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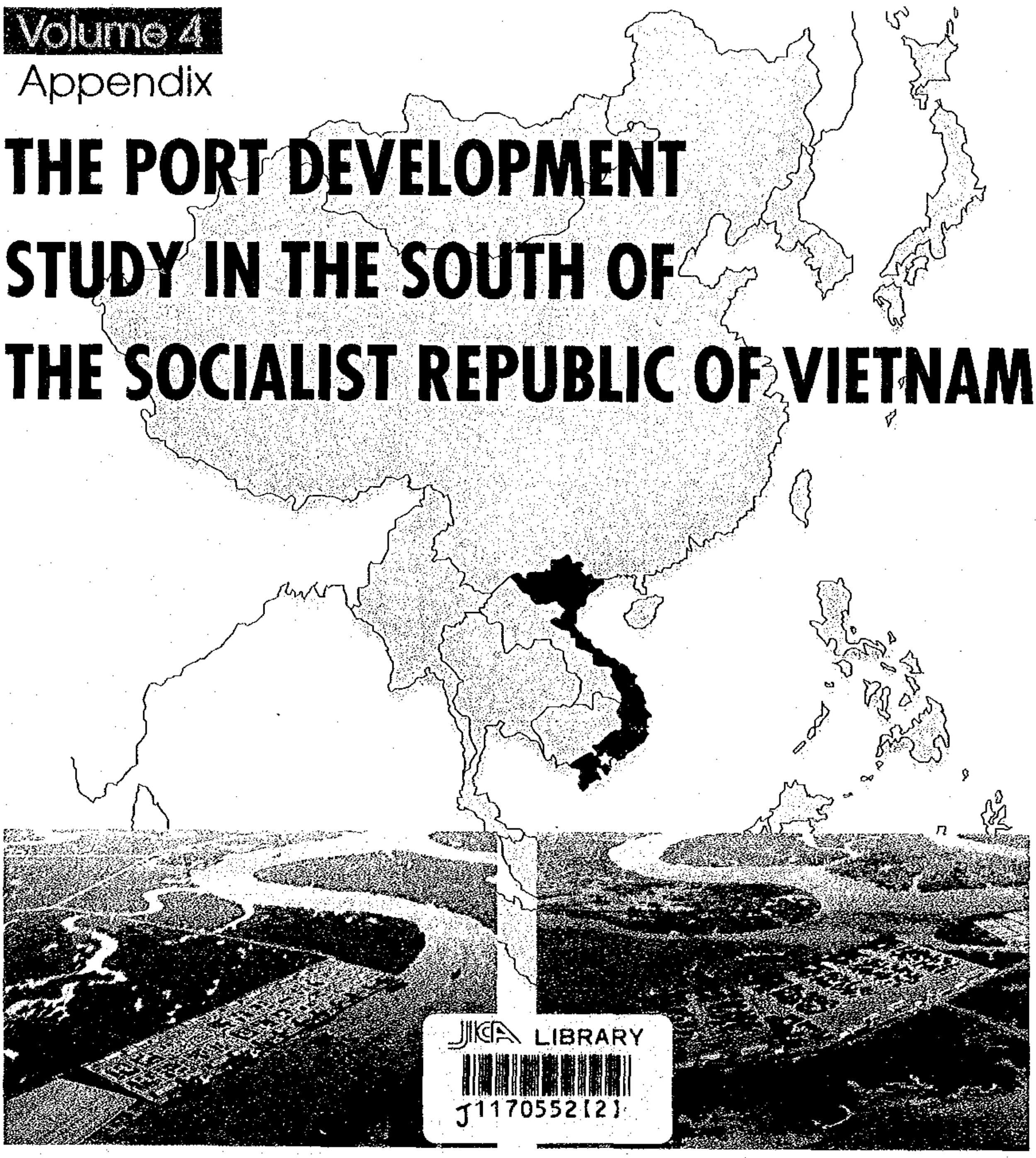
FINAL REPORT

Volume 4
Appendix

THE PORT DEVELOPMENT STUDY IN THE SOUTH OF THE SOCIALIST REPUBLIC OF VIETNAM



December 2002

The Overseas Coastal Area Development Institute of Japan (OCDI)
JAPAN Port Consultants, Ltd. (JPC)

The Port Development Study in the South of The Republic of Vietnam FINAL REPORT Volume 4 Appendix December 2002

Note: The following exchange rate is used in this report.

US$ 1.00=Vietnam Dong 15,000VND=Japanese Yen 120

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Table A3.2.1 Monthly Number of Days with Thunderstorm at HCM City (1952 to 1987)

Thunderstorm	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum	4	1	3	11	18	16	18	15	13	14	13	5
Average	0.2	0.1	0.3	2.3	9.4	9.4	8.8	6.5	7.5	7.6	4.2	1.1
Minimum	0	0	0	0	3	2	2	0	1	3	0	0

Source: Tan Son Nhat Station

Table A3.2.2 Annual Number of Days with Thunderstorm at HCM City (1952 to 1987)

Number of Thunderstorm at HCM City Area	
Annual maximum	89 (in 1976)
Annual average	57.5
Annual minimum	31 (in 1952)

Source: Tan Son Nhat Station

Table A3.2.3 (1) Monthly Relative Humidity at HCM City (1952 to 1987)

(Unit: %)

Relative Humidity	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum	77	74	73	78	82	87	85	86	88	87	86	81
Average	71	69	69	71	78	82	82	83	84	84	80	75
Minimum	66	62	65	67	71	76	79	79	80	80	74	74

Source: Tan Son Nhat Station

Table A3.2.3 (2) Monthly Absolute Humidity at HCM City (1952 to 1987)

(Unit: %)

Absolute Humidity	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum	26.4	26.0	27.3	35.8	30.8	31.4	30.6	30.7	30.5	30.7	30.2	26.7
Average	23.2	23.7	25.5	28.3	30.0	29.8	29.3	29.6	29.4	29.0	27.3	24.9
Minimum	20.1	21.0	21.1	26.1	18.8	23.5	20.6	28.8	20.1	23.2	24.7	22.8

Source: Tan Son Nhat Station

Table A3.2.4 (1) Monthly Shining Hour at Vung Tau (1981 to 1985)

(Unit: hour)

Shining Hour	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum	292	279	327	296	263	210	252	251	213	237	276	273
Average	259	266	301	275	245	180	231	197	188	194	245	235
Minimum	221	257	275	236	210	147	198	161	116	160	218	220

Source: Vung Tau Meteorological Station

Table A3.2.4 (2) Monthly Shining Hour at HCM City (1959 to 1987)

(Unit: hour)

Shining Hour	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum	288	287	305	292	243	224	223	220	205	226	258	273
Average	244	249	276	242	204	173	185	175	163	183	201	222
Minimum	180	208	242	196	140	120	144	146	122	128	141	170

Source: Tan Son Nhat Station

Table A3.2.5 Annual Shining Hour at HCM City (1959 to 1987)

(Unit: hour)

Shining Hour at HCM City Area	
Annual maximum	2,675 (in 1963)
Annual average	2,493
Annual minimum	2,114 (in 1975)

Source: Tan Son Nhat Station

Table A3.2.6 (1) Monthly Total Evaporation at HCM City (1952 to 1981)

(Unit: mm)

Evaporation	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum	191	199	248	234	184	155	149	163	122	117	142	161
Average	154	167	193	182	135	112	117	115	93	86	104	125
Minimum	127	139	129	144	87	89	86	86	66	71	71	102

Source: Tan Son Nhat Station

Table A3.2.6 (2) Annual Total Evaporation at HCM City (1952 to 1981)

(Unit: mm)

Total Evaporation at HCM City Area	
Annual maximum	1,932 (in 1968)
Annual average	1,581
Annual minimum	1.363 (in 1956)

Source: Tan Son Nhat Station

Table A3.2.7(1) Monthly Number of Times with Fogs at HCM City (1952 to 1981)

(Unit: Times)

Fog	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum	31	25	30	29	30	23	26	23	23	26	23	30
Average	8.6	6.1	6.5	5.5	4.2	4.6	5.0	4.8	5.7	7.3	6.1	8.4
Minimum	0	0	0	0	0	0	0	0	0	0	0	0

Source: Tan Son Nhat Station

Table A3.2.7(2) Annual Number of Times with Fogs at HCM City (1952 to 1981)

(Unit: Times)

Fog at HCM City Area	
Annual maximum	301 (in 1963)
Annual average	72.9
Annual minimum	10 (in 1975)

Source: Tan Son Nhat Station

Table A3.2.8 Tidal Windows at Vung Tau Channel

(Impassable time for required tidal levels, Δh, above CDL)

Quarter	Δh<1m				Δh<2m				Δh<3m				Δh<4m			
	Total			Average	Total			Average	Total			Average	Total			Average
	Freau-ency (times)	Dura-tion (days)	Time ratio (%)	impassable time (hr/time)	Freau-ency (times)	Dura-tion (days)	Time ratio (%)	impassable time (hr/time)	Freau-ency (times)	Dura-tion (days)	Time ratio (%)	impassable time (hr/time)	Freau-ency (times)	Dura-tion (days)	Time ratio (%)	impassable time (hr/time)
Dec-Feb	32	3.3	3.7	**2.50**	84	17.7	19.7	**5.06**	154	45.9	51.0	**7.16**	98	89.7	99.6	**21.96**
Mar-May	27	2.7	2.9	**2.41**	113	22.6	24.6	**4.81**	159	55.3	60.1	**8.35**	93	91.9	99.9	**23.72**
Jun-Aug	52	7.2	7.8	**3.33**	106	24.7	26.9	**5.59**	155	63.6	69.1	**9.85**	92	92.0	100.0	**24.00**
Sep-Nov	21	1.7	1.9	**1.95**	108	20.7	22.7	**4.59**	153	51.5	56.5	**8.07**	95	90.5	99.5	**22.87**
Annual Total	132	15.0	4.1	**2.72**	441	85.7	23.5	**5.00**	621	216.3	59.3	**8.36**	378	364.1	99.8	**23.12**

Note: Calculated based on Tide Table at Vung Tau in 2001

Source : Study Team

Table A3.2.9 Frequency of Occurrence of Wave Height Observed in Ganh Rai Bay

(April 1986 to April 1987)

Wave Height (m)	Frequency of Occurrence (%)	
	Rainy Season (May to October)	Dry Season (November to April)
Below 0.25	5	4
0.25 - 0.75	75	49
0.75 - 1.25	15	38
1.25 - 2.00	5	9
Above 2.00	0	0
Total	100	100

Source: Saigon Petroleum Design Data

Table A3.2.10 Maximum Wave Characteristics Observed in Sao Mai and Nghinh Phong (1986 to 1987)

Month/Year	Sao Mai (10° 22'30"N, 107° 03'37"E)			Nghinh Phong (10° 20'00", 107° 05'00"E)		
	H (m)	T (s)	L (m)	H (m)	T (s)	L (m)
Sep. 1986	1.20	3.8	45	1.50	6.2	90
Oct. 1986	0.75	4.6	38	1.69	3.4	64
Nov. 1986	0.70	3.6	16	1.97	5.9	57
Dec. 1986	0.70	2.5	16	1.96	7.5	64
Jan. 1987	0.60	5.4	22	1.71	4.2	24
Feb. 1987	0.75	4.7	21	1.58	4.7	26
Mar. 1987	0.70	3.2	37	1.89	4.8	24
Apr. 1987	0.88	2.6	22	1.57	5.4	24

Source: TEDI South

Table A3.2.11 Maximum Significant Wave Heights in Vietnamese offshore Area

Wave Direction	NW	N	NE	E	SE	S	SW	W
Wave Height (m)	7-8	9-10	8-9	6-7	6-7	7-8	7-8	7-8

Source: Global Wave Statistics, published by British Maritime Technology

Table A3.2.12 Maximum Current Speed at the Thi Vai River

Location	Current peed(m/sec.)
Cai Mep river estuary	2.50
Cai Mep river	2.48
Go Gia intersection	1.80
Oil port	1.91
Thi Vai port	1.33
Upstream of Thi Vai	1.31

Source: Pre-Feasibility Study on Vung Tau International Container Terminal, TEDI South, 2000

Table A3.2.13 Maximum Current Velocity in Ganh Rai Bay (Observed during 14 to 29 June, 2001)

<table>
<tr><td>Tide</td><td colspan="6">During Flood Tide</td><td colspan="6">During Ebb Tide</td></tr>
<tr><td rowspan="3">Point</td><td colspan="12">Layers</td></tr>
<tr><td colspan="2">Bottom</td><td colspan="2">Middle</td><td colspan="2">Surface</td><td colspan="2">Bottom</td><td colspan="2">Middle</td><td colspan="2">Surface</td></tr>
<tr><td>V (m/s)</td><td>Dir. (°)</td><td>V (m/s)</td><td>Dir. (°)</td><td>V (m/s)</td><td>Dir. (°)</td><td>V (m/s)</td><td>Dir. (°)</td><td>V (m/s)</td><td>Dir. (°)</td><td>V (m/s)</td><td>Dir. (°)</td></tr>
<tr><td>V1</td><td>1.08</td><td>007</td><td>1.08</td><td>354</td><td>1.22</td><td>354</td><td>1.37</td><td>173</td><td>1.74</td><td>169</td><td>1.77</td><td>160</td></tr>
<tr><td>V2</td><td>0.89</td><td>307</td><td>1.17</td><td>314</td><td>1.30</td><td>318</td><td>0.95</td><td>128</td><td>1.16</td><td>126</td><td>1.32</td><td>127</td></tr>
<tr><td>V3</td><td>0.81</td><td>335</td><td>0.94</td><td>338</td><td>1.22</td><td>338</td><td>0.73</td><td>165</td><td>0.96</td><td>160</td><td>1.07</td><td>155</td></tr>
<tr><td>V4</td><td>0.78</td><td>025</td><td>0.78</td><td>017</td><td>0.83</td><td>020</td><td>0.65</td><td>017</td><td>0.60</td><td>195</td><td>1.03</td><td>185</td></tr>
<tr><td>V5</td><td>0.55</td><td>354</td><td>0.61</td><td>355</td><td>0.64</td><td>358</td><td>0.47</td><td>160</td><td>0.69</td><td>157</td><td>0.79</td><td>163</td></tr>
<tr><td>V6</td><td>0.65</td><td>257</td><td>0.74</td><td>258</td><td>0.77</td><td>264</td><td>0.84</td><td>245</td><td>1.11</td><td>259</td><td>1.22</td><td>260</td></tr>
<tr><td>V7</td><td>0.68</td><td>295</td><td>1.02</td><td>296</td><td>1.40</td><td>134</td><td>0.92</td><td>116</td><td>1.35</td><td>109</td><td>1.62</td><td>120</td></tr>
</table>

Source: Study Team

Note: Direction: clockwise angle in degrees from the North

Table A3.2.14 Velocity of Ocean Current in the Offshore of the Study Area

Item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Velocity	0.5	0.7	0.3	0.3	0.1	0.5	0.5	0.4	0.7	0.0	0.8	0.6
Average Direction	243	233	254	293	26	68	46	44	67	0	231	247
Maximum Velocity	2.5	2.0	1.5	0.7	2.5	1.7	2.0	1.5	2.1	1.5	2.5	1.0
Direction of Max.	240	230	230	270	20	170	90	40	100	90	250	240

Source: Japan Oceanographic Data Center of Japan Maritime Safety Agency
Note: Unit; Velocity: knot, Direction: clockwise angle in degrees from the North

Table A3.2.15 Water Temperature in the Thi Vai River and Vung Tau
(Measured at the Thi Vai River in Dec.1986 to Sep.1987, Vung Tau city in 1981 to 1985)

Water Temperature	Degree (℃)	Remark
Monthly maximum	32.3	May
Monthly average At port planning site at Ganh Rai Bay	 26.8 to 31.2 25.3 to 30.2	 Thi Vai river Fish berth area
Monthly minimum	26.0	January

Source: Meteorological and Hydrological Report on Thi Vai River and Vung Tau, May 1995

Table A3.2.16 Water Salinity in Ganh Rai Bay

Water Saltiness	*Salinity (per mill)*	*Occurred Month*
Maximum monthly average	33.5	April
Range of monthly average	27 to 34	
Minimum monthly average	29.8	July

Source: Meteorological and Hydrological Report on Thi Vai River and Vung Tau, May 1995

Table A3.2.17 Results of Water Quality Measurement

Point	Sampling Depth	SS (mg/l)	Salinity[1] (per mill)	Water Temperature[1] (℃)	Bulk Density (Kg/l)	Transparency of Water (m)
V1	S[2]	28.8	28.0-31.4	28.7-29.6	1.011	1.3
	M	13.9	28.4-32.4	28.5-29.6	1.014	
	B	16.4	30.6-32.7	28.4-29.1	1.013	
V2	S	8.0	-	-	1.011	1.7
	M	31.2	-	-	1.014	
	B	37.3	-	-	1.014	
V3	S	106.6	26.5-29.6	28.6-29.3	1.012	1.2
	M	88.9	27.1-30.5	28.3-29.5	1.009	
	B	106.6	27.5-30.7	28.3-29.5	1.008	
V4	S	34.4	-	-	1.017	0.4
	M	60.0	-	-	1.013	
	B	40.3	-	-	1.007	
V5	S	104.4	-	-	1.009	0.5
	M	119.9	-	-	1.011	
	B	89	-	-	1.011	
V6	S	214.4	-	-	1.011	0.3
	M	359.8	-	-	1.013	
	B	370.4	-	-	1.011	
V7	S	26.1	-	-	1.011	0.9
	M	134.4	-	-	1.008	
	B	40.3	-	-	1.013	

Source: Study Team

Note 1) Salinity and water temperature were measured at one hour interval during 14 to 19 June 2001 at V1, and during 14 to 29 June 2001 at V3, such values shown in the above table were extracted from values observed on 19 June 2001 (mean tide) at V1, and 21 June 2001 (spring tide) at V3.

Note 2) S means surface layer, M means middle layer, and B means bottom layer.

Table A3.2.18 Visibility Observed at Bach Ho Oil-Rig

Visibility (Km)	Remarks
20	Usually
5	December
3 to 5	Other months
1 to 3	September and October
0.1 to 0.5 (Minimum case)	August and December

Source: Meteorological and Hydrological Report on Thi Vai River and Vung Tau, May 1995

