TABLES

Table 4.1.1 Number of Vessel Calls by Cargo Group

Cargo Group/Years		2001	2002	2003	2004	2005	2010
Exports		286	344	388	444	366	666
Mobile conveyor hopper	A	7	8	8	9	10	19
Crane + grab/cage/pallet	B	216	265	262	260	176	209
Bulk unloader	C	0	0	0	0	0	0
Pipeline	D	0	0	0	0	0	0
Containers	E	63	71	118	175	180	438
Imports		249	247	300	401	376	749
Mobile conveyor hopper	A	10	11	11	12	14	23
Crane + grab/cage/pallet	B	106	101	112	147	118	172
Bulk unloader	C	45	39	29	29	29	26
Pipeline	D	9	7	5	6	5	6
Containers	E	79	89	143	207	210	522
Total Container		142	160	261	382	390	960
Other		393	431	427	463	352	455
Total Vessel Call		535	591	688	845	742	1,415

Source: Review works report of Cai Lan Port Expansion Project, 1998

Table 4.1.2 Construction Item and Quantity

Item		Quantity			
		Unit	Stage 1	Stage 2	Total
I.	Marine Works				
	Dredging & Reclamation				
	1-1 Dredging (Inner channel + Turning + Berth Trench)	m^3	2,420,000	500,000	2,920,000
	1-2 Dredging (Caisson)	m^3	290,000	0	290,000
	1-3 Dredging (Outer)	m^3	0	3,235,000	3,235,000
	1-4 Rock Removal	m^3	148,200	0	148,200
	1-5 Reclamation	m^3	1,568,000	800,000	2,368,000
	Revetment	m	2,200	0	22,000
	Berth Construction				
	3-1 Berth Length	m	620		
	3-2 Caisson Work	no	35	33	68
	3-3 Crane Foundation	m	400	0	400
	3-4 Quay Fittings etc.	L.S	1	1	1
	Navigation Aids	L.S	1	1	1
II.	On-land Civil Works				
	Road				
	5-1 Access Road	m	1,660	0	1,660
	5-2 Port Service	m	2,520	2,820	5,340
	Paving				
	6-1 C.T. Paving	m^2	58,000	53,000	111,000
	6-2 Interlock Con. Block	m^2	41,400	50,000	91,400
	6-3 Asphalt	m^2	34,000	23,200	57,200
	6-4 Macadam	m^2	85,100	37,600	122,700
	Land-leveling	L.S	1	1	1
	Soil Improvement etc.				
	Storm Water Drainage	L.S	(Outlet Nrs. 5)	(Outlet Nrs. 3)	(Total Outlet 8)
III.	Building/Utilities				
	Buildings	L.S	Main Admin Buildings, Gates, CFS, M/R shop etc.	Transit shed, Gates, etc.	1
	Utilities	L.S	1	1	1

Note: L.S = Lump Sum
Source: Review works report of Cai Lan Port Expansion Project, 1998

Table 4.1.3 Proposed Stepwise Configuration of Project

I. Characteristics of Largest Vessels Expected

	2000-2002 (Stage 1 of Phase I)	2005 (Stage 2 of Phase I)	2006-2010 (Phase II)
Container Vessel 90% Loaded	1,100-1,200 TEU (19,000DWT) Average Loa 171 m, Beam 27.2 m Draught Sailing 9.2 m, Max 9.7 m	1,100-1,200 TEU (19,000DWT) Average Loa 171 m, Beam 27.2 m Draught Sailing 9.2 m, Max 9.7 m	1,300-1,400 TEU (24,000DWT) Average Loa 175 m, Beam 27.6 m Draught Sailing 10.1 m, Max 10.6 m
Bulk Vessel 90% Loaded	40,000DWT Part Loaded (36,000 Sailing DWT) Average Loa 190 m, Beam 28.5m Draught Sailing 10.4 m, Max 11.2 m	50,000DWT Part Loaded (41,000 Sailing DWT) Average Loa 194 m, Beam 31.8 m Draught Sailing 10.4 m, Max 12.0 m	50,000DWT Part Loaded (46,000 Sailing DWT) Average Loa 194 m, Beam 31.8 m Draught Sailing 11.3 m, Max 12.0 m
General/Dry Bulk Vessel Fully Loaded	30,000DWT Average Loa 180 m, Beam 25.1m Draught Sailing / Max 10.4 m	30,000DWT Average Loa 180 m, Beam 25.1m Draught Sailing / Max 10.4 m	30,000DWT Average Loa 180 m, Beam 25.1m Draught Sailing / Max 10.4 m

II. Water Facilities Channel, Basin and Berths

Water Facilities/Year	2000-2002	2005	2006-2010
Outer Channel	10 m × 130 m	10 m × 150 m	11 m × 150 m
Inner Channel	11 m 180 m wide	11 m 200 m wide	11 m 200 m wide
Turning Basin	12 m 350 Diameter	13 m 350 Diameter	13 m 350 Diameter
Berth Trench	13 m, 12 m, 9.0 m	13 m, 12 m, 9.0 m	13 m, 12 m, 9.0 m

III. Port Facilities

Port Facilities		2000-2002	2005	2006-2010
Berths	Container	1 × 200 m (20-30,000DWT)	1 × 200 m (20-30,000DWT)	1 × 200 m + 1 × 250 m (20-30,000DWT)
	Bulk/General	1 × 220 m (40,000DWT) 1 × 200 m (20-30,000DWT) 1 Existing 166 m (10,000DWT)	1 × 220 m (40,000DWT) 2 × 200 m (15-30,000DWT) 1 Existing 180 m (10,000DWT) 2 × 180 m (10,000DWT)	1 × 220 m (40,000DWT) 2 × 200 m (15-30,000DWT) 1 Existing 180 m (10,000DWT) 3 × 180 m (10,000DWT)
Wharf Bulk Berth Container General/Dry Bulk Berth (International/Domestic) Domestic General/Dry Bulk Existing Berth		1 berth * 2 berths * Total 2 berths (multi purpose) 1 berth (Domestic Berth)**	1 berth 1+1=2 berths 3 berths * Total 7 berths (multi purpose) 1 berth (Domestic Berth)	1 berth 2+1=3 berths * 3+1=4 berths Total 9 berths (multi purpose) 1 berth (Domestic Berth)

* Wharf will be extended newly. ** During the construction of stage 1, the existing berth will be utilized as a multi-purpose berth including wheat handling.

Table 4.3.1 Results of Analysis of Domestic Wastewater Samples from Field Survey

Sta No	Location	Sample No.	Date	Time	Flow, m^3/s	Temp, °C	pH	DO, mg/ℓ	COD_{Cr} mg/ℓ	BOD_5, mg/ℓ	TDS, mg/ℓ	SS, mg/ℓ	NH_4-N, mg/ℓ	T-N, mg/ℓ	T-P, mg/ℓ	Feacal Coliform, MPN/ 100ml/ℓ
D1	Cam Pha fishing harbour Loyola lake	D1/1	28/7.98	11:25	0.01050	31.4	7.18	1.56	18.39	10.21	734	26.47	3.99	16.99	3.16	44,000
		D1/2	28/7.98	17:25	0.01590	29.1	7.21	1.55	23.50	6.33	744	30.07	3.29	17.82	3.60	48,000
		D1/3	28/7.98	22:50	0.01620	28.2	7.25	1.48	20.20	5.20	952	41.81	3.87	15.62	3.70	52,000
		D1/4	29/7.98	6:10	0.00260	28.2	7.30	1.20	30.43	13.67	912	211.27	2.98	26.90	3.60	52,000
	Average value				0.01130	29.2	7.24	1.45	23.13	8.85	836	77.41	3.53	20.08	3.52	49,000
D2	Cam Pha Coc 6 bridge near Cam Pha Market	D2/1	28/7.98	12:00	0.00082	36.8	7.47	2.82	16.43	5.15	866	38.40	1.75	13.37	2.94	13,400
		D2/2	28/7.98	17:55	0.00167	31.4	7.39	1.14	17.11	5.27	908	18.13	1.97	9.43	2.56	22,200
		D2/3	28/7.98	23:15	0.00706	28.7	7.27	1.28	22.59	6.63	811	28.80	0.81	7.85	1.94	22,600
		D2/4	29/7.98	6:50	0.00169	30.0	7.28	2.18	16.27	6.32	858	19.20	1.17	9.85	1.98	22,200
	Average value				0.00356	31.7	7.35	1.86	18.10	5.85	869	26.13	1.43	10.13	2.36	20,100
D3	Cam Pha Trung bridge Old Road 18	D3/1	28/7.98	12:25	0.16415	36.9	6.48	1.90	8.16	5.99	462	14.60	0.93	12.23	1.36	15,800
		D3/2	28/7.98	18:30	0.02452	27.7	5.29	5.15	37.51	10.21	4,420	368.73	1.29	6.25	1.08	12,200
		D3/3	28/7.98	23:30	0.03845	27.5	5.03	6.24	32.86	7.75	450	259.87	1.02	6.33	0.34	13,400
		D3/4	29/7.98	7:25	0.04159	27.3	4.96	6.18	18.32	8.54	490	152.47	1.37	6.94	0.46	16,600
	Average value				0.06733	29.9	5.44	4.87	24.21	8.12	1456	198.92	1.15	7.94	0.81	14,500
D4	Hong Gai near Ha Long II Market	D4/1	26/7.98	5:10	0.00996	29.2	7.23	0.96	15.40	7.87	620	32.27	0.31	19.13	2.74	76,000
		D4/2	26/7.98	12:00	0.00795	29.9	7.08	0.80	63.67	17.62	552	61.53	5.78	25.80	3.97	92,000
		D4/3	26/7.98	17:15	0.00836	31.3	6.94	0.54	102.04	23.45	566	90.40	7.81	40.14	1.91	84,400
		D4/4	26/7.98	23:10	0.00691	29.7	6.93	0.82	172.52	27.55	612	63.60	5.91	27.66	2.11	84,000
	Average value				0.00830	30.0	7.05	0.78	88.41	19.13	588	61.95	4.95	28.18	2.68	84,100
D5	Bai Chay beach near Post Office	D5/1	25/7.98	5:30	0.00718	29.1	7.58	0.50	28.61	9.31	452	49.76	3.92	30.31	2.46	36,000
		D5/2	25/7.98	11:00	0.00714	29.7	7.55	0.74	175.73	20.54	512	81.13	4.72	29.09	3.28	52,000
		D5/3	25/7.98	17:45	0.01021	29.1	7.50	0.84	57.21	14.49	438	65.33	3.80	18.54	2.89	68,000
		D5/4	25/7.98	23:00	0.00557	29.5	7.45	0.53	59.03	16.73	894	67.00	7.12	41.83	3.32	41,000
	Average value				0.00753	29.4	7.52	0.65	80.15	15.27	574	65.81	4.89	30.69	2.99	50,000
D6	Bai Chay near Thanh Nien Hotel	D6/1	25/7.98	5.05	0.00280	27.2	7.28	3.78	19.39	11.07	348	36.60	4.81	9.87	1.81	64,000
		D6/2	25/7.98	11:25	0.00697	28.1	7.15	3.18	32.26	17.22	402	32.47	7.77	7.94	1.64	84,000
		D6/3	25/7.98	17:15	0.00493	28.1	7.16	2.93	77.65	17.66	366	60.13	0.86	10.04	1.58	65,000
		D6/4	25/7.98	22:45	0.00349	27.6	7.11	2.28	38.80	16.41	345	38.33	1.26	10.26	1.62	36,000
	Average value				0.00455	27.8	7.18	3.04	42.03	15.59	371	41.88	3.68	9.53	1.66	63,000
H1	Cam Pha, Can Mat sewer, Road 18	H1/1	28/7.98	10:45	0.04503	31.5	5.90	5.25	19.20	7.42	454	231.67	1.38	3.42	1.40	18,600
		H1/2	28/7.98	16:45	0.01060	29.7	5.59	5.58	24.09	7.56	404	199.20	1.54	3.53	1.29	22,000
	Average value				0.04282	30.6	5.75	5.42	21.65	7.49	429	215.44	1.46	3.48	1.35	20,300
H2	Cam Pha, 100 m south of center cross road	H2/1	28/7.98	12:50	0.00382	32.8	7.24	0.40	99.41	18.73	666	141.27	4.38	39.60	5.97	84,000
		H2/2	28/7.98	18:50	0.00249	30.9	7.45	0.38	102.11	19.26	574	178.60	4.05	72.45	5.01	88,000
	Average value				0.00316	31.9	7.35	0.39	100.76	19.00	620	159.94	4.22	56.03	5.49	86,000
H3	Cam Pha, Ba Tro bridge by Cam Pha sports ground	H3/1	28/7.98	10:15	0.01486	32.2	4.65	5.08	68.17	21.31	420	152.60	1.04	14.09	1.50	29,000
		H3/2	28/7.98	16:20	0.01688	29.7	4.12	5.71	64.12	19.34	404	191.27	1.17	12.42	1.07	34,000
	Average value				0.01587	31.0	4.40	5.40	66.15	20.33	412	171.94	1.11	13.26	1.29	31,000
H4	Hong Gai, inside the Children's Culture Hall	H4/1	26/7.98	6:45	0.00590	29.4	6.99	1.14	16.02	6.34	14552	253.67	3.62	20.59	1.66	76,000
		H4/2	26/7.98	10:25	0.02063	31.6	7.18	0.92	25.33	11.07	10714	168.87	4.07	29.55	1.12	92,000
	Average value				0.01327	30.5	7.09	1.03	20.68	8.71	12633	211.27	3.85	25.07	1.39	84,000
H5	Hong Gai, Bridge 1, Cao Xanh Street	H5/1	26/7.98	7:10	0.01550	30.0	7.18	0.30	27.13	12.05	3126	62.13	2.80	15.68	1.66	36,600
		H5/2	26/7.98	11:30	0.01456	30.6	7.07	0.26	11.24	5.14	2960	41.33	3.37	16.24	1.98	40,200
	Average value				0.01503	30.30	7.13	0.28	19.19	8.60	3043	51.73	3.09	15.96	1.82	38,400
H6	Hong Gai, Bridge 2, Cao Xanh Street	H6/1	26/7.98	7:45	0.01373	31.2	7.51	2.77	11.24	5.03	9810	239.80	1.46	8.65	1.42	38,500
		H6/2	26/7.98	11:00	0.00912	31.4	7.88	6.04	17.45	4.04	9560	197.40	1.81	6.08	1.86	41,200
	Average value				0.01143	31.3	7.70	4.41	14.20	4.54	9685	218.60	1.64	7.37	1.64	40,000
H7	Hong Gai, inside Hong Gai harbour	H7/1	26/7.98	6.00	0.00567	29.7	7.23	1.26	15.19	6.24	10092	223.47	3.36	21.60	1.62	65000
		H7/2	26/7.98	10:00	0.00944	30.1	7.25	0.34	53.50	11.06	8910	184.60	1.96	45.07	1.57	76,500
	Average value				0.00756	29.9	7.24	0.80	34.35	8.65	9501	204.04	2.66	33.34	1.60	72,400
H8	Bai Chay, near Heritage Halong Hotel	H8/1	25/7.98	6:20	0.00398	30.2	7.63	3.09	21.02	8.17	5856	201.40	2.56	21.29	1.63	52,000
		H8/2	25/7.98	12:20	0.00645	30.3	7.25	0.70	45.24	15.86	4241	141.20	3.60	31.45	2.27	108,000
	Average value				0.00522	30.3	7.44	1.90	33.13	12.02	5065	171.30	3.08	26.37	1.95	80,000
TOTAL AVERAGE FLOW, m^3/s					0.21659											

Table 4.3.2 Results of Analysis of Industrial Wastewater Samples from Field Survey

Stn No	Location	Date	Time	Flow, m³/s	Temp, °C	pH	DO, mg/ℓ	COD_{Cr} mg/ℓ	BOD_5, mg/ℓ	TDS, mg/ℓ	SS, mg/ℓ	NH_4-N, mg/ℓ	T-N, mg/ℓ	T-P, mg/ℓ	Fecal Coliform, MPN/100mℓ
1	Cua Ong Coal Processing Plant*1	22/7/98	12:00	n/a	32.7	5.76	6.09	241.65	197.40	328	6811.80	0.18	15.52	1.20	4,400
2	Coc 6 and Deo Nai Coal Mines	27/7/98	10:15	4.7227	31.1	3.36	5.92	98.08	6.20	704	77.80	1.38	12.82	0.23	3,200
3	Cam Pha Mechanical Center	22/7/98	15:50	0.0021	28.2	7.74	6.05	18.82	6.01	230	12.20	0.45	2.87	0.94	5,080
4	Cam Pha Center Market	27/7/98	11:40	0.0007	31.1	7.48	2.02	531.28	215.00	1592	712.13	14.00	124.84	4.84	130,000
5	Cam Pha Beer Factory	22/7/98	14:10	0.0005	31.2	5.31	4.58	766.27	275.10	552	245.27	0.59	20.83	4.96	24,200
6	Vung Duc Coal Shipping Port	23/7/98	11:05	n/a	33.8	8.09	6.32	49.04	2.17	24514	66.13	0.42	5.47	1.04	14,400
7	Quinh Hanh Mineral Water Factory	27/7/98	16:00	0.0031	33.6	7.35	2.80	59.26	5.54	3188	116.07	1.43	6.83	1.32	16,800
8	Tan Lap coal mine	27/7/98	15:22	0.0523	34.7	6.44	5.80	64.52	6.74	636	212.33	0.83	4.68	0.61	3,720
9	Ha Lam coal mine	27/7/98	16:00	0.0546	32.4	7.36	5.57	135.48	5.23	281	353.60	0.65	4.25	0.31	4,840
10	Ha Tu coal mine	27/7/98	15:22	0.2533	32.8	7.47	6.40	69.47	8.97	932	617.40	0.44	4.13	0.84	3,040
11	Nam Cau Trang Processing Factory	23/7/98	14:20	0.0125	37.0	7.79	5.60	31.63	7.13	196	22.00	0.38	3.75	1.58	4,680
12	QNPC Guest House	27/7/98	16:40	0.0015	32.3	7.74	2.30	73.56	28.55	385	36.13	3.96	29.98	5.42	120,000
13	Quang Ninh Provincial Hospital	23/7/98	10:00	0.0159	31.1	7.37	2.85	16.35	9.93	458	71.13	1.96	19.15	2.21	340,000
14	Vuon Dao Market	24/7/98	9:45	0.0009	30.7	7.36	0.75	28.39	33.94	644	60.40	2.66	35.58	1.65	220,000
15	Quang Ninh Beer Factory	23/7/98	11:00	0.0096	31.2	5.73	1.15	386.07	120.00	1044	154.40	0.97	28.55	2.54	58,300
16	Oco Sen wastes dumping site	25/7/98	18:20	0.0025	30.5	7.43	3.86	83.45	4.78	510	26.74	7.71	33.82	0.40	52,100
17	Frozen seafood processing plant	24/7/98	17:15	0.0005	29.4	7.59	4.21	79.52	36.00	12052	362.13	2.75	129.45	3.10	9,320
18	Ha Long Ship Building Factory 1	24/7/98	15:00	0.0002	31.1	7.48	11.25	19.17	7.54	366	22.20	0.34	30.47	0.61	8,440
19	Ha Long Ship Building Factory 2	24/7/98	15:45	n/a	33.8	8.01	5.20	16.13	4.55	13080	42.67	0.20	2.73	0.69	14,980
20	Vinaflour wheat flour mill	24/7/98	10:45	0.002	30.8	7.56	1.32	19.13	9.88	358	26.73	1.59	26.55	1.38	1,680
	Averages				32.0	7.02	4.50	164.36	48.53	3093	502.46	2.14	26.96	1.79	51,959
	Totals			5.1349											

Note: *1 Discharge to settling pond

Table 4.3.3 Domestic Wastewater Pollution Loads from Points Sampled in Field Survey

