MINISTRY OF TRANSPORT
SOCIALIST REPUBLIC OF VIET NAM

THE PREPARATORY SURVEY ON LACH HUYEN PORT INFRASTRUCTURE CONSTRUCTION IN VIET NAM

FINAL REPORT

JULY 2010

JAPAN INTERNATIONAL COOPERATION AGENCY

ORIENTAL CONSULTANTS CO., LTD.

PADECO CO., LTD.

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Exchange Rate (As of March, 2010)
VND 1 = JPY 0.00528
USD 1 = JPY 89.60
(VND 1 = USD 0.000058928 = JPY 0.00528)

PREFACE

In response to the request from the Government of The Socialist Republic of Vietnam, Government of Japan decided to conduct the Preparatory Survey for Lach Huyen Port Infrastructure Construction in The Socialist Republic of Vietnam and entrusted to the study to the Japan International Cooperation Agency (JICA).

JICA selected and dispatched a study team headed by Mr. Nagao Nobuaki of Oriental Consultants co., LTD and consist of Oriental Consultants co., LTD and PADECO co., LTD between Oct 2009 and July 2010.

The team held discussions with the officials concerned of Ministry of Transport and The Vietnam Maritime Administration and conducted field surveys at the study area. Upon returning to Japan, the team conducted further studies and prepared this final report.

I hope that this report will contribute to the enhancement of friendly relationship between our two countries.

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of The Socialist Republic of Vietnam for their close cooperation extended to the study.

July 2010

Kiyofumi Konishi,

Director General
Economic Infrastructure Department
Japan International Cooperation Agency

LETTER OF TRANSMITTAL

July 2010

Mr. Kiyofumi Konishi
Director General
Economic Infrastructure Department
Japan International Cooperation Agency

Dear Mr. Konishi,

It is my great pleasure to submit herewith the Final Report of a Preparatory Survey on Lach Huyen Port Infrastructure Construction in Viet Nam

The study team composed of ORIENTAL CONSULTANTS CO., LTD and PADECO CO., LTD. conducted surveys in the Socialist Republic of Vietnam over the period between October 2009 and May 2010 according to the contract with the Japan International Cooperation Agency (JICA).

The study team compiled this report, which proposes a medium term port development plan for 2020 and an implementation plan as Japan's ODA loan project, through close consultation with officials of the Government of the Socialist Republic of Vietnam and other authorities concerned.

On behalf of the study team, I would like to express my sincere appreciation to the Government of Vietnam and other authorities for their diligent cooperation and assistance and for the heartfelt hospitality, which they extended to the study team during our stay in Vietnam.

I am also very grateful to the Japan International Cooperation Agency, the Ministry of Foreign Affairs of Japan, the Ministry of Land, Infrastructure, Transport and Tourism of Japan, and the Embassy of Japan in the Socialist Republic of Vietnam for giving us valuable suggestions and assistance during the course of the study.

Yours faithfully,

Nobuaki Nagao
Team Leader
The Preparatory Survey
on Lach Huyen Port Infrastructure
Construction in Viet Nam

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LIST OF ABBREVIATIONS

A	AASHTO	American Association of State Highway and Transportation Officials
	ACL	American Container Line, Inc.
	AIDS	Acquired Immune Deficiency Syndrome
	AIS	Automatic Identification System
	ALiCC	Arch action Low improvement ratio Cement Column
	APL	American President Lines
	ADCP	Acoustic Doppler Current Profiler
	ADB	Asian Development Bank
	ASEAN	Association of South East Asian Nations
B	B/C	Cost-Benefit Ratio
	BKK	Bangkok
	BLT	Build - Lease - Transfer
	BOD	Biological Oxygen Demand
	BOO	Build-Operate-Own
	BOR	Berth Occupancy Ratio
	BOT	Build-Operate-Transfer
	BRICs	Brazil, Russia, India and China
	BS	British Standard
	BT	Built – Transfer
	BTO	Build - Transfer - Operate
C	CBR	California Bearing Ratio
	CBTA	Cross Border Transport Agreement
	CD	Chart Datum
	CDL	Chart Datum Level
	CDM	Cement Deep Mixing
	CFS	Container Freight Station
	CHE	Cargo Handling Equipment
	CIF	Cost, Insurance and Freight
	CIQ	Customs, Immigration, Quarantine
	CKYH	Coscon, "K"LINE, Yang Ming, Hanjin Shipping
	CNC	CNC Lines
	COSCO	China Ocean Shipping Company
	COSCON	COSCO Container Lines Co., Ltd
	CSD	Cutter Suction Dredger
	CTP	China-Transpacific Service
	CY	Container Yard
D	DAP	Diammonia Phosphate Fertilizer
	DO	Dissolved Oxygen
	DSCR	Debt Service Coverage Ratio
	DVIZ	Dinh Vu Industrial Zone
	DWT	Deadweight Tonnage
E	ECD	Empty Container Depot
	ECDIS	Electronic Chart Display and Information System
	EHS	Environment, Health and Safety
	EIA	Environmental Impact Assessment
	EIR	Equipment Interchange Receipt
	EIRR	Economic Internal Rate of Return

	EMP	Environmental Management Plan
F	FC	Full Container Ship
	FDI	Foreign Direct Investment
	FEU	Forty-Foot Equivalent Unit
	FIRR	Financial Internal Rate of Return
	FOB	Free On Board
	F/S	Feasibility Study
	FTA	Free Trade Agreement
G	GL	Ground Level
	GOJ	The Government of Japan
	GOV	The Government of Socialist Republic of Viet Nam
	GDP	Gross Domestic Product
	GMS	Greater Mekong Subregion
	GPS	Global Positioning System
	GSO	General Statistics Office of Vietnam
	GT	Gross Tonnage
H	HAPACO	Hai Phong Industrial Zone Joint Stock Company
	HCM	Ho Chi Minh
	HECO	Highway Engineering Consultants
	HHWL	Highest High Water Level
	HIV	Human Immunodeficiency Virus
	HK	Hong Kong
	HP	Haiphong
	HPH	Hutchison Port Holdings
	HWL	High Water Level
	HYMENET	The Center fot Hydrometeorological and Environmental Station Network
I	ICB	Interlocking Concrete Block
	IDC	Interest During Construction
	IMF	International Monetary Fund
	IMO	International Maritime Organization
	IP	Industrial Park
	IZ	Industrial Zone
	IRR	Internal Rate of Return
	ISL	Institute of Shipping Economics and Logistics
	IT	Information Technology
J	JBIC	Japan Bank for International Cooperation
	JBSI	Japan Bridge & Structure Institute, Inc.
	JCC	Joint Coordination Committee
	JETRO	Japan External Trade Organization
	JICA	Japan International Cooperation Agency
	JIS	Japanese Industrial Standards
	JIT	Just in Time
	JOPCA	Japan Overseas Ports Cooperation Association
	JPY	Japanese Yen
	JV	Joint Venture
L	LC	Laem Chabang
	LCP	Laem Chabang Port
	LCL	Less than Container Load

	LED	Light Emitting Diode
	LIBOR	London Interbank Offered Rate
	LLWL	Lowest Low Water Level
	Loa	Length Over All
	LWL	Low Water Level
M	MARPOL	International Convention for the Prevention of Pollution from Ships
	METI	Ministry of Economy, Trade and Industry
	MLWL	Mean Low Water Level
	MOM	Minutes of Meeting
	MONRE	Ministry of Natural Resources and Environment
	MOT	Ministry of Transport
	MOU	Memorandum of Understanding
	MP	Multi Purpose Ship
	MPA	Maritime and Port Authority of Singapore
	MPI	Ministry of Planning and Investment
	MPMU	Major Projects Management Unit
	MSC	Mediterranean Shipping Company S.A.
	MSC No.1	Maritime Safety Company No.1
	MSL	Mean Sea Level
	MWL	Mean Water Level
N	N.A.	Not Applicable
	NCPFP	National Committee for Population and Family Planning
	NK	Nippon Koei Co., Ltd
	NPV	Net Present Value
O	ODA	Official Development Assistance
	OOCL	Orient Overseas Container Line
P	PAB	Project Affected Fishing Boats
	PAH	Project Affected Household
	PAP	Project Affected People
	PAT	The Port Authority of Thailand
	PC	Prestressed Concrete
	PC	The People’s Committee
	PCU	Passenger Car Unit
	PDA	Pile Driving Analyzer
	PHC	Prestressed High-strength Concrete
	PIANC	Permanent International Association of Navigation Congress
	PIL	Pacific International Lines (Pte) Ltd .
	PM	Prime Minister
	PMB	Port Management Body
	PMU	Project Management Unit
	POC	Port Operating Company
	PPP	Public Private Partnership
	PRC	People's Republic of China
	PSA	Port of Singapore Authority
	PTI	Pre Trip Inspection
	PVD	Prefabricated Vertical Drain
Q	QGC	Quay Gantry Crane
R	RAP	Resettlement Assistance Program

	RC	Reinforced Concrete
	RCL	Regional Container Lines
	RO	Rehabilitate – Own
	ROE	Return on Equity
	RORO	Roll-On/Roll-Off ship
	ROT	Rehabilitate - Operate - Transfer
	RTG	Rubber Tyred Gantry (Crane)
S	SAPROF	Special Assistance for Project Formation
	SC	Slot Charter
	SCF	Standard Conversion Factor
	SDVDC	South Dinh Vu Development Joint Stock Company
	SITC	SITC Container Lines Co., Ltd
	SP	Singapore
	SPC	Special-Purpose Company
	SPP	Steel Pipe Pile
	SPT	Standard Penetration Test
	SSPP	Steel Sheet Pipe Pile
	STEP	Special Terms for Economic Partnership
T	TCVN	Vietnam Standards (Tiêu Chuẩn Việt Nam)
	TCXDVN	Vietnamese Construction Standard (Tiêu chuẩn Xây dựng Việt Nam)
	TDSI	Transport Development and Strategy Institute
	TEDI	Transport Engineering Design Incorporated
	TEDIPORT	Port & Waterway Engineering Consultant Joint Stock Company
	TEU	Twenty-foot Equivalent Unit
	TNWA	The New World Alliance
	TSHD	Trailing Suction Hopper Dredger
	TSS	Total Suspended Solids
U	UKC	Under Keel Clearance
	UNCTAD	United Nations Conference on Trade and Development
	UNESCO	United Nations Educational, Scientific and Cultural Organization
	USA	United States of America
	UXO	Unexploded Ordnance
V	VAT	Value-Added Tax
	VHF	Very High Frequency
	VIDIFI	Vietnam Infrastructure Development and Financial Investment
	VINALINES	Vietnam National Shipping Lines
	VINAMARINE	Vietnam National Maritime Bureau
	VINASHIN	Vietnam Shipbuilding Industry Corporation
	VITRANSS	National Transport Development Strategy in the Socialist Republic of Vietnam
	VMS	Vietnam Maritime Safety Agency
	VND	Vietnamese Dong
	VNHC	Vietnam National Hydrographic Center
	VPA	Vietnam Seaports Association
	VTS	Vessel Traffic Service
W	WACC	Weighted Average Cost of Capital
	WB	The World Bank
	WTO	World Trade Organization

Executive Summary

1. Background and Objective of the Study

In the northern region of Viet Nam, maritime cargo traffic volume is likely to increase to 56 million tons in the year 2010, and to 110 – 130 million tons in the year 2020. These figures will exceed the cargo handling capacity of both Hai Phong and Cai Lan ports (total capacity of 75 million tons) located in the northern region. There is an urgent need to boost the cargo handling capacity of ports located in the northern region of Viet Nam.

2. Demand Forecast and Port Development Scale

The estimated container cargo volume are 3.59 million TEU in 2015 and 5.08 million TEU in 2020 and the general cargo and bulk cargo volume are 11.2 million ton in 2015 and 12.9 million ton in 2020 for Northern Vietnam. These cargoes should be shared by Hai Phong port, Cai Lan port and Lach Huyen port. As a result, the container volume and general & bulk cargo volume for Lach Huyen Port are estimated as 2.23 million TEU and 2.38 million ton respectively in 2020.

In order to handle these cargoes in Lach Huyen port in 2020, the **five (5) container berths** (L=375m x 5, D= -14m CDL) and **three (3) multi-purpose berths** (L=250m x 3, D= -13m CDL) need to be constructed.

3. Container Berth No.1 & No.2 Development by 2015

In the frame work of Medium Term Development Plan of Lach Huyen Port for target year of 2020, the first two (2) container berths has been decided to be implemented by VINALINES as a Project Owner by the Prime Minister Decision dated April 11, 2007 and MOT Decision on December 22, 2008. Therefore, this Initial Development Plan for the target year of 2015 is prepared for the first two (2) container berths development and other related port infrastructure development.

The scale and scope of container berths development was reviewed by SAPROF study and following modifications on original plan were proposed:

(1) The design container vessel sizes should be 50,000DWT (full load) and 100,000DWT (partial load) instead of 30,000DWT (full load) and 50,000DWT (partial load).

(2) According to the above modification for vessel sizes, total length of berths No.1 & 2 should be extended from 600m to 750m.

(3) The terminal yard area should be enlarged from 36ha to 45ha.

(4) Quay Gantry Cranes should be large-size one suitable for 100,000DWT container vessels.

(5) Barge berths for domestic waterway traffic should be constructed in the north-eastern part of terminal.

(6) The construction of terminal land reclamation and soil improvement should be carried out by the public sector instead of VINALINES.

4. Cost Estimate for Container Berth No.1 & No.2 Development by 2015

The project cost is summarized in Table 4.1, the breakdown of the cost is shown in Table 4.2, and project cost by year is shown in Table 4.3.

Table 4.1 Summary of the Project Cost

Breakdown of Cost	Foreign Currency Portion (in million JPY)			Local Currency Portion (in million VND)			Total (in million JPY)		
	Total	Public Portion	Others	Total	Public Portion	Others	Total	Public Portion	Others
Package-1	16,473	16,473	0	2,093,062	2,093,062	0	27,525	27,525	0
Package-2	5,555	5,555	0	4,689,474	4,689,474	0	30,315	30,315	0
Price Escalation	2,437	2,437	0	2,742,219	2,742,219	0	16,916	16,916	0
Physical Contingency (5%)	1,223	1,223	0	476,238	476,238	0	3,738	3,738	0
Consulting Service	646	646	0	58,071	58,071	0	952	952	0
Land Acquisition	0	0	0	7,482	0	7,482	40	0	40
Administration Cost	0	0	0	503,327	0	503,327	2,658	0	2,658
VAT	0	0	0	1,504,659	0	1,504,659	7,945	0	7,945
Import Tax	0	0	0	486,526	0	486,526	2,569	0	2,569
Interest during Construction	477	477	0	0	0	0	477	477	0
Commitment Charge	320	320	0	0	0		320	320	0
Total	**27,132**	**27,132**	**0**	**12,561,058**	**10,059,064**	**2,501,994**	**93,454**	**80,244**	**13,211**

Source: SAPROF Team

Table 4.2 Breakdown of the Project Cost

No. Item	Unit	Quantity	Local Currency Portion (in VND)		Foreign Currency Portion (in JPY)		Remarks
			Unit Price	Amount	Unit Price	Amount	
I Construction Expenses							
A Package-1 (Dredging)				***2,093,062,015,200***		***16,473,438,600***	Public Portion
0 Temporary Facility				***34,851,216,000***		***0***	Public Portion
a Temporary Yard	m2	8,000.0	4,356,402	34,851,216,000	0	0	
1 Dredging				***2,058,210,799,200***		***16,473,438,600***	Public Portion
a Access Channel	m3	32,300,860.0	159,300	2,058,210,799,200	850	16,473,438,600	VN40:JP60
b Wharf Slope Dredging	m3	567,514.0	N.A.	0	0	0	*Private Portion*
c Berth Box	m3	54,553.0	N.A.	0	0	0	*Private Portion*
d Between Channel and Berth Box	m3	98,142.0	N.A.	0	0	0	*Private Portion*
B Package-2 (CT, Protection, Public Facilities)				***4,689,474,307,639***		***5,554,726,722***	Public Portion
0 Temporary Facility				***139,404,864,000***		***0***	Public Portion
a Temporary Yard	m2	32,000.0	4,356,402	139,404,864,000	0	0	
1 Container Terminal				***79,073,459,100***		***2,350,001,970***	Public Portion
a Berth Structure	L.S	1.0	N.A.	0	0	0	*Private Portion*
b Earth Retaining Wall	m	750.0	103,054,818	77,291,113,500	3,027,009	2,270,256,750	
c Earth Retaining Wall for Barge Berth	m	180.0	9,901,920	1,782,345,600	443,029	79,745,220	
2 Reclamation				***600,087,179,286***		***0***	Public Portion
a Terminal Area	m3	2,955,483.0	203,042	600,087,179,286	0	0	
3 Port Protection Facilities				***2,473,677,207,710***		***0***	Public Portion
a Inner Revetment	m	750.0	40,162,324	30,121,743,000	0	0	
b Outer Revetment-A	m	720.0	193,692,006	139,458,244,320	0	0	
c Outer Revetment-B	m	2,510.0	198,346,558	497,849,860,580	0	0	
d Training Dike-1	m	3,110.0	119,133,461	370,505,063,710	0	0	
e Training Dike-2	m	3,290.0	307,135,810	1,010,476,814,900	0	0	
f Training Dike-3	m	1,200.0	354,387,901	425,265,481,200	0	0	
4 Soil Improvement				***1,004,710,309,560***		***2,100,315,625***	Public Portion
a Terminal Area	m2	366,625.0	1,261,246	462,404,314,750	4,665	1,710,305,625	
b Barge Berth Area	m2	5,000.0	3,373,909	16,869,545,000	78,002	390,010,000	
c Inner Revetment	m2	4,550.0	2,324,418	10,576,101,900	0	0	
d Outer Revetment A	m2	13,104.0	2,094,872	27,451,202,688	0	0	
e Outer Revetment B	m2	52,459.0	5,019,258	263,305,255,422	0	0	
f Access Road	m2	192,900.0	1,161,762	224,103,889,800	0	0	
5 Access Road behind Port				***62,027,985,000***		***0***	Public Portion
a Access Road	m	1,000.0	62,027,985	62,027,985,000	0	0	
6 Public Related Facilities (CIQ)				***328,503,425,659***		***472,238,250***	Public Portion
a Reclamation	m3	344,131.0	203,042	69,873,046,502	0	0	
b Dredging	m3	103,897.0	223,127	23,182,225,919	0	0	
c Quaywall	m	375.0	237,948,361	89,230,635,375	1,259,302	472,238,250	
d Pavement	m2	40,300.0	1,071,745	43,191,323,500	0	0	
e Building	L.S.	1.0	59,935,258,841	59,935,258,841	0	0	
f Utilities	L.S.	1.0	28,349,124,722	28,349,124,722	0	0	
g Soil Improvement	m2	23,600.0	624,653	14,741,810,800	0	0	
7 Navigational Aids				***1,989,877,324***		***632,170,877***	Public Portion
a New Channel Buoys	nos	20.0	74,547,220	1,490,944,400	28,323,068	566,461,360	
b Relpace Existing Buoy	nos	3.0	97,456,616	292,369,848	0	0	
c Light Beacon	nos	4.0	51,640,769	206,563,076	4,531,691	18,126,764	
d Pilot Assistance System	L.S.	1.0	0	0	47,582,753	47,582,753	
Total Expense				**6,782,536,322,839**		**22,028,165,322**	
II Price Escalation				**2,742,219,111,537**		**2,437,148,434**	Public Portion
III Physical Contingency (5%)				**476,237,771,719**		**1,223,265,688**	Public Portion
IV Consulting Service				**58,071,069,646**		**645,546,327**	Public Portion
V Land Acquisition				**7,481,807,000**		**0**	Other Portion
VI Administration Cost				**503,327,304,137**		**0**	Other Portion
VII VAT				**1,504,658,809,587**		**0**	Other Portion
VIII Import Tax				**486,526,125,823**		**0**	Other Portion
IX Interest during Construction				**0**		**477,285,786**	Public Portion
X Commitment Charge				**0**		**320,230,622**	Public Portion
Total Project Cost				**12,561,058,322,289**		**27,131,642,178**	
(In VND)				17,699,626,916,589			
(In JPY)						93,454,030,120	

Source: SAPROF Team

Table 4.3 Cost by Year

Breakdown of Cost	Total (in million JPY)	Public Portion (in million JPY)	Others (in million JPY)
2010	80	80	0
2011	80	80	0
2012	11,948	10,254	1,694
2013	37,339	31,998	5,341
2014	30,408	26,070	4,338
2015	13,348	11,521	1,827
2016	202	197	5
2017	47	43	5
Total	**93,454**	**80,244**	**13,211**

Source: SAPROF Team

5. Vessel Access Channel

In the original plan, the dimensions of vessel access channel were one way traffic system, 130m in width, -10.3m CDL in depth and 1:10 of side slope, however, SAPROF study recommended following modifications:

5.1 Dimension

a) The width of channel should be 160m for the portion protected by the sand protection dyke and 210m for the portion without sand protection dyke, suitable for 100,000DWT container vessels in accordance with the guidelines of PIANC.

b) The depth of channel should be -14m CDL from initial stage since there is high possibility that mother container vessels more than 50,000DWT (4,000TEU) of international trunk route of Asia – North America (Trans Pacific) will call Lach Huyen Port directly and the international gateway port should be able to accept such mother vessels at any tidal conditions.

5.2 New Navigation Aid

a) Channel buoys should be replaced from the existing floating buoys to Spar Buoys which will not move around like a floating buoy and be able to show exact position.

b) Light beacons should be installed on the sand protection dyke to show the existence of obstacle for fishermen.

c) A pilot assistance system which could display own ship position at real time should be provided to the pilot office.

5.3 Measures against Sedimentation

a) The sand protection dyke should be constructed up to seabed elevation of -5.0m CDL for 7,600m long.

6. Public Related Facilities

The public related facilities such as buildings for Maritime Administration, Customs, Immigration, Quarantine and amenity for port workers, and a mooring facility for service vessels are not included in the scope of Project. However, SAPROF study team recommends these basic public related facilities to be included in the scope of Project.

The proposed scales of public related facilities are ①Land reclamation: 344,000 m3, ②Dredging in front of berth: 104,000 m3, ③Service boats berth: 375m L x 30m W x -4m D, ④Pavement: 121,000 m2, ⑤Buildings: 4,600 m2 and ⑥Utilities and Others: 1 set.

7. Implementation Schedule

GOV wants to complete the construction of container Berth No.1 & 2 by the end of 2014 and commence operation from beginning of 2015, however, considering the standard process and steps necessary for the yen loan agreement, it is estimated that the construction work will commence from middle of the year 2012. As the construction work period is required about 41 months, the port operation can only be started in July 2015.

It should be noted that above implementation schedule is prepared based on the assumption that all procurement process proceeds without any delay.

8. Contract Packages

Considering the required technical qualification for each main work, interface between each work, financial scale of each work, smooth and quick implementation of work, etc., the packaging of contract for the port portion of ODA Project is recommended to be divided into two (2) packages as follows:

- Package 1: Dredging of Navigation Channel
- Package 2: Construction of Container Terminal, Port Protection Facilities and Public Related Facilities.

In addition to above 2 construction packages, the consulting service of construction supervision for both constructions should be added as Package 3.

- Package 3: Consulting Services for Construction Supervision

9. Financial and Economic Analysis

9.1 Financial Analysis

Financial analysis is made in order to confirm 1) the financial viability of public investment portion and 2) the financial affordability of private investment portion. Since the Project is designed as PPP concept, the financial arrangement is intended to fulfill the requirement of both public and private.

Public sector requires the reasonable return to cover the weighted average capital cost (WACC) in long term. 85.9 percent of the project is financed by ODA loan (STEP condition) and 14.1 percent is financed by the budget of the Government of Vietnam. The budget portion should have a reasonable return to cover the opportunity cost of the capital (15%). WACC is calculated as 0.32 percent.

Financial Internal Rate of Return (FIRR) of the public investment in the middle growth case is 1.24 percent, which is above WACC. It is considered that the public investment is financially viable.

Sensitivity analysis indicates that change of capital cost makes bigger impact on FIRR. Attention should be paid to management of the capital cost.

Private sector requires the return on their equity to cover at least the opportunity cost of the capital. 15 percent is considered as the opportunity cost. At the same time, private banks request the enough margins of the available cash to debt service. Average annual debt service coverage ratio (DSCR) should be bigger than 1.5

Return on Equity (ROE) of the private investment in the middle growth case is 16.2 percent, which is above the opportunity cost. Average DSCR for this case is 1.68, which is above 1.5. It is considered that the private investment is financially affordable.

Sensitivity analysis indicates the change of container handling charges makes bigger impact to ROE as well as the impact on public financial return. Attention should be paid to structure of container handling charges as well as sharing mechanism of the profit regarding berth operation.

Table 9.1 Summary of FIRR, ROE, DSCR Sensitivity Analysis

Case		ROE	DSCR	Public FIRR
Container Volume	High Gowth Case	18.2%	1.68	1.33%
	Middle Growth Case (Base Case)	16.2%	1.68	1.24%
	Low Growth Case	14.0%	1.66*	1.11%
Capital Cost	Base Case +10 %	13.3%	1.53	1.21%
	Base Case +5%	14.7%	1.60	1.23%
	Base Case	16.2%	1.68	1.24%
Container Charges	85$	12.8%	1.44*	0.17%
	95 $ for 40 feet (Base Case)	16.2%	1.68	1.24%
	105$	19.5%	1.93	2.15%

*: Less than 1.0 for the first repayment year

9.2 Economic Analysis

1) EIRR Results

EIRR of the base case of the Lach Huyen Port project with Tan Vu-Lach Huyen Highway Project is estimated at 23.9% /annum. The rate exceeds the social discount rate or opportunity cost of capital of 12% in the Vietnam.

Accordingly, it can be concluded that the project is economically feasible.

2) Sensitivity Analysis

In order to examine the feasibility of a project when the given assumptions are changed, the following sensitivity analysis is carried out.

- Project costs increase by 10% and 20%, and
- Project benefits decrease by 10% and 20%

On the results of sensitivity analysis, Lach Huyen Port project can be concluded that the projects are economically feasible, even if the project cost is increased 20% and at same time, the benefits are decreased by 20% from the base case. (See Table 9.2)

Table 9.2 Sensitivity Analysis of EIRR for Medium-tem Development Project in 2020 (5 Container Terminals and 3 Multi Purpose Terminals)

		Benefits		
		Base case	10% down	20% down
Project Cost	Base case	23.9%	21.9%	19.7%
	10% up	21.9%	20.1%	18.1%
	20% up	19.7%	18.6%	16.6%

3) EIRR for Short-term Development Project (2 Container Terminals)

For reference, based on following components, the short-term development project (2 container terminals) is also considered for analyzing of EIRR.

The benefit concept of "With" and "Without" cases are same condition as economic analysis for medium term project. The cargo handling capacities of 2 container terminals are assumed 890,000TEU per year. And the period of calculation for the economic analysis (project life) is assumed to be 30 years (2015-2046) after the completion of short-term port development project implementation.

EIRR for the Short-term Project (2 Container Terminals) is estimated at 14.3%/annum. Therefore, the project is economically feasible for both short-term and medium-term development project

Table 9.3 Sensitivity Analysis of EIRR for Short-term Development Project (2 Container Terminals)

		Benefits		
		Base case	10% down	20% down
Project Cost	Base case	14.3%	12.8%	11.1%
	10% up	12.8%	11.4%	9.9%
	20% up	11.1%	10.3%	8.8%

10. Port Management Unit (PMU)

It is strongly advisable to enhance and improve port management capability that is essential for accomplishing a sustainable development of Lach Huyen Port .In dealing with a lack of effective port management system in the current administrative framework and looking for great growth opportunities of the Lack Huyen port, a Port Management Unit (PMU) which will bear broader responsibilities and duties over port operations is recommended to be set up under the supervision of VINAMARINE.

11. Detailed Design Stage

In addition to ordinary scope of Detailed Design, following issues are recommended to be studied and surveyed.

11.1 Dredged Material Dumping Site

At present the dumping site for dredged material is planned in South Dinh Vu area because this area is nearest candidate site among the dumping sites already approved by Hai Phong P.C. in EIA report. However this dumping site requires constructing a temporary dyke which is very costly and the dumped soil land shall be improved with huge cost before using there for IZ development since the dredged material is not suitable for reclamation.

Comparing with south Dinh Vu site, the future expansion site of Lach Huyen Port or Lach Huyen offshore area will be better candidate sites from the viewpoint of saving dredging cost. Therefore, it is recommendable to conduct EIA study for these sites and getting approval from authorities concerned before bidding for selection of dredging contractor.

11.2 Ship Maneuvering Simulation

This Lach Huyen Channel is one way, width of 160m with sand protection dyke and 210m without sand protection dyke and length of approx. 18 km. For the partial loaded 100,000DWT container vessel, the navigation in this channel is not easy when marine conditions and climate conditions are not favorable. In order to know the limit natural conditions and suitable tug assistance, therefore, the ship maneuvering simulation is recommended to be conducted during detailed design stage.

12. Construction Stage

12.1 Maintenance Dredging Plan

In order to establish a reliable maintenance dredging plan, check surveys on actual sedimentation phenomena and marine conditions should be carried out at every three (3) months during capital dredging period and mathematical sedimentation analysis should be conducted by the Consultant.

13. Operation Stage

13.1 Operation and Efficiency Indicators

In order to evaluate the efficient utilization of the facilities constructed in this ODA Project, following operation and efficiency indicators should be checked in 2017, after 2 years from the commencement of Lach Huyen Port operation.

Table 13.1 Performance Guidelines

	Measuring Item	Guideline
1	Berth Occupancy Rate	30%
2	Container Dwell Time	6 Days
3	Throughput	500,000TEU in 2016 750,000TEU in 2020
4	Maximum DWT of Vessels Docked at Berth One and Two	More than 50,000DWT vessels

14. Natural and Social Environment Consideration

14.1 Natural Environment

1) Baseline Environmental Condition Surveys in Preparation Stage of the Project

The baseline environmental surveys done at the project site and its surroundings are regarded as adequate as the minimum requirement for the purpose of the approved EIA Report (2008). Still the important limitation of the survey is that it was done only once (in May 2006) and hence cannot be regarded as fully representative to account for seasonal variation. Accordingly, during the detailed engineering stage ecosystem surveys with at-least 2 times of sampling as appropriate to account for the 2 predominant dry and rainy seasons is recommended.

2) Significant Aspects of Construction Stage of the Project

The construction contractor shall fully comply with EHS (environment, health and safety) aspects concerned to the execution of construction works with strictly adhering the concept of "Safety First". The contractor shall ensure all natural resources required for the construction of port such as sand, soil and stones are procured from legally certified suppliers. Moreover, the contractor shall be obligated to use the service of an independent reputed organization to conduct regular periodical environmental monitoring of the construction site and its vicinity that would cover ambient environment of on-land area (Cat Hai Island) and coastal water environment (Lach Huyen Estuary).

3) Significant aspects of operation stage of the project

The port shall be equipped with operational waste reception, treatment and disposal facilities as appropriate to manage all wastes generated both due direct port operation and wastes disposed by ships and vessels. Moreover, an emergency management system to effectively deal with potential emergency situation like accidents, fires and oil spills shall be in place with capability to activation at short notice. Port operational agency shall be obligated to conduct regular periodical environmental monitoring with priority focus on the estuarine coastal water environment.

14.2 Social Environment

1) Significant Aspects of Preparation Stage of the Project

Land acquisition and safeguard policy for coastal fishing activities are two primary social impacts to be addressed. The project requires acquiring clearance of some aquaculture ponds, which requires support for the livelihood recovery of the affected people. As there are some gap between JBIC Guideline/WB OP 4.12 and Vietnamese safeguard policy, it is recommendable to refer the resettlement policy framework (RPF) of "Northern Delta Transport Development Project", which is ongoing project by MOT supported by the World Bank.

The safeguard policy should cover the safeguard measures for potentially affected coastal fishermen. It is not necessary to compensate by money but support for livelihood recovery or vocational training for job transfer.

2) Significant Aspects of Construction Stage of the Project

Considering the labor safety, proper training and management is essential. As the responsible agency for the project implementation, MPMU II shall include the supervisory mechanism to ensure the contractor's EHS training and enforcement on the ground in the EMP.

As for the control of the transmittable diseases, proper supervision and collaboration with contractors for the health care training are recommendable.

In order to maintain the affordability of goods for the local communities, it is recommendable to monitor the price indexes and affordability/income level of the local communities. Such monitoring result shall be shared among MPMU II and local authorities to consider necessary measures if it is necessary.

Due to no requirement for the residential resettlement, follow-up for livelihood support should be focused. Although MPMU II is not responsible for the implementation of the safeguard policy, it is recommendable to include a mechanism to check the appropriate implementation of such policy in EMP.

In order to monitor unexpected negative impacts on fishing communities, it is recommendable to conduct periodical sample survey including the fish yield and income level of the project affected fishermen. In the case of necessity to improve the safeguard policy for the coastal fishing, MPMU II shall coordinate responsible authorities to improve the modified policy.

3) Significant aspects of operation stage of the project

As a part of environmental management plan (EMP) and responsibility of the implementation agency, MPMU II shall supervise VINALINE and other private operators to ensure the EMP including the proper implementation and follow-up of the safe guard policies.

PART – 1

Necessity and Background of the Project

1. Introduction

1.1 Background of the Preparatory Survey

In the northern region of Viet Nam, maritime cargo traffic volume is likely to increase to 56 million tons in the year 2010, and to 110 – 130 million tons in the year 2020. These figures will exceed the cargo handling capacity of both Hai Phong and Cai Lan ports (total capacity of 75 million tons) located in the northern region. There is an urgent need to boost the cargo handling capacity of ports located in the northern region of Viet Nam.

Facing this situation, the Government of Socialist Republic of Viet Nam (hereinafter referred to as "GOV") directed Transport Engineering Design Incorporated (hereinafter referred to as "TEDI") to make a feasibility study on Lach Huyen Port Infrastructure Construction Project (hereinafter referred to as "the Project") located in the northern region of Viet Nam. Based on the result of the feasibility study, GOV has requested the Government of Japan (hereinafter referred to as "GOJ") to provide yen loan to the Project in order to enforce the development plan proposed in its feasibility study stage. In accordance with this request, the Japan International Cooperation Agency (hereinafter referred to as "JICA") dispatched a mission on the Project (hereinafter referred to as "the JICA Mission") to Viet Nam from July 20 to 23, 2009 in order to develop scope and implementing arrangements of a further survey which will review the currently available data and conduct supplementary study to facilitate formation of the Project (hereinafter referred to as "the Preparatory Survey"). Based on this preliminary survey, the scope and implementing arrangements of the Preparatory Survey were settled and signed by JICA, Ministry of Transports and Vietnam National Shipping Lines (hereinafter referred to as "VINALINES").

The Project is comprised of developments of port and its access road and bridge. Although it is considered essential that both components are implemented in an integrated manner, the Preparatory Surveys for them are conducted by different survey teams. Since this report mainly describes the port portion, for detailed information of the access road and bridge, refer to the report prepared by another Preparatory Survey team.

1.2 Objectives of the Preparatory Survey

The principal objectives of the Preparatory Survey are to examine the existing feasibility study on port development plans including the Hai Phong – Lach Huyen International Gateway Port development plan from a technical and a financial as well as a natural and social environmental standpoint, and refine the implementation plan of the future development plan of Lach Huyen Port Infrastructure Construction Project.

1.3 Survey Area

The Preparatory Survey shall cover the area of Hai Phong – Lach Huyen International Gateway Port as shown in Figure 1.3.1.

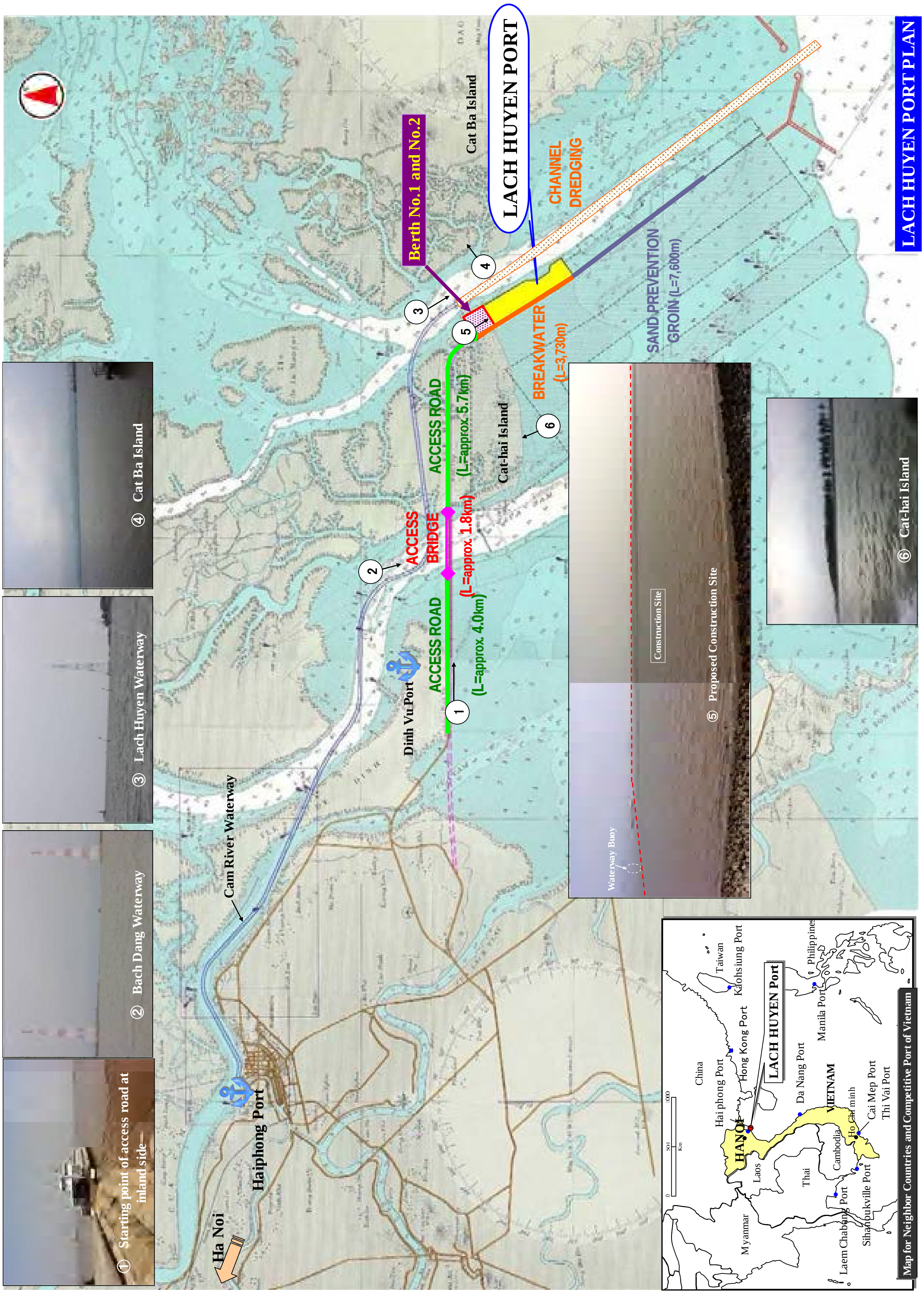


Figure 1.3.1 Survey Area

1.4 Survey Schedule

The Preparatory Survey commenced immediately following the agreement on the inception report. Detailed Survey schedule is shown in Figure 1.4.1.

