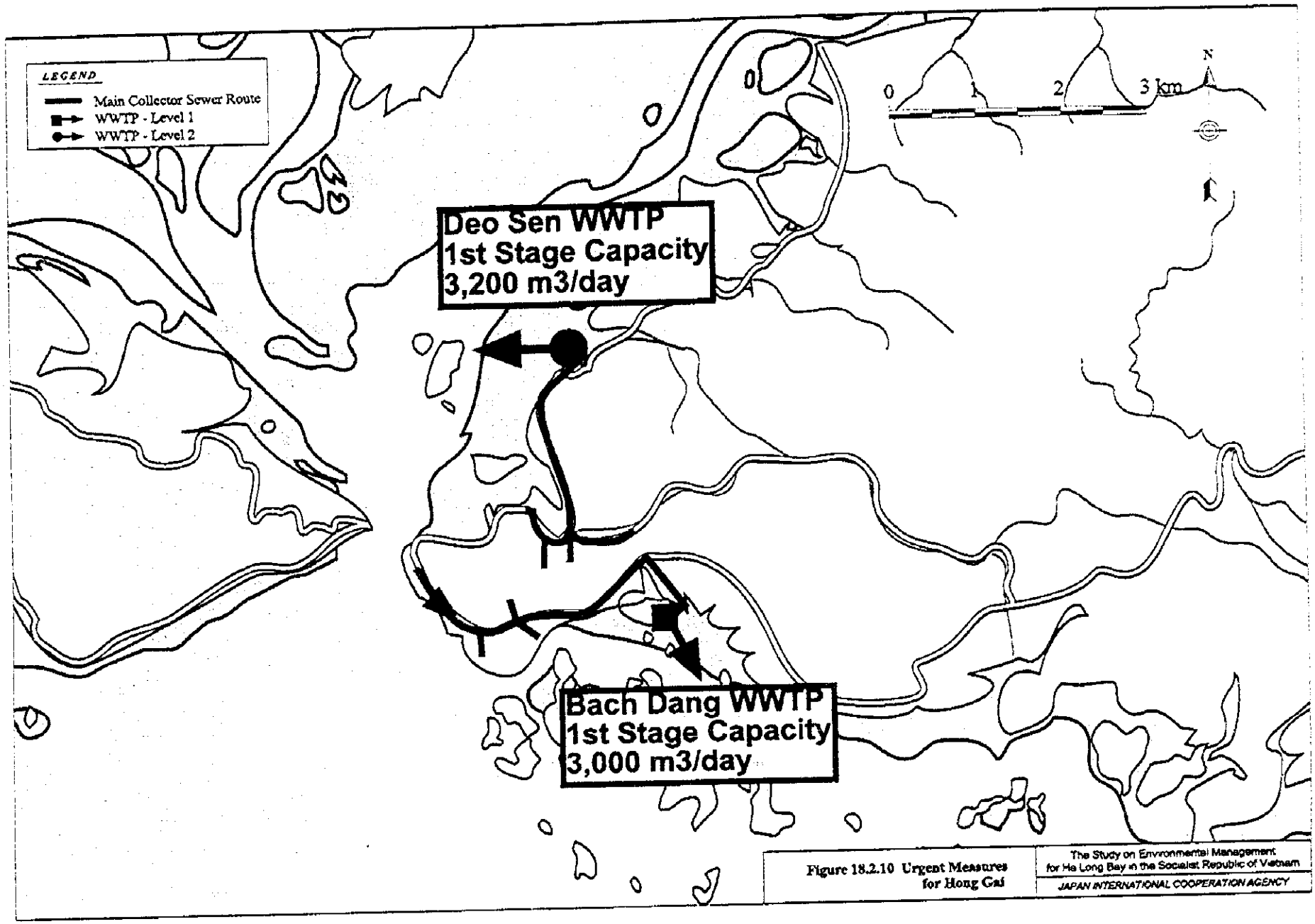

Figure 18.2.10 Urgent Measures for Hong Gai

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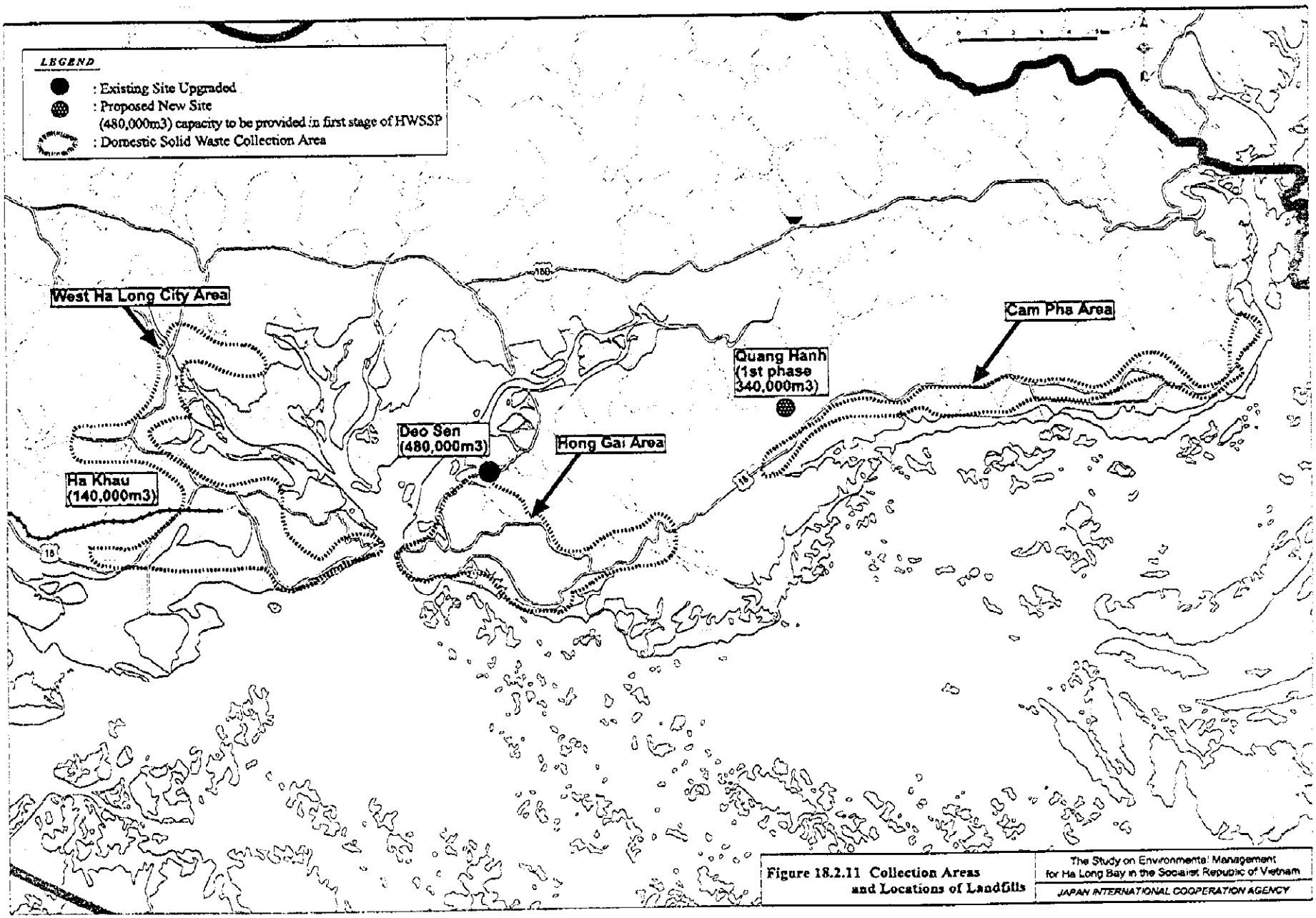

Figure 18.2.11 Collection Areas and Locations of Landfills

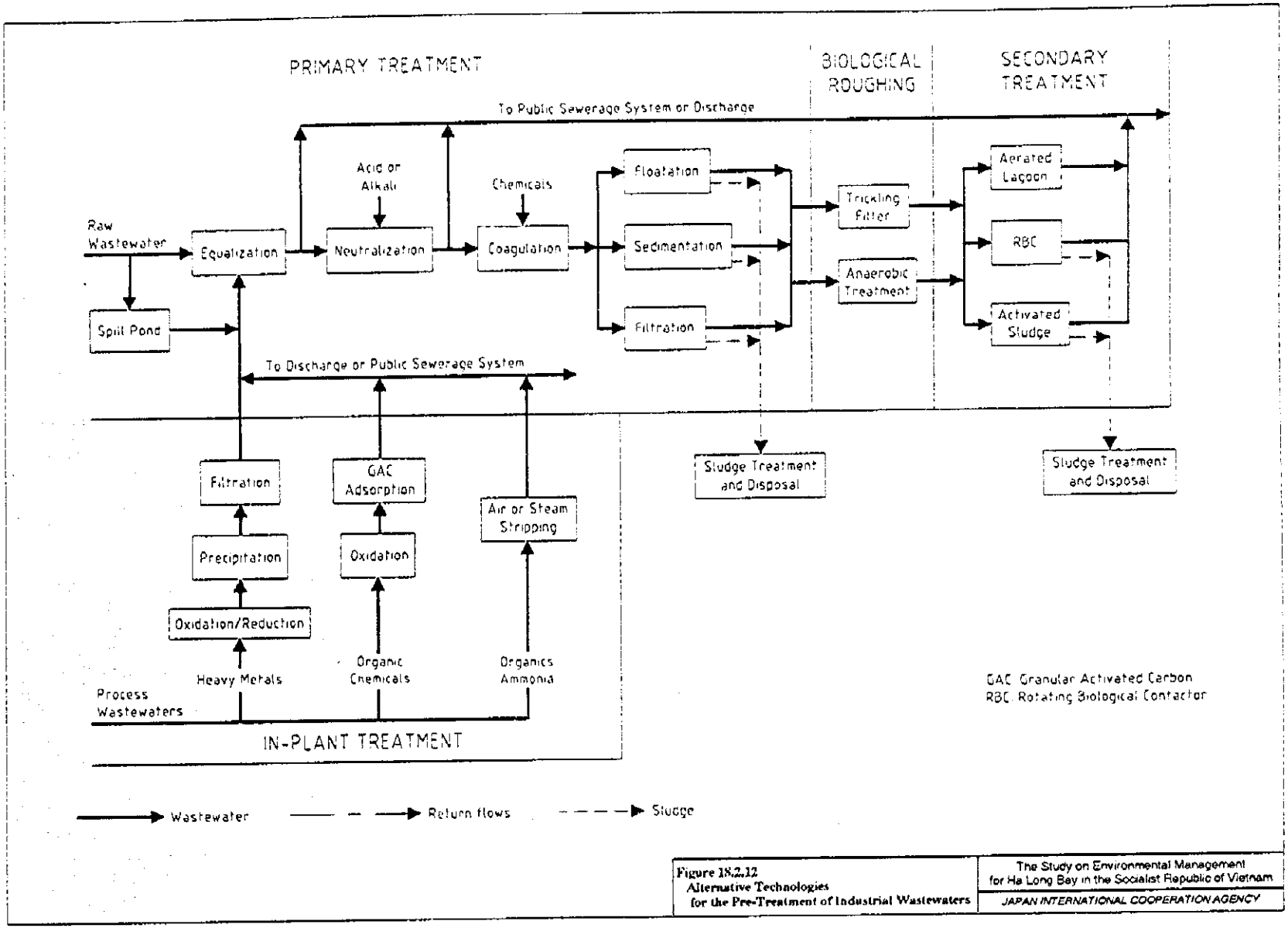

Figure 18.2.12
Alternative Technologies for the Pre-Treatment of Industrial Wastewaters