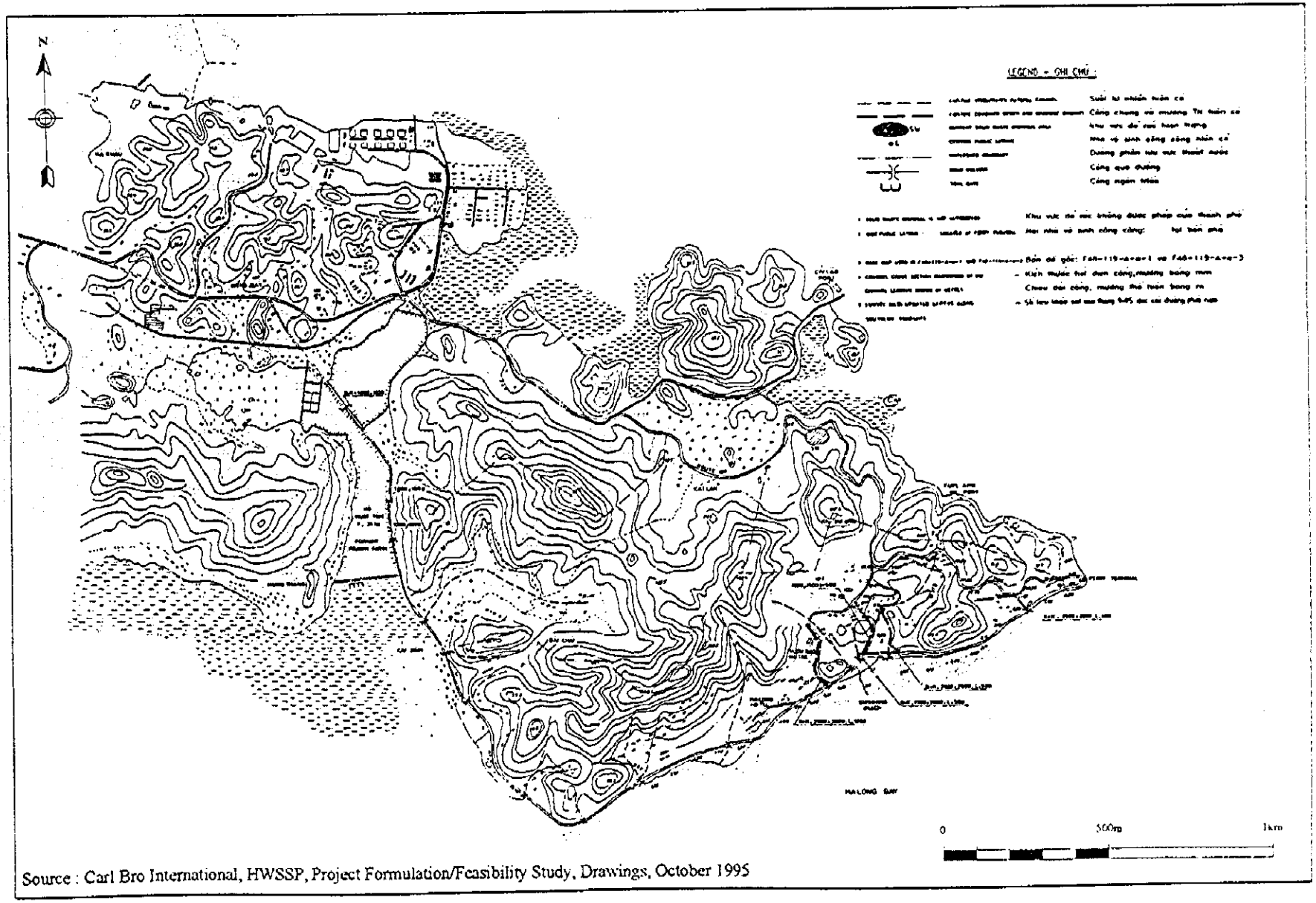
Stn No	Location	Sample No	Date	Time	Flow, m^3/s	COD_{Cr}, kg/d	BOD_5, kg/d	SS, kg/d	NH_4-N, kg/d	T-N, kg/d	T-P, kg/d	Feacal Coliform, MPN/d
D1	Cam Pha fishing harbour Lovelo lake	D1/1	28/7/98	11:25	0.01050	16.7	9.3	24.0	3.6	15.4	2.9	3.99E+11
		D1/2	28/7/98	17:25	0.01590	32.3	8.7	41.3	4.5	24.5	4.9	6.59E+11
		D1/3	28/7/98	22:50	0.01620	28.3	7.3	58.5	5.4	26.1	5.2	7.28E+11
		D1/4	29/7/98	6:10	0.00260	6.8	3.1	47.5	0.7	6.0	0.8	1.17E+11
	Average load					21.0	7.1	42.8	3.6	18.0	3.4	4.76E+11
D2	Cam Pha Coc 6 bridge near Cam Phu Market	D2/1	28/7/98	12:00	0.00082	1.2	5.18	38.40	1.75	13.37	2.94	9.49E+09
		D2/2	28/7/98	17:55	0.00167	2.5	5.27	18.13	1.97	9.43	2.56	3.20E+10
		D2/3	28/7/98	23:15	0.00706	13.8	6.63	28.80	0.81	7.85	1.94	1.38E+11
		D2/4	29/7/98	6:50	0.00169	6.6	6.32	19.20	1.17	9.85	1.98	9.00E+10
	Average load					6.0	2.0	7.7	0.3	2.8	0.6	6.73E+10
D3	Cam Pha Trang bridge Old Road 18	D3/1	28/7/98	12:25	0.16145	115.9	85.1	207.4	13.2	173.8	19.3	2.24E+12
		D3/2	28/7/98	18:30	0.02452	79.5	21.6	781.2	2.7	13.2	2.3	2.58E+11
		D3/3	28/7/98	23:40	0.03815	109.2	25.7	863.3	3.4	21.0	1.1	4.45E+11
		D3/4	29/7/98	7:25	0.04189	66.3	30.9	551.8	5.0	25.1	1.7	6.01E+11
	Average load					92.7	40.8	600.9	6.1	58.3	6.1	8.87E+11
D4	Hong Gai near Ha Long II Market	D4/1	26/7/98	5:10	0.00996	13.3	6.8	27.8	0.3	16.5	2.4	6.54E+11
		D4/2	26/7/98	12:00	0.00795	43.7	12.1	42.3	4.0	17.7	2.7	6.32E+11
		D4/3	26/7/98	17:15	0.00836	73.7	17.0	65.3	5.6	29.0	1.4	6.10E+11
		D4/4	26/7/98	23:10	0.00691	103.0	16.4	38.0	3.5	16.5	1.3	5.02E+11
	Average load					58.4	13.1	43.3	3.4	19.9	1.9	5.99E+11
D5	Bai Chay beach n near Post Office	D5/1	25/7/98	5:30	0.00718	17.7	5.8	30.9	2.4	18.8	1.5	2.23E+11
		D5/2	25/7/98	11:00	0.00714	108.4	12.7	50.0	2.9	17.9	2.0	3.21E+11
		D5/3	25/7/98	17:45	0.01021	50.5	12.8	57.6	3.4	16.4	2.5	6.00E+11
		D5/4	25/7/98	23:00	0.00557	28.4	8.1	32.2	3.4	21.6	1.6	2.12E+11
	Average load					51.3	9.8	42.7	3.0	18.7	1.9	3.39E+11
D6	Bai Chay near Thanh Nien Hotel	D6/1	25/7/98	5:05	0.00280	4.7	2.7	8.9	1.2	2.4	0.4	1.55E+11
		D6/2	25/7/98	11:25	0.00697	19.4	10.4	19.6	4.7	4.8	1.0	5.06E+11
		D6/3	25/7/98	17:15	0.00493	33.1	7.5	25.6	0.4	4.3	0.7	2.90E+11
		D6/4	25/7/98	22:45	0.00349	11.7	4.9	11.6	0.4	3.1	0.5	1.09E+11
	Average load					17.2	6.4	16.4	1.6	3.6	0.6	2.65E+11
H1	Cam Pha, Can Mot sewer, Road 18	H1/1	28/7/98	10:45	0.04503	74.7	28.9	901.3	5.4	13.3	5.4	7.24E+11
		H1/2	28/7/98	16:45	0.04060	84.5	26.5	698.8	5.4	12.4	4.5	7.72E+11
	Average load					79.6	27.7	800.0	5.4	12.8	5.0	7.48E+11
H2	Cam Pha, 100 m south of center cross road	H2/1	28/7/98	12:50	0.00382	32.8	6.2	46.6	1.4	13.1	2.0	2.77E+11
		H2/2	28/7/98	18:50	0.00249	22.0	4.1	38.4	0.9	15.6	1.1	1.89E+11
	Average load					27.4	5.2	42.5	1.2	14.3	1.5	2.33E+11
H3	Cam Pha, Ba Toa bridge by Cam Pha sports ground	H3/1	28/7/98	10:15	0.01486	87.5	27.4	195.9	1.3	18.1	1.9	3.59E+11
		H3/2	28/7/98	16:20	0.01688	93.5	28.2	279.0	1.7	18.1	1.6	4.96E+11
	Average load					90.5	27.8	237.4	1.5	18.1	1.7	4.28E+11
H4	Hong Gai, inside the Children's Culture Hall	H4/1	26/7/98	6:45	0.00590	8.2	3.2	129.3	1.8	10.5	0.8	3.87E+11
		H4/2	26/7/98	10:25	0.02063	45.1	19.7	301.0	7.3	52.7	2.0	1.64E+12
	Average load					26.7	11.5	215.2	4.5	31.6	1.4	1.01E+12
H5	Hong Gai, Bridge 1, Cao Xanh Street	H5/1	26/7/98	7:10	0.01550	36.3	16.1	83.2	3.7	21.0	2.2	1.90E+11
		H5/2	26/7/98	11:30	0.01456	14.1	6.5	52.0	4.2	20.4	2.5	5.06E+11
	Average load					25.2	11.3	67.6	4.0	20.7	2.4	4.98E+11
H6	Hong Gai, Bridge 2, Cao Xanh Street	H6/1	26/7/98	7:45	0.01373	13.3	6.0	284.5	1.7	10.3	1.7	4.60E+11
		H6/2	26/7/98	11:00	0.00912	13.5	3.2	155.5	1.4	4.8	1.5	3.25E+11
	Average load					13.4	4.6	220.0	1.6	7.5	1.6	3.92E+11
H7	Hong Gai, inside Hong Gai harbour	H7/1	26/7/98	6:00	0.00567	7.4	3.1	109.5	1.6	10.6	0.8	3.33E+11
		H7/2	26/7/98	10:00	0.00944	43.6	9.0	150.6	1.6	36.8	1.3	6.26E+11
	Average load					25.5	6.0	130.0	1.6	23.7	1.0	4.80E+11
H8	Bai Chay, near Heritage Halong Hotel	H8/1	25/7/98	6:20	0.00398	7.2	2.8	69.3	0.9	7.3	0.6	1.79E+11
		H8/2	25/7/98	12:20	0.00645	25.2	8.8	78.7	2.0	17.5	1.3	6.02E+11
	Average load					16.2	5.8	74.0	1.4	12.4	0.9	3.90E+11
TOTAL AVERAGE LOAD						551	179	2541	39	262	30	6.8E+12

Table 4.3.4 Industrial Wastewater Pollution Loads from Points Sampled in Field Survey

Sta No	Location	Date	Time	Flow, m³/s	COD_{Cr}, kg/d	BOD_5, kg/d	SS, kg/d	NH_4-N, kg/d	T-N, kg/d	T-P, kg/d	Fecal Coliform, MPN/d
1	Cua Ong Coal Processing Plant*1	22/7/98	12:00	n/a							
2	Coc 6 and Deo Nai Coal Mines	27/7/98	10:15	4.7227	40,021	2,530	31,716	563	5,231	94	1.31E+13
3	Cam Pha Mechanical Center	22/7/98	15:50	0.0021	3.4	1.1	2.2	0.1	0.5	0.2	9.22E+09
4	Cam Pha Center Market	27/7/98	11:40	0.0007	32.1	13.0	43.1	0.8	7.6	0.3	7.86E+10
5	Cam Pha Beer Factory	22/7/98	14:10	0.0005	33.1	11.9	10.6	0.0	0.9	0.2	1.05E+10
6	Vung Duc Coal Shipping Port	27/7/98	11:05	n/a							
7	Quanh Hanh Mineral Water Factory	27/7/98	16:00	0.0031	15.9	1.5	31.1	0.4	1.8	0.4	4.50E+10
8	Tan Lap coal mine	27/7/98	15:22	0.0523	292	30	959	3.8	21.1	2.8	1.65E+11
9	Ha Lam coal mine	27/7/98	16:00	0.0546	639	25	1,668	3.1	20.0	1.4	2.28E+11
10	Ha Tu coal mine	27/7/98	15:22	0.2533	1,520	196	13,512	10	90	18	6.65E+11
11	Nam Cau Trang Processing Factory	23/7/98	14:20	0.0125	31.2	7.7	23.8	0.4	4.1	1.7	5.05E+10
12	QNPC Guest House	27/7/98	16:40	0.0015	9.5	3.7	4.7	0.5	3.9	0.7	1.56E+11
13	Quang Ninh Provincial Hospital	23/7/98	10:00	0.0159	22.5	13.6	97.7	2.7	26.3	3.0	4.67E+12
14	Vuon Dao Market	24/7/98	9:45	0.0009	2.2	1.1	4.7	0.2	2.8	0.1	1.71E+11
15	Quang Ninh Beer Factory	23/7/98	11:00	0.0096	320	100	128.1	0.8	23.7	2.1	4.84E+11
16	Deo Sen wastes dumping site	25/7/98	18:20	0.0025	18.0	1.0	5.8	1.7	6.7	0.1	1.13E+11
17	Frozen seafood processing plant	24/7/98	17:15	0.0005	3.4	1.6	15.6	0.1	5.6	0.1	4.03E+09
18	Ha Long Ship Building Factory 1	24/7/98	15:00	0.0002	0.3	0.1	0.4	0.0	0.5	0.0	1.46E+09
19	Ha Long Ship Building Factory 2	24/7/98	15:45	n/a							
20	Vinaflour wheat flour mill	24/7/98	10:45	0.002	3.3	1.7	4.6	0.3	4.6	0.2	2.90E+09
	Totals				42,970	2,939	48,257	588	5,452	126	1.99E+13

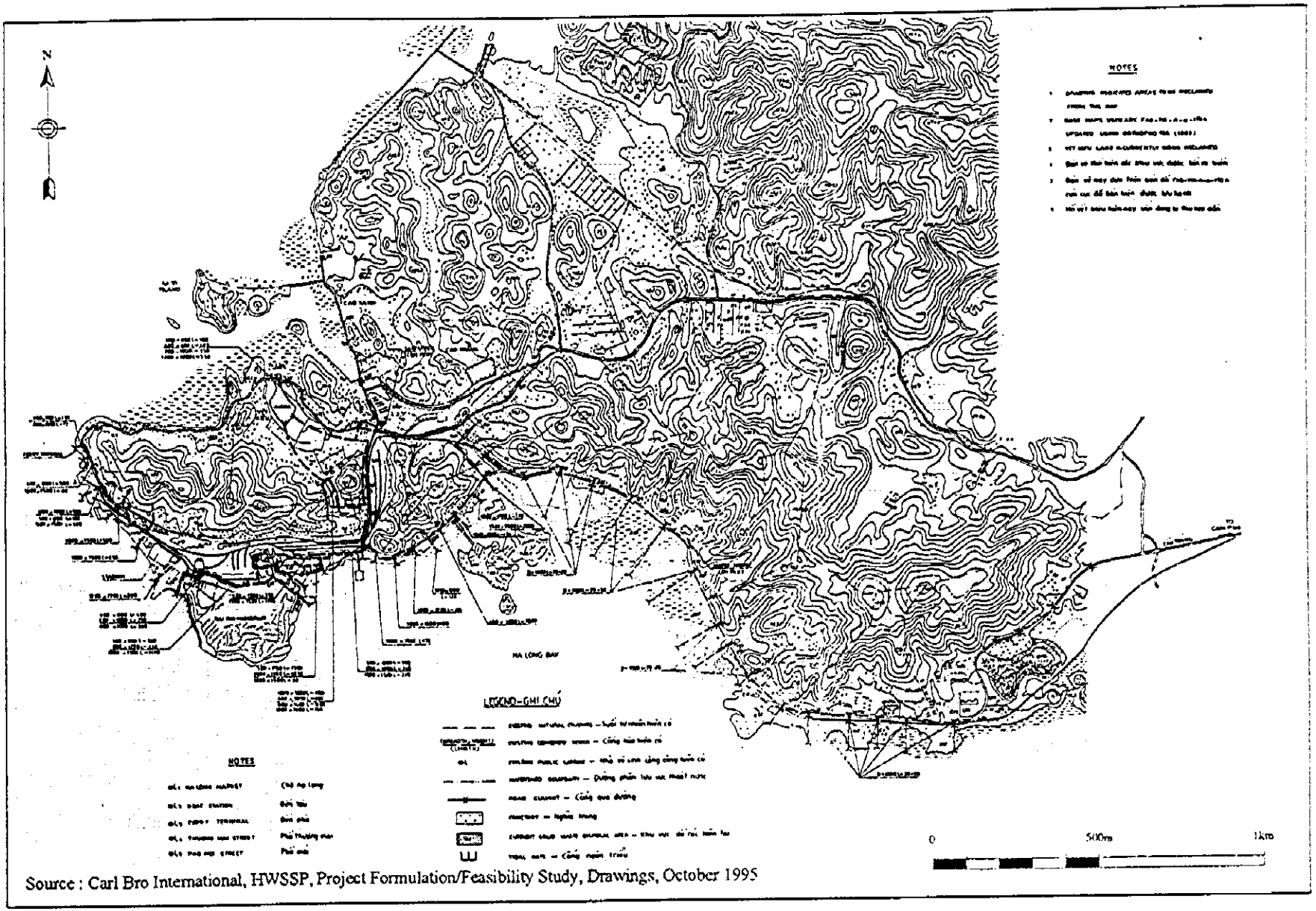
Note: *1 Discharge to settling pond

FIGURES



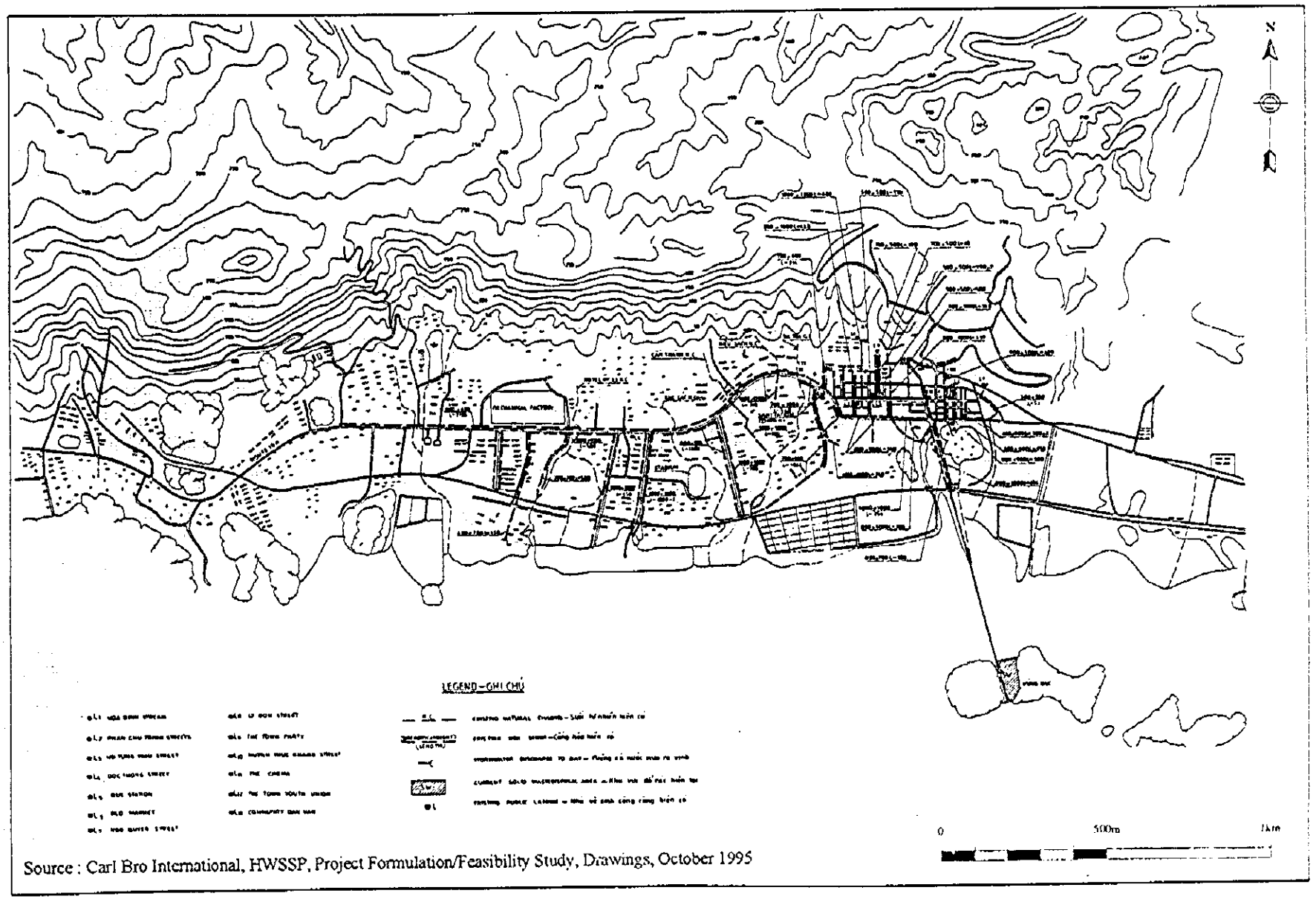
Source : Carl Bro International, HWSSP, Project Formulation/Feasibility Study, Drawings, October 1995