TIME		TASK	REPORTS
October 2009 October 2009		**Preparatory Work in Japan** ★Collection & analysis of existing data / information ★Preparation of Inception Report & Questionnaires	
October 2009 Nobember 2009	PHASE-1	**1st Work in Viet Nam** ★Presentation / Discussion of Inception Report ★Existing Data Collection and Analysis ★Socio-economic Situation of Vietnam and Surrounding Region ★Situation of Distribution of Goods and Ocean Shipping in Vietnam and Surrounding Region ★Present Situation of Ports in Northern Vietnam and Surrounding Region ★Past Port Development Plans in Northern Vietnam and Lach Huyen Port ★Demand Forecast (Target Year 2020) ★Collection of Existing Natural Condition Data and Execution of Additional Investigation ★Assessment of the Existing Simulation Data on Sedimentation and Execution of Further Study ★Review of Natural and Social Environmental Assessment Study and Conduct Further Study	**Inception Report**
November 2009 January 2010	PHASE-2	★The Scale of Medium Term Port Development Plan ★Port Layout Plan ★Access from Land to the Port ★Conceptual Design and Cost Estimates ★Consideration on Natural and Social Environment	
January 2010 January 2010	PHASE-2	**1st Work in Japan** ★Preparation of Interim Report	
February 2010 March 2010 April 2010	PHASE-3	**2nd Work in Viet Nam** ★Presentation / Discussion of Interim Report ★Recommendation of Suitable Project Scope ★Establishment of Basic Design Conditions ★Basic Design of Port Structures, Cargo handling Equipment and Related Facilities ★Construction Plan ★Project Cost Estimates ★Project Implementation Schedule ★Organizational Structure for Project Implementation ★Financial Condition of Executing Agency and Financial Implementation Plan ★Recommendation of Appropriate Contract Packages ★Financial Analysis of Container Terminal ★Economic Analysis of Whole Project ★Operation and Effective Indicators ★Recommendation for Suitable and Effective Collaboration between Public and Private ★Operation and Management Organization ★Mitigation Measures for Natural and Social Environmental Aspects ★Navigational Safety and Vessel Traffic Control	**Interim Report**
April 2010 April 2010	PHASE-3	**2nd Work in Japan** ★Preparation of Draft Final Report	
May 2010 May 2010	PHASE-3	**3rd Work in Viet Nam** ★Presentation / Discussion of Draft Final Report	**Draft Final Report**
June 2010 June 2010		**Final Work in Japan** ★Finalization and Submission of Final Report	**Final Report**

Figure 1.4.1 Survey Schedule

2. Socio – Economic Background Information

2.1 General

2.1.1 Population

According to the preliminary results of census April 1, 2009, the population of Vietnam is estimated as 85,789,573. Vietnam is divided into 58 provinces and there are also 5 centrally-controlled municipalities existing at the same level as provinces. Ho Chi Minh City is the biggest municipality with population of 7,123,000 and followed by Hanoi (6,449,000) as shown in Table 2.1.1.

Table 2.1.1 Average Population by Region and Province

Region	Provinces	Population (1 April 2009)	Region	Provinces	Population (1 April 2009)
Whole Vietnam		**85,789,573**	Central Highlands 5,107,437	Daklak	1,728,380
Red River Delta 18,433,563	Bắc Ninh	1,024,151		Dak Nông	489,442
	Hà Nam	785,057		Gia Lai	1,272,792
	Hải Dương	1,703,492		Kontum	430,037
	Hưng Yên	1,128,702		Lâm Đồng	1,186,786
	Nam Định	1,825,771	South Central Coast 7,028,570	Bình Định	1,485,943
	Ninh Bình	898,459		Khánh Hòa	1,156,903
	Thái Bình	1,780,954		Phú Yên	861,993
	Vĩnh Phúc	1,000,838		Quảng Nam	1,419,503
	Hà Nội *	6,448,837		Quảng Ngãi	1,217,159
	Hải Phòng *	1,837,302		Đà Nẵng *	887,069
North Central Coast 10,073,336	Hà Tĩnh	1,227,554	Southeast 15,758,966	Bà Rịa-Vũng Tàu	994,837
	Nghệ An	2,913,055		Bình Dương	1,482,636
	Quảng Bình	846,924		Bình Phước	874,961
	Quảng Trị	597,985		Bình Thuận	1,169,450
	Thanh Hoá	3,400,239		Đồng Nai	2,483,211
	Thừa Thiên-Huế	1,087,579		Ninh Thuận	564,129
Northeast 9,480,044	Bắc Giang	1,555,720		Tây Ninh	1,066,402
	Bắc Kạn	294,660		Hồ Chí Minh City *	7,123,340
	Cao Bằng	510,884	Mekong River Delta 17,178,871	An Giang	2,144,772
	Hà Giang	724,353		Bạc Liêu	856,250
	Lạng Sơn	731,887		Bến Tre	1,254,589
	Lào Cai	613,075		Cà Mau	1,205,108
	Phú Thọ	1,313,926		Đồng Tháp	1,665,420
	Quảng Ninh	1,144,381		Hậu Giang	756,625
	Thái Nguyên	1,124,786		Kiên Giang	1,683,149
	Tuyên Quang	725,467		Long An	1,436,914
	Yên Bái	740,905		Sóc Trăng	1,289,441
Northwest 2,728,786	Điện Biên	491,046		Tiền Giang	1,670,216
	Hoà Bình	786,964		Trà Vinh	1,000,933
	Lai Châu	370,135		Vĩnh Long	1,028,365
	Sơn La	1,080,641		Cần Thơ *	1,187,089

Source: The 2009 Vietnam population and housing census, Preliminary result, GSO
Note: *: municipality

The Vietnam categorizes the various provinces into eight regions. The Red River Delta comprising of 10 provinces is the most populated region (18,433,563), followed by Mekong River Delta (17,178,871). The Red River Delta and the Mekong River Delta are the regions containing the deltas of the two large rivers, where fertile land and favorable conditions for agricultural cultivation are located. These two regions share 41.5% of the country's population.

On the other hand, the population density in the Red River Delta is also the highest (1,232 people/km^2) and followed by the Southeast (453 people/km^2) and then the Mekong River Delta (423 people/km^2). The national average population density is 259 people/km^2, and the least populated region is the Northwest (72.9/km^2). Figure 2.1.1 illustrates the regions of Vietnam and their population densities.

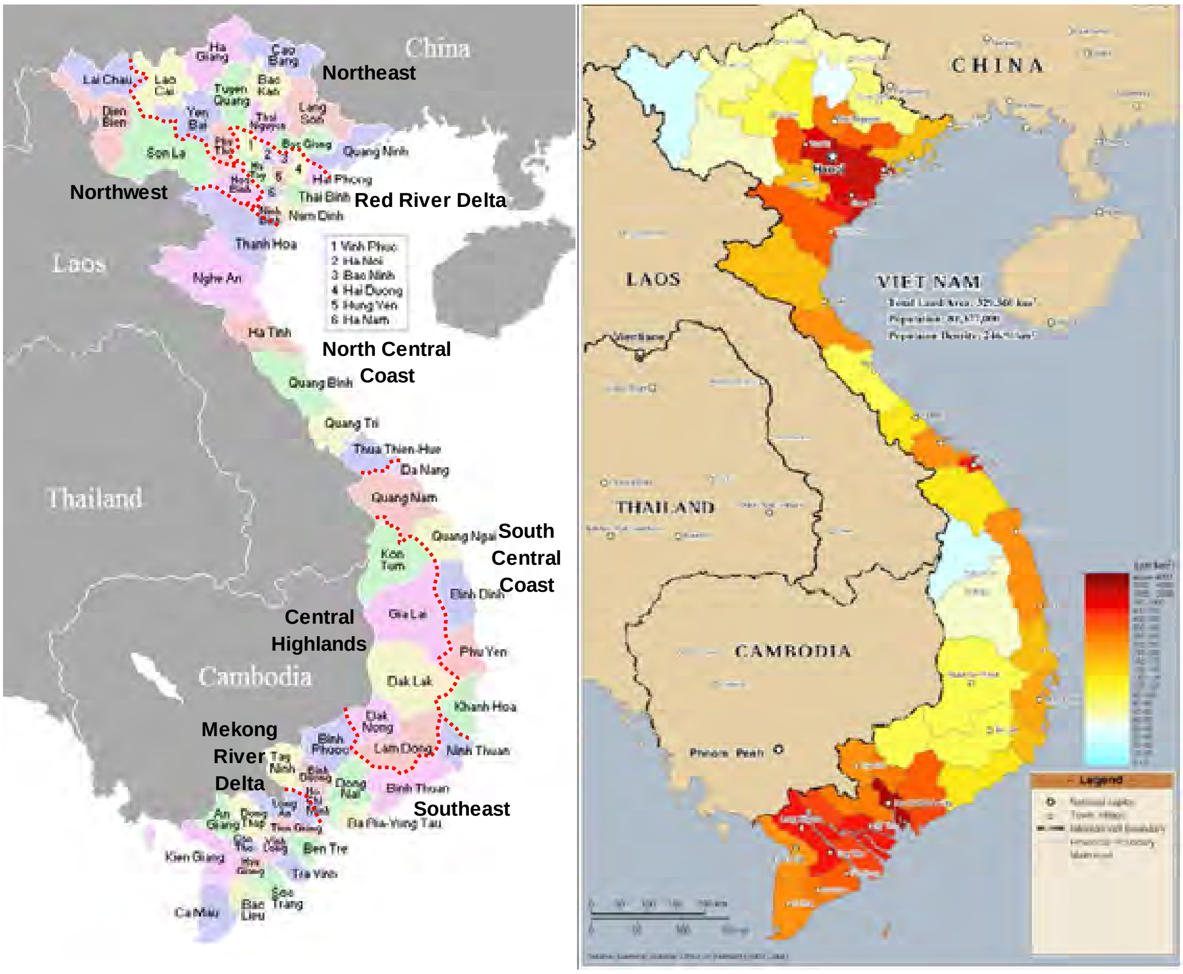


Figure 2.1.1 Regions and Population Density

Source: GSO and Wikipedia, modified by JICA Study Team

According to the National Committee for Population and Family Planning (NCPFP), it is estimated that the annual population growth rate for the period from 2010 through 2020 is 1.3%. With this growth rate, the populations are estimated as 92.9 million in 2015, 99.3 million in 2020. Moreover, average population by region is forecast for 8 regions up to the year 2020 as shown in the Table 2.1.2.

2.1.2 Economic Indices

Actual GDPs of Viet Nam, Asian countries and USA since 2000 and their forecasts by IMF are shown in Figure 2.1.2. From 2004 to 2007, annual GDP growth rate in Viet Nam rose to over 8%, and then slowed down to 6.2% in 2008. Figure 2.1.2 clearly indicates the impact of global financial crisis on each country's GDP in the years of 2008 and 2009. After 2009, the GDPs growth rates are estimated to recover from the year 2010.Table 2.1.3 indicates the GDP's forecast by IMF, ADB, the World Bank (WB) and the Ministry of Planning and Investment (MPI).

In the international donor agency's forecast, only Viet Nam, China, India and Indonesia is estimated more than 4% of GDP growth rate in 2009. Ministry of Planning and Investment (MPI) in Viet Nam is assumed for GDP growth rate in 2010-2020 as 6.5% for sustainable growth of GDP and 7.5% for high level of GDP.

Table 2.1.2 Average Population by Region

Region	Actual Data	Forecast		
	2009	2010	2015	2020
Red River Delta	**18,433.6**	**18,691.6**	**20,037.2**	**21,479.6**
Growth Rate		*1.4%*	*1.4%*	*1.4%*
Northeast	**9,480.0**	**9,555.9**	**9,944.3**	**10,348.5**
Growth Rate		*0.8%*	*0.8%*	*0.8%*
Northwest	**2,728.8**	**2,769.7**	**2,983.8**	**3,214.4**
Growth Rate		*1.5%*	*1.5%*	*1.5%*
North Central Coast	**10,073.3**	**10,174.1**	**10,693.0**	**11,238.5**
Growth Rate		*1.0%*	*1.0%*	*1.0%*
South Central Coast	**7,028.6**	**7,112.9**	**7,550.1**	**8,014.1**
Growth Rate		*1.2%*	*1.2%*	*1.2%*
Central Highlands	**5,107.4**	**5,184.0**	**5,584.7**	**6,016.3**
Growth Rate		*1.5%*	*1.5%*	*1.5%*
Southeast	**15,759.0**	**16,105.7**	**17,957.0**	**20,021.1**
Growth Rate		*2.2%*	*2.2%*	*2.2%*
Mekong River Delta	**17,178.9**	**17,333.5**	**18,127.7**	**18,958.2**
Growth Rate		*0.9%*	*0.9%*	*0.9%*
WHOLE COUNTRY	**85,789.6**	**86,927.4**	**92,877.7**	**99,290.6**
Growth Rate		1.3%	1.3%	1.3%

Source: Future growth rates were estimated by NCPFP and 2009 data is actual data on census April 1, 2009

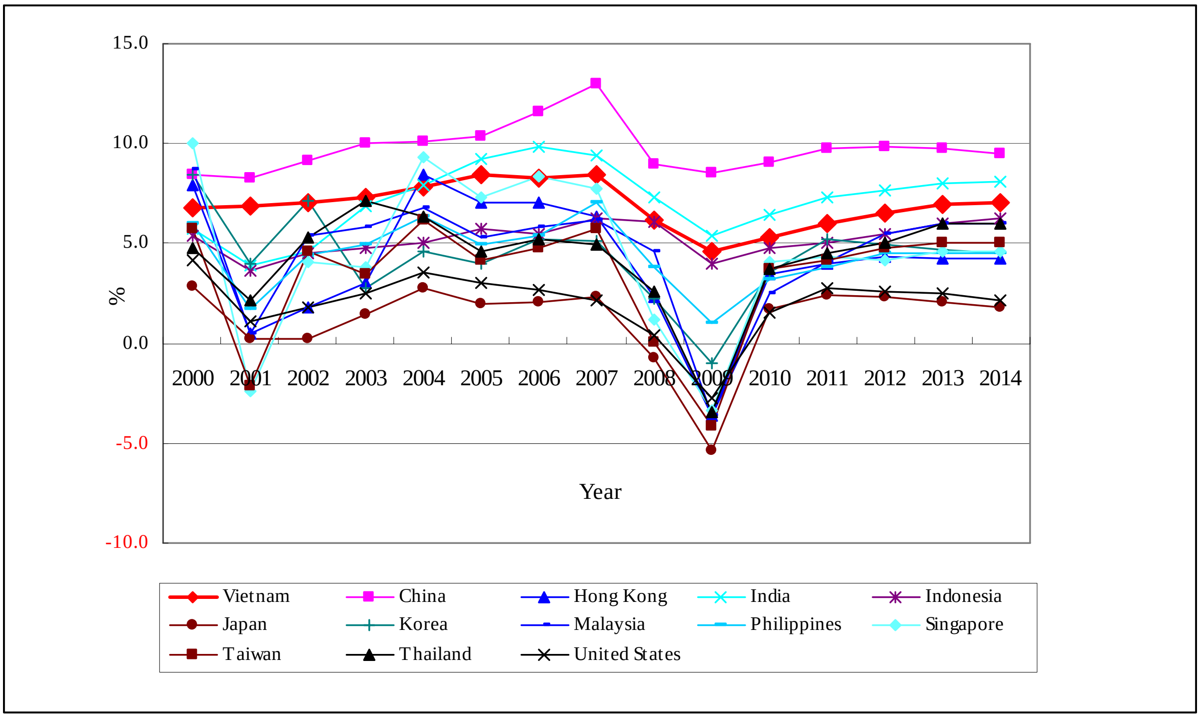


Figure 2.1.2 Actual GDP Growth Rates and IMF's Forecast in Vietnam, Asian Countries/USA

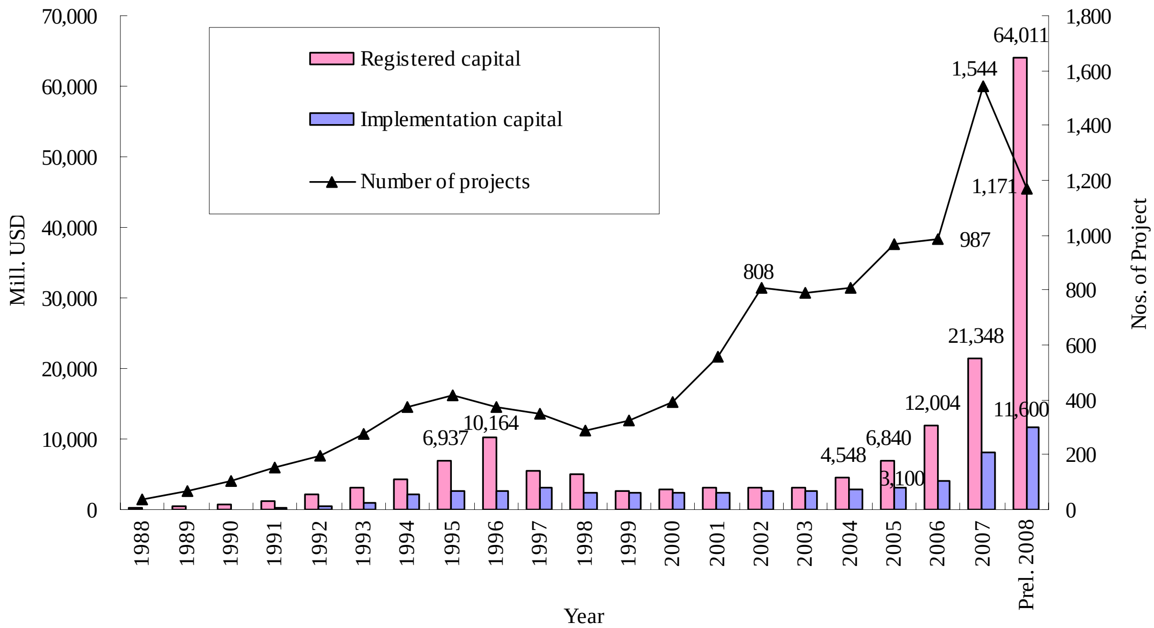
Table 2.1.3 GDP Growth Rate of Viet Nam, Asian Countries/USA by Year

Country \ Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	Forecast by	2009	2010	2011	2012	2013	2014
Vietnam	6.8	6.9	7.1	7.3	7.8	8.4	8.2	8.5	6.2	IMF	4.6	5.3	6.0	6.5	7.0	7.0
										ADB	4.7	6.5				
										WB	**5.5**	5.0	7.0			
										MPI	5-5.5%	6.5% for 2010-2020				
China	8.4	8.3	9.1	10.0	10.1	10.4	11.6	13.0	9.0	IMF	8.5	9.0	9.7	9.8	9.8	9.5
										ADB	8.2	8.9				
										WB	6.5	8.3	7.2			
Hong Kong	8.0	0.5	1.8	3.0	8.5	7.1	7.0	6.4	2.4	IMF	-3.6	3.5	4.0	4.3	4.3	4.3
										ADB	-4.0	3.0				
India	5.7	3.9	4.6	6.9	7.9	9.2	9.8	9.4	7.3	IMF	5.4	6.4	7.3	7.6	8.0	8.1
										ADB	6.0	7.0				
										WB	5.9	8.1	8.5			
Indonesia	5.4	3.6	4.5	4.8	5.0	5.7	5.5	6.3	6.1	IMF	4.0	4.8	5.0	5.5	6.0	6.3
										ADB	4.3	5.4				
										WB	3.5	5.0	6.0			
Japan	2.9	0.2	0.3	1.4	2.7	1.9	2.0	2.3	-0.7	IMF	-5.4	1.7	2.4	2.3	2.0	1.8
										WB	-6.8	1.0	2.0			
Korea	8.5	4.0	7.2	2.8	4.6	4.0	5.2	5.1	2.2	IMF	-1.0	3.6	5.2	5.0	4.7	4.5
										ADB	-2.0	4.0				
Malaysia	8.7	0.5	5.4	5.8	6.8	5.3	5.8	6.2	4.6	IMF	-3.6	2.5	4.1	5.5	6.0	6.0
										ADB	-3.1	4.2				
										WB	-4.4	2.2	5.3			
Philippines	6.0	1.8	4.4	4.9	6.4	5.0	5.3	7.1	3.8	IMF	1.0	3.2	3.8	4.5	4.5	4.5
										ADB	1.6	3.3				
										WB	-0.5	2.4	4.5			
Singapore	10.1	-2.4	4.1	3.8	9.3	7.3	8.4	7.8	1.1	IMF	-3.3	4.1	4.3	4.2	4.6	4.6
										ADB	-5.0	3.5				
Taiwan	5.8	-2.2	4.6	3.5	6.2	4.2	4.8	5.7	0.1	IMF	-4.1	3.7	4.2	4.8	5.0	5.0
										ADB	-4.9	2.4				
Thailand	4.8	2.2	5.3	7.1	6.3	4.6	5.2	4.9	2.6	IMF	-3.5	3.7	4.5	5.0	6.0	6.0
										ADB	-3.2	3.0				
										WB	-3.2	2.2	3.1			
United States	4.1	1.1	1.8	2.5	3.6	3.1	2.7	2.1	0.4	IMF	-2.7	1.5	2.8	2.6	2.5	2.1
										WB	-3.0	1.8	2.5			

Source: IMF (International Monetary Fund), World Economic Outlook Database, October 2009
ADB (Asia Development Bank), Asian Development Outlook 2009 Update, Sep 2009
WB (World Bank), Global Development Finance, May 2009. But 2009's GDP 5.5% in Vietnam, WB updated 4 Nov 2
MPI (Ministry of Planning and Investment) , 2009 GDP forecast was announced by 7th plenary session of National Assembly's Economic Committee, May 2009

2.1.3 Foreign Direct Investment (FDI)

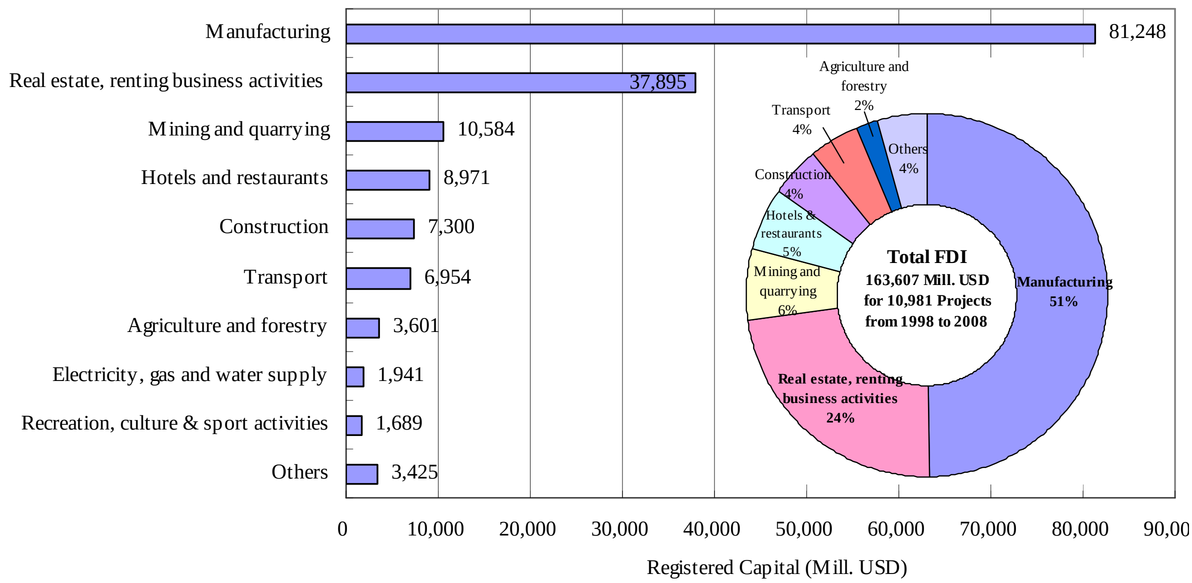
After 20 years of economic reform, Vietnamese economic growth is driven by the strong FDI inflows. Especially, the past three years, since 2006, FDI inflows sharply increased, thanks to the favorable FDI promotion policies after the accession WTO. In 2006, registered FDI recorded 12 billion USD; then, in 2007 reached 21.3 billion USD; in 2008 increased 64 billion USD, tripled from 2007 (Figure 2.1.3).



Source: GSO

Figure 2.1.3 FDI Inflows

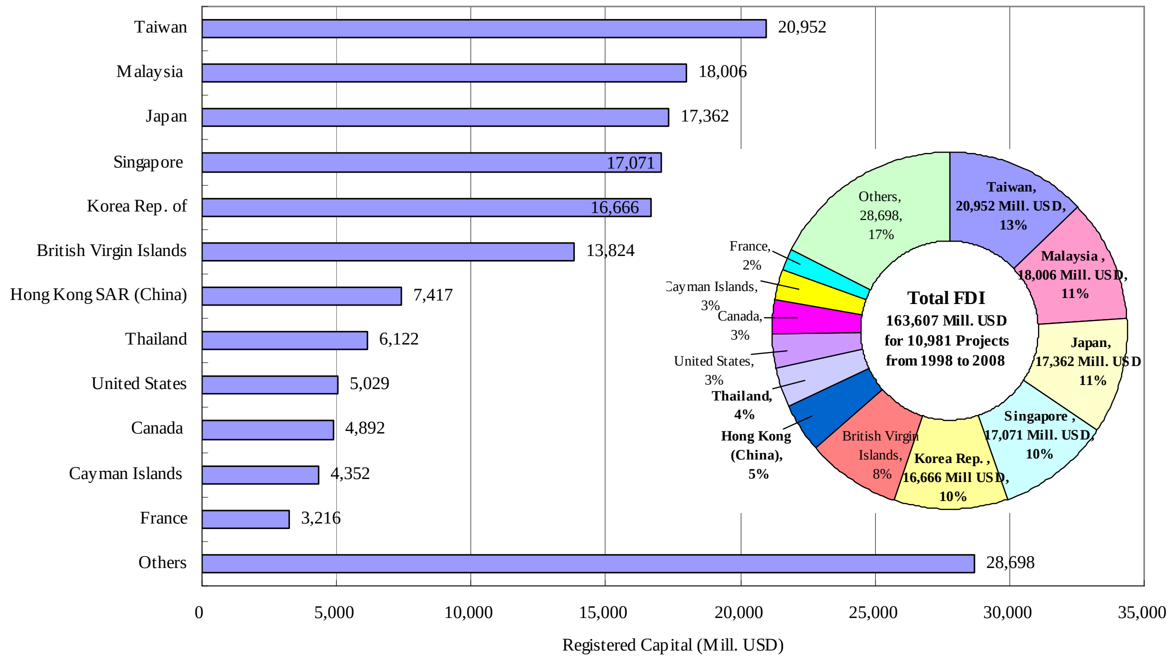
From 1988 to 2008, FDI inflows have been focused especially on manufacturing sector with 81.3 billion USD (51% of total) and followed by real estate, renting business activities sector with 37.9 billion USD (24% of total), both sectors have high proportion in the FDI inflow (Figure 2.1.4).



Source: GSO

Figure 2.1.4 FDI Inflows from 1988 to 2008 by Sector

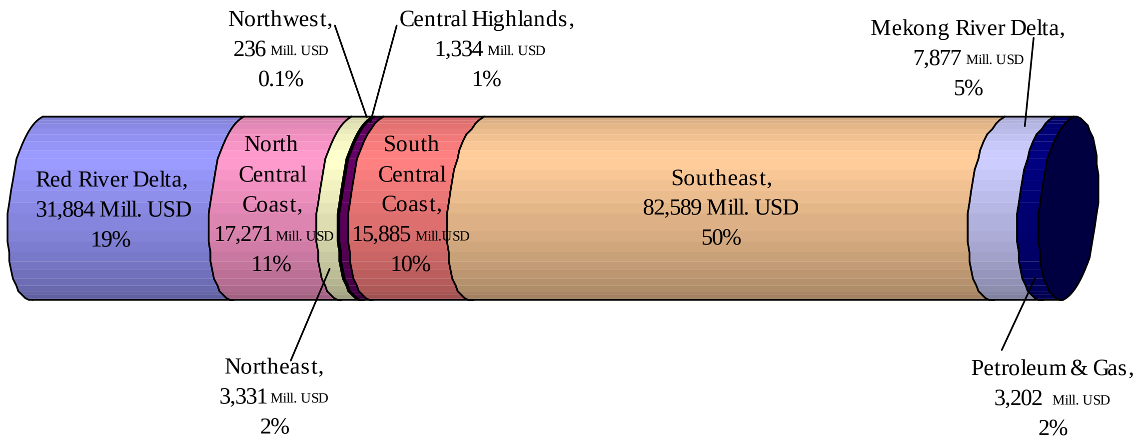
From 1988 to 2008, top 10 countries and territories having invested into Vietnam are Taiwan, Malaysia, Japan, Singapore, Korea, British Virgin Islands, Hong Kong, Thailand, United States and Canada, accounting for 78% of registered capital of total FDI inflows. Out of the top 10 countries and territories, seven are Asian countries accounting for 64 % in total FDI inflows as shown in Figure 2.1.5.



Source: GSO

Figure 2.1.5 FDI Inflows from 1988 to 2008 by Countries

From 1988 to 2008, registered capital of FDI Inflows in the Southeast region hit the highest 82.6 billion USD accounting for half of total and followed by Red River Delta 31.9 billion USD (19% of total). Figure 2.1.6 shows registered capital in FDI inflows (1998-2008) by regions.

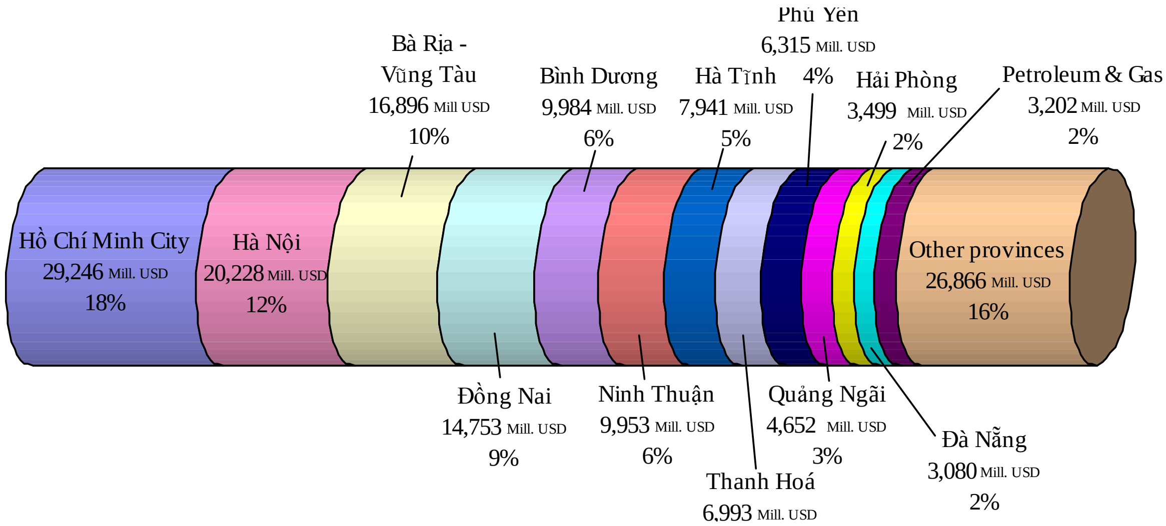


Source: GSO

Note: Including supplementary capital to licensed projects in previous years, including Petroleum & Gas

Figure 2.1.6 Registered Capital of FDI Inflows from 1988 to 2008 by Regions

On the other hands, top 12 provinces and municipalities of registered capital of FDI flows are Ho Chi Minh City, Hanoi, Ba Ria-Vung Tau, Dong Nai, Binh Duong, Ninh Thuan, Ha Tinh, Thang Hoa, Phu Yen, Quang Ngai, Hai Phong, Danang, accounting for 82% of total registered capital of FDI flows (Figure 2.1.7).

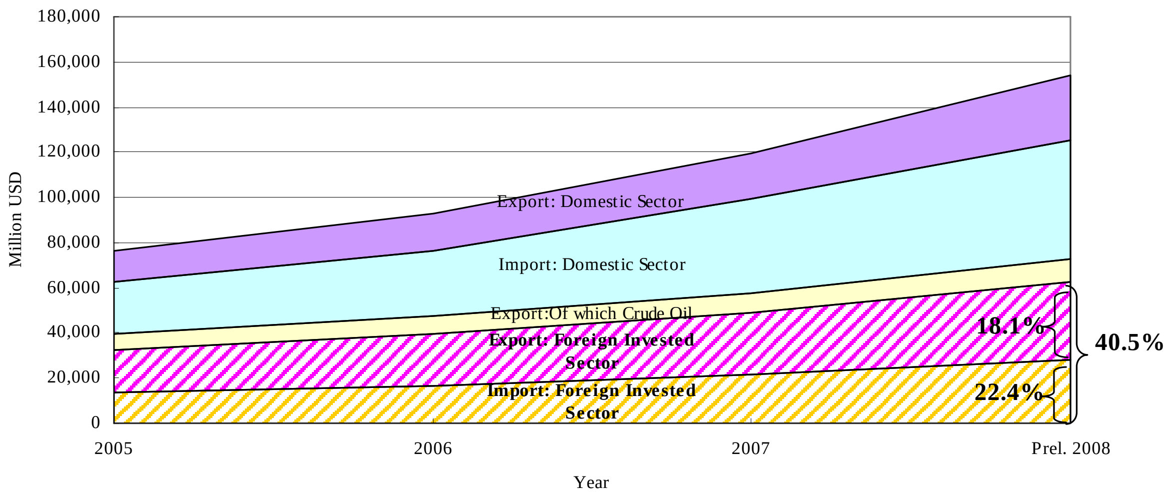


Source: GSO

Note: Including supplementary capital to licensed projects in previous years, including Petroleum & Gas

Figure 2.1.7 Registered Capital of FDI Inflows from 1988 to 2008 by Provinces and Municipalities

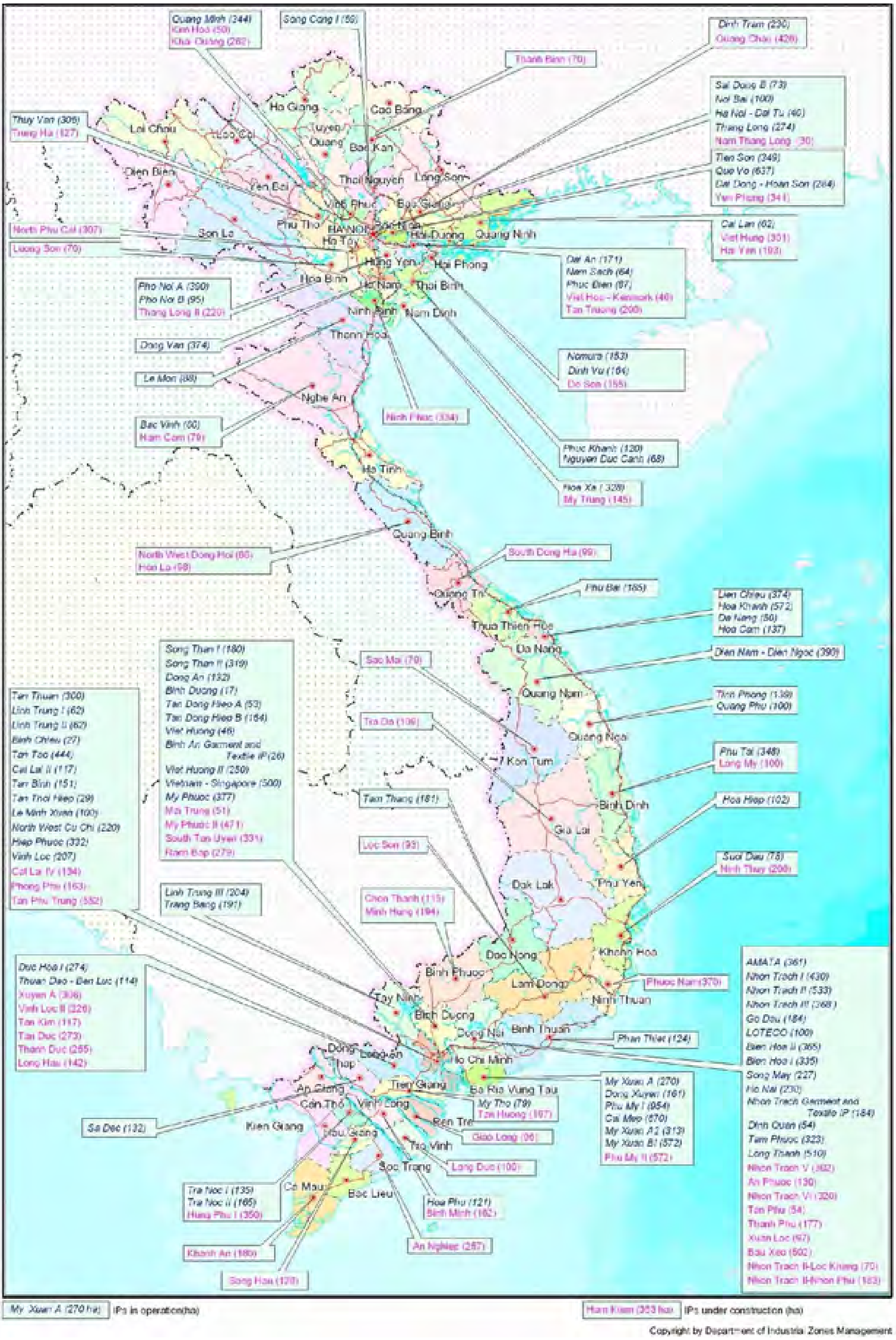
Based on the information of Ministry of Planning and Investment, the share of foreign investment sector in the total trade value was 40.5% in 2008, consisting of 18.1% for Export and 22.4% for Import (Figure 2.1.8).



Source: For Implementation of the Five-year Socio-economic Development Plan 2006-2010, MPI

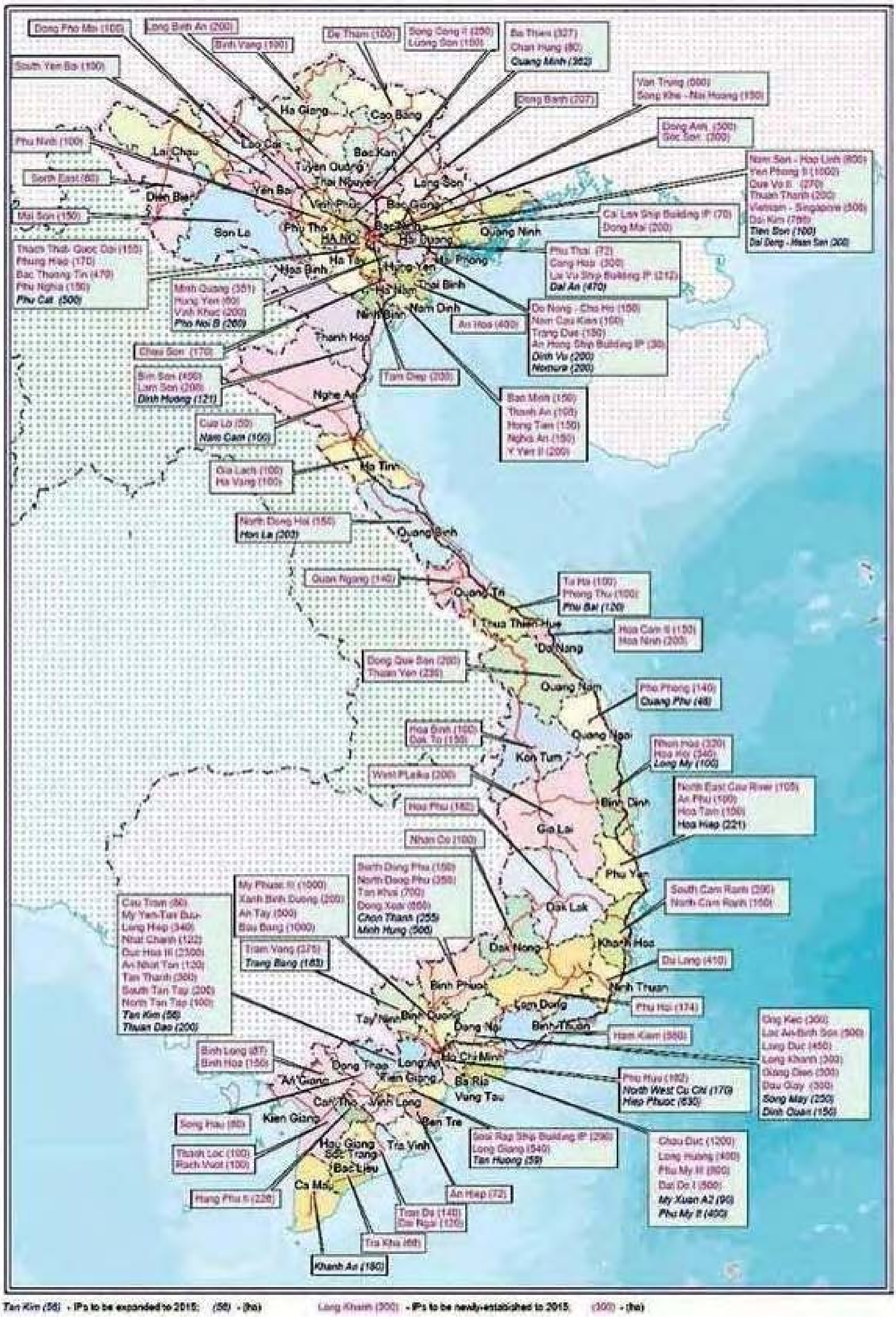
Figure 2.1.8 Foreign Invested Sector in Merchandise Trade (2005-2008)

According to the information of Ministry of Planning and Investment, by the end of June 2009, Vietnam had 230 industrial parks and export processing zones with 144 operating and 86 still under construction. Figure 2.1.9 shows the list of established Industrial Parks and Figure 2.1.10 shows "Master plan of Industrial Park Development to 2015 and Vision 2020".