Table A3.2.19 (1) Summary of Soil Lavoratory Test Result of Thi Vai

Layer No.	Boring No.	Sample No.	Elevation (m)	Wet Unit Weight (tf/m³) ?t	Specific Gravity Gs	Void Ratio e_o	Percent of Particle < 0.075mm (%)	Water Content (%) W	Saturation Degree (%) St	Liquid Limit (%) WL	Plastic Limit (%) Wp	Plasticity Index (%) Ip	Unconfined Comp. Test (kgf/cm²) qu	Triaxial Comp. Test (Kgf/cm²) Cu	Compression Index Cc	Preconsolid. Pressure (kgf/cm²) Pc
Layer 1 (CH) Very Soft CLAY	PM1	207	-4.4	1.47	2.67	2.608	99.0		100	97.6	34.5	63.1				
		189	-5.4	1.46	2.67	2.560	98.0		99	87.1	31.2	55.9				
		208	-8.4	1.41	2.68	2.573	99.0	87.5	91	106.0	37.2	68.8				
		209	-11.4	1.42	2.67	2.814	99.0		97	100.8	41.1	59.7				
		210	-14.4	1.41	2.66	2.855	99.0		97	105.1	41.1	64.0				
		190	-15.4		2.70		99.0	65.8						0.16	1.100	1.26
		211	-18.4	1.41	2.65	2.786	98.7		96	106.0	37.1	68.9				
		212	-21.4	1.42	2.68	2.268	95.0	73.5	87	78.6	32.5	46.1				
		213	-24.4			1.084	88.0		89							
		191	-27.4	1.62	2.70	1.571	99.0	54.8	94	68.0	29.9	38.1	0.39		0.698	0.91
		214	-28.4		2.66	3.222	93.0	89.6	74							
		215	-29.9		2.73	0.587	83.3		92							
	PM2	125	-8.90	1.53	2.68	2.116	76.4	77.5	98	88.0	37.1	50.9				
		126	-11.90	1.51	2.68	2.153	75.4	78.0	97	96.0	40.0	56.0				
		127	-14.90	1.59	2.69	1.773	72.4	63.9	97	69.3	33.9	35.4				
		108	-15.90	1.52	2.70	1.325	31.5		64				0.18		0.392	0.48
		128	-18.40	1.55	2.69	1.956	60.4	70.4	97	67.5	30.5	37.0				
		129	-21.90	1.58	2.70	1.872	68.4	68.7	99	72.1	31.9	40.2				
		109	-26.70	1.59	2.71	1.631	99.0	54.0	90	71.2	31.3	39.9		0.16	0.631	0.75
		131	-26.90	1.54	2.69	1.989	99.0	71.8	97	82.5	33.5	49.0				
		132	-29.90	1.54	2.71	1.765	96.0	57.9	89	69.8	34.1	35.7				
		133	-32.90	1.48	2.67	2.380	91.4	86.7	97							
		134	-35.90	1.53	2.69	2.165	98.0	80.4	100	92.4	40.0	52.4				
		135	-38.90	1.53	2.69	2.092	98.0	76.2	98	81.8	32.5	49.3				
		137	-41.90	1.53	2.68	2.190	98.0	81.9	100	90.1	37.8	52.3				
	PM3	106	-11.90	1.55	2.69	1.892	99.0	66.9	95	78.5	30.6	47.9	0.10	0.04	0.545	0.29
		110	-10.90	1.54	2.69	1.862	99.0	64.3	93	81.9	33.9	48.0				
		111	-14.90	1.56	2.70	1.784	99.0	60.5	92	83.0	33.2	49.8				
		112	-17.90	1.57	2.71	1.794	99.0	61.9	94	80.9	33.1	47.8				
		113	-20.90	1.57	2.71	1.737	99.0	58.7	92	83.6	32.7	50.9				
		114	-23.90	1.54	2.70	1.935	99.0	67.5	94	78.4	31.4	47.0				
		Average		1.52	2.69	2.045	90.6	70.4	93	84.6	34.5	50.2	0.22	0.12	0.673	0.74
Layer 2 (CL) Stiff Lean CLAY	PM3	115	-24.70	2.01	2.73	0.675	84.4	23.2	94	36.3	17.4	18.9				
		116	-25.90	2.01	2.73	0.625	84.8	19.6	86	36.7	17.0	19.7				
		107	-27.90	1.94	2.72	0.778	92.1	26.5	93	31.3	18.3	13.0	0.56		0.110	1.13
		Average		1.99	2.73	0.693	87.1	23.1	91	34.8	17.6	17.2	0.56		0.110	1.13
Layer 3 (SM) Medium Dense Silty SAND	PM1	216	-30.90		2.73		27.0	20.0								
		192	-31.90		2.69		25.5	15.9								
		217	-35.40		2.68		28.6	17.8					0.99			
		218	-38.40		2.69		28.1	18.0								
		219	-41.40		2.68		28.0	20.0								
		220	-44.40		2.69		25.5	19.0								
		223	-47.40		2.65		13.3	14.2								
		224	-50.40					18.8								
	PM2	138	-46.90		2.66		17.5	19.5								
		139	-48.90		2.65		12.5	19.3								
		140	-49.90		2.66			18.2								
		141	-50.90		2.67		15.5	17.0								
		142	-53.90		2.66		11.3	12.9								
	PM3	117	-28.70		2.68		12.0	13.6								
		118	-32.90		2.66			13.9								
		119	-35.90		2.67		13.0	15.6								
		120	-38.90		2.66		15.0	16.0								
		121	-41.90		2.68		20.5	23.1								
		122	-44.90		2.67		18.5	17.0								
		123	-45.90		2.66			18.2								
		Average			2.67		19.5	17.4					0.99			
Layer 4 (CL) Hard Lean CLAY	PM1	225	-52.40		2.65			14.2								
		193	-53.40	1.84	2.73	1.007	13.9	35.6	97	60.9	37.6	23.3			0.246	1.65
		226	-53.50					18.8								
		227	-54.9	1.76	2.73	1.220	90.0	43.5	97	70.7	41.8	28.9				
		228	-55.9	1.79	2.74	1.157	96.0	41.1	97	66.7	40.6	26.1				
	PM2	143	-54.9	2.12	2.73	0.525	82.0	18.2	95	37.6	19.9	17.7				
		144	-56.1	2.14	2.73	0.508		18.2	98							
	PM3	124	-46.9		2.73		62.6	21.5								
		Average		1.93	2.72	0.883	68.9	26.4	97	59.0	35.0	24.0			0.246	1.65
Lens TK1 (SM)	PM2	130	-27.9		2.66		10.2	21.1								
Lens TK2 (SM)	PM2	135	-42.9		2.67		10.6	14.1								
Lens TK3 (SM)	PM1	221	-45.4	2.02	2.68	0.595	28.0	20.0	90	22.0	16.7	5.3				
		222	-46.4	2.02	2.69	0.582	25.5	19.0	88							
		Average		2.02	2.69	0.589	26.8	19.5	89	22.0	16.7	5.3				

Source : Study Team

Table A3.2.19 (2) Summary of Soil Lavoratory Test Result of Cai Mep Site

Layer No.	Boring No.	Sample No.	Elevation (m)	Wet Unit Weight (tf/m^3) ?t	Specific Gravity Gs	Void Ratio e_o	Percent of Particle < 0.075mm (%)	Water Content (%) W	Saturation Degree (%) St	Liquid Limit (%) W_L	Plastic Limit (%) Wp	Plasticity Index (%) Ip	Unconfined Comp. Test (kgf/cm^2) qu	Triaxial Comp. Test (Kgf/cm^2) Ccu	Compression Index Cc	Preconsolid. Pressure (kgf/cm^2) Pc
Layer 1 (CH) Very Soft Fat CLAY	CM1	953	-0.90	1.38	2.63	2.925	96.0	107.1	96	98.1	43.2	54.9				
		954	-6.40	1.60	2.69	1.802	98.0	66.6	99	62.1	27.4	34.7				
		955	-9.40	1.61	2.70	1.755	95.0	63.6	98	66.3	28.6	37.7				
		956	-12.40	1.57	2.70	1.903	99.0	68.3	97	85.6	32.9	52.7				
		957	-16.40	1.58	2.70	1.813	99.0	65.0	97	74.0	31.8	42.2				
		958	-19.40	1.58	2.71	1.794	99.0	62.5	94	72.5	37.8	34.7				
		959	-23.40	1.57	2.70	1.872	99.2	67.3	97	77.0	33.3	43.7				
		960	-27.40	1.56	2.69	1.892	99.2	67.3	96	75.3	35.6	39.7				
		961	-30.40	1.59	2.70	1.813	99.2	66.4	99	72.3	30.5	41.8				
		972	-5.40	1.50	2.69	2.092	98.0	73.1	94	86.3	35.6	50.7	0.39	0.08		
		973	-10.40	1.56	2.69	1.892	98.0	68.6	98	74.2	28.8	45.4	0.28	0.13	0.887	0.71
		974	-15.40	1.56	2.70	1.727	99.4	57.0	89	78.1	37.2	40.9	0.27	0.13	0.864	1.00
		975	-20.40	1.58	2.69	1.832	99.6	65.7	97	77.7	36.2	41.5	0.24	0.12	0.937	1.08
		976	-25.40	1.57	2.70	1.784	98.4	62.2	94	73.8	32.2	41.6	0.30	0.18	0.850	1.03
	CM2	49	-9.30	1.58	2.70	1.784	98.4	63.6	96	62.4	25.9	36.5				
		57	-12.30	1.55	2.71	1.978	98.6	70.8	97	76.9	33.4	43.5	0.26	0.08	0.867	1.04
		50	-14.30	1.56	2.70	1.903	99.0	67.4	96	68.8	32.5	36.3				
		51	-24.30	1.54	2.71	1.914	98.0	66.4	94	65.3	26.4	38.9				
		52	-32.30	1.59	2.71	1.883	99.2	69.4	100	72.0	31.8	40.2				
	CM3	60	-18.00	1.55	2.70	2.034	99.6	74.2	99	70.3	32.1	38.2				
		61	-13.50	1.52	2.71	2.188	99.6	78.4	97	71.4	32.5	38.9				
		62	-28.50	1.56	2.71	2.045	99.0	75.2	100	73.9	30.7	43.2				
		71	-20.00	1.55	2.70	1.967	99.6	70.4	97	76.1	31.1	45.0	0.32	0.09	0.718	1.07
		Average		1.56	2.70	1.939	98.6	69.4	97	74.4	32.5	41.9	0.29	0.12	0.854	0.99
Layer 2 (CH) Soft Fat CLAY	CM1	962	-33.40	1.58	2.69	1.832	99.2	66.2	97	77.2	31.9	45.3				
		963	-36.40	1.57	2.70	1.842	99.2	64.9	95	76.4	35.5	40.9				
		964	-39.40	1.56	2.71	1.883	99.2	66.0	95	72.6	30.2	42.4				
		965	-42.40	1.56	2.70	1.872	96.0	66.3	96	71.7	30.0	41.7				
	CM2	53	-37.30	1.60	2.70	1.842	99.2	67.7	99	71.8	31.4	40.4				
		54	-42.80	1.58	2.70	1.872	99.6	68.7	99	68.7	31.4	37.3				
		58	-40.30	1.62	2.71	1.737	99.6	63.3	99	71.5	29.9	41.6	0.64	0.21	0.741	1.23
	CM3	63	-34.50	1.51	2.70	2.176	98.4	78.4	97	76.9	32.8	44.1				
		64	-38.50	1.56	2.70	1.967	99.4	70.9	97	69.0	29.2	39.8				
		65	-41.50	1.60	2.71	1.853	96.0	68.3	100	66.4	27.2	39.2				
		66	-42.50	1.61	2.70	1.621	99.0	56.6	94	73.0	31.4	41.6				
		72	-40.50	1.60	2.71	1.823	99.2	66.2	98	71.5	29.9	41.6	1.85	0.21	0.751	1.39
		Average		1.58	2.70	1.860	98.7	67.0	97	72.2	30.9	41.3	1.25	0.21	0.746	1.31
Layer 3 (SC) Medium Clayey Sand	CM3	67	-43.50		2.72		30.0	17.5		23.7	17.0	6.7				
		68	-45.00		2.72		40.0	14.3		22.7	12.8	9.9				
		73	-44.50		2.72		45.3	13.0		24.8	14.0	10.8	1.71			
		Average			2.72		38.4	14.9		23.7	14.6	9.1	1.71			
Layer 4 (SM) Dense Fine SAND	CM1	966	-45.70		2.66		28.0	17.7								
		967	-48.70		2.67		15.9	19.2								
		968	-51.90		2.67		13.5	16.5								
		969	-54.90		2.66		10.0	13.7								
		970	-57.90		2.66		15.0	18.2								
		971	-59.90		2.67		12.0	20.4								
	CM2	55	-44.80		2.69		24.0	24.5								
	CM3	69	-47.00		2.66		27.0	16.5								
		70	-49.00		2.67		17.5	14.8								
		Average			2.67		18.1	17.9								

Source : Study Team

Table A3.2.19 (3) Summary of Soil Lavoratory Test Result of Vung Tau Site

Layer No.	Boring No.	Sample No.	Elevation (m)	Wet Unit Weight (t/m^3) ?t	Specific Gravity Gs	Void Ratio e_o	Percent of Particle < 0.075mm (%)	Water Content (%) W	Saturation Degree (%) St	Liquid Limit (%) WL	Plastic Limit (%) Wp	Plasticity Index (%) Ip	Unconfined Comp. Test (kgf/cm^2) qu	Triaxial Comp. Test (Kgf/cm^2) Ccu	Compression Index Cc	Preconsolid. Pressure (kgf/cm^2) Pc
Layer 1 (CH) Very Soft CLAY	VT1	179	-4.80	1.48	2.68	2.190	98.0	76.0	93							
		184	-6.80		2.66		94.6						0.07	0.06	1.302	0.48
		180	-8.80	1.50	2.69	1.989	65.0	67.3	91	57.4	24.0	33.4				
		185	-9.80		2.70		94.6	60.1		71.1	29.8	41.3		0.12	0.674	0.65
	VT2	149	-4.50	1.65	2.70	1.523	98.0	53.9	96	46.8	29.7	17.1				
		145	-7.50		2.69		99.0	64.2		59.6	30.9	28.7	0.19	0.07	0.751	0.65
		150	-8.50	1.64	2.70	1.500	98.0	52.2	94	50.6	28.4	22.2				
	VT3	168	-3.70	1.62	2.69	1.745	99.0	65.1	100	53.0	33.4	19.6				
		169	-6.70	1.58	2.70	1.389	88.0		76	52.5	26.2	26.3				
		164	-9.70		2.70		72.0	54.5		53.9	25.5	28.4	0.19	0.11	0.462	0.62
		170	-10.70	1.57	2.68	1.945	92.0	71.9	99							
	Average			1.58	2.69	1.754	90.7	62.8	93	55.6	28.5	27.1	0.15	0.09	0.797	0.60
Layer 2 (SC) Loose Clayey SAND	VT1	181	-13.00	2.02	2.68	0.595	33.8	20.0	90	18.2	14.5	3.7				
	VT2	151	-12.50	2.12	2.68	0.464	30.1	15.9	92	17.2	11.0	6.2				
	Average			2.07	2.68	0.530	32.0	18.0	91	17.7	12.8	5.0				
Layer 3 (CL) Stiff Lean CLAY	VT2	146	-15.10	1.99	2.73		77.0	25.3		52.7	23.2	29.5		0.67	0.123	2.26
		152	-15.60	1.87	2.72	0.850	40.9	26.9	86	27.6	17.2	10.4				
	Average			1.93	2.73	0.850	59.0	26.1	86	40.2	20.2	20.0		0.67	0.123	2.26
Layer 4 (SC-SM) Medium Dense Silty/Clayey SAND	VT1	182	-14.30	2.03	2.69	0.601	34.2	20.8	93	21.8	13.8	8.0				
		183	-15.30		2.66		15.0	18.3				0.0				
		194	-18.30		2.67		16.5	16.9		17.0	16.0	1.0				
		195	-19.30	2.08	2.71	0.557	34.3	19.6	95	18.9	13.6	5.3				
		196	-22.80	1.93	2.70	0.765	53.1	26.0	92	27.2	15.3	11.9				
		198	-25.80		2.66		11.5	16.4				0.0				
	VT2	153	-18.50	1.91	2.72	0.838	32.5	28.7	93	28.1	20.2	7.9				
	VT3	171	-15.70	1.91	2.69	0.781	27.7	26.4	91	22.5	19.4	3.1				
	Average			1.97	2.69	0.708	28.1	21.6	93	22.6	16.4	4.7				
Layer 5a (CL) Stiff Sandy CLAY	VT3	172	-18.70	1.85	2.70	1.000	79.0	36.8	99	43.2	21.4	21.8				
		165	-20.70	1.82	2.73	1.022	52.2	34.4	92	43.7	23.8	19.9			0.262	1.83
		173	-21.20	1.82	2.74	1.045	57.0	35.9	94	37.8	20.2	17.6				
	Average			1.83	2.72	1.022	62.7	35.7	95	41.6	21.8	19.8			0.262	1.83
Layer 5b (CH) Very Stiff Fat CLAY	VT1	187	-30.30	1.88	2.71	0.936	37.4	34.4	100							
	VT1	199	-32.10	1.70	2.74	1.342	99.0	44.8	92							
	VT1	188	-34.80	1.72	2.72		90.6	46.3		69.6	33.0	36.6	1.08	0.69	0.402	2.71
	VT1	200	-40.30	1.69	2.73	1.395	96.6	48.3	95	71.9	32.6	39.3				
	VT2	154	-21.50	1.78	2.71	1.022	86.0	33.3	88	60.2	28.0	32.2				
	VT2	155	-23.50	1.76	2.73	1.238	98.0	44.1	97	78.2	31.0	47.2				
	VT2	156	-26.50	1.77	2.72	1.248	95.0	45.7	100	69.8	30.4	39.4				
	VT2	147	-29.50	1.75	2.71		99.0	43.2		70.4	32.7	37.7	1.38	0.64	0.153	2.68
	VT2	157	-30.00	1.73	2.74	1.228	99.0	40.9	91	62.4	27.0	35.4				
	VT2	158	-33.00	1.68	2.73	1.374	99.4	46.6	93	80.8	33.7	47.1				
	VT2	159	-36.00	1.72	2.72	1.325	99.4	47.2	97							
	VT2	160	-40.00	1.77	2.73	1.220	98.0	43.4	97	77.5	33.1	44.4				
	VT2	161	-43.00	1.72	2.72	1.386	99.4	50.4	99	81.5	34.4	47.1				
	VT2	162	-47.00	1.73	2.72	1.211	99.0	40.8	92	79.7	34.0	45.7				
	VT2	148	-50.50	1.78	2.72	1.159	96.0	41.6	98	69.1	36.3	32.8	4.78		0.342	2.00
	VT3	174	-24.20	1.73	2.73	1.256	97.0	43.1	94	75.6	32.1	43.5				
	VT3	166	-26.20	1.77	2.72	1.230	98.0	45.1	100	77.2	32.2	45.0	1.53	0.29	0.409	2.64
	VT3	175	-27.70	1.73	2.73	1.238	99.0	41.3	91							
	VT3	176	-30.70	1.75	2.73	1.294	98.0	47.5	100	73.9	28.7	45.2				
	VT3	177	-33.70	1.60	2.72	1.519	99.0	48.1	86	75.3	31.5	43.8				
	VT3	167	-36.70	1.73	2.72	1.345	87.0	48.9	99	78.9	32.2	46.7	1.65	0.43	0.149	2.41
	VT3	178	-37.20	1.60	2.73	1.505	97.6	47.4	86	72.8	33.1	39.7				
	Average			1.73	2.72	1.274	94.0	44.2	95	73.6	32.0	41.6	2.08	0.51	0.291	2.49
Layer 6 (SM) Very Dense Silty SAND	VT1	201	-42.30		2.67	0.856	19.3	22.3		20.2	18.9	1.3				
		202	-45.30		2.68		23.2	24.0		19.5	17.6	1.9				
	VT2	163	-51.80	1.89	2.71		53.0	29.3	93	38.4	21.6	16.8				
	Average			1.89	2.69	0.856	31.8	25.2	93	26.0	19.4	6.7				
Layer 7 Weatherd Rock																
Lens TK1	VT1	186	-22.3	1.99	2.72	0.669	47.8	22.2	90	25.8	14.2	11.6			0.086	1.61

Source : Study Team

Table A3.3.1 Planned Dimensions of Ships Calling on Ports in Vietnam

No.	Name of Channel/Port	Planned Ship Size			
		Load (DWT)	Length (m)	Width (m)	Max. Draft (m)
1	Hon Gai - Cai Lan				
	Hon Bai - Hon Mot Segment	50,000	232	30.0	12.7
	Hon Mot - Bai Chay Segment	20,000	177	23.4	10.0
	Bai Chay - Cai Lay Segment	15,000	162	21.7	9.1
2	Hai Phong				
	Nam Trieu	7,000	129	17.6	7.2
	Bach Dang	7,000	129	17.6	7.2
	Cam River	7,000	129	17.6	7.2
	Vat Cach	3,000	86	13.2	5.9
3	Pha Rung	15,000	162	21.7	3.5
4	Van Gia	10,000	144	19.4	8.2
5	Hai Thinh	300	43	7.0	2.6
6	Diem Dien	200	37	6.5	2.4
7	Thanh Hoa	400	47	7.5	3.0
8	Cua Lo	500	103	15.4	6.0
9	Cua Hoi	1,000	53	9.5	4.2
10	Cua Gianh	1,000	53	9.5	4.2
11	Nhat Le	300	43	7.0	2.6
12	Cua Viet	1,000	53	9.5	4.2
13	Thuan An	1,000	53	9.5	4.2
14	Da Nang				
	Buoy No.0 - Tien Sa	15,000	162	21.7	3.5
	Tien Sa - Wharf No.6	5,000	103	15.4	6.0
	Wharf No.6 - Wharf No.2	1,000	53	9.5	4.2
15	Qui Nhon	15,000	162	21.7	3.5
16	Dam Mon	30,000	199	26.1	11.0
17	Nha Trang	15,000	162	21.7	3.5
18	**Sai Gon - Vung Tau**	**25,000**	**188**	**24.8**	**10.5**
19	**Dong Nai**	**15,000**	**162**	**21.7**	**3.5**
20	**Thi Vai**				
	Vung Tau - Cai Mep	**30,000**	**199**	**26.1**	**11.0**
	Cai Mep - Thi Vai	**30,000**	**199**	**26.1**	**11.0**
	Thi Vai - Go Dau	**10,000**	**53**	**9.5**	**4.2**
21	Cau Tieu	3,000	86	13.2	5.9
22	Dinh An	5,000	103	15.4	6.0
23	Nam Cam	600	47	8.4	3.0

Source: VINAMARINE

Table A3.3.2 Design Dimensions of Navigational Channels in Vietnam in 1998

No.	Name of Channel	High Tide (CDL)	Shallowest Depth of Channel (CDL)	Design Dimensions of Channel		
				Depth (CDL)	Width (m)	Slope
1	Hai Phong Channel					
	Nam Trieu - Bach Dang	+2.8 to + 3.4	-2.9	-4.2	100	1/15
	Cam River	+2.8 to +3.4	-3.8	-4.2	80	1/10
	Turning Basin	+2.8 to +3.4	-3.8	-4.2	250	1/10
2	Le Mon Channel	+2.8 to +3.4	+0.3	-1.0	50	1/10
3	Cua Lo Channel	+2.2 to +2.9	-2.5	-4.0	60	1/10
4	Cua Hoi Channel	+2.2 to +2.9	-1.5	-2.5	60	1/15
5	Thuan An Channel	+0.5 to +0.7	-1.5	-3.5 or -4.0	50	1/10
6	Quy Nhon Channel	+2.0 to + 2.3	-7.0	-8.0	80	1/10
7	**Sai Gon - Vung Tau Channel**	**+3.0 to +4.0**	**-7.0**	**-8.5**	**150**	**1/5 to 1/7**
8	Dinh An Channel	+4.0 to +4.8	-3.0	-4.2	80	1/15

Source: Viet Nam Marine Safety Bureau

Table A3.3.3 Investment Cost for Maintenance Dredging of Channels in Vietnam in 2000