Figure 4.3.1 Existing Sanitary Drainage System in Bai Chay Region



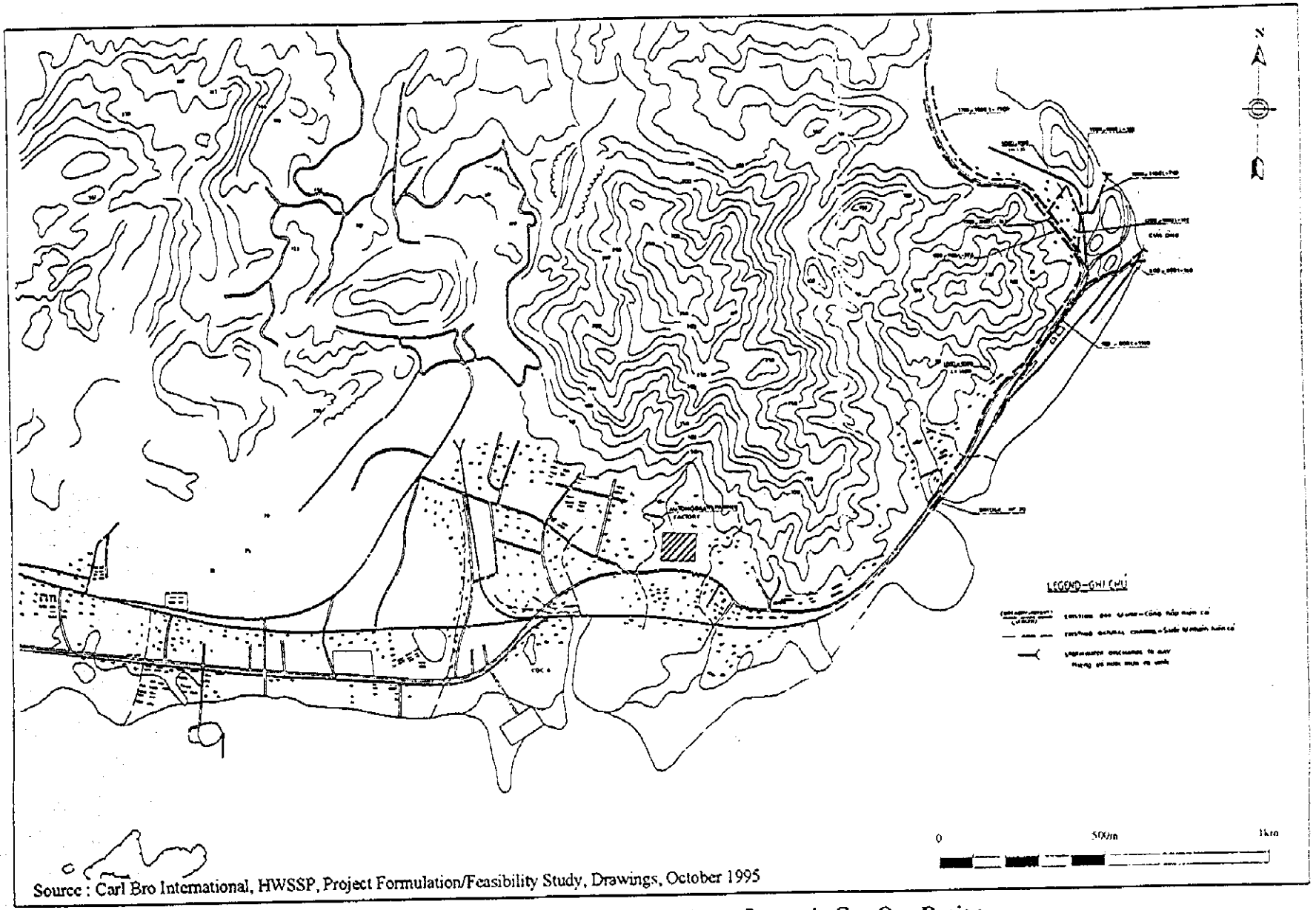
Source : Carl Bro International, HWSSP, Project Formulation/Feasibility Study, Drawings, October 1995

Figure 4.3.2 Existing Sanitary Drainage System in Hong Gai Region



Source : Carl Bro International, HWSSP, Project Formulation/Feasibility Study, Drawings, October 1995

Figure 4.3.3 Existing Sanitary Drainage System in Cam Pha Region



Source : Carl Bro International, HWSSP, Project Formulation/Feasibility Study, Drawings, October 1995

Figure 4.3.4 Existing Sanitary Drainage System in Cua Ong Region

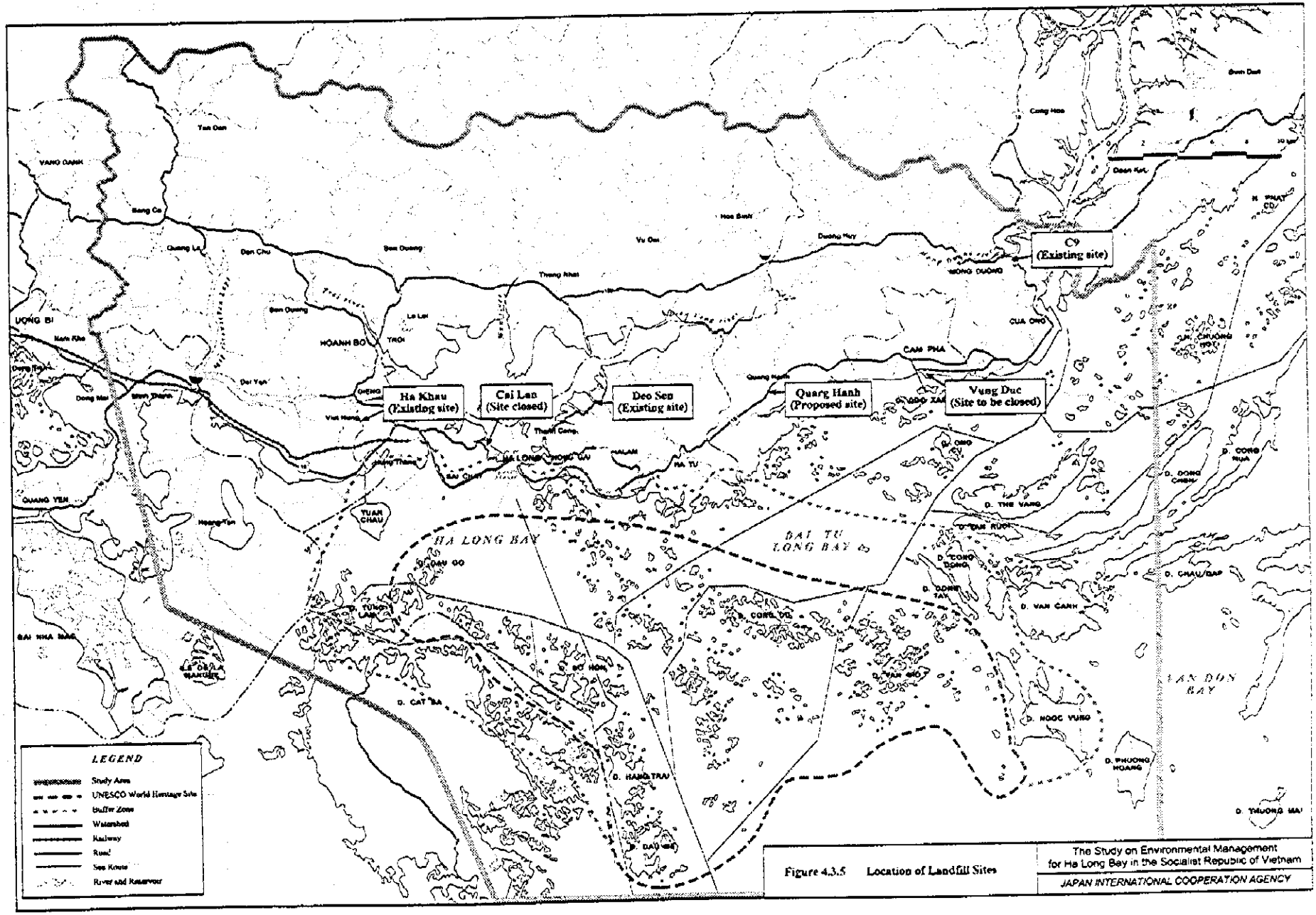


Figure 4.3.5 Location of Landfill Sites

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

JAPAN INTERNATIONAL COOPERATION AGENCY

CHAPTER 5

CHAPTER 5 COASTAL AND AQUATIC ECOSYSTEM

5.1 Wetland Ecosystem

In the study area, wetlands spread widely along the seashore of Bai Chay, Ha Long and Bai Tu Long bays as shown in Figure 5.1.1 because the seabed slope is gentle in general and the tidal range is large. Shallow waters, mostly less than 20 m in depth widely, extends off the wetland.

According to the text of the Ramsar Convention on Wetlands of International Importance, "wetlands" are defined as areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water, the depth of which at low tide does not exceed six meters.

According to a report of the Haiphong Institute of Oceanology (HIO, 1997), the wetland areas of Bai Chay bay and Ha Long bay reach about 40,000 ha, comprising 7,500 ha in Bai Chay bay and 32,500 ha in Ha Long bay. The wetland is broadly classified into 14 types and 4 groups in Bai Chay bay and 20 types and 4 groups in Ha Long bay by HIO, as shown in Tables 5.1.1 and 5.1.2.

The wetland in Bai Chay bay are composed of the non-vegetated tidal wetland group with 2,354 ha (31%), the vegetated wetland groups with 2,184 ha (29%), the man-made wetland group with 2,163 ha (29%) and the permanently submerged wetland group with 779 ha (11%) most of which are tidal channels and creeks. Main wetland types in Bai Chay bay are the wetland type with dense mangrove, the low tidal mud flats, the tidal channels, and the man-made salt-blackish aquaculture pond.

The wetland in Ha Long bay is composed of the permanently submerged wetland group with 27,748 ha (87%), the non-vegetated wetland group with 3,427 ha (11%), the man-made wetland group with 502 ha (2%) and the vegetated wetland group with 379 ha (1%). The types which have ecological, landscape and tourism values are the wetland type with dense mangroves (357 ha), the low tidal mud flats (3,109 ha), the beaches (24 ha), the coral reefs (120 ha), and the salt lakes (40 ha).

5.1.1 Mangrove Swamps

(1) Distribution of Mangrove Swamps

The Quang Ninh province has a long coastline with a lot of islands suitable for the formation and development of mangrove swamps. Most tidal wetland areas in the study area were formerly covered by mangrove swamps, but now the dense mangrove areas are limited to the Hoang Tai island area, the estuary of Mong Duong river, the inlet of Quan Hanh area, and the seashore area of Bai Chay bay.

In to the EIA report for the Cai Lan port project, 13 species of mangrove have been identified in Bai Chay bay. Of these, *Aegiceras corniculatum*, *Kandelia candel* and *Avecinnia marina* are dominant.

The data of DARD shows that mangrove swamps covered an area of 39,400 ha in Quang Ninh province in 1972 when reclamation and dike construction for aquaculture were not carried out. Since then the mangrove swamp areas have reduced because of these activities, and was 12,670 ha in 1996.

According to the DARD's study on mangrove swamps, the condition of mangrove swamps in the province varied in different localities and these can be divided into three areas on the basis of natural geographical conditions and characteristics of mangrove forests. Typical species of mangrove in each area are shown in Table 5.1.3.

1) The area from Mong Cai to Cua Ong

Topography in this area is favorable for the development of mangrove swamps. It has a network of islands such as Vinh Thue, Cai Chieu, Cai Bau blocking the wind and sea waves and forming a closed bay, and as a result silt remains are concentrated along the coast. Owing to this condition, the composition of species in this area is rich and mangrove trees can grow tall to the height of 5 to 6 m. DARD has been carrying out the program of mangrove gene preservation in this area.

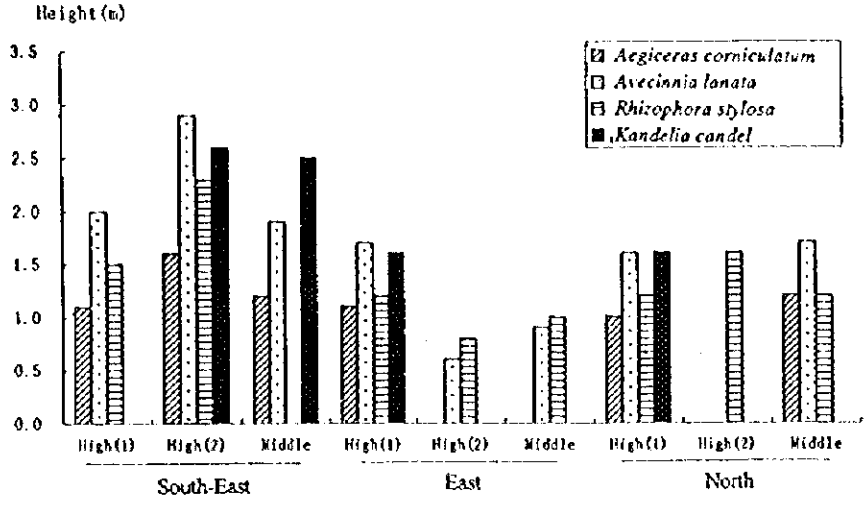
2) The area from Cua Ong to Cua Luc

This area faces Ha Long bay and Bai Tu Long bay, and is located within the study area. Tidal movements in this area are quick and as a result the condition of habitat for mangrove is not so good because of little silt. In this area, there is no pure community of *Avicennia marina* or *Bruguiera gymnorhiza*, but mostly of mixed community of small and low trees.

3) The area from Cua Luc to Cua Nam Trieu

This area is characterized by its large estuary which is included mostly in the study area. A favorable condition of salinity for mangrove is maintained and there are species of both high and low salinity-resistance. The topography is flat with rare big waves owing to the sheltering effect of islands in Ha Long bay. River systems such as Da Bac, Kinh Thay, Thai Binh carry a considerable volume of silt toward the estuary and create tidal flats favorable for the growth of mangrove swamps. During high tide, saline water penetrates into the hinterland through the rivers. It is then mixed with fresh inland water to create brackish tidal flats favorable for the growth of species of low salinity resistance.

The Field Survey reveals that 19 mangrove species are recorded, 16 species in Binh Huong estuary and 13 species in Bai Chay bay. The vegetation coverage in Binh Huong estuary reaches 75-100% on high tidal area and 70-90% on middle tidal area. Dominant species in Binh Huong estuary are *Aegiceras corniculatum*, *Avecinnia lanata*, *Rhizophora stylosa* and *Kandelia candel*. The mean height of *Aegiceras corniculatum* ranges from 1.0 to 1.6 m, *Avecinnia lanata* from 0.6 to 2.9 m, *Rhizophora stylosa* from 0.8 to 2.3 m and *Kandelia candel* from 1.6 to 2.6 m.



Note : 1.The location of survey point is shown in Figure 5.1.2.

2 Survey was carried out at two places at high tidal zone and one place at middle tidal zone.

Mean Height of Dominant Species of Mangroves

Mangrove swamps play an important role in the marine ecosystem by forming nursery and breeding grounds for fish and protecting coast and estuary areas from erosion. The mangrove swamps in Quang Ninh province, however, have been destroyed by construction of dikes for aquacultural ponds, agricultural production and urban development. Consequently, the mangrove swamp area has been seriously reduced. The reforestation of mangrove swamps by replanting in the destroyed and newly formed swamps is a matter of urgency and necessity for Quang Ninh province at present, and a program of reforestation has been carried out by a project of Red Cross. In 1997 the area of 40 ha in Hai Ninh district and 200 ha in Yen Hung district were reforested. The mangrove species used in reforestation is selected mainly out of 6 species such as *Avecinnia marina, Kandelia candel, Bruguiera gymnorhiza, Rhizophora stylosa, Aegiceras corniculatum* and *Sonneratia caseolaris*, on the basis of their ecological characteristics and geographical distribution and the purpose in reforestation

(2) Fauna in Mangrove Swamps and Tidal Flats

Mangrove swamps and tidal flats form the specific ecosystem. Fish living in mangrove swamps and tidal flats of the study area can be divided into "resident" or "migrant" group based on their behaviors. The resident fish group is composed

of species digging holes into the bottom under the mangrove canopy or beneath dike stones of nearby pond gates. Typical species are as follows:

- *Boleophthalmus pectinirostris (goby)*
- *Periophthalmus cantonensis (goby)*
- *Trypauchen taenia (goby)*
- *Glossogobius giuris (goby)*
- *Bostrichthys sinensis (goby)*
- *Arius sinensis (sea catfish)*

The migrant fish group is composed of species living in water layers which intrude into mangrove swamps and tidal flats with flood tide and leave with ebb tide. Common species belong to this group are as follows:

- *Mugil affinis (mullet)*
- *Zebrias quagga (sole)*
- *Platycephalus indicus (flathead)*
- *Leiognathus rivulatus (pony fish)*
- *Gerres filamentosus (mojarra)*
- *Pardachirus pavoninus (sole)*
- *Sparus latus (porgy)*
- *Terapon jarbua (tigerperch)*
- *Pomadasys hasta (grunt)*
- *Pseudorhombus assius (citharid)*
- *Sparus macrocephalus (porgy)*

Shellfish composed of Crustacean and Molluses are distributed in both mangrove swamps and tidal flats. Among shellfish living in mangrove swamps and tidal flats, many species have high economic value. Important species from the economic viewpoint with their useful purpose are as follows:

- *Scylla serrata (mud crab)*
- *Macrophthalmus simdentatus (littoral crab)*
- *Uca arcuata (wind crab)*
- *Penaeus merguiensis (white shrimp)*
- *Squilla sp. (horse shrimp)*
- *Arca granosa (blood clams)*
- *Cylina sinensis (blood clams)*
- *Sanguinolaria diphos (gallop clams)*

5.1.2 Seagrass and Seaweed Bed

According to the existing data about seagrass, 6 species of seagrass have been identified ; *Cymodocea rotundata, Halophila ovalis, H.beccarii, Zostera japonica, Ruppia maritima, Najas indica* in Cat Ba island and Ha Long bay. Before 1970's, Dau Go cave and Tuan Chau island were the major distribution area of seagrass beds in Ha Long bay, but the distribution of seagrass beds were diminished severely.

The Field Survey which was carried out at 13 sites shown in Figure 5.1.2, records 11 species of sea algae in the study area.

5.1.3 Coral Reef

According to the HIO's survey from 1993 to 1995, the distribution of coral reef in the study area is limited to the southern part of Ha Long bay shown in Figure 5.1.3. The fauna of hard corals is rather abundant, 117 species belonging to 40 genera, 12 families of Scleractinian. However, the vertical distribution of coral reef is restricted within 2-4 m in depth and the horizontal extent of coral reef is also narrow. The number of genera concentrated in family Faviidae with 11 genera, and the number of species concentrated in families Faviidae with 34 species and Acroporidae with 28 species. The number of taxon and living coral coverage tend to increase from seashore to offshore.