Source: MPI

Figure 2.1.9 List of Established Industrial Parks



Source: MPI

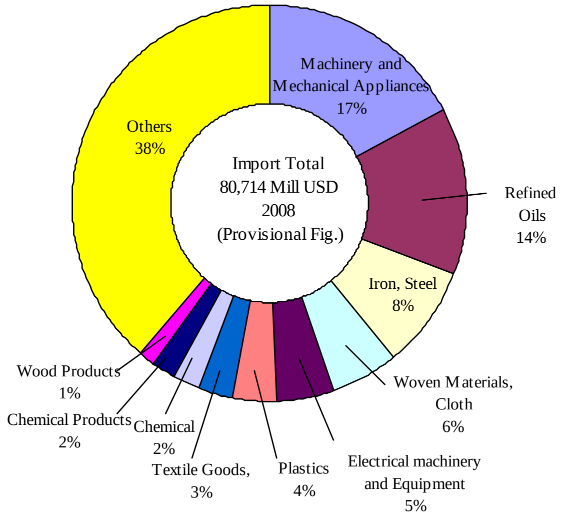
Figure 2.1.10 Master Plan of Industrial Park Development to 2015 and Vision 2020

2.2 Distribution of Goods and Ocean Shipping

2.2.1 Distribution of Goods

1) Trade in Viet Nam

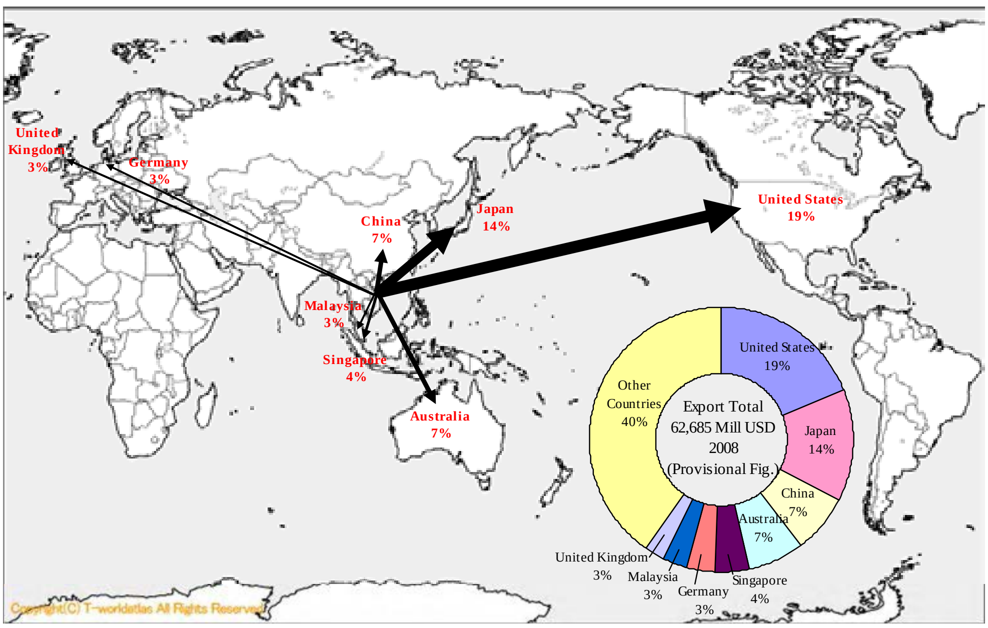
Vietnam has demonstrated its strong commitment to trade liberalization in recent years. It has joined the WTO in 2007 and signed Free Trade Agreements (FTAs) with ASEAN countries and the USA. Vietnam also has a cooperation agreement with the EU. In 2008, exports are mainly made up of crude oil, apparel/clothing and shoes, whereas imports are mainly made up of machinery, refined oil and steel (Figure 2.2.1).



Source: JETRO

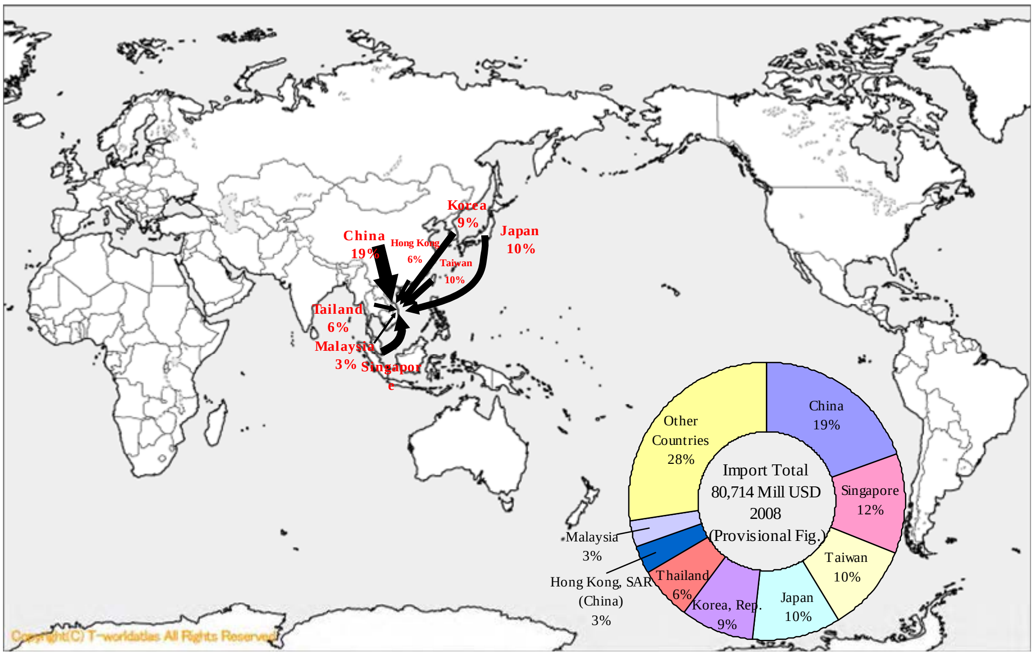
Figure 2.2.1 Main Commodity of Import and Export

The main export customers of Vietnam are the USA, Japan, Australia and China. For imports, the country's main partners are China, Singapore, Taiwan, Japan, South Korea and Thailand. (See Figure 2.2.2 and Figure 2.2.3 Trade Partner Country of Import and Export in 2008)



Source: JETRO

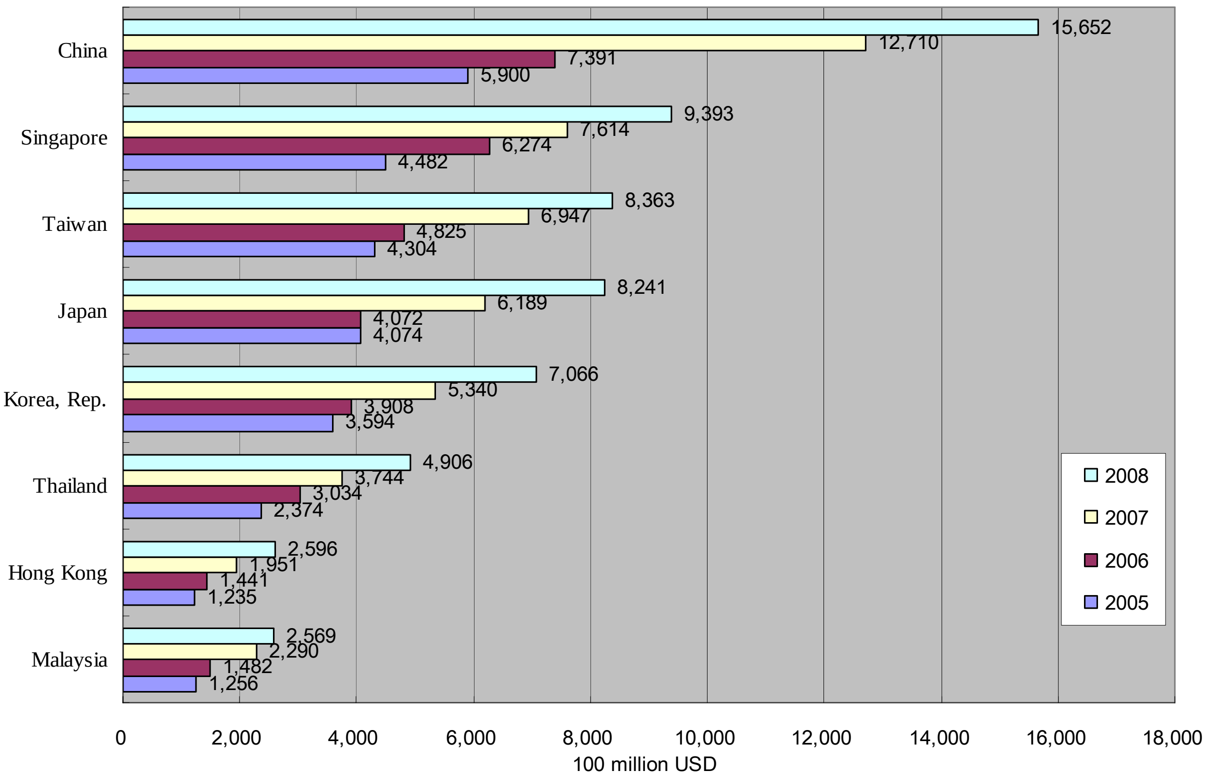
Figure 2.2.2 Trade Partner Country of Export in 2008



Source: JETRO

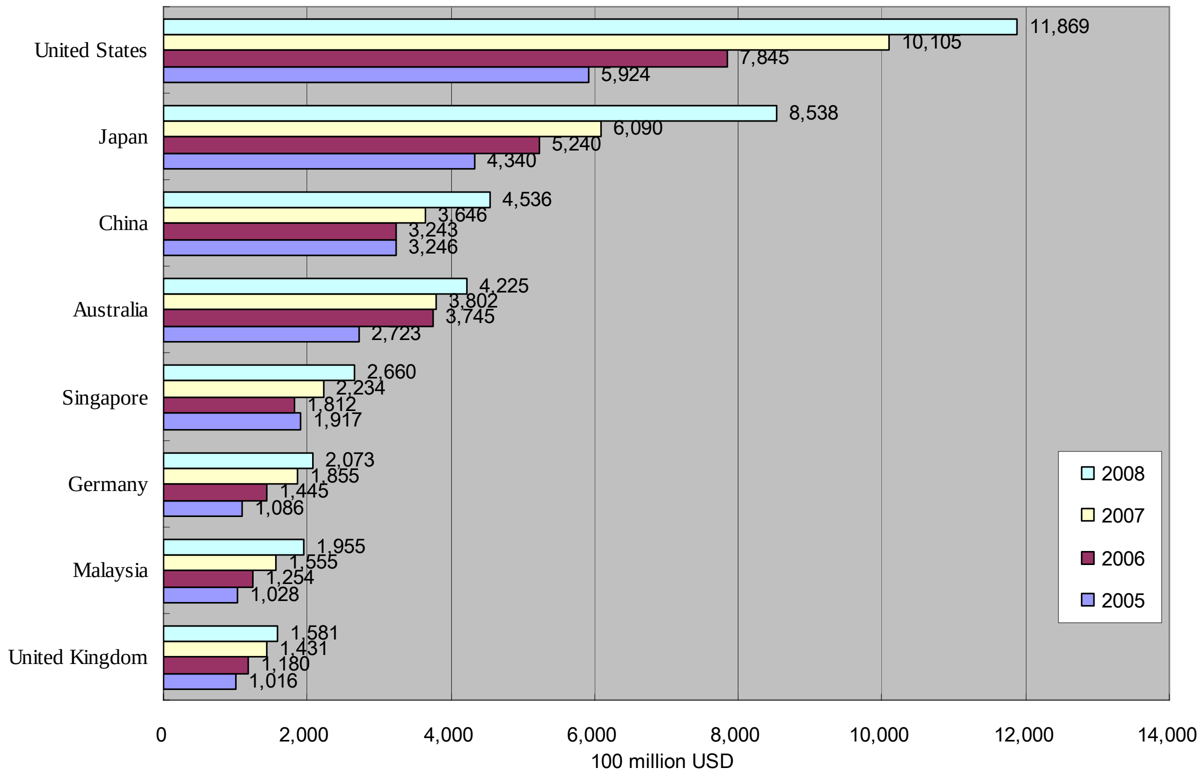
Figure 2.2.3 Trade Partner Country of Import in 2008

Historical trade partner changing from 2005 to 2008 is shown in the Figure 2.2.4 and Figure 2.2.5. China is top trade partner, and then Japan is second, followed by USA and Singapore.



Source: GSO and JETRO

Figure 2.2.4 Leading Import Market 2005-2008

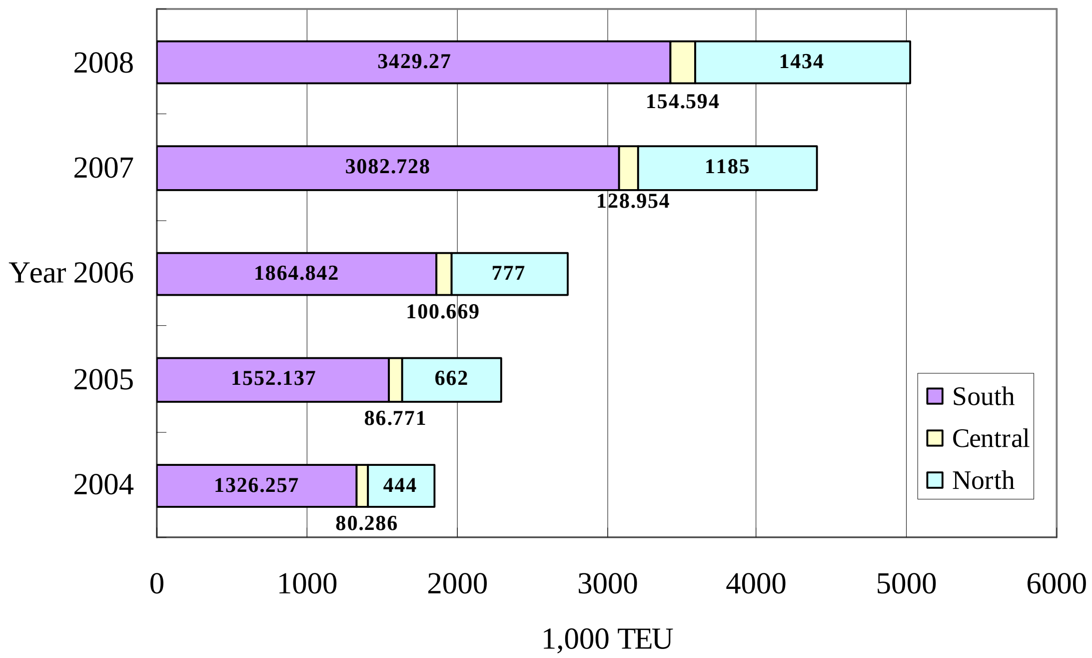


Source: GSO and JETRO

Figure 2.2.5 Leading Export Market 2005-2008

2) Rapid Growth of Container Movement in Viet Nam's Sea Ports

In 2008, Viet Nam's seaport handled 5,018,000 TEU, 2.7 times of 1,851,000 TEU in 2004. Especially, Northern Vet Nam's sea ports handled 1,434,000 TEU, 3.2 times of 444,000 TEU in 2004 (Figure 2.2.6).



Source: Vietnam Seaport Association and VINAMARINE

Figure 2.2.6 Rapid Growth of Container Movement in Viet Nam's Sea Ports

3) Nationwide Cargo Throughputs in the Seaports

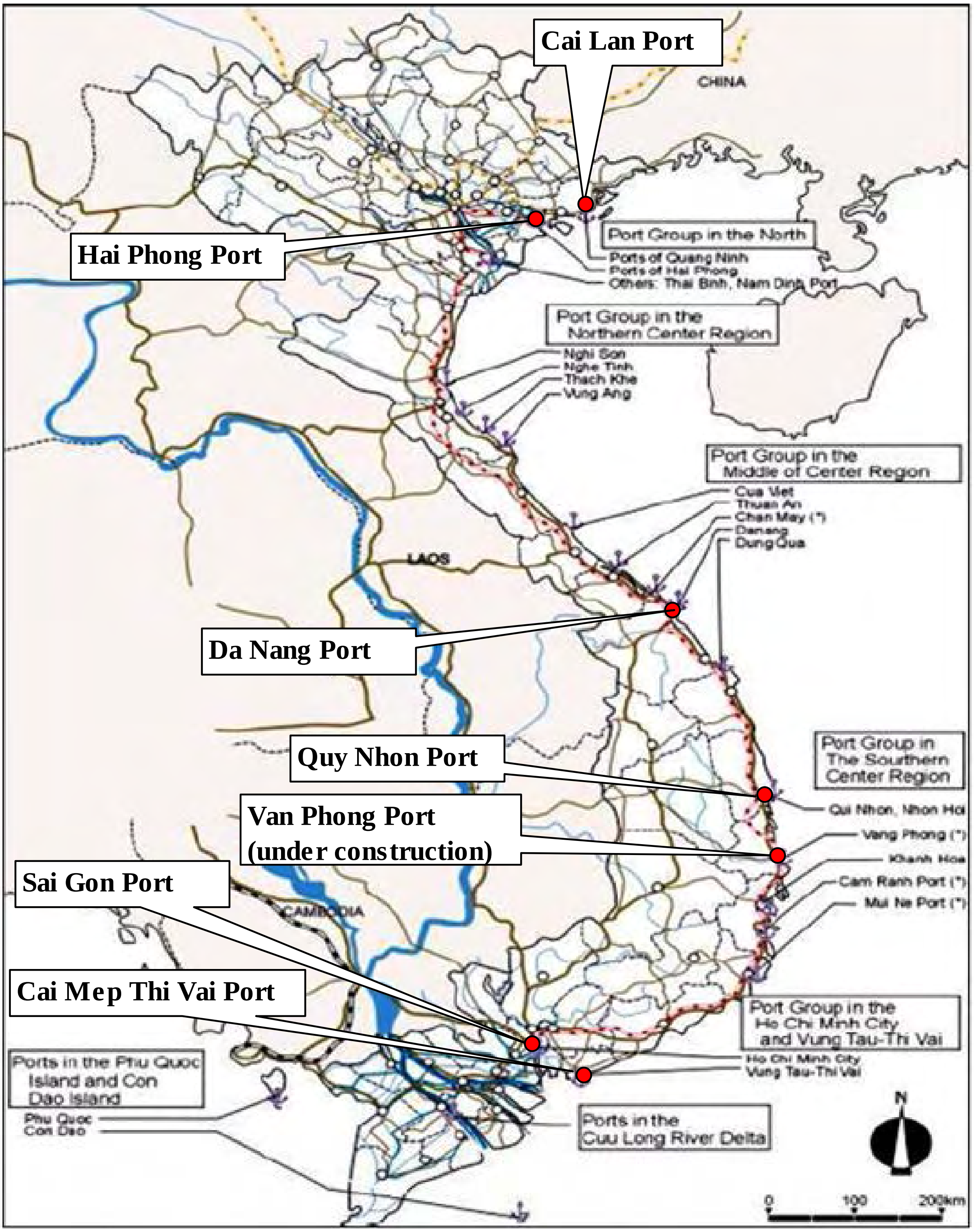
In 2008, Viet Nam's seaport handled 143,612,000 tons, comprising 46,592,000 tons of import, 54,182,000 tons of export and 42,838,000 tons of domestic transport. On the other hand, total vessel calls were 30,367 in the Vietnam's Seaports, consisting of 9,867 calls in North Vietnam, 8,423 calls in Central Vietnam and 12,077 in South Vietnam (Table 2.2.1).

Table 2.2.1 Cargo Throughputs in Vietnam' Sea Port

2008							
No.	**Ports'name**	**Vessels**	**Cargo throughput (x 1,000 MT)**				**TEUs**
		Calls	***Tons***	***Import***	***Export***	***Domestic***	
NORTH		**9,867**	**59,655**	**13,814**	**22,748**	**23,093**	**1,446,944**
1	Quang Ninh	378	3,023	856	1,664	503	35,028
2	Cam Pha	2,186	25,232	-	13,431	11,801	
3	Cang dau B12	325	6,753	3,382	3,371		
4	Hai Phong	4,779	13,900	7,635	3,231	3,034	729,978
5	Doan Xa	245	3,303	533	338	2,432	156,314
6	Vat Cach	997	1,501			1,501	
7	Cua cam	439	566	126	80	360	
8	Transvina	200	2,600	55	79	2,466	115,771
9	Dinh Vu	318	2,777	1,227	554	996	218,269
10	Other Private Ports						191,584
CENTRAL		**8,423**	**15,035**	**1,649**	**5,993**	**7,393**	**154,594**
1	Thanh Hoa	1,344	1,527	20	100	1,407	
2	Nghe Tinh	893	1,331	43	522	766	
3	Ha Tinh	352	1,187	10	813	364	
4	Quang Binh	202	132		14	118	
5	Vinashin-Cua Viet	95	30	13	10	7	
6	Thuan An	82	177	1	25	151	
7	Chan May	251	800	18	400	382	
8	Da Nang	1,542	2,742	526	1,230	986	61,881
9	9 Song Han						
10	Hai Son	125	120	10		110	10,000
11	Nguyen Van Troi	202	136			136	
12	Ky Ha	135	210	10	60	140	
13	Ky Ha – Quang Nam	286	400	126	176	98	6,115
14	Quy Nhon	1,296	3,311	835	1,524	952	72,276
15	Thi Nai	467	464	10	54	400	
16	Nha Trang	648	1,172	15	211	946	4,322
17	Cam Ranh	503	1,296	12	854	430	
SOUTH		**12,077**	**68,922**	**31,129**	**25,441**	**12,352**	**3,429,270**
1	Ben Dam – Con Dao VT	221*	250			250	
2	Thuong Cang Vung Tau	467	855	32	704	119	251
3	Phu My	382	2,743	2,179	88	476	
4	Dong Nai	775	2,803	721	914	1,168	
5	Binh Duong	620	356	130	120	106	109,943
6	Xang Dau Cat Lai	90	1,100	1,100			
7	Saigon Petro	134	808	808			
8	Saigon New	2,168	20,180	9,751	10,429		2,018,104
9	Sai Gon	1,819	13,166	5,413	2,845	4,908	510,496
10	Tan Thuan Dong	141	556	498	36	22	
11	Ben Nghe	857	4,199	1,512	500	2,187	188,815
12	VICT	1,015	5,360	2,670	2,690		536,176
13	Rau Qua	136	308	294	14		
14	Lotus	411	1,134	1,040	94		24,252
15	Nha Be Oil	213	4,500	4,500			
16	My Tho	184	286	17	81	188	
17	Dong Thap	33	184	25		159	
18	Vinh Long	10	179			179	
19	Can Tho	1,388	2,843	263	2,074	506	10,692
20	Binh Minh	12	190			190	
21	Tra Noc – Can Tho	385	2,926	32	2,329	565	
22	Cai Cui	324	2,554	3	2,359	192	
23	My Thoi	292	1,442	141	164	1,137	30,541
TOTAL		**30,367**	**143,612**	**46,592**	**54,182**	**42,838**	**5,030,808**

Source: Vietnam Seaport Association and Port operator data by VINAMARINE

Viet Nam has 80 seaports in 8 categorized seaport groups. The major seaports in Viet Nam are illustrated in Figure 2.2.7. In 2009, the construction of Van Phong Port started aiming for deep-sea transshipment hub port.



Source: VINAMARINE and Study Team

Figure 2.2.7 Major Seaports in Viet Nam

4) Shipping Route and Line in the Northern Seaports

In 2008, the Northern Seaports in Viet Nam acted as only feeder ports, no deep-sea ports for trunk line vessels. Therefore, most of the Vietnamese export or import cargoes without deep-sea port in Southern Vietnam were transported to the neighboring hub ports where the vessels sailing on trunk line could call, such as ports of Hong Kong and Singapore, and then transshipped to the mother vessels and transported to the destination ports (Figure 2.2.8).

Source: ASEAN Logistics Network Map, 2nd Edition 2008, JETRO, Arrangement by JICA Study Team

Figure 2.2.8 Trunk and Feeder Shipping Routes of Viet Nam's Seaports

In 2009, the shipping schedule of Hai Phong Port has 43 liner service routes, 22 routes via Hong Kong port and 7 routes via Singapore Port. The maximum onboard capacity is 3,252 TEUs. (Table 2.2.2)

Table 2.2.2 Liner Service in Hai Phong Port (as of November 2009)

No.	Shipping Line	Service Code	Type of Service	Frequency	Fixed Day Service	Total Vessels	Shipboard Capacity	Service Partners	Shipping Route	Days of Round Trip
1	Advance Container Lines (Pte) Ltd	North Vietnam Exp	Feeder service	2 sailings a week	Yes	1	938 TEU	Advance Container Lines (Pte) Ltd Samudera Shipping Line Ltd	Singapore(PSA)-Haiphong-Danang-Qui Nhon-Singapore(PSA)	14
2	Bien Dong Shipping Co	Vietnam-Singapore	Feeder service	1 sailing a week	No	4	3,252 TEU	Bien Dong Shipping Co Mitsui OSK Lines Ltd	Haiphong-HCM-Singapore (PSA)-HCM-Haiphong	14
3		Vietnam-Hong Kong	Feeder service	3 sailings a week	Yes	3	1,285 TEU	Bien Dong Shipping Co Slot-charter Mitsui OSK Lines Ltd	Haiphong-Hong Kong- Haiphong	7
4		Vietnam-Thailand	Feeder service	1 sailing a week	Yes	2	1,154 TEU	Bien Dong Shipping Co Slot-charter Mitsui OSK Lines Ltd	Haiphong-HCM-Bangkok-Laem Chabang-HCM-Haiphong	14
5		Vietnam-Korea	Mainline service	1 sailing a week	Yes				Haiphong-Busan-Haiphong	14
6	Cosco Container Lines Ltd	HPP	Mainline service	1 sailing a week	Yes	1	422 TEU		Hong Kong-Haiphong-Fangcheng-Hong Kong	7
7	China Shipping Container Lines Co Ltd	Chiwan-HK-Haiphong	Mainline service	1 sailing a week	Yes	1	170 TEU		Chiwan-Hong Kong-Haiphong-Chiwan	7
8	CT Navigation SA	Vietnam	Mainline service	1 sailing a week	Yes	1	556 TEU		Kaohsiung-Haiphong-Danang-Kaohsiung	7
9	China United Lines Ltd	SVG	Feeder service	1 sailing a week	Yes	1	525 TEU		Shekou-Hong Kong-Haiphong-Fangcheng-Shekou	7
10	Evergreen Line	KHP	Mainline service	1 sailing a week	Yes	1	629 TEU		Kaohsiung-Haiphong-Kaohsiung	7
11	Gold Star Line Ltd	HHS	Feeder service	1 sailing a week	Yes			Slot-charter Gold Star Line Ltd Sinokor Merchant Marine Co Ltd	Haiphong-Hong Kong-Haiphong	7
12		HSX	Mainline service	1 sailing a week	Yes			Slot-charter Gold Star Line Ltd Perkapalan Dai Zhun Sdn Bhd (PDZ)	Hong Kong-Haiphong-Fangcheng-Hong Kong	7
13	Hanjin Shipping Co Ltd	HES	Mainline service	1 sailing a week	Yes				Haiphong-Shanghai-Busan-Shanghai-Haiphong	14
14	Heung-A Shipping Co Ltd	HPS1	Mainline service	1 sailing a week	Yes	2	1,306 TEU		Gwangyang-Busan-Hong Kong-Haiphong-Fangcheng-Hong Kong-Gwangyang	14
15		HPS2	Mainline service	1 sailing a week	Yes				Haiphong-Fangcheng-Shekou-Hong Kong- Ulsan-Busan-Hong Kong-Haiphong	14
16	Hub Shipping Sdn Bhd	Pkg-Hph-Hcm-Pkg	Feeder service	1 sailing a week	Yes	1	700 TEU	CNC Line Co Ltd Gemartrans (Vietnam) Co Ltd Hub Shipping Sdn Bhd	Port Klang-Haiphong-HCM-Port Klang	14
17	Kawasaki Kisend Kaisha Ltd	GEMCO-2	Feeder service	1 sailing a week	Yes			Gemadept Logistics Co Ltd Slot-charter Kawasaki Kisen Kaisha Ltd	Haiphong-Hong Kong-Haiphong	7
18		GEMCO-3	Feeder service	1 sailing a week	Yes			Gemadept Corp Slot-charter Kawasaki Kisen Kaisha Ltd	Haiphong-Kaohsiung-Haiphong	7
19	MCC Transport Pte Ltd	NVN2	Feeder service	1 sailing a week	Yes	2	1,775 TEU	Evergreen Line MCC Transport Pte Ltd	Tanjung Pelepas-Singapore (PSA)-Taijung Pelepas-Haiphong-Danang-Nhatrang-Tanjung Pelepas	14
20		NVN4	Feeder service	1 sailing a week	Yes	1	1,128 TEU	Evergreen Line MCC Transport Pte Ltd	Singapore (PSA)-Quy Nhon-Haiphong-Quy Nhon-Nha Trang-Tanjung Pelepas-Singapore (PSA)	14
21	Mariana Express Lines Ltd	KHX	Feeder service	2 sailings a week	Yes	2	1,404 TEU	Mariana Express Lines Ltd Slot-charter Yang Ming Marine Transport Corp	Kaohsiung-Haiphong-Kaohsiung	7
22	Mitsui OSK Lines Ltd	TVS	Mainline service	1 sailing a week	Yes			Bien Dong Shipping Co Slot-charter Mitsui OSK Lines Ltd	Haiphong-HCM-Bangkok-Laem Chabang-HCM-Haiphong	14
23		VH2	Feeder service	1 sailing a week	Yes			Bien Dong Shipping Co Slot-charter Mitsui OSK Lines Ltd	Hong Kong-Haiphong-Hong Kong	7
24		VSS	Feeder service	1 sailing a week	Yes			Bien Dong Shipping Co Mitsui OSK Lines Ltd	Haiphong-HCM-Singapore (PSA)-HCM-Haiphong	14
25		VH3	Feeder service	1 sailing a week	Yes			Bien Dong Shipping Co Slot-charter Mitsui OSK Lines Ltd	Haiphong-Shekou-Hong Kong-Haiphong	7
26		VH4	Feeder service	1 sailing a week	Yes			Bien Dong Shipping Co Slot-charter Mitsui OSK Lines Ltd	Haiphong-Hong Kong-Haiphong	7
27	Mediterranean Shipping Co SA	Tongking Express	Feeder service	1 sailing a week	Yes	1	2,157 TEU		Hong Kong-Haiphong-Shantou-Hong Kong	7
28	Namsung Shipping Co Ltd	Vietnam Haiphong	Mainline service	1 sailing a week	Yes	2	684 TEU		Incheon-Gwangyang-Busan-Hong Kong-Haiphong-Shekou-Incheon	14
29	Orient Oversea Container Line Ltd	HPH	Feeder service	1 sailing a week	Yes				Haiphong-Kaohsiung-Haiphong	7
30	STX Pan Ocean Co Ltd	KHX	Feeder service	1 sailing a week	Yes	1	1,049 TEU	Korea Marine Transport Co Ltd STX Pan Ocean Co Ltd	Shanghai-Busan-Gwangyang-Haiphong-Xiamen-Shanghai	14
31		KVX	Feeder service	1 sailing a week	Yes	1	1,118 TEU	Korea Marine Transport Co Ltd STX Pan Ocean Co Ltd	Incheon-Busan-Hong Kong-Haiphong-Hong Kong-Shekou-Incheon	14
32	PDZ Lines	HSX	Feeder service	1 sailing a week	Yes	1	384 TEU	Slot-charter Gold Star Line Ltd PDZ Lines Slot-charter Zim Intergrated Shipping Services Ltd	Hong Kong-Haiphong-Fangcheng-Hong Kong	7
33		HEX	Feeder service	1 sailing a week	Yes				Singapore (PSA)-Haiphong-Singapre (SPA)	7
34	Regional Container Lines Public Co Ltd	RHP	Mainline service	1 sailing a week	Yes			Slot-charter Regional Container Lines Public Co Ltd Steamers Feederships (99) Pte Ltd	Singapore (PSA)-Haiphong-Singapre (SPA)	14
35		RSK	Mainline service	1 sailing a week	Yes	3	1,884 TEU		Songkhla-Hong Kong-Haiphong-Hong Kong-Keelung-Taichung-Hong Kong-Sihanoukville-Songkhla	21
36		RSX	Mainline service	1 sailing a week	Yes	2	2,228 TEU		Shekou-Singapore (PSA)-Haiphong-Hong Kong-Xiamen-Hong Kong-Shekou	14
37	Russo-Orient Shipping Line Co Ltd	Russo-Orient Exp	Mainline service	2 sailings a week	No				Vostochniy-Vladivostok-Hong Kong-Singapore (PSA)-HCM-Haiphong-Hong Kong-Vostochniy	
38	Samudera Shipping Line Ltd	NVX	Feeder service	1 sailing a week	Yes	1	1,054 TEU	Advance Container Lines (Pte) Ltd Samudera Shipping Line Ltd	Singapore (PSA)-Haiphong-Danang-Quy Nhon-Singapore (PSA)	14
39	Sinokor Merchant Marine Co Ltd	HHS	Mainline service	weekly	No	1	300 TEU		Hong Kong-Haiphong-Hong Kong	
40	SITC Container Lines Co Ltd	CJV	Mainline service	1 sailing a week	No				Tokyo-Yokkaichi-Nagoya-Shanghai- Hong Kong-HCM-Haiphong-Tokyo	
41	Steamers Feederships (99) Pte Ltd	Sing-Haiphong	Mainline service	2 sailings a week	Yes			Gemartrans (Vietnam) Co Ltd Slot-charter Regional Container Lines Public Co Ltd Sea Consortium Pte Ltd Slot-charter Steamers Feederships (99) Pte Ltd	Singapore (PSA)-Haiphong-Singapore (PSA)	14
42	Vinalines Shipping Co	HCM-HPH	Feeder service	5 sailings a week	No	5	2,275 TEU		HCM-Haiphong-HCM	6
43	Wan Hai Lines Ltd	HPH/HP2	Mainline service	2 sailings a week	Yes	2	1,282 TEU		Haiphong-Kaohsiung-Haiphong	7

Source: Web Sites of Shipping Lines

5) Vietnam-China Boarder Transport in the Northern Vietnam

Vietnam-China border regions have effectively cooperated in transport, tourism, culture and education. In 2003, the Greater Mekong Subregion (GMS) Cross-Border Transport Agreement (CBTA) entered into force for a multilateral legal instrument among GMS countries (Cambodia, People's Republic of China [PRC], Lao People's Democratic Republic [Lao PDR], Myanmar, Thailand and Vietnam).

In 2005, a new highway connecting Nanning National Route 1 in Vietnam was opened. In 2007, China and Vietnam agreed to construct an economic cooperation zone astride the boarder at Pingxiang city, Guangxi and Lang Son province in Vietnam. In 2008, Vietnam and China signed MOU to include the Nanning-Hanoi corridor and the Youyiguan-Huu Nghi Border Crossing Point under the umbrella of the GMS Cross-Border Transport Agreement.

In 2007, the regular scheduled road transport service from Hanoi to China has begun and then, using the return transport, the consolidation service for multi customers also started. In 2008, for facilitation of the movement of Chinese goods, Vietnam Government has the planning of six-lane expressway from Hanoi to Lang Son to connect with Guangxi.

Source: GMS Transport Strategy 2006-2015, ADB

Figure 2.2.9 New GMS Corridors

Figure 2.2.10 shows the present condition of sea and land transport of Hanoi-Guangzhou. After opening Nanning - Youyiguan expressway in the end of 2005 and opening Nanning – Zhanjiang - Guangzhou around the same time, the sea transport cost of Hanoi-Guangzhou is half price of the land transport cost, but the sea transport days are 1.5 times longer than land transport days.

Source: JETRO

Figure 2.2.10 Sea and Land Transport from Hanoi to Guangzhou Area

Table 2.2.3 shows major economic data (2008) of Guangdong and Guangxi province in China. GDP growth in both provinces is more than 10%, even if after global economic crisis in 2008.

Table 2.2.3 Major Economy Data of Guangdong and Guangxi Province (2008)

Province	Guangdong	Guangxi
Capital	Guangzhou	Nanning
Area	179,800km2	236,700 km2
Population (end of 2007)	94,490,000	50,020,000
Population density	526 /km2	210 /km2
GDP	CNY 3,569.6 billion	CNY 717.2 billion
GDP Growth	10.1%	12.9%
Per capita	CNY 37,588	CNY 14,966

CNY=approx 13Yen, 1 Dong=approx. 0.005 Yen (Dec 2009)

Fangcheng Port in Guangxi province is one of major 24 ports in China. Fangcheng port has 36 berths including 21 deep-sea berth s of more than 10,000 ton vessel accommodation and maximum berth capacity with 200,000 ton vessel accommodation. 11 deep-sea berths for 50,000 to 200,000 ton vessel accommodation is under-construction now. Target capacity of Fangcheng Port North International port group (Fangcheng Port, Qin Zhou port and BeiHai port) is 100 million ton in 2010 and 300 million ton in 2020.

Ranking of GDP for Greater Pearl River Delta (Guangzhou, Hong Kong, and Macau) is eleventh in the World. In the TEU-ranking of the container ports in 2008, Hong Kong is No. 3 (24.2 million TEU), Shenzhen is No.4 (21.4 million TEU) with 27.1% growth rate in 1998-2008 and Guangzhou is No. 8 (11.0 million TEU) with 29.2% growth rate in 1998-2008. (Table 2.2.4)

Table 2.2.4 TEU-ranking of the top 10 world container ports in 2008

TEU-Ranking 2008	(1998)	Port (Country)	Mill TEU 1998	2007	2008	TEU% Growth 2007-2008	1998-2008
1	(1)	Singapore (Singapore)	15.1	27.9	29.9	7.1%	7.1%
2	(10)	Shanghai (China, PR of)	3.1	26.2	28.0	7.0%	24.7%
3	(2)	Hong Kong (China, PR of)	14.6	24.0	24.2	1.0%	5.2%
4	(18)	Shenzhen (China, PR of)	2.0	21.1	21.4	1.5%	27.1%
5	(5)	Busan (Korea, Rep of)	5.2	13.3	13.4	1.4%	10.0%
6	(11)	Dubai (UAE)	2.8	10.7	11.8	11.1%	15.5%
7	(64)	Ningbo (China, PR of)	0.4	9.4	11.2	19.0%	41.3%
8	(52)	Guangzhou (China, PR of)	0.8	9.3	11.0	18.8%	29.2%
9	(4)	Rotterdom (Netherlands)	6.0	10.8	10.8	-0.1%	6.0%
10	(35)	Qingdao (China, PR of)	1.2	9.5	10.3	9.1%	23.9%

Source: ISL Port Data Base 2009

Moreover, 3 major ports (Guangzhou, Shenzhen and Xiamen) in Pearl River Delta have planning huge development in the future. Table 2.2.5 shows actual volume of cargo and container cargo and future development plan in Chinese major ports.