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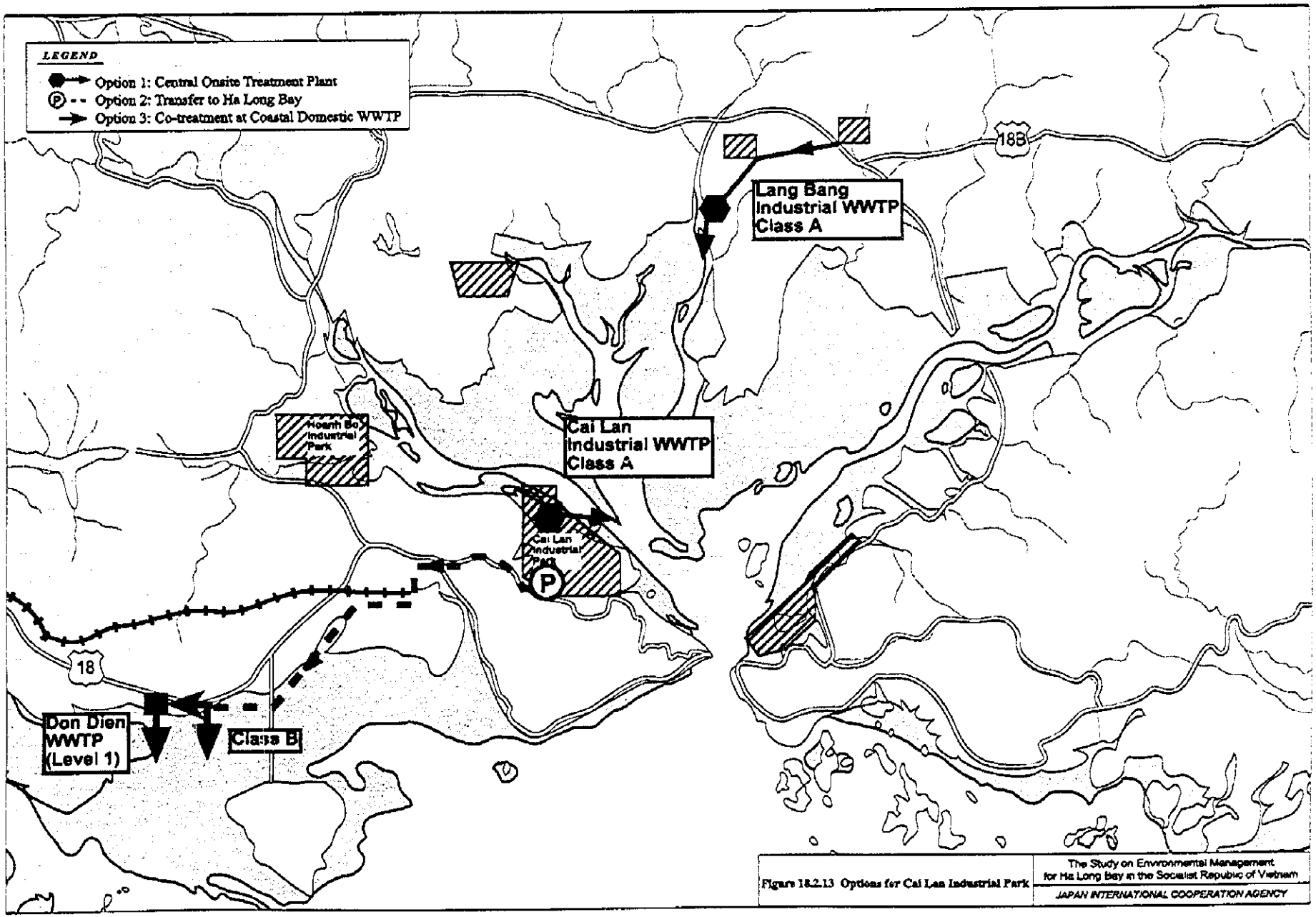

Figure 18.2.13 Options for Cai Lan Industrial Park

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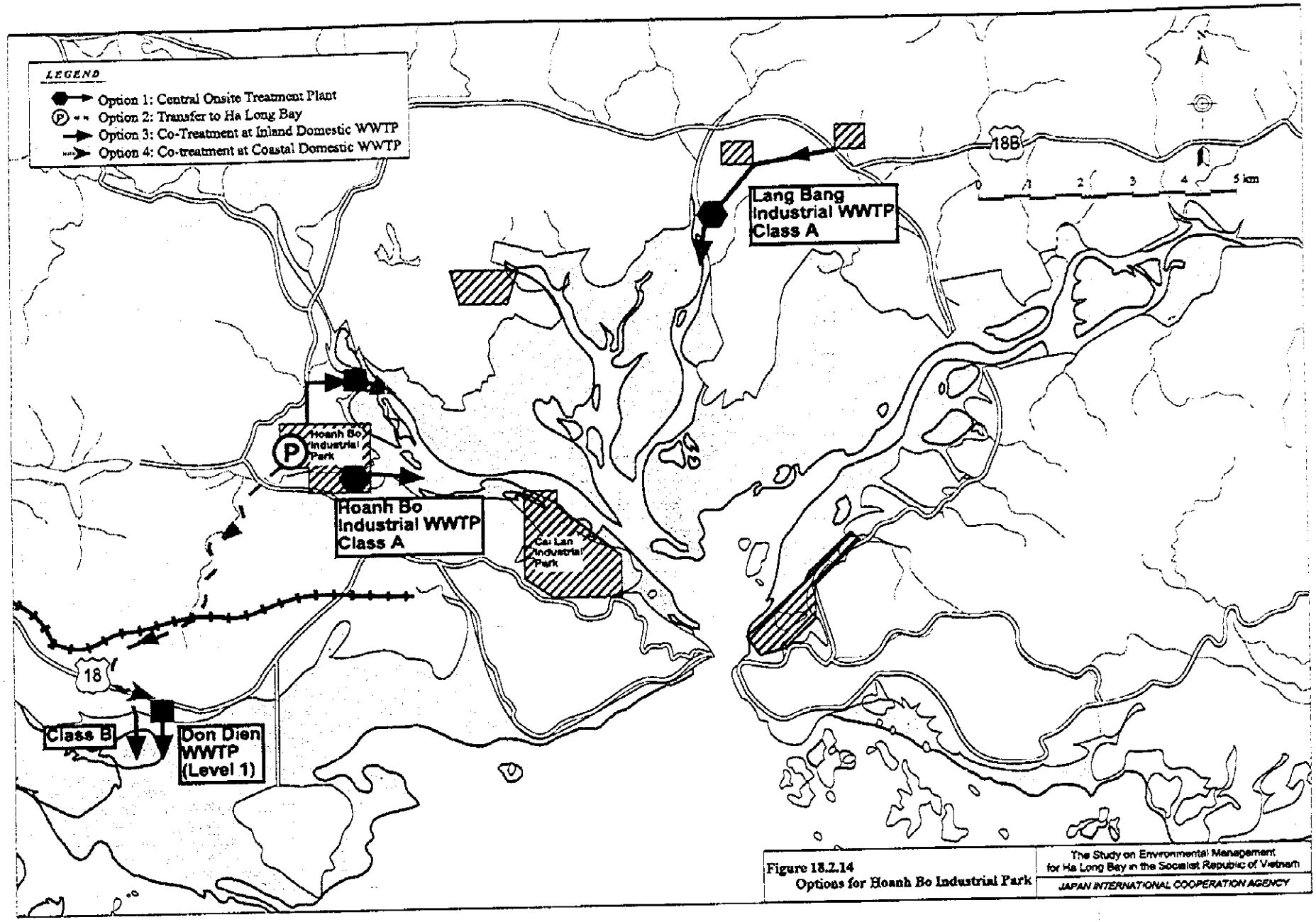

Figure 18.2.14
Options for Hoanh Bo Industrial Park

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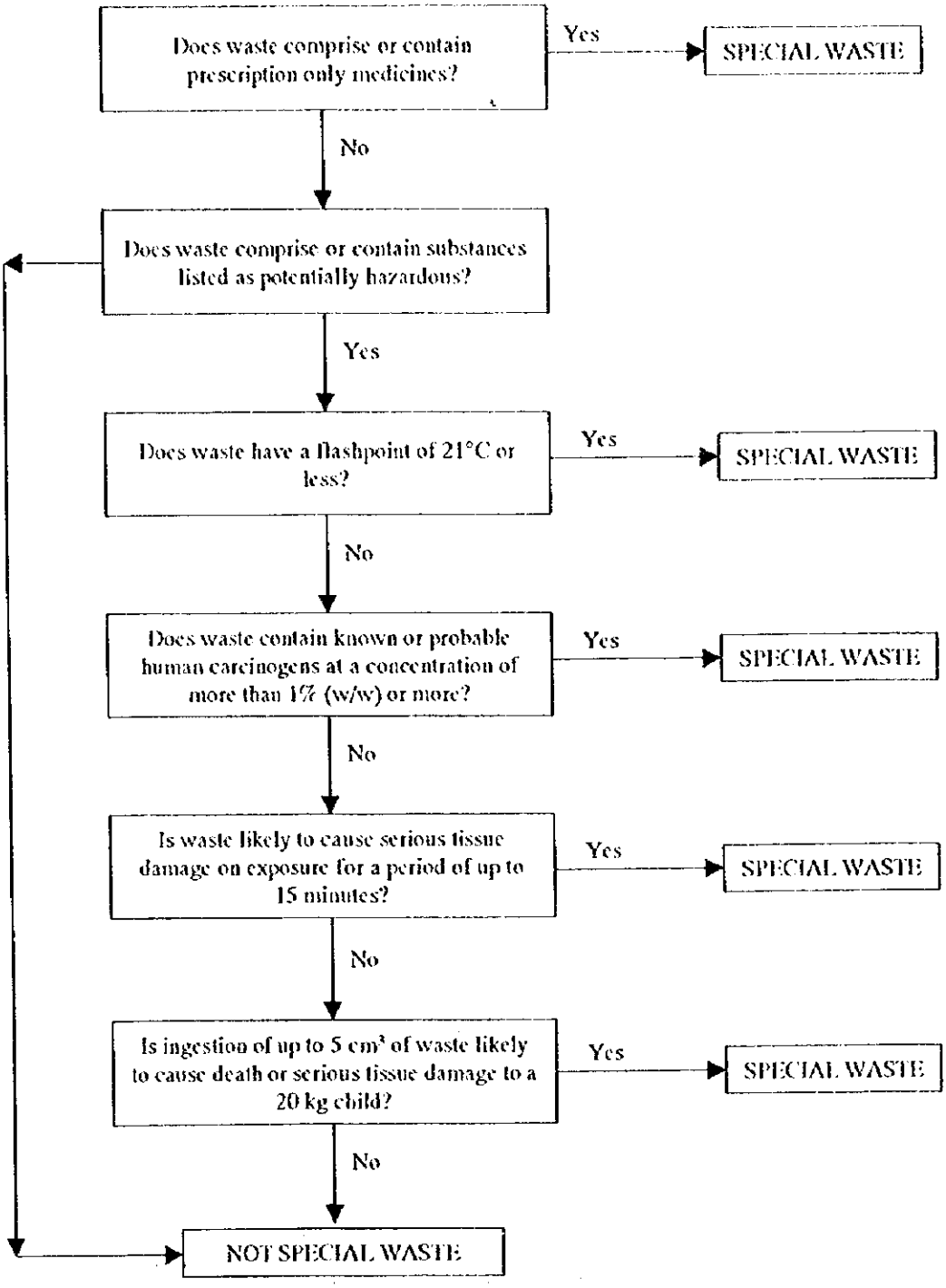