There are no corals around Hong Gai and Bai Chay in the mainland and near islands such as Vung Oan, Gieng Coi, Vung Chua, Hon Deu, Tuan Chau, due to mud bottom and high turbidity. The nearshore sites such as Cap De, Bui Xam and Co Ngua have smaller number of species compared with the far offshore sites that have higher number of species and abundance. The living coral coverage ranged from 15% to 55%, and most reefs belong to the poor reefs (the cover is lower than 25%) and the fair reefs (cover ranged from 25 to 49%), and only the reefs at Soi Van, Vung Ha, Dau Be and Hang Trai belong to the good reefs (cover ranged from 50 to 74%). There are no "excellent reefs" with cover over 75% in the study area. Among the species, dominant species belong to families Faviidae, Poritidae, Oculinidae and Agariciidae which are more tolerant to turbidity of sea waters.

As a result of the Field Survey, which was carried out in the sites shown in Figure 5.1.4, 122 species belonging to 41 genera of Scleractinians were identified. The number of species and coral cover are shown in Figure 5.1.5. Among 17 survey sites only 2 sites belong to "excellent reefs", 2 sites belong to the good reefs, 6 sites belong to the fair reefs and 4 sites belong to the poor reefs. Among them, one site (No.15) is all covered with dead corals and no coral has been observed at two sites (No.13, 16). In some sites, high percentage of dead corals was observed such as No.1, 2, 5, 7, 8 and especially all of the corals are dead at No.15.

5.2 Aquatic Ecosystem

5.2.1 Plankton

The Field Survey was carried out in the rainy season, July 1998, in order to understand the current condition of phytoplankton and zooplankton at 10 survey points as shown in Figure 5.2.1. Also DOSTE has conducted field survey in the dry season, December 1998 at 10 survey points near coast.

(1) Phytoplankton

1) Rainy Season

According to the analyzed result of phytoplankton samples collected at 10 survey points, 166 species of 6 phytoplankton phylums were identified. Of them Bacillariophyta has the highest number of species with 128 species (occupying 77% of total number), followed by Dinophyta with 33 species (20%), Cyanophyta with 2 species (1%), and 3 other phylum, Chlorophyta, Euglenophyta and Chrisophyta with one species each (1%). The cell number of phytoplankton varied in different survey points as shown in Figure 5.2.2. The species composition showed that flora of phytoplankton has the characteristics commonly observed in coastal waters of the temperate and subtropical zone.

The cell number of surface layer ranges from 14,040 to 77,100 cells/ℓ and bottom layer from 33,170 to 157,020 cells/ℓ. The range of cell number shows the level of commonly observed in coastal waters where eutrophication has not progressed severely. The number of species, bottom layer is mostly higher than surface layer, because benthic algae such as *Navicula*, *Pleurosigma* and *Amphora* are much distributed in bottom layer compared to surface layer. Of Dinophyta, 10 species belong to harmful algae, but their density is low, the highest number is 800 cells/ℓ belonging to *Dinophisis caudata*.

2) Dry Season

According to the analyzed result of phytoplankton samples collected at 10 survey points, 126 species of 4 algae have been identified. Of them Silic Bacillariophyceae has the highest number of species with 98 species (occupied

77.8% of total number), followed by Dinophyceae with 26 species (20.6%). Most species in the dry season are composed of the species living in seawater and brakish water, and the species living in freshwater are few. There were few fresh-water species in the dry season compared with the result of the rainy season. The number of species at each layer showed the tendency that the surface layer has the higher values than the bottom layer though the difference is not so large. On the contrary, the number of species in the rainy season showed that the surface layer has the lower values than the bottom layer.

The cell number of surface layer ranges from 8,960 to 146,280 cells/ℓ, and bottom layer ranges from 3,720 to 145,000 cells/ℓ. In comparison with the rainy season, the average cell number of the dry season is higher in surface layer and lower in the bottom layer.

(2) Zooplankton

1) Rainy Season

According to the result of samples collected at 10 survey points, 47 species were identified. Copepoda has the highest number of species with 25 species, followed by Crustacean larvae with 10 species, Cladocera and Molluses larvae with 3 species each, Chaetognatha with 2 species. Besides them Coelenterata, Ostracoda, Tunicata and fish larvae, has one species only.

The number of species and individual number at each point are shown in Figure 5.2.3. The number of species at each survey point varied from 6 to 28 species. The species composition showed that fauna of zooplankton has the characteristics commonly observed in coastal waters of the temperate and subtropical zone as well as phytoplankton. At No. 14 and 15 located at the southern end of the study area, oceanic species were comparatively abundant. It suggests that the waters around there are affected by oceanic waters. The individual number of zooplankton is 140 individuals/m^3 on the average of all survey points and varies from 6 to 429 indiv./m^3 at each survey point.

2) Dry Season

According to the result of samples collected at 10 survey points, 46 species of zooplanktons have been identified. The number of species at each survey point varied from 9 to 30 species. The average species number in the dry season is 20 and it shows higher value than the rainy season. The individual number of zooplankton is 491 individuals/m^3 on the average of all survey points and varies from 90 to 878 individuals/m^3 at each survey point. The average individual number in the dry season shows higher value than that of the rainy season.

5.2.2 Zoobenthos

The Field Survey was carried out to understand the current condition of zoobenthos on main habitats as shown in Figure 5.2.4.

According to the result of the Field Survey, 208 species of zoobenthos were identified. Among them, molluses has the highest number of species with 92 species, followed by Crustaceans (Crustacea) with 23 species and the echinoderm has the lowest number with only 15 species. The counting in various habitats showed that there are 169 species on littoral in mangrove, 104 species in soft bottom in sublittoral and 99 species in hard coral reef. The individuals of zoobenthos varies in different habitats : 110 to 4,242 individuals./m^2 on the littoral in mangroves, 85 to 530 individuals/m^2 in the soft bottom in sublittoral and 9 to 98 individuals/kg dead corals in hard coral reef bottom.

Zoobenthos living in the mangrove swamps were surveyed at 6 survey points on littoral zone at Hoang Tan, Dai Yen and Cua Luc inlet. From samples collected, 58 species of zoobenthos were recorded. Number of species, individual number and biomass at each point are shown in Figure 5.2.5. Number of species of each site ranges from 1 to 9 species. It suggests that the fauna of zoobenthos in mangrove swamps has low diversity. However, individual number and biomass show high value. In comparison with the result of benthos in soft bottom sublittoral surveyed concurrently in the study area, the benthos in mangrove swamps is four times individual number and more than ten times biomass. Dominant species on individual number are *Ostrea* sp., *Cerithidea cingulata*, *Septifer* sp., and *Pagurus*

sp. Abundant molluses is the characteristics of zobenthos fauna in mangrove swamps.

Zoobenthos living in the sublittoral in the soft bottom were surveyed at 10 survey points in Ha Long bay. From samples collected, 96 species of zoobenthos were recorded. Number of species, individual number and biomass at each point are shown in Figure 5.2.6. Number of species of each point ranges from 9 to 29 species. Dominant species on individuals are *Terebellides stroemi*, *Dentalium aprium*, *Nepthys polybrranchia*, *Dentalium longitrorsum*, and *Cuspidaria nobilis*. These species can be widely observed in the coastal waters of the temperate and subtropical zone.

Zoobenthos living in the coral reefs were surveyed at 10 survey points. From samples collected, 89 species of zoobenthos were recorded. Number of species, individual number, and biomass at each point are shown in Figure 5.2.7. Number of species of each point ranges from 12 to 26 species. Dominant species on individuals are *Lithophaga malaccana*, *Eunice siciliensis*, *Sipunculus* ap., and *Lithophaga teres*.

5.2.3 Fish and Shellfish

A hearing survey to fishermen and local agencies was carried out to understand the habitats of main fish and shellfish and fishing activities in the study area. According to the survey, 189 species belong to 124 genera, 66 families were recorded in Ha Lon bay. There are 5 important habitats for fishes, comprising of mangrove, coral reef, rocky reef, bay and embayment, and sand-mud bottom areas. Every habitat is characterized by some typical species. Also it was found that there are 3 spawning areas in the study area: Cua Luc-Tuan Chau-Dau Be (for drifting fishes), coral reefs and adjacent waters (for bottom fishes), and Ngoc Vung-Cong Do (for groupers and snappers). There are seven main fishing grounds in the study area: Dau Be, Dau Go, Hon Soi Den-Ngoc Vung, Cua Dua-Cong Do, Tuan Chau, Cong Dong-Cong Tay, and Hon Net-Hon Ong Cu shown in Figure 5.2.8. Main species at each fishing ground are as follows.

Main Species of Fish and Shellfish in Main Fishing Grounds in Ha Long Bay

No.	Fishing ground	Main species
I	Dau Be	Fish belong to genus and families: *Upeneus* (goatfish), *Saurida* (lizardfish), Sciaenidae (croaker), Serranidae (sea bass), Bothidae (lefteye flounder), Leiognathidae (ponyfish), Platycephalidae (flathead), Shellfishes and Squids
II	Dau Go	*Upeneus* (goatfish), *Leiognathidae* (ponyfish), *Saurida* (lizardfish), *Pleuronectiformes* (flatfish), *Siganus* (rabbit fish), Platycephalidae (flathead), Bivalvia, Shellfishes and Squids
III	Soi Den islet, Ngoc Vung	Serranidae (sea bass), Sciaenidae (croaker), *Muraenesox* (pike eel), *Saurida* (lizardfish)
IV	Cua Dua, Cong Do	Clupeidae (herring), *Pleuronectiformes* (flatfish), *Siganus* (rabbit fish), Sciaenidae (croaker), *Saurida* (lizardfish)
V	Tuan Chau	Leiognathidae (ponyfish), *Upeneus* (goatfish), Clupeidae (herring), *Saurida* (lizardfish), *Pleuronectiformes* (flatfish), *Siganus* (rabbit fish), *Sardinella aurita* (herring), Platycephalidae (flathead) Bivalvia, Shellfishes and Squids
VI	Cong Dong Cong Tay	*Scomberomorus* (mackerel), Carcharhinidae (rquiem shark), Leiognathidae (ponyfish), Sciaenidae (croaker), *Chupanodon*, Bivalvia and Squids
VII	Hon Net - Hon Ong Cu	*Upeneus* (goatfish), *Saurida* (lizardfish), Serranidae (sea bass), *Siganus* (rabbit fish), Sciaenidae (croaker), Leiognathidae (ponyfish), *Pleuronectiformes* (flatfish), *Sillago* (smelt-whiting), Bivalvia, Shellfishes and Squids

Note: Fishing grounds are shown in Figure 5.2.8

TABLES

Table 5.1.1 Wetlands in Bai Chay Bay

Type	Tidal wetland groups and types	Area (ha)	%
I. Vegetated wetland group	1. Wetland type with dense mangroves	1,597	21.3
	2. Wetland type with sparse mangroves	587	7.8
II. Non-vegetated wetland group	3. High tidal sand flats	265	3.5
	4. High tidal mud flats	14	6.2
	5. Low tidal mud flats	1,399	18.7
	6. Tidal delta	13	0.2
	7. Tidal sand spits	14	0.2
	8. Flat with grovels, pebbles and boulders	3	0.0
	9. Tidal creeks	646	8.6
III. Permanently submerged wetland group	10. Sunken rocks	1	0.0
	11. Tidal channels	798	10.6
IV. Man-made wetland group	12. Salt-brackish aquaculture ponds	2,001	26.7
	13. Fresh-brackish aquaculture ponds	146	1.9
	14. Lands reclaimed for agriculture	16	0.2
Total		7,500	100.0

Source: Task and Data Requirements of Land Use and Reclamation Study, HIO, 1997

Table 5.1.2 Wetlands in Ha Long Bay

Type	Tidal wetland groups and types	Area (ha)	%
I. Vegetated wetland group	1. Wetland type with dense mangroves	357	1.1
	2. Wetland type with sparse mangroves	22	0.1
II. Non-vegetated wetland group	3. High tidal sand flats	57	0.2
	4. High tidal mud flats	122	0.4
	5. Low tidal mud flats	3,109	9.6
	6. Low tidal sand flats	57	0.2
	7. Beaches	24	0.1
	8. Beaches of shell debris	3	0.0
	9. Abrasive terraces of stone	24	0.1
	10. Boulder flats	13	0.0
	11. Tidal creeks	18	0.1
III. Permanently submerged wetland group	12. Coral reefs	120	0.4
	13. Water bodies at 0-6 m deep	21,384	65.8
	14. Tidal channels	5,414	16.7
	15. Salt lakes	40	0.1
	16. Seagrass beds	670	2.1
	17. Sunken rocks	120	0.4
IV. Man-made wetland group	18. Salt-brackish aquaculture ponds	417	1.3
	19. Aquaculture ponds for molluscs	80	0.2
	20. Aquaculture ponds for peal oysters	5	0.0
Total		32,506	100.0

Source: Task and Data Requirements of Land Use and Reclamation Study, HIO, 1997

Table 5.1.3 Species Composition of Mangroves in Quang Ninh Province

(1) Area from Mong Cai to Cua Ong

Type of Swamps	Scientific Name	
1) Newly formed swamps	*Avecinnia marina*	
2) Medium tidal flat	*Rhizophora stylosa*	*Kandelia candel*
	Bruguiera gymnorhiza	*Aegiceras corniculatum*
	Avicennia marina	
3) High tidal swamps	*Excoccaria agallocha*	*Lumnitzera racemosa*
	Acanthus ilicijolius	
4) Swamps rarely flooded with tide	*Xylocarpus obovatus*	*Hibiscus tiliaceus*
	Heritiera littpralis	*Cerbera manghas*
	Clerodendron inerme	*Scaevola bainanengis*
	Pandanus tectorius	*Derris trifoliata*

(2) Area from Cua Ong to Cua Luc

Types of Swamps	Scientific Name	
1) Newly formed swamps (narrow area)	*Avecinnia marina*	
2) High and medium tidal swamps	*Avecinnia marina*	*Rhizophora stylosa*
	Bruguiera gymnorhiza	*Kandelia candel*
	Aegiceras corniculatum	
3) Swamps rarely flooded with tide	*Hibiscus tibiaccus*	*Excoccaria agallocha*
	Lumnitzera racemosa	*Scaevola taccada*
	Clerodendron inerme	

(3) Area from Cua Luc to Cua Nam Trieu

Types of Swamps	Scientific Name	
1) Newly formed swamps	*Avecinnia marina*	
2) Medium tidal swamps	*Rhizophora stylosa*	*Kandelia candel*
	Bruguiera gymnorhiza	*Aegiceras corniculatum*
	Avecinnia marina	
3) High tidal swamps	*Xylocarpus granatum*	*Excoccaria agallocha*
	Sonneratia caseolaris	*Aegiceras corniculatum*
4) Brackish waters	*Acanthus ilicijolius*	