Table 2.2.5 Chinese Port Development Plan

Chinese Port	Actual Data		Development Plan 2010		2020		2030	Remarks
	Cargo Volume (mil. ton)	Container Cargo (mil. TEU)	Cargo Volume (mil. ton)	Container Cargo (mil. TEU)	Cargo Volume (mil. ton)	Container Cargo (mil. TEU)	Cargo Volume (mil. ton)	
Guangzhou	Year 2008							
	347	11.0		14.0				
Shenzhen	Year 2008							
	211	21.4	280	28.0	440		480	
Shekou	Year 2007							Shenzhen Area
	54.3	5.0						
Yantian	Year 2007							Shenzhen Area
	54.3	10.0						
Xiamen	2007	2008			*Future Volume*			
	81.2	5.0	120	10.0	*260-290 ton*	*17 - 19*		
Qingdao	Year 2008							
	300	10.0	320	12.0	450	22		
Tianjin (Tientsin)	Year 2008							
	356	8.5						
Shanghai	Year 2008							
	508	28.0						
Nantong	Year 2007							
	120	0.43	200	1.5				
Lianyungang	Year 2008							
	101	3.0	120	3.4	190	8.0		
Ningbo	Year 2008							
	520	10.9		11.0				
Yantai	Year 2008							
	111	1.5	200	2.5～3.0				
Dailian	Year 2008							
	246	4.5	250	8.0				

Source: KWE Kintesu World Express, Inc.

2.2.2 Ocean Shipping

Vietnam has 126 ports along their 3,260 km coast line, and 24 ports of them are opened for international trade. Shipping lines have liner services only in six ports out of the 24 ports, namely, Ho Chi Minh, Vung tau, Hai Phong, Cai Lan, Quy Nhon, and Danang.

There are three trunk lines in the world shipping industry. They are Far East - Southeast Asia - Europe, Southeast Asia - Far East - USA West coast, and USA East coast - Europe routes. Vietnamese ports are geographically included in the above former two trunk routes covering Asia. Despite their geographical locations, no Vietnamese ports are listed in the published shipping schedule as calling ports by the shipping lines operating Asia/USA and Asia/Europe direct services at the moment. Vietnamese cargos from / to the origins / destinations on the above trunk routes are still transshipped at the hub ports where the trunk line vessels call.

The reason of this situation is that Vietnamese ports are too shallow and small to receive large container vessels, and container volumes handled in the ports did not satisfy the space of large vessels at one calling until a few years ago. However, recently Vietnam has grown to become the “world’s factory” after BRICs countries, therefore, cargo volume jumped up by development of manufacturing and consuming power.

Ho Chi Minh area had been an only surpassing big location in Vietnam until several years ago. Hai Phong and Cai Lan ports appeared recently on the stage as the 2nd key port in this country, which is regarded as a gate for not only North Vietnam but also northern part of Indo-China countries like as North Thailand and Laos, and the border area of China. Both ports, however, are not incorporated in the trunk lines, neither in Asia/USA nor Asia/Europe route yet.

Since 2004, the container throughput in Hai Phong and Cai Lan have increased average 38% every year until 2008, and still continues to grow.

The deployed vessels are greater than 1,000 TEU and applicable for feeding the panamax/post panamax container vessels. They are also servicing markets and area where the demand for large container vessels is too low. Such size are deployed into near seas navigation route around South East Asia, as panamax/post panamax size vessels are not into South East Asia/ USA route including Hai Phong. Propulsion trends in container vessels are prevailing due to high fuel oil price and the following cost to vessel operation and port charges increase.

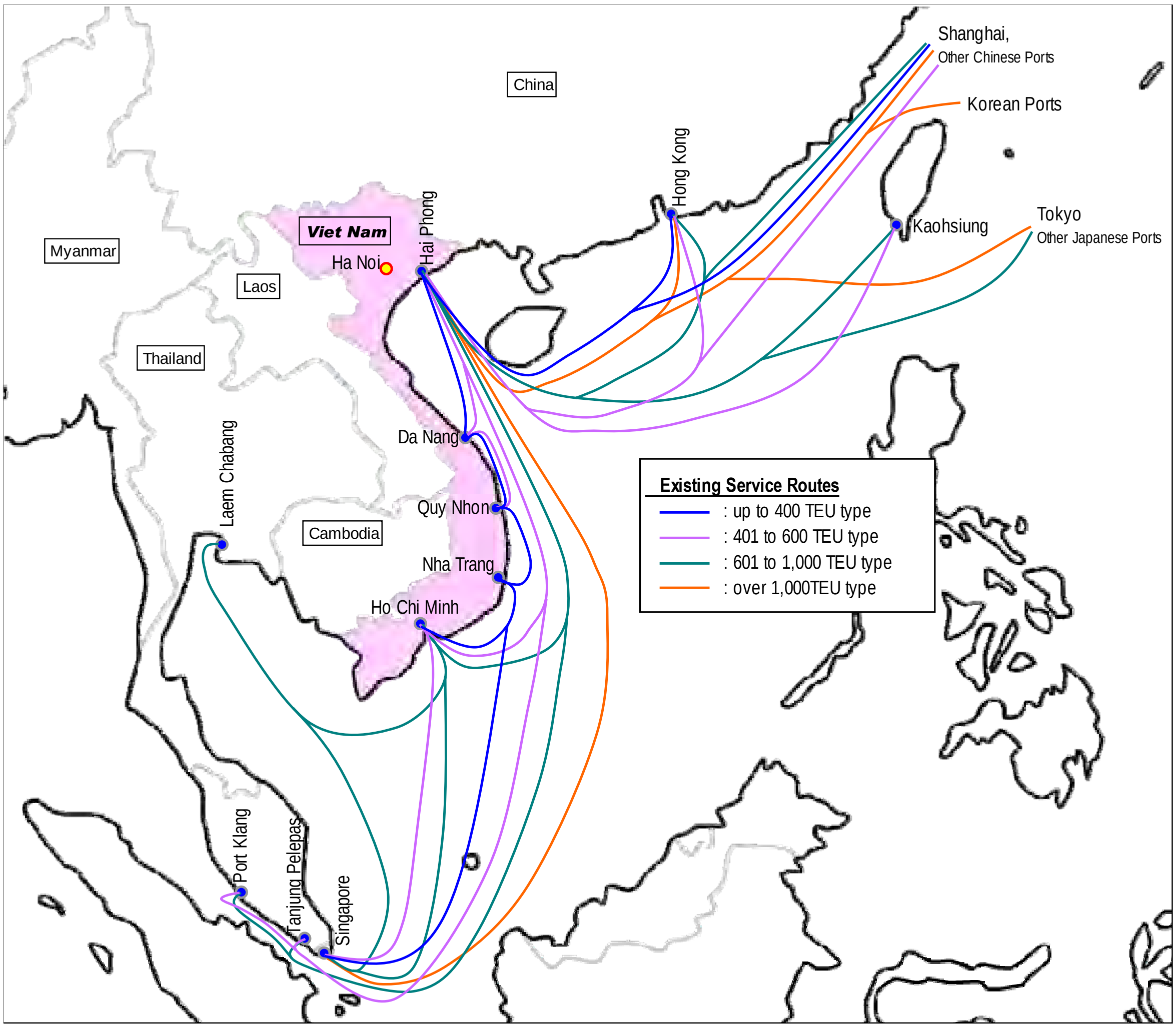
The size of feeder vessels are getting larger, as the feeder transportation demand from hub to feeder ports increases. This is because post panamax / panamax size vessels currently appeared on most main route in Asia

The existing routes served by the shipping companies calling at Hai Phong / Cai Lan and the vessel size are shown on the following map (Figure 2.2.11) with colored line in respective vessels’ container loading capacity. This map was organized from the following table (Table 2.2.6), which shows the service nets and details of the deployed vessels.

It is shown that most vessels in this route are 500/600 TEU type, and basically serving weekly. It can be found that the world major shipping companies have slot charter contract with regional feeder shipping companies, or have joint service as a partner.

Slot charter is to buy partial space from an owner, and partner is to throw their own vessels together into a group to maintain a round service.

It also shows that they connect the neighboring and closed ports/countries each other by deploying small size of container vessels, and containers are relayed from/to the trunk service at the hub ports, where are Kaohsiung, Chinese ports and Singapore. There is currently no direct service between India, Europe and USA, and Hai Phong/Cai Lan. A few direct services are towards Far eastern countries, Japan and Korea.



Source: Study Team

Figure 2.2.11 Existing Service Route

Table 2.2.6 Service Type and Vessels calling at Haiphong

Shipping Cos. In Service	Route	Vessels Name	Loading Capacity	Frequency	P: Partners SC: Slot Charter
APL	SP/HCM/SP	"Cape Arago" "Westerhever	FC 1,066 TEU FC 1,572 TEU	2 /Week	P: ACL
China Shipping	Chiwan/HK/HP/Chiwan	"Su Peng"	MP 170 TEU	Weekly	
COSCO	HK/HP/Zhanjing HP/Danang/QuiNhon/SP HP/HK/HP	"Bei Hai"	MP 602 TEU	Weekly Weekly	P: Sinotrans SC : Gold Star SC: COSCON P: Sinocor
Evergreen	Kaohsiung/HP/Kaohsiung	"Da Ping" "Dong Du"	MP 602 TEU FC 566 TEU	Weekly	
Gemartrans	HP/Kaohsiung/HK/HP HP/HK/HP HP/QuiNhon/HCM/SP/HCM/HP HP/Danang/QuiNhon/SP/HP	"Vinalines Pioneer" "Matura ll"	FC 588 TEU FC 534 TEU	Weekly Weekly 2/Week	SC: K P: K, TS,SC:Cosco P: Cosco, etc. SC:Coscon

Shipping Cos. In Service	Route	Vessels Name	Loading Capacity	Frequency	P: Partners SC: Slot Charter
Hanjing	Busan/HK/HP/ Busan			Weekly	SC: Hanjing, MOL
Heung A	Gwanyang/Busan/HK/HP/ Fangcheng/HK. HP/Fengchang/ Shekou	"Heung A Bangkok" "Heung A Singapore" "Heung A Hong Kong" "El Bravo"	FC 653 TEU FC 653 TEU FC 650 TEU FC 1,118 TEU	Weekly	
Hub Shipping	PKelang/HCM/HP/PKelang	"Hub Enzo"	FC 818 TEU	Weekly	P: CNC, Gemartrans
K Line	Kaohsiung/HP, HP/HK, HP/Kaohsiung/HCM/HP	"Vinalines Pioneer"	FC 588 TEU	2/Week Weekly	P: Wan Hai SC: Gemartrans P: Gemartrans
MCC Transport	SP/HP/T Pelepas, TPelepas/SP/HP/ Danang/NhaChang/TPelepas,/ HP/HK/Kaohsiung/HP TPelepas/SP/HP/ Qui Nhon/SP	"Fesco Ayon" "MCC Confidence" "MCC Proteus"	FC 1,102 TEU FC 543 TEU FC 653 TEU	Weekly Weekly Weekly Weekly	 P: Evergreen P: Evergreen P: Evergreen
MSC	HK/HP/Shantou/HK	"MSC Wellington"	FC 1,271 TEU	Weekly	
MOL	HK/HP/Chiwang/HK, HP/HK/HP			Weekly Weekly	SC: Bien Dong
Bien Dong	HP/HCM/SP/HCM/HP,/HCM HP/Fengchang/HK/HP, HP/HCM/BKK/LC/HCM/HP	"VinashinFreighter" "Vinashin Trader" "Van Hung" "Van Ly" "Bien Dons Star" "Van Phuc"	FC 610 TEU FC 610 TEU FC 420 TEU FC 357 TEU FC 750 TEU FC 404 TEU	Weekly 2/Week Weekly	P: MOL SC: MOL
Nam Sung	Korean Ports/HK/HP/ Shekou/Xiamen/Inchon	"Bonny Star" "Happy Star"	FC 342 TEU FC 342 TEU	Weekly	
OOCL	HP/Kaohsiung/HP	"Grand Ocean"	FC 560TEU	Weekly	
RCL	SP/HP/SP			Weekly	
RSK	Shekou/SP/HP/ HK/Xiamen	"Ocean Bhum" "Resourceful"	FC 1,114 TEU FC 1,114 TEU	Weekly	
Samdera/ Advance CL	SP/HP/Danang/QuiNhon/SP HP/Chiwan/HK HK/HCM/HK	"Sinar Padang" "Kota Ria" "Kota Rakyat"	FC 400 TEU FC 938 TEU FC 938 TEU	Weekly	 P: MOL
Sinocor Merchant Marine	HK/HP/HK	"Hua Sha"	MP 300TEU	Weekly	
SITC CL	Japanese Ports / Shanghai/HK/HCM/ HP/Tokyo	"Josco Lily" "SITC Tokyo" "Trinity"	FC 1,049 TEU 847 TEU 907 TEU	Weekly	
NYK RCL	Guangzhou/Cai Lan/HCM HCM/Cai Lan/HK/Japan. ports Songkhla/HK/HP/HK	"ACX Lilly" "Asian Gyro" "Pira Bhum" "Ratha Bhum" "Supa Bhum"	1,404 TEU 1,032 TEU FC 628 TEU FC 628 TEU FC 628 TEU	Weekly Weekly	P: Tokyo Senpaku P: Tokyo Senpaku
TS Lines	Shekou/HK/Fangcheng /HP/Fangcheng, Fangcheng/HP/Chiwan			2/week	P: CU Lines
Vinalines	HCM/HP	Various	MP/FC 215/556 TEU	5/week	

Shipping Cos. In Service	Route	Vessels Name	Loading Capacity	Frequency	P: Partners SC: Slot Charter
Vinashin Ocean Shipping	?	"Vinashin Express 1"	MP 567 TEU	?	
Wan Hai	HP/Kaohsiung/HP	"Venus C" "Tai Ping"	FC 816 TEU ? TEU	Weekly	P: K Line, SC: Coscon, Evergreen, MOL

Source: Containerization International Year Book 2009 and International Transportation Handbook 2009
HP : Hai Phong, HCM: Ho Chi Minh, SP: Singapore, HK: Hong Kong, LC: Laem Chabang, BKK: Bangkok
SC: Slots Charter, P: Partners, FC: Full Container Ship, MP: Multi-purpose Ship

From the above table (Table 2.2.6), the actual substance of the service around Hai Phong area and the connecting transportation would be cleared. Only Tokyo Senpaku, under the name of NYK launched service on calling at Cai Lan since 2004 and has twice a week service with middle size container vessels, and MSC did in 2009. The containers of these lines are transported between Hai Phong and Cai Lan by motor barges and other provinces by trucks.

Now the cargo movement Asia/Europe is growing more than Asia/USA in percentages, it is said, and some Chinese shipping line swapped the fleet of post panamax size deployed in USA route for Europe route.

But there is little possibility for Far East Asia/Europe line vessels to call directly at Hai Phong due to several days' deviation from the usual navigation route at moment. Cargo transportation pattern between Vietnam/Europe will be transshipped at the hub ports like as Singapore for another several years, too, unless the new line which is originated from Hai Phong.

For eastbound cargo, there is possibility that panamax or post panamax size of container vessels will extend her service route to Lach Huyen from China and Taiwan area, especially on completion of expansion of width in Panama Canal which is to be completed in 2014, since many shipping lines maintain South China/USA west coast service by such size of vessels now.

The following table (Table 2.2.7) shows the respective operation group and their vessels of container loading capacity at present. Some vessels out of the fleet will be feasible to call at Lach Huyen on opening of the new modern container terminal. The service between Asia and US East coast via Suez Canal is excluded from this list. Such westbound routes have recently commenced due to avoiding heavy congestion of Panama Canal and escalation of Canal toll, of which amount is appropriated for the construction of new canal.

The existing calling situations of the shipping service in Hai Phong and Cai Lan are as follows:

(1) Water depth in Hai Phong Channel is 7.8m, which can accommodate approximate 10,000 DWT container vessels to be equivalent to 500/600 TEU with full load condition in spite of tidal condition, and moreover, there is no big container terminal here which has capacity to handle huge volume of containers quickly at present. In so way, the smaller type of vessels, therefore, are deployed, or around 1,000 TEU type vessels come on berth Hai Phong in not full load, with empty containers/vacant space. The channel through Cai Lan is deeper than to Hai Phong, 12m in depth, but small volume of cargo is concentrated.

(2) There have been not enough containers accumulated to handle the large size vessels in a short stay on the berth in one calling. The smaller sizes and frequency services have compensated for the above situation.

(3) The terminal is indispensable to make the shipping lines learn container productivity at quay side for keeping their service schedule as their planning. But they will not be able to catch operative condition at the existing port. Only modern equipment and facilities can perform the steady and

expeditious container handling with skillful operation.

(4) Approximately there are several days' deviations from the regular course on Kaohsiung or Shanghai/Singapore/Europe to the location of Hai Phong port. The shipping companies cannot deserve this extra navigable time and expenses for their accounts and Asia/Europe clients. Connecting feeder vessels can compensate heir loss time with transshipment at neighboring hub ports from Hai Phong.

All the other items but No. 4 out of the above descriptions can be solved on construction of the new container terminal in Hai Phong area and how to operate it to fascinate and to induce the users are essential for port of Lach Huyen.

Table 2.2.7 Existing PRC (Asia) /USA Service

Group Name	Organized Members	Capacity of Deployed vessels	Typical Vessels' names Deployed	
TNWA	MOL, APL, Hyundai	2,996 - 6,479 TEU	MOL Miracle APL England Hyundai Dominion	2,996 TEU 5,508 TEU 6,479 TEU
Grand Alliance	NYK, Hapag-Lloyd, OOCL	2,893 - 8,060 TEU	NYK Springitde Dresden Express OOCL Hamburg	2,893 TEU 4,639 TEU 8,063 TEU
CKYH	Coscon, K Line, Yang Ming, Hanjin	2,702-5,576 TEU	COSCO Panama Chicago Bridge YM Prosperity Hanjin Osaka	2,702 TEU 5,576 TEU 3,266 TEU 4,024 TEU
Maersk	Maersk	1,129 – 6,600 TEU	Astor Albert Maersk	1,129 TEU 6,600 TEU
Evergreen	Evergreen	2,728 – 7,024 TEU	Ever Gifted Ever Shine	2,728 TEU 7,024 TEU
CMA CGM	CMA CGM	4,298 – 8,600 TEU	CMA CGM Galaxy CMA CGA Courage	4,298 TEU 8,600 TEU
China Shipping	China Shipping	4,250 – 5,688 TEU	Xin Dan Dong Xin Yan Tai	4,250 TEU 5,688 TEU
MSC	MSC	873 – 8,034 TEU	MSC Immacorata MSC Beijing	873 TEU 8,034 TEU
CTP	Wan Hai, PIL	2,495 – 4,250 TEU	Wan Hai 302 Wan Hai 509	2,495 TEU 4,250 TEU
China Express	China Express, Matson	1,970 – 2,524 TEU	R J Pfeiffer Manukai	1,970 TEU 2,524 TEU

Source: MOL's data & Containerization International Year Book 2009

Northern Vietnamese ports, comparing to the southern ports, the service frequency had been poor till the several years ago. Naturally, it is not always dominant in physical and geographical location, and the trade container volume. However the service numbers of the shipping companies to Hai Phong/Cailan are increasing due to the recent jumping up of container volume. The following table shows the new joiners and the increase of frequency in services 2006 vs. 2010.

Table 2.2.8 Service Variation of Type and Vessels calling at Hai Phong/Cai Lan in 2010 & 2006

	2010				2006			
Shipping Lines In Service	**Route**	**Frequency**	**Partners**	**Vessels in Service**	**Route**	**Frequency**	**Partners**	**Vessels in Service**
ACL	SP/HP/Danang/Quinhon/SP	Weekly		Kota Machan 606 TEU Kota Ria 938 TEU	Same as 2010	Weekly		Jatianom 459TEU Kota Bintang 476 TEU Sinar Padang 495 TEU Cape Arago 1066 TEU
APL	Feeder from Kao, HK, SP, or Chiwan	Weekly		Nil	Nil	Nil	Nil	Nil
Biendong	SP/HCM/HP/HCM/SP HP/HK/HP	Weekly Weekly	SC:MOL SC:MOL	Vinashin Mariner Vinashin Navigator 1016 TEU	Nil	Nil	Nil	Nil
Chien Lie (CMA CGM)	Kao/HP/Kao Kao/HP/Kao	Weekly Weekly	SC: Y.Ming SC: TS Lines Wan Hai	Mell Senang 698 TEU Mell Seraya 704 TEU Kuo Chang, Kuo Chia, Kuo Fu, Kuo Yu 1295 TEU	Nil	Nil	Nil	Nil
ECL	Yoko/Nya/Kobe/HP/HCM	1-2/month			Same as 2010	1-2/month		
Evergreen	Kao/HK/HP/Kao	Weekly	SC: Wan Hai	Rio Lawrence 1155 TEU	Nil	Nil	Nil	Nil
Gold Star	Shekou/HK/HP/Shekou	Weekly		Xiao Yun 300TEU	Nil			
Hanjin/ Sinotrans	Busan/Shai/HP/Shai/ Busan/	Weekly		Appen Charlotte 1043 TEU Sinar Bintan 1060 TEU	Nil			
Heung-A	KwangYang/Busan/HK/ HP/Shekou?HK/KwangY	Weekly		DS Ability 1118 TEU Heung A Bangkok 650 TEU	Same as 2010	Weekly		Hueng-A Bangkok Hueng-A Hong Kong 650 TEU
Hyungdai/ Spic/TSK	Feeder service from HCM				Nil			
Kambara Kisen	Feeder service from Shanghai	Weekly			Nil			
KL/Wan Hai/ GEMCO	HK/HP/HK Another feeder service From HK	Weekly		Vinalines Pioneer 588 TEU	Kao/HP/Danang/ HC Another feeder service fm HK	Weekly	GEMCO Loop 1	Gematrans Pioneer Van Phong 585/563 TEU
KMTC/STX Pan Ocean	Busan/KwangYang/HP/ Xiamen/Shai/Busan	Weekly		Lantau Breeze 1049 TEU MareAdriaticum 1054 TEU	Nil			

Maerks	Feeder service from Kao	Weekly			Feeder service from HK or Kao			
Marui (Ro/Ro)		6-8/month			Nil			
MOL	Feeder service from HK				Feeder service from HK			
Nam Sun	Inchon/Busan/HK/HP/ HK/Shekou/Xiamen/ Inchon			Bohai Star 706 TEU Liberty Star 706 TEU	Nil			
OOCL	Kao/HP/Kao	Weekly			Nil			
PIL	Feeder service from Shanghai			Kota Tegue 700 TEU Kota Terau 720 TEU	Feeder service from SP			
RCL	SP/HP/HK/Fencheng/ SP	Weekly		Methi Bhum 926 TEU Nethi Bhum 928 TEU	Nil			
SITC	HP/HK/Xiamen/Shai Shi/Japanese Ports/ Busan/ Shai/Keelung/HP Incheon/Pyongtaek/Shai/ HK/HP/Xiamen/Incheon			Josco Star 1043 TEU Josco View 1049 TEU Sunrise Express 1049 TEU SITC Express 917 TEU SITC Quingdao 787 TEU	Nil			
TS Lines	Feeder from Kao by Chien Lie Line				Nil			
Toko	Yoko/Kobe/HP/HCM	2-3/month			Japanese ports/HP/HCM	2-3/month		
TSK	Feeder from Kao Japanese ports/Nansha/ Cailan/HCM/SP/Jakarta/ HCM/Cailan/HK/Tokyo	2/week		ACX Cosmos 1241 TEU ACX Lilly 1182 TEU Asian Gyro 1098 TEU Asian Zehhyr 1098 TEU	Japanese ports/ Shai/HK/Huangpu/ Cai Lan/HCM/ Shekou/HK/Tokyo	Weekly		ACX Cherry ACX Cosmos 1241 TEU Sunrise 1181 TEU
Wan Hai	Kao/HP/Kao	2/week		An Chun 642 TEU Shin Chung 640 TEU	Same as 2010	Weekly		Padma 734 TEU
Dongnama					Feeder from HK	Weekly		
Hapag					Feeder from SP			

Source: International Transportation Handbook 2010 & 2006
HP: Hai Phong, HCM: Ho Chi Minh, SP: Singapore, HK: Hong Kong, Kao: Kaohsiung, Shai: Shanghai
SC: Slot Charter, P: Partner

3. Present Situation of Ports

3.1 Northern Sea Ports

Until now the sea ports in Vietnam were divided into eight (8) groups, however, by the new Master Plan for Vietnam Seaport System Development till 2020 orientation to 2030, they are re-grouped into six (6). The ports concerning this SAPROF study belong to the Group 1: North.

There are two big port groups in the Group 1, namely Hai Phong and Quang Ninh with national general ports of Hai Phong and Cai Lan and many local ports and dedicated ports. Total throughput in Hai Phong and Cai Lan ports in 2000 was 9.2 million tons and had strongly grown every year and reached to 29.8 million tons in 2008. However, seaport sales have not been facilitated because Hai Phong Port is located deep inside riverbank with a limited channel depth to the ports, and the industrial zone development and logistic facilities have not been developed yet synchronously in Cai Lan Port. There is no international gateway seaport in the region and big vessels are obliged to reduce load and transfer a part of cargo by barges before entering into the port.

3.1.1 Quang Ninh Port Zone

1) Quang Ninh Zone Ports

- Two (2) dedicated ports for coal of Cua Ong and Hon Gai servicing the whole nation’s demand and export.
- Petroleum Port (B12) servicing northern regions.
- General Ports: Quang Ninh Floating Berth and Cai Lan Port.

2) Cai Lan Port

Present condition of Cai Lan Port is summarized as shown in Table 3.1.1.

Table 3.1.1 Facility and Equipment of Cai Lan Port

<table>
<tr><th>Berth</th><th>Length</th><th>Depth</th><th>Cargo</th><th>Yard</th><th>Warehouse</th><th>Equipment</th></tr>
<tr><td>No.1</td><td>166m</td><td>-9.0m</td><td>Bulk/G.C.</td><td rowspan="4">14.2 ha</td><td rowspan="4">1.54 ha</td><td rowspan="4">Mobile Crane: 1x64t, 1x104t,
RTG: 4x40t, 1x50t
Rubber Tyre Crane 3x14t, 1x25t
Ev Crane: 1x50t,
Forklift: 2x7t, 3x8t
13 Chassis</td></tr>
<tr><td>No.5</td><td>220m</td><td>-12.0m</td><td>Bulk/G.C.</td></tr>
<tr><td>No.6</td><td>220m</td><td>-12.0m</td><td>Bulk/G.C.</td></tr>
<tr><td>No.7</td><td>220m</td><td>-13.0m</td><td>Container</td></tr>
</table>

Cai Lan Port was developed in Bai Chay Bay by dredging up to -9.0m to -13.0m. Berth No.5 to Berth No.7 were constructed by the Japan’s ODA fund in 2004 and started container handling. However, during the past few years, throughput of container in Cai Lan Port had been decreased drastically because of damage of quay gantry container cranes by typhoon in 2006, but it has been recovering very quickly in this year.

Cai Lan Port shall be accessed through about 33km long approach channel of -10m deep in Ha Long Bay from the ocean and further deepening of the approach channel can not be expected from an environmental point of view.

Cai Lan Port is managed and operated by the Quang Ninh Port Company under the JV of Quang Ninh Province and VINALINES. Cai Lan Port has decided to develop No.2 to No.4 container berths by 2012 by the private fund of American developer. Throughput of Cai Lan Port during 2002 to 2009 is presented in Table 3.1.2.

Table 3.1.2 Throughput of Cai Lan Port

TT	Criteria	Unit	2000	2001	2002	2003	2004	2005	2006	2007	2008	11 months 2009
I	**Bulk cargo capacity**	**Ton**	**1,533,130**	**1,525,911**	**1,563,232**	**1,623,215**	**2,335,059**	**3,177,937**	**3,738,540**	**2,967,566**	**3,339,818**	**4,686,722**
II	**Total passing cargo capacity**	**Ton**	**1,513,261**	**1,513,573**	**1,559,076**	**1,748,406**	**2,475,597**	**3,185,136**	**3,498,824**	**2,805,408**	**3,022,618**	**4,289,116**
	Export	Ton	284,773	284,858	368,338	491,366	980,710	974,717	1,157,528	1,562,421	1,664,397	1,365,110
	Import	Ton	419,824	638,312	924,795	1,025,686	828,242	1,059,104	883,548	831,760	856,349	1,512,346
	Domestic	Ton	808,664	590,403	265,943	231,354	666,645	1,151,315	1,457,748	411,227	501,872	1,411,660
*	**Container**	**teus**	**2,182**	**662**	**244**	**2,289**	**121,252**	**211,788**	**245,923**	**66,701**	**63,367**	**301,299**
_	**Cargo container**	**Ton**	**0**	**0**	**0**	**1,121**	**55,320**	**93,151**	**113,360**	**32,220**	**30,147**	**129,882**
	Export	Ton					11,673	14,359	18,869	10,752	11,259	21,868
	Import	Ton					15,477	39,558	30,166	15,724	17,310	51,257
	Domestic	Ton				1,121	28,170	39,234	64,325	5,744	1,578	56,757
_	**Non-bulk cargo container**	**Ton**	**2,182**	**662**	**244**	**47**	**10,612**	**25,486**	**19,203**	**2,261**	**3,073**	**41,535**
	Export	Ton					1,568	6,547	2,388	176	2,278	17,755
	Import	Ton					354	1,047	2,930	84	122	1,529
	Domestic	Ton	2,182	662	244	47	8,690	17,892	13,885	2,001	673	22,251
*	**Details of passing capacity**	Ton	1,513,261	1,513,573	1,559,076	1,748,406	2,475,597	3,185,136	3,498,824	2,805,408	3,022,618	4,289,116
1	**Export**	**Ton**	**284,773**	**284,858**	**368,338**	**491,366**	**980,710**	**974,717**	**1,157,528**	**1,562,421**	**1,664,397**	**1,365,110**
	Cargo container	Ton					114,820	216,166	263,748	150,542	225,180	306,152
	Non-bulk cargo container	Ton						43,340	6,045	440	5,695	248,570
	Oil	Ton	3,757	5,077	9,460	7,500	3,460	4,067	7,684	2,950	4,696	8,618
	Wood chip	Ton	16,771	7,516			9,621	251,204	374,688	493,617	416,996	285,851
	Wood	Ton							10,050	6,448	1,604	
	Stone (Tan Mai, Banpu)	Ton	51,103	75,436	73,040	90,014	73,127	72,160				
	Fertilizer	Ton								114,511	203,967	4,926
	Ore	Ton									291,025	126,729
	Steel	Ton									25,060	127
	Coal	Ton	213,142	170,359	285,838	387,728	779,620	378,266	450,223	781,655	457,664	370,313
	Clinker	Ton										
	Equipment	Ton									2,040	1,324
	Cement	Ton										12,500
	Contruction material	Ton							39,182	9,146	29,968	
	Others	Ton		26,470		6,124	62	9,514	5,908	3,112	502	
2	**Import**	**Ton**	**419,824**	**638,312**	**924,795**	**1,025,686**	**828,242**	**1,059,104**	**883,548**	**831,760**	**856,349**	**1,394,354**
	Cargo container	Ton					228,500	614,205	347,785	220,289	346,200	717,598
	Non-bulk cargo container	Ton						8,230	7,325	210	305	21,406
	Oil	Ton			128,122	113,276	132,564	149,148	144,854	144,625	121,554	162,404
	Chemical	Ton							15,800	22,269	8,576	5,010
	Gypsum	Ton	6,311	48,134	40,401	137,393	40,637	6,100				
	Klinker	Ton		38,600	329,147	390,812	156,848					
	Wheat	Ton							176,137	168,893	32,987	
	Wheat flour	Ton									400	
	Barley corn	Ton		38,720	146,984	124,987	150,248	117,506				148,259
	Fertilizer	Ton		56,378	247,896	180,498	81,568	96,886	62,644	121,461	124,684	92,961
	Fertilizer in bags	Ton	290,477	425,384		12,025	3,838	21,837	15,466	100,172	75,018	
	Feedstuffs	Ton	61,828					15,041	75,785	17,576	57,098	185,205
	Equipment	Ton	6,118			43,678	13,858	10,426	27,145	21,085	3,327	5,269
	Scrap bundle	Ton					2,487	10,006		656	61,563	118
	Asphalt	Ton					7,760	9,540	7,498	14,524	17,448	
	Others	Ton	55,090	31,096	32,245	23,017	9,934	179	3,109		7,189	56,124
3	**Domestic**	**Ton**	**808,664**	**590,403**	**265,943**	**231,354**	**666,645**	**1,151,315**	**1,457,698**	**411,227**	**501,845**	**1,411,660**
*	*Domestic export*	*Ton*	*726,905*	*558,937*	*260,888*	*221,840*	*371,269*	*778,496*	*774,177*	*322,399*	*200,986*	*796,117*
	Cargo container	Ton					209,411	433,019	524,343	60,448	1,040	596,834
	Non-bulk cargo container	Ton						75,573	27,637	4,225	1,483	31,220
	Wheat	Ton	33,071	52,159	42,569	20,528	18,992	20,789	30,703	16,615	8,935	9,339
	Container	Ton										8,652
	Wood	Ton										3,228
	Oil	Ton							5,532	3,212	3,299	17,057
	Klinker	Ton	376,294	221,061	12,783	9,748	12,000	176,738	142,308	201,021	158,521	100,545
	Fertilizer	Ton								20,577	16,811	15,991
	Chemical	Ton								7,756		505
	Ore	Ton								3,130	5,269	
	Coal	Ton	107,412	115,875	35,000	26,767	20,885	38,938	9,416	140	1,000	
	Cement	Ton										4,779
	Steel	Ton										2,633
	Equipment	Ton								419	2,814	5,334
	Others	Ton	210,128	169,842	170,536	164,797	109,981	33,439	34,238	4,856	1,814	
*	*Domestic import*	*Ton*	*81,759*	*31,466*	*5,055*	*9,514*	*295,376*	*372,819*	*683,521*	*88,828*	*300,859*	*615,543*
	Cargo container	Ton	55,981	15,058	4,870		240,130	211,509	564,005	31,456	27,720	197,764
	Non-bulk cargo container	Ton						27,787	7,075	778	100	280,294
	Wheat	Ton									2,501	
	Oil	Ton						1,597		9,750	2,573	9,550
	Container	Ton										1,960
	Wood	Ton	24,723	3,807	185		30,666	106,031	97,582	33,434	25,039	12,685
	Barley corn	Ton					12,661		9,508	11,831	23,265	12,444
	Klinker	Ton								826		
	Ore	Ton									199,269	90,005
	Steel	Ton										795
	Equipment	Ton								658	3,169	7,396
	Construction material	Ton					11,919	25,895	5,351		17,223	
	Others	Ton	1,055	12,601						95		2,650
	Loading rate		1,01	1,01	1,00	0,93	0,94	1,00	1,07	1,06	1,10	1,09
III	**Cargo Volume by transport line, including:**											
1	By sea transport							2,707,366	2,974,000	2,384,597		
2	By road transport							477,770	524,824	420,811		
IV	**Vessel quantity:**											
1	*By type*								*479*	*493*	*516*	*416*
	Passenger ship								17	42	59	10
	Bulk cargo ship								292	323	347	255
	Container vessel								170	128	110	151
2	*By capacity*								*0*	*493*	*516*	
	Under 10.000T									250	333	198
	From 10.000 to under 20.000									148	97	82
	From 20.000 to under 30.000									63	59	80
	Above 30.000									32	27	56

3.1.2 Hai Phong Port Zone

Currently, seaport network in Hai Phong Port Zone located mainly along Cam Riverbank with about 17 major ports stretching on 7.8km bank. Total throughput of this port group in 2004 was about 13 million tons/year, mainly handled in Hai Phong Port (80% - 90%), and in 2008, within 4 years, it reached to 27 million tons/year.

Hai Phong Port is the largest international commercial port in Northern Vietnam and handling the second largest throughput in Vietnam following Saigon Port. Hai Phong Port includes four (4) loading zones which are planned for development as follows:

- Vat Cach Zone will be upgraded for a 650m berth, which can receive ship under 3,000DWT. This port will be domestic operation and act as a cargo transfer facility in Hai Phong Port.
- Hoang Dieu Zone with a 1,718m berth will be upgraded, which functions as a general port (general cargo and container zone incorporated with one international passenger wharf).
- Doan Xa Zone (with a 200m pier) will be repaired to maintain the function for general cargo. This zone can receive 5,000DWT vessels.
- Chua Ve Zone was developed for the first dedicated modern container port in the region. Rehabilitation of No.1 and No.2 berths and construction of No.3 berth were implemented by Japan’s ODA fund as Hai Phong Port Rehabilitation Project Phase I during 1997 to 2001. Additional two (2) berths were also constructed by the Japan’s ODA fund as Hai Phong Port Rehabilitation Project Phase II during 2001 to 2005.

Dinh Vu Zone will be developed for general cargo and container. The two (2) berths of Dinh Vu General Cargo Port are under operation. The first two container berths in Dinh Vu New Port were developed by private entity and under operation using tower cranes and the other 3 container berths are now under construction by Hai Phong Port.

Present situation of Hai Phong Zone Ports are summarized as shown in Table 3.1.3.

Table 3.1.3 Facility and Equipment of Hai Phong Ports

Berth	Length	Depth	Cargo	Yard	Warehouse	Equipment
Main Port (Hoan Dieu)						
1,2,3	413m	-8.7m	Container	29.63ha	3.01ha	Tower Crane: 26x5t-40t, Floating Crane: 2x10t-85t, RTG: 6x 25t-50t Forklift: 36x3t-45t Tug/Service Boat: 8x305CV-3,200CV, Weighbridge: 4x80t Automatic Filling Line 8x3,500t/day/ship
4 - 11	1,304m		G.C			
Chua Ve Container Terminal						
1-5	848m	-8.4m	Container	18.87ha	0.6ha	QGC: 6x35.6t Tower Crane: 5x5t-40t RTG: 12x35.6t, Rubber Tyre Crane: 2x25t-50t Forklift: 22x3t-45t Weighbridge: 1x80t
Doan Xa Port						
1	220m	-7.8m	Container	6.5ha	0.12ha	Tower Crane 2x40t, 1X10t, Forklift Truck 3x5t, 1x10t, 4x45t, Crane 1x16t

Berth	Length	Depth	Cargo	Yard	Warehouse	Equipment
Dinh Vu General Port						
1	237m	-9.3m	G.C.	23.64ha	0.36ha	Tower Crane: 3x40t Top Lifter: 3x45t Rubber Tyred Crane: 1x25t
2	188m	-9.3m	G.C.			
Dinh Vu New Port						
1	200m	-10.2m	Container	56.9ha	0.1ha	Tower Crane: 2x5t-40t
2	200m	-10.2m	Container			
3-5	200m	-10.2m	Container			*Under Construction /2010
Vat Cach Port						
1-6	485m	-4.0m/-4.7m	G.C.	21ha	0.72ha	Shore Crane: 11x5t-36t Forklift: 4x4t-7t Truck: 9x5t-16t Excavator: 1
Cua Cam Port						
1-4	350m	-2.5m/-7.0m	G.C.	2.7ha	1.17ha	Shore Crane: 4x7.5t-16t Rubber Tyre Crane: 4x16t-36t Crawler Crane: 1x25t
Transvina Port						
1	165m	-7.8m	Container	5.1ha	0.12ha	Harbour Mobile Crane: 1x100t Tower Crane: 1x40t Forklift 3x45t, 1x5t Lift Truck: 6x3t-10t Container Truck: 15x10t-30t Tug Boat 1x800HP, 1x1600HP
Green Port						
2	320m	-8.0m	Container	4.73ha		Slewing Gantry Crane: 2x40t Mobile Crane: 2x40t Straddle Carrier: 4x40t Tug Boat: 1x70t
Le Chan Port						
1	144m		Container	6.65ha		2 Jib Cranes

Hai Phong ports are located along the maritime access channel of 42.8km from Buoy No. Zero and its depth is kept to -7.3m up to Dinh Vu Port and to -5.5m up to central terminal. The average tidal difference is 2.5m. The limited depth of access channel is the biggest problem for Hai Phong Ports. However, Hai Phong Port has a long history for operation and not only accumulation of port facilities but also supporting functional facilities and infrastructures and many peoples living with port business. Therefore, it is very important to use Hai Phong ports effectively.

Hai Phon Port is managed and operated by Haiphong Port Holding Limited Liability Co. under VINALINES. VINALINES is operating not only Hai Phong Port but also other main Vietnamese ports, such as Saigon Port, Da Nang Port, Can Tho Port and Cai Lan Port through its subsidiary companies.

Throughput of Hai Phong Port during 2002 to 2009 is presented in Table 3.1.4.