No.	Name of Channel	Design Dimensions of Channel		Kind of Dredger	Investment Cost (Million VND)
		Width (m)	Depth (CDL)		
1	Hai Phong Channel	80 to 250	-4.2 to -4.5	Suction Dredger - high capacity	33,000
2	Pha Rung Channel	80	-3.2	Suction Dredger - high capacity	3,000
3	Cai Lan Channel	80	-6.8	Suction Dredger - high capacity	1,300
4	Cua Hoi Channel	60	-2.8	Suction Dredger - shallow draft	1,000
5	Cuu Lo Channel	60	-3.8	Suction Dredger - shallow draft	3,500
6	Thuan An Channel	50	-4.2	Suction Dredger - shallow draft	600
7	Cua Viet Channel	60	4.0	Suction Dredger - shallow draft	2,000
8	Cuu Gianh Channel	60	-3.4	Suction Dredger - shallow draft	1,000
9	Da Nang Channel	298	-10.00	Backhoe Dredger	3,000
10	Qui Nhon Channel	80	-8.5	Suction Dredger - small capacity	2,000
11	**Sai Gon - VT Channel**	**150**	**-8.5**	**Backhoe Dredger**	**11,000**
12	Dinh An Channel	80	-3.2	Suction Dredger - high capacity	2,500

Source: Viet Nam Marine Safety BureauTable

Table A3.3.4 Dredging Fleet of Viet Nam Waterway Construction Cooperation(VINAWACO)

Type	Ship Name	Year built	Country built	Length L (m)	Breadth B (m)	Height H (m)	Draft D (m)	Engine capacity (HP)	Pumping capacity (m^3)	Hooper capacity (m_3)	Dredging depth (m)	Pumping Distant(m)		Speed (knot)	Dredging per year (10^3m^3)
												Max	Min		
Suction Hopper Dredger	Long Chau	1969	Germany	95	16	6	5.3	5,810	3,500	3,200	16			10	3,500
	Tran H Dao	1969	Germany	95	16	6	5.68	6,650	3,500	3,500	16			10	3,500
	HB38	1989	Vietnam	53.7	10	4	1.6	1,590	400	400	7			7	500
Sea Backhoe Dredger	TC81	1981	France	69.8	12.6	4	2.4	2,060	800		16			10	1,000
	TC82	1982	France	69.8	12.6	4	2.4	2,060	800		16			10	1,000
	TC54	1954	Germany	52.5	9.73	3.3	1.85	665	300		14				300
	TC91	1989	Russia					920	600		14			4-5	300
River Backhoe Dredger	TC82	1983	Russia	52.6	9.6	2.8	1.8	490	275		12				250
Cutter Suction Dredger	H 01	1961	America	39	11	2.8	2.1	1,950	500		10	2,000	200		300
	H 02	1965	America	21	8	2.5	1.0	1,185	480		10	1,500	200		200
	H 03	1965	America	21	8	1.5	1.0	1,185	480		10	1,500	200		300
	H 04	1965	America	21	8	1.8	1.0	1,185	480		10	1,500	200		300
	H 19/5	1982	Vietnam	25	8.33	2.2	1.2	1,065	480		10	1,500	200		
	Pe Ka6	1975	Holland	24	7.08	1.8	1.2	1,700	500		10	5,000	300		550
	H 06	1965	America	23	7.4	3.2	1.2	910	300		9.5	1,200	200		
Cutter Suction Dredgers for southern region of VN	H 06	1986	Vietnam					525	250						
	H 07	1985	Vietnam	19	6.6	1.8	1.0	545	300		8	800	200		
	H 08	1963	America	16	6.5	1.6	0.85	574	300		8	800	200		
	H 09	1964	America	15	5.5	1.6	1.05	574	300		8	800	200		
	H 10	1965	America	15	5.5	1.6	1.05	574	300		8	1,000	200		
	H 11	1965	America	15	5.6	1.25	1.0	290	100		5	500	100		
	H 12	1979	Vietnam	15	6.2	1.5	0.9	375	200		8	500	150		
	H 22/12	1984	Vietnam	16.5	3.75	1.2	0.8	215	100		5	300	100		
	H 30/4	1985	Vietnam	16.5	3.75	1.2	0.8	215	100		5	300	100		
Large Cutter Suction Dredger	HA 97	1997	America	34.7	9.15		1.68	4,170	2,300		17.7	7,000			4,000
	VN America	1997	America	34.7	9.15		1.68	4,170	2,300		17.7	7,000			4,000
	12-9	1996	Poland	35.0		2.97	1.65	3,300	2,100		16.0	5,000	1,000		2,000
	HP 01	1995	Poland	36.5	10.7		1.70	2,400	1,450		16.0	5,000	1,000		1,200

Source : VINAWACO

Notes : Design capacities are:

- For Sea Backhoe Dredgers, the calculated capacity is liquid volume(m^3). Actual capacity is equal to 15% liquid volume.
- For River Backhoe Dredgers, the actual capacity is taken as 65%.

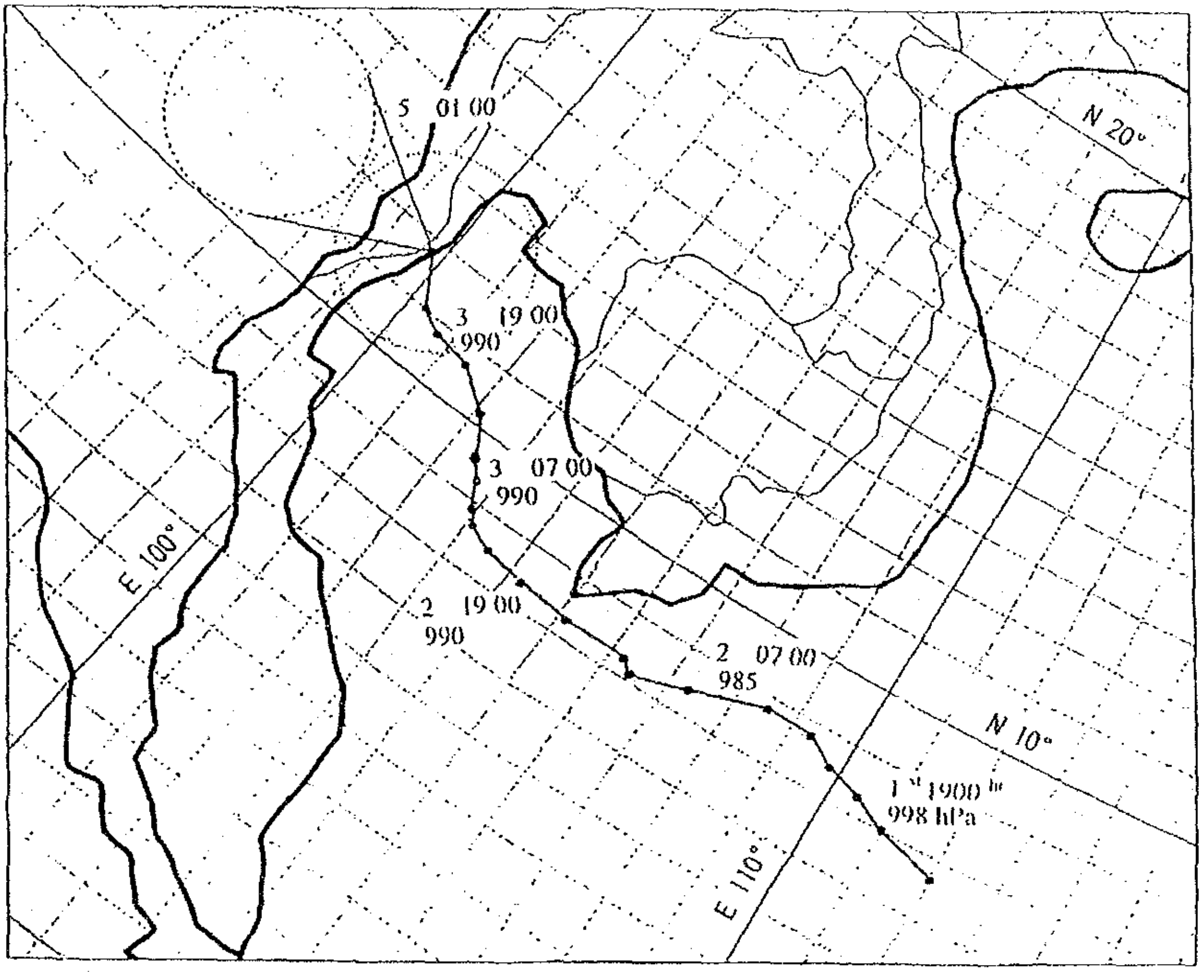


Figure A 3.2.1 The Track of Typhoon 9726 (Linda), Nov. 1977
Source: Study Team

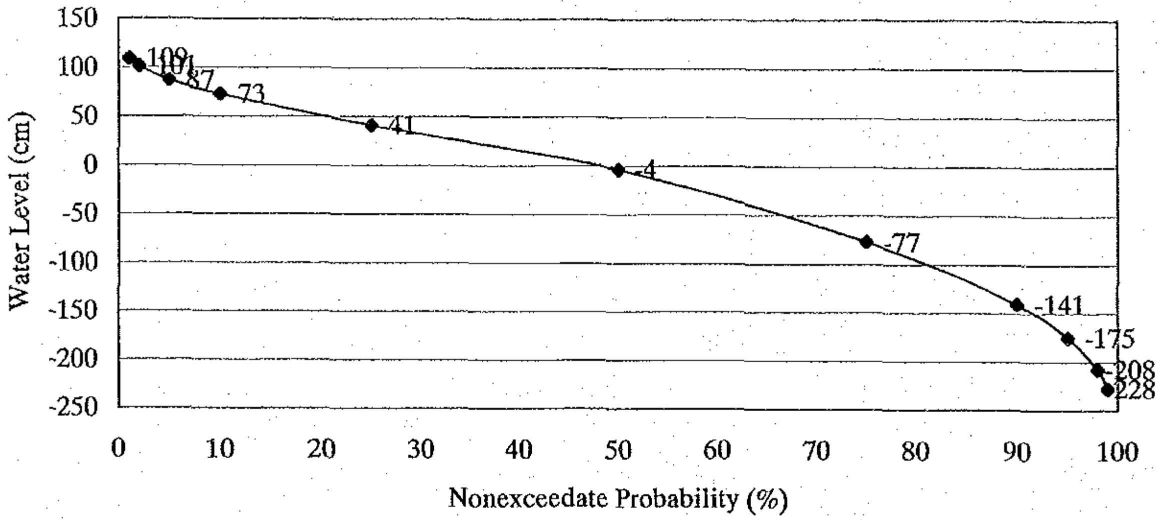


Figure A3.2.2 (1) Water Level by Nonexceedance Probability at Vung Tau (1995 to 2000)
Source: Vung Tau Station

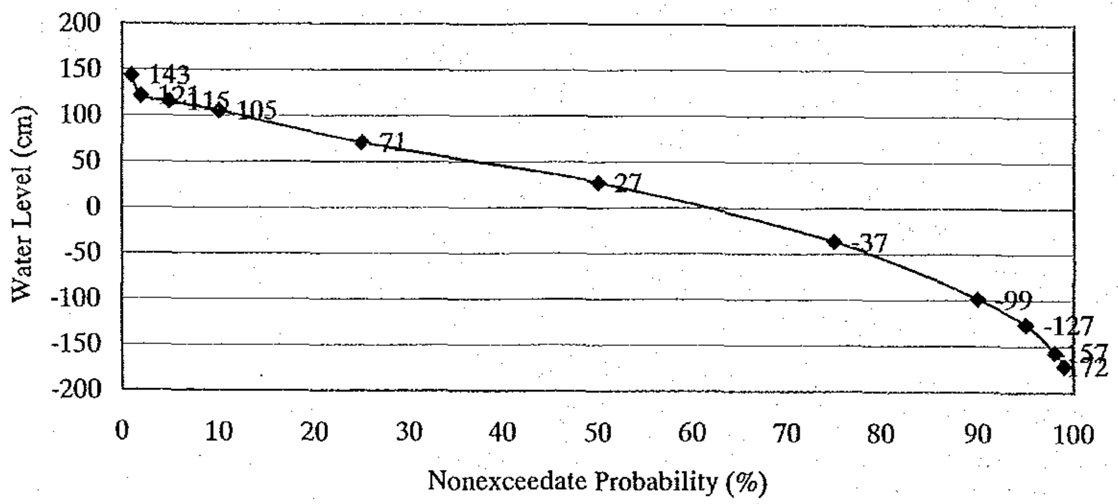


Figure A3.2.2 (2) Water Level by Non-exceedance Probability at Phu An (1995 to 2000)
Source: Phu An Station

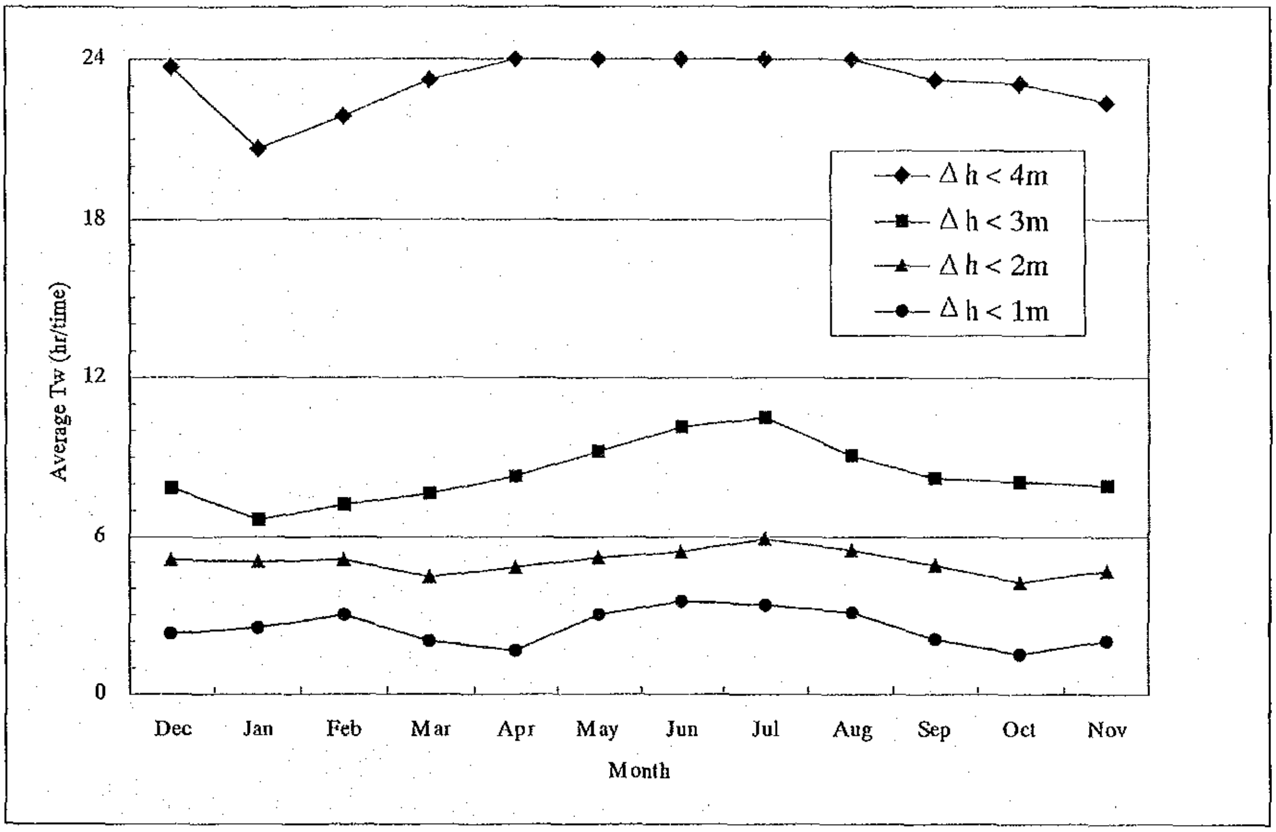
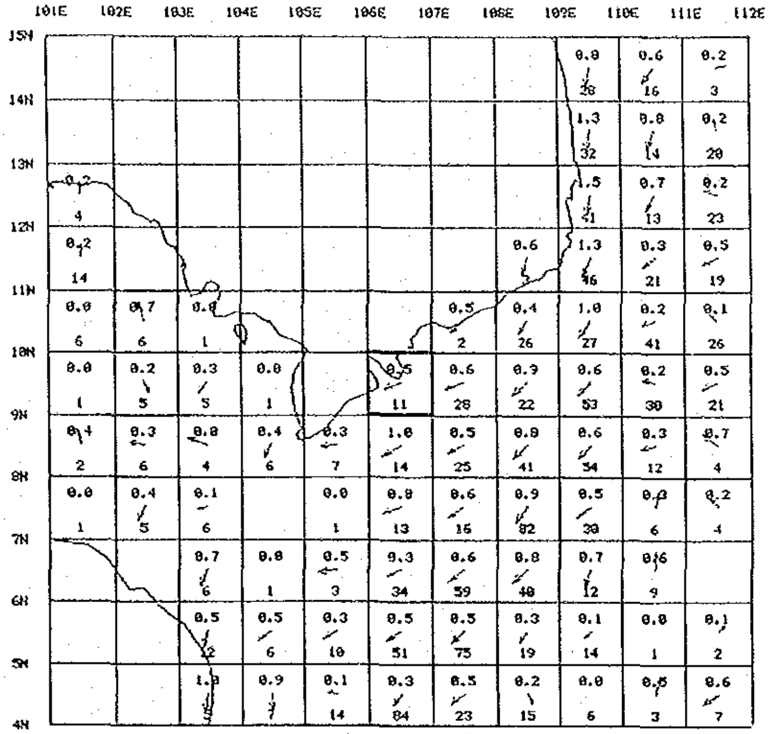


Figure A3.2.3 Monthly Variation of Impassable Time, at Vung Tau Approach Channel
Source: Study Team