FIGURES

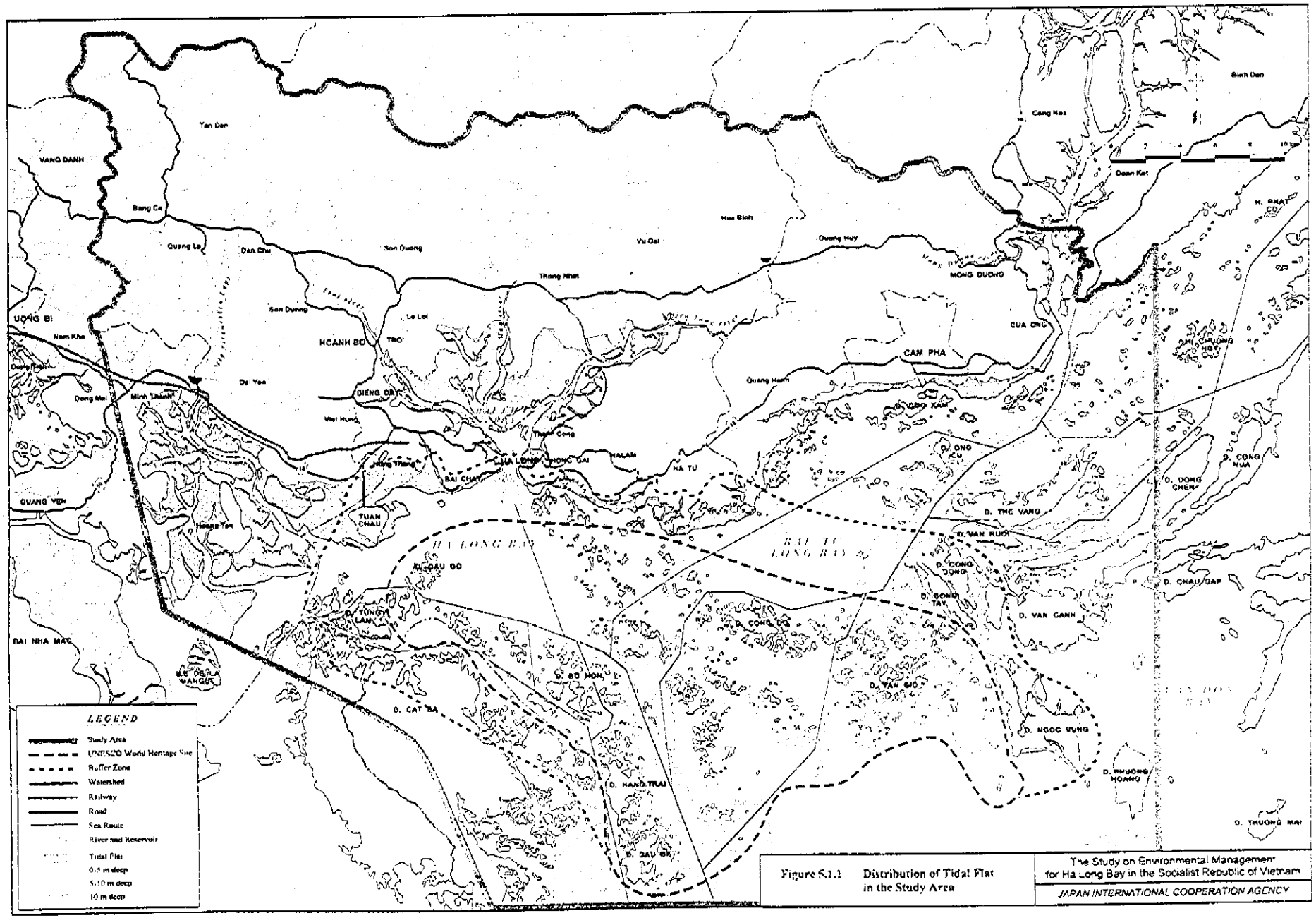


Figure 5.1.1 Distribution of Tidal Flat in the Study Area

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

JAPAN INTERNATIONAL COOPERATION AGENCY

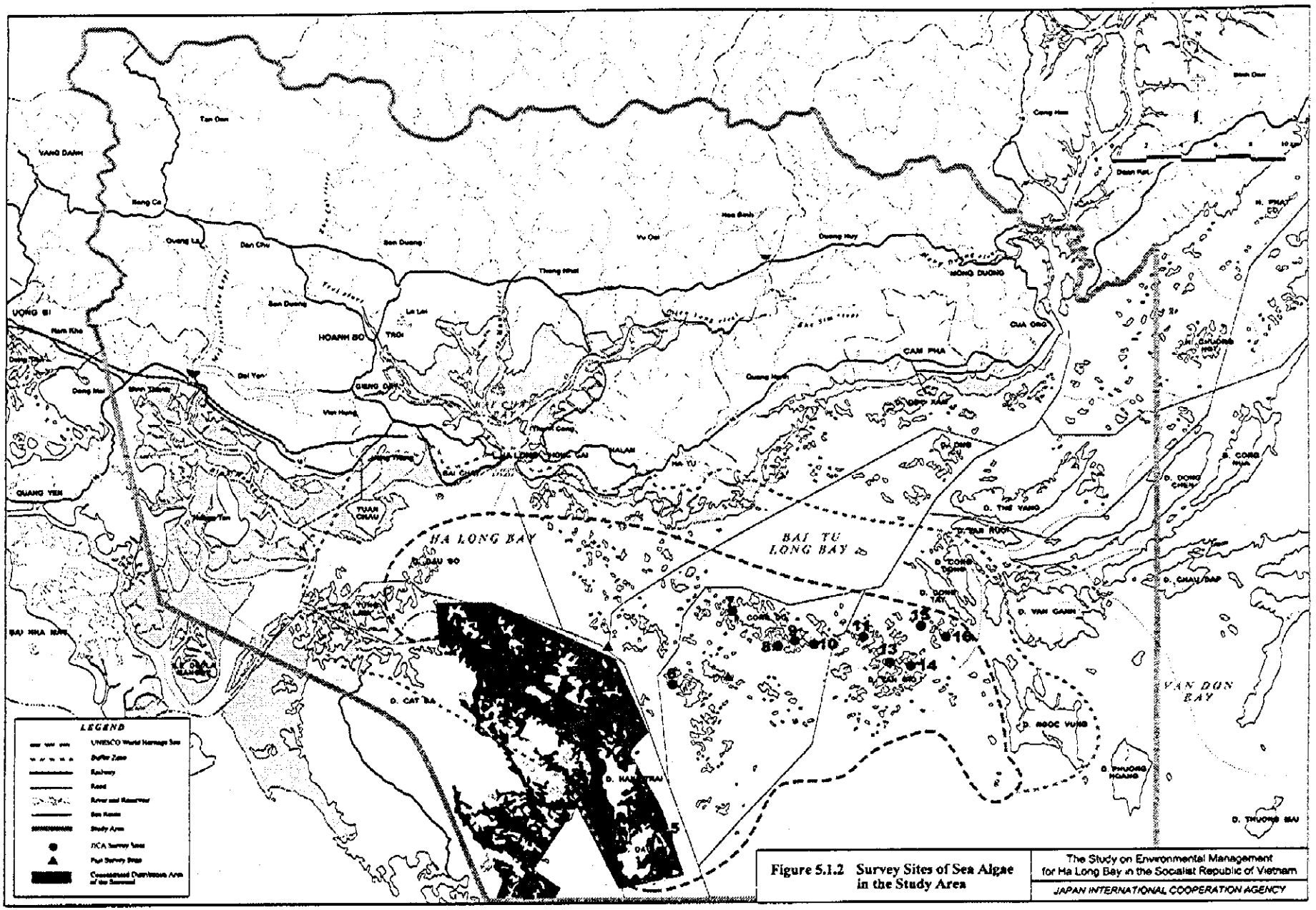


Figure 5.1.2 Survey Sites of Sea Algae in the Study Area

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

JAPAN INTERNATIONAL COOPERATION AGENCY

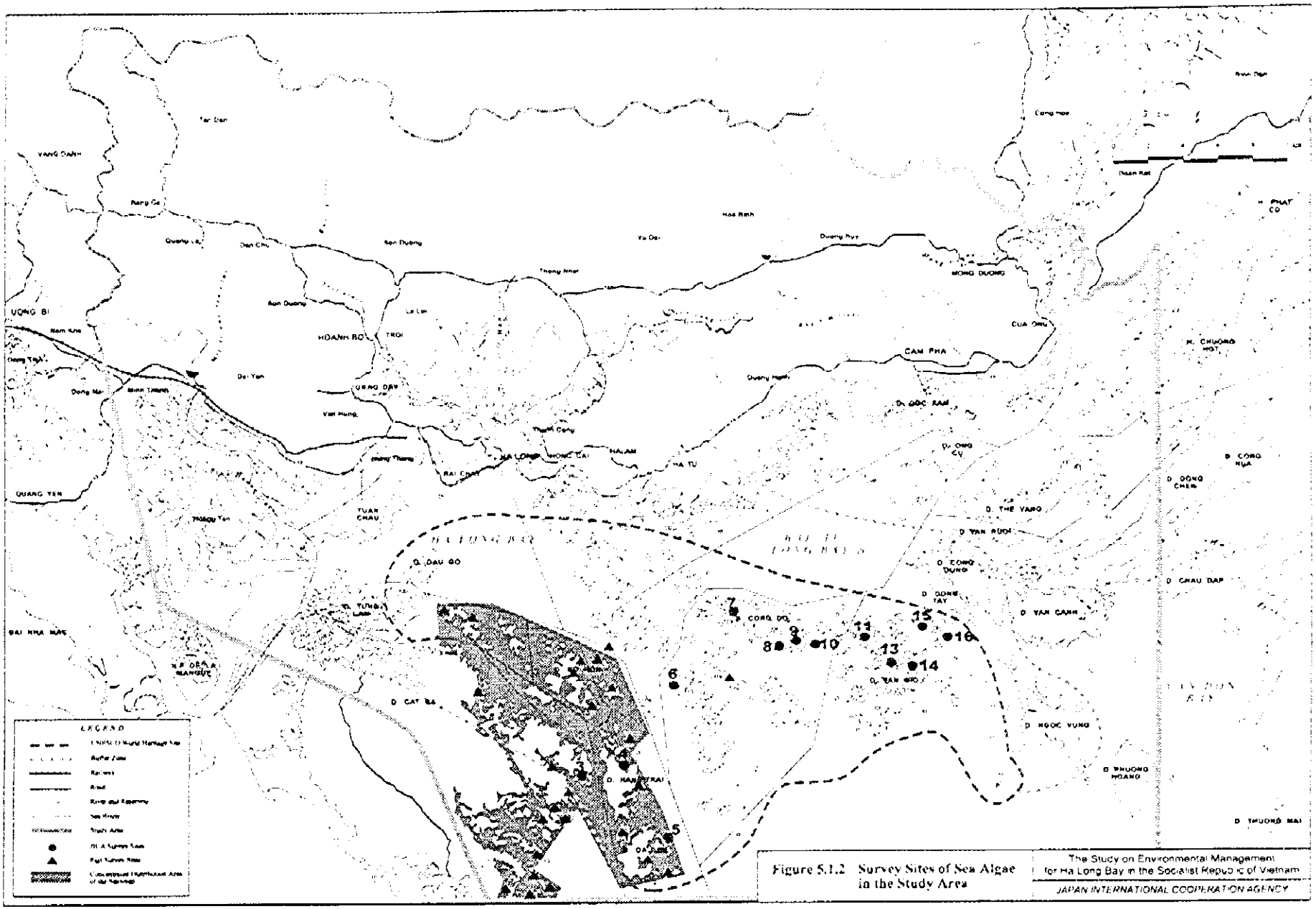


Figure 5.1.2 Survey Sites of Sea Algae in the Study Area

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

JAPAN INTERNATIONAL COOPERATION AGENCY

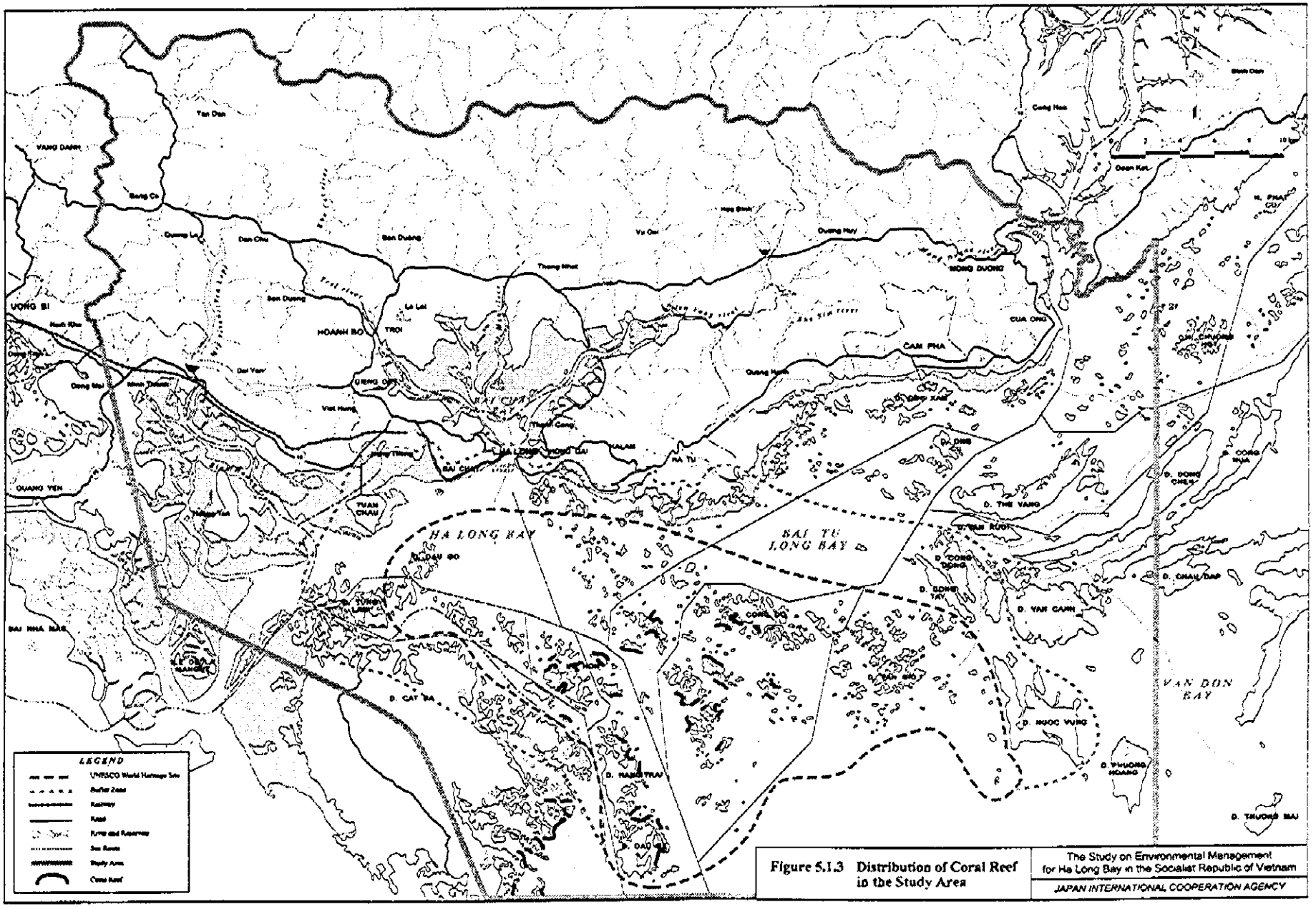


Figure 5.1.3 Distribution of Coral Reef in the Study Area

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

JAPAN INTERNATIONAL COOPERATION AGENCY

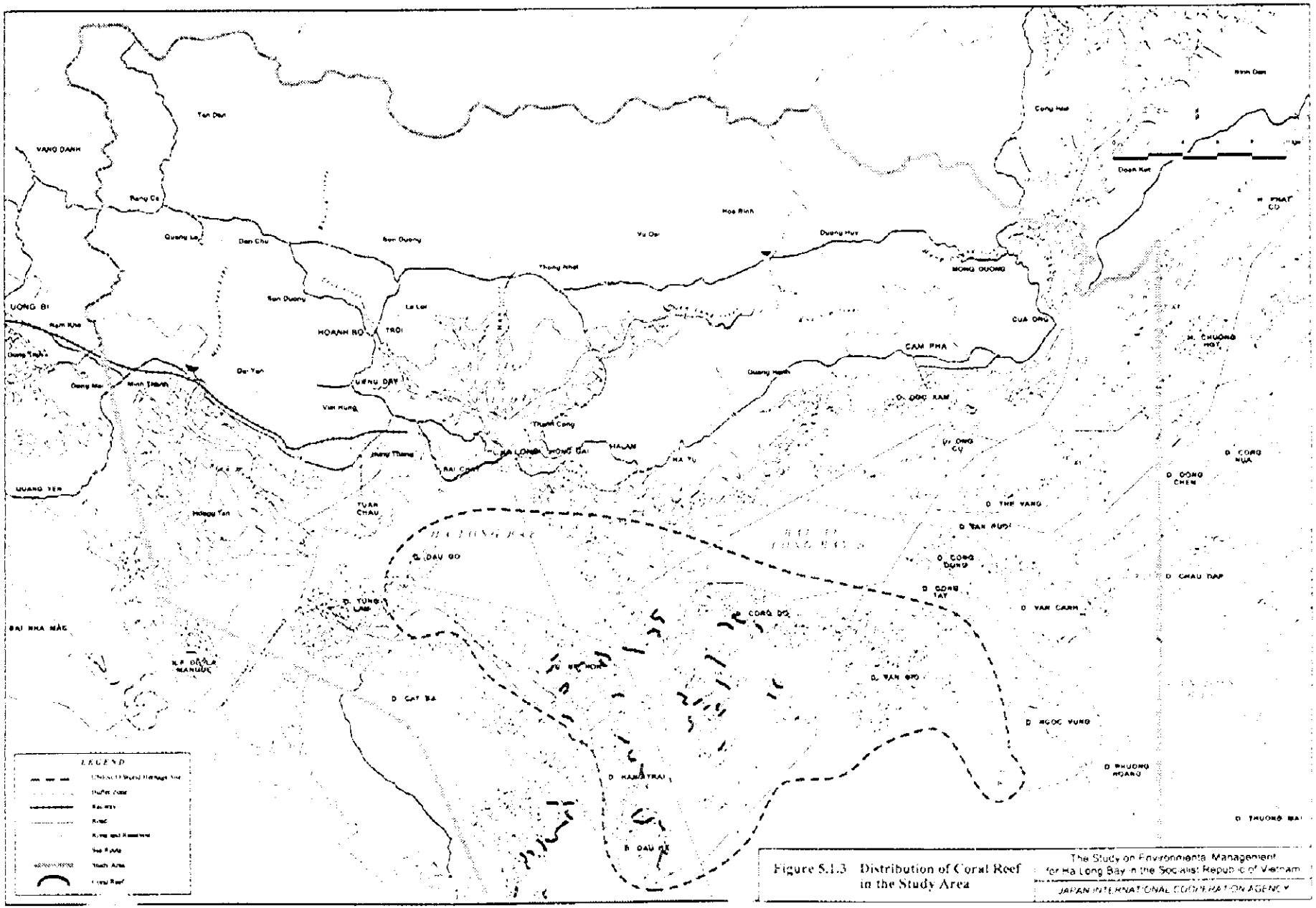


Figure 5.1.3 Distribution of Coral Reef in the Study Area

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

JAPAN INTERNATIONAL COOPERATION AGENCY

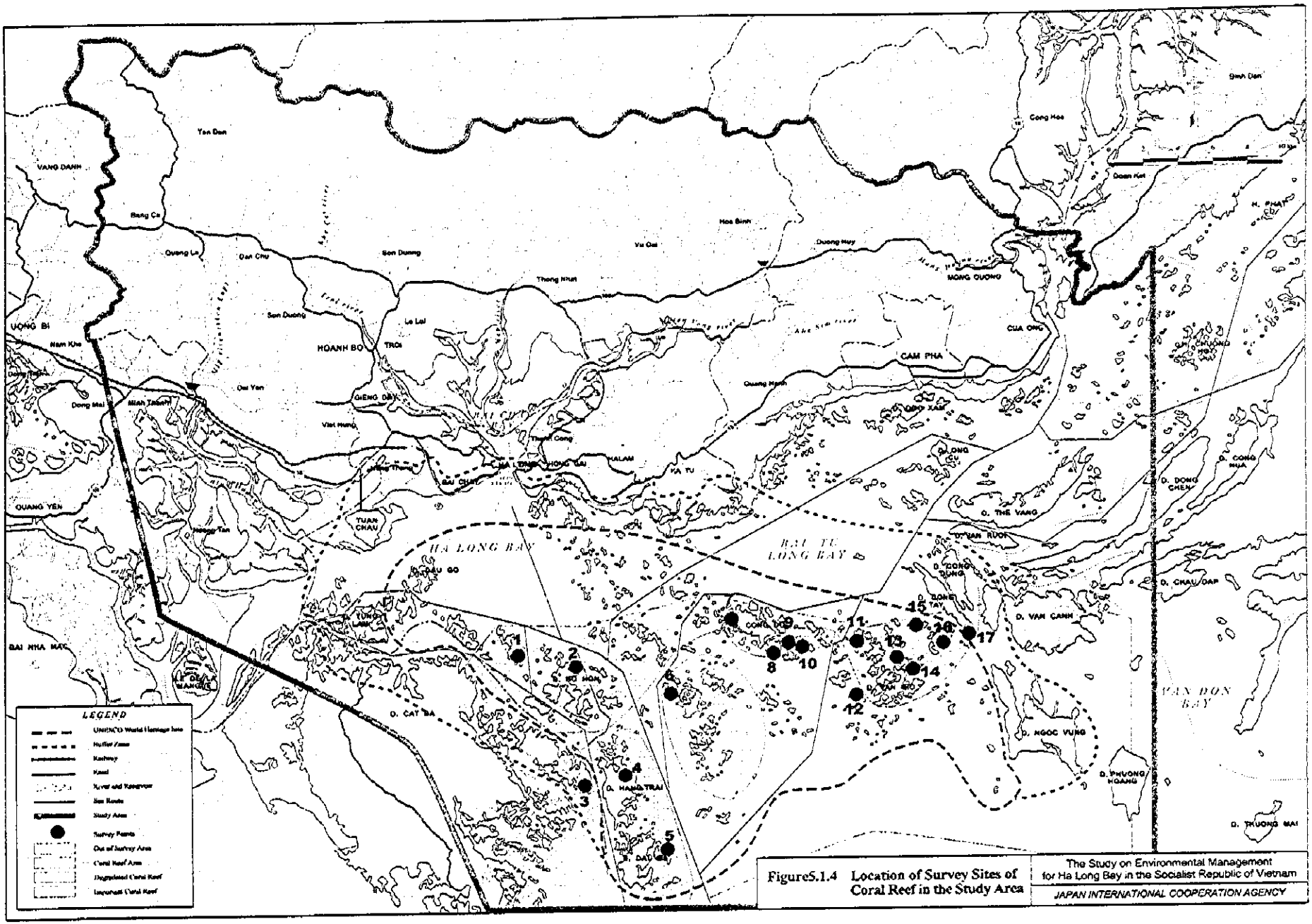
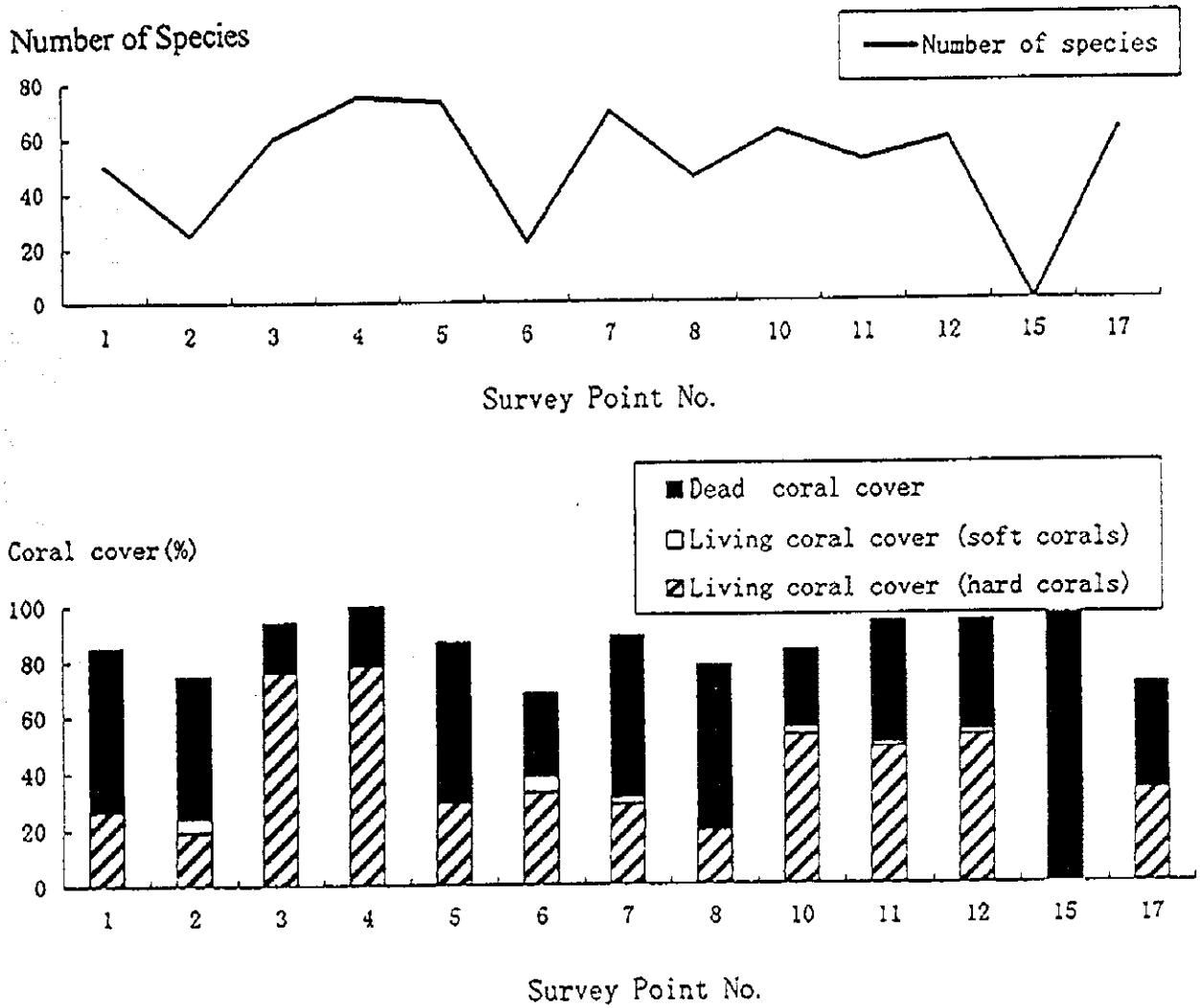