Table 3.1.4 Throughput of Hai Phong Port

	2002	2003	2004	2005	2006	2007	2008	2009 until Oct
1. Export	**1,365,476**	**1,757,845**	**1,792,445**	**2,349,120**	**2,825,099**	**2,684,001**	**3,243,855**	**1,977,551**
Sugar								
Apatit		1,750	2,029		45,790	75,824	261,446	60,592
General	3,947	2,035	500	1,750	504	33,177		
Container	1,193,139	1,650,877	1,650,945	1,827,447	2,193,578	2,117,574	2,190,655	1,649,867
Timber	65,886	28,800	68,388	109,131	103,836	82,533	54,800	45,567
Logistic cargo								
Chemical			287				2,922	
Metal	6,998	1,250	2,002	2,712	409	13,041	204,558	18,205
Klinker			2,100		54,311	51,662	154,439	21,146
Forest and native products								
Foodstuff	10,000							
Miscellaneous								
Equipment	11,055	2,477	5,944	10,151	10,317	14,735	18,092	21,768
Asphalt			1,399					
Fertilizer			212	5,679		27,784	110,504	31,568
Metalic ore	50,379	29,656	11,376	17,149	25,044	28,455	43,924	10,069
Food and vegitable								
Jute carpet								
Gypsum			60					
Coal				331,492	306,938	4,991	18,985	5,716
Construction Material	24,072	41,000	14,798	38,051	67,962	230,109	149,024	94,581
Cement			32,405	5,558	16,410	4,100	27,312	18,470
Oil						16	5,703	
2. Import	**5,286,584**	**5,401,816**	**5,368,625**	**5,196,931**	**5,198,668**	**6,218,248**	**7,634,025**	**7,103,342**
Sugar			2,199		5,893			2,000
Apatit			49	83	2,100	40	57	133
General	121,105	31,386	16,527	6,353	5,516	10,459	17,438	11, 226
Cotton								
Container	1,652,471	1,974,339	1,792,646	2,035,552	2,237,235	3,285,283	3,990,268	3,007,776
Timber	36,357	46,783	72,101	21,307	41,699	13,059	13,669	38,217
Logistic cargo								
Chemical	43,192	38,267	40,078	56,655	47,060	64,945	46,404	16,982
Metal	1,974,411	1,535,265	1,607,142	1,426,176	1,220,232	1,409,737	1,791,699	1,990,958
Klinker	133,229	279,003	286,376	154,056	146,148	26,149	30,832	3,000
Forest and native products	5,382		21,635	3,738				
Foodstuff	118,852	6,546	823	3,933	160			
Miscellaneous		2,911		796				
Equipment	145,641	105,523	137,863	111,199	88,789	249,282	325,785	259,687
Salt	52,152	1,132					22,921	61,961
Asphalt	12,057							
Fertilizer	589,320	552,182	446,514	259,515	101,807	54,593	18,922	99,305
Sulfur				58,073	96,701	95,251	73,443	143,246
Metalic ore	75,373	77,695	133,623	113		49,358	60,907	32,786
Food and vegitable			50	209	219	38,241		72,135
Foodstuff for cattle	218,398	698,176	399,636	513,652	762,977	833,030	608,688	869,331
Gypsum	106,744	52,322	118,958	121,709	17,608	22,603	10,340	
Coal			42,849	26,671	23,466		13,582	23,586
Construction Material	1,900	1	27,115	6,501	550	245	39,964	1,688
Cement					400,508			
Oil		285	222,441	390,640				467,076
3. Domestic	**3,669,293**	**3,358,601**	**3,325,436**	**2,966,007**	**3,127,601**	**3,398,319**	**3,091,106**	**2,982,229**
Sugar	14,324	502	4,874	8,743	4,958	240		11,444
Apatit	53,354	89,637	98,620	114,231	114,293	109,283	135,624	98,368
General	268,717	65,323	60,980	55,649	39,891	55,397	57,224	67,449
Cotton	0	0	0	0	0			
Container	1,183,766	1,303,783	1,466,208	1,379,057	1,146,160	1,168,873	1,552,846	1,683,740
Timber	2,120	13,349	28,996	51,052	33,407	18,696	12,666	1,865
Logistic cargo	0	0	0	0	0			
Chemical	18,768	7,420	12,387	15,998	3,433	4,260	4,583	7,497
Metal	240,395	269,411	285,358	243,201	160,302	157,437	203,633	261,517
Klinker	41,387	34,189	48,565	140,275	460,925	509,190	182,741	289,464
Forest and native products	7,369	14,571	10,436	7,917	0		1,413	1,955
Foodstuff	571,881	199,198	249,819	60,718	50,082			
Miscellaneous	0	46	45	0	0			14,570
Salt	46,750	21,796	15,302	6,504	1,719		1,638	1,014
Equipment	8,801	13,042	13,867	16,374	19,194	47,391	18,237	12,665
Asphalt	821	1,390	130	61	0			
Fertilizer	252,149	300,599	161,187	192,722	120,171	278,589	276,357	110,994
Sulfur	0	0	61,686	2,654	0	2,114	8,132	
Metalic ore	27,034	39,362	51,348	54,236	50,960	42,380	78,161	7,871
Food and vegitable	6,146	12,393	18,116	13,490	17,614	62,784	63,126	46,673
Foodstuff for cattle	73,001	283,258	219,382	288,871	279,437	147,489	134,275	123,211
Gypsum	0	6,119	11,909	0	0		6,119	2,350
Coal	0	773	149,658	52,660	40,642	27,819	21,739	46,264
Construction Material	185,410	237,612	142,447	116,463	100,664	114,322	42,378	49,310
Cement	667,100	444,682	213,815	144,619	475,446	652,050	275,958	133,998
Oil	0	146	301	512	58	5	14,256	10,010
Sulfur					8,245			

3.2 Hinterland Transportation

3.2.1 Road

The road network in the northern Viet Nam, 116,410km of total distance consist of national highway (6,882 km), provincial road (8,950km), district road (15,350km) and others (99,964km) based on TDSI's data in 2005. The road network in the Northern Vietnam has been developed connecting the capital city, Hanoi and major cities and international ports, Hai Phong and Cai Lan as well as the small and medium cities and towns. The major national highways in the area are: NH1, NH2, NH3, NH5, NH6, NH10 and NH18.

In the future road network, the Ministry of Transport of Vietnam has planned Tan Vu-Lach Huyen Highway for connection with Lach Huyen Port. Moreover, Hanoi-Hai Phong Express Highway (105.5km of distance, 120km/hour of design speed, both direction 3 lanes) was also authorized as BOT method development project.

(1) National Highway 1 (NH1)

The longest and the most important route longitudinally connects Lang Song province in the north and Ca Mau province in the south with a total length of 2,300km. NH1 has a 2-lane carriageway but it is widened to 4-lanes in some sections near the large and medium cities. NH1 links major cities, major ports and airports along the coastline in Vietnam such as Hue, Da Nang, Qui Nhon, Nha Trang and HCMC and traverses 33 provinces. NH1 from Dong Dang (Lang Son) to Gia Bay Bridge (Thai Nguyen) has been improved recently, and thus the quality is good.

(2) National Highway 2 (NH2)

A major route in Northern Vietnam connecting capital Hanoi, Vinh Phuc province, Phu Tho province, Tuyen Quang province and Ha Giang province with a total length of 313km. The section through Vinh Phuc has been upgraded with 4 lanes under BOT scheme. NH2 is planned to be upgraded to Class III.

(3) National Highway 3 (NH3)

A major route links capital Hanoi with Northernmost provinces of Vietnam including Thai Nguyen province, Bac Kan province and Cao Bang province with a total length of 350km. This route starts from Duong Bridge and finishes at Ta Lung border gate. NH3 is planned to be upgraded to Class III.

(4) National Highway 5 (NH5)

A major transport route connecting capital Hanoi and international port, Hai Phong with a total length of 106km. NH5 has basically a 4-lane carriageway traversing rural areas except for many small cities and towns in Hung Yen province, Duong province and Hai Phong province. Several industrial parks and small and medium sized factories are located along this route. NH5 runs parallel with the railway of the Hanoi – Hai Phong line in some sections. Traffic congestion and accident has been caused due to the capacity shortage in some sections. It is planned to improve the capacity in whole section.

(5) National Highway 6 (NH6)

A major route connecting Northern part provinces including Hanoi province, Hoa Binh province, Son La province and Dien Bien province with a total length of 504km. NH6 is the road links Hanoi with Northwestern provinces of Vietnam. The start point is Nhue River bridge and the end point is Muong Lay town in Dien Bien province. NH6 traverses rural mountainous areas except for some small and medium sized cities in Quang Ninh province and Dien Bien province. It is panned to upgrade to Class I-II in Ha Noi – Xuan Mai and to Class III in Xuan Mai – Hoa Binh.

(6) National Highway 10 (NH10)

A major route connecting the Northern part provinces including Quang Ninh province, Hai Phong province Thai Binh province Nam Dinh province and Thanh Hoa province with a total length of 230km. NH10 basically a 2-lane carriageway but in some short sections passing medium sized towns, the carriageway is widened to 4-lanes. NH10 traverses rural areas except for some small and medium sized cities in Quang Ninh province, Hai Phong province and Thai Binh province. Some small and medium sized factories are located in the area. It is planned to upgrade to Class III in Ninh Binh, to upgrade to Class IV in Thanh Hoa, and to construct bypass in Nga Son town.

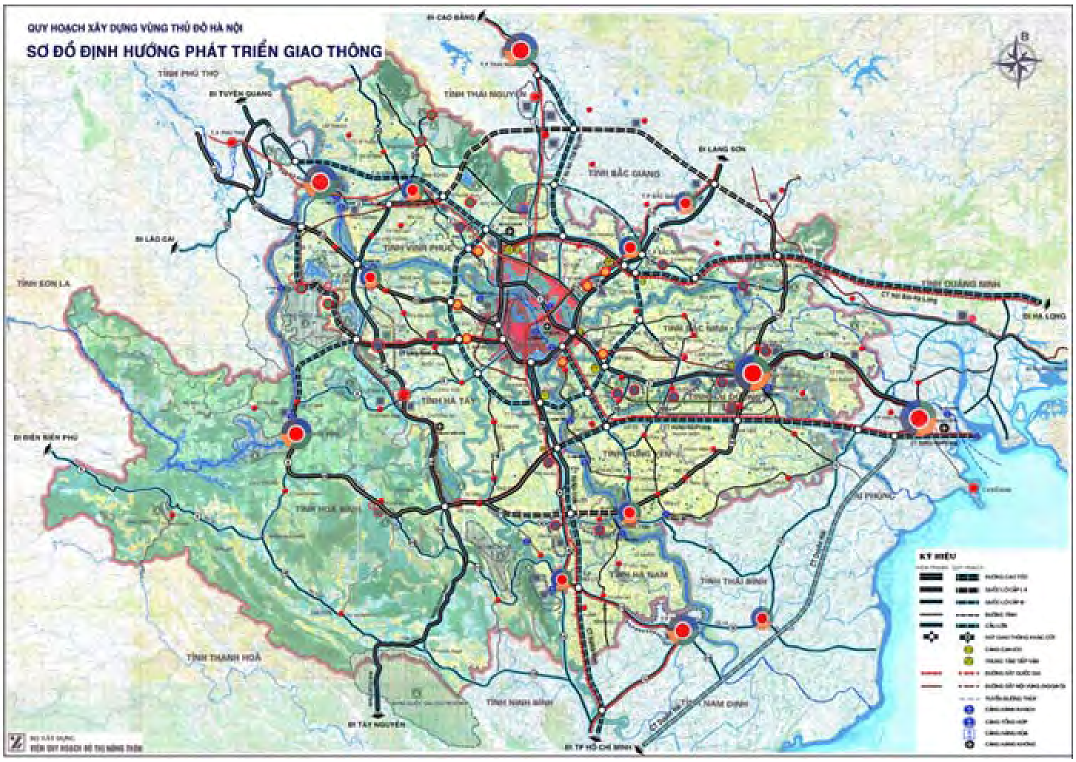
(7) National Highway 18 (NH18)

A major route connecting Noi Bai in Hanoi and Mong Cai, the eastern border between Quang Ninh province and China with a total length of 342km. NH18 has basically a 2-lane carriageway. NH18 traverses rural agricultural areas except for some small and medium sized cities in Bac Ninh province and Hai Duong province. Some small and medium sized factories are located in this area. The section from Bac Ninh to Cua Ong is class II-III, while the section from Cua Ong to Mong Cai is class V. The section from Cua Ong to Mong Cai is planned to be upgraded to Class III.

Above NH1, NH3, NH5, NH10 and NH18 were improved/upgraded by the Japan's ODA fund.

In addition to National Highways, the following expressways are planned in the Northern Vietnam.

- Ha Noi - Hai Phong, 105km in length
- Ha Noi - Viet Tri - Lao Cai , 264km in length
- Ha Noi - Ha Long - Mong Cai, 294km in length
- Ha Noi - Thai Nguyen - Cho Moi (Bac Kan), 90km in length
- Lang Hoa Lac - Hoa Binh, 56km in length
- Ninh Binh - Hai Phong - Quang Ninh, 160km in length



Source: Road Transport Development Master Plan 2020

Figure 3.2.1 Road Plan in the Northern Vietnam

3.2.2 Railway

There are five railway routes in the Northern part of Vietnam.

(1) **Hanoi – Ho Chi Minh City Line**: The longest railway line occupying two thirds of the total Vietnam railway network which connects the capital city in the north and HCMC with the total length of 1,726km. This line is the biggest railway service provider dominating more than 80% of total passenger transport and nearly 60% of cargo transport in Vietnam. Since this line runs along the long coast line between the north to south, it competes with air transport for long distance and with bus transport for medium distance. Regarding cargo transport service, inland waterway transport and truck transport are competitors. Many cities are located along this line and there is a constant demand for railway transport on all the section along this line.

(2) **Hanoi - Hai Phong Line**: This line links capital city Hanoi and international port city Hai Phong with the total length of 102km. The composition of passenger and cargo transport on this line is about fifty – fifty at present but passenger transport is expected to increase with the raise of travelers and commuters between Hanoi and Hai Phong. The container cargo transport by rail is also expected to increase since industrial parks along this line are developing very rapidly and container throughput of Hai Phong Port has also been growing drastically recent years. Hanoi - Hai Phong Line is planned to be improved to double track with 1435mm gauge in whole section, and be elevated in the section from Ly Thuong Kiet to Hai Phong Station. The new railway is expected to be constructed along Hanoi – Hai Phong expressway, which will be connected to Lach Huyen Port.

(3) **Hanoi - Dong Dang Line**: This line is one of two international routes connecting Hanoi and Dong Dang in Lang Son province which is located north-east border gate to Nanning of China with the total length of 162km. This line is equipped with a dual gauge accommodating both types of trains of normal gauge and meter gauge. The northern section of the line is located in a mountainous area with many tunnels and where the agricultural productivity is not high. However this line has significant potential as a strategic land transport route between Vietnam and China.

(4) **Hanoi - Quan Trieu Line**: This line was initially developed to transport mineral ore from the mines located 75km north of Hanoi. This line is equipped with a dual gauge and operated only single trip per day for each passenger and cargo train. Noi Bai Airport (Hanoi International Airport) is located near this line and this line has development potential to serve between the hinterland of Hanoi and the capital city.

(5) **Hanoi - Lao Cai Line**: This line is another international route to China. This line links Hanoi and Lao Cai in Lao Cai province which is the west gate to Kunming, China with the total length of 296km. Agricultural commodities and mineral ore produced along this line are the main cargo goods.

Source: Hai Phong City Master Plan

Figure 3.2.2 Railway Plan around Hai Phong

3.2.3 Inland Waterway

Main waterways in the North are Red River and Thai Binh River. They are affected by hydrographic factors. The minimum width ranges from 30m to 36m while that of depth is from 1.5m to 3.6m. There is great difference in depth between the dry and rainy season (5m to 7m, even 10m). Besides there are lots of river ports but most of them are small with low capacity of loading and unloading. In spite of many limitations, waterway transport is still a favorite choice because it is not expensive and suitable to certain kinds of goods. Vietnam is now carrying out a program on up-gradation of river ports as well as river bet dredging to improve waterway ability.

3.2.4 Industrial Parks in the Northern Viet Nam

In 2010, total developing area of Industrial Parks (total 49 IPs) in the northern Viet Nam, is more than 17,000 ha. (Table 3.2.1).

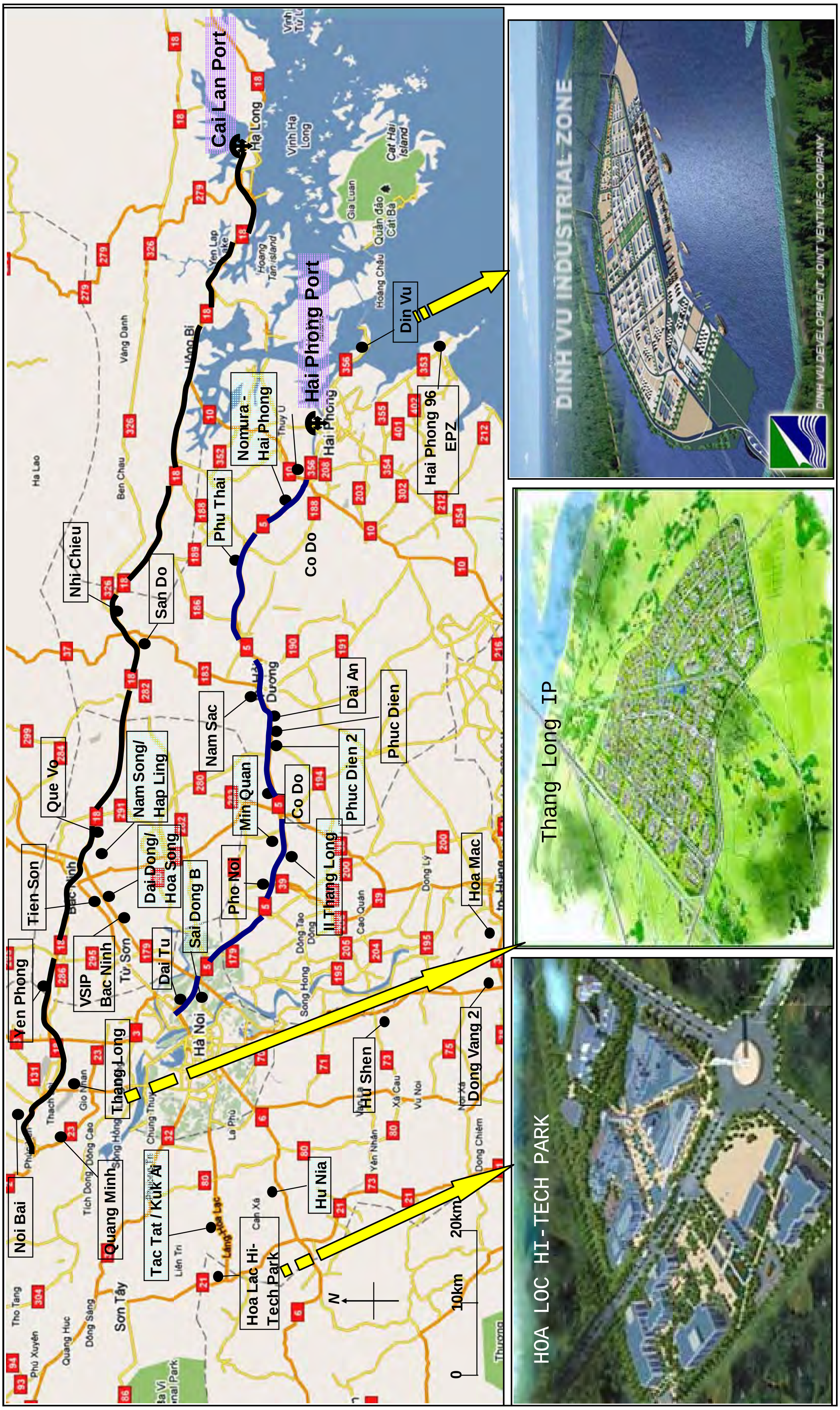
The Dinh Vu Industrial Zone (DVIZ) in Hai Phong, having biggest developing area (1,463 ha) in Northern Viet Nam, is a development with port facilities (Dinh Vu Terminal) initiated by a consortium of international companies in close co-operation with the Vietnamese Authorities.

Figure 3.2.3shows the main Industrial Park Locations around Red River Delta, Hai Phong Port and Cai Lan Port.

Table 3.2.1 Industrial Parks in the Northern Viet Nam

Municipality/ Province	No.	Name of IP	Area (ha)	Investor
Hanoi	1	Thang Long	302	Dong Anh Co. & Sumitomo Corp. Joint Venture
	2	Thach That - Quoc Oai	155	Vietnam Investment Development Group (VID)
	3	Soc Son	55	Ha Noi Construction Investment JSC
	4	Sai Dong B	97	Hanoi Electronics Corporation (Hanel)
	5	Sai Dong A	420	Deawoo and Ha Noi Electronics Joint Venture
	6	Quang Minh	344	Vietnam Investment Development Group (VID)
	7	Phu Nghia	670	Phu My Industrial Development JSC
	8	Noi Bai	100	Noi Bai Development Co. Ltd.
	9	Nam Thang Long	261	Infrastructure Development JSC - Ha Noi Industrial and Trade Association
	10	Khu Công nghệ cao Sinh	200	Pacific Land ltd và Cty CP Tư vấn Đầu tư Xây dựng & Ứng dụng Công nghệ mới Vinaconex R&D
	11	Hanoi - Dai Tu	40	Vietnam Investment Development Group (VID)
	12	Dong Anh	470	Projects Management Board of Dong Anh District
	13	Bac Thuong Tin	112	D.I.A Development and Investment Co.
	14	Bac Thang Long	302	Dong Anh Co. & Sumitomo Corp. Joint Venture
Hai Phong	1	Trang Due	600	Công ty CP Khu Công Nghiệp Sài Gòn – Hải Phòng
	2	Nomura	153	Công ty Phát triển Khu Công Nghiệp Nomura Hải Phòng
	3	Nam Cau Kien	263	Công ty CP Công nghiệp Tàu thủy Shinec
	4	Dinh Vu	1,463	Công ty Liên doanh TNHH Phát triển Đình Vũ
	5	Do Son	150	Công ty Liên doanh Khu Chế Xuất Hải Phòng
Quang Ninh	1	Viet Hung	301	507 Construction Company
	2	Hai Yen	182	Công ty Kinh doanh Bất động sản Viglacera
	3	Dong Mai	200	Công ty Kinh doanh Bất động sản Viglacera
	4	Cai Lan	278	Quang Ninh Construction & Cement JSC
Bac Ninh	1	Yen Phong II	479	Cty CP Sông Đà 10 & Cty CP Xây dựng hạ tầng Sông Đà
	2	Yen Phong I	750	Tổng Công ty Thủy tinh và Gốm Xây dựng
	3	Tien Son	410	Công ty Đầu tư Phát triển Hạ tầng INDECO
	4	Thuan Thanh III	368	Công ty CP Khai Sơn
	5	Thuan Thanh II	250	Cty TNHH Shunfar
	6	Thuan Thanh 1	200	Công ty Đầu tư Phát triển Nhà & Đô thị (HUD)
	7	Que Vo III	593	Cty CP Nông sản Bắc Ninh
	8	Que Vo II	570	Công ty CP Đầu tư Phát triển Đô thị và Khu Công
	9	Que Vo I	640	Công ty CP Phát triển Đô thị Kinh Bắc
	10	Nam Son - Hap Linh	800	Viglacera Company
	11	Hanaka	74	Cty CP Tập đoàn Hanaka
	12	Do Thi Dai Kim	508	Tập đoàn Hồng Hải Foxconn (Đài Loan)
	13	Dai Dong - Hoan Son	600	Công ty CP Phát triển Đô thị Kinh Bắc
Hai Duong	1	Phuc Dien	170	Công ty xây dựng Số 2 (Thuộc Tổng Công ty xây dựng Hà Nội)
	2	Nam Sach	63	PhuThai Land Corporation
	3	Lai Cach	191	Dai An JSC
	4	Dai An	645	Dai An JSC
Hung Yen	1	Thang Long 2	219	Sumitomo Japan Corporation & Thang Long IP Co.
	2	Pho Noi A	390	Công ty Cổ phần xây dựng & phát triển đô thị Hòa Phát
	3	Minh Duc	200	VNT Co. Ltd
	4	Det may Pho Noi B	135	Pho Noi B Textile Development JSC
Vinh Phuc	1	Kim Hoa	264	Công ty TNHH Một Thành viên Phát triển đô thị & Khu công nghiệp IDICO
	2	Khai Quang	262	Công ty Cổ phần phát triển hạ tầng Vĩnh Phúc
	3	Chan Hung	131	Công ty Kinh doanh Bất động sản Viglacera
	4	Binh Xuyen	982	Công ty TNHH Đầu tư xây dựng An Thịnh
	5	Ba Thien	327	Công ty TNHH và Quản lý hạ tầng Compal
Total			17,338	

Source: Website of "VIPIP: Vietnam Industrial Zones" (January 2010)



Source: INVEST VIETNAM, Each IP Home Page

Figure 3.2.3 Industrial Park Locations around Red River Delta

4. Past Port Development Plans in Northern Viet Nam

4.1 Urgent Rehabilitation Plan of Hai Phong Port Master Plan Study

This study was conducted by JICA in 1993 for the transport development in the Northern ports of Vietnam. In this study, the total cargo volume was forecasted to grow from 2.4 million tons of 1992 to 5.7 million tons in 2000 and container traffic will be 200,000 TEU by 2000. Based on the demand forecast result, it was proposed that the existing access channel of Hai Phong port should be deepened to -6.0m and the berth No. 1 to No.3 of Hai Phong main port and Chua Ve port should be improved for container handling. This study also had highlighted the severe problems on deepening and maintaining of the Nam Trieu outer channel.

4.2 Hai Phong Port Rehabilitation Project Phase I

This study was conducted in 1995 and 1996 by JICA to review the above Urgent Rehabilitation Plan of Hai Phong Port Master Plan and define the urgent improvement project for the port facilities up to the year 2000. At that time, it was expected that container traffic will increase rapidly and the site at Chua Ve port had sufficient land areas and room for additional berths to meet the projected traffic demand. Therefore, this report recommended implementing following projects urgently:

- Chua Ve port should be restructured to be a new dedicated container terminal. So that, in addition to the 2 existing berths, one berth and the stacking yard should be expanded and 2 quay gantry cranes and 4 RTG should be installed.
- During above new container facilities are under construction, the berth No.1 to No.3 of Hai Phong Main Port should be used for container handling temporarily to meet the excess container traffic.

Above plans were established within the framework of the Master Plan of development for projected traffic demand up to 2010. However, the improvement of access channel was not included in this project since it was under detailed investigation by the other consultant, Haecon, at that time as will be mentioned below.

4.3 General Study of Access Channel to Hai Phong Port

This study was conducted by the Belgian harbor and engineering consultant, Haecon in 1995 and 1996. This study carried out a comprehensive program of field data collection and analysis for the improvement of access channel of Hai Phong Port. The scope of this study consisted of site survey and monitoring, hydraulic and sedimentation analysis, comparative study on alternative alignments of access channel and detailed design of access channel. In this study, the new channel alignment in Lach Huyen through the Trap Canal was proposed as the most recommendable option for Hai Phong Port and approved and agreed to implement it by the following two stages by the Vietnamese Authorities concerned:

- Stage 1: The portion of Lach Huyen access channel is dredged to -7.7m CDL and other portion is to -7.5m CDL, for which required dredging volume was estimated at 13.8 million m^3. By this dredging, fully laden 10,000DWT vessels with under keel clearance of 1.2m can be navigable at 15% of total time (waiting times is within 10days excepting navigation restriction at storm condition).
- Stage 2: The portion of Lach Huyen access channel is deepened to -9.0m CDL and other portion is to -8.15m to -8.35m, for which required dredging volume was estimated at 18.9 million m^3. By this improvement, fully laden 10,000DWT vessels can be navigable at 65% of total time (waiting time is less than 20 hours) with under keel clearance of 1.05m in calm river and 1.7m in Lach Huyen Channel.

The decision between the two stages will be made subsequently by economic comparison among waiting times, number of ship calls, capital investment and traffic increase. However, this analysis was out of scope of this study and any prediction was made on financial viability of channel improvement related to varying ship sizes and waiting time.

4.4 Cai Lan port Expansion Project

This study was conducted by JICA in 1998 aiming to define following matters:

- Traffic demand forecast in Northern Vietnam for short term (2005) and long term (2010) development.
- Allocation of forecast traffic demands of short term and long term development to Cai Lan Port and Hai Phong Port.
- To identify the required facilities for the Stage 1 development suitable for the traffic demand of 2005.
- To establish the outline development plan for target year of 2010.

In this study, the total cargo volume of Northern Vietnam was forecasted at 18.3 million tons in 2010 and it was distributed 6.8 million tons to Hai Phong Port and 11.4 million tons to Cai Lan Port. This study recommended to construct additional three (3) berths, one (1) container berth and Two (2) bulk/general cargo berths and to dredge the access channel up to -10m as the Stage 1 development. This study also presented the provable expansion of 9 new berths and channel depth of -11m as the Stage 2 development.

4.5 Access Channel to the Ports in Hai Phong Area

This study was conducted by MOT/TEDI in 1997 under the following scope of works:

- To forecast cargo demand of the ports in Hai Phong area for the target years of 2000 and 2010.
- To propose the access channel alignment and configuration suitable for navigation of 10,000DWT and larger ships.
- To analyze and assess the economic feasibility of the proposal.

The recommendations made by the study were:

- To make a new route for the outer part of access channel passing through the Trap Canal and Lach Huyen waterway instead of the existing route through Nam Trieu Channel.
- The new channel should have the bottom width of 80m in inner part and 100m in outer part.
- The depth of new channel should be -8.0m to -7.95m which provide under keel clearance of 1.05m at inner channel and 1.7m at outer channel.
- Navigation water level is +2.5m CDL.
- Access availability is 65%.

It was recommended to implement above channel improvement work in two phases. The first phase should be carried out as an urgent project by 2010, of which dredging volume would be 13.9 million m^3 and the second phase will be implemented in future in accordance with the further development of berths in the area.

4.6 Feasibility Study of Hai Phong Rehabilitation Project Phase II

This study was conducted by MOT/TEDI in 1998 aiming to confirm the feasibility of Phase II rehabilitation project of Hai Phong Port.

The main issues studied were:

- To forecast cargo demand and shipping fleet
- To determine necessary port improvement/rehabilitation for Phase II project.
- To determine the required access channel improvement for Phase II project.
- To estimate the project costs.
- To analyze economical and financial feasibility of the project.

The study concluded:

- To cope with the increasing container demand, the expansion of container terminal up to 420,000TEU should be concentrated at Chua Ve Port where 2 additional berths would be required.
- The route of outer part of access channel should be shifted from the existing Nam Trieu channel to Lach Huyen channel through Trap Canal.
- For develop above new channel with the depth -7m, 17 million m^3 of dredging would be required.
- Because of the difficulty to maintain and prepare the cost for making channel more deepen, the channel depth of -7.0m and ship size limit for fully laden 10,000DWT vessel would apply for the foreseeable future to 2010 and beyond.
- By this channel improvement, ship waiting time would be reduced. However, the reduction was not quantified in this study.

4.7 Master Plan of Northern Seaport Group 1 till year 2010 and orientation to 2020

This master plan of Northern Seaport Group 1 is a part of the master plan for Vietnam Seaport System Development till 2010 orientation to 2020 was prepared by Vietnam maritime Administration (VINAMARINE) and approved by the Prime Minister under decision No. 2020/1999/QG-TTg dated 12 October 1999.

The planned area consists of Quang Ninh, Thai Binh, Nam Dinh, Ninh Binh and Hai Phong provinces.

The total cargo volume in the North was forecasted at 89 to 123 million tons/year in 2020.

Target vessel sizes were planned for each port as follows:

- Cai Lan Port: 40,000 to 50,000DWT
- Petrol B12 Port: 40,000DWT
- Cam Pha Coal Port: 65,000DWT
- Hai Phong Port: 10,000 to 20,000DWT

It was planned that in Cai Lan Port, three (3) berths, No.2, No.3 and No.4 would be constructed and in Dinh Vu Port, six (6) berths would be constructed.

4.8 Construction Investment Project of Hai Phong - Lach Huyen Gateway Port

This study was conducted by TEDI in 2007 under the finance of VINAMARINE.

1) Objective of the Project

The objective is to prepare the construction investment plan for the development of Hai Phong – Lach Huyen Gateway Port in order to meet the demand forecast during years 2010 and 2020, contributing to stimulate socio-economic development of Northern area.

2) Study Scope

- To prepare the master plan of new gateway port for Northern area and the transport network link to the port till year 2020 orientation to 2030.
- To implement the feasibility study on construction investment for Lach Huyen general cargo port in the Initial Stage and Medium Term development for target year 2015 and 2020, respectively.

3) Potential Plan of Lach Huyen Gateway Port

Lach Huyen gateway port will consist of the following zones:

Port	General Cargo Port	Liquid Cargo Port	Industrial Zone Port	Shipbuilding Zone
Area (ha)	825	80	430	540
Berth Length (m)	13,200	1,600	8,000	3,800
Max. Ship (DWT)	80,000	50,000	10,000 – 30,000	100,000
Throughput (Mill. T/Year)	200 - 300	20	30	-

4) Forecast Throughput of Northern Ports

(Unit: 1,000t)

Port	2004	2015		2020	
	Actual	Case 1	Case 2	Case 1	Case 2
Total North Port Group	**32.6**	**77**	**80**	**110**	**130**
I. Hai Phong Port Area	**14.8**	**38.7**	**38.7**	**38.7**	**38.7**
- General cargo	13	28	28	28	28
- Cement & Clinker	1	6.7	6.7	6.7	6.7
- Oil	0.8	4	4	4	4
II. Quang Ninh Area	**17.8**	**32.3**	**33.3**	**36.3**	**40.3**
- General cargo	2.5	11	12	18	20
- Cement	1.4	7.3	7.3	7.3	8.3
- Oil	3.7	3	3	0	0
- Coal	10.2	11	11	11	12
III. Lach Huyen Port Area	**0**	**6**	**8**	**35**	**51**
- General Cargo	0	4	6	26	40
- Oil	0	2	2	9	11

5) Forecast Throughput of Lach Huyen Gateway Port

(Unit: 1,000t)

Year	2015	2020		
Cargo Type		Alternative 1	Alternative 2	Alternative 3
A. General Cargo	6,000	26,000	26,000	40,000
- Container	5,500	18,000	14,000	24,000
(1,000TEU)	(460)	(1,498)	(1,148)	(1,951)
- Bulk Cargo	-	3,700	3,700	6,000
- Packed General cargo	500	4,300	8,300	10,000
B. Liquid Cargo	2,000	9,000	9,000	11,000
Total	8,000	35,000	35,000	51,000

6) Scale of Lach Huyen Port

Year	2015	2020		
Port	**Container Terminal**	**Container Terminal***	**Genera Cargo Terminal**	**Bulk Cargo Terminal**
Number of Berth	2	4	5	2
Area	36 ha	72 ha	58 ha	28 ha
Length of Berth	600m	1,200m	1,000m	500m
Average Width	600m	600m	540m	560m
Depth of Berth	-14m	-14m	-12m	-13m

Note: * Scale of 2020 includes the facilities developed in 2015.

7) Scale of Access Channel

Item		Unit	2015	2020
1	Length	m	15,700	16,500
2	Width	m	130	150
3	Depth of Navigable Channel	m	13.3	14.9
4	Dredging Level	m	-10.3	-11.9
5	Channel Dredging Volume	m^3	8,221,225	13,142,929
6	Basin Dredging Volume	m^3	720,209	10,339,991
7	Total Dredging volume	m^3	8,941,434	23,482,920

8) Scale of Port Protection Facilities

Item		Unit	2015	2020
1	Breakwater			
	- Length	m	3,900	3,900
	- Top Elevation	m	+5.0	+9.0
2	Sand Protection Dyke			
	- Length	m	5,700	10,700
	- Top Elevation	m	+2.0	+2.0

9) Transportation Network link

- Initial Period: Traffic volume is estimated at 8 million tons/year. A new road from the port to Hai Phong City with 3 lanes and 12 km in length and another new road to Quang Ninh Province with 2 lanes and 23 km in length will be constructed.
- Year 2020: Traffic volume is estimated at 35 million tons/year. The road from port to Hai Phong city will be upgraded to 6 lanes.
- Year 2030: Traffic volume is estimated at 120 million tons/year. The railway toward Hai Phong will be constructed.

10) Project Cost

Project cost of Initial Stage was estimated at 7,018,819 million VND and the development cost for Second Stage of 2020 was estimated at 16,151,122 million VND.

11) Financial Viability

The results of financial analysis are as follows:

- IRR: 12.1%
- B/C: 1.13
- NPV: 2,856,668 million VND

5. Demand Forecast

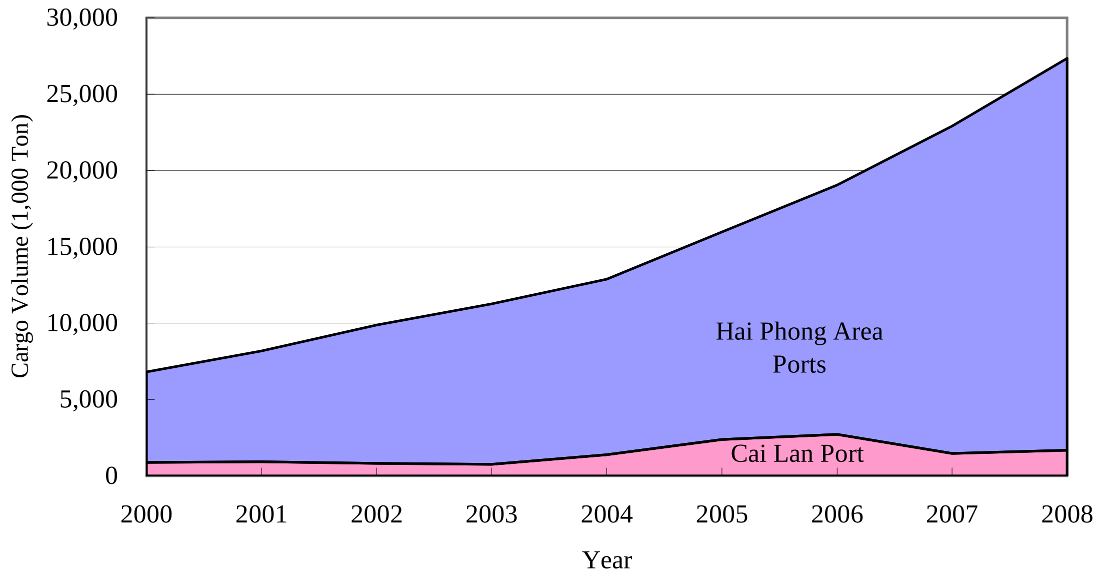
5.1 General

In this chapter, the method of the demand forecast is conducted by Macro forecast for whole cargo and Micro forecast for commodity-wise cargo in the Northern Vietnam Ports. And cargo demand Lach Huyen port is analyzed as overflowed cargo based on the cargo handling capacity of Northern Vietnam Ports including their future expansion. Consequently, detail container cargo volume is analyzed in the final section of this chapter in order to estimate the cargo traffic in terms of TEUs.

5.2 Cargo Throughputs of the Northern Ports in Vietnam

Northern Ports (without oil products, cement and fertilizer) in Vietnam are divided into 2 areas such as Hai Phong Area Port and Cai Lan Port. In 2008, total cargo throughputs of Northern Ports amounted to approximately 25 million ton as shown in Figure 5.2.1.

Total cargo throughput in 2008, 25,340 thousand ton is almost 3.9 times of volume (6,494 thousand ton) in 2000 with yearly average growth rate 19% from 2000.