Figure 18.2.15 Special Waste Assessment Procedure Diagram

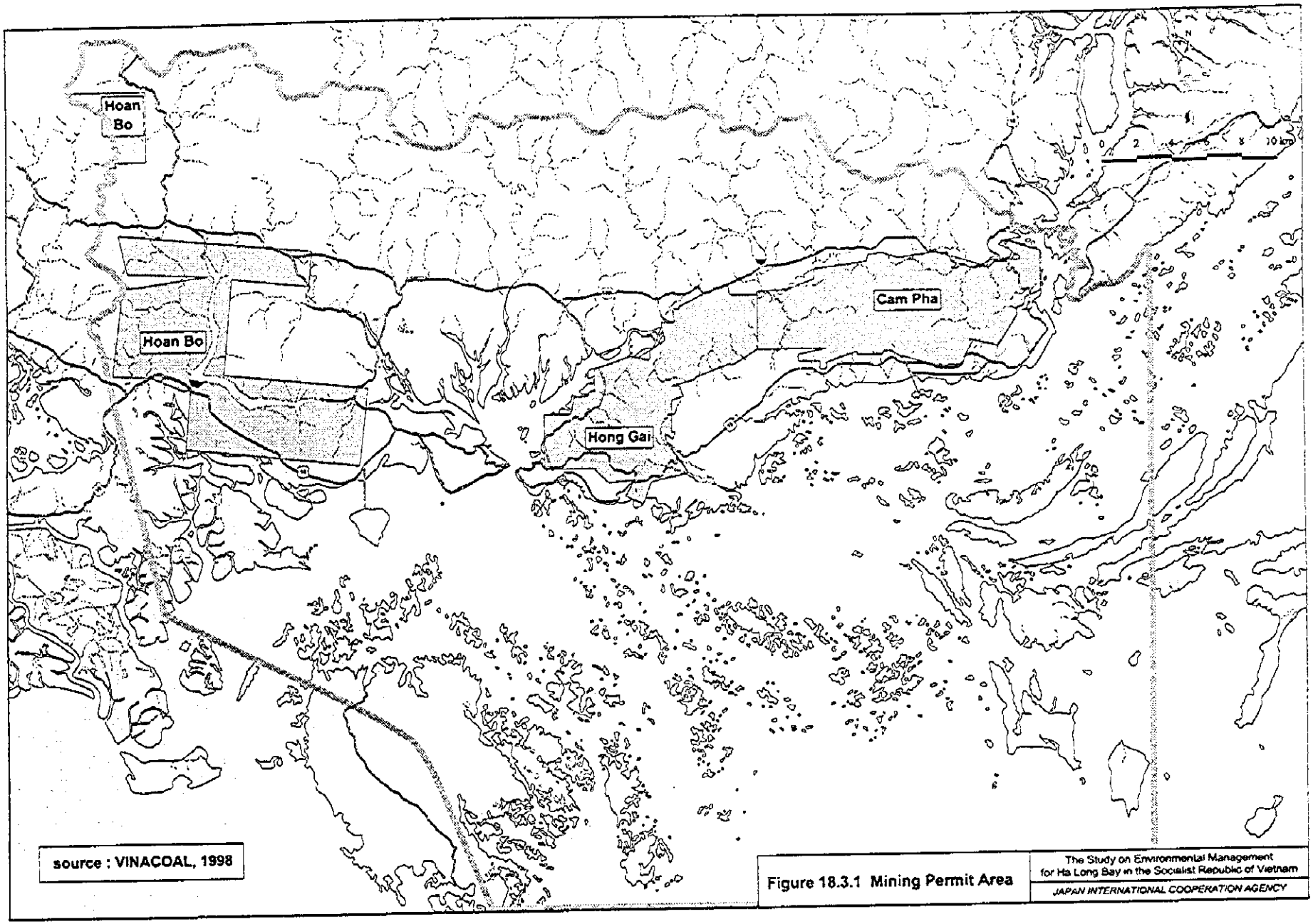

Figure 18.3.1 Mining Permit Area

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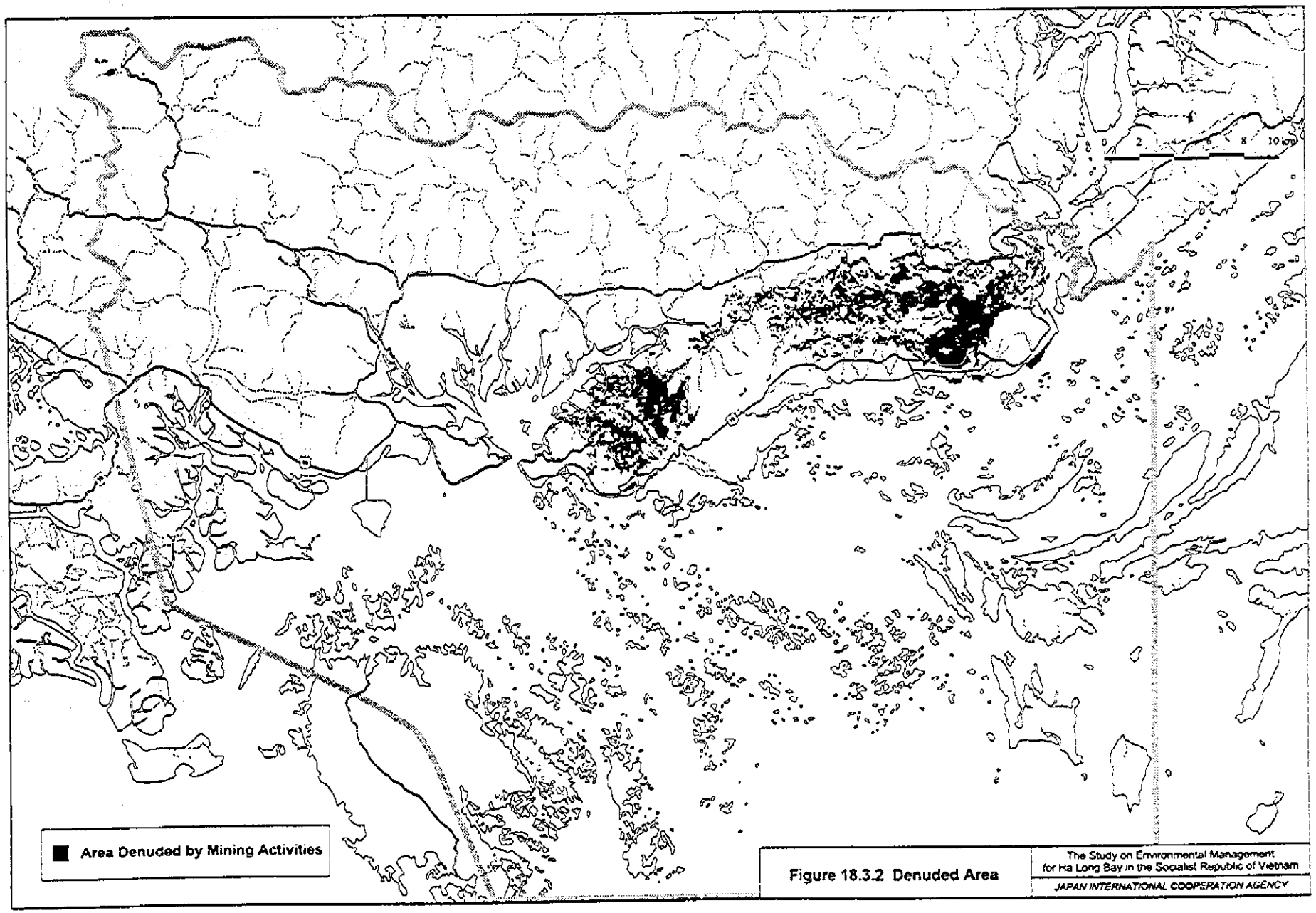

Figure 18.3.2 Denuded Area

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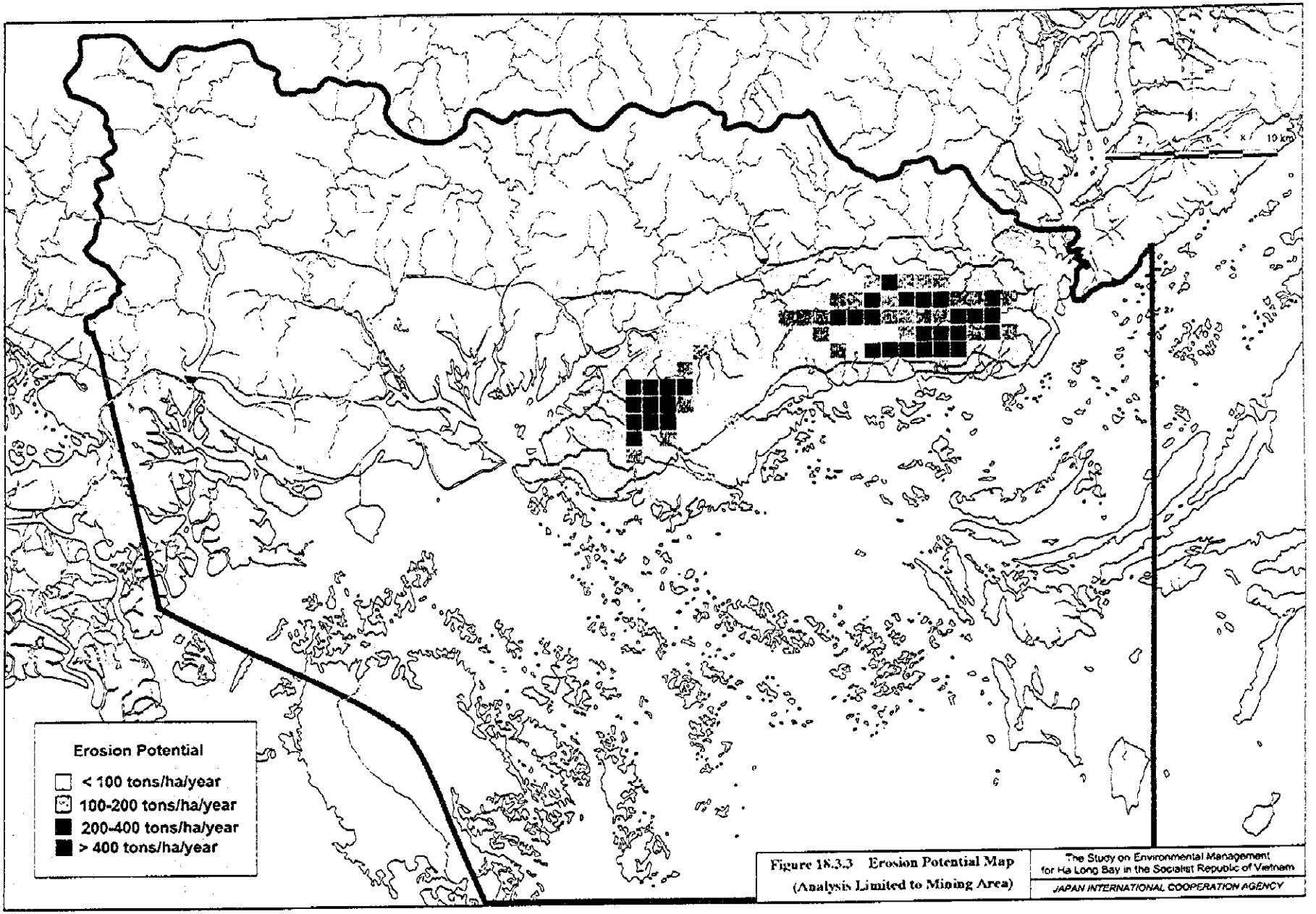

Figure 18.3.3 Erosion Potential Map
(Analysis Limited to Mining Area)

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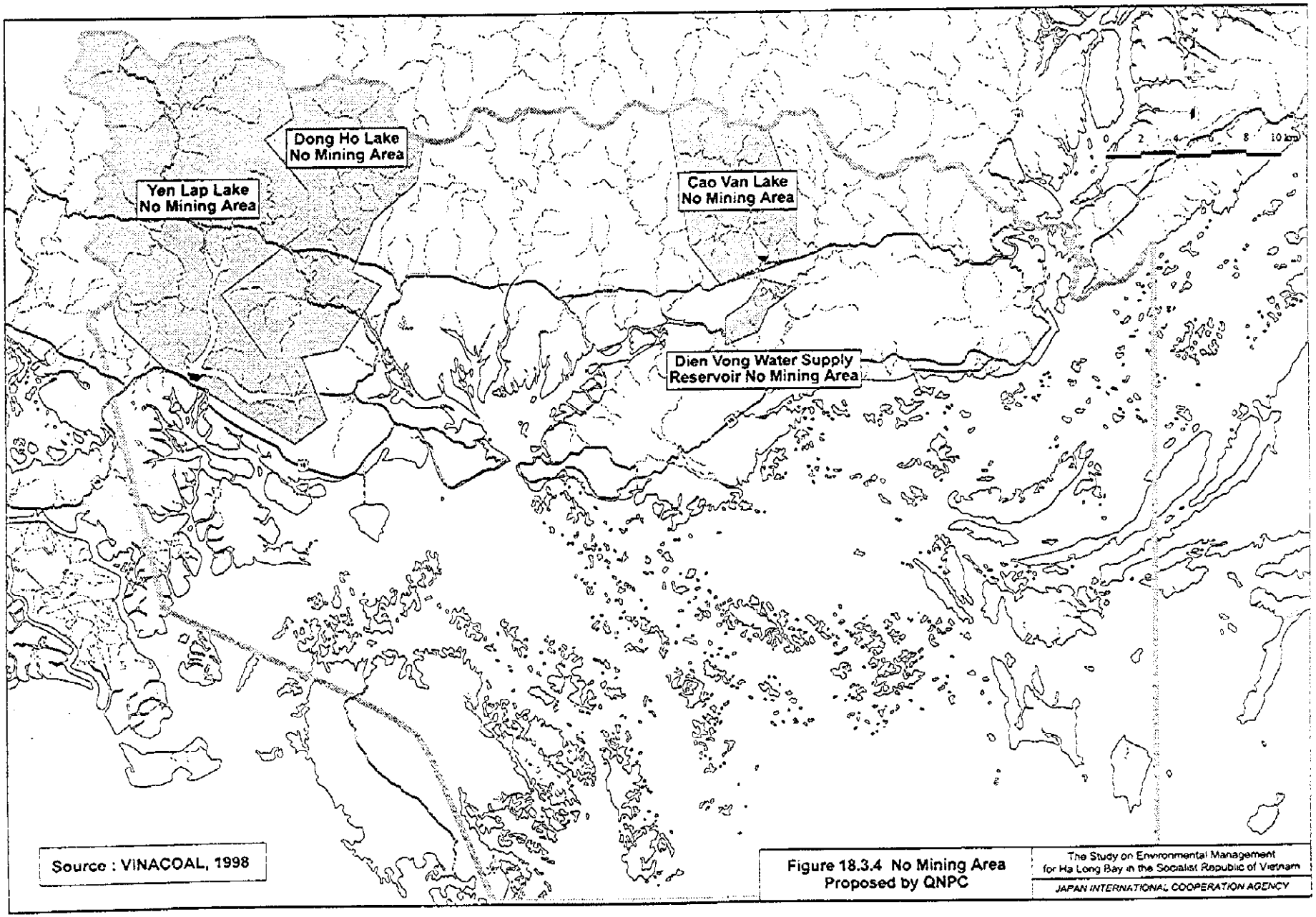