Figure5.1.4 Location of Survey Sites of Coral Reef in the Study Area

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

JAPAN INTERNATIONAL COOPERATION AGENCY



Note: The location of survey point is shown in Figure 5.1.4

Figure 5.1.5 Number of Species and Coral Cover at Each Survey Site in the Study Area

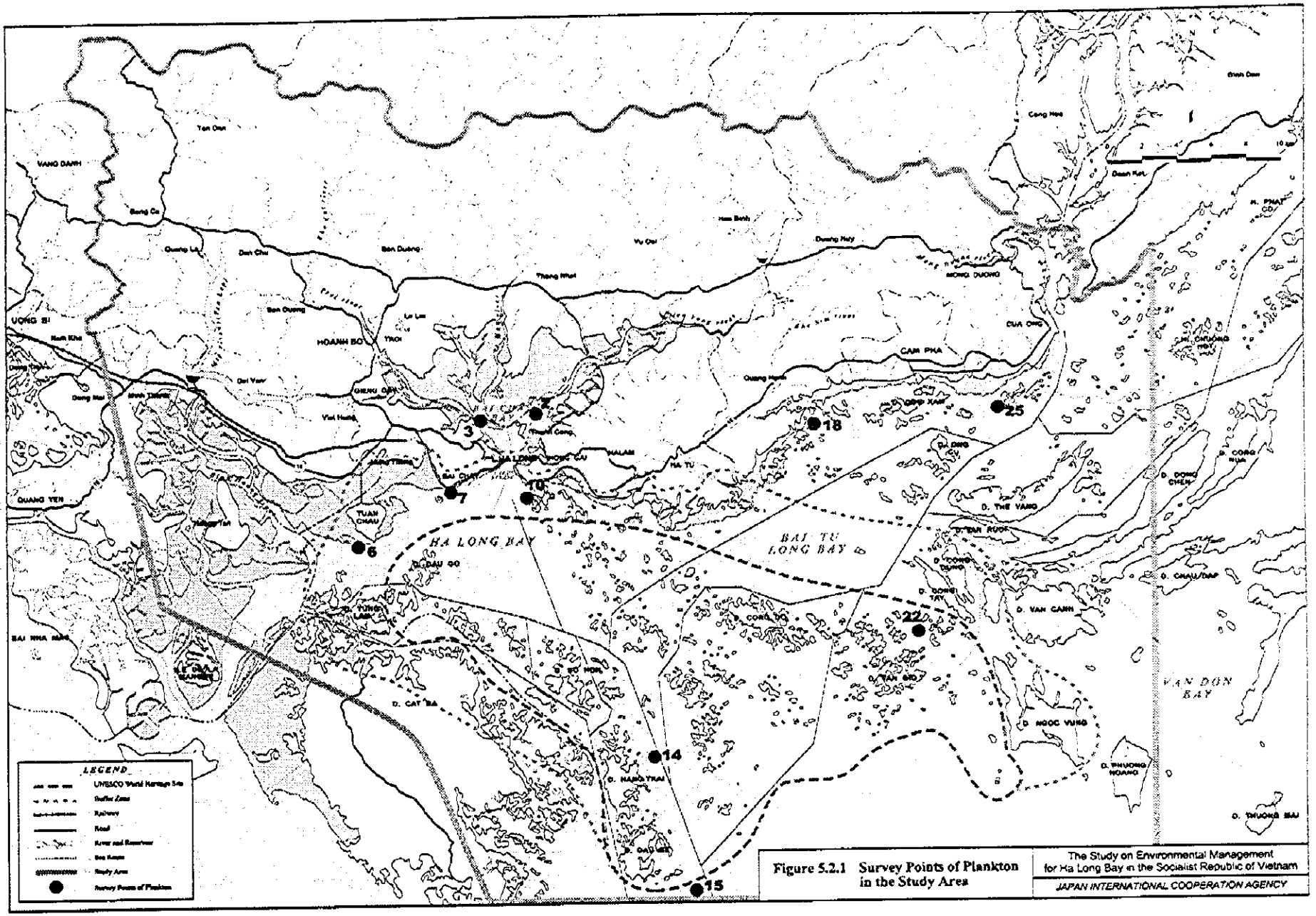
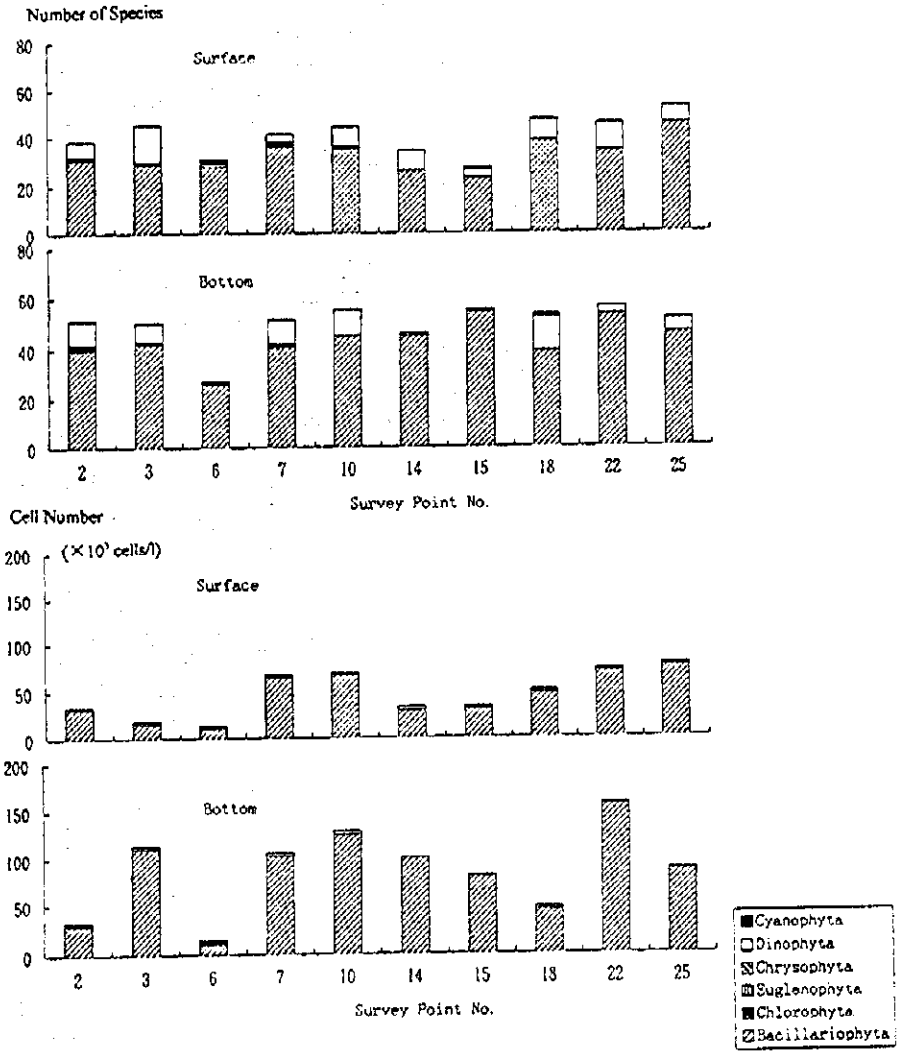


Figure 5.2.1 Survey Points of Plankton in the Study Area

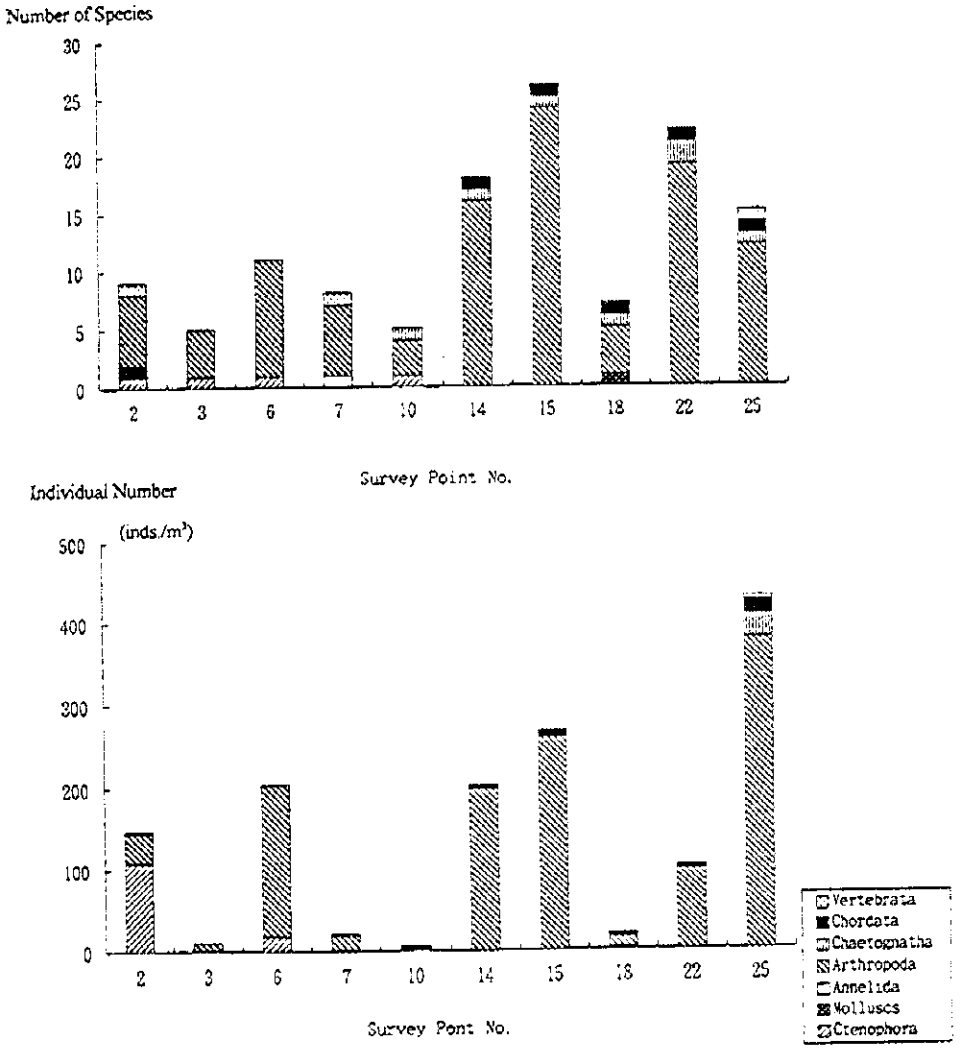
The Study on Environmental Management for Ha Long Bay in the Socialist Republic of Vietnam

JAPAN INTERNATIONAL COOPERATION AGENCY



Note: The location of survey points is shown in Figure 5.2.1

Figure 5.2.2 Number of Species and Cell Number of Phytoplankton



Note: The location of survey points is shown in Figure 5.2.1

Figure 5.2.3 Number of Species and Individual Number of Zooplankton

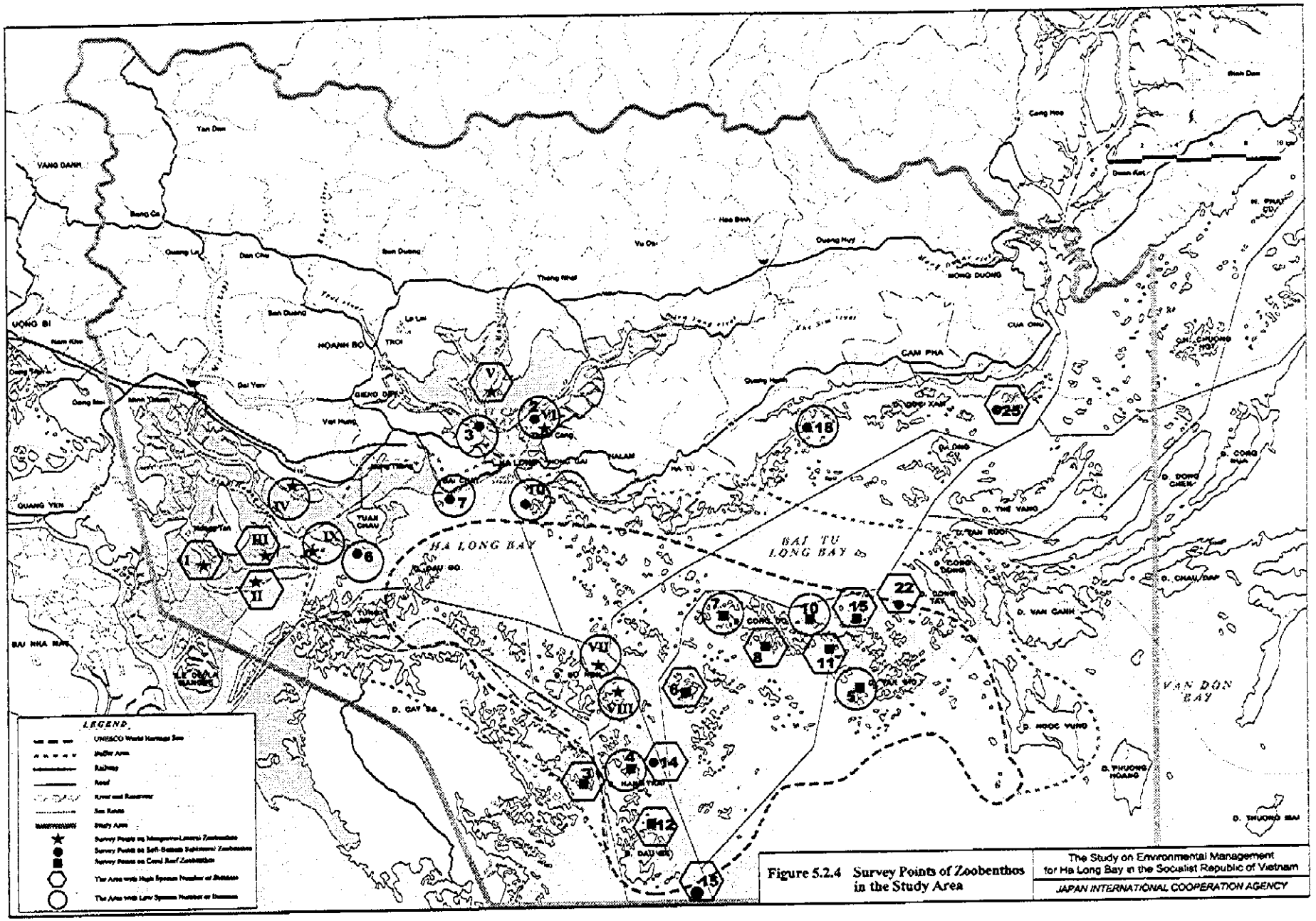
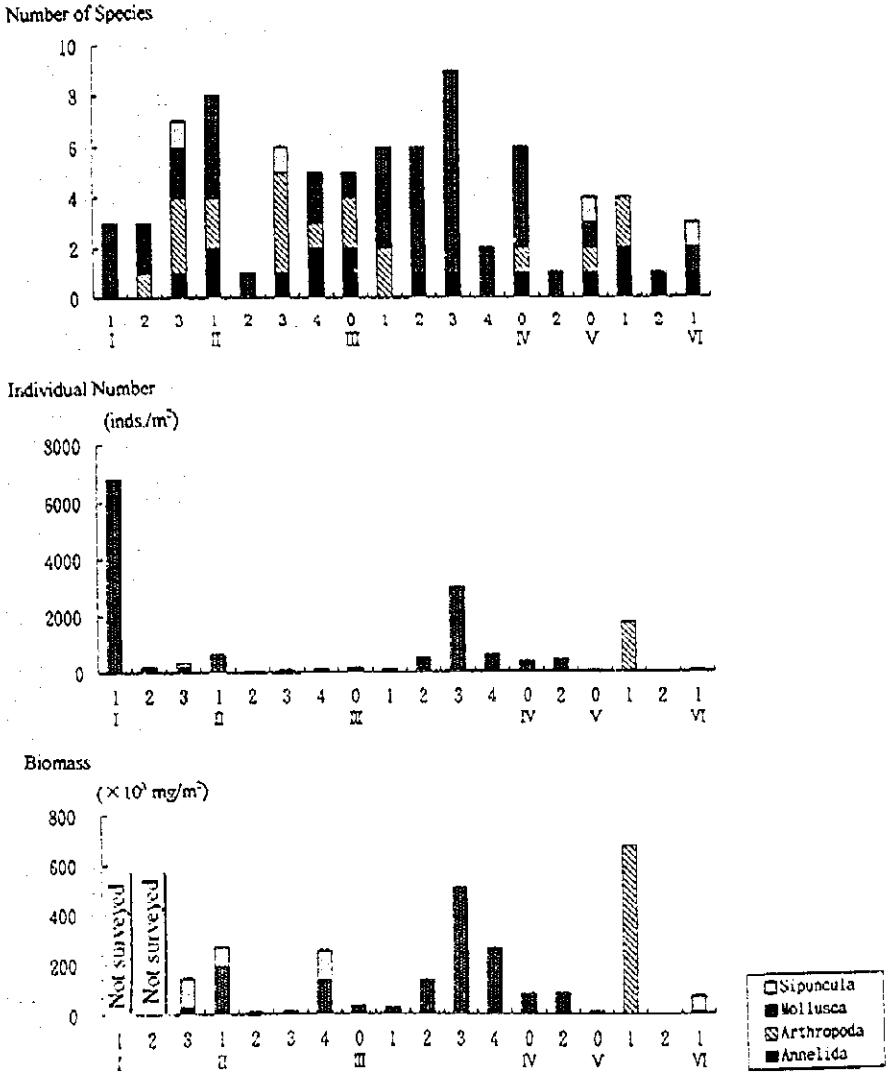