Unit: 1,000 ton

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008
Hai Phong Area Ports	5,606	7,006	8,920	9,775	10,527	11,176	13,087	19,836	23,777
Cai Lan Port	888	927	812	756	1,193	2,108	2,854	1,450	1,563
Total Cargo Throughput	**6,494**	**7,933**	**9,732**	**10,531**	**11,720**	**13,284**	**15,941**	**21,286**	**25,340**
Growth Rate		22.2%	22.7%	8.2%	11.3%	13.3%	20.0%	33.5%	19.0%

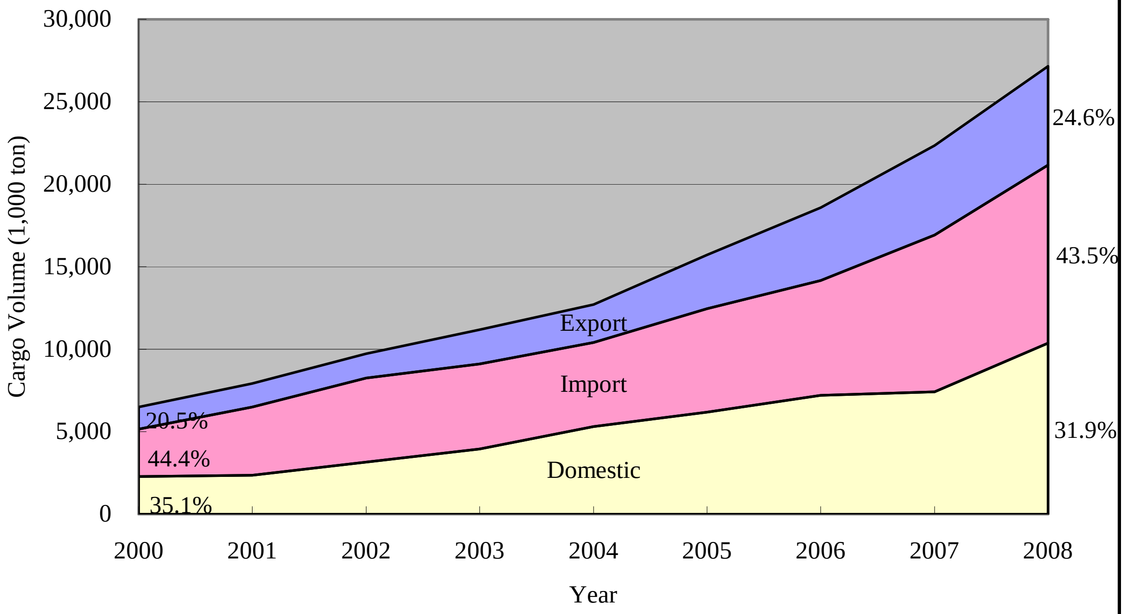
Note: Cargo Throughputs Volume is not including oil products, cement and fertilizer

Source: Original data from Hai Phong Port, Hai Phong private port and Cai Lan Port in the final report of "Port Capacity Reinforcement Plan in Northern Vietnam (Sep. 2009), and container data (2003-2008) by VINAMARINE

Figure 5.2.1 Total Cargo Throughputs in the Northern Ports in Viet Nam

5.3 Export, Import and Domestic Cargo Volume Share

In 2008, cargo volume share of Export, Import and Domestic in the Northern Ports were 24.6%, 43.5% and 31.9%, respectively. The share of Export gradually went up from 20.5% in 2000 to 24.6% in 2008 but the Import share marginally went down from 44.4% to 43.5%. The Domestic share went down from 35.1% 2000 in to 31.9% in 2008.



Unit: 1,000 ton

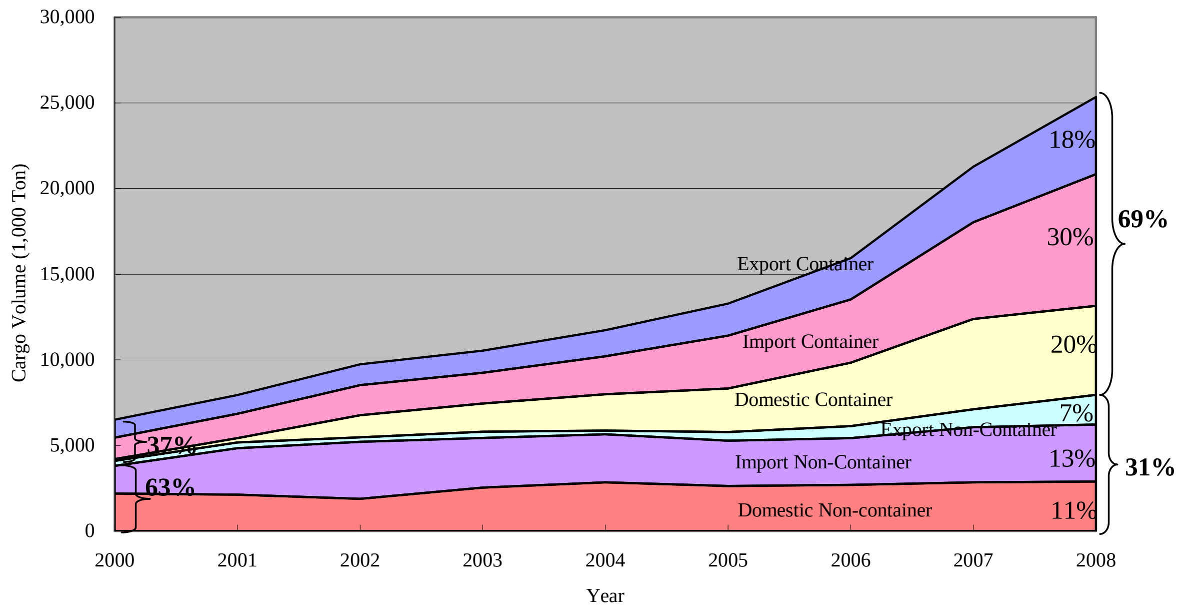
	Year	2000	2001	2002	2003	2004	2005	2006	2007	2008
Export	**Volume**	1,334	1,438	1,470	1,656	1,708	2,381	3,117	4,307	6,233
	Share	20.5%	18.1%	15.1%	15.7%	14.6%	17.9%	19.6%	20.2%	24.6%
Import	**Volume**	2,883	4,126	5,103	4,693	5,042	5,727	6,405	8,855	11,024
	Share	44.4%	52.0%	52.4%	44.6%	43.0%	43.1%	40.2%	41.6%	43.5%
Domestic	**Volume**	2,278	2,370	3,159	4,182	4,970	5,176	6,419	8,124	8,083
	Share	35.1%	29.9%	32.5%	39.7%	42.4%	39.0%	40.3%	38.2%	31.9%
Total		6,494	7,933	9,732	10,531	11,720	13,284	15,941	21,286	25,340

Note: Cargo Throughputs Volume is not including oil products, cement and fertilizer
Source: Original data from Hai Phong Port, Hai Phong private port and Cai Lan Port in the final report of "Port Capacity Reinforcement Plan in Northern Vietnam (Sep. 2009), and container data (2003-2008) by VINAMARINE

Figure 5.3.1 Export, Impart and Domestic Cargo in the Northern Ports in Viet Nam

5.4 Container and Non-container Cargo

In 2008, container cargo volume share in the Northern Ports are dramatically changed from 37% in 2000 to 69%, while on the other hand, non-container cargo share drop from 63% in 2000 to 31% in 2008. Another way of saying, container cargo volume is sharply increased from 2,387 thousand ton in 2000 to 17,382 thousand ton in 2008 with yearly average growth rate 29%, and non-container gradually increased from 4,105 thousand ton in 2000 to 7,958 thousand ton in 2008 with yearly average growth rate 9%. (Figure 5.4.1)



	2000	2001	2002	2003	2004	2005	2006	2007	2008
Export Container	1,037	1,087	1,201	1,294	1,510	1,865	2,421	3,253	4,504
Import Container	1,263	1,420	1,773	1,790	2,228	3,092	3,683	5,652	7,688
Domestic Container	88	244	1,285	1,653	2,127	2,539	3,719	5,276	5,190
Export Non-Container	297	350	269	362	199	516	697	1,054	1,729
Import Non-Container	1,621	2,705	3,330	2,903	2,814	2,635	2,722	3,203	3,336
Domestic Non-container	2,190	2,126	1,874	2,529	2,842	2,636	2,700	2,848	2,893
Total Container	2,387	2,752	4,259	4,737	5,865	7,496	9,822	14,181	17,382
	37%	*35%*	*44%*	*45%*	*50%*	*56%*	*62%*	*67%*	*69%*
Total Non-Container	4,107	5,182	5,473	5,795	5,855	5,787	6,119	7,105	7,958
	63%	*65%*	*56%*	*55%*	*50%*	*44%*	*38%*	*33%*	*31%*
Total	6,494	7,933	9,732	10,531	11,720	13,284	15,941	21,286	25,340

Figure 5.4.1 Container and Non-container Cargo in the Northern Ports in Viet Nam

5.5 Macro Demand Forecast

In general, cargo volume of international ports and GDP are close relationship, especially, in Viet Nam, import and export values are largely influenced to GDP. In 2008, based on GSO’s preliminary figures, import values (goods and services) are comparable to 94.7% of National Amount (GDP), and export values are 78.2% of GDP. On the other hand, nowadays, hinterland of the Northern Ports is not only the Northern region of Viet Nam, but also all over the Viet Nam, because of closely-linked to central and southern regional connection by domestic sea transport. Therefore, in the method of Macro Demand Forecast are analyzed by correlation between GDP value and cargo volume.

According to General Statistics Office of Vietnam, the growth of Vietnam’s GDP in 2009 reached to 5.32%. Also, MPI predicted long-term target in 2010-2020 by 2 options: (1) sustainable growth of economy as 6.5% and (2) growth of economy at high level as 7.5%. In the low-growth, VITRANSS 2 predicted 5.6%. Alternatives scenario of GDP growth rate for 2009-2020 are summarized as follows.

Table 5.5.1 GDP Alternative Scenarios

Alternative Scenarios \ Year	2009	2010-2020
High Growth Scenario	5.32%	7.5%
Sustainable Growth Scenario		6.5%
Low Growth Scenario		5.6%

5.6 Results of Macro Forecast

Very high correlation (R^2=0.9477) between cargo volume of the Northern Ports in the Vietnam and GDP show in the following Figure 5.6.1. The results of Macro Forecast with each alternative scenarios show in Figure 5.6.2.

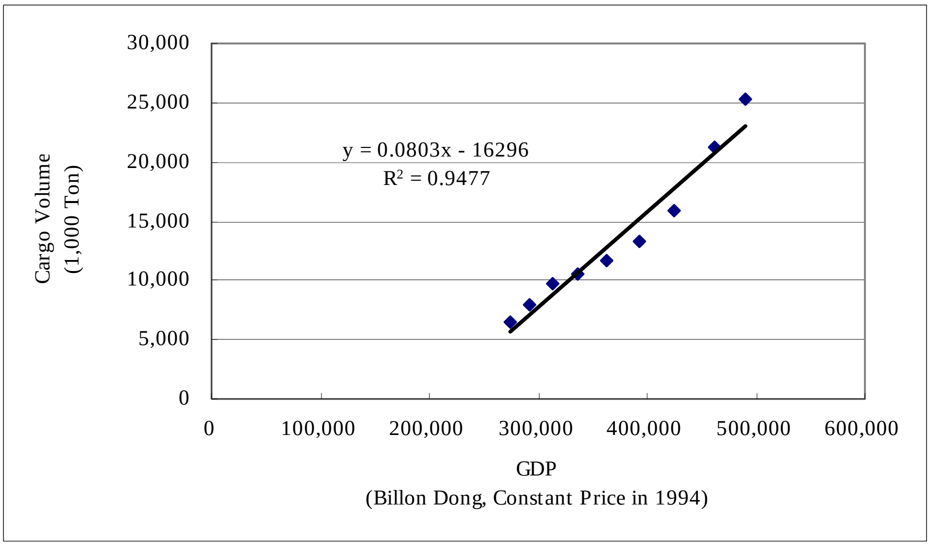


Figure 5.6.1 Correlation between Cargo Volume of the Northern Ports in the Vietnam and GDP

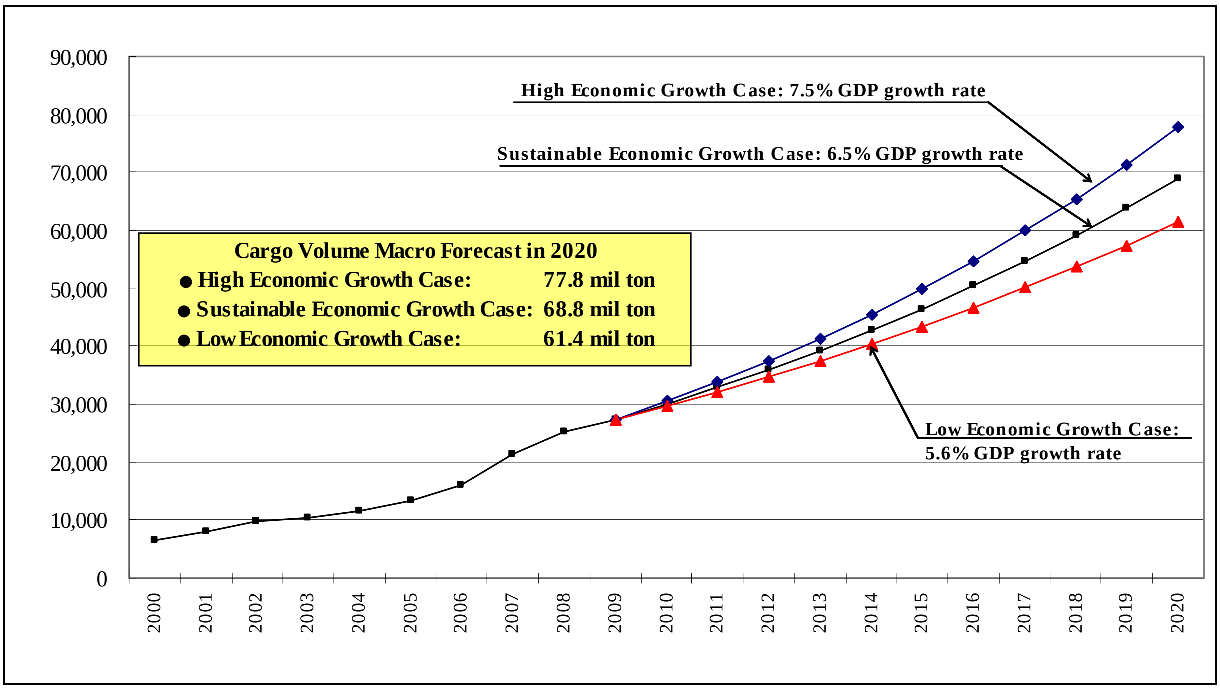


Figure 5.6.2 Results of Macro Forecast with Alternative Scenarios

5.7 Micro Demand Forecast

In the Micro Forecast, commodity-wise cargoes is firstly grouping by each sector, and secondly analyzing with correlation between grouping cargo volume and GDP or GDP by sector. Thirdly, containerization should be considered with compatibility of characteristic products.

Table 5.7.1 Commodity-wise Cargoes Grouping for Micro Forecast

Cargo Commodity \ Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	Micro Forecast Consideration
1. Export	**1,334**	**1,438**	**1,470**	**1,656**	**1,708**	**2,381**	**3,117**	**4,307**	**6,233**	
Container	1,037	1,087	1,201	1,294	1,510	1,865	2,421	3,253	4,504	Correlation of GDP
General	50	16	5	152	1	12	11	43	30	Correlation of GDP (convert to Container Cargo)
Timber	83	97	66	29	78	360	489	583	477	Correlation of Primary Sector GDP as Agriculture or Forestry Product
Food and vegetable	10	7	9	7	3	4	4	8	3	
Industrial Product	-	1	-	-	0	-	-	-	-	Correlation of Secondary Sector GDP as Industrial Product or Construction material (40% of forcast cargo convert to Container Cargo in 2020)
Equipment	8	7	11	2	6	10	10	18	46	
Construction Material	95	141	101	127	89	110	107	230	156	
Metal	3	2	7	1	2	3	0	13	331	
Foodstuff	25	28	20	12	6	-	1	60	80	
Apatite	2	-	-	2	2	-	46	76	261	Correlation of Secondary Sector GDP as Mining Product
Metallic ore	20	50	50	30	11	17	25	28	343	
2. Import	**2,883**	**4,126**	**5,103**	**4,693**	**5,042**	**5,727**	**6,405**	**8,855**	**11,024**	
Container	1,263	1,420	1,773	1,790	2,228	3,092	3,683	5,652	7,688	Correlation of GDP
General	98	86	290	45	20	6	6	9	10	Correlation of GDP (convert to Container Cargo)
Miscellaneous	-	-	-	3	-	1	3	17	24	Correlation of GDP (convert to Container Cargo)
Timber	14	42	36	47	72	21	42	13	19	Correlation of Primary Sector GDP as Agriculture or Forestry Product
Forest and native products	-	-	5	-	22	4	-	1	-	
Food and vegetable	13	317	227	114	135	149	145	145	-	
Foodstuff for cattle	42	185	273	763	445	664	872	937	832	
Cotton	129	-	-	-	-	-	-	-	-	Correlation of Secondary Sector GDP as Industrial Product or Construction material (40% of forcast cargo convert to Container Cargo in 2020)
Chemical	75	67	43	38	40	57	63	87	51	
Metal	1,018	1,620	1,974	1,535	1,607	1,426	1,220	1,410	1,819	
Construction Material	37	32	14	0	35	17	10	-	-	
Equipment	111	169	146	150	154	111	89	271	391	
Foodstuff	24	94	246	131	151	121	176	169	33	
Sulfur	-	-	-	-	-	58	97	95	96	Correlation of Secondary Sector GDP as Mining Product
Metallic ore	59	95	75	78	134	0	-	49	61	
3. Domestic	**2,278**	**2,370**	**3,159**	**4,182**	**4,970**	**5,176**	**6,419**	**8,124**	**8,083**	
Container	88	244	1,285	1,653	2,127	2,539	3,719	5,276	5,190	Correlation of GDP
General	1,006	834	511	271	207	86	50	60	75	Correlation of GDP (convert to Container Cargo)
Food and vegetable	44	77	67	35	38	31	21	16	7	Correlation of Primary Sector GDP as Agriculture or Forestry Product (40% of forcast cargo convert to Container Cargo in 2020)
Foodstuff for cattle	81	79	73	283	219	289	279	147	158	
Forest and native products	6	3	7	15	10	8	59	7	1	
Wheat	-	-	-	-	-	21	40	12	26	
Timber	28	25	8	80	90	189	168	98	84	
Flour	-	-	-	-	-	-	-	16	11	
Chemical	30	21	19	7	12	16	3	12	5	Correlation of Secondary Sector GDP as Industrial Product or Construction material
Metal	243	233	240	269	285	243	160	157	227	
Construction Material	305	341	198	251	154	143	106	114	48	
Foodstuff	278	340	572	199	250	61	-	53	20	
Equipment	42	27	98	989	1,364	1,379	1,640	2,000	1,841	
Apatit	68	62	53	90	99	114	114	109	136	Correlation of Secondary Sector GDP as Mining Product
Sulfur	-	-	-	-	62	3	8	2	6	
Metallic ore	60	84	27	39	51	54	51	45	248	

Source: Original data from Hai Phong Port, Hai Phong private port and Cai Lan Port in the final report of "Port Capacity Reinforcement Plan in Northern Vietnam (Sep. 2009), and container data (2003-2008) by VINMARINE

In the above table, containerization was considered from conventional cargo such as general cargo, miscellaneous cargo and 40% of industrial and construction material of Import and Export cargo.

5.8 Results of Micro Forecast

In the Micro Forecast, commodity-wise cargoes is firstly grouping by each sector, and secondly, analyzing with correlation between grouping cargo volume and GDP or GDP by sector. Thirdly, containerization should be considered with compatibility of characteristic products.

The national goal in Viet Nam is to become an industrial country by 2020, therefore, the component rate of GDP by sector in 2020 adapted to same target of Red River Delta component rate in 2010 estimated by Central Economic Institute such as 12% for Agriculture Sector, 45% for Industry & Construction sector and 43% for Service sector.

The GDP by Sector in 2000, 2008 and 2020 summarized as follows. In the Micro Forecast, GDP growth rate in 2010-2020 adapt to 6.5% of sustainable growth planning by MPI.

Table 5.8.1 Results of GDP by Sector in 2000, 2008 and 2020

GDP by Sector	2000	2008	2020	Remarks
Agriculture, forestry and fishery	63,717	86,082	128,078	Target Rate by MPI in 2010
Component Rate	*23%*	*18%*	*12%*	15-16%
Industry and construction	96,913	203,791	463,717	Target Rate by MPI in 2010
Component Rate	*35%*	*42%*	*45%*	43-44%
Service	113,036	199,960	439,526	Target Rate by MPI in 2010
Component Rate	*41%*	*41%*	*43%*	40-41%
GDP	273,666	489,833	1,031,346	

The results of Micro Forecast of 3 alternative scenarios shows in Table 5.8.2, Table 5.8.3 and Table 5.8.4. The high growth case estimated 1.2 times of increased volume of middle growth case and the low growth case 0.8 times of increased volume of middle growth case based on the results of Micro Forecast.

Table 5.8.2 Results of Micro Forecast (Middle Growth Case)

Category of Cargo	Type of Cargo	Unit	2008	2015	2020
1. Export			**6,233**	**11,712**	**16,192**
Container and Containerized Cargo	Container Cargo	1,000 ton	4,534	8,792	12,484
Agriculture, forestry Product	General Cargo	1,000 ton	482	1,132	1,597
Industry and construction material	General Cargo	1,000 ton	613	699	675
Mining Products	Dry Bulk Cargo	1,000 ton	604	1,089	1,435
2. Import			**11,024**	**22,766**	**30,349**
Container and Containerized Cargo	Container Cargo	1,000 ton	7,722	18,880	26,069
Agriculture, forestry Product	General Cargo	1,000 ton	851	1,808	2,492
Industry and construction material	General Cargo	1,000 ton	2,294	1,824	1,464
Mining Products	Dry Bulk Cargo	1,000 ton	157	254	323
3. Domestic			**8,083**	**18,318**	**25,245**
Container and Containerized Cargo	Container Cargo	1,000 ton	5,265	13,925	20,317
Agriculture, forestry Product	General Cargo	1,000 ton	287	605	832
Industry and construction material	General Cargo	1,000 ton	2,141	3,227	3,411
Mining Products	Dry Bulk Cargo	1,000 ton	390	562	684
Cargo Volume by Cargo Type					
Total Cargo Volume		1,000 ton	**25,340**	**52,796**	**71,785**
Container and Containerized Cargo		1,000 ton	17,521	41,597	58,871
		1,000TEU	1,434	3,586	5,075
General Cargo		1,000 ton	6,668	9,295	10,472
Dry Bulk Cargo		1,000 ton	1,151	1,904	2,442

Table 5.8.3 Results of Micro Forecast (Low Growth Case)

Category of Cargo	Type of Cargo	Unit	2008	2015	2020
1. Export			**6,233**	**10,616**	**14,200**
Container and Containerized Cargo	Container Cargo	1,000 ton	4,534	7,940	10,894
Agriculture, forestry Product	General Cargo	1,000 ton	482	1,002	1,374
Industry and construction material	General Cargo	1,000 ton	613	682	662
Mining Products	Dry Bulk Cargo	1,000 ton	604	992	1,269
2. Import			**11,024**	**20,418**	**26,484**
Container and Containerized Cargo	Container Cargo	1,000 ton	7,722	16,648	22,400
Agriculture, forestry Product	General Cargo	1,000 ton	851	1,617	2,164
Industry and construction material	General Cargo	1,000 ton	2,294	1,918	1,630
Mining Products	Dry Bulk Cargo	1,000 ton	157	234	290
3. Domestic			**8,083**	**16,271**	**21,812**
Container and Containerized Cargo	Container Cargo	1,000 ton	5,265	12,193	17,307
Agriculture, forestry Product	General Cargo	1,000 ton	287	541	723
Industry and construction material	General Cargo	1,000 ton	2,141	3,009	3,157
Mining Products	Dry Bulk Cargo	1,000 ton	390	527	625
Cargo Volume by Cargo Type					
Total Cargo Volume		1,000 ton	**25,340**	**47,305**	**62,496**
Container and Containerized Cargo		1,000 ton	17,521	36,782	50,601
		1,000TEU	1,434	3,171	4,362
General Cargo		1,000 ton	6,668	8,770	9,711
Dry Bulk Cargo		1,000 ton	1,151	1,754	2,184

Table 5.8.4 Results of Micro Forecast (High Growth Case)

Category of Cargo	Type of Cargo	Unit	2008	2015	2020
1. Export			**6,233**	**12,808**	**18,183**
Container and Containerized Cargo	Container Cargo	1,000 ton	4,534	9,643	14,074
Agriculture, forestry Product	General Cargo	1,000 ton	482	1,263	1,820
Industry and construction material	General Cargo	1,000 ton	613	716	687
Mining Products	Dry Bulk Cargo	1,000 ton	604	1,186	1,602
2. Import			**11,024**	**25,115**	**34,213**
Container and Containerized Cargo	Container Cargo	1,000 ton	7,722	21,112	29,739
Agriculture, forestry Product	General Cargo	1,000 ton	851	2,000	2,820
Industry and construction material	General Cargo	1,000 ton	2,294	1,730	1,299
Mining Products	Dry Bulk Cargo	1,000 ton	157	273	356
3. Domestic			**8,083**	**20,365**	**28,677**
Container and Containerized Cargo	Container Cargo	1,000 ton	5,265	15,657	23,328
Agriculture, forestry Product	General Cargo	1,000 ton	287	669	941
Industry and construction material	General Cargo	1,000 ton	2,141	3,444	3,665
Mining Products	Dry Bulk Cargo	1,000 ton	390	596	743
Cargo Volume by Cargo Type					
Total Cargo Volume		1,000 ton	**25,340**	**58,288**	**81,074**
Container and Containerized Cargo		1,000 ton	17,521	46,412	67,141
		1,000TEU	1,434	4,001	5,788
General Cargo		1,000 ton	6,668	9,821	11,232
Dry Bulk Cargo		1,000 ton	1,151	2,055	2,701

The results of Micro Forecast with each alternative scenarios show in Figure 5.8.1

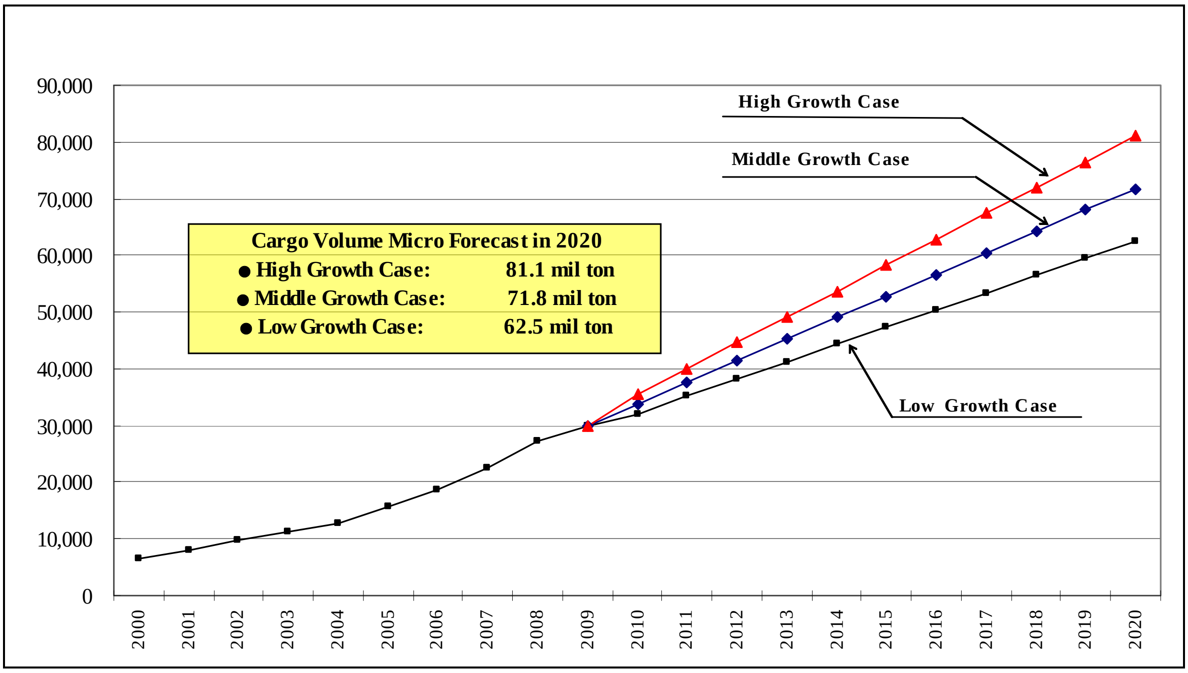


Figure 5.8.1 Results of Micro Forecast with Alternative Scenarios

5.9 Cargo Volume of Lach Huyen Port

5.9.1 Demand Forecast of Lach Huyen Port

Firstly, cargo demand of Lach Huyen port can be considered overflowed cargo more than cargo handling capacity volume of Northern ports in the Viet Nam. Moreover, the following items are the role of Lach Huyen Port in Vietnam Sea Port System for demand forecast.

(1) Lach Huyen Port will be a general port group used for handling of general cargoes, container cargoes, bulk cargoes and liquid cargoes (Petrol)

(2) Lach Huyen port will not be used for handling of specialized cargoes such as: coal (to be handled at Cam Pha), and military cargoes (a military port will be formed at South Do Son)

(3) Lach Huyen port belongs to the Northern sea port group (group 1) and play role as a key international gateway port of the North (Port of class I, to be ranked in accordance with Marine Law). Lach Huyen port is a main junction for cargo exchange of northern provinces to the countries in the region.

(4) In the future (after 2020) Lach Huyen port will likely to play more role of container transshipment for the northern area (together with Van Phong port in the Central, Cai Mep-Thi Vai or Ben Dinnh-Sao Mai port in the South).

Addition to above items, depend on the present circumstance of cargo handling system in the northern Vietnam, cargoes of cement and fertilizer handled in their own private port like DAP Fertilizer Jetty, Ching Fong Haiphong Cement Plant Jetty or Cam Pha port

The capacities of existing ports are estimated based on the existing port facilities and equipment for Haiphong ports group and Cai Lan port, and for Dinh Vu port additional container berths under construction are considered and for Cai Lan port 3 additional container berths which are decided to be constructed within a few years are also considered. Figure 5.9.1 shows the expansion plan of 3 additional berths in the existing Cai Lan port facilities.

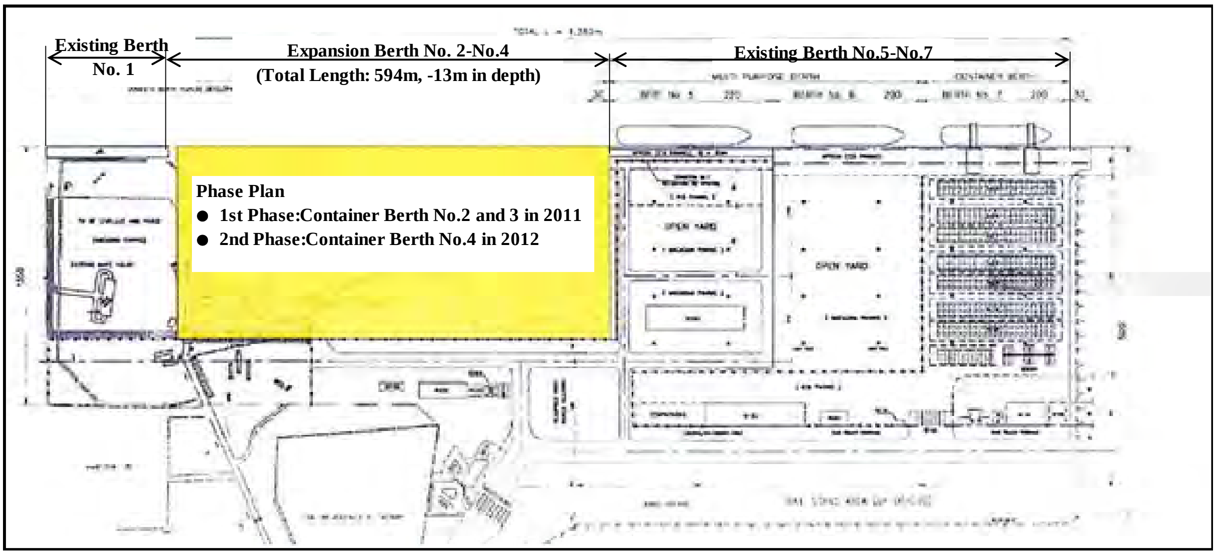
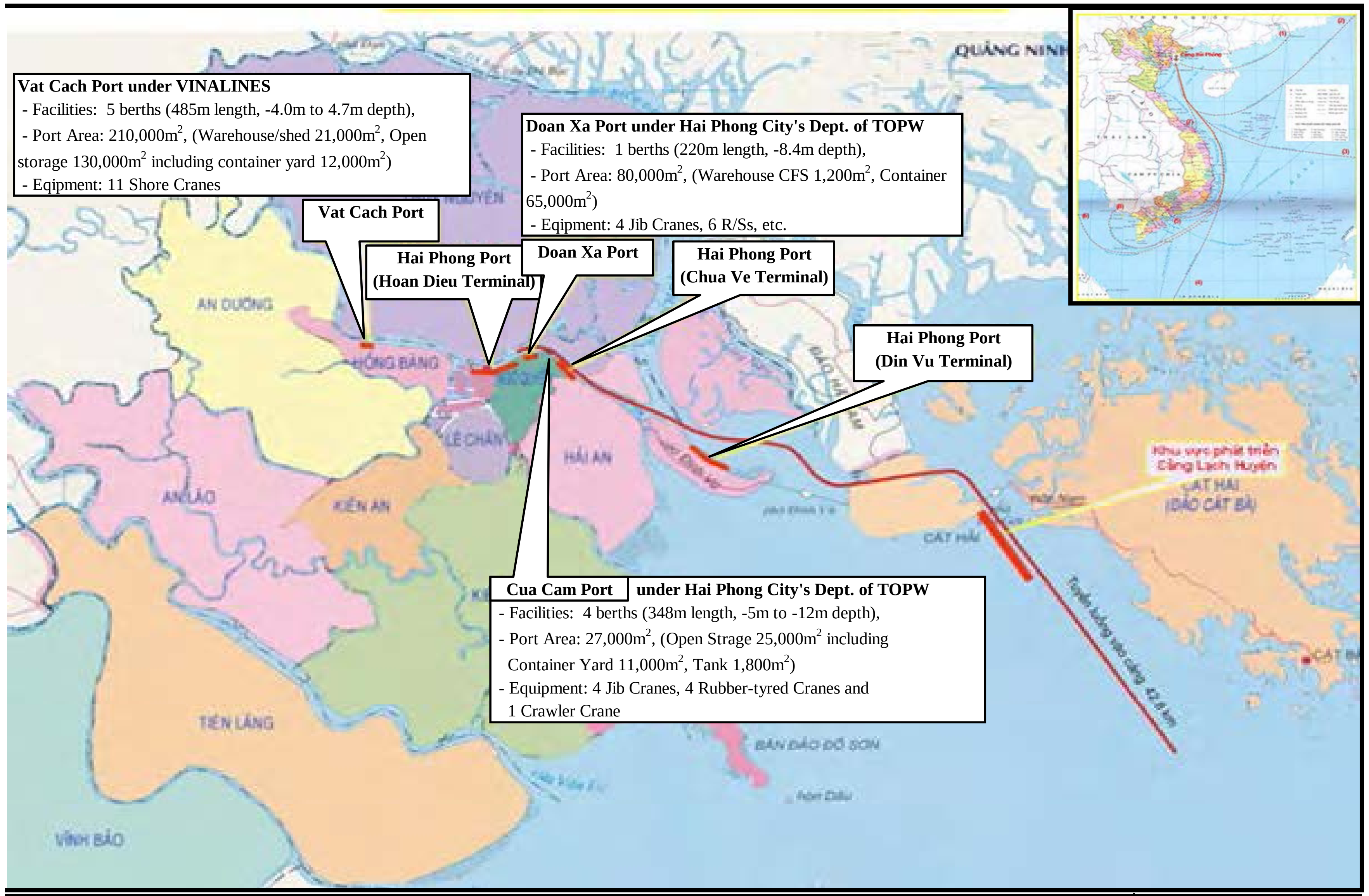
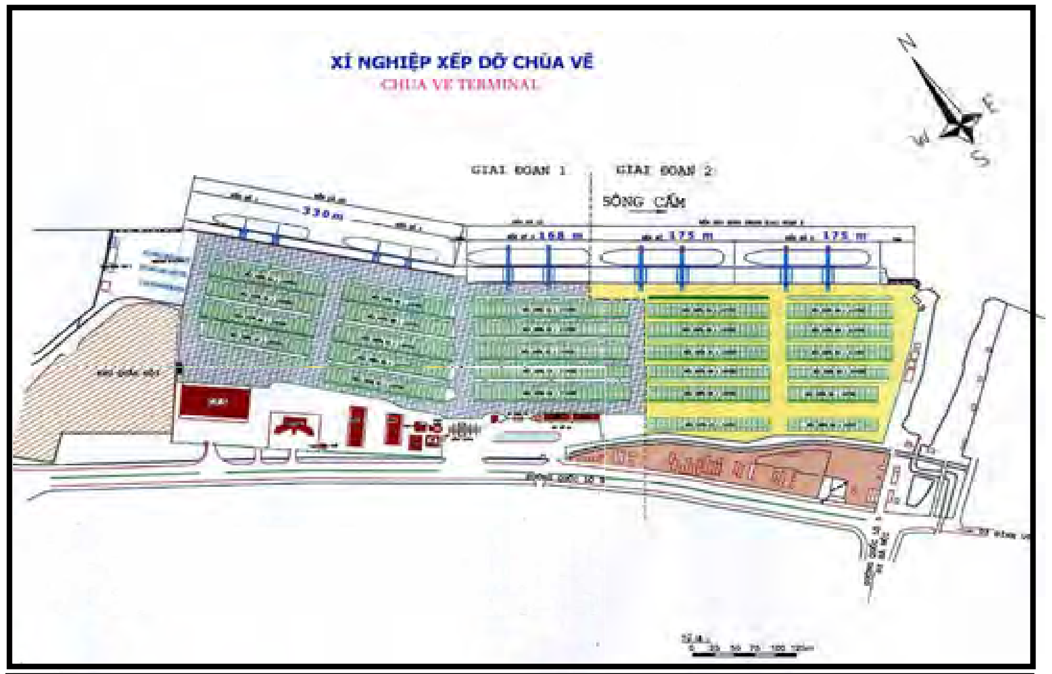


Figure 5.9.1 Existing Port Facilities and Expansion Plan of Cai Lan Port

Din Vu port also has phase plan of expansion plan as 1'st Phase 200m of berth length in 2010, 2nd Phase 200m of berth length in 2011 and 3rd Phase 202 m of berth length in 2012. Figure 5.9.2 shows the existing Hai Phong port location and on going plan.

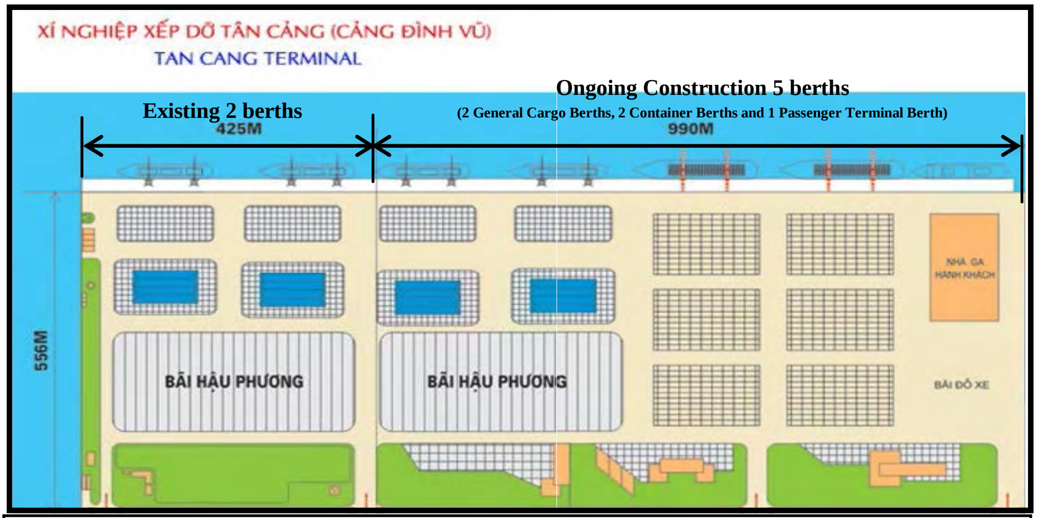
The cargo handling capacity volume of Northern ports in Viet Nam is estimated in the following Table 5.9.1. In 2012, the capacity of the existing Northern ports is estimated 3,470 thousand TEU of container cargo and 12,600 thousand tons of conventional cargo.