January



July

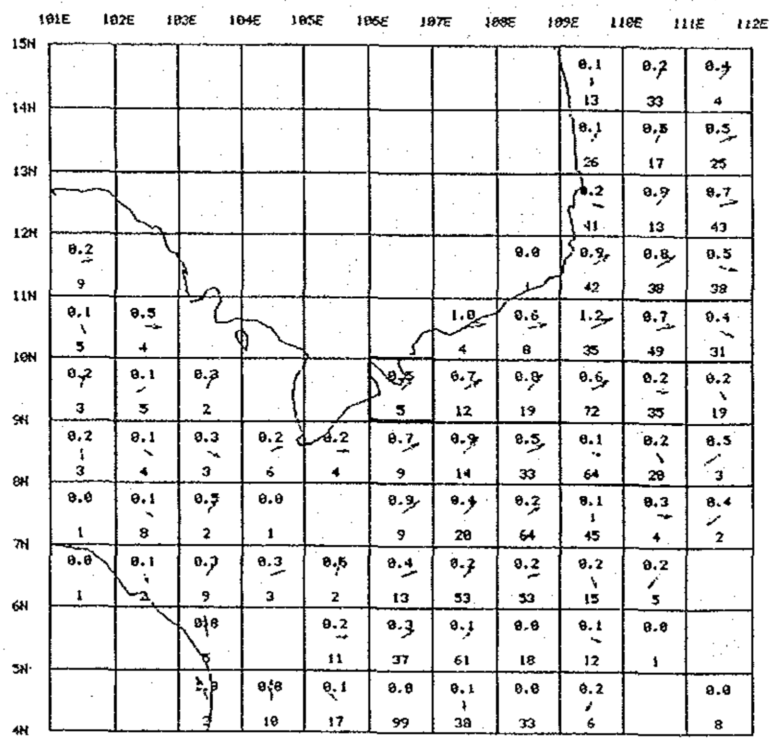


Figure A3.2.4 Ocean Current in Offshore of the Study Area

Source: Japan Oceanographic Data Center

Note: Upper figure: Average speed, Lower figure: Number of samples

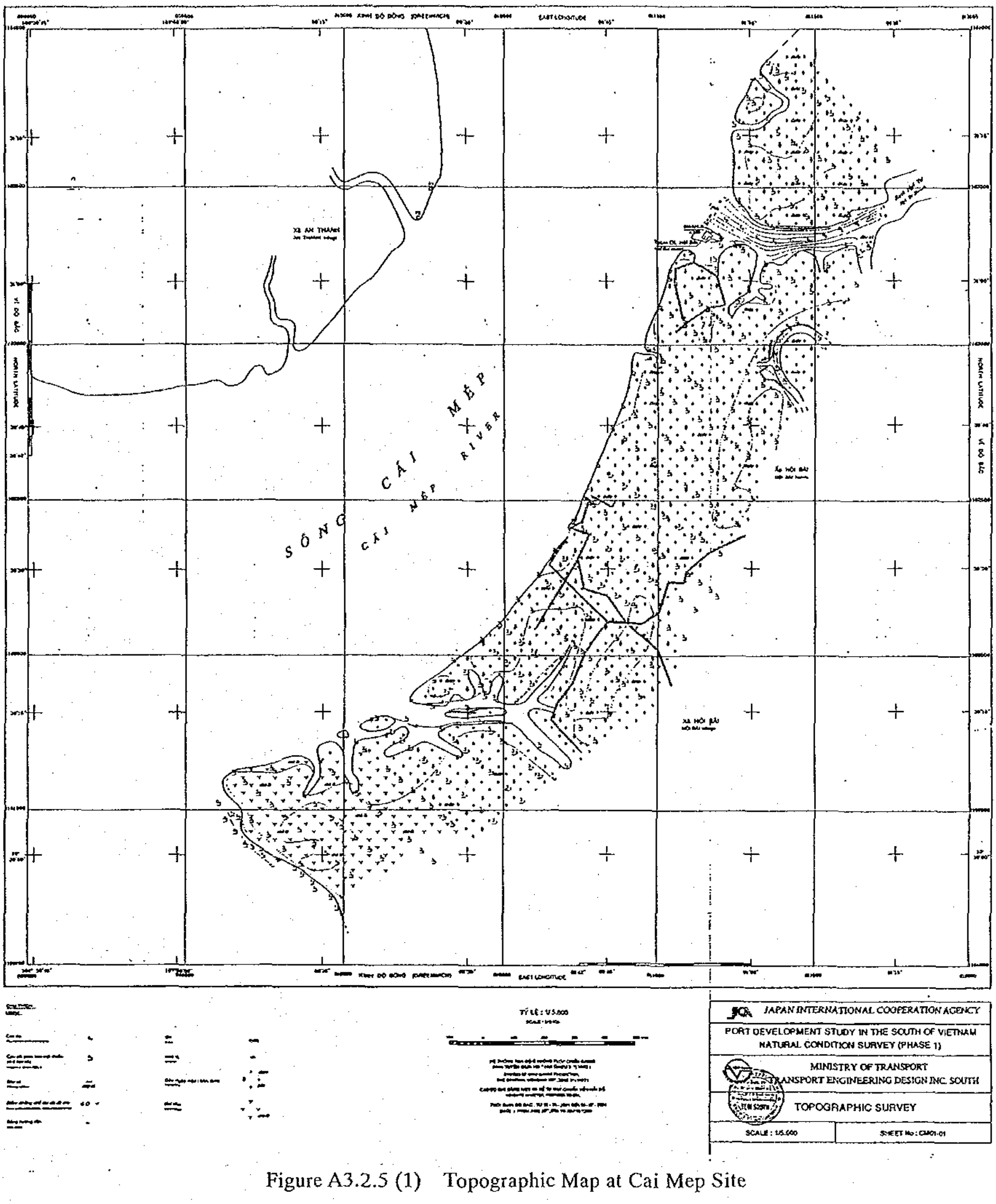


Figure A3.2.5 (1) Topographic Map at Cai Mep Site

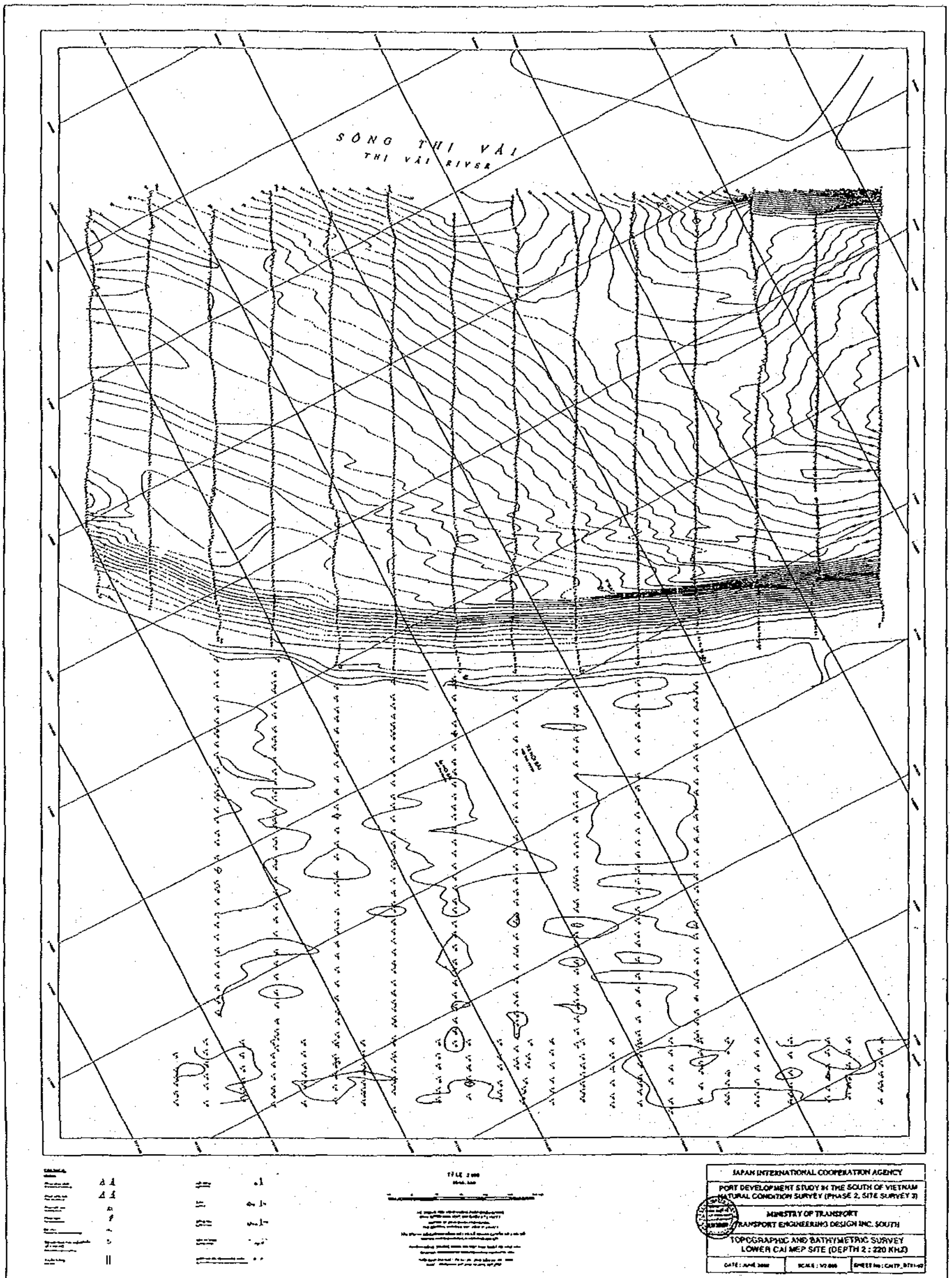


Figure A3.2.5 (2) Topographic and Bathymetric Map at Cai Mep Site

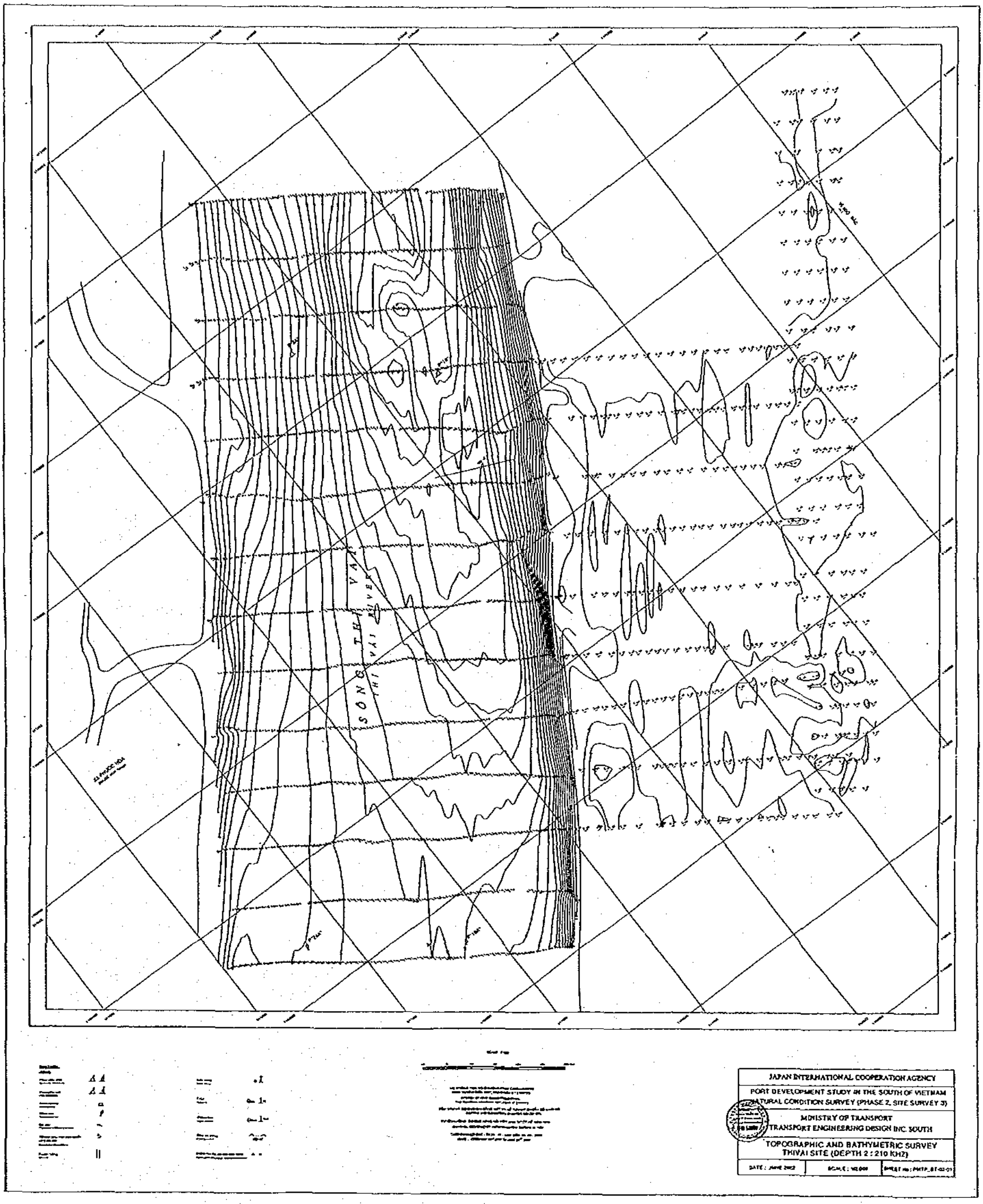


Figure A3.2.5 (3) Topographic and Bathymetric Map at Thi Vai Site

Figure A3.2.6 (1) Bathymetric Maps

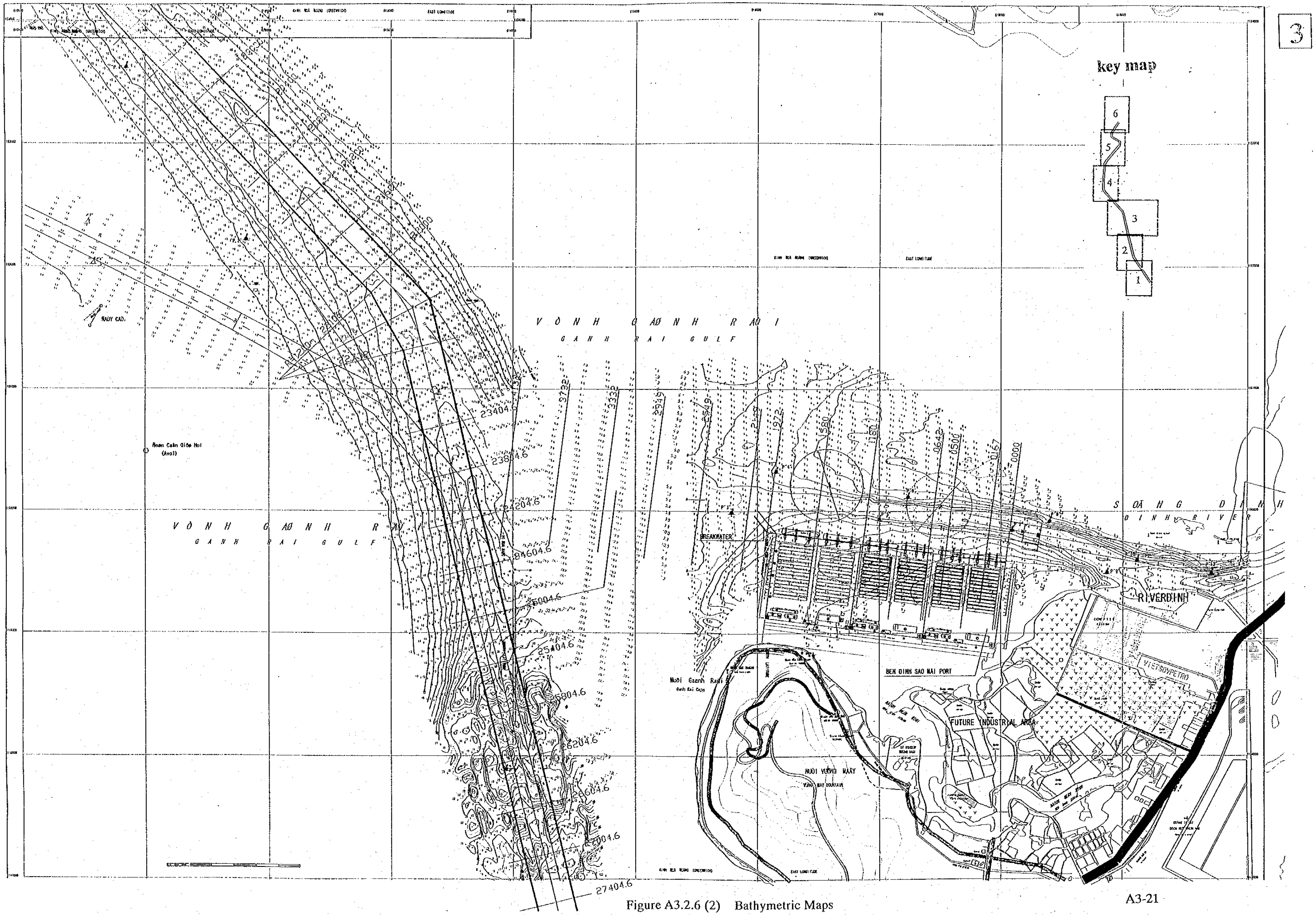
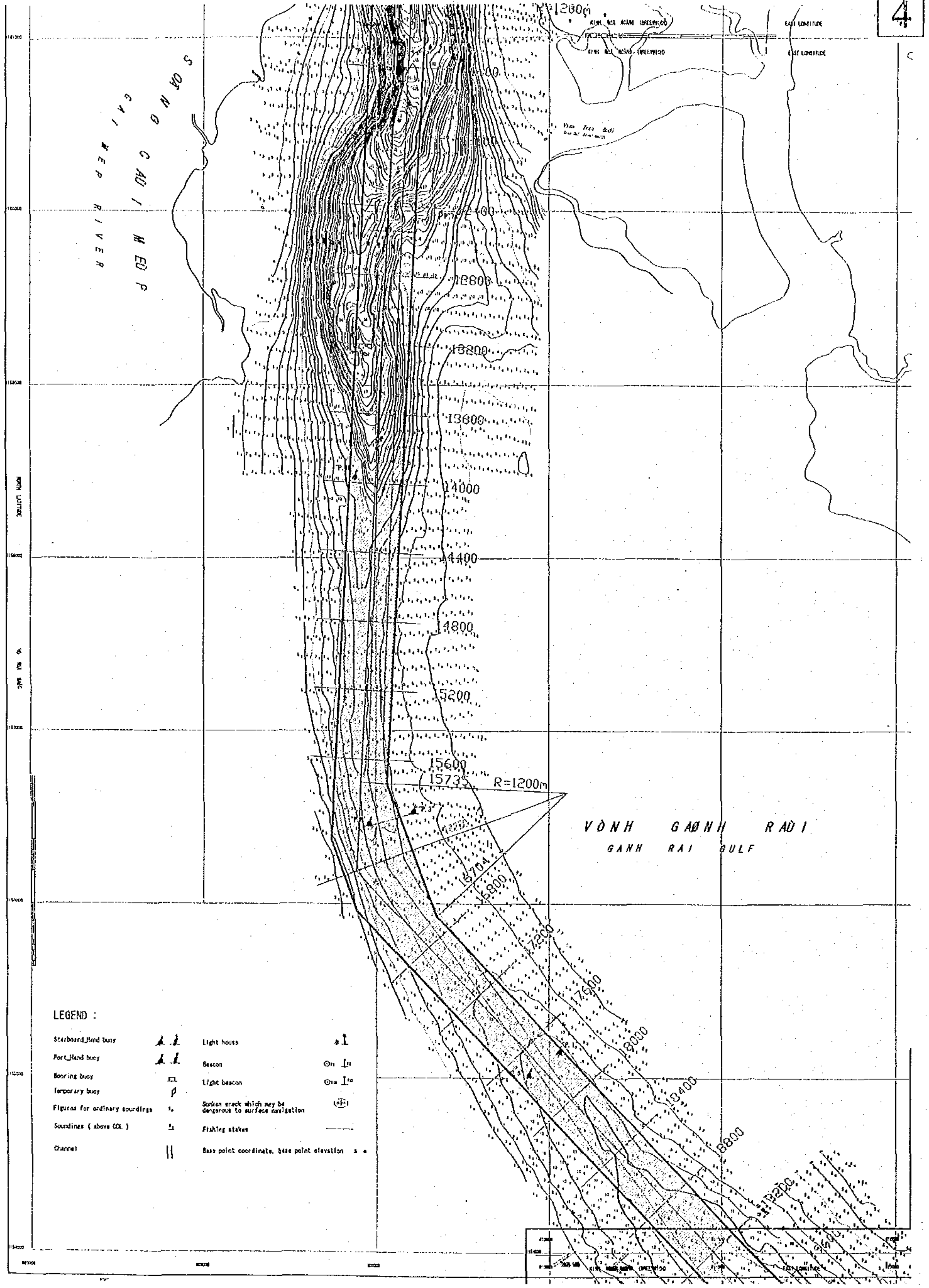