Figure 5.2.4 Survey Points of Zoobenthos in the Study Area

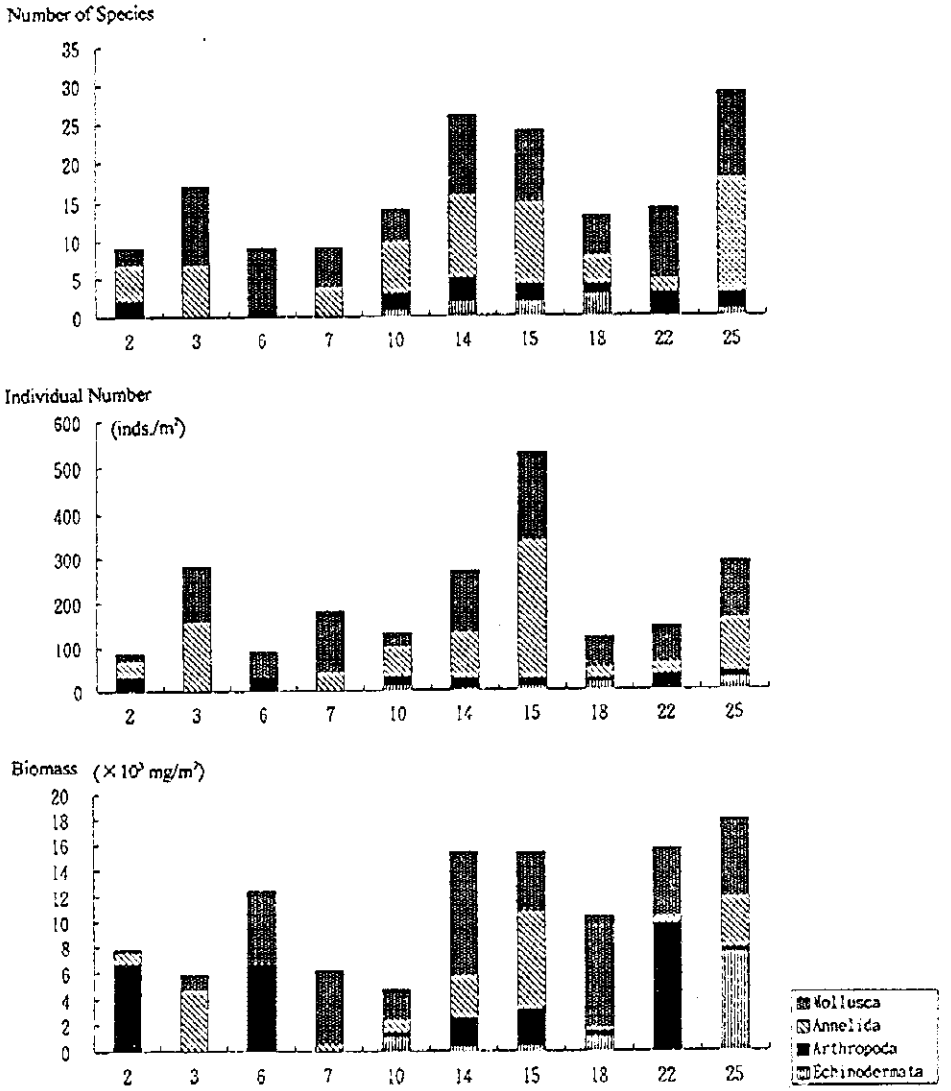
The Study on Environmental Management for Ha Long Bay in the Socialist Republic of Vietnam

JAPAN INTERNATIONAL COOPERATION AGENCY



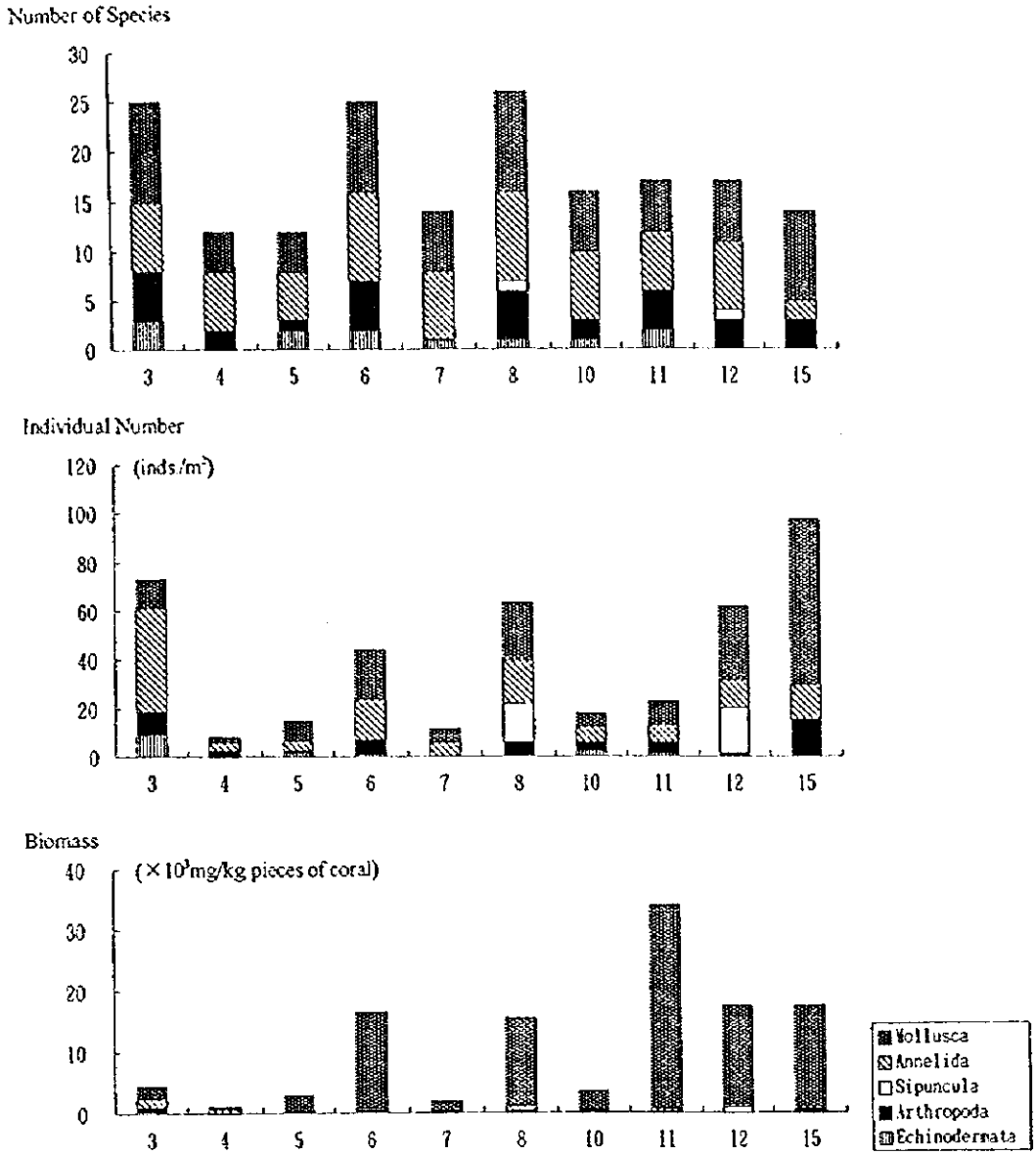
Note: 1. The number of 0-4 shows sampling station No. at each survey point (I-VI).
2. The location of survey points is shown in Figure 5.2.4.

Figure 5.2.5 Number of Species, Individual Number and Biomass of Zoobenthos in Mangrove Swamps



Note: The location of survey points is shown in Figure 5.2.4

Figure 5.2.6 Number of Species, Individual Number and Biomass of Zoobenthos in Sublittoral in the Soft Bottom



Note: The location of survey points is shown in Figure 5.2.4

Figure 5.2.7 Number of Species, Individual Number and Biomass of Zoobenthos in Coral Reefs

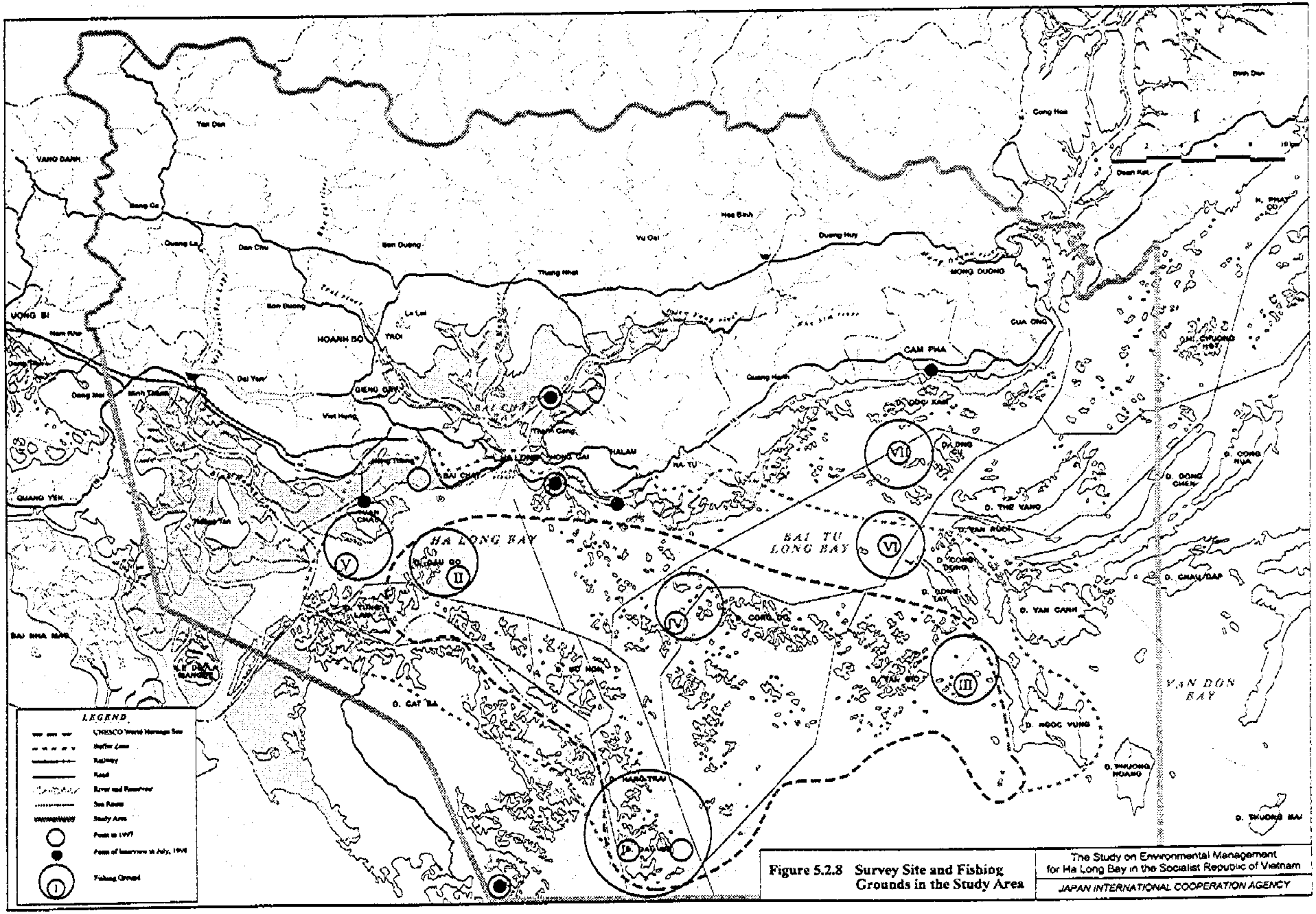


Figure 5.2.8 Survey Site and Fishing Grounds in the Study Area

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

JAPAN INTERNATIONAL COOPERATION AGENCY

CHAPTER 6

CHAPTER 6 LEGAL AND INSTITUTIONAL CONDITIONS

6.1 Legal Conditions for Environment

6.1.1 National Policy on Environmental Management

Much of Vietnamese environmental policy is articulated in the "National Plan for Sustainable Development and Environment". In general, its policy aims at:

a) satisfying the basic material, spiritual and cultural needs of the current and future generations of Vietnamese people by wisely managing the country's natural resources, and
b) establishing and enforcing policies, action plans, and institutional frameworks to ensure sustainable use of natural resources that are closely connected to all aspects of the process of socioeconomic development in Vietnam.

The basic objectives of the policy include:

a) preserving those key ecological processes and ecosystems that influence the well being of the Vietnamese people,
b) conserving the abundance and genetic diversity of domestic and wild animals and plants for current and future generations,
c) ensuring the long term sustainable use of natural resources by fostering efficient use and monitoring actual use,
d) maintaining basic environmental quality, and
e) attaining a population growth level and distribution that consistent with Vietnamese natural capacity and ensuring adequate living standards for the people.

(1) Forests

The strategy for forest protection and biodiversity is provided in the National Conservation Strategy (1984), the Tropical Forestry Action Plan (1991) and Vietnam Biodiversity Action Plan (1995). The Forestry Resources Protection and Development Act (1991) establishes three categories of forestland: 1) protection forests (critical watersheds and wetlands), 2) special use forests (protected areas), and 3) production forests. Decree 327 issued in 1992, sets out guidelines for a ten-

year program aimed to protect forests and to "regreen" denuded hillsides and barren forest lands. The Vietnam National Environmental Action Plan (VNNEAP) of August 1995 identified upland forest conservation and management for bio-diversity and watershed protection as a priority.

(2) Agricultural Land

Much of agricultural land is in lowland rice culture in the Red river and Mekong deltas. In these areas, agricultural policy needs to encourage agricultural productivity while controlling and limiting the use of pesticides, herbicides, and chemical fertilizer. In the uplands, new agroforestry systems are being established to increase agricultural productivity. These new systems are being encouraged because of their potential to reduce erosion and enhance watershed protection.

(3) Coastal Wetland Ecosystems

Vietnamese coastal wetland ecosystems include mangrove forests, salty swamp forests, tidal mud flats, sand dunes, and salt water marshes. These coastal ecosystems play an important ecological, environment, and economic role. They provide habitat for many commercial species including shrimp, fish, snails, and oysters. In addition, they are the nesting grounds for migratory birds. These areas are also the first lines of defense against high winds, storms, and major typhoons. The policy with respect to coastal wetlands aims at 1) master planning to set out specific conservation zones to protect breeding areas, and 2) implementing sustainable practices for utilization of these areas including restrictions on tree cutting, shrimp culture, and other aquaculture.

(4) Marine and Estuarine Ecosystems

Environmental policy with respect to the marine and estuarine ecosystems is primarily concerned with ensuring sustainable harvest of marine resources, control of land based and ship based pollution, and protection of critical environmental resources such as coral reefs and sea grasses. Policy is in place to reduce and control illegal fishing and the use of illegal fishing methods.

(5) Freshwater Resources

Agriculture is the single largest consumer of water because irrigation is used in many regions to maintain high agricultural productivity. Flood control and drainage systems are needed to prevent flooding, waterlogging, and salt-water intrusion. Also, water resources are becoming increasingly important for energy production as Vietnam moves towards harnessing their hydroelectric potential. Water resource policy aims at sustainably exploiting and managing water resources, balancing the conflicting water demands, preventing water pollution and ecosystem degradation, and limiting natural disasters. Policy is to be established within the framework of monitoring the impacts of river basin development. Water resource development projects are to be evaluated in terms of their environmental impacts, impacts on other water resource uses, and existing and planned water resource projects. Standards have been designed to limit water pollution, control industrial wastewater, establish wastewater treatment systems and control the use of agro-chemicals.

(6) Biodiversity

The National Biodiversity Program (Decree No. 845/ Ttg - December 1995) is aimed at protecting rich and unique biological resources. Its specific objectives are:

a) protection of special and fragile ecosystems in danger of degradation or destruction through human activities,
b) protection of components of biodiversity that are threatened by over-exploitation, and
c) determination of the economic value and other values of all components of biodiversity in the context of sustainable development of natural resources.

The Program is directed at implementation of the Law on Environmental Protection and International Conventions on Biodiversity by creating regulations on 1) preservation, use, exploitation, and exchange of genetic or racial resources and species, and 2) prevention of further degradation and destruction of special and fragile ecosystems. It is also directed at setting aside protected areas and conservation zones while encouraging integrated conservation and rural

development projects. The Program contains the following capacity building elements,

a) education and awareness raising,
b) increasing qualifications and capability of specialist and managers,
c) scientific research on sustainable use of biodiversity resources,
d) integrating the National Program with other socioeconomic development plans, and
e) strengthening regional and international cooperation.

(7) Controlling Industrial and Urban Pollution

General policy on pollution control aims at preventing, stopping, and reducing pollution. Environmental standards have been put in place. The GOV's intentions towards enforcement of these standards will place pressure on industry and urban centers to control pollution emission and discharge. The regulations regarding Environmental Impact Assessment (EIA) of new projects emphasize the need for pollution control and abatement measures to be implemented as an integral part of the project. Article 17 of the Law on Environmental Protection requires that existing facilities conduct an EIA. The facility must examine its pollution management and control measures. Based on EIA, it must prepare a plan for upgrading their facilities to meet environmental standards and conditions.

GOV is also encouraging transfer of new technologies, use of cleaner technology, and recycling and reuse of wastes. The National Environmental Agency (NEA) is considering using economic instruments such as pollution charges as another mechanism to encourage reduction in pollution.

(8) Prevention and Limitations of Natural Disasters

Vietnam is under constant threat from natural disasters, especially typhoons and floods. GOV includes its policy to minimize the effects on natural disasters as part of the national policy on sustainable development and environment. The national policy on disasters involves;

a) minimizing erosion and flood risk by encouraging watershed management that prevents further forest destruction and promote forest planting, and

b) preventing the impact of natural disasters by constructing dykes, dams and barrages, upgrading flood forecasting, improving information networks and emergency services.

(9) Environmental Impact Assessment of Development Projects

The Vietnamese EIA process requires both new investments projects and existing facilities to prepare EIA reports. In the case of new projects, EIA reports are required to provide a set of environmental mitigation measures and environmental monitoring requirements that become conditions of the approval of the project. In the case of existing facilities, EIA reports provide a remedial action plan designed to reduce pollution and control other activities that are having harmful effects.

The policy of GOV is that all projects and facilities, old and new are subject to the environmental assessment process. EIA process is an essential tool in ensuring the environmental considerations in the development process. There are new efforts to increase the use of EIA process within the overall development planning process.

(10) Measures for Policy Implementation

The basic measures for implementation of environmental policy are:

a) Establishment of legislative and regulatory instruments including,
b) Establishment of the environmental management system as national and provincial levels,
c) Training and education of specialists and managers,
d) Establishing laboratories and environmental monitoring systems,
e) Economic instruments,
f) Research in science and technology,
g) Raising of environmental awareness, and
h) Strengthening international and regional cooperation.

(11) Problems and Constraints in Implementation

Vietnam has made good progress in developing a set of laws and regulations to define the legal framework for environmental management. The establishment of an environmental management system operated by trained staff and effective institutions is now in progress. There is much to be done to clarify the

responsibilities between MOSTE and other national ministries. Each of these national ministries must set policies and delegate responsibility to the provincial authorities. At the provincial levels, there is also a need to clarify the responsibilities between the provincial DOSTE and the departments of other ministries.

Most ministries do not have sufficient financial and human resources to fulfill their environmental management responsibilities. Considerable effort and funding are required to increase the capacity of the existing agencies. More environmental staff is needed in most branches of the government. New and existing staff will require considerable training and retraining. Capacity building is needed to put monitoring and laboratory systems in place. These systems are necessary to provide decision-makers with reliable information about the changes occurring in the environment as a result of human activity. Environmental research and development to find new solutions and technologies must complement training and capacity building. Here again, there is a shortage of financial resources to conduct the necessary research.

Economic instruments such as pollution charges, environmental taxes, and environmental funds may be used to create a disincentive to pollute or otherwise cause environmental damage. To date, this is one of the least used of the regulatory instruments available to Vietnam, due in part in a transition economy. This will mean introducing a completely new program, because, a number of problems can be anticipated in obtaining agreement from industrial facilities and other polluters.

Despite of continuing efforts of GOV, the general level of environmental awareness within the people is relatively low. Until people become aware of the need for environmental protection, it can be expected to decline the environmental quality. The pressure for socioeconomic development for those people lacking in environmental awareness, it may seem better to follow a "pollute now, pay later" approach to development. Unfortunately, the experience in other parts of world has shown that the costs of cleaning up the environment after harmful effects is more expensive than planning for environmentally sound development. There are also numerous examples where life sustaining environmental resources have

destroyed and lost forever. It may be difficult for Vietnam to choose any other path to development, unless the range of options for development is expanded.

6.1.2 National Laws and Regulations

(1) The Law on Environmental Protection (LEP)

A large number of environmental protection laws and regulations have been promulgated over the past few years (Table 6.1.1). The Law on Environmental Protection (1993) provides the basic framework for the environmental protection and management in Vietnam. The LEP mandates the Central Government overall responsibility for environmental protection. In general, the law stipulates,

a) that polluting activities are strictly prohibited,
b) that EIA of new projects and existing facilities are required,
c) that the introduction of new technologies or alien species is controlled,
d) that the government may demand financial contributions for those causing damage to the environment,
e) inspection procedures to ensure compliance with the law, and
f) procedures for dealing with environment accidents.