Chua Ve Terminal under VINALINES
- Facilities: 5 berths (848m length, -8.5m depth),
- Port Area: 138,600m^2,
- Equipment: 6 Gantry Cranes, 5 Jib Cranes, 3 Mobile Cranes 12 RTGs, 22 Forklifts, 1 W/B.

Hoan Dieu Terminal under VINALINES
- Facilities: 11 berths (1,717m including 3 Container Berths of 413m in length and 8 General Cargo Berths of 1,304m of length)
- Port Area: CFS Area 3,320m^2, Shed 32,500m^2, Container Yard 100,000m^2, General Cargo Yard (96,000m^2)
- Equipment: 26 Jib cranes, 6 Mobile Cranes, 36 Forklifts, 3 Weigh Bridges (W/B)



Din Vu Terminal (General) under VINALINES
- Facilities: 2 berths (425m length, -10.2m depth),
- Total Port Area: 240,000m^2 (CFS 3,600m^2, Open storage 105,500m^2)
-Equipment: 3 shore Cranes, 2 Rubber-tyred Cranes, 3 R/Ss, etc.

Source: Hai Phong Port

Figure 5.9.2 Location of Hai Phong Area Ports and major berth condition

Table 5.9.1 Cargo Handling Capacity Volume of Northern ports in the Viet Nam

	Actual 2008		Existing Berth Capacity			Expansion Berth Capacity (2010)			Expansion Berth Capacity (2011)			Expansion Berth Capacity (2012-2020)		
	Ton (1,000 ton)	TEU	Berth Length (m)	Ton (1,000 ton)	TEU	Berth Length (m)	Ton (1,000 ton)	TEU	Berth Length (m)	Ton (1,000 ton)	TEU	Berth Length (m)	Ton (1,000 ton)	TEU
Container Handling Volume														
Chua Ve	7,731	729,978	848	8,210	707,786	848	8,210	707,786	848	8,210	707,786	848	8,210	707,786
Hoan Dieu			413	4,014	346,029	413	4,014	346,029	413	4,014	346,029	413	4,014	346,029
Dinh Vu (New)	2,715	218,269	400	2,635	227,191	600	5,271	454,381	800	7,906	681,572	1,002	10,542	908,762
Doan Xa	2,232	156,314	220	2,265	195,244	220	2,265	195,244	220	2,265	195,244	220	2,265	195,244
Transvina	1,371	115,771	165	1,642	141,557	165	1,642	141,557	165	1,642	141,557	165	1,642	141,557
Green	2,150	191,584	320	2,281	196,607	320	2,281	196,607	320	2,281	196,607	320	2,281	196,607
Le Chan	N.A	N.A	144	1,368	117,964	144	1,368	117,964	144	1,368	117,964	144	1,368	117,964
Cai Lan	425	35,028	200	2,373	244,667	200	2,373	244,667	596	7,906	681,572	794	9,933	856,334
Sub-Total	16,624	1,446,944	2,710	24,789	2,177,045	2,910	27,424	2,404,236	3,506	35,593	3,068,331	3,906	40,255	3,470,284
Conventional Cargo Handling Volume														
Hoan Dieu	6,238		1,304	6,408		1,304	6,408		1,304	6,408		1,304	6,408	
Cua Cam	566		220	577		220	577		220	577		220	577	
Vat Cach	1,501		485	1,887		485	1,887		485	1,887		485	1,887	
Dinh Vu (Gen)			525	1,165		525	1,165		525	1,165		525	1,165	
Cai Lan	2,289		646	2,563		646	2,563		646	2,563		646	2,563	
Sub-Total	10,594		3,180	12,600		3,180	12,600		3,180	12,600		3,180	12,600	
Total	**27,218**	**1,446,944**		**37,389**	**2,177,045**		**40,025**	**2,404,236**		**48,193**	**3,068,331**		**52,856**	**3,470,284**

Source: Original cargo data from Hai Phong Port, Hai Phong private port and Cai Lan Port in the final report of "Port Capacity Reinforcement Plan in Northern Vietnam (Sep. 2009), Vietnam Ports Association (VPA), Port operator data by VINAMARINE

5.9.2 Allocation of Cargo among Ports in the Area

The basic considerations of allocation of cargo among Haiphong port, Cai Lan port and Lach Huyen port are as follows:

(1) All container terminals in the existing ports are still very new constructed only 6 to 7 years ago and new four (4) container berths in Dinh Vu port will open soon and No.2 to No.4 container berths in Cai Lan port are determined to be completed within a few years. From national economic view point these facilities should be utilized effectively as much as possible.

(2) This Hai Phong International Gateway Port Development Project is planned to be implemented by Public Private Partnership (PPP). In PPP the public sector should provide incentives to private sector and should not interfere business activities of private sector as much as possible. Therefore, actual cargo volume to be handled at each port should be left for their free marketing efforts.

(3) When Lach Huyen port is opened and left for free competition among three ports, it will be highly provable that most cargoes will shift from the existing ports to Lach Huyen port, since all kind of vessels from small size to large size can enter at any tidal conditions with shortest distance from ocean route.

From above considerations, SAPROF team propose to allocate to Lach Huyen port the cargo which exceed the capacity of existing ports and the cargo equivalent to 10% of the existing ports capacity which will shift from the existing ports at 2015 and it will increase up to 20% by 2020 for development planning of Lach Huyen port, with consideration as actualization of container cargo handling for South East Asia/USA Trunk Line in Lach Huyen port.

Consequently, the allocation of cargo volumes among the three (3) ports will become as follows:

Table 5.9.2 Allocation of Cargo among Three Ports

Cargo Type	**Unit**	Haiphong Port		Cai Lan Port		Lach Huyen Port	
		2015	**2020**	**2015**	**2020**	**2015**	**2020**
High Growth Case							
Container	000 ton	27,290	24,258	8,940	7,946	10,182	34,937
	000TEU	2,352	2,091	771	685	878	3,012
GC +Bulk	000 ton	9,339	7,927	2,536	2,153	0	3,853
Total	000 ton	**36,629**	**32,185**	**11,476**	**10,099**	**10,182**	**38,790**
Middle Growth Case							
Container	000 ton	27,269	24,240	8,933	7,940	5,394	26,691
	000TEU	2,352	2,091	771	685	463	2,299
GC +Bulk	000 ton	8,808	7,927	2,392	2,153	0	2,834
Total	000 ton	**36,077**	**32,167**	**11,325**	**10,093**	**5,394**	**29,525**
Low Growth Case							
Container	000 ton	24,935	24,240	8,168	7,940	3,678	18,421
	000TEU	2,150	2,091	704	685	317	1,586
GC +Bulk	000 ton	8,276	7,484	2,248	2,032	0	2,379
Total	000 ton	**33,211**	**31,723**	**10,416**	**9,973**	**3,678**	**20,800**

In November 2009, 43 liner services in Hai Phong Port consist of Hong Kong route (47%), Singapore (21%), Busan route (9%), Kaohsiung route (14%) and other routes (9%). There is high possible that 70 % (Hong Kong, Busan and Kaohsiung route) in total liner services is gradually converted to South East Asia/USA Trunk Line through Lach Huyen Port from 2015 to 2020. (See Figure 5.9.3)

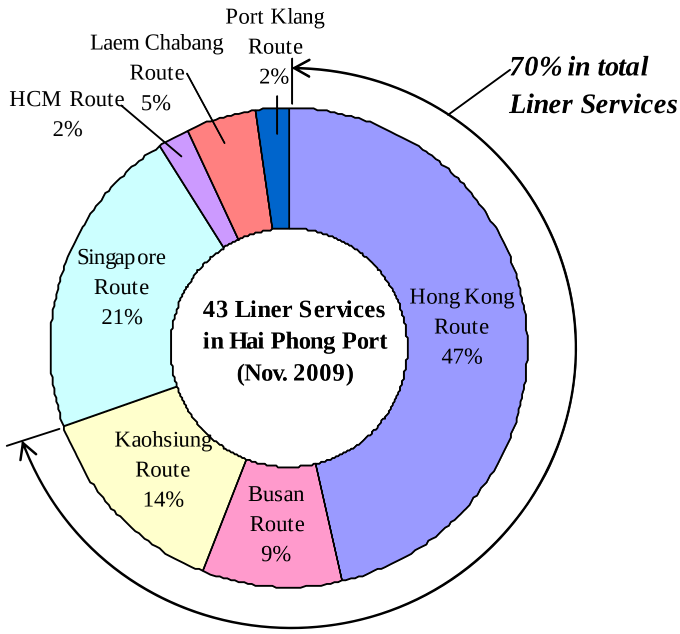


Figure 5.9.3 Liner Services in Hai Phong Port (Nov. 2009)

The demand forecast of Northern Ports, cargo handling capacities of Hai Phong and Cai Lan Port and required of cargo handling capacity of Lach Huyen Port are described in Figure 5.9.4.

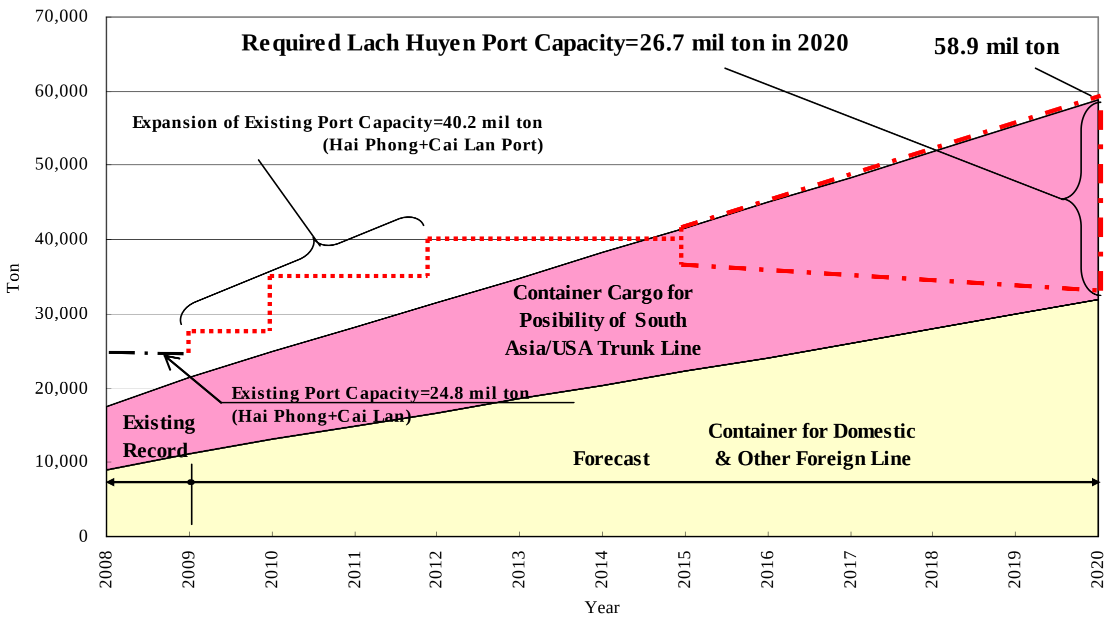


Figure 5.9.4 Container Demand Forecast of Northern ports in the Viet Nam and Lach Huyen Port (Middle Growth Case)

5.9.3 Cargo Volume of Lach Huyen Port

Yearly cargo volume of Lach Huyen port is forecast as shown in Table 5.9.3.

Table 5.9.3 Forecast Cargo Volume of Lach Huyen Port

Cargo Type	Unit	2015	2016	2017	2018	2019	2020
High Growth Case							
Container	1,000 ton	10,182	15,077	20,000	24,951	29,930	34,937
	1,000TEU	878	1,300	1,724	2,151	2,580	3,012
GC +Bulk	1,000 ton	-	-	1,947	2,610	3,246	3,853
Total	1,000 ton	**10,182**	**15,077**	**21,947**	**27,561**	**33,176**	**38,790**
Middle Growth Case							
Container	1,000 ton	5,394	9,607	13,843	18,102	22,385	26,691
	1,000TEU	463	826	1,191	1,559	1,928	2,299
GC +Bulk	1,000 ton	-	-	1,119	1,714	2,286	2,834
Total	1,000 ton	**5,394**	**9,607**	**14,962**	**19,817**	**24,671**	**29,525**
Low Growth Case							
Container	1,000 ton	3,678	4,741	7,660	11,228	14,815	18,421
	1,000TEU	317	409	658	966	1,275	1,586
GC +Bulk	1,000 ton	-	-	1,102	1,610	2,098	2,379
Total	1,000 ton	**3,678**	**4,741**	**8,762**	**12,838**	**16,914**	**20,800**

Consequently, cargo volume of Middle Growth case of Lach Huyen Port is estimated 2,299,000 TEU for container and 2,834,000 tons for general cargo and bulk cargo in 2020

The details of container forecast for Northern Viet Nam Ports and Lach Huyen Port are estimated in Table 5.9.4. In this estimation, TEU/Box ratio and empty container ratio are adapted with Hai Phong Port data. And Export and Import container is estimated to totally balance.

Table 5.9.4 Details of Container Forecast for Northern Viet Nam Ports and Lach Huyen Port

	Unit	Northern Viet Nam Port			Lach Huyen Port	Remarks
		2008	2015	2020	2020	
1. Export						
Container	1,000 ton	4,534	8,792	12,484	8,375	
Container	1,000TEU	504	1,245	1,719	1,092	Export and Import container volume was estimated to totally balance.
Loaded	1,000TEU	281	549	780	514	
Empty	1,000TEU	224	695	939	578	
40'	No.	168	415	573	364	TEU/Box ratio was estimated 1.5 based on latest 3 years of Hai Phong Port Data
20'	No.	168	415	573	364	
Box No.	No.	336	830	1,146	728	
2. Import						
Container	1,000 ton	7,722	18,880	26,069	16,861	
Container	1,000TEU	504	1,245	1,719	1,092	Export and Import container volume was estimated to totally balance.
Loaded	1,000TEU	478	1,180	1,629	1,034	
Empty	1,000TEU	26	65	90	58	Empty container ratio was for import container estimated 5.5% for import container based on latest 3 years of Hai Phong Data
40'	No.	168	415	573	364	TEU/Box ratio was estimated 1.5 based on latest 3 years of Hai Phong Port Data
20'	No.	168	415	573	364	
Box No.	No.	336	830	1,146	728	
3. Domestic						
Container	1,000 ton	5,265	13,925	20,317	1,455	
Container	1,000TEU	437	1,096	1,637	115	
Loaded	1,000TEU	326	870	1,270	89	
Empty	1,000TEU	111	200	292	26	
40'	No.	146	357	521	38	TEU/Box ratio was estimated 1.5 based on latest 3 years of Hai Phong Port Data
20'	No.	146	357	521	38	
Box No.	No.	292	714	1,042	76	
Total Container	1,000 ton	**17,521**	**41,597**	**58,871**	**26,691**	
	1,000TEU	**1,434**	**3,586**	**5,075**	**2,299**	Ton/TEU was estimated based 11.6 ton in 2009 based on VINAMARINE data

Note: Based on container data (year 2000 to Oct. 2009) of Hai Phong Port and VINAMARINE data, the Study Team estimated.

6. Necessity of the Project

6.1 Increase of Sea Borne Traffic Volume

In recent years the sea borne traffic volume in Northern Vietnam has been showing rapid increase. The general cargo volume excluding oil, coal, cement and clinker which are handled at dedicated ports was 25.3 million tons in total and of which container were 1.43 million TEUs in 2008. Its average growth rate during last 8 years was 19% for total cargo volume and the container cargo volume was increased drastically at 29% annum by TEU basis during the same period. These cargoes are forecasted to be 72 million tons and 5.1 million TEUs in 2020 respectively.

The existing main ports in Northern Vietnam for handling those cargoes are Hai Phong Port including Dinh Vu Port, and Cai Lan Port. Even if add the capacity of existing port development plans, namely 4 container berths of Dinh Vu Port and 3 container berths of Cai Lan Port, the total handling capacity of the existing ports are assessed at 53 million tons in which container cargo volume will be 40 million tons or 3.5 million TEUs and container cargo will be saturated in 2015 and non-container cargo 2017.

Since the port is a vital nation’s infrastructure that contributes to the growth of Vietnamese economy, it should therefore be avoided that the port is saturated with the cargoes and can not provide any more services to the customers to the extent that would cause jeopardizing the nation’s economy.

To cope with this situation, well before the critical moment comes to the reality, the development of sufficient capacity of additional port is necessary to absorb the spill-over cargoes from the ports of Hai Phong and Cai Lan.

6.2 Global Container Shipping Trend

What to be considered when developing a new port is the trend of global shipping market. The sharp increase in world container traffic throughout the decades wielded influence on many fields. The shipping industries sought to increase the scale of their service capacities by forming strategic consortium, acquiring other shipping lines, and throwing many large sized vessels in the market.

At the same time, these major shipping companies, as well as some of the ship financiers, have been continuing to order larger sized vessels to comply with growing customers’ needs and seeking the economies of scale. As a result, ships slots number in service was increased from 4.8 million TEU to 12.1 million TEU in 8 years during 2000 – 2008 in total, or increased by 12 % annually in the same period. Also, a total of 1,201 larger sized vessels with more than 4,000 TEUs capacity, were in service in 2008, sharing 57% of the total capacity of the world container vessels, although their share was only 6.4% in 1997. Thus, it can be said that growing in ships slots and size is more prominent in future. In fact, 449 of over 4,000 TEU vessels, equivalent to 3.5 million TEUs or sharing 88% in total were ordered in the year 2007. These vessels will be delivered and in service within next few years.

From the geographic condition of Hai Phong Port, there is a high possibility that if deep-sea port is developed, the mother container vessels (4,000TEU – 8,000TEU) now plying in the Trans-Pacific trunk route between Hong Kong, Kaohsiung, etc and the west coast of USA will extend their service range up to Hai Phong Port. However, regarding the container vessels now plying Asia-Europe trunk route will not call Hai Phong Port in foreseeable future, since deviation time from trunk route is big, and the cargoes to/from Europe will be transshipped traditionally at Singapore, Tanjung Pelepas, etc., for the time being. However, for this feeder services, it is apparent that medium size mother ships (2,000TEU to 4,000TEU) currently deployed in the trunk routes are most likely to be cascaded down to the feeder routes. A necessity and rationale to construct a deep sea port is that the port must be ready to accommodate such redeployed larger and deep draft ships into the feeder routes.

On the other hand, the existing Hai Phong container ports are situated along the banks of Cam River and Bach Dang River and there is restriction in water depth of access channel that can provide up to around CDL – 7.0m. Therefore, Hai Phong ports can't accept such a cascaded mother container vessels.

Cai Lan Port was developed as a deep seaport of CDL -13m but it is necessary to pass the dredged access channel in Ha Long Bay which has been designated as the World Heritage by UNESCO. The water depth of the access channel is CDL -10m at present and further deepening is necessary to accept large container vessels. However, from the environmental considerations, the further deepening of this access channel will be impossible.

Therefore, to cope with the rapidly increasing sea borne traffic demand and global trends of ship size of container vessels, it is necessary to develop another port which can accommodate 50,000DWT to 100,00DWT (4,000TEU – 8,000TEU).

For the candidate site of new deep seaport in Northern Vietnam, Cam Pha area and Do Son area in addition to Lach Huyen area were studied and assessed from the viewpoints of natural conditions, access transportation to hinterland, future expansion potential, investment cost, environmental aspects, etc., by the Feasibility Study made by TEDI and selected Lach Huyen area as the most suitable site for a deep seaport by the reasons summarized below:

Cam Pha Site: This site has many advantages especially in natural conditions but has some limitations such as the acceptable ship size (less that 30,000DWT), space for future development, transportation system to hinterland, etc. Especially, inland waterway access from Hai Phong area has to pass through Ha Long Bay, world cultural heritage site.

Do Son Site: This site has advantage for access transportation to hinterland, however, has disadvantages for natural conditions (wave, siltation, sea depth) and physical and social environmental aspects. This site should be reserved for tourism and resort development as planned in Hai Phong's special development plan toward 2020.

Lach Huyen Site: This site can permit large ship enter and leave easily and has unlimited potential for port development in terms of expansion, and is not located in the Ha Long Bay and dose not affect the planned residential areas or tourist areas of Do son or Cat Ba eco-tour area. .

6.3 Vietnam Seaport System Development Master Plan

VINAMARINE (Vietnam Maritime Administration) has prepared the Master Plan of Vietnam Seaport System Development until 2020 toward to 2030, which was approved by the Prime Minister on December 24, 2009. In this master plan, the Hai Phong Port is designated to develop as an International Gateway Port as follows:

(1) By 2020 in a vision to 2030 to invest in synchronous system of seaports and access channels. To build: Van Phong transshipment container terminal for the vessels of 9.000 TEU to 15,000 TEU; international gateway ports in **Haiphong**, Baria - Vung Tau and Central focal economic zone (when it will be possible) for the vessels of 8,000DWT to 100,000 DWT, container vessel of 4,000TEU to 8,000 TEU.

(2) **Hai Phong Port**: International gateway port, national general hub port of the North with following functional areas:

- **Lach Huyen terminal**: it is the main terminal of Hai Phong port, mainly used for import-export container vessel of 4,000 TEU to 6,000 TEU and 50,000 DWT to 80,000 DWT, operated in far navigation transportation routes. Port infrastructures, cargo handling technology will be developed as synchronous and modern system at international level. The logistic park will be developed in services area behind the berth. Berth, technical infrastructures connecting to national network and service area behind the berth will be investment emphasis at the planning stage.

- **Dinh Vu area**: mainly for un-full general & container cargo vessel 20,000 DWT to 30,000 DWT. The dedicated terminals are arranged of factories and services enterprises inside Dinh Vu industrial zones.
- **Cam river area**: main function is locally general terminal for vessel of 5,000 DWT to 10,000 DWT, there is no plan for further development and expansion; for long term the port will change to other functions, the terminals in inner city will be reallocated. Main terminals in this area are Chua Ve and Vat Cach.
- **Chanh river area** (Yen Hung – Quang Ninh): main function is dedicated port with general container terminal for vessels of 10,000 DWT to 40,000 DWT. The port includes dedicated terminal for Yen Hung – Dam Nha Mac industrial zone, dedicated terminal for building and repairing of 100,000DWWT ships, dedicated terminal for oil product (at Qua Muom island).
- **Dedicated terminals and satellite terminals**: directly serve for industrial and services enterprises, the riverside terminals and local terminals service for local ships (incl. Diem Dien – Thai Binh, Hai Thinh – Nam Dinh). To be develop in accordance with general plan, to be satellite terminal of Hai Phong port.

(3) Sufficiently meet the market demand of volume of cargo and size of in/out vessel, ensuring the competitiveness in international market and regional market. At the same time to be the driving force for development of industrial, economical and urban zones of coastal areas. To develop container and other cargo receiving and forwarding centers in industrial and services zone behind the berths for maximum use of port capacity and regional public transport networks.

7. Natural Conditions

7.1 General

During the Works in Vietnam, data and project-related information on the natural conditions in and around Lach Huyen new international gateway port area were collected from both governmental and non-governmental sources of agencies. The data and information collected on the natural conditions will be used to determine the basis for port planning, preliminary design of port facilities, environmental impact study, etc., in order to formulate the medium term development plan or implementation plan as Japan's ODA Loan Project together with design, construction plan and cost estimate for various proposed port facilities.

In addition, a series of site surveys such as bathymetric survey in new port area, subsoil investigation at reclamation area and along breakwater/training dyke, seabed material survey, current and tide survey, were carried out during the 1st Work in Vietnam from October 2009 to January 2010. The results of these field surveys for natural conditions are presented in this sub-chapter in details.

7.2 Outline of Natural Conditions

7.2.1 Topography and Bathymetry

The proposed Project Site is located along the east edge of the Bay of Haiphong on the south of Cat Hai Island. The proposed site area is well sheltered by Cat Ba Island from the intruding northerly and easterly waves generated in the Gulf of Tonkin. The Bay bathymetry has being developed by the effects of the estuaries of such major rivers to follow into the bay as the Lach Huyen River, Cam river, Bach Dang river and Chanh river. The whole area of the Bay is much influenced by the estuary of these major rivers and the tides of the Gulf of Tonkin. The site mostly lies at tidal flats of the Haiphong Bay.

The bathymetry of Haiphong Bay is gradually sloped in an average slope of 0.04 to 0.08% to the directions of south-southeast. The sand bars and littoral dunes have been developed along the river estuaries, and appear at the low tide. The Project site for reclamation locates at the sand bars developed along the west bank of Lach Huyen river estuary and the water depth varies from CD+2.0 to ±0.0 m and gradually deepens to southeast direction.

7.2.2 Meteorological Feature

The Project site area belongs to the weather regime of tropical wind.

1) Temperature

The temperature observed at Cat Hai station shows is moderate. Table 7.2.1 shows the monthly change of the mean, highest and lowest temperatures. The monthly highest temperature records 38.0^{o}C (in October) while the monthly lowest temperature is 3.7^{o}C (in December). The difference between the highest and lowest monthly average temperatures is 34.3^{o}C.

Table 7.2.1 Air Temperature at Cat Hai Station

(^{o}C)

	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Mean
Highest	27.8	27.6	28.8	33.6	36.2	36.1	35.9	35.7	35.3	38.0	33.6	28.2	---
Mean	16.9	17.5	20.3	24.1	27.5	28.5	29.4	28.8	27.9	26.0	23.7	19.1	24.1
Lowest	14.6	5.3	7.1	13.4	15.9	18.4	23.4	23.1	16.6	14.0	9.0	3.7	---

Source: EIA Report, Lach Huyen Gateway Port Construction Project (2010-2015): Ministry of Transport, 2008

2) Humidity

The Humidity is very high at the project site area. The area experiences normally about 75 to 90 % all the year around.

Table 7.2.2 Air Humidity at Cat Hai Station

(%)

	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Mean
Mean	76.7	84.9	86.7	89.0	84.0	85.6	84.0	84.7	84.0	80.2	77.2	78.7	83.1

Source: EIA Report, Lach Huyen Gateway Port Construction Project (2010-2015): Ministry of Transport, 2008

3) Rainfall

The weather regime is divided into rainy season from May to October and dry season from November to April. The average rainfall at Cat Hai area is about 1,600 and 200 mm/year in the rainy season and the dry season respectively, and 1,800 mm/year through a year. TEDI F/S report indicates that the maximum rainfall of 320.5 mm/day was observed at Hon Dau area on July 14, 1992.

Rainy day defined as a day with rainfall of not less than 0.1 mm appears about 113 day annum (75 days in rainy season and 38 days in little rainy season) which is equivalent to about 31% of annual days.

Rainstorm with thunder discharge appears 44.3 days annum on average at Cai Hai area. According to the data below, storm season is from May to September. Rainstorm often causes strong rain, whirl winds and high waves.

Table 7.2.3 Average Monthly Number of Rainstorm Day

(day)

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Year
Phu Lien	0.1	0.5	3.5	3.8	5.9	7.3	7.1	8.7	5.6	2.0	0.2	0.1	44.8
Hon Dau	0.2	0.3	3.4	3.8	5.1	6.3	5.7	9.4	6.2	3.3	0.3	0.1	44.1
Cat Hai	0.0	0.29	3.29	3.43	4.57	9.29	7.43	8.14	5.43	2.0	0.43	0.0	44.3
Bai Chay	0.2	0.4	3.5	3.8	5.8	8.5	7.6	13.2	6.3	3.9	0.1	0.1	53.4
Cua Ong	0.1	0.5	3.3	3.6	4.9	8.1	8.3	10.0	5.6	2.0	0.2	0.0	46.6

Source: Report on Environmental Impact Assessment for Lach Huyen Gateway port Construction Project, 2008, Original Data from The North-East Meteorological Station, 1975-2006

4) Fog

Fog occurrence concentrates in winter season from December to April. The frequency of foggy day is 21.2 days annum and 6.5 days in peak month of March as summarized below table.

In the month from January to April, fog with visibility of less than 1 km (Grade 0-3) occurs in an average of about 0.4 days per month while foggy day with visibility of less than 10 km (Grade 0- 6) occurs 4.3 days per month.

Table 7.2.4 Foggy Day Occurrence (1984-2004)

	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Mean
Max	15	9	20	16	3	0	2	0	6	2	5	15	61
Average	2.4	4.0	6.5	4.6	0.3	0	0.1	0	0.3	0.2	0.6	2.1	21.2

Source: Report on Port Capacity Reinforcement Plan in Northern Vietnam: Nippon Koei Co., Ltd. & Associates, September 2009

5) Winds

The climate in Northern Vietnam and the adjacent area is relatively calm except for stormy season which usually starts in June and finishes in November.

The wind in Viet Nam is normally governed by the prevailing seasonable climate character. The prevailing wind direction is north to northeast due to the northeast monsoon climate in dry season (September to February) while south to southeast wind due to southwest monsoon climate in rainy season (March to July). But, in the northern delta area, the northerly winds in dry season change to north-easterly or easterly while southerly winds in rainy season to southerly or south-easterly due to the local topography.

Table 7.2.5 below shows the annual frequency in occurrence of normal wind by speed and direction compiled from the wind data observed 3-year period from 2006 to 2008. These data show that the predominant wind directions range from East to South (about 45% of occurrence) and North (around 13%) of the whole winds. The wind of more than 15 m/s in speed is very rare in occurrence.

Table 7.2.5 Frequency in Occurrence of Normal Wind Speed by Direction

Wind Direction	Wind Speed (m/s)										Total	
	Calm		1.0 -4.0		5.0 – 9.0		10.0 – 15.0		> 15.0			
	N	%	N	%	N	%	N	%	N	%	N	%
N	---	---	432	9.97	132	3.05	4	0.09	0	0.00	---	---
NNE	---	---	89	2.05	36	0.83	1	0.02	0	0.00	---	---
NE	---	---	241	5.56	63	1.45	3	0.07	0	0.00	---	---
ENE	---	---	134	3.09	12	0.28	0	0.00	0	0.00	---	---
E	---	---	578	13.35	482	11.13	23	0.53	0	0.00	---	---
ESE	---	---	227	5.24	123	2.84	1	0.02	0	0.00	---	---
SE	---	---	307	7.09	132	3.05	4	0.09	0	0.00	---	---
SSE	---	---	87	2.01	126	2.91	36	0.83	0	0.00	---	---
S	---	---	180	4.16	144	3.32	11	0.25	0	0.00	---	---
SSW	---	---	21	0.48	51	1.18	13	0.30	0	0.00	---	---
SW	---	---	50	1.15	24	0.55	0	0.00	0	0.00	---	---
WSW	---	---	4	0.09	0	0.00	0	0.00	0	0.00	---	---
W	---	---	36	0.83	3	0.07	0	0.00	1	0.02	---	---
WNW	---	---	20	0.46	1	0.02	0	0.00	0	0.00	---	---
NW	---	---	155	3.58	15	0.35	0	0.00	0	0.00	---	---
NNW	---	---	108	2.49	16	0.37	1	0.02	0	0.00	---	---
Total	204	4.71	2,669	61.63	1,360	31.40	97	2.24	1	0.02	4,331	100

Source: Report on Port Capacity Reinforcement Plan in Northern Vietnam: Nippon Koei Co., Ltd. & Associates, September 2009

Monthly change in wind speed is summarized as follows. Occurrence of high wind prevails in rainy season from March to September.

Table 7.2.6 Wind Speed at Cat Hai Station

(m/sec)

	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Mean
Max	10	12	20	20	>20	>20	>20	>20	>20	20	14	12	>20
Average	3.9	3.9	3.9	3.1	3.2	3.1	3.0	3.7	3.3	3.3	3.2	3.0	3.4

Source: EIA Report, Lach Huyen Gateway Port Construction Project (2010-2015): Ministry of Transport, 2008

The extreme wind speed generated by tropical typhoons is about 40 -50 m/s. The predominant direction of these strong winds is southeast and observed 52 m/s at Hai Phong city during the storm Sarah on July 21, 1977. The probability of occurrence for extreme wind speed is summarized by wind direction as follows in TEDI F/S report.

Table 7.2.7 Extreme Wind Speed based on Hon Dau Station Wind Data

(m/sec)

Wind Direction	Return Period (Yr)					
	5	10	15	25	50	100
N	32.1	36.2	40.2	42.5	45.4	49.2
NE	36.7	42.2	47.4	50.4	54.2	59.3
E	**38.2**	43.3	**48.3**	**51.1**	**54.7**	**59.5**
SE	33.6	38.6	42.7	46.5	49.6	54.0
S	36.3	41.6	46.5	49.5	53.3	58.0
SW	36.6	41.3	45.5	48.0	51.5	56.5
W	31.2	36.9	42.0	45.0	49.3	54.5
NW	37.6	**43.3**	46.8	49.5	53.4	58.5
Maximum	38.2	43.3	48.3	51.1	54.7	59.5

Source: TEDI F/S Term-End Report

6) Seismic Conditions

The regional earthquake activities in and around Vietnam are deemed to be quite negligible. According to the statistical data by US Geological Survey Earthquake Hazards Program (1975-2006), a earthquake event of magnitude of 5.7 Richer Scale occurred at a place of about 151 km away from Lach Huyen on December 31, 1994. It is reported that maximum horizontal tremor intensity is estimated 0.024 for the earthquake.

TCXDVN 375; 2006 recommends to apply Level 3 (kh=0.04 or less for the projected area among 3 seismic activity levels in Vietnam.

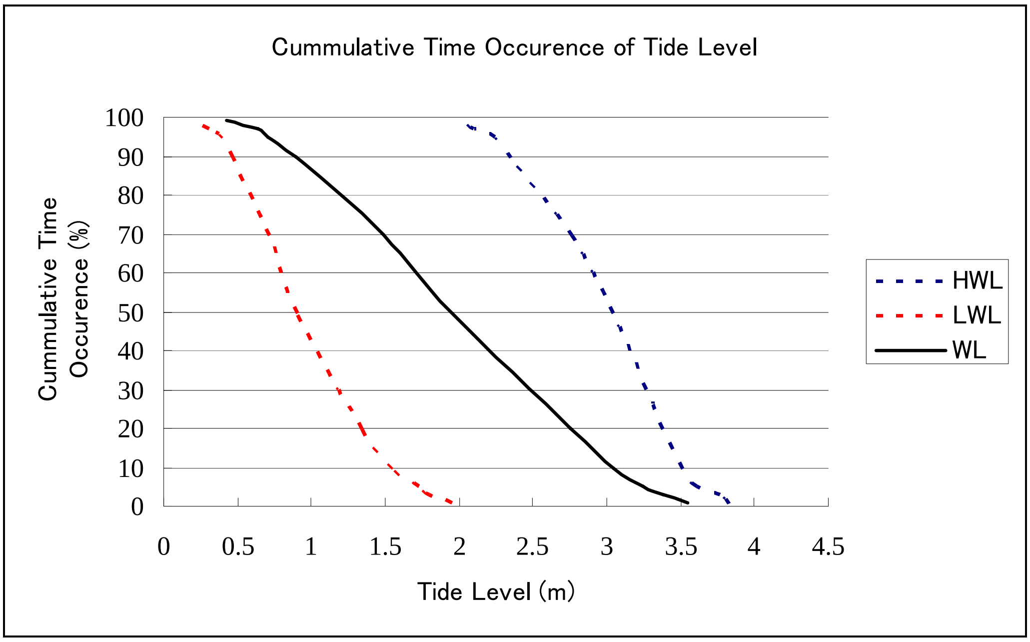
7.2.3 Oceanographic Feature

1) Tides

The tide regime at Hon Dau is usually diurnal. The tide level prediction at Hon Dau is given in the TEDI F/S report as follow.

- HWL : CD +3.55 m
- MHWL : CD +3.05 m
- MWL : CD +1.95 m
- MLWL : CD+0.91 m
- LWL : CD +0.43 m
- * CD referred and equals to Chart Datum.

In addition to the astronomical influence, the actual water levels may be significantly affected by barometric pressure, and wind and wave setup around Lach Huyen estuary area. The extreme water level at Hon Dau was observed CD+4.21 m for the highest on October 22, 1985 and CD +0.03 m for lowest on January 2, 1991, respectively. TEDI F/S report indicates that the extreme high sea water level at 1 % frequency of occurrence is CD+4.43 m, which is predicted by frequency theory based on the highest water levels from 1974 to 2004.



Source: TEDI F/S Report

Figure 7.2.1 Cumulative Time Occurrence of Tide Level

2) Currents

The current at Lach Huyen estuary is governed semi-diurnal tidal flow. The survey in January 1987 shows that average current speed is 0.3 -0.5 m/s. But due to the effects of wind and wave generated flow, the current becomes the maximum speed of 1.0 to 1.2 m/s at flood as well as ebb tide and may reach to the greatest speed at 1.5 to 1.8 m/s during ebb tides at the river estuaries. Sea chart on Hai Phong to Cam Pha indicates that the tidal stream is 2.6 knot (=1.34 m/s) highest speed 8 hours after high water along Cua Nam Trieu.

3) Waves

Hon Dau Station records (3-year period from 2006 to 2008) shows the following normal waves which are generated by local winds at the area. The wave height more than 1.0 m occupied 8.59% of occurrence. 60% of waves come from directions from E to S and prevailing wave direction is E to S. But high waves seem much prevail from SE and S directions.

Table 7.2.8 Frequency in Occurrence of Normal Wave Height by Direction

Wave Direction	Wave Height (m)										Total	
	0 – 0.25		0.25 – 0.5		0.5 – 1.0		1.0 – 1.5		> 1.5			
	Nr	%	Nr	%	Nr	%	Nr	%	Nr	%	Nr	%
N	---	---	3	0.09	57	1.74	8	0.24	1	0.03	---	---
NE	---	---	0	0.00	47	1.43	16	0.49	0	0.00	---	---
E	---	---	184	5.60	844	25.71	63	1.92	5	0.15	---	---
SE	---	---	37	1.13	429	13.07	89	2.71	6	0.18	---	---
S	---	---	4	0.12	149	4.54	75	2.28	13	0.4	---	---
SW	---	---	0	0.00	10	0.30	5	0.15	1	0.03	---	---
W	---	---	0	0.00	1	0.03	0	0.00	0	0.00	---	---
NW	---	---	0	0.00	10	0.30	0	0.00	0	0.00	---	---
Total	1,226	37.34	228	6.94	1,547	47.12	256	7.80	26	0.79	3,283	100

Source: Report on Port Capacity Reinforcement Plan In Northern Vietnam, September 2009: Nippon Koei Co., Ltd. & Associates

The following extreme high wave was observed at meteorological station in Hon Dau water in a period for 20 years from 1965 to 1985.

Wave Direction	South	East
Wave Height	5.6 m	5.6 m
Wave Length	210 m	96 m
Date	July 3, 1964	September 20, 1975

Source: TEDI F/S Term-End Report

According to the observation in the second half of 20th century, 13 numbers of tropical typhoon occurred on average per year in the East Pacific region, of which 7 numbers affected Viet Nam. Cat Hai area which locates the northern coastal area of the country was attacked at 0.92 times per annum on average. The wave data at Hon Dau observation station for 20 years from 1988 to 2008 were used to analyze the extreme wave height probability based on the Gumbel and Weibull distribution methods and obtained the following results.

Return Period (Yr)	Wave Height (m)	Wave Period (Sec)
1	1.22	5.8
5	3.18	8.9
10	3.71	9.7
30	4.45	10.8
50	4.77	11.3
75	5.01	11.7
100	5.18	12.0
120	5.28	12.1

Wave Period: estimated by the relationship T=1.5539H+3.9222

Source: Report on Port Capacity Reinforcement Plan in Northern Vietnam: Nippon Koei Co., Ltd. & Associates, September 2009

7.2.4 Geological Conditions

1) General Conditions

The Lach Huyen Port Development area is located in the lower reaches of the Red River (Coi River). Large amounts of soil and sand now come from the Nam Trieu River and the Lach Huyen River, resulting in a thick built-up of a soft clay layer.

This project area belongs to Cat Hai district, Haiphong city. It is situated on the right of Lach Huyen river. The right bank of the river, beginning from stone jetty in the south of Cat Hai island, is a big sand bar with the length of about 6,000m and the width of 1,000m, its altitude is from 0 to +1.0m. The opposite bank is Cat Ba island.

2) Geological Characteristics

In this region, the Feasibility Study Report for Hai Phong International Gateway Port Project, a geological and property survey was conducted by TEDI in 2007. And later on, five additional borings (PBH-1 to 5) and indoor soil property tests were conducted in 2008 by Nippon Koei.