Figure A3.2.6 (2) Bathymetric Maps



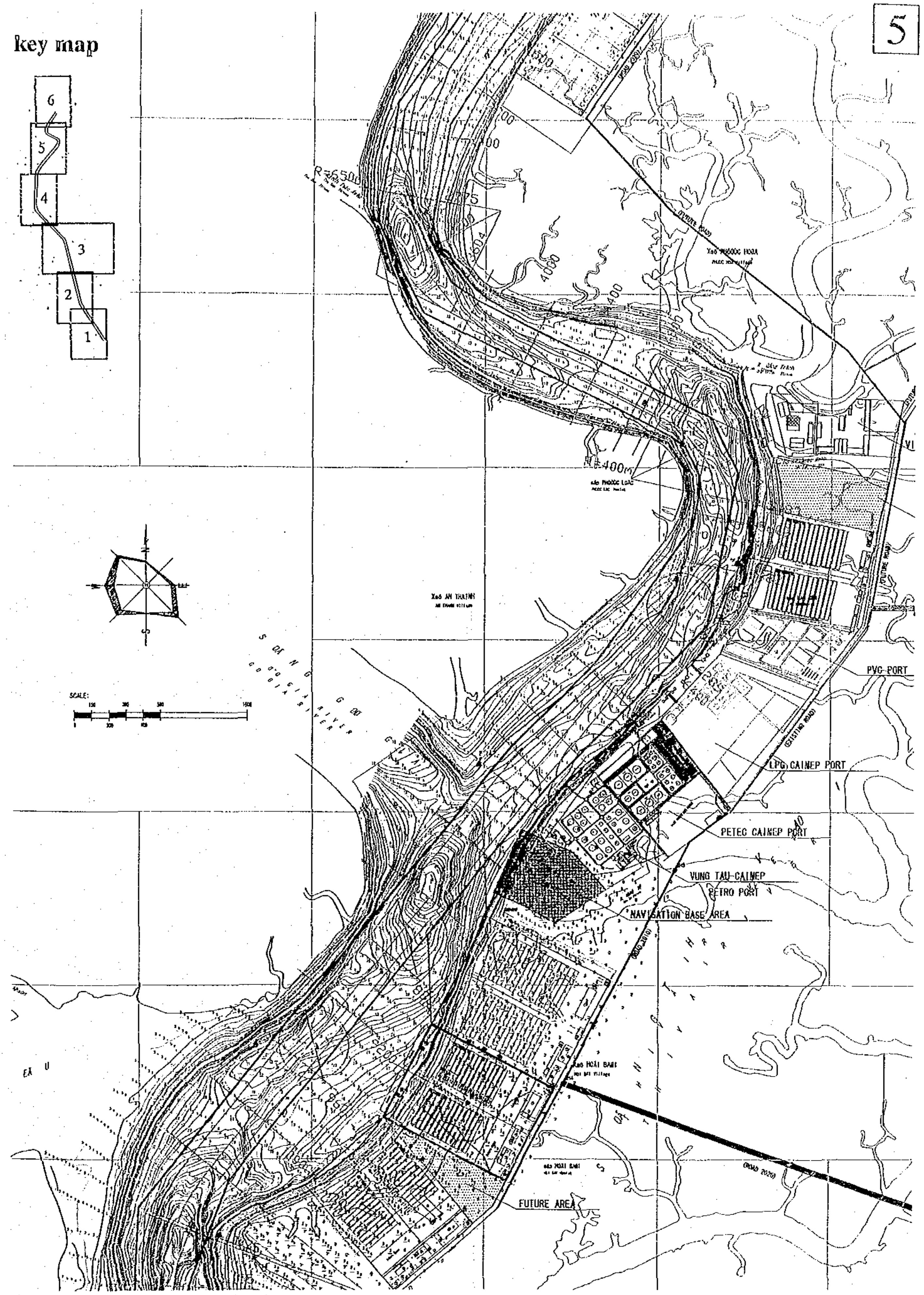


Figure A3.2.6 (3) Bathymetric Maps

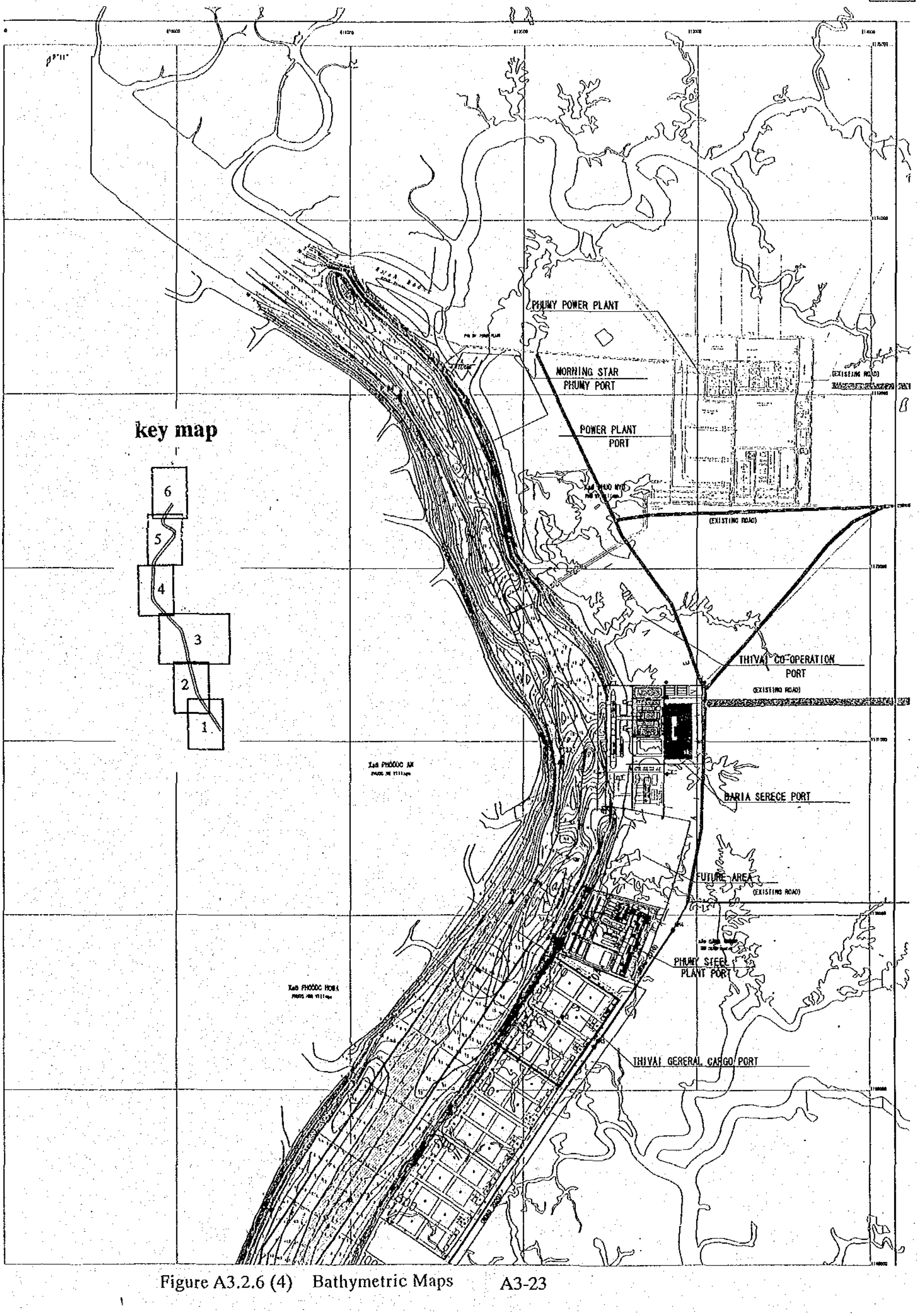


Figure A3.2.6 (4) Bathymetric Maps

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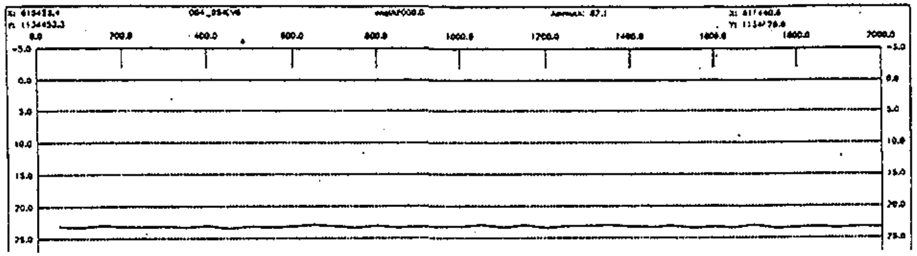

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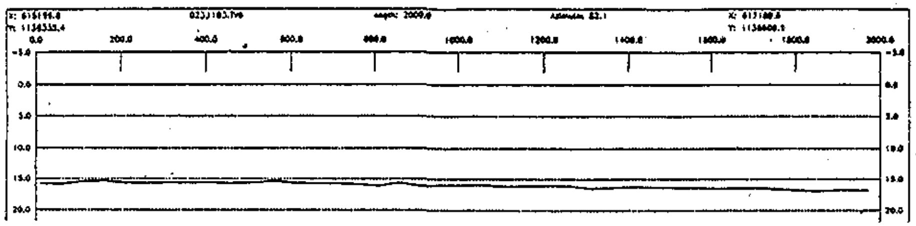

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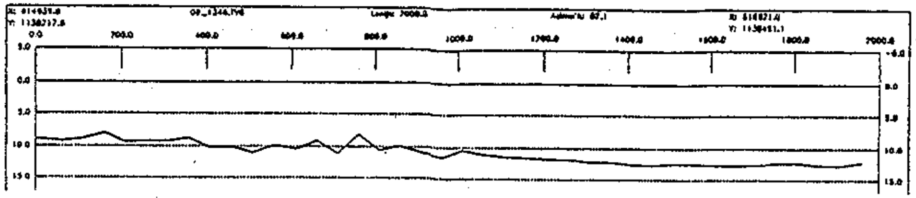

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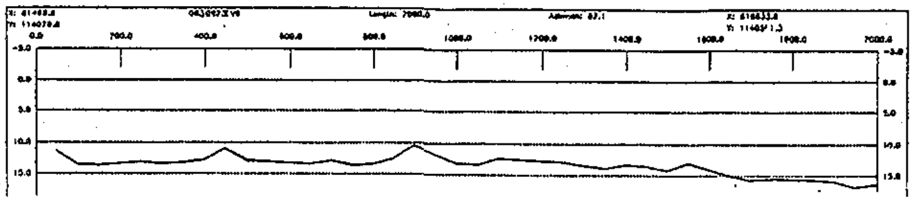

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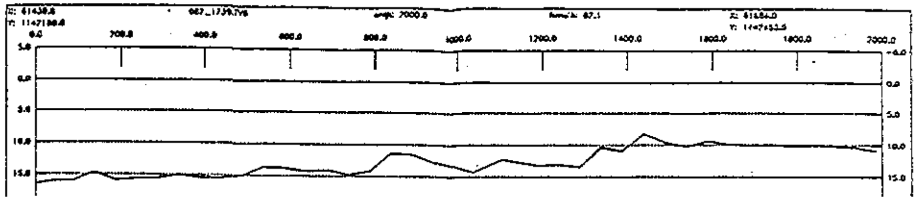

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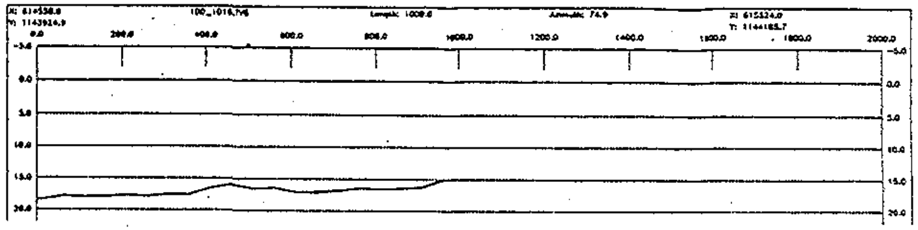

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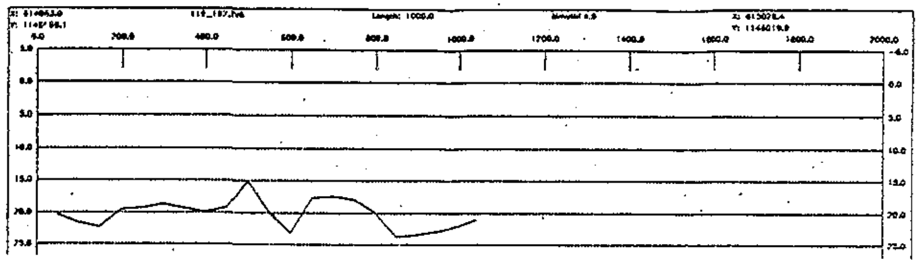

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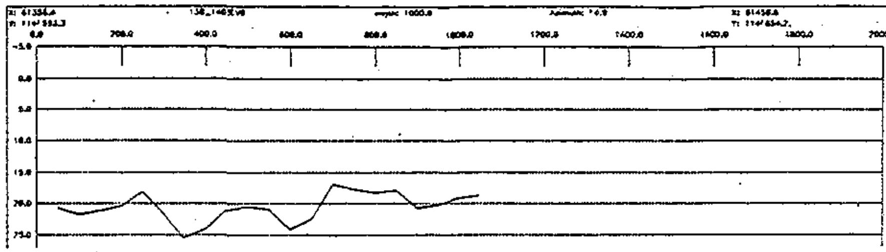
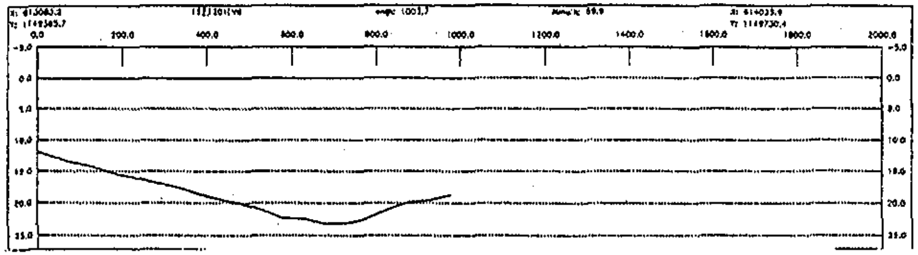


Figure A3.2.7 (1) Cross Section of Bathymetric Survey

Source: Study Team

CROSS SECTION 9



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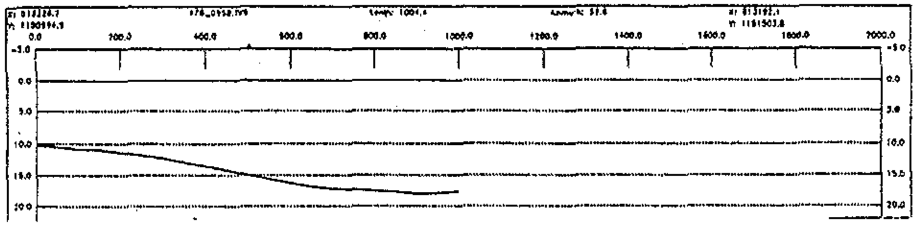

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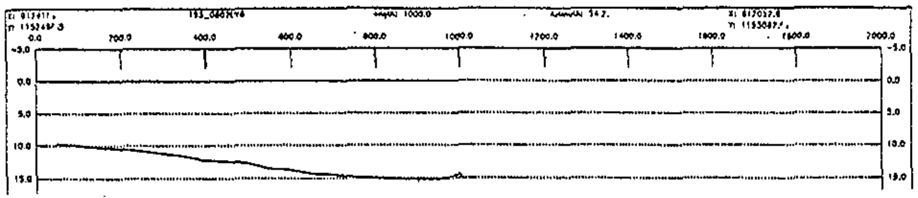

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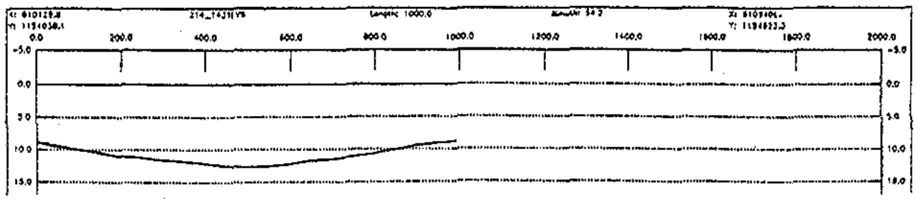

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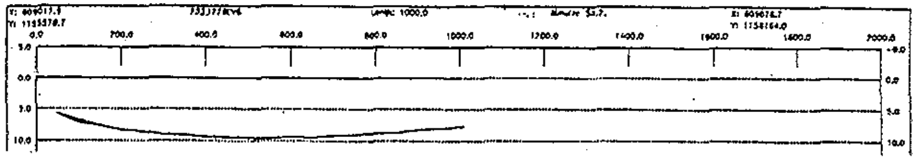

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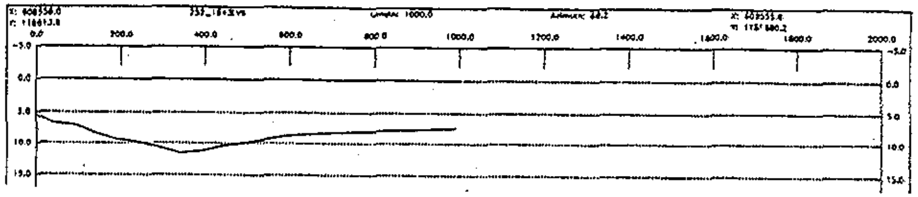

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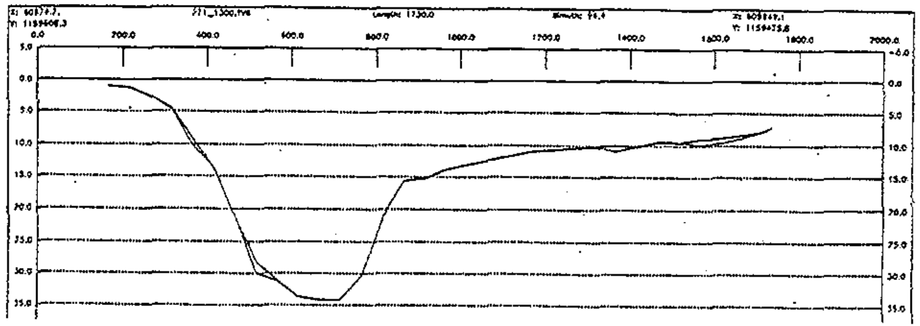
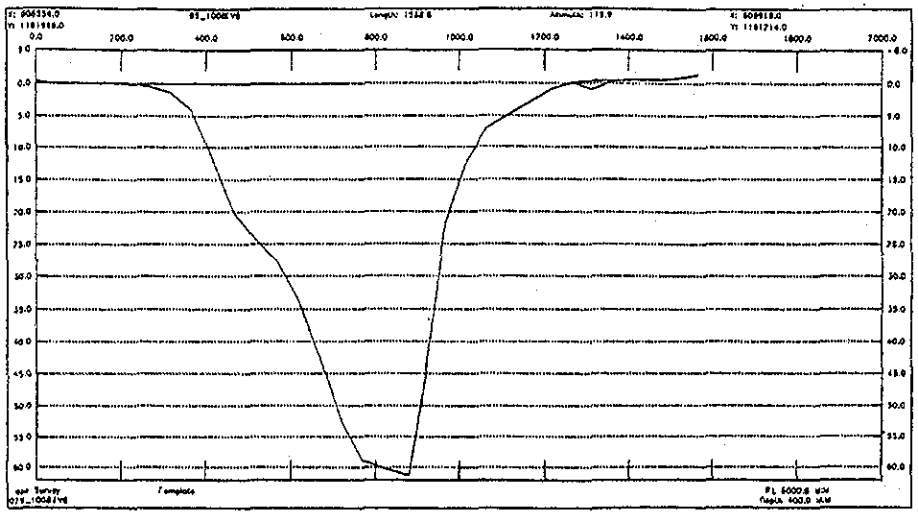


Figure A3.2.7 (2) Cross Section of Bathymetric Survey

Source: Study Team

CROSS SECTION 16



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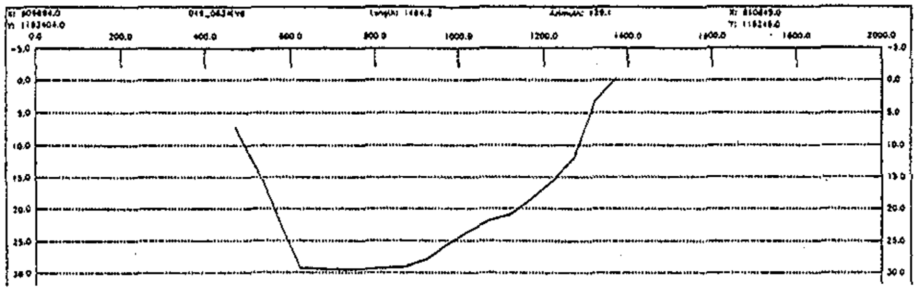

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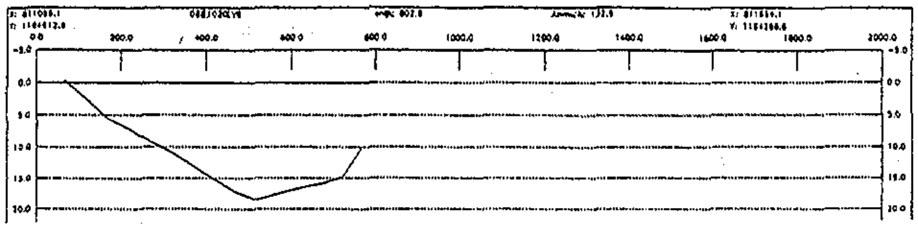

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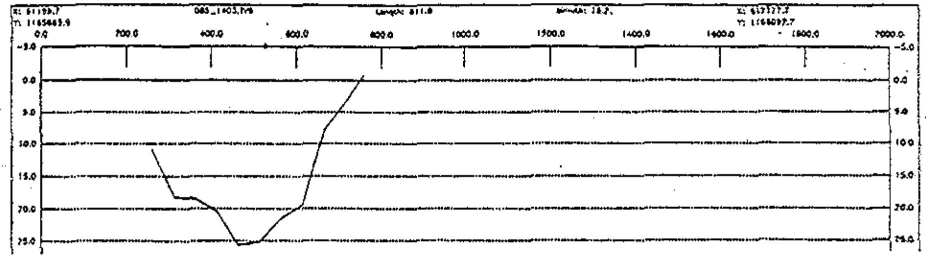

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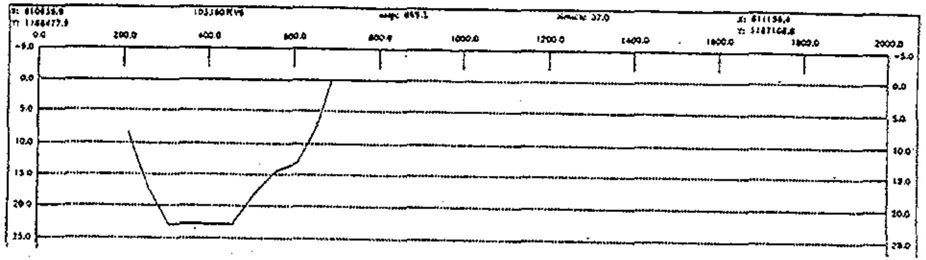

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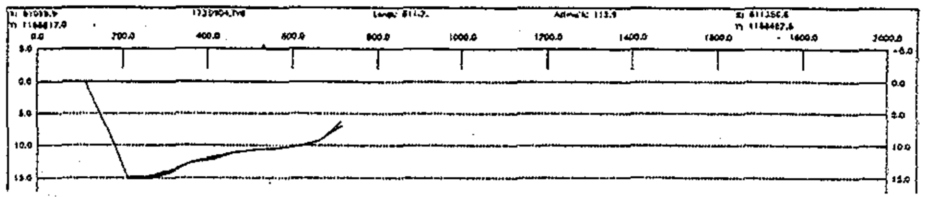

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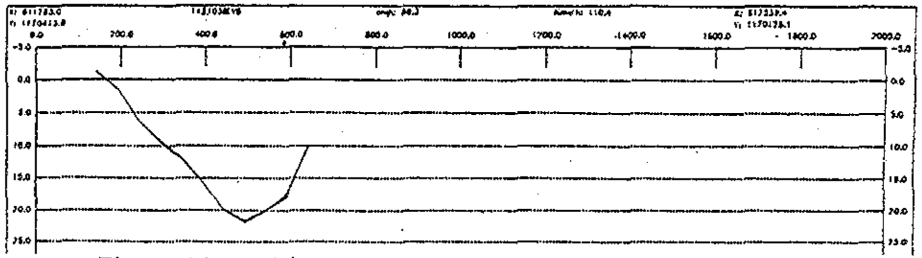
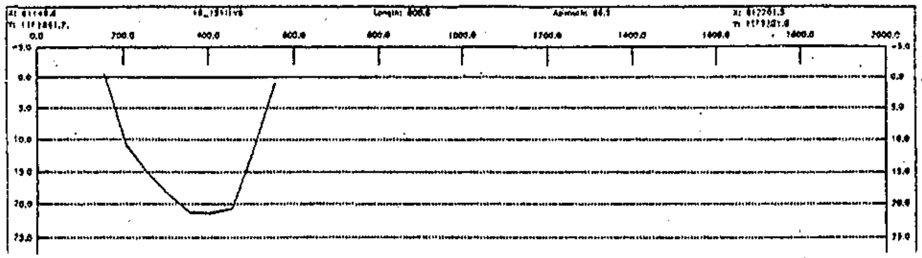