Basic laws in other economic sectors have provisions relating to environmental protection. As such the legal framework for environmental protection in general is well developed, but there remains a need for clarification of the responsibilities for environmental management.

(2) Inspection

Circular No. 1485-Mtg, December 12, 1998 of MOSTE provides guidance on the structure, responsibility, and scope of the activity of environmental inspection. The inspection agency within MOSTE is responsible for state inspection for environmental protection. The inspection agencies at the provincial level carry out inspection on behalf of the Provincial People's Committee. In Quang Ninh province, the Inspection Division is part of DOSTE. At the national level, NEA undertakes the following inspection:

a) to assess the implementation of the regulations on environmental protection in all ministries and branches of the Central Government,

b) to assess the implementation of State's management function of the People's Committee of cities and provinces,
c) to determine compliance with the regulations in LEP by organisations and individuals throughout Vietnam, and
d) to determine violations of LEP by organisations and individuals.

NEA also plays a coordinating role with respect to any special inspection organisation created at the national level. It has the responsibility to prepare reports on environmental incidents, pollution, and degradation in provinces and cities. These reports are submitted to Director of NEA for review and decision. At the provincial level, DOSTE undertakes the following inspection:

a) to assess the implementation of the regulations on environmental protection in all departments and branches of the provincial government,
b) to assess the implementation of State's management function of the People's Committees of provinces, districts, wards, and communes,
c) to determine compliance with the regulations in LEP by organisations and individuals within their localities,
d) to determine violations of LEP that may occur during activities of organisations and individuals, and
e) to coordinate with inspection of other departments and branches.

The DOSTEs may prepare reports on environmental incidents, pollution, and degradation in provinces and cities. These reports are submitted to the Director of DOSTE for decision. Inspection can take on three different forms: 1) periodic inspection, 2) sudden inspection without prior warning; and 3) inspection to ensure implementation. The results of inspections must be recorded in a written report, and is to be read aloud in front of witnesses, to the individual responsible for the organisation that is being inspected.

(3) Enforcement

Decree No. 26/CP dated April 26th, 1996 of the Government "Regulation on Punishment for Administratively Violating Environmental Protection Legislation" outlines the forms of punishment and the responsibilities and authority for enforcement. The various articles provide for warnings and fines for violations of:

a) prevention of pollution and environmental regulation and of protection of biodiversity and natural resources,
b) prohibitions on exploitation and trading of rare and precious animals and plants, and of use instruments and methods of mass killing and catching,
c) infringement of regulations on environmental protection of soil resources,
d) regulations on exports and import of wastes, hazardous substances, radioactive materials, and genetic material,
e) regulation on disposal of radio-active waste and waste contaminated with viruses and other pathogens,
f) regulations on noise and vibration detrimental to human health and affecting the daily life of the people, and
g) regulations burning and destruction of forests and exploitation of mineral resources.

The authority for dealing with violations is delegated to environmental inspectors and the chief inspector of DOSTE, Director, Vice Director, and Chief Inspector of NEA and Chairman of the People's Committee (Table 6.1.2).

(4) Environmental Standards

The MOSTE has published Vietnamese environmental standards. Table 6.1.3 lists the published documents related to wastewater and water quality. In Quang Ninh province, there appear to be no local standards. The general policy dictates that the national standards are to be followed.

6.1.3 Sectoral Laws

(1) Mining Law

1) Decree on Mineral Resources, 1989

The basic law on mining is the Decree Law on Mineral resources issued 1989. Mine operators conduct activities according to the Decree Law, its regulations, and terms and conditions attached to their license. With respect to the environmental protection associated with mineral activities, the Mineral Law states that:

a) those organizations or individuals that have obtained a permission to conduct activities in the field of minerals must use technologies, equipment, materials that are environmentally sound, and
b) those organizations of individuals that have obtained a permission to conduct activities in the field of minerals must cover all the cost for rehabilitation of the environment. The feasibility study should include EIA of mining.

According to LEP mine operators must use non-polluting techniques, rehabilitate and reclaim the land and surrounding environment during and after completion of mining activities.

2) Technical Regulations on Exploitation of Open-Pit Mines, 1991

Article 1.3 of the Technical Regulations on the Exploitation of Open-Pit Mines (TCVN-5326-91) sets out the existing rules on environmental protection. Mine operators are directed to undertake their operations in a way that minimizes impacts on land, forests, and dwellings. The main provisions are:

a) operators must limit the use of land for waste discharges,
b) waste from road and railway construction must have a proper disposal,
c) lake drainage should prevented or compensation made,
d) drainage into rivers and lakes must be monitored,
e) dangerous discharges must be treated before disposal,
f) residential areas are to be protected from noise, dust, and other hazards,
g) remedial measures undertaken including plantings on the overburden sites, and
h) reclamation is to be undertaken where possible and abandoned sites to be left in the best possible condition.

3) EIA

Under LEP, all mines are subject to EIA process. New mines must prepare an EIA report that provides i) environmental description of the mine site, ii) assessment of environmental impacts, iii) mitigation measures to prevent or reduce impacts, and iv) recommendation on environmental monitoring. Existing mines are also subject to EIA to determine the current state of the environment and recommend corrective actions to improve the environmental situation.

(2) Law on the Conservation and Management of Living Aquatic Resources, 1989

The Law on Conservation and Management of Living Aquatic Resources provides for the basic protection of key ecological resources including economic exploitable fish and shellfish species and their habitats. Living aquatic resources are defined to include "all species with economic or scientific value, living in the inland waters, internal waters, territorial seas, the contiguous zones, and exclusive economic zones and the continental shelf of Vietnam". Article 8 of the Law prohibits the following activities that are detrimental to aquatic resources or cause pollution in the habitat of aquatic species:

a) fishing methods such as using pesticides, using electricity, using small mesh size in nets, catching juvenile fish, using dynamite and other explosives, using high intensity lights, and fishing in prohibited zones,
b) releasing or leaking harmful toxic substances in excess of allowable limits,
c) removal of mangroves forests, rocks, coral reefs, aquatic plants, or other living creatures, and
d) the construction, demolition, or modifications on infrastructure in the aquatic environment.

The Law provides that special permission should be sought from the Chairman of the Council of Ministers for removal of mangroves or other resources and for construction of facilities in the aquatic environment. Article 8 gives the mandate to protect important ecological resources by preventing direct removal and by prohibiting construction. It will be almost impossible to implement this article in practice without greatly restricting future economic development activity. However, it may provide the necessary mandate to allow for conservation of selected key ecological areas. The Law also provides for:

a) restrictions on fishing during times of spawning,
b) setting of quotas of allowable catch,
c) restrictions on gear types and fishing methods,
d) demarcation of fishing zones,
e) prohibition of catch of rare and endangered species or high economically valued species, and

l) introduction of exotic species into Vietnam from other parts of the world.

The Council of Ministers exercises complete control over the conservation and development of aquatic resources but delegates certain responsibilities to the Ministry of Fisheries.

6.1.4 International Context

In addition to its national laws and regulations, Vietnam has a number of environmental obligations under the international laws. Vietnam participates in a number of international conventions on environmental protection, many of which relate to environment and protection of the UNESCO World Heritage site in Ha Long bay.

(1) Convention Concerning the Protection of World Cultural and Natural Heritage

Vietnam is a signatory to the Convention Concerning the Protection of the World Cultural and Natural Heritage (adopted in Paris by the General Conference at its seventeenth session, 16 November 1972). Ha Long bay was nominated for inclusion as a World Heritage site in January 1992, based on the ongoing geological processes of limestone decay, the biological richness of the area, and sites of archaeological interest. The terms and conditions to support World Heritage sites include the following article, which could be used to help protect Ha Long bay from the effects of development:

"Article 11.4 ... a list of the property appearing in the World Heritage List for the conservation of which major operations are necessary and for which assistance has been requested under this Convention. This list shall contain an estimate of the cost of such operations. The list may include only such property forming part of the cultural and natural heritage as is threatened by serious and specific dangers, such as the threat of disappearance caused by accelerated deterioration, large-scale public or private projects or rapid urban or tourist development projects, destruction caused by changes in the use or ownership of the land, major alterations due to unknown cause, abandonment for any reason whatsoever, the outbreak or the threat of an armed conflict, calamities and cataclysm, serious fires,

earthquakes, landslide, volcanic eruption, and changes in water level, floods, and tidal waves."

(2) International Convention for the Prevention of Pollution from Ships

One of the most important conventions relating to the Port is the International Convention for the Prevention of Pollution from Ships - MARPOL 1973, which provides guidelines addressing wastes from ships and other ocean vessels. The modified Protocol of 1978, MARPOL 73/78, deals with the discharge of harmful substances into the sea from ships. MARPOL 73/78 consists of five annexes dealing with oily wastes, "noxious liquid substances", harmful substances in packaged form, sewage, and garbage.

Under Annex I, it is specified that ports are obliged to provide facilities to receive oily waste and oily water from ships using the port. Similarly, under Annex II, the ports are required to provide facilities to receive tank washings and highly viscous or solidifying noxious liquid substances that are imported in bulk at the port. The Guidelines provide a basis for determining the adequacy of facilities required by individual ports for the reception of sewage from ships.

(3) Convention on Wetlands of International Importance Especially as Waterfowl Habitat

Vietnam is also a signatory to the Convention on Wetlands of International Importance Especially as Waterfowl Habitat, Ramsar, 2-2-1971 (as amended by the Paris Protocol on 3 December 1982). The most important terms and conditions of Ramsar with respect to the project site are:

"Article 3.1 The Contracting Parties shall formulate and implement their planning so as to promote the conservation of the wetlands included in the List, and as far as possible the wise use of wetlands in their territory."

"Article 5.1 The Contracting Parties shall consult with each other about implementing obligations arising from the Convention especially in the case of a wetland extending over the territories of more than one Contracting Party or where a water system is shared by Contracting Parties. They shall at the same time

endeavor to coordinate and support present and future policies and regulations concerning the conservation of wetlands and their flora and fauna."

Ha Long bay is not on the 'List' of Ramsar wetland sites. To date, the various development plans for Ha Long bay have not taken into consideration the wise use of wetlands in this area. Although present regulations concerning the conservation of wetlands have been supported, very little has been done by way of future coordination. The wetland areas of Ha Long bay have been important to local people for thousands of years. It provides food, fibre and fuel, supports food chains, and helps regulate water quality, flooding and coastal erosion. Based on the fulfillment of the selection criteria, and the requirement that member states designate the largest possible number of wetland sites, it seems necessary that conservation of at least some of Ha Long bay's wetlands should be promoted, according to the Ramsar membership regulations.

(4) Other Conventions

Other relevant conventions include:

a) the Convention on International Trade in Endangered Species of Wild Fauna and Flora (signed at Washington, DC on March 3, 1973),
b) the Convention on the Prevention of Marine Pollution by the Dumping of Wastes and Other Matter (London Dumping Convention),
c) the Convention on Biological Diversity (Rio de Janeiro, June 5, 1992),
d) Agenda 21, emanating from the United Nations Conference on Environment and Development (UNCED) (June 3-14, 1992), and
e) the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal.

6.2 Institutional Framework for Environmental Management

6.2.1 MOSTE and DOSTE

Government Decree 175/CP, which provides guidance on the implementation of law, delegates to and assigns the responsibilities for environmental protection to MOSTE, other ministries, People's Committees, State agencies and organizations, and business and production institutions (Table 6.2.1). MOSTE also has broad

responsibilities for international activities related to environmental protection, and participation in international environmental organizations.

(1) Responsibilities Delegated Environmental Management Divisions (EMDs)

In general, EMDs of provincial DOSTEs have been delegated the following responsibilities:

a) to prepare and submit a provincial environmental protection plan to MOSTE for approval and follow-up implementation;
b) as assigned by MOSTE, to carry out appraisal of EIA of investment projects and provincial socioeconomic master plans;
c) to implement environmental monitoring, pollution control, and waste control;
d) to propose solutions to environmental protection problems in the provinces,
e) to cooperate with the inspection agency of DOSTE in carrying out environmental inspection; and
f) to disseminate environmental protection activities, organize and conduct propaganda campaigns for environmental protection and cooperation with concerned agencies in enhancing, training, and improving environmental awareness.

Most environmental management divisions in DOSTEs do not have sufficient staff with adequate training to fulfill these responsibilities. Current capacity building efforts by international agencies are focusing on environmental monitoring, EIA, pollution control, and waste management.

In implementing environmental monitoring, pollution control, and waste management, DOSTEs will need scientific and technical information. This may require setting up institutions such as new laboratories, monitoring stations, and environmental research centers. However, the current situation is that MOSTE has set up national and regional institutions to fulfill these functions.

6.2.2 Economic Development Regulation and Administration

The following six main economic activities in Quang Ninh province are regulated and administered by central government agencies.

a) The Ministry of Industry administers coal mining. The Department of Science, Technology and Environment within the Ministry of Industry is responsible for advising on the formulation of regulations and procedures governing coal mining operations.
b) The Vietnam General Department of Tourism administers tourism development and management. Tourism is viewed as the industry with the greatest immediate growth potential.
c) The Ministry of Transportation and Communication administers transportation including ports, harbors, and sea transportation generally.
d) The Ministry of Agriculture and Rural Development administers agriculture.
e) The Ministry of Fisheries controls fisheries.
f) Oil imports/export are administered by PETROLIMEX, which is attached to the Ministry of Trade.

These economic activities have potential to create serious pollution problems and/or to degrade valued environmental resources. Specific measures must be put in place to ensure the environmental protection.

(1) Environmental Management of Coal Mining

The Decree on Mineral Resources, 1989, Technical Regulations on Exploitation of Open-Pit Mines, 1991, and LEP assign responsibility for environmental management to the coal mining operators. In Quang Ninh province, the Vietnam National Coal Corporation (VINACOAL) is in charge of all mining operations including those recently transferred from QNPC and the Army. VINACOAL was established in 1994 to manage all coal production and marketing (domestic and international), and its commitment to development of an environmental management system for their operations is essential to the maintenance of environmental quality in Ha Long bay.

1) Inspection

The Ministry of Industry (MOI) has responsibility for inspection of coal mines. Local offices within the provincial industry departments conduct the inspections to ensure the coal operators comply with the conditions attached to their licenses. Inspection teams from MOI in Hanoi investigate to ensure that operating

standards are in accordance with the regulations. The provincial DOSTE has responsibility for inspections to ensure compliance with environmental standards. While there are environmental aspects associated with MOI inspections, these are not given prominence in inspection activity and reporting. In general environmental inspections are not stringent and hence enforcement and compliance are low.

2) Environmental management

VINACOAL's policy is to obey all regulations of environmental management organisations responsible for Ha Long bay. VINACOAL, itself, is currently conducting a number of environmental management activities. Every year its enterprises prepare an environmental management plan and budget to be approved by the VINACOAL general management. VINACOAL is preparing guidelines that will stipulate environmental operating conditions for all staff. Environmental monitoring is undertaken by the Center for Measurement and Product Quality in VINACOAL. Specific environmental remediation and prevention activities include treatment of wastewater, reforestation and land reclamation rehabilitation of lakes, streams, and rivers and dust prevention.

3) Environmental fund

It has been proposed that VINACOAL enters into a cooperative agreement with QNPC for environmental improvement of the provincial coal industry. This agreement would formally establish the Environmental Fund by setting aside 1% of VINACOAL's annual revenue for the purposes of environmental improvement. The Fund would be used for i) environmental improvements in its operations and properties; ii) environmental restoration projects located outside the properties; and iii) contributions to QNPC for general environmental management activities. It is expected that this fund will be used for make specific improvements such us treatment of wastewater, land reclamation, and dust control and prevention. Senior environmental managers estimate that 1% of the revenue is currently being allocated to environmental expenditures. Today this is approximately VND 30 billion (US$2.2 million).

(2) Environmental Management of Tourism

The environmental concerns with respect to tourism are threefold: i) increased solid waste and wastewater from hotels and tourist facilities; ii) increase solid waste and wastewater pollution from tourist boats using the World Heritage site; and iii) increase demand for coastal lands for development. The first concern with respect to tourist facilities is primarily responsibilities of the People's Committee of Ha Long city. They must ensure that facilities have proper waste treatment and garbage disposal facilities. Environmental management of World Heritage site is the responsibility of the Ha Long Bay Management Board (HLMB). However, the licensing of tourist boats falls within the responsibility of the Transport and Communications Department. Any controls on the wastewater systems of tourist boats will have to come through more stringent licensing requirements. The third concern, the conversion of coastal areas for tourist facilities and infrastructure should be considered within the overall development planning process.

(3) Environmental Management of Ports and Harbours

The major ports in the study area are under the control of the QN Port Authority. The major port systems are:

a) Ha Long City System, which includes: the coal port (owned by VINACOAL), oil port (PETROLIMEX), and Cai Lan Port (Vietnam Maritime Corporation); and
b) Cam Pha Port System, which contains the coal port and the floating port near Hon Net island.

Their primary environmental management responsibility is controlling ship-based pollution including oil and chemical spills. In the event of any oil spill, the Director of QN Port Authority is in charge. But the individual port management must conduct the response and clean up. The QN Port Authority does not have environmental management division. Few staff have had environmental training. They occasionally make some inspections to see that ships have oil separators (ballast, bilge water, and domestic wastewater). Based on a Directive from Central Government, they have a new responsibility for State Inspection with respect to

seaports as of as of August 1, 1998. The individual ports are responsible for environmental management of their facilities.

(4) Environmental Management of Fisheries and Aquaculture

The Law on Conservation and Management of Living Aquatic Resources provides directions of the management and conservation of living aquatic resources and their habitat. It divides the authority and responsibilities between the Council of Ministers, the Ministry of Fisheries, and People's Committees of provinces, cities, and special zones. (Table 6.2.2)

6.2.3 Ha Long Bay Management Board (HLMB)

UNESCO added Ha Long bay to the World Heritage List on December 14, 1994 at the 18th session of the World Heritage Commission held in Phuket, Thailand. HLMB was established in 1995 to care for the World Heritage in Ha Long bay, and it is responsible for:

a) conservation of the World Heritage site,
b) management of tourist facilities within the World Heritage site,
c) maintenance of environmental quality in the World Heritage site, and
d) protection of the environmental resources within the World Heritage site.

HLMB intends to add a new division responsible for tourism and guiding in 1999. It cooperates with Ministry of Communications and DOSTE with respect to licensing of tourist boats. It also cooperates and seeks advice of DOSTE on issues and problems of environmental degradation of World Heritage site. HLMB makes an annual report on general management of Ha Long bay to QNPC, Ministry of Culture and Information, and National UNESCO Committee. This report has a small section on environmental protection and management.

HLMB is currently preparing a five year plan for conserving and upgrading the landscape including: 1) rehabilitation of caves; 2) making small landing places; 3) constructing minor visitor facilities; and 4) enhancing archaeological sites. Its main environmental management activities are:

a) patrol of site to protect environmental resources,

b) collection of floatables (i.e. garbage),
c) co-operation with DOSTE to implement the Law on Environmental Protection and MOSTE regulations,
d) surveillance of activities that cause environmental damage, investigation of violations (with help of DOSTE) and reporting to QNPC for punishment, and
e) environmental awareness (notices on wharves, notices on large tourist boats, and training of boat personnel to act as a guide an inform people not to litter and discharge waste).

HLMB is facing two major difficulties: lack of public awareness of laws and regulations, and limited funds to prevent illegal activities.

6.2.4 Sanitation and Wastes

There are two main agencies for sanitation management such as the Ha Long Environmental Sanitation Company and the Cam Pha Urban Environment Company. Both companies are under control of their respective Municipal People's Committees and the Director of the companies report to the Chairman of the People's Committees. The overall responsibilities are restricted to:

a) collection and disposal of solid waste,
b) maintenance of the sanitary drainage system,
c) washing roads,
d) maintenance of public street lighting (including payments of electricity charges),
e) maintenance of public toilets,
f) road sweeping,
g) maintenance of parks and verges,
h) provision of funeral services, and
i) maintenance of cemeteries.

The current staff and budget shortages of these companies make it difficult to conduct activities specifically directed at environmental management and to provide basic services that they are responsible for. However, planned upgrading and the drainage and sanitation system will reduce the number of point sources

discharges of domestic wastewater and storm runoff to Bai Chay and Ha Long bays.