Figure 18.3.4 No Mining Area Proposed by QNPC

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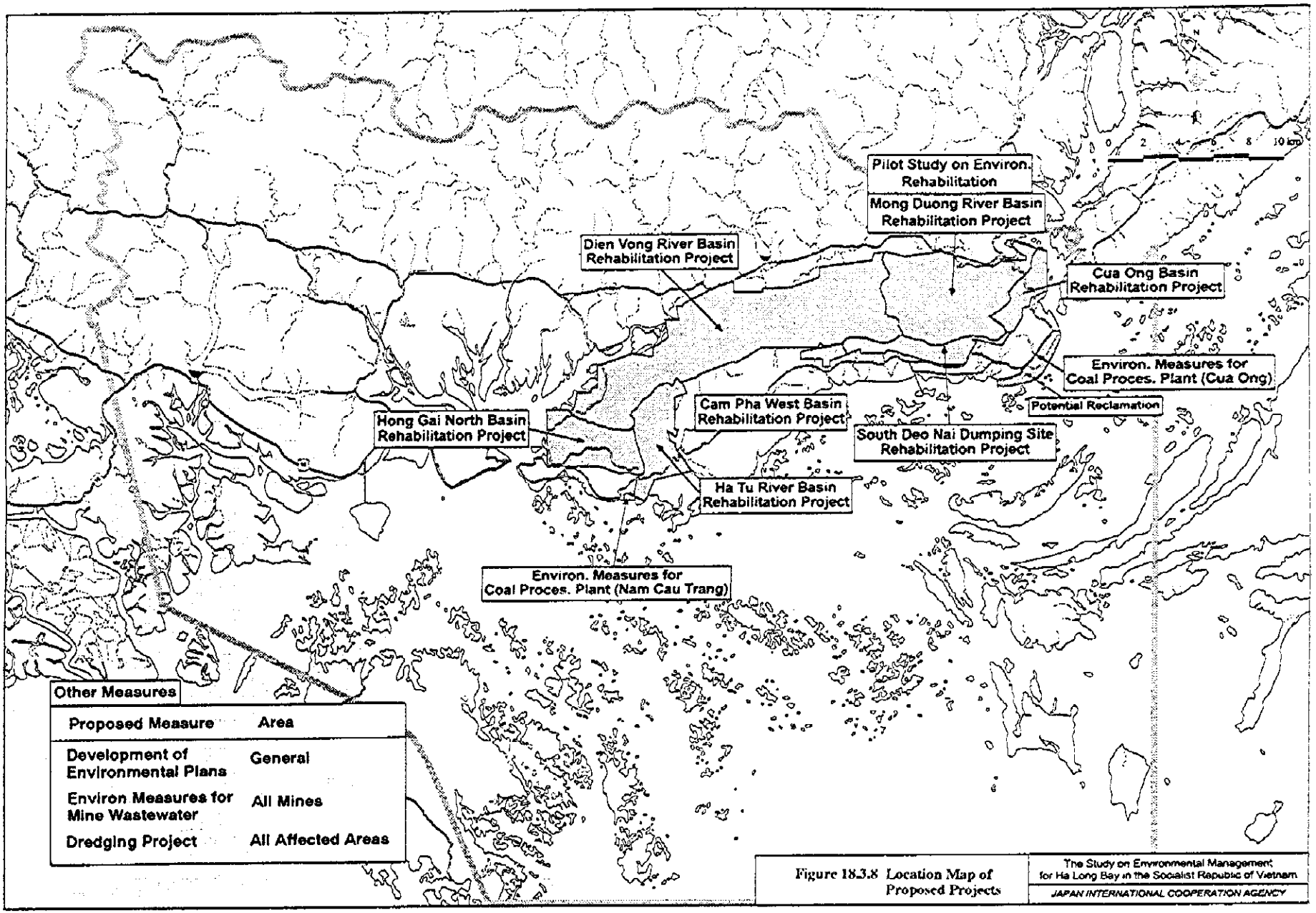

Figure 18.3.8 Location Map of Proposed Projects

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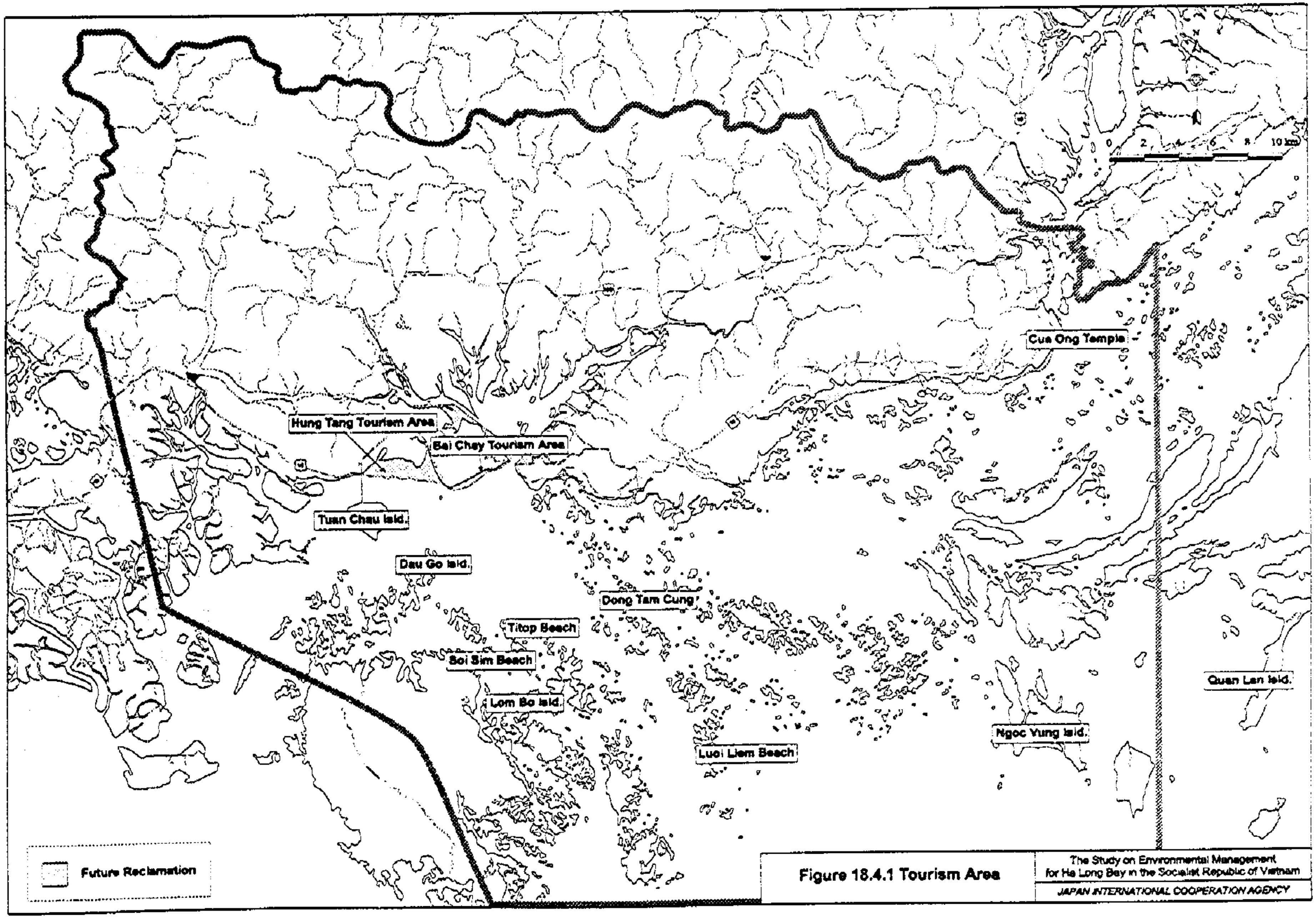

Figure 18.4.1 Tourism Area

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CHAPTER 19

CHAPTER 19 COMPARISON OF ALTERNATIVE PLANS

19.1 Setting Alternatives

19.1.1 Methodology

In Chapter 18, possible environmental measures were considered by each pollution source to achieve the proposed conservation criteria in 2010. Each component of the measures was validated from a viewpoint of technical soundness and social acceptance. Alternatives of component of the measures were also analyzed in the sector studies. Among them, however, it is necessary to analyze alternatives by combining the environmental measures of domestic wastewater and industrial wastewater. Because generated pollution loads from them were concentrated on Bai Chay bay, applicable combination of the measures for domestic and industrial wastewater should be required to manage them effectively and efficiently. Thus, the optimum environmental measures of domestic and industrial wastewater were selected by the following process:

1) Identification of areas, items, components for alternative setting,
2) Preparation of alternatives considering technical feasibility,
3) Estimation of investment cost of each alternative, and
4) Selection of the optimum measures by the least cost method.

19.1.2 Areas, Items, and Components for Alternative Setting

(1) Areas

Most planned development projects such as industrial parks are concentrated around the Bai Chay bay, and a remarkable population increase is expected around the bay and vicinity area. Moreover, the water quality of Bai Chay bay has close relation with those of the Bai Chay coastal area and the Hong Gai coastal area as well as the World Heritage area. On the other hand, the Binh Houng estuary seems to have more room of self-purification capacity compared with other areas in AMZ. Therefore, Bai Chay bay, Binh Houng estuary, Bai Chay coastal area, and Hong Gai coastal area are to be the areas considered for

alternative plans. In Cam Pha and Cua Ong area, mining activities produce major problems. Considering the crucial conditions, such problems are to be managed by measures for mining locally and urgently. Therefore, it is not appropriate to set alternatives in this area.

(2) Items

Normally, organic pollution loads of BOD and COD are main treated items of domestic wastewater control. In the case of discharging treated wastewater into Bai Chay bay, treatment methods which remove nutrients pollution loads will be required to prevent the progress of eutrophication. Hence, to meet the conservation criteria, nutrient pollution loads in terms of T-N and T-P are to be taken into account.

Alternatives are to be drawn up to attain the allowable pollution loads into Bai Chay bay, because it is essential to meet the conservation criteria. Total allowable pollution loads set for Bai Chay bay are 3,300 kg/day in BOD, 7,200 kg/day in T-N, and 2,900 kg/day in T-P as shown in Chapter 18. Among them, for example, the amounts of runoff load in BOD from domestic and industrial sources into Bai Chay bay account for 40% and 50%, respectively. Because it is difficult to control pollution loads from livestock and non-specific sources, the allowable pollution loads from domestic and industrial sources into Bai Chay bay are calculated by subtracting total allowable loads from loads of livestock and non-specific sources. The obtained allowable domestic and industries loads are as follows:

- BOD	1,300 kg/day	- COD	2,200 kg/day
- T-N	1,200 kg/day	- T-P	160 kg/day

(3) Components

The following domestic and industrial wastewater treatment plants (WWTPs) including collection systems and pumping stations are selected as the components for alternative setting. Based on the combinations of these components such as discharge point of treated wastewater, and/or whether or not industrial wastewater is connected with the sewerage system, necessary sewered population and facilities like pumping stations are changed. In the case of the industrial

wastewater to be discharged into the sewerage system, a pre-treatment is required to keep good treatment conditions in the WWTP of sewerage system.

Category	Facility
Domestic wastewater	1. Dong Dang WWTP
	2. Don Dien WWTP
	3. Deo Sen WWTP
Industrial wastewater	1. Hoanh Bo Industrial WWTP
	2. Cai Lan Industrial WWTP

Note: WWTP means wastewater treatment plant.

19.1.3 Description of Alternatives

The alternatives are drawn up on the basis of discharge points of treated wastewater from the industrial parks, whether they are to be discharged directly into Bai Chay bay or Binh Huong estuary, or to be connected with sewerage systems. These considerations led to five alternatives. In addition, the option of developing Dong Dang wastewater treatment plant (WWTP) was also considered. If the Dong Dang WWTP is not developed, the domestic wastewater is to be conveyed to Don Dien WWTP. Accordingly, ten possible alternatives are drawn up as follows, and their brief descriptions are summarized here.

Description of Alternatives

WWTP	Dischar. Point	Alternative 1		Alternative 2		Alternative 3		Alternative 4		Alternative 5	
		Alt.1.1	Alt.1.2	Alt.2.1	Alt.2.2	Alt.3.1	Alt.3.2	Alt.4.1	Alt.4.2	Alt.5.1	Alt.5.2
Dong Dang	BC	O	X	O	X	O	X	O	X	O	X
Don Dien	BH	O	O	O	O	O	O	O	O	O	O
Deo Sen	BC	O	O	O	O	O	O	O	O	O	O
Hoanh Bo industrial	BC	O	O	O	O	X	X	X	X	X	X
	BH	X	X	X	X	O	O	X	X	X	X
	SS	X	X	X	X	X	X	O	O	O	O
Cai Lan industrial	BC	O	O	X	X	X	X	O	O	X	X
	BH	X	X	O	O	O	O	X	X	X	X
	SS	X	X	X	X	X	X	X	X	O	O

Note: 1) BC; Bai Chay bay, BH; Binh Huong estuary, SS; Sewerage system,
2) O : applicable, X : not applicable

(1) Alternative 1.1 and 1.2 (see Figure 19.1.1)

Two alternatives are drawn up on the basis of treated wastewater from both Hoanh Bo and Cai Lan industrial parks to be discharged into Bai Chay bay. Corresponding to this, Dong Dang WWTP is considered in the alternative 1.1, while it is not considered in the alternative 1.2. Instead, domestic wastewater is to be conveyed to the Don Dien WWTP in the alternative 1.2.