The geological layers in this region are broken down into formations in the order of newer generations (Layer-I, Layer-2, Layer-8, etc.). The geological status for each layer, as well as the N-value distribution conditions, is shown in Table 7.2.9.

Table 7.2.9 Soil Properties and N-Value at Each Layer

Layer	Soil Description	N-Value	
		Range	Average
Layer-1	Grey small sand mixed clamshell (**Sand**)	4~8	6
Layer-2	Liquid plastic grey clay (**Clay**)	1~5	3
Layer-3	Plastic mixed sand (**Sand**)	-	-
Layer-4	Soft plastic clay (**Clay**)	4~8	6
Layer-5	Spotted clay (grey, yellow grey, red brown), tough plastic, semi-tough (**Clay**)	5~23	12
Layer-6	Green grey, grey, soft plastic clay (**Clay**)	4~9	7
Layer-7	Medium dense-yellow grey sand (**Sand**)	19~25	22
Layer-8	Clay/strongly to medium strongly weathered siltstone(**Clay**)	-	-

7.3 Natural Conditions Surveys in this Study

The following surveys have been carried out in this Study to check the existing data and obtain the latest information for reviewing the Feasibility Study Report implemented by TEDIPORT.

(1) Sub Soil Conditions Surveys

- Offshore Boring

  10 offshore borings at the first phase reclamation area and along the planned sand prevention groin.

- Seabed Material Survey

  80 location in and around the port development area

(2) Hydrographic Surveys

- Bathymetric Survey

  420 km long (1km long per section in every 50 m interval, which is perpendicular to navigation channel)

- Tidal Observation

  1 location at Ben Got Jetty in Cat Hai Island, Observation for 15 consecutive days

(3) Current Observations

- Current Measurement

  4 locations along the navigation channel

- Cylinder Sampling

  4 locations along the navigation channel

- Water Sampling

  4 locations along the navigation channel

7.3.1 Subsoil Conditions Survey

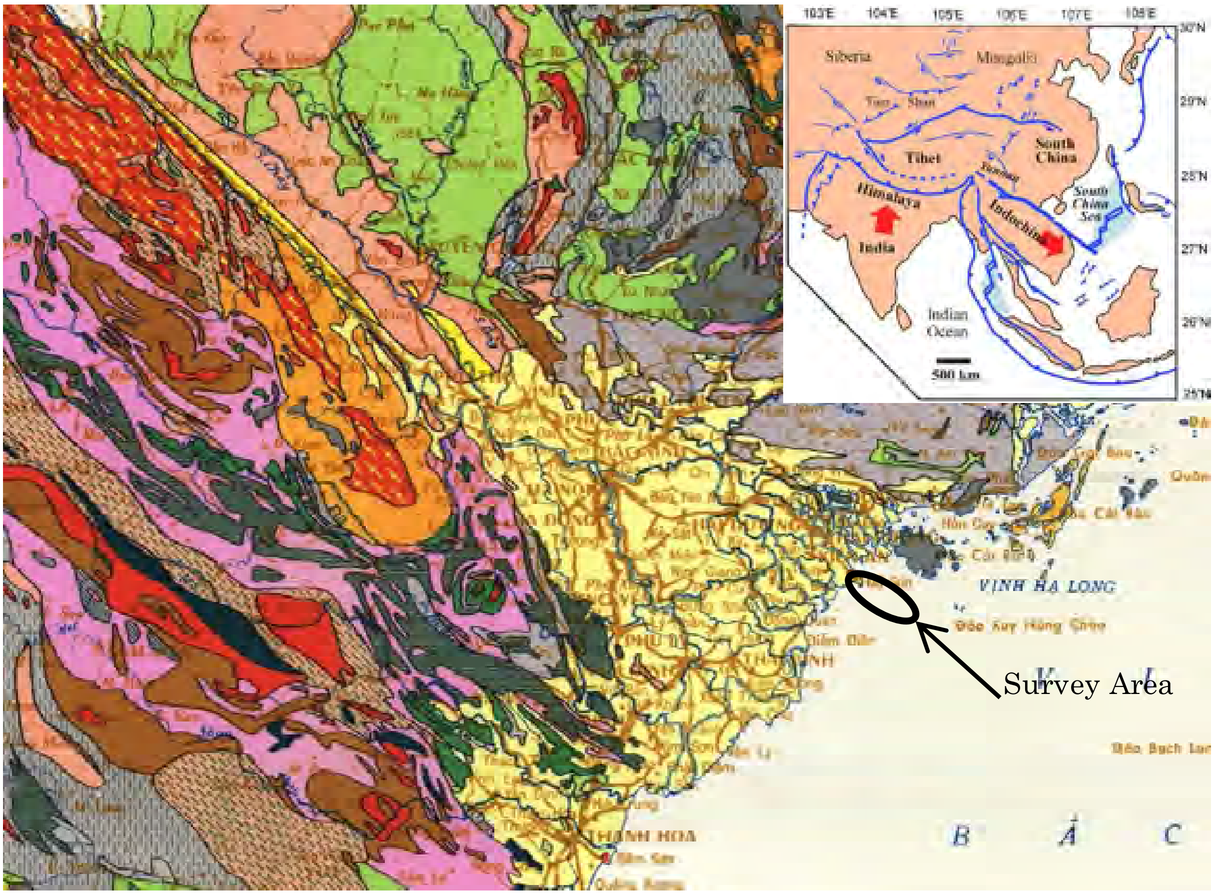
1) Location, Topography and Geology

Hai Phong is a port city, located in the east of northern coastal area, approximately 120 km away from Hanoi Capital. The investigation area locates in Cat Hai Island that is 13 km away from Hai Phong downtown in the east.

Location of the project site is shown in Figure 7.3.1 and Figure 7.3.2.

Survey area is located at the sea side of south end of Cat Hai Island which is at the front end of delta area of Red River. Large amount of soil and sand flow in from the Nam Trieu River and Lach Huyen River, resulting in a thick buildup of a soft clay layer. At ground surface, sand can be seen in Cat Hai Island and at its surrounding areas and shellfish which lives in seabed sand are landed at Ben Got Jetty of Cat Hai Island as shown in Figure 7.3.3.

As shown in Figure 7.3.1, geological structure can be seen from north west to south east direction. Because the boundary of tectonic plate exists around this area from north west to south east direction as shown in the upper right map of Figure 7.3.1. Therefore some geological and structural boundary may exist between Cat Hai Island and Cat Ba Island. One symptom of this is outcrops observed in Cat Ba Island. Weathered lime stone which is main bed rock of Cat Ba Island can be seen as shown in Figure 7.3.3. However only silt/clay stone is identified as a bed rock of Lach Huyen survey area according to survey results including existing ones. It means Lach Huyen River is flowing along the geological or structural boundary between Cat Hai Island and Cat Ba Island.



(Extracted from Geological Map Viêt-nam_Kampuchia_Lào. 1971)

Figure 7.3.1 Location of Survey Area on Geological Map

(Extracted from Google Earth)

Figure 7.3.2 Location of Survey Area

		
Sand beach near Ben Got Jetty at low tide	Stone revetment and sand beach in port reclamation area at low tide	Port reclamation area (view from sea side to land side)
		
Sand shoal at port reclamation area between SBH-1 and SBH-3	Dyke at east side of Cat Ba Island; sea at left and Saltpan at right side.	Wide saltpan area inside the Cat Hai Island
		
Shellfish living in sandy place is collected at Ben Got Jetty.	Outcrops of hard lime stone seen at the west seaside of Cat Ba Island.	Inclined outcrop of lime stone seen at the west seaside of Cat Ba Island

Figure 7.3.3 Photos at and near Survey Area

2) Offshore Boring

a) Location and co-ordinates of boring points

10 offshore borings has been carried out at the first phase reclamation area and along the planned sand prevention groin from November - 09th - 2009 to December - 05th - 2009. The locations of boring points and those quantities are tabulated in Table 7.3.1 and shown in the Figure 7.3.4.

Table 7.3.1 Co-ordinates, elevation and quantities of the boring investigation

No.	Bore-hole No.	Actual Coordinates (m) – VN2000		Elevation (m)	Depth (m)	Length of drilling(m)		Number of sample		Number of SPT	Remarks
		Northing	Easting			Soil	Rock	Undis-turbed	Dis - turbed		
1	SBH1	2301288	620055	-1.90	27.00	24.00	3.00	9	15	15	Offshore
2	SBH2	2301113	619715	-1.27	29.20	26.20	3.00	7	19	19	"
3	SBH3	2301053	620204	0.40	30.00	27.00	3.00	5	22	22	"
4	SBH4	2300859	619883	0.75	31.60	28.60	3.00	5	23	23	"
5	SBH5	2300223	619522	0.10	37.50	34.50	3.00	5	29	29	"
6	SBH6	2299377	620036	-0.90	41.80	38.80	3.00	7	31	31	"
7	SBH7	2298491	620565	-0.30	36.45	36.45	-	5	31	31	"
8	SBH8	2296864	623100	-3.30	33.70	30.70	3.00	3	27	27	"
9	SBH9	2295022	624596	-2.90	55.45	55.45	-	5	50	50	"
10	SBH10	2293121	625955	-3.60	51.45	51.45	-	4	47	47	"
Total					374.15	353.15	21.00	55	294	294	

Figure 7.3.4 Location of Boring Points

b) Boring Investigation Result

(1) Soil stratifications at Site

Soil stratifications have been identified due to the boring investigation results, which are tabulated in Table 7.3.2 with existing soil stratifications classified before.

Table 7.3.2 Soil Stratification at Project Site

Existing Investigation Result				Soil Stratification identified in this Study		
Layer Name	Soil Description	N-value Range	N-value Average	Layer Name	Color	N-Value
Layer-1	Grey small sand mixed clamshell (Sand)	4 - 8	6	Layer 1: Loose Sand (SP) - Clayey Sand (SC)	Grey, Light Grey	3 – 10 (6)
Layer-2	Liquid plastic grey clay (Clay)	1 - 5	3	Layer 2: Fat Clay with Sand (CH)	Brownish and Yellowish Grey	0 – 8 (2)
Layer-3	Plastic mixed Sand (Sand)	-	-	Layer 3: Clayey Sand (SC)	Light Grey, Greenish Grey	0 – 17 (6)
Layer-4	Soft plastic clay (Clay)	4 - 8	6	Layer 4: Stiff Sandy Lean Clay (CL)	Reddish and Yellowish Brown	2 – 23 (10)
Layer-5	Spotted clay (grey, yellow grey, red brown) tough plastic, semi-tough (Clay)	5 - 23	12			
Layer-6	Green grey. grey, soft plastic clay (Clay)	4 - 9	7	Layer 5: Firm Fat Clay with Sand (CH)	Grey, Yellowish Light Grey	0 – 15 (6)
-	-	-	-	Layer 6: Stiff - very Stiff Fat Clay with Sand (CH)	Grey	9 – 21 (14)
-	-	-	-	Layer 7: Stiff – very Stiff Sandy Lean Clay (CL)	Yellowish Grey, Light Grey	9 – 50 (22)
Layer-7	Medium dense. yellow grey sand (Sand)	19 - 25	22	Layer 8: Very Dense Sand (SP)	Yellowish Grey, Light Grey	9 – 50 (45)
Layer-8	Clay / strongly to medium strongly weathered silt stone	-	-	Layer 9: Completely Weathered Sand Stone	Reddish Brown	>50
Layer 9	Moderately Weathered Silt/Clay Stone	-	-	Layer 10: Highly – Moderately Weathered Silt/Clay Stone	Reddish Brown	-
Layer 10	Silt/ Clay Stone	-	-			

As shown in the above table, soil layers including bed rock at the site can be classified into 10 layers and distribution of each layer can be summarized in Table 7.3.3.

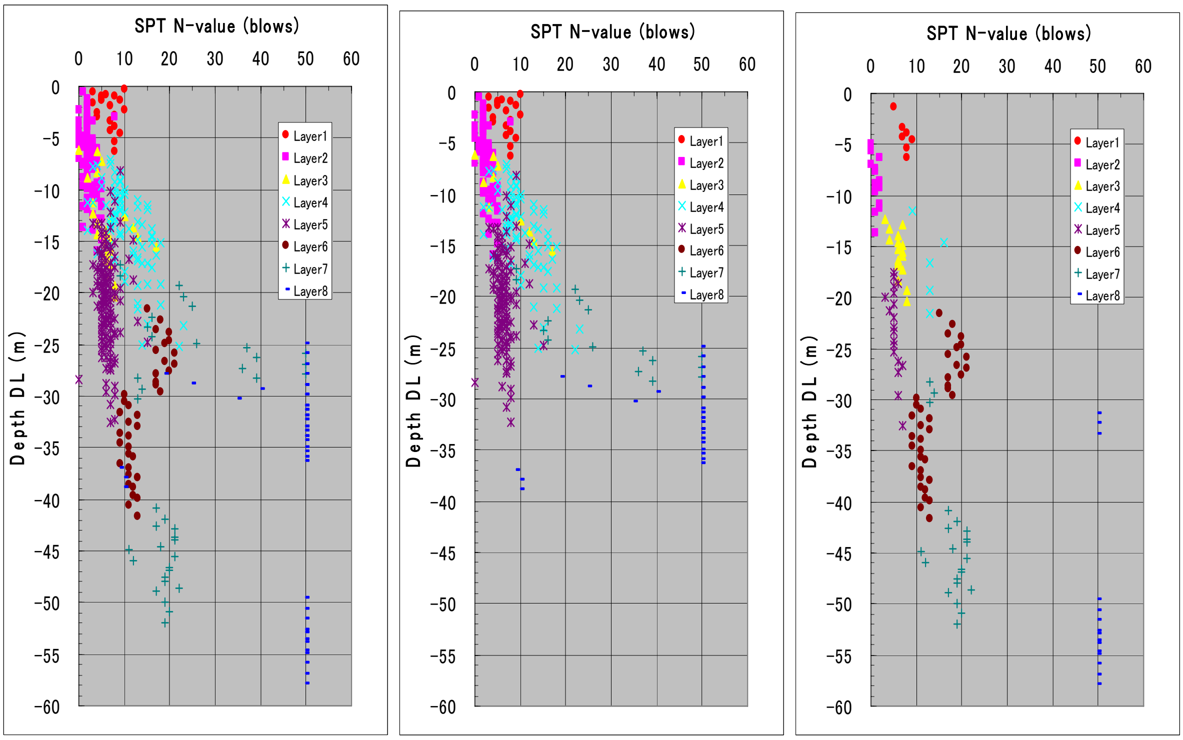
Borehole location map including existing boreholes is shown in Figure 7.3.5.

Representative soil profile with SPT-N values is shown in Figure 7.3.6 and all soil profiles prepared this time are shown in Appendix 7-1.

SPT –N value distribution with depth including existing boring results is shown in Figure 7.3.4.

Existing soil investigation results at study area referred for the preparation of this study report are as follows;

- CONTAINER TERMINAL DEVELOPMENT PROJECT IN HAI PHONG INTERNATIONAL GATEWAY PORT, FEASIBILITY STUDY, SOIL INVESTIGATION REPORT, January 2009, by NIPPON KOEI CO., LTD.
- REPORT ON HYDRO-METEODOLOGICAL, TOPOBATHYMETRIC MAPS AND SOIL INVESTIGATION DATA COLLECTION, November 2007, by TEDIPORT.
- HAI PHONG PORT REHABILITATION PHASE II PROJECT PROPOSED ACCESS CHANNEL ARE, GEOTECHNICAL INVESTIGATION REPORT, May 2000, by TEDI.



All data | Port Area (within 3km from shore line) | Off-Shore Area (more than 3km away from shore line)

Figure 7.3.5 SPT N-value Distribution with Depth

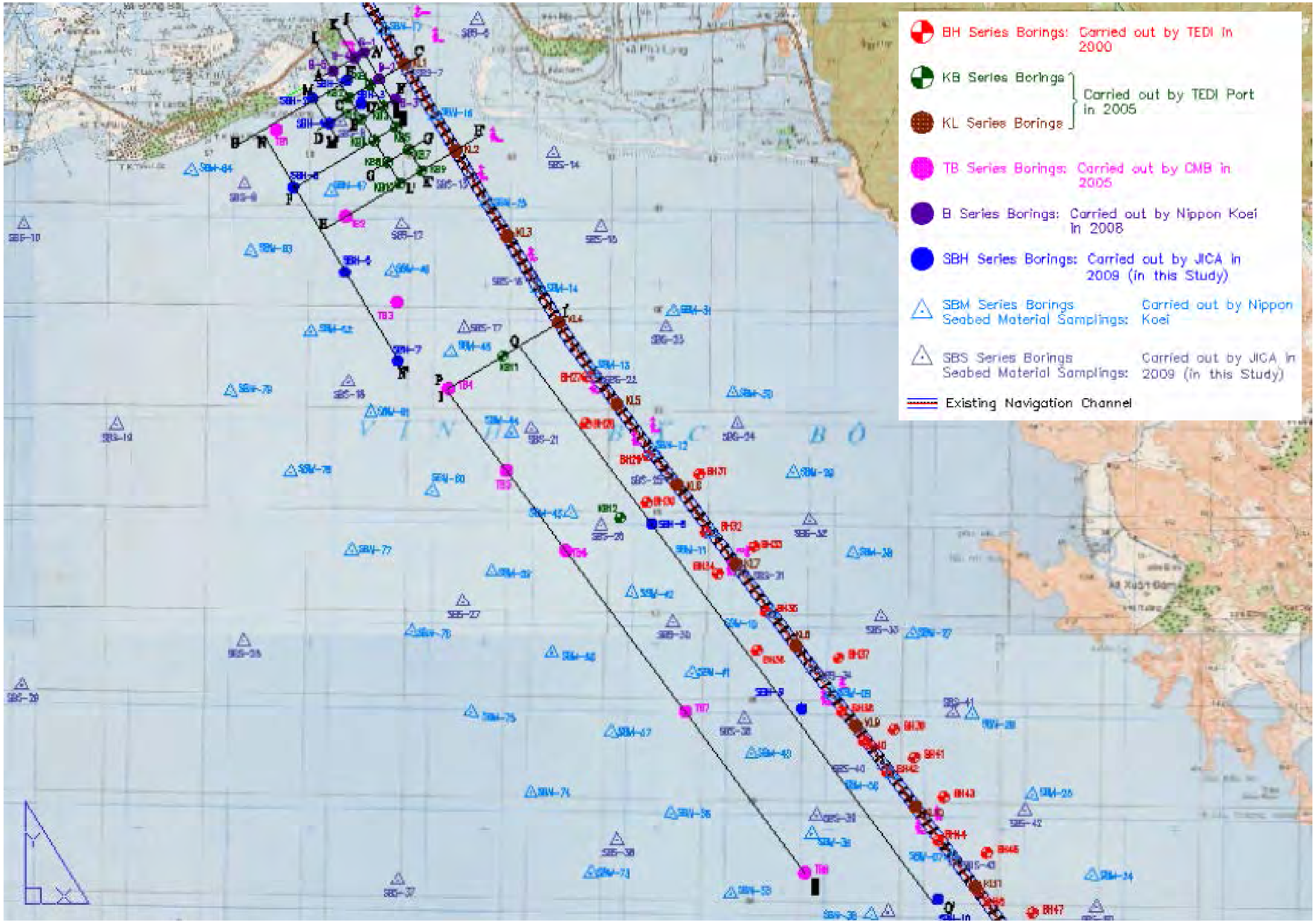


Figure 7.3.6 Locations of Boring Points including Existing Boreholes

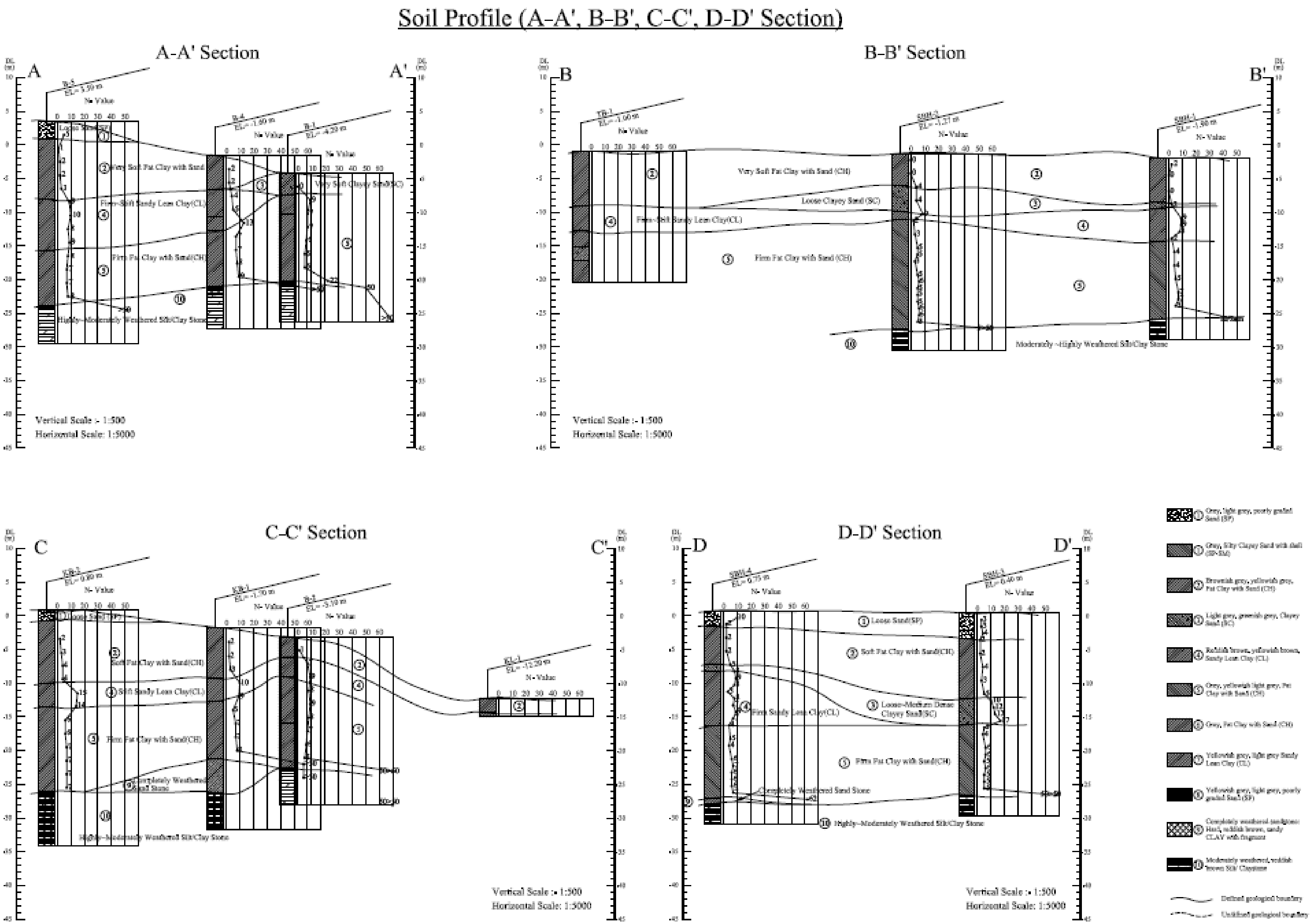


Figure 7.3.7 Soil Profile (A-A', B-B', C-C' and D-D' Section) (Including existing boring results)

Table 7.3.3 Distribution of Soil Layers

Layer Name		Features of Soil Layers		
		Distributed Area	Distributed Depth DL (m)	Distributed Thickness (m)
Layer 1	Loose Sand (SP) - Clayey Sand (SC)	Distributed at west side of navigation channel in 1km wide and 10km long from 27+200 to 37+500 along the navigation channel.	GL to -4	0.5 to 5.0
Layer 2	Fat Clay with Sand (CH)	Distributed at whole survey area. 1) Port Area (within about 3km from shore line) 2) Off-Shore Area (more than 3km away from shore line)	+1 to -17 -3 to -14	5.0 to 14.0 5.0 to 9.0
Layer 3	Clayey Sand (SC)	Distributed at the following two area; 1) Within 1km from shore line of Cat Hai Island. 2) Between 5km and 10km off shore side.	-4 to -16 -13 to -21	0.5 to 4.0 3.0 to 9.0
Layer 4	Stiff Sandy Lean Clay (CL)	Distributed at only Port Area. 1) Port Area (within about 3km from shore line) 2) Off-Shore Area (more than 3km away from shore line)	-6 to -26 Not distributed	1.0 to 16.0
Layer 5	Firm Fat Clay with Sand (CH)	Distributed at whole survey area. 1) Port Area (within about 3km from shore line) 2) Off-Shore Area (more than 3km away from shore line)	-7 to -32 -17 to -28	2.5 to 17.0 3.5 to 7.0
Layer 6	Stiff - very Stiff Fat Clay with Sand (CH)	Distributed at only off-shore area, confirmed at only SBH-9 and 10. 1) Port Area (within about 3km from shore line) 2) Off-Shore Area (more than 3km away from shore line)	No distribution -21 to -42	17.5 to 21.0
Layer 7	Stiff – very Stiff Sandy Lean Clay (CL)	Distributed at west end of port area and off -shore area. 1) West end of Port Area (within about 3km from shore line) 2) Off-Shore Area (more than 3km away from shore line)	-17 to -34 -28 to -53	1.5 to11.5 3.5 to 12.0
Layer 8	Very Dense Sand (SP)	Distributed at west end of port area and off -shore area. 1) West end of Port Area (within about 3km from shore line) 2) Off-Shore Area (more than 3km away from shore line)	-26 to -40 -31 to -60	8.0 to 11.0 3.0 to 5.5
Layer 9	Completely Weathered Sand Stone	Distributed at port area only, it is not confirmed its existence at off-shore area. 1) Port Area (within about 3km from shore line) a) At SBH-2 and ABH-4 b) At KB-1 and KB-3	-27 to -28 -21 to -30	0.3 to 0.6 4.5 to 5.0
Layer 10:	Highly – Moderately Weathered Silt/Clay Stone	Bed rock identified at almost all boreholes this time except SBH-7, 9, 10. 1) Port Area (within about 3km from shore line) 2) Off-Shore Area (more than 3km away from shore line)	-21 to -38 -35 to < -60	-

: Sand Layer, : Clay Layer, : Weathered Rock

(2) Soil Properties

Laboratory test results including existing results are shown as a relationship between depth (D.L.) and each value in Appendix 7-2.

Soil properties obtained from subsoil condition surveys which have been carried out this time and from existing soil investigation results are tabulated in Table 7.3.4 and Table 7.3.5 and also in Appendix 7-2 which shows the soil properties of each layer at Port Area (within about 3km from shore line of south end of Cat Hai Island) and Off-shore Area (more than 3km away from shore line) respectively.

Table 7.3.4 Soil Properties of each Layer at Port Area

Layer No.	Soil Type	Type of Value	SPT N-value	Particle density D (g/cm³)	Fine Content (%)	Natural water content w (%)	Atterberg Limits: Liquid limit W_L(%)	Atterberg Limits: Plastic limit Wp(%)	Atterberg Limits: Plasticity index Ip (%)	Bulk density (g/cm³): Natural	Bulk density (g/cm³): Dry	Void ratio eo	Consolidation test: Cv (x 10⁻⁴ cm²/s) (1-2kgf/cm2)	Consolidation test: Cc	Consolidation test: Cr	Consolidation test: CR = Cc/(1+e0)	Consolidation test: RR = Cr/(1+e0)	Consolidation test: Pc (KG/cm²)	Unconfined compression test: qu (KG/cm²)	Unconfined compression test: ef (%)	Compressive strength of rock Rn (KG/cm²): Natural	Compressive strength of rock Rn (KG/cm²): Saturated
1a	Grey, light grey, poorly graded sand (SP)	Max	10	2.68	22.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Min	3	2.65	2.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Average	6.6	2.66	8.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1b	Grey, silty, clayey sand with shell (SM)	Max	10	2.66	39.0	-	36.3	30.6	8.7	-	-	-	-	-	-	-	-	-	-	-	-	-
		Min	7	2.65	27.3	-	32.4	25.5	5.7	-	-	-	-	-	-	-	-	-	-	-	-	-
		Average	8.5	2.66	31.8	-	34.3	27.7	6.6	-	-	-	-	-	-	-	-	-	-	-	-	-
2	Brownish grey, yellowish grey, Fat Clay with sand (CH)	Max	8	2.73	99.7	84.8	85.3	35.5	52.6	1.91	1.46	2.31	1.92	0.90	0.194	0.68	0.088	1.57	0.80	12.8	-	-
		Min	0	2.67	35.2	25.5	25.2	14.6	6.9	1.50	0.81	0.83	0.27	0.09	0.013	0.05	0.007	0.36	0.05	2.0	-	-
		Average	2.6	2.69	80.9	50.1	54.0	26.4	27.6	1.71	1.14	1.41	0.77	0.52	0.119	0.22	0.047	0.93	0.32	6.7	-	-
3	Light grey, greenish grey, clayey sand (CS)	Max	17	2.68	66.1	35.3	40.9	21.5	23.5	1.99	1.60	0.96	1.86	0.47	0.058	0.25	0.031	1.74	0.43	-	-	-
		Min	0	2.67	31.3	21.4	22.3	14.5	6.3	1.85	1.37	0.67	0.93	0.14	0.019	0.07	0.011	1.06	0.43	-	-	-
		Average	7.0	2.67	49.9	27.3	31.0	17.0	13.9	1.91	1.47	0.82	1.27	0.26	0.033	0.14	0.018	1.38	0.43	-	-	-
4	Reddish brown, yellowish brown, sandy lean clay (CL)	Max	23	2.74	99.4	40.0	53.4	27.1	28.7	2.08	1.96	1.03	4.71	0.91	0.063	0.47	0.036	3.48	1.08	9.5	-	-
		Min	2	2.66	31.4	18.5	25.3	14.1	9.4	1.62	1.32	0.56	0.60	0.10	0.016	0.06	0.010	0.62	0.33	6.3	-	-
		Average	10.5	2.69	81.9	28.0	39.9	20.2	19.6	1.95	1.55	0.76	2.36	0.28	0.030	0.15	0.017	1.39	0.62	7.9	-	-
5	Grey, yellowish light Grey, fat clay with sand (CH)	Max	15	2.73	99.4	52.8	65.6	33.2	45.1	1.90	1.45	1.49	2.09	0.74	0.198	0.32	0.091	2.97	0.97	10.2	-	-
		Min	0	2.67	51.7	20.3	25.9	12.3	12.3	1.65	1.09	0.87	0.75	0.26	0.033	0.13	0.016	0.61	0.09	4.4	-	-
		Average	6.5	2.70	93.8	42.9	50.8	23.9	26.9	1.78	1.22	1.23	1.26	0.52	0.110	0.23	0.050	1.80	0.66	6.9	-	-
6	Grey, fat clay with sand (CH)	Max	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Min	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Average	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7	Yellowish grey, light grey, sandy lean clay (CL)	Max	50	2.68	98.4	36.0	45.6	17.9	28.2	-	-	-	-	-	-	-	-	-	-	-	-	-
		Min	9	2.65	49.1	18.8	20.9	13.8	4.9	-	-	-	-	-	-	-	-	-	-	-	-	-
		Average	28.9	2.67	66.0	24.0	30.6	16.6	14.0	-	-	-	-	-	-	-	-	-	-	-	-	-
8	Yellowish grey, light grey, poorly graded sand (SP)	Max	50	2.66	10.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Min	9	2.64	0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Average	43.9	2.66	2.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9	Reddish brown completely weathered sand stone	Max	50	2.77	86.0	27.3	42.2	21.9	20.2	2.36	1.56	0.76	-	-	-	-	-	-	-	-	-	-
		Min	50	2.73	52.4	15.1	33.2	21.3	12.0	1.99	1.56	0.76	-	-	-	-	-	-	-	-	-	-
		Average	50.0	2.74	68.8	21.2	37.5	21.6	15.9	2.18	1.56	0.76	-	-	-	-	-	-	-	-	-	-
10	Reddish brown highly to moderately weathered silt/claystone	Max	-	2.83	-	-	-	-	-	2.72	-	-	-	-	-	-	-	-	-	-	1081	686
		Min	-	2.70	-	-	-	-	-	2.40	-	-	-	-	-	-	-	-	-	-	71	61
		Average	-	2.76	-	-	-	-	-	2.60	-	-	-	-	-	-	-	-	-	-	388	341

Table 7.3.5 Soil Properties of each Layer at Off-shore Area

Layer No.	Soil Type	Type of Value	SPT N-value	Particle density D (g/cm³)	Fine Content (%)	Natural water content w (%)	Atterberg Limits: Liquid limit W_L(%)	Atterberg Limits: Plastic limit Wp(%)	Atterberg Limits: Plasticity index Ip (%)	Bulk density (g/cm³): Natural	Bulk density (g/cm³): Dry	Void ratio eo	Consolidation test: Cv (x 10⁻⁴ cm²/s) (1-2kgf/cm2)	Consolidation test: Cc	Consolidation test: Cr	Consolidation test: CR = Cc/(1+e0)	Consolidation test: RR = Cr/(1+e0)	Consolidation test: Pc (KG/cm²)	Unconfined compression test: qu (KG/cm²)	Unconfined compression test: ef (%)	Compressive strength of rock Rn (KG/cm²): Natural	Compressive strength of rock Rn (KG/cm²): Saturated
1a	Grey, light grey, poorly graded sand (SP)	Max	7	2.66	10.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Min	5	2.66	7.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Average	6.0	2.66	8.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1b	Grey, silty, clayey sand with shell (SM)	Max	8	2.66	30.3	-	37.0	30.6	6.7	-	-	-	-	-	-	-	-	-	-	-	-	-
		Min	7	2.65	26.4	-	30.8	25.2	5.6	-	-	-	-	-	-	-	-	-	-	-	-	-
		Average	7.8	2.66	28.0	-	33.9	27.8	6.2	-	-	-	-	-	-	-	-	-	-	-	-	-
2	Brownish grey, yellowish grey, Fat Clay with sand (CH)	Max	2	2.71	99.7	76.0	86.0	36.1	50.0	1.85	1.36	2.09	0.52	0.82	0.196	0.28	0.066	0.83	0.42	10.5	-	-
		Min	0	2.67	83.9	38.1	38.9	21.4	17.5	1.53	0.87	0.99	0.24	0.39	0.056	0.15	0.020	0.28	0.05	5.3	-	-
		Average	1.1	2.69	88.3	62.0	67.5	29.7	37.8	1.61	0.99	1.74	0.35	0.62	0.127	0.22	0.044	0.57	0.16	8.5	-	-
3	Light grey, greenish grey, clayey sand (CS)	Max	8	2.69	45.5	27.2	36.6	18.2	21.2	-	-	-	-	-	-	-	-	-	-	-	-	-
		Min	3	2.65	23.1	20.5	25.1	14.4	10.1	-	-	-	-	-	-	-	-	-	-	-	-	-
		Average	6.1	2.67	33.8	24.2	31.4	16.2	15.2	-	-	-	-	-	-	-	-	-	-	-	-	-
4	Reddish brown, yellowish brown, sandy lean clay (CL)	Max	18	2.74	94.6	31.2	46.6	24.8	21.8	2.01	1.60	0.91	-	-	-	-	-	-	-	-	-	-
		Min	9	2.71	54.3	22.4	27.3	14.7	12.6	1.88	1.43	0.71	-	-	-	-	-	-	-	-	-	-
		Average	12.8	2.73	83.0	27.2	39.4	20.9	18.5	1.94	1.51	0.82	-	-	-	-	-	-	-	-	-	-
5	Grey, yellowish light Grey, fat clay with sand (CH)	Max	7	2.71	99.4	50.7	67.6	33.5	38.0	1.94	1.51	1.39	1.86	0.60	0.171	0.25	0.071	2.02	0.14	11.2	-	-
		Min	3	2.67	62.8	28.4	37.2	18.2	19.0	1.68	1.12	0.77	0.86	0.16	0.023	0.09	0.013	0.86	0.14	11.2	-	-
		Average	5.3	2.69	86.9	40.6	51.8	25.2	26.6	1.83	1.34	1.03	1.36	0.38	0.097	0.17	0.042	1.44	0.14	11.2	-	-
6	Grey, fat clay with sand (CH)	Max	21	2.70	99.6	58.0	70.7	33.3	39.6	-	-	-	-	-	-	-	-	-	-	-	-	-
		Min	9	2.67	61.9	21.7	26.0	17.5	8.5	-	-	-	-	-	-	-	-	-	-	-	-	-
		Average	14.0	2.68	84.4	41.9	52.3	25.5	26.0	-	-	-	-	-	-	-	-	-	-	-	-	-
7	Yellowish grey, light grey, sandy lean clay (CL)	Max	22	2.70	76.4	27.1	35.8	21.2	19.9	-	-	-	-	-	-	-	-	-	-	-	-	-
		Min	11	2.67	48.0	22.1	25.4	13.7	7.4	-	-	-	-	-	-	-	-	-	-	-	-	-
		Average	17.9	2.69	64.2	23.3	29.1	16.1	13.0	-	-	-	-	-	-	-	-	-	-	-	-	-
8	Yellowish grey, light grey, poorly graded sand (SP)	Max	50	2.66	2.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Min	50	2.65	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Average	50.0	2.66	1.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9	Reddish brown completely weathered sand stone	Max	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Min	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Average	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10	Reddish brown highly to moderately weathered silt/claystone	Max	-	-	-	-	-	-	-	2.68	-	-	-	-	-	-	-	-	-	-	659	593
		Min	-	-	-	-	-	-	-	2.61	-	-	-	-	-	-	-	-	-	-	230	194
		Average	-	-	-	-	-	-	-	2.65	-	-	-	-	-	-	-	-	-	-	503	444

The following existing soil laboratory test results are referred for analyzing the data of Prot Area and Off-shore Area.

- Port Area: SBH-1 to 7 (by JICA Study), B-1 to 5 (by Nippon Koei), KB-1-10 (by TEDIPORT) ; Total 22 boreholes
- Off-shore Area: SBH-8 to 10 (JICA Study), KB-11, 12 (by TEDI) : Totally 5 borehole

According to soil test results obtained from the above survey results, differences of soil properties between Port Area and Off-shore Area are not recognized except Layer 2 (Soft Fat Clay with Sand).

Characteristics of soil properties of soil layers are described as follows;

a) Physical properties

i) Density of Soil Particle: D

Density of soil particle (D = Gs γw, Gs: Specific Gravity of soil, γw: unit weight of water) shows 2.70 g/cm3 in average through all soil layers at whole survey area and ranging between 2.64 and 2.74 g/cm3. This value shows that all soil layers at the survey area are composed of inorganic soils.

ii) Fine Content: Fc (Weight percentage passing 74μm Sieve) (Refer to Figure 7.3.8)

Fine content is one of the indices obtained form sieve analysis test. When it is more than 50%, we classify the soil as fine soil like silt or clay.

According to sieve analysis test result, Layer 2, 4, 5 can be classified as fine soils, however Layer 3 is classified as coarse and fine soils depending on samples. It means that the layer 3 should be considered as possible layer of consolidation settlement and also should not be considered as permeable layer from conservative point of view.

iii) Natural Water Content and Liquid Limit (Refer to Figure 7.3.8)

As for the Layer 2, average natural water content at Port Area is 50% which is 10% lower than one of Off-shore Area. Average natural water content of soil Layer 3, 4, 5, 6, 7 for whole area are 26, 28, 43, 42, 50% respectively. And also average value of Liquid Limit (LL) and Plasticity Index (IP) of Layer 2 at Port Area are 54% and 26% respectively which are also about 10% lower than ones of Off-shore Area. These results are suggestive of bigger void ratio and higher compressibility of Soil Layer 2 at Off-shore Area than ones at Port Area.

According to liquid limit test result as shown in the right end of Figure 7.3.8, liquid limits of soil Layer 2, 5, 6 are distributed between intermediate and very high, high and high plasticity respectively. Therefore clays of only these three layers have high plasticity.

iv) Bulk Density (Unit Weight) and Void Ratio (Refer to Figure 7.3.9)

Values of bulk density and void ratio are distributed with depth as shown in Figure 7.3.9 and those average values for each layers are tabulated in Table 7.3.6.

There is a theoretical correlation between bulk density (saturated) and void ratio as follows;

$$\gamma = (Gs+e0)\,\gamma w\,/(1+e0)$$

And also since e0 = Wn Gs,

$$\gamma = Gs(1+Wn)\,\gamma w / (1+Wn\,Gs)$$

Therefore if some physical properties can be known such as Gs, e0 or Wn, bulk density can be calculated from above formula.