Figure A3.2.7 (3) Cross Section of Bathymetric Survey

Source: Study Team

CROSS SECTION 23



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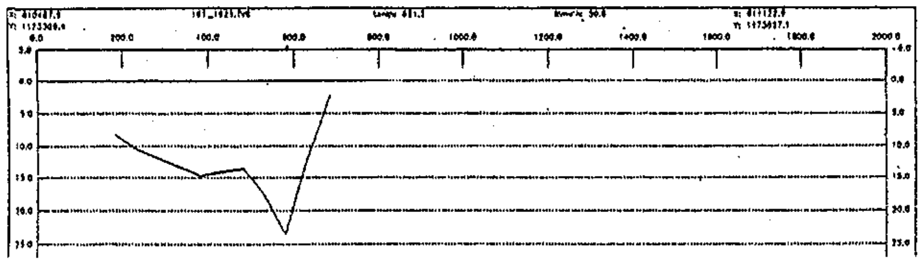

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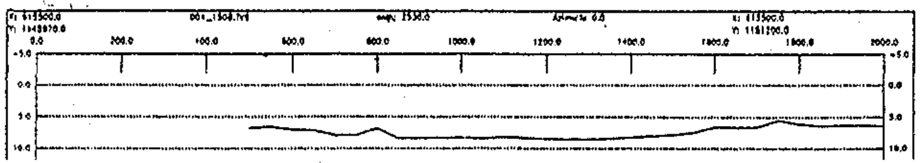

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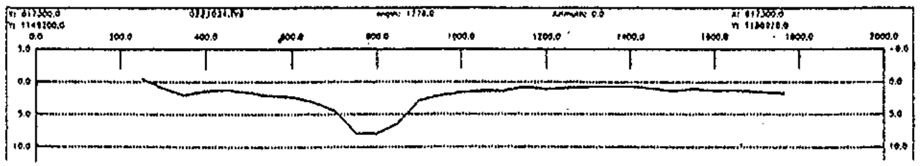

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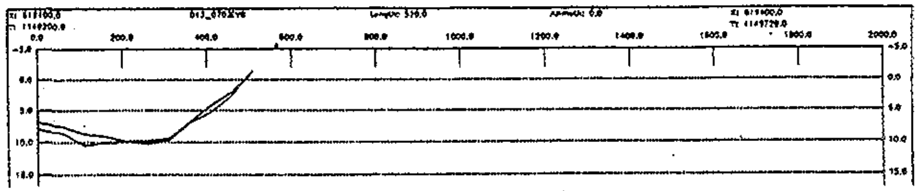

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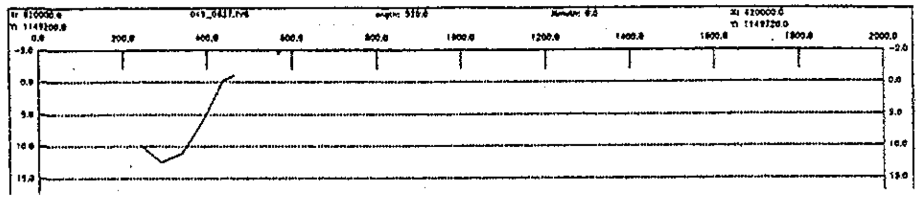

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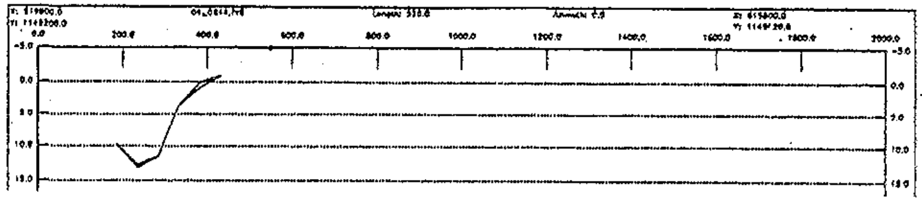

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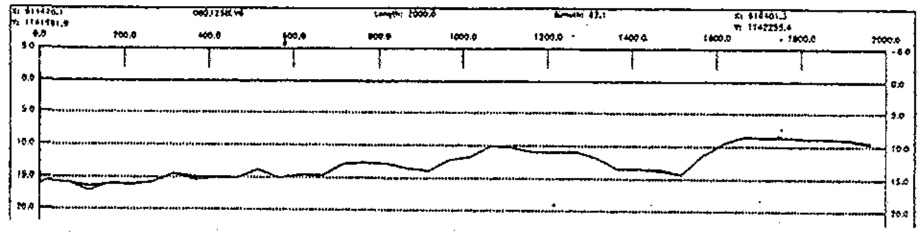


Figure A3.2.7 (4) Cross Section of Bathymetric Survey

Source: Study Team

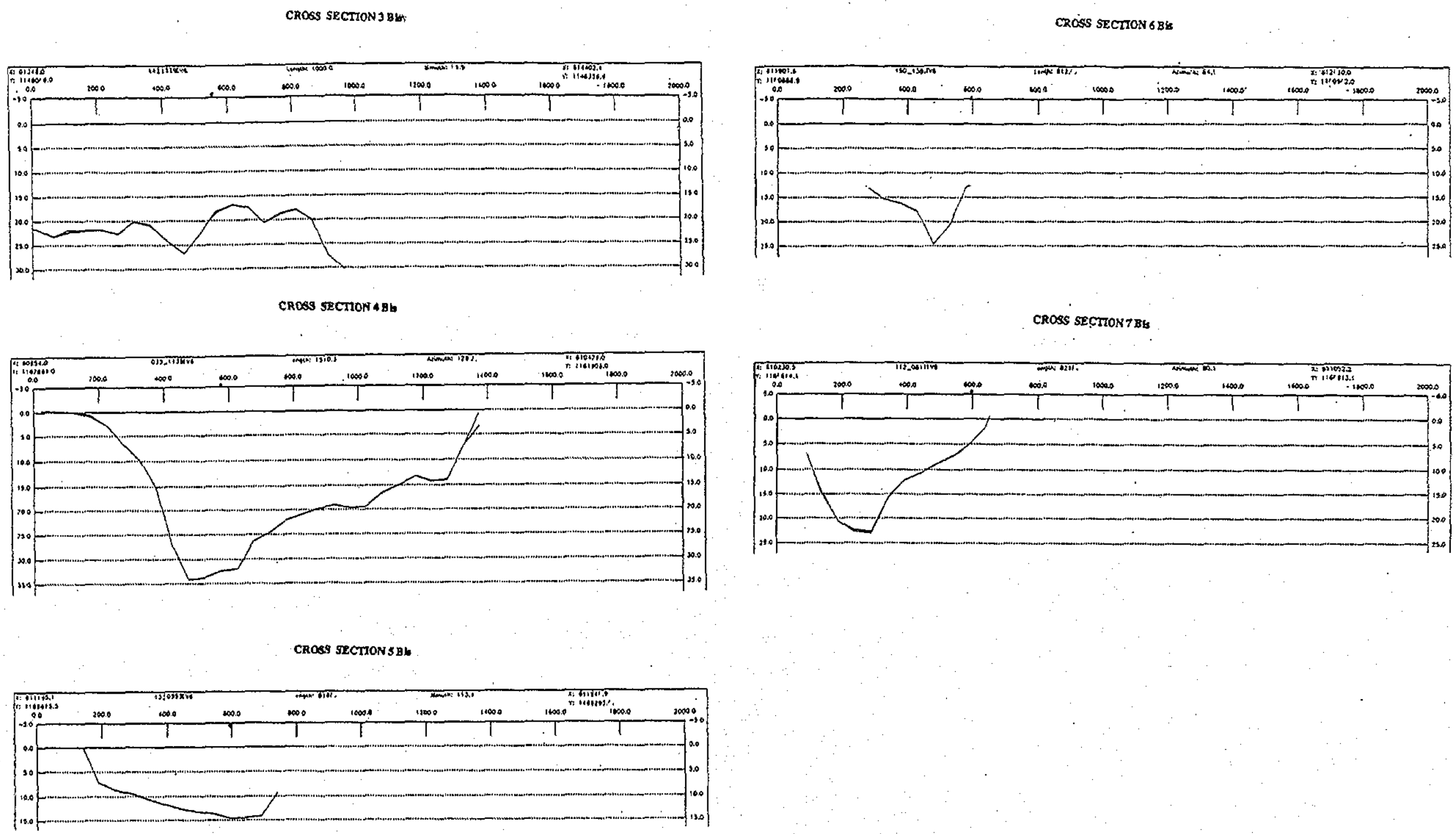


Figure A3.2.7 (5) Cross Section of Bathymetric Survey
Source: Study Team

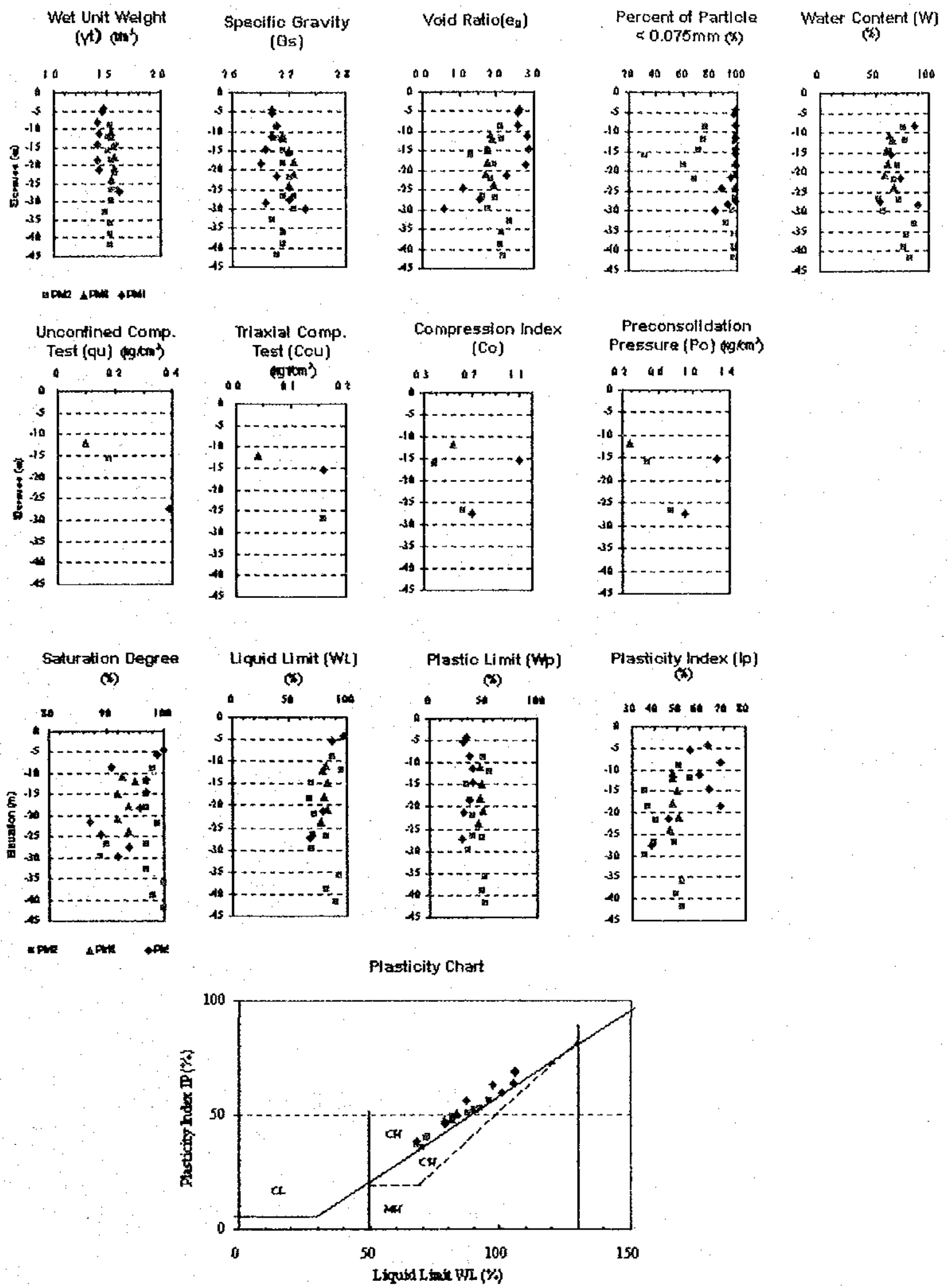


Figure A3.2.8 (1) Soil Laboratory Test Results of Thi Vai Site (Very Soft Surface Layer)

Source: Study Team

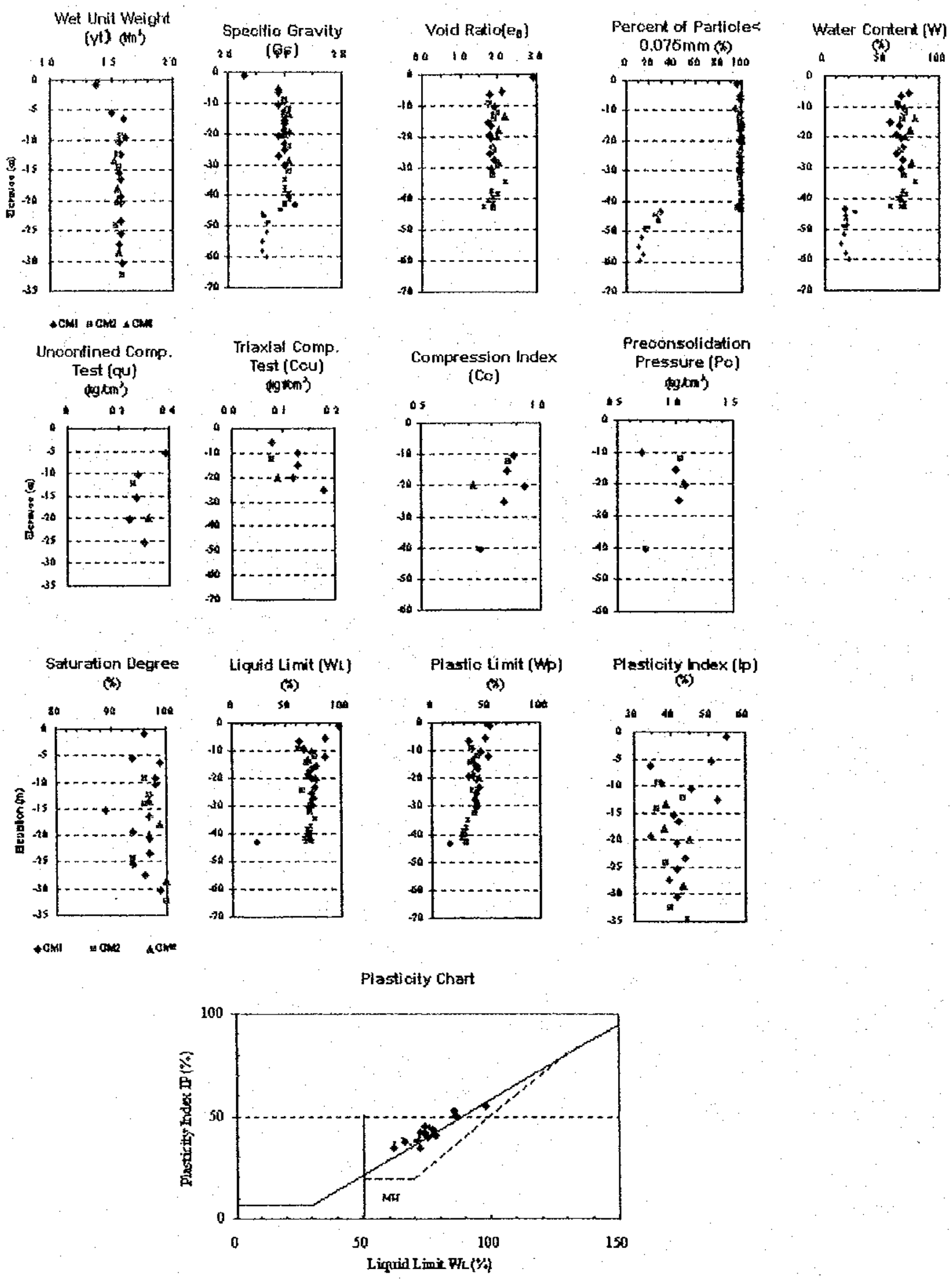


Figure A3.2.8 (2) Soil Laboratory Test Results of Cai Mep Site (Very Soft Surface Layer)
Source: Study Team

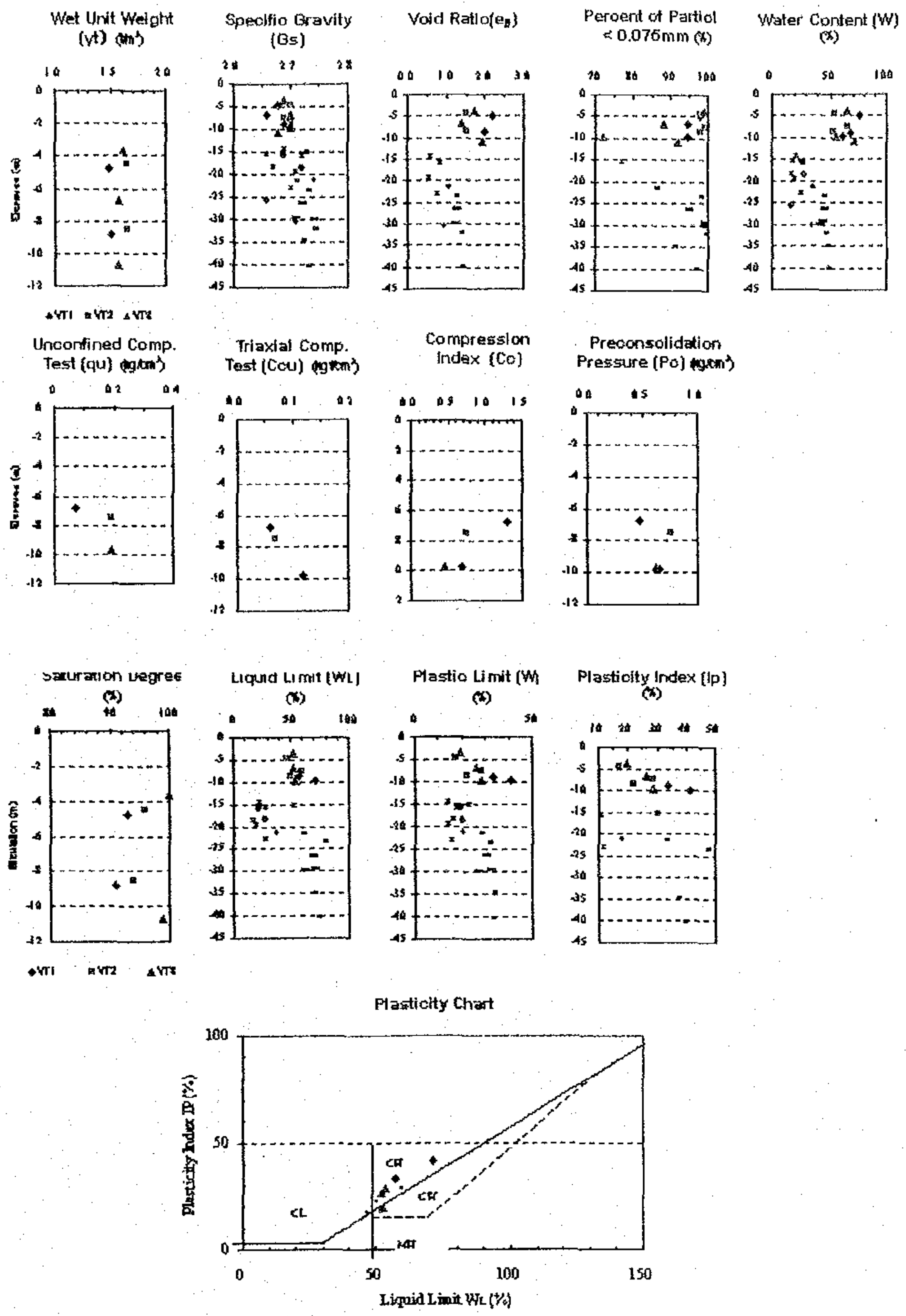


Figure A3.2.8 (3) Soil Laboratory Test Results of Vung Tau Site (Very Soft Surface Layer)
Source: Study Team