Alterna-tive	Measures	Treatment level	Discharge point	Necessary facility
Alt. 1.1	Dong Dang WWTP (100,700)	Level 2	Bai Chay bay	-
	Don Dien WWTP (15,000)	Level 1	Binh Huong estuary	-
	Deo Sen WWTP (210,400)	Level 2	Bai Chay bay	-
	Hoanh Bo industrial WWTP	Class A	ditto	-
	Cai Lan industrial WWTP	ditto	ditto	-
Alt. 1.2	Dong Dang WWTP (-)	-	-	Pump St.
	Don Dien WWTP (111,700)	Level 1	Binh Huong estuary	-
	Deo Sen WWTP (210,400)	Level 2	Bai Chay bay	-
	Hoanh Bo industrial WWTP	Class A	ditto	-
	Cai Lan industrial WWTP	ditto	ditto	-

Note: Numbers in parenthesis show sewered population including sub-catchments 2 and 3 for Don Dien WWTP.

(2) Alternative 2.1 and 2.2 (see Figure 19.1.2)

Two alternatives are drawn up on the basis of the treated wastewater form one industrial park such as the Cai Lan industrial park to be discharged into the Binh Huong estuary area, other industrial park: The Hoanh Bo industrial park into Bai Chay bay. Thus, the Dong Dang WWTP is considered in the alternative 2.1, while it is not considered in the alternative 2.2. Instead, domestic wastewater is to be conveyed to the Don Dien WWTP in the alternative 2.2.

Alterna-tive	Measures	Treatment level	Discharge point	Necessary facility
Alt. 2.1	Dong Dang WWTP (92,200)	Level 2	Bai Chay bay	-
	Don Dien WWTP (15,000)	Level 1	Binh Huong estuary	-
	Deo Sen WWTP (190,200)	Level 2	Bai Chay bay	-
	Hoanh Bo industrial WWTP	Class A	Bai Chay bay	-
	Cai Lan industrial WWTP	Class B	Binh Huong estuary	Pump St.
Alt. 2.2	Dong Dang WWTP (-)	-	-	Pump St.
	Don Dien WWTP (105,000)	Level 1	Binh Huong estuary	-
	Deo Sen WWTP (183,700)	Level 2	Bai Chay bay	-
	Hoanh Bo industrial WWTP	Class A	Bai Chay bay	-
	Cai Lan industrial WWTP	Class B	Binh Huong estuary	Pump St.

Note: Numbers in parenthesis show sewered population including sub-catchments 2 and 3 for Don Dien WWTP.

(3) Alternative 3.1 and 3.2 (see Figure 19.1.3)

Two alternatives are drawn up on the basis of the treated wastewater from both the Hoanh Bo and Cai Lan industrial parks to be discharged into Binh Huong estuary. Correspondingly, the Dong Dang WWTP is considered in the alternative 3.1,

while it is not considered in the alternative 3.2. Instead, domestic wastewater is to be conveyed to the Don Dien WWTP in the alternative 3.2.

Alterna-tive	Measures	Treatment level	Discharge point	Necessary facility
Alt. 3.1	Dong Dang WWTP (87,500)	Level 2	Bai Chay bay	-
	Don Dien WWTP (15,000)	Level 1	Binh Huong estuary	-
	Deo Sen WWTP (164,000)	Level 2	Bai Chay bay	-
	Hoanh Bo industrial WWTP	Class B	Binh Huong estuary	Pump St.
	Cai Lan industrial WWTP	ditto	ditto	Pump St.
Alt. 3.2	Dong Dang WWTP (-)	-	-	Pump St.
	Don Dien WWTP (98,500)	Level 1	Binh Huong estuary	-
	Deo Sen WWTP (164,000)	Level 2	Bai Chay bay	-
	Hoanh Bo industrial WWTP	Class B	Binh Huong estuary	Pump St.
	Cai Lan industrial WWTP	ditto	ditto	Pump St.

Note: Numbers in parenthesis show sewered population including sub-catchments 2 and 3 for Don Dien WWTP.

(4) Alternative 4.1 and 4.2 (see Figure 19.1.4)

Two alternatives are drawn up on the basis of the wastewater form the Hoanh Bo industrial park to be connected with the public sewerage system, and the wastewater from the Cai Lan industrial park is to be discharged into Bai Chay bay. Therefore, the Dong Dang WWTP is considered in the alternative 4.1, while it is not considered in the alternative 4.2. Instead, domestic wastewater is to be conveyed to the Don Dien WWTP in the alternative 4.2.

Alterna-tive	Measures	Treatment level	Discharge point	Necessary facility
Alt. 4.1	Dong Dang WWTP (94,200)	Level 2	Bai Chay bay	-
	Don Dien WWTP (15,000)	Level 1	Binh Huong estuary	-
	Deo Sen WWTP (185,700)	Level 2	Bai Chay bay	-
	Hoanh Bo industrial WWTP	Pretreatment	Sewerage system (Dong Dang WWTP)	-
	Cai Lan industrial WWTP	Class A	Bai Chay bay	-
Alt. 4.2	Dong Dang WWTP (-)	-	-	Pump St.
	Don Dien WWTP (105,000)	Level 1	Binh Huong estuary	-
	Deo Sen WWTP (185,700)	Level 2	Bai Chay bay	-
	Hoanh Bo industrial WWTP	Pretreatment	Sewerage system (Don Dien WWTP)	Pump St.
	Cai Lan industrial WWTP	Class A	Bai Chay bay	-

Note: Numbers in parenthesis show sewered population including sub-catchments 2 and 3 for Don Dien WWTP.

(5) Alternative 5.1 and 5.2 (see Figure 19.1.5)

Two alternatives are drawn up on the basis of the wastewater from both the Hoanh Bo and Cai Lan industrial parks to be connected with the public sewerage systems. Thus, the Dong Dang WWTP is considered in the alternative 5.1, while it is not considered in the alternative 5.2. Instead, domestic wastewater is to be conveyed to the Don Dien WWTP in the alternative 5.2.

Alterna-tive	Measures	Treatment level	Discharge point	Necessary facility
Alt. 5.1	Dong Dang WWTP (92,200)	Level 2	Bai Chay bay	-
	Don Dien WWTP (15,000)	Level 1	Binh Huong estuary	-
	Deo Sen WWTP (169,000)	Level 2	Bai Chay bay	-
	Hoanh Bo industrial WWTP	Pretreatment	Sewerage system (Dong Dang WWTP)	Pump St.
	Cai Lan industrial WWTP	ditto	Sewerage system (Don Dien WWTP)	Pump St.
Alt. 5.2	Dong Dang WWTP (-)	-	-	Pump St.
	Don Dien WWTP (98,500)	Level 1	Binh Huong estuary	-
	Deo Sen WWTP (169,000)	Level 2	Bai Chay bay	-
	Hoanh Bo industrial WWTP	Pretreatment	Sewerage system (Don Dien WWTP)	Pump St.
	Cai Lan industrial WWTP	ditto	ditto	Pump St.

Note: Numbers in parenthesis show sewered population including sub-catchments 2 and 3 for Don Dien WWTP.

19.2 Study on Alternative Selection

19.2.1 Evaluation

Cost estimation of each alternative was carried out for their evaluation. Estimated costs including those of construction, operation, and maintenance are as shown in Appendices 6.1 to 6.10 and summarized below. Alternative 3.2 is the least-cost alternative followed by alternative 3.1. Alternative 5.1 is the most expensive.

Comparison of Alternatives

(Unit: US$ x 10^6)

Alternatives	Domestic WWTP	Industrial WWTP	Total
Alt.1.1	85	15	100
Alt.1.2	84	15	99
Alt.2.1	85	14	99
Alt.2.2	84	14	98
Alt.3.1	82	13	95
Alt.3.2	79	13	92
Alt.4.1	92	10	102
Alt.4.2	88	14	102
Alt.5.1	91	13	104
Alt.5.2	88	13	101

Notes: 1) Sewerage costs does not include those of 1st stage of HWSSP
2) Sewerage costs include those of sewerage systems of Bach Dang.
3) In case of industrial wastewater to be treated to class B, cost for that is not included.
4) Industrial wastewater treatment costs include those of Lang Bang.

19.2.2 Selected Alternative

As the result of evaluation of alternatives by the least cost method, alternative 3.2 was selected as the optimum combination of measures to achieve the conservation criteria of the water quality in Bai Chay bay area in 2010 set for the EMP. The components of the selected alternative 3.2 are summarized below:

- Don Dien WWTP: Sewered population 98,500 (in 2010)
  Additional main collectors including pump station 13 km
  Oxidation Ditch treatment

- Deo Sen WWTP: Sewered population 164,000 (in 2010)
  Additional main collectors including pump station 12 km
  Oxidation Ditch treatment and Phosphorus removal

- Hoanh Bo Industrial WWTP: Collection system including pump station 5.4 km
  Main pump station
  Wastewater treatment plant to be prepared by industrial park

- Cai Lan Industrial WWTP: Collection system including pump station 5.4 km
  Main pump station

Wastewater treatment plant to be prepared by industrial park

The proposed domestic and industrial WWTPs aim to reduce organic, nutrients, and SS loads. Based on the selected alternative, the allowable SS runoff load of non-specific sources is calculated for sub-catchments of No.4 to 7, where the increase of denuded area is comparatively large. The calculated allowable SS load from non-specific source is 83 tons/day, and hence total 463 km^2 of green coverage will be required in sub-catchments of No.4 to 7.

19.3 Prediction of Water Quality by the Selected Plan

To predict the effect of the Selected plan, the best alternative considered in the Study, the model was run again replacing Scenario II by the optimum plan. The discharges and pollution loads for Scenario II were changed to those for the optimum plan as shown in Figure 19.3.1 and Table 19.3.1 under the same pollution load levels as Scenario II.

(1) Prediction of Currents by the Selected Plan

The hydrodynamic model was run to provide hydrodynamic conditions for the selected plan to be used in the prediction of water quality. The only changes of the conditions from Scenario II were the new discharge of No. 1.1 and the additional discharge of No. 13 in Table 19.3.1. No significant change was found in the circulation patterns shown in Figure 19.3.2~19.3.4 compared to the results by Scenario II.

(2) Prediction of Water Quality

Predicted concentrations of water quality parameters for the selected plan were shown in Figure 19.3.5~19.3.14. BOD concentrations were estimated from COD by the conversion factor of BOD = COD/4.9 derived from the Field Survey for reference.

The concentrations by the selected plan decreased in Bai Chay bay and increased in western side of the causeway compared to the results by Scenario II except I-P. This shift corresponded to the relocation of pollution loads discharged inside Bai Chay bay in Scenario II to the western side of the causeway in the selected plan as No. 1.1 in Figure 19.3.1 and Table 19.3.1.

The causeway toward Tuan Chau island clearly separated the distributions of all water quality parameters in a similar way to the results by Scenario II. These influences were not found in the results by the present condition targeting 1998 in Section 12.5 because just less than half of the construction of the causeway was completed as of 1998.

(3) Difference between the Results by the Selected Plan and those by Scenario II

To show the effect by the selected plan, the differences of the water quality parameters compared to the results by Scenario II were obtained as shown in Figure 19.3.15~19.3.24.

The causeway toward Tuan Chau island clearly separated the decreased and increased area of the concentrations caused by the reallocations of pollution loads. The reduction effects of the pollution loads inside Bai Chay bay are remarkable for most water quality parameters especially near the mouth of Troi River, the discharge point No. 4 in Figure 19.3.1. On the other hand, local increases of the concentrations were found near the new discharge point No. 1.1 in Figure 19.3.1 for all water quality parameters except I-P.

Compared with the simulated water quality and the conservation criteria, the simulated water quality by the selected plan met the conservation criteria.

TABLE

Table 19.3.1 Discharges and Pollution Loads by the Selected Plan

No.	Name of Sub-catchment	Discharge (m3/s)	SS (kg/day)	COD (kg/day)	T-N (kg/day)	T-P (kg/day)	I-N * /T-N	I-P * /T-P
1	Mip River	23.6	32,100	3,060	2,340	1,140	0.17	0.035
1.1		0.7	4,726	2,907	1,922	225	0.50	0.066
2	Hung Thang Basin	0.7	2,000	270	150	80	0.15	0.049
3	Bai Chay Basin	0.8	1,200	200	110	60	0.50	0.049
4	Troi River	18.7	26,500	2,680	2,290	950	0.50	0.066
5	Man River	11.2	16,800	1,680	1,250	620	0.50	0.053
6	Dieng Vong River	24.4	39,100	3,780	2,690	1,090	0.50	0.062
7	Hong Gai North Basin	1.6	7,392	632	397	155	0.50	0.016
8	Hon Hay South Basin	0.8	2,673	993	788	147	0.50	0.016
9	Ha Tu Basin	3.3	23,000	1,470	980	350	0.20	0.040
10	Cam Pha West Basin	3.2	11,500	1,510	740	210	0.12	0.029
11	Cam Pha Central Basin	2.0	11,428	1,028	850	189	0.23	0.036
12	Cam Pha East Basin	1.5	18,300	1,740	690	120	0.05	0.035
13	Cua Ong Basin	3.7	4,900	580	360	80	0.20	0.042
14	Mong Duong River	10.1	22,500	1,390	1,320	460	0.20	0.042
15-1	Cat Ba Island	3.5	3,267	437	367	160	0.15	0.049
15-2	Cat Ba Island	3.5	3,267	437	367	160	0.15	0.049
15-3	Cat Ba Island	3.5	3,267	437	367	160	0.15	0.049
Total		116.8	233,920	25,231	17,978	6,356	-	-

Note: * The ratio of I-N/T-N and I-P/T-P were used based on the Field Survey data with some calibration to estimate inorganic part and organic part in the loads separately.