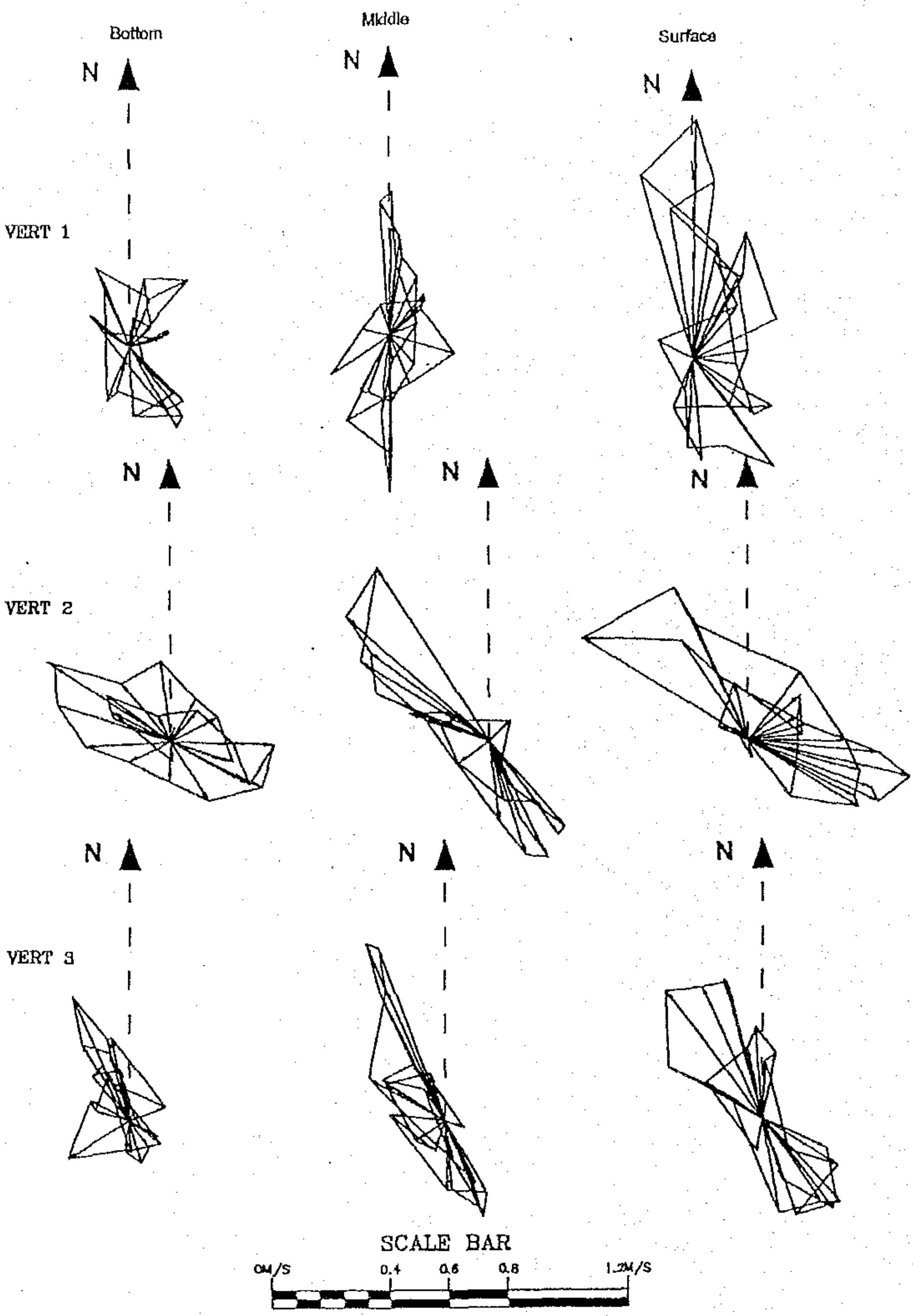
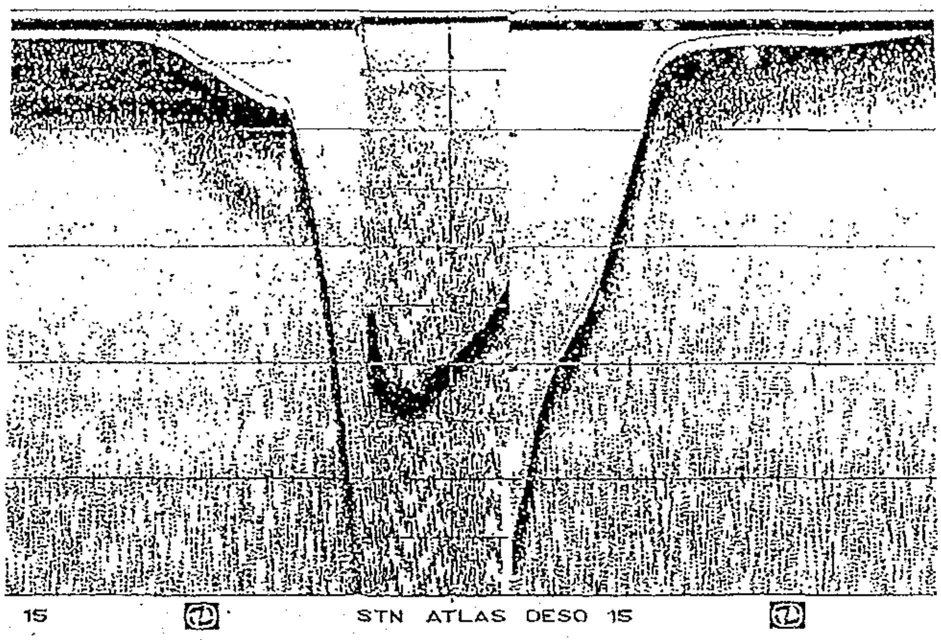
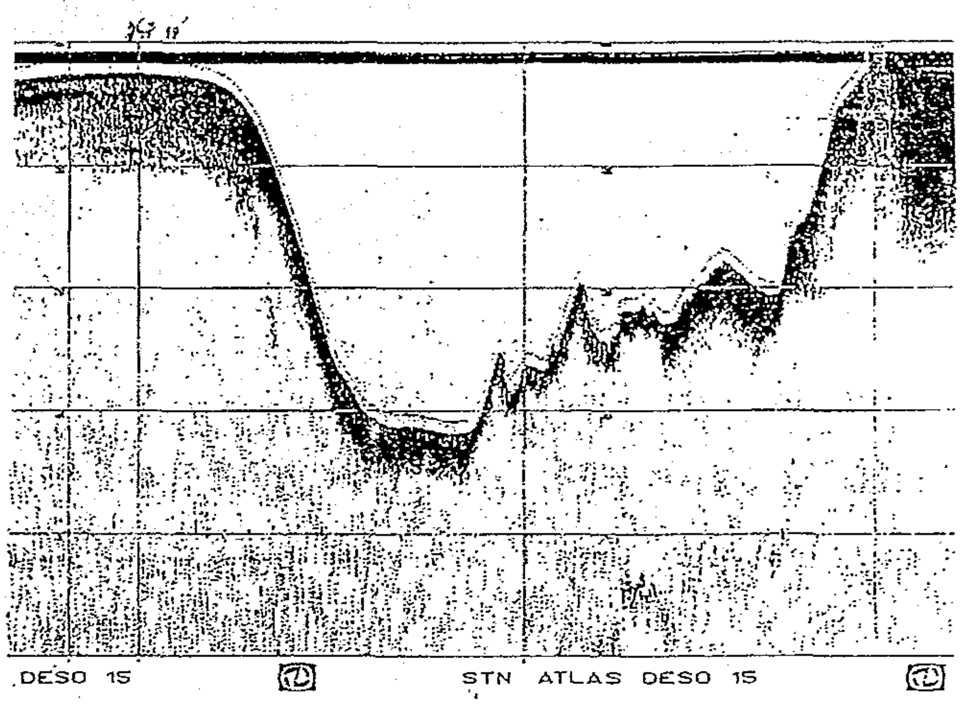


Figure A3.3.1 Current Vectors in Ganh Rai Bay measured during Neap Tide (on 16 in June 2001)
Source: Study Team



(1) Record of the River Profile with Ripples at Cai Mep



(2) Record of the River Profile at the Deepest Section at Cai Mep

Figure A3.3.2 Examples of Sounding Records in Thi Vai River
Source: Study Team

Additional Natural Condition Surveys

The Study Team carried out the following additional natural condition surveys in the two candidate port sites comprising Thi Vai and Lower Cai Mep, and a part of the planned approach channel in the western offshore of the Vung Tau Cape by sub-letting to a local consulting firm.

(i) Topographic survey;
(ii) Bathymetric survey; and
(iii) Geotechnical investigation.

The Survey intends to collect the fundamental data to be utilized mainly for planning and designing of the port and its related facilities to be required in the Feasibility Study, accordingly all the results of the Survey has been especially incorporated in the fields of the design works and the channel dredging study.

Topographic Survey

(1) Topographic Survey Area

A total of some 140 ha topographic survey by cross sectioning method at one hundred (100) m intervals of measuring lines at the port areas, and at fifty (50) m intervals at the access road areas was carried out summarized in Table A3.4.1 below.

Table A3.4.1 Area of Topographic Survey

Site	Thi Vai Site	Lower Cai Mep Site	Total
Port Area	36 ha (800m×450m)	64 ha (800m×800m)	100 ha
Access Road	12.25 ha (1,225m×100m)	28 ha (2,800m×100m)	40.25 ha
Total	48.25 ha	92 ha	140.25 ha

(2) Measurement Equipment

The following measurement equipment were employed:
1) Levels, transits (or theodolites), staff, scales, drawing boards etc.; and
2) Differential global positioning system (DGPS) having accuracy of positioning less than 1 m.

(3) Topographic Map

The results of the topographic survey at the two access road areas were reflected on topographic map with a scale of 1:2,000 each in one drawing of A1 size. And the results of the topographic survey at the two port areas were reflected on topographic and bathymetric maps with a scale of 1:2,000 each in one drawing of A1 size as seen reduced in the size of A4 in Figure A3.2.5 (2) and Figure A3.2.5 (3) included in Appendix to Chapter 3. The map conforms to and contains contour lines at one m intervals and waterline (CDL 0 m level). A total of five (5) maps were constructed to prepare the fundamental design condition.

Bathymetric Survey

(1) Bathymetric Survey Area

A total of 1,363 ha bathymetric survey by cross sectioning method at one hundred (100) m intervals of measuring was carried out as summarized in Table A3.4.2 below.

Table A3.4.2 Area of Bathymetric Survey

Unit: ha

Site	Thi Vai Site	Lower Cai Mep Site	Vung Tau Site	Total
Area	72 ha (1,200m×600m)	91 ha (1,300m×700m)	1,200 ha (2,000m×6,000m)	1,363 ha

(2) Measurement Equipment

The following measurement and analysis devices were employed:

1) Echo sounder(s): Dual frequency type of about 210 kHz and 33 kHz for the sounding;

2) Lead : Leads suitable to measure depths of less than 5 m with an accuracy of 0.01 m;

3) Differential Global Positioning System (DGPS): Accuracy of positioning of less than about 0.5 m;

(3) Drawing of Bathymetric Chart

The results of the bathymetric survey was reflected on bathymetric charts with a scale of 1:10,000 for site of the planned Vung Tau approach channel. The charts at Thi Vai site and Lower Cai Mep site were provided with a scale of 1:2,000, and respectively combined into each one drawing together with the Map. A total of eight (8) charts were constructed to prepare the fundamental design condition.

In this connection, the bathymetric chart covering the whole area of the planned approach channel from the mouth of Ganh Rai Bay to the two planned ports of Lower Cai Mep port and Thi Vai port was constructed based on the several past charts and the results of bathymetric charts which had been prepared in the Phase 1 and the Phase 2 site survey carried out by the Study Team as seen in Figure A3.2.6(1)- Figure A3.2.6(4) which are included in Appendix to Chapter 3.

Geotechnical Investigation

(1) Scope of Work

The Study Team carried out geotechnical investigation with a total of fifteen (15) borings comprising nine (9) under-water boreholes and six (6) on-land boreholes at three (3) sites in the Survey Area, i.e. Thi Vai, Lower Cai Mep and Vung Tau Approach channel. as summarized in Table A3.4.4 below.

Table A3.4.3 List of Boring Logs

Boring No.	Coordinate		Ground Elevation (m)	Drilling Depth (m)	Place of Boring
	X	Y			
Thi Vai Site					
TV-1	612005.563	1169520.500	-12.3	45.0	Under-water
TV-2	612163.762	1169376.183	+1.7	50.0	On-land
TV-3	612394.907	1169.287.648	+1/0	20	On-land
TV-4	612670.526	1169.586.316	+1.7	20	On-land
Lower Cai Mep Site					
CM-1	610563.652	1162337.000	-6.38	56.0	Under-water
CM-2	610612.604	1162642.163	-16.30	50.0	Under-water
CM-3	610778.750	1162387.500	+2.20	50.0	On-land
CM-4	611375.338	1162457.988	-0.90	20.0	On-land
CM-5	612099.125	1163668.644	-0.92	20.0	On-land
Vung Tau Ste (Approach Channel)					
LK-1	609581.356	1155757.468	-9.7	4.0	Under-water
LK-2	615387.290	1142501.503	-13.4	4.0	Under-water
LK-3	615892.890	1140734.010	-13.2	4.0	Under-water
LK-4	616105.212	1139349.950	-9.2	4.0	Under-water
LK-5	616461.904	1138660.974	-11.8	4.0	Under-water
LK-6	618254.371	1138482.820	±0.0	4.0	Under-water

Source: Study Team

The items of geotechnical investigation carried out in the Phase 2, are basically the same as those of the Phase 1, as summarized below.

(a) Standard penetration test (SPT) was made to measure N-value and at the same time sampling of disturbed soil were collected at every one (1) m intervals.
(b) Disturbed samples taken from the split-barrel sampler were visually observed by the experienced expert.
(c) In case cohesive soil layer was found, sampling of four (4) undisturbed soil per boring hole was done at Thi Vai site and Cai Mep site.
(d) The following laboratory tests were carried out:

Disturbed sample: Bulk density, Specific gravity, Grain size analysis, Atterberg limit
Undisturbed sample: Unconfined compression test, Triaxial compression test, CU test, and Consolidation test.

Characteristics of Soil Strata

Location maps of boring holes at Thi Vai site, Lower Cai Mep site and Vung Tau Approach Channel are respectively shown in Figure A3.4.1 (1), (2), (3-1) and (3-2).

And their soil profiles of Thi Vai site, Lower Cai Mep site and Vung Tau Approach Channel are respectively shown in Figure A3.4.2 (1), (2) and (3).

Geotechnical investigation at Thi Vai site and Lower Cai Mep site, aims at collecting the soil properties for defining design soil conditions for the port facilities and its related facilities including soil improvement work to be required in the stage of Feasibility Study. In this regard, the most important subjects are:

- Soil strength and consolidation characteristics, and
- Depth of "bearing layer" for foundation pile structure.

As can be seen, boring holes at Thi Vai site and Lower Cai Mep site, were carried out to provide the design soil conditions, at the points where the wharves and the access roads are to be constructed. As the results, the soil strata can be summarized as follows:

- Thickness of the very soft surface layer (CH) with N-value of less than 3 varies 14.5 m (16 to 34 m in Phase 1 Survey) at Thi Vai site to 30 m (29 to 30 m in the Phase 1 Survey). Of course it changes from place to place.
- Bearing layer for foundation pile structure with N-value more than 50 exists at -43 to -45 m (-46 to -52 m in the Phase 1 Survey)

As seen there is not outstanding difference in the results of soil strata between two phases. Based on the results of geotechnical investigation, the design soil conditions to be applied for the design were established as detailed in Figure 28.1-1 and Figure 28.1-2.

Geotechnical investigation at the Vung Tau approach channel, intends to confirm that whether the hard soil strata i.e. hard rocks exist in water area to be dredged for construction of the planned approach channel. As can be seen in Figure A3.4.2 (3), such rock strata were not found in elevation of -14 m to -16 m which are the planned depths in the planned approach channel.

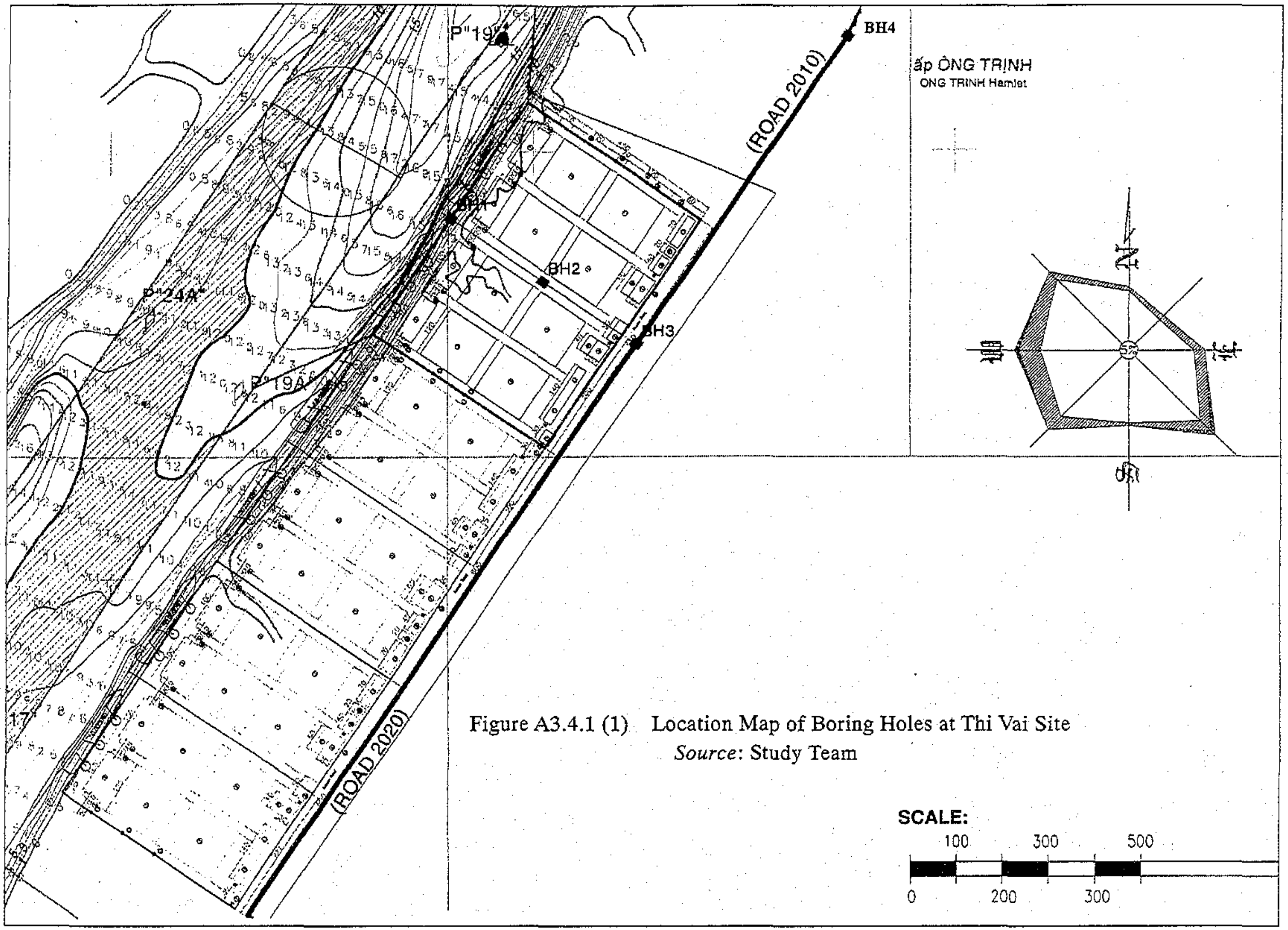


Figure A3.4.1 (1) Location Map of Boring Holes at Thi Vai Site
Source: Study Team