FIGURES

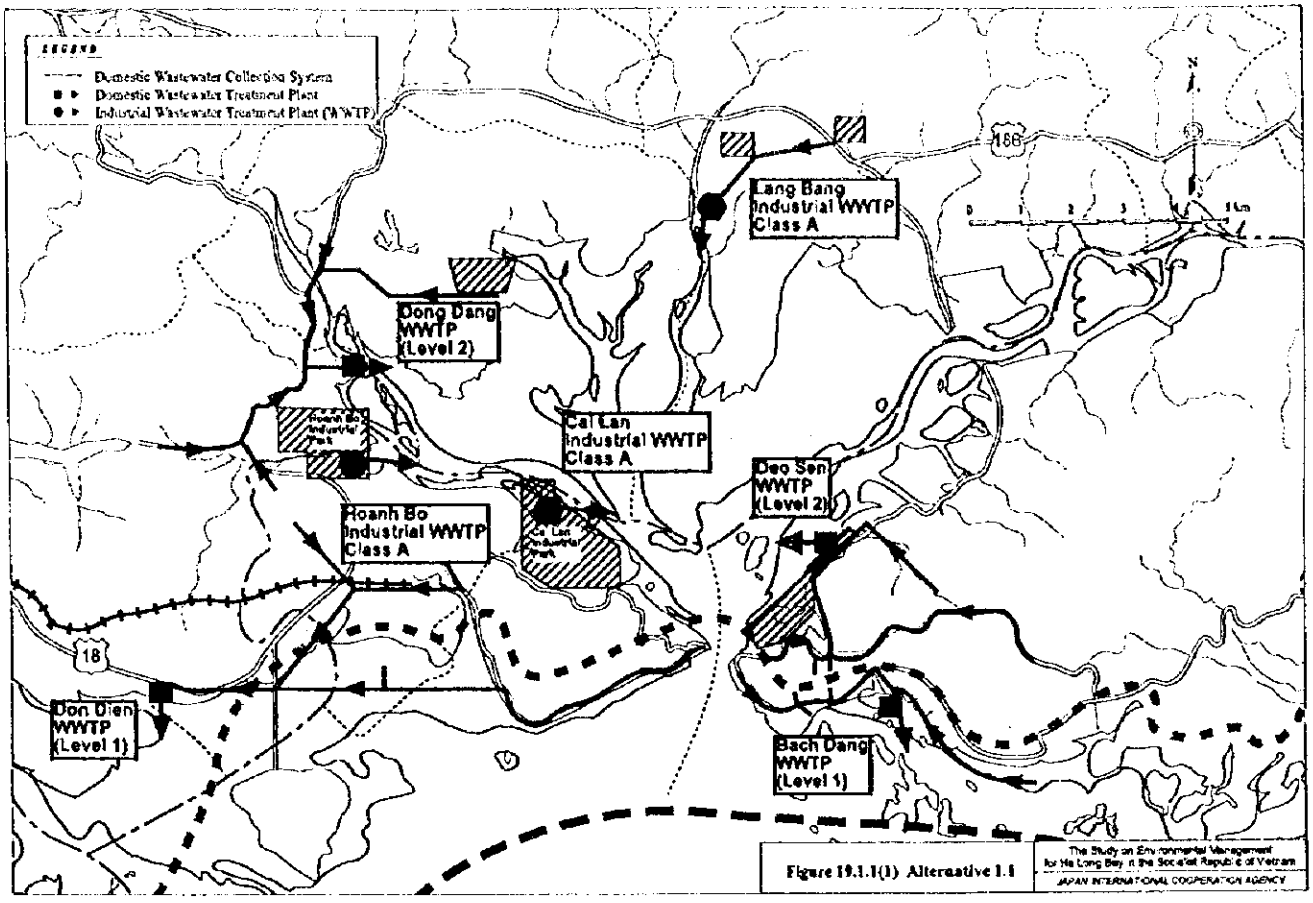

Figure 19.1.1(1) Alternative 1.1

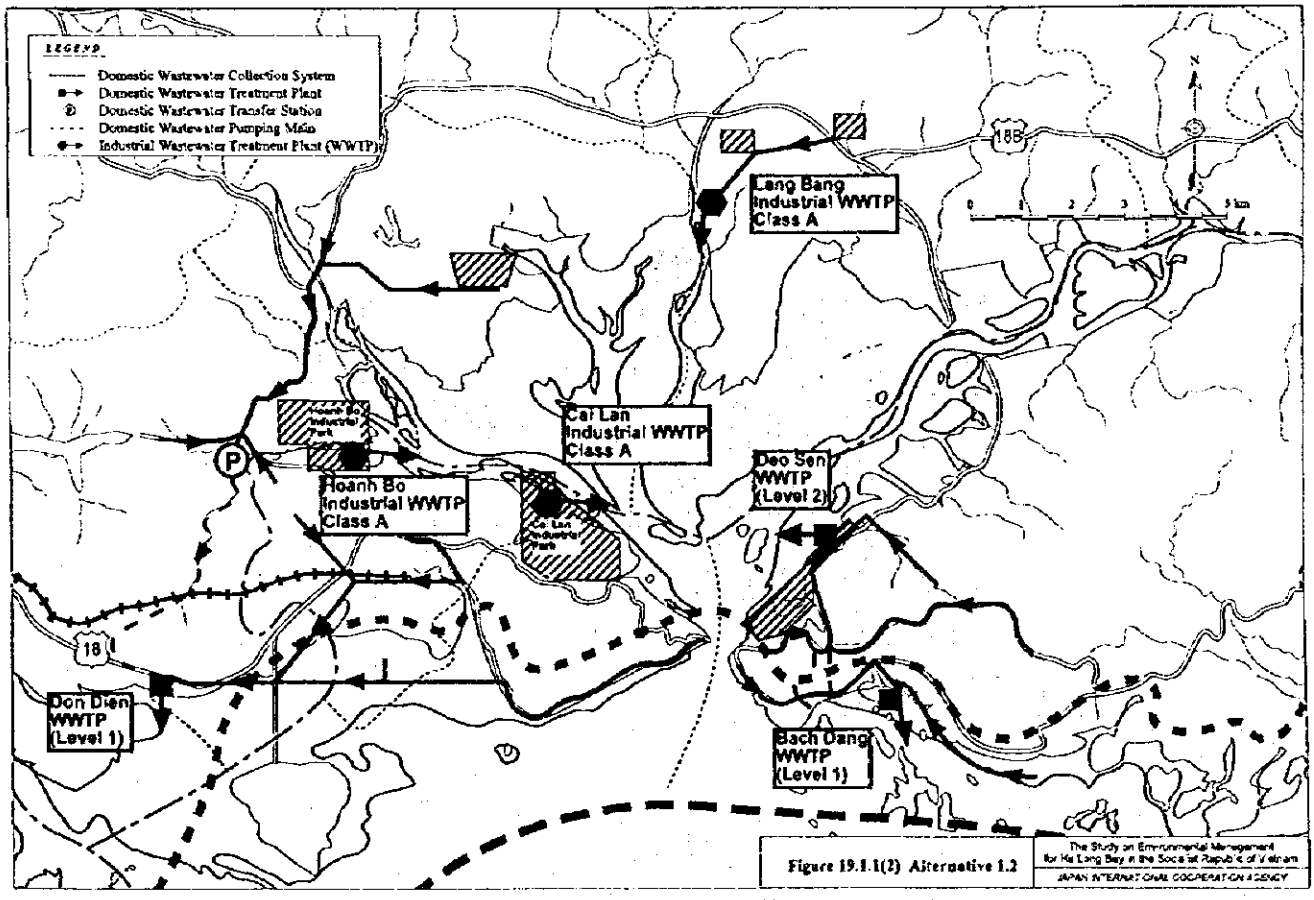

Figure 19.1.1(2) Alternative 1.2

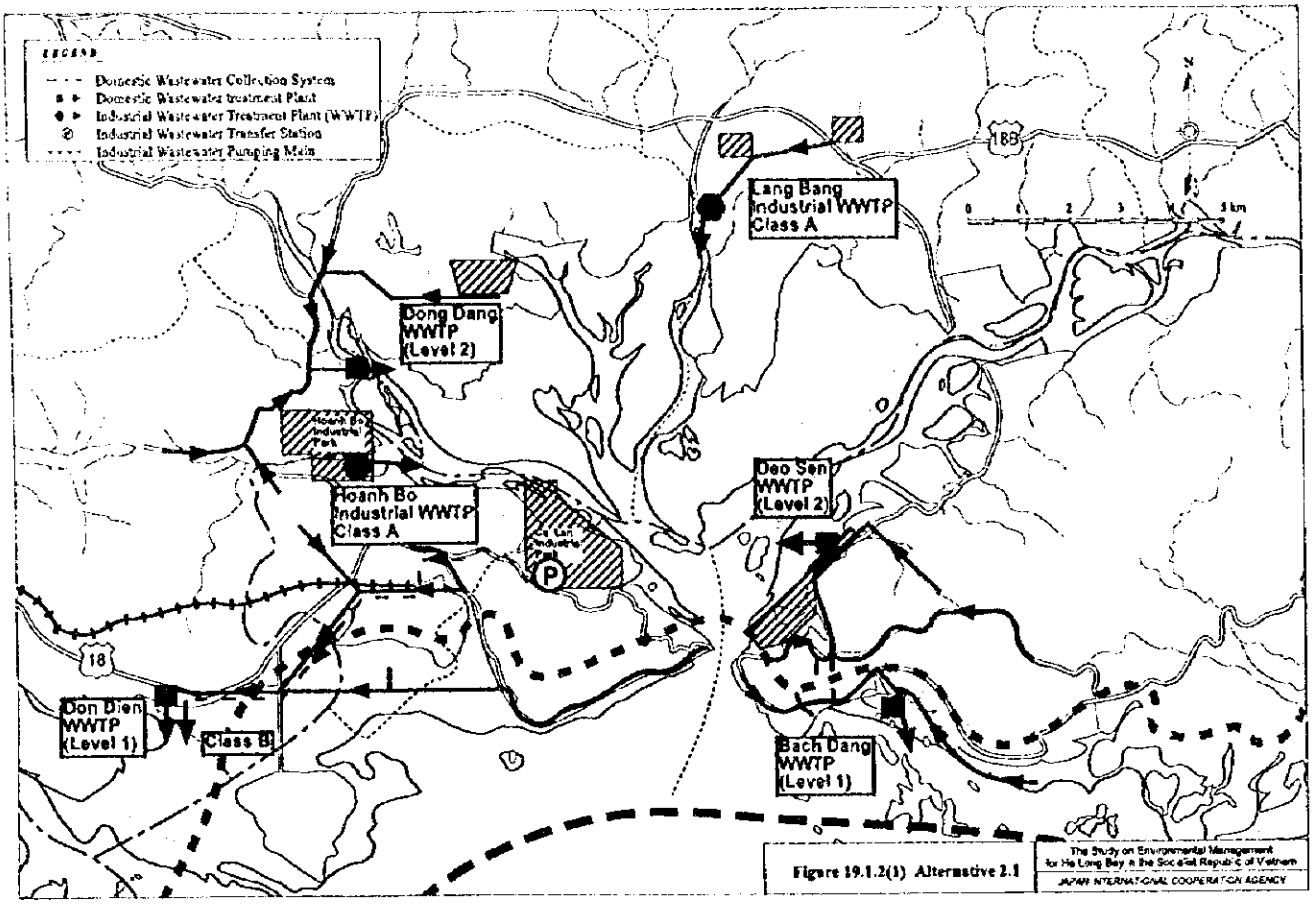

Figure 19.1.2(1) Alternative 2.1

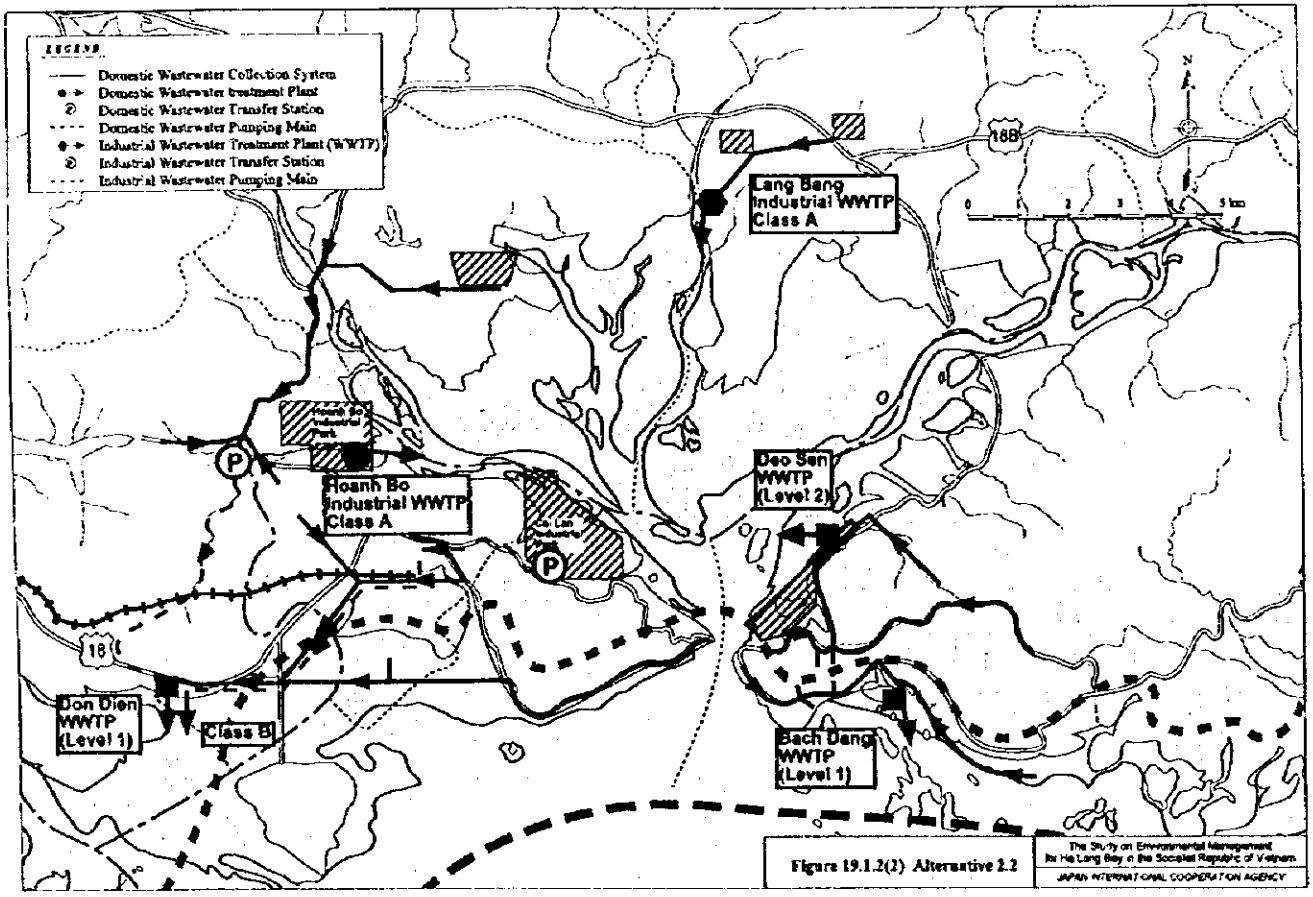

Figure 19.1.2(2) Alternative 2.2

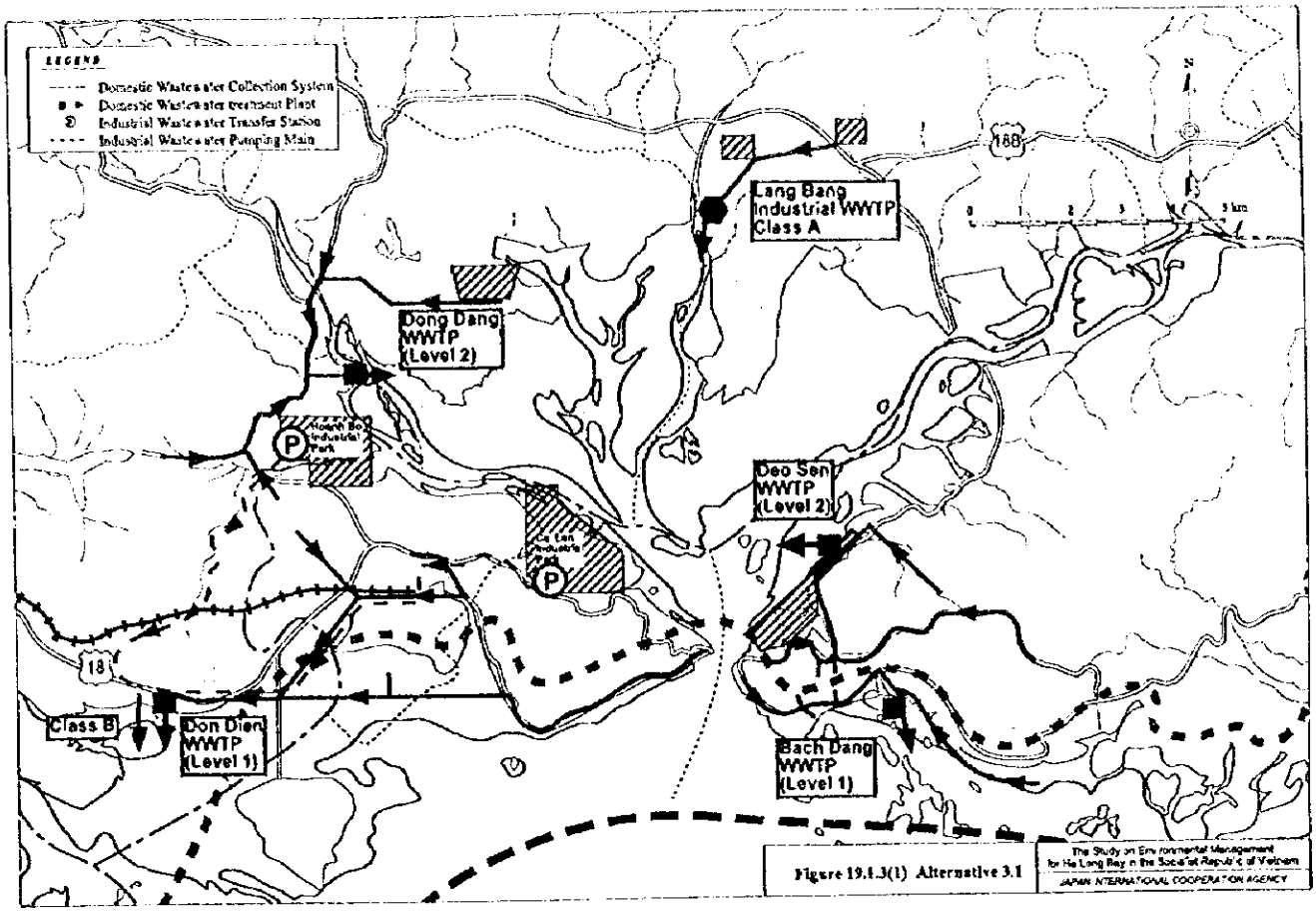

Figure 19.1.3(1) Alternative 3.1

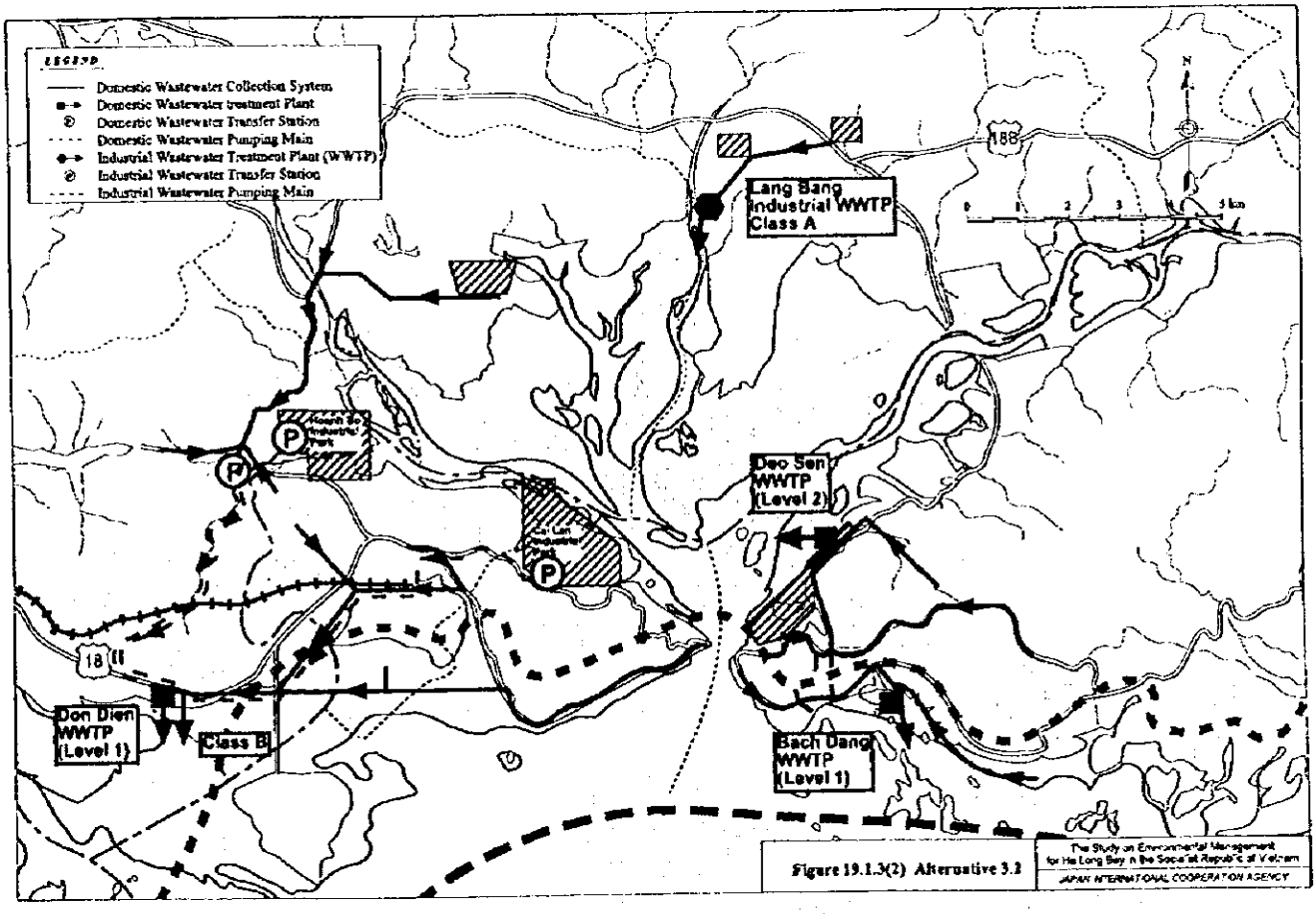

Figure 19.1.3(2) Alternative 3.2

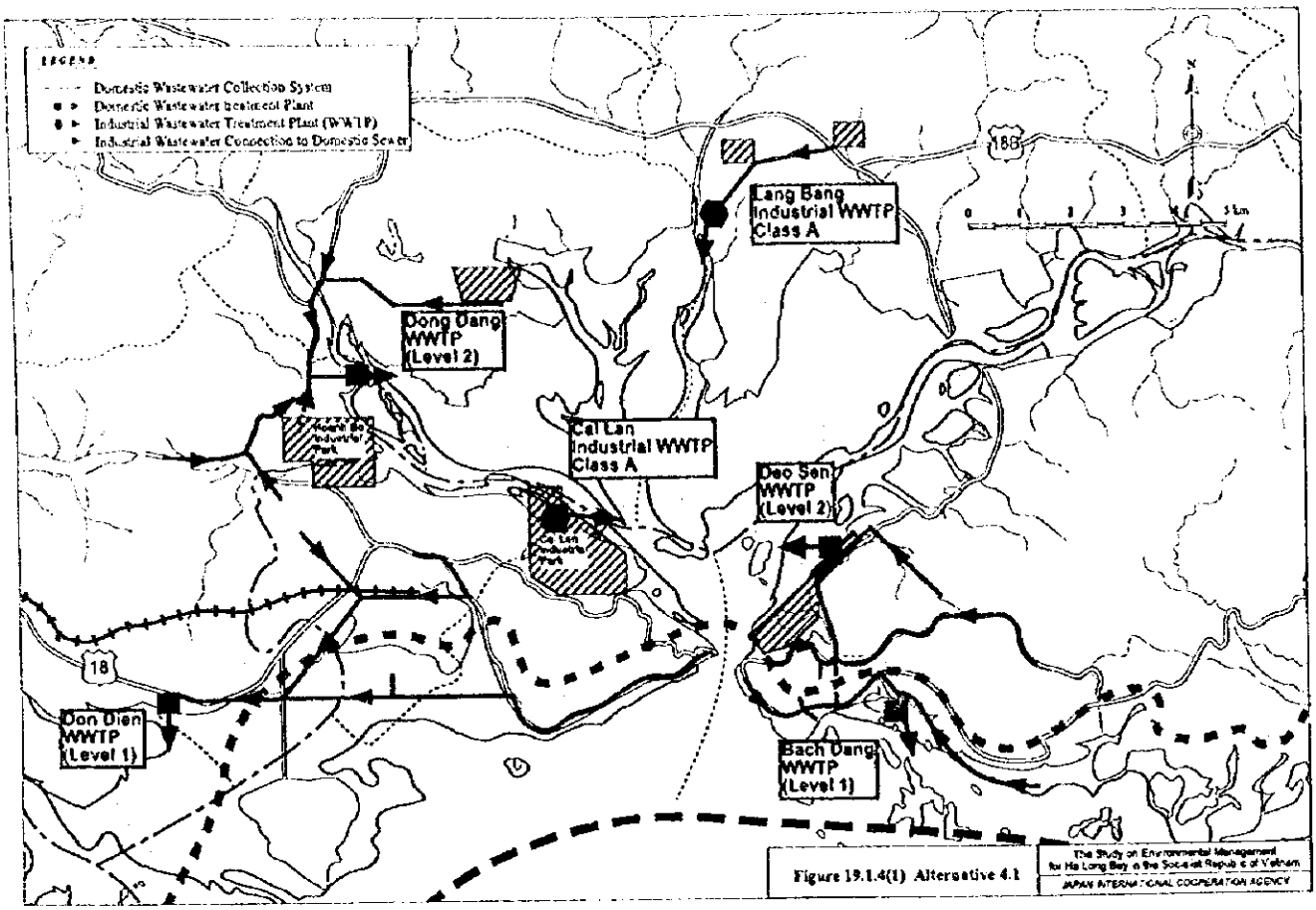

Figure 19.1.4(1) Alternative 4.1

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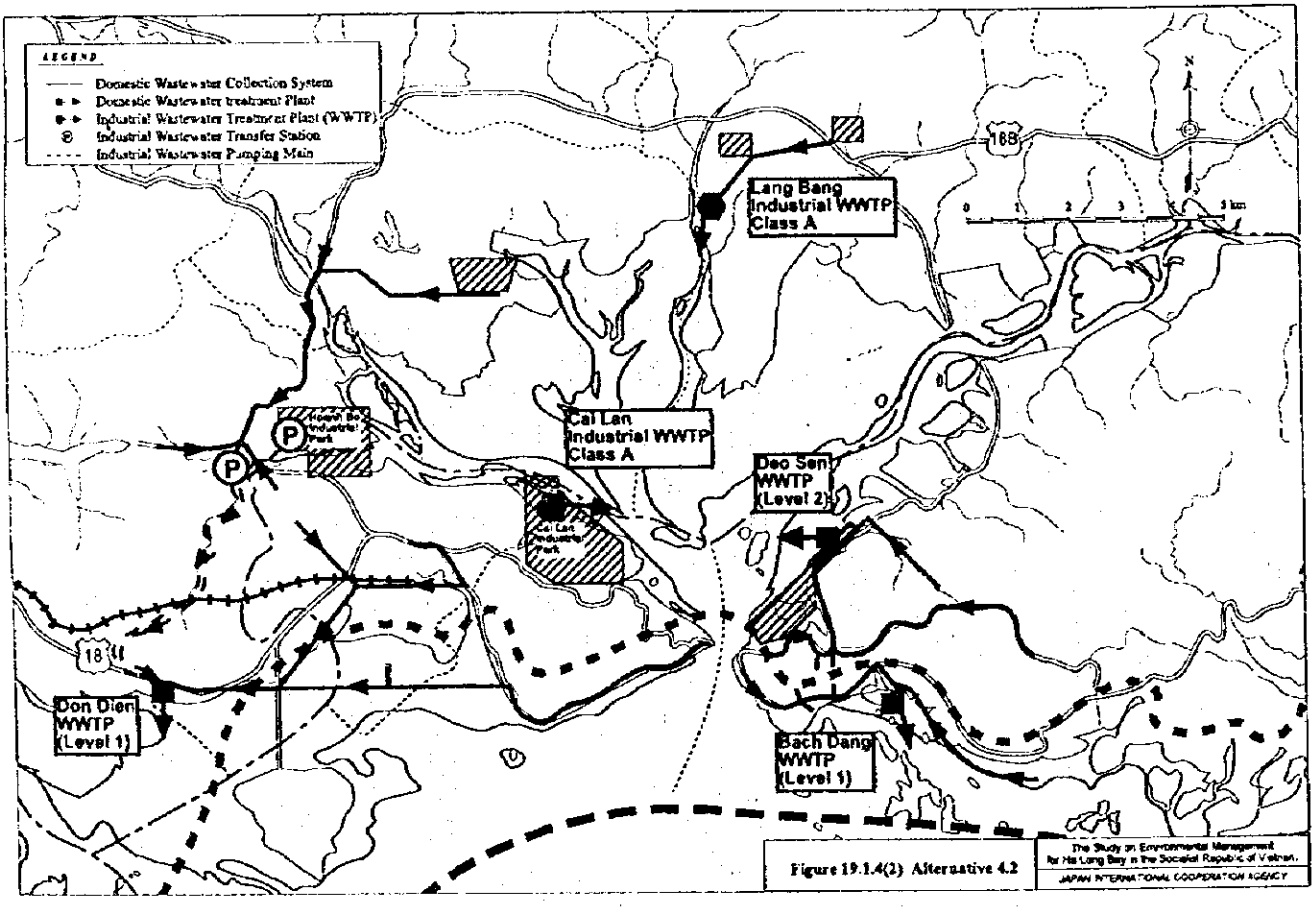