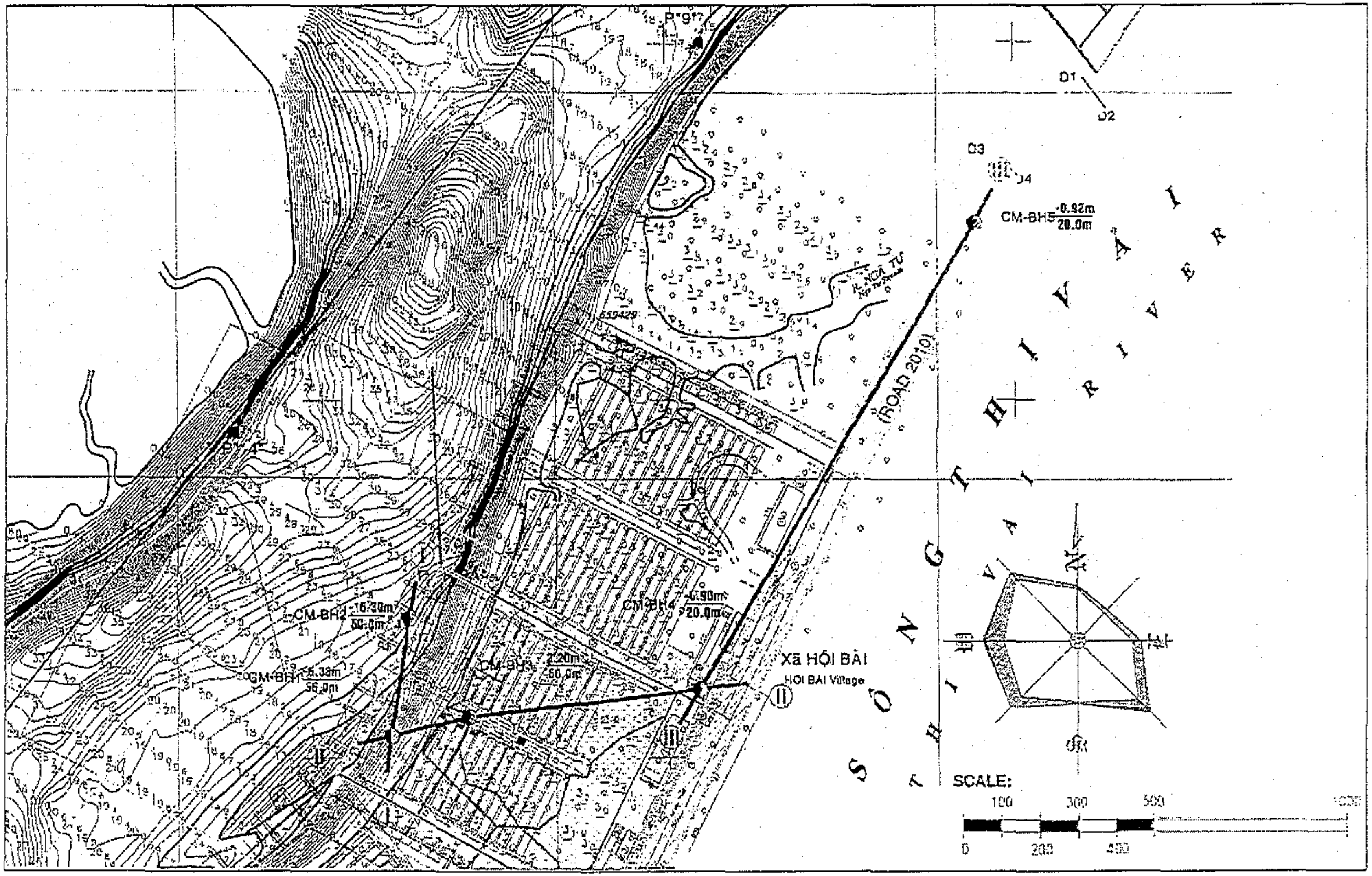


Figure A3.4.1 (2) Location Map of Boring Holes at Lower Cai Mep Site

Source: Study Team

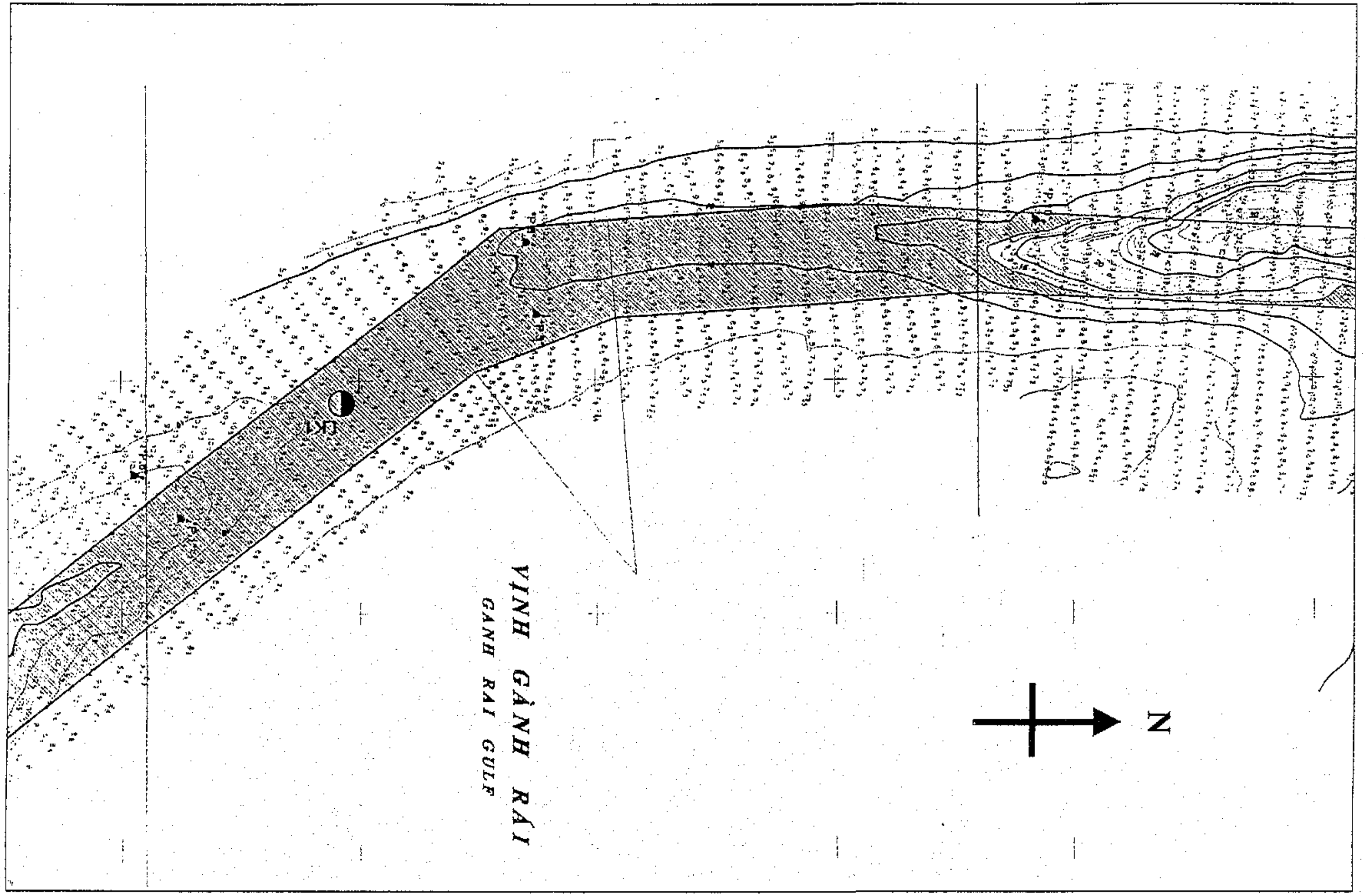


Figure A3.4.1 (3-1) Location Map of Boring Holes at Vung Tau Approach Channel *Source*: Study Team

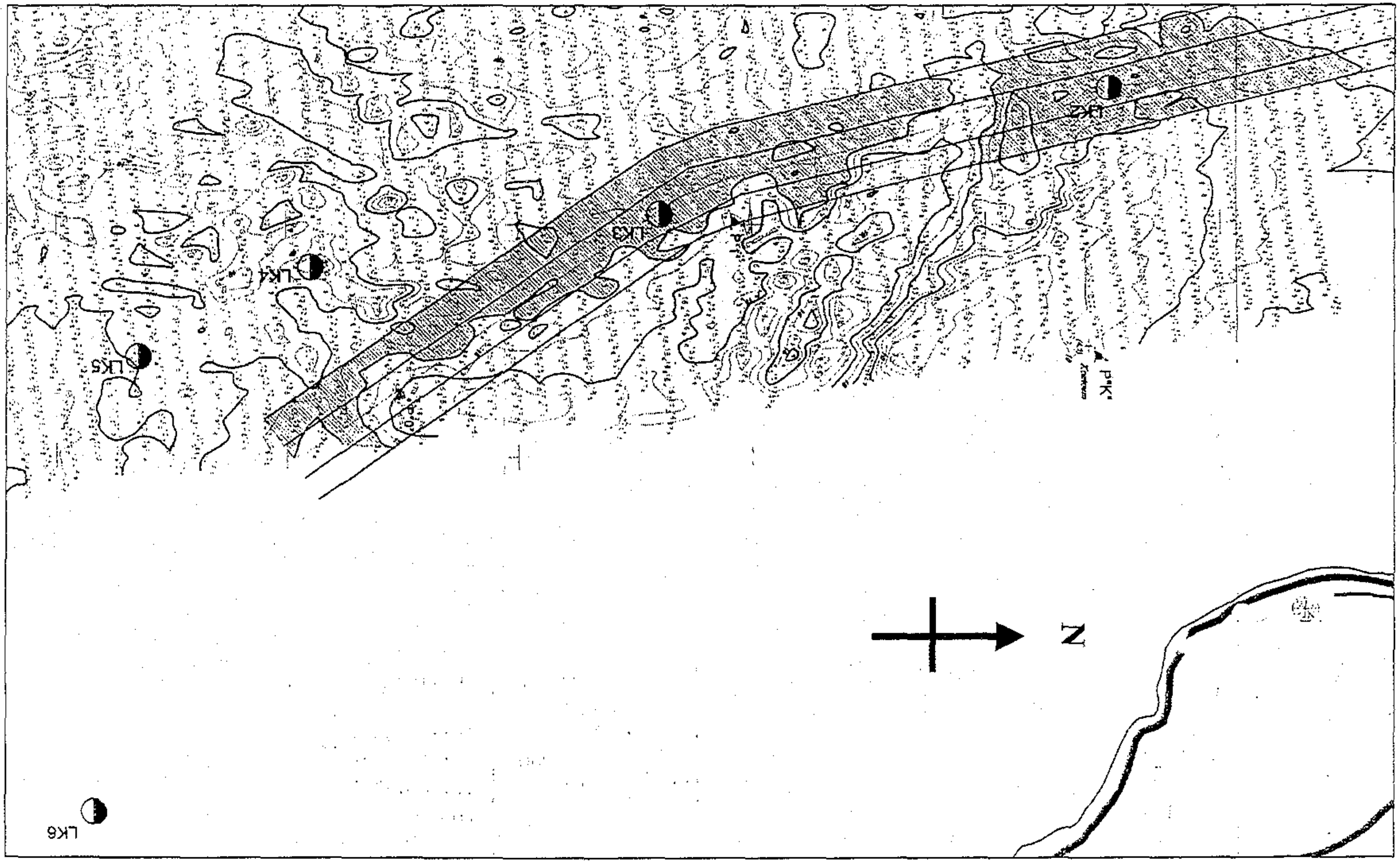


Figure A3.4.1 (3-2) Location Map of Boring Holes at Vung Tau Approach Channel

Source: Study Team

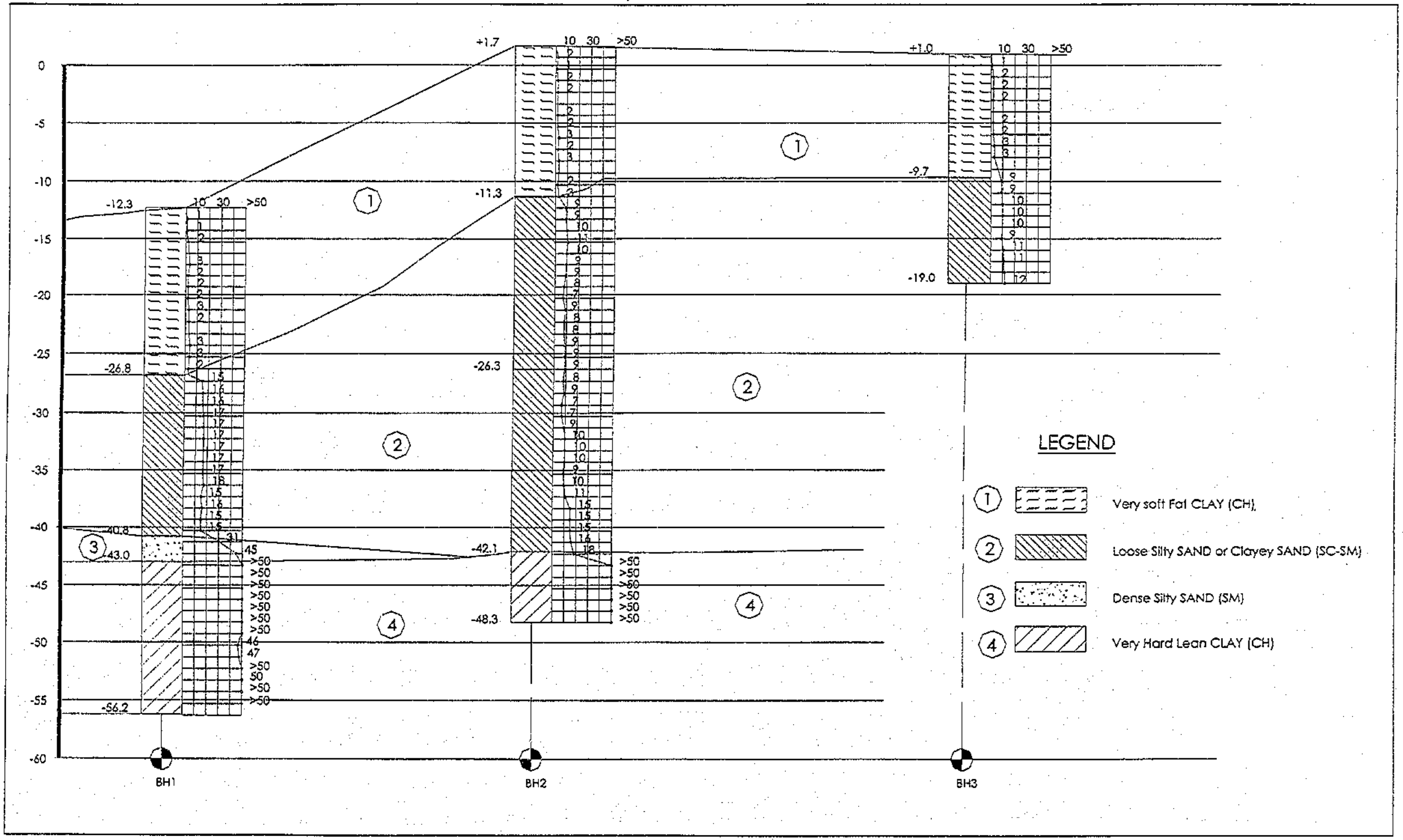


Figure A3.4.2 (1) Soil Profile of Thi Vai Site
Source: Study Team

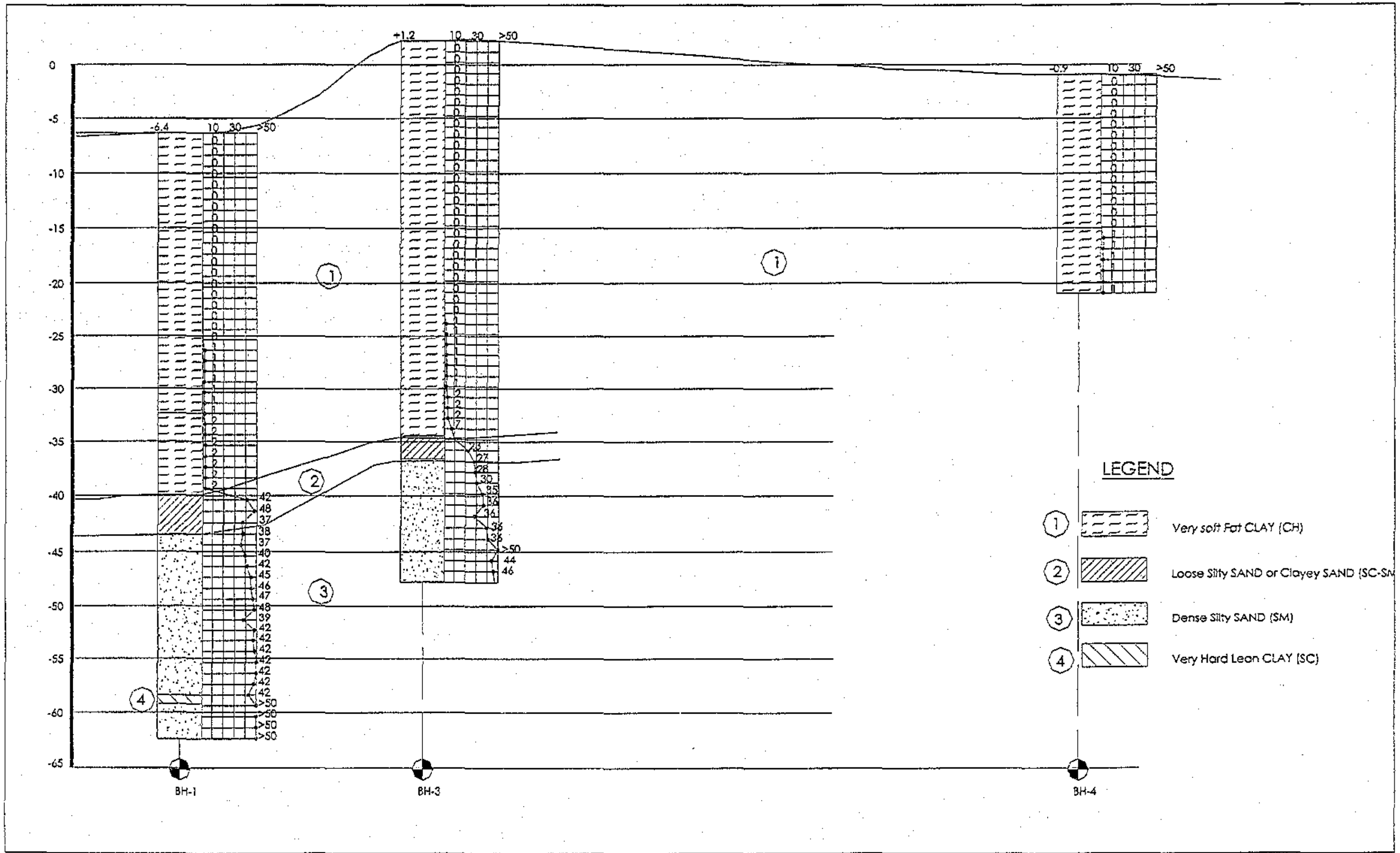


Figure A3.4.2 (2) Soil Profile of Cai Mep Site

Source: Study Team

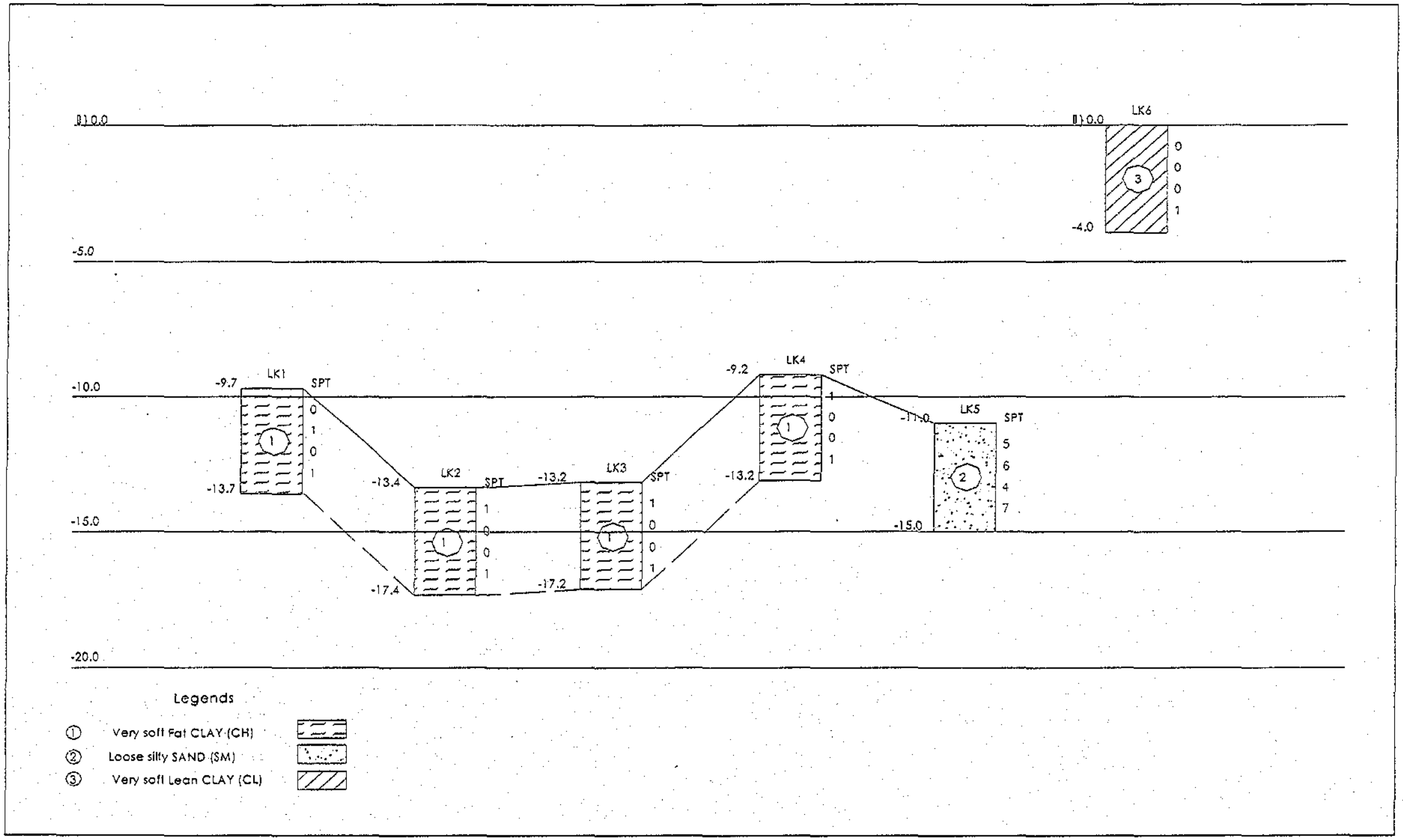


Figure A3.4.2 (3) Soil Profile of Vung Tau Approach Channel

Source: Study Team