Figure 19.1.4(2) Alternative 4.2

The Study on Environmental Management for Ha Long Bay in the Socialist Republic of Vietnam
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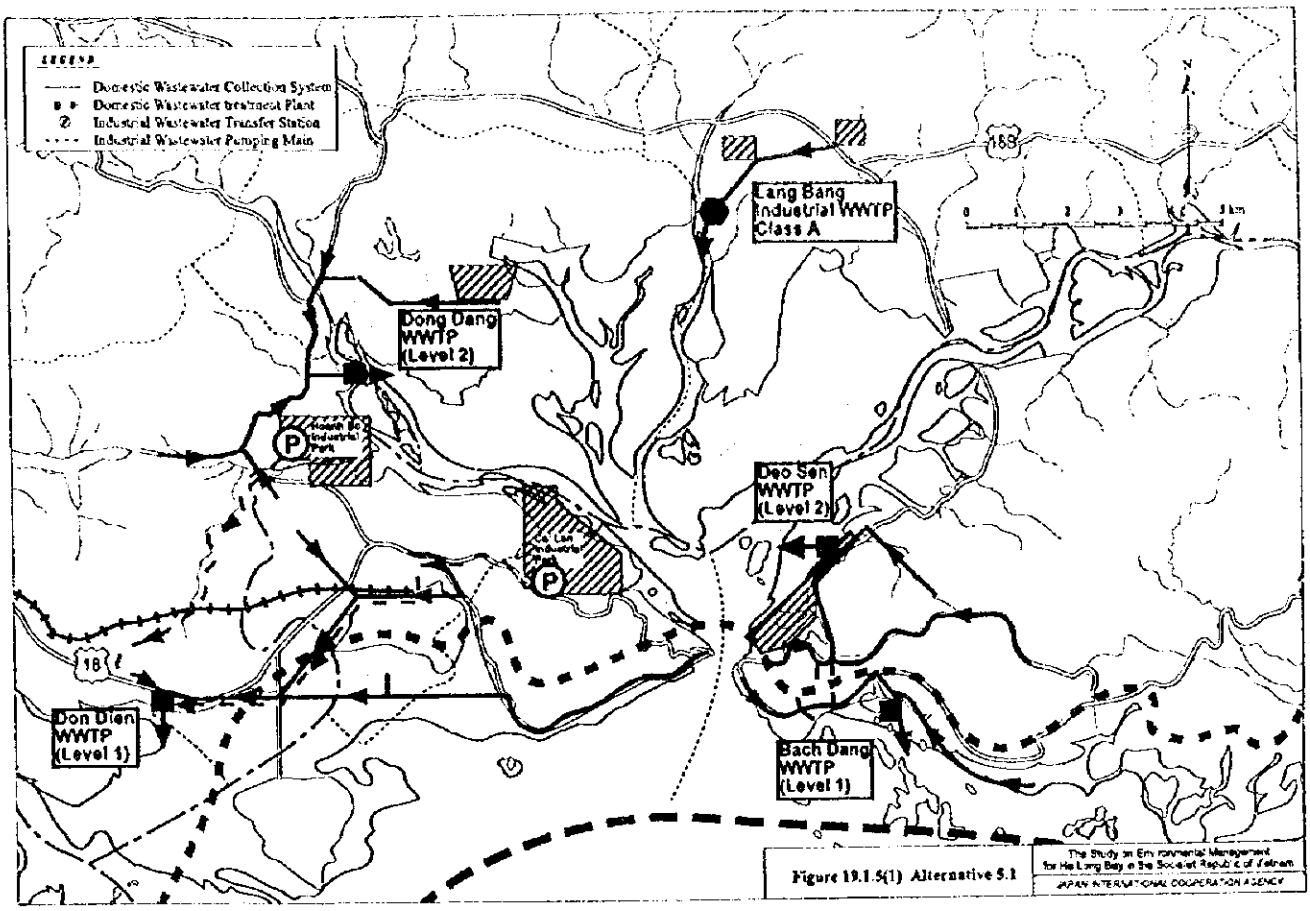

Figure 19.1.5(1) Alternative 5.1

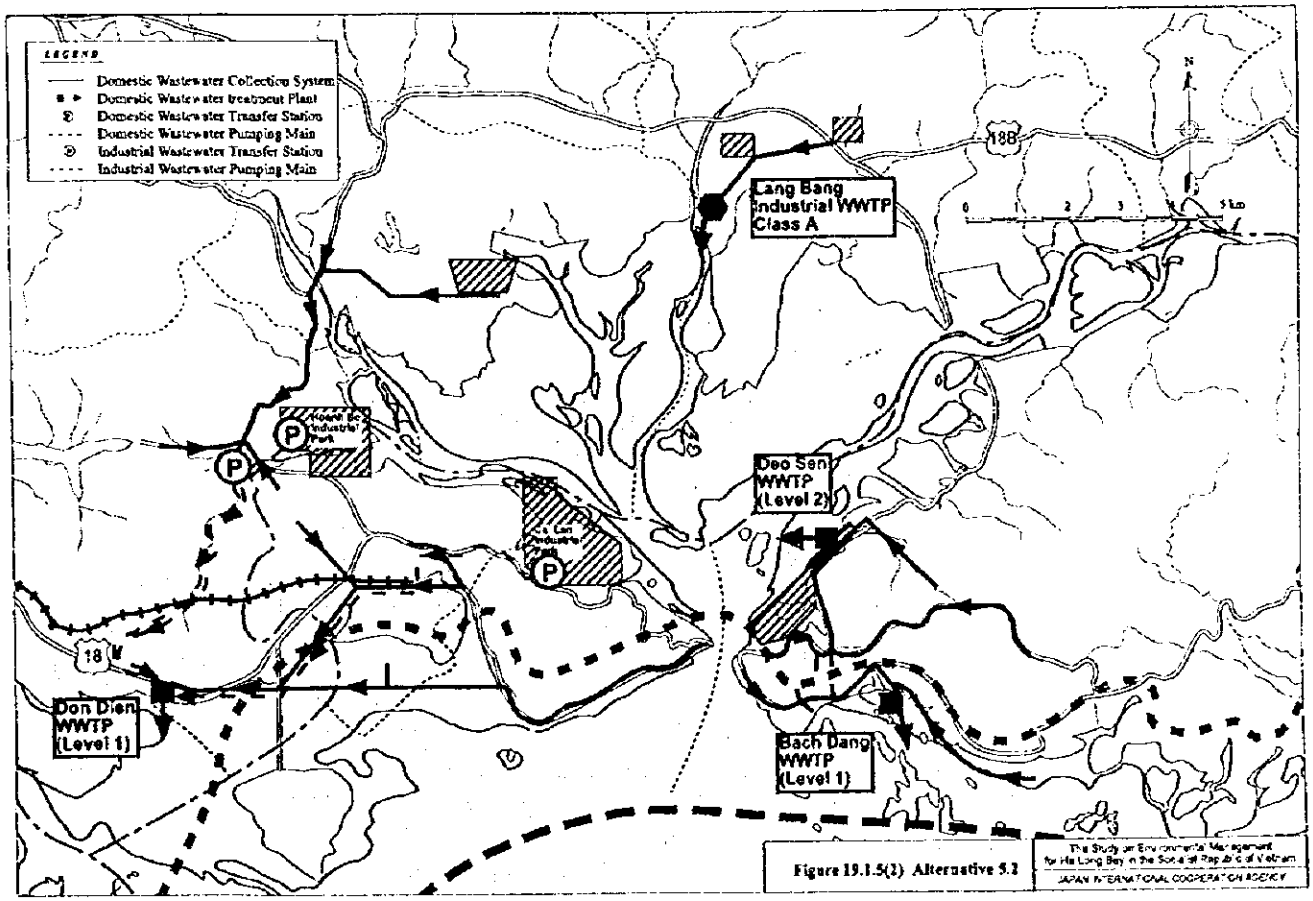

Figure 19.1.5(2) Alternative 5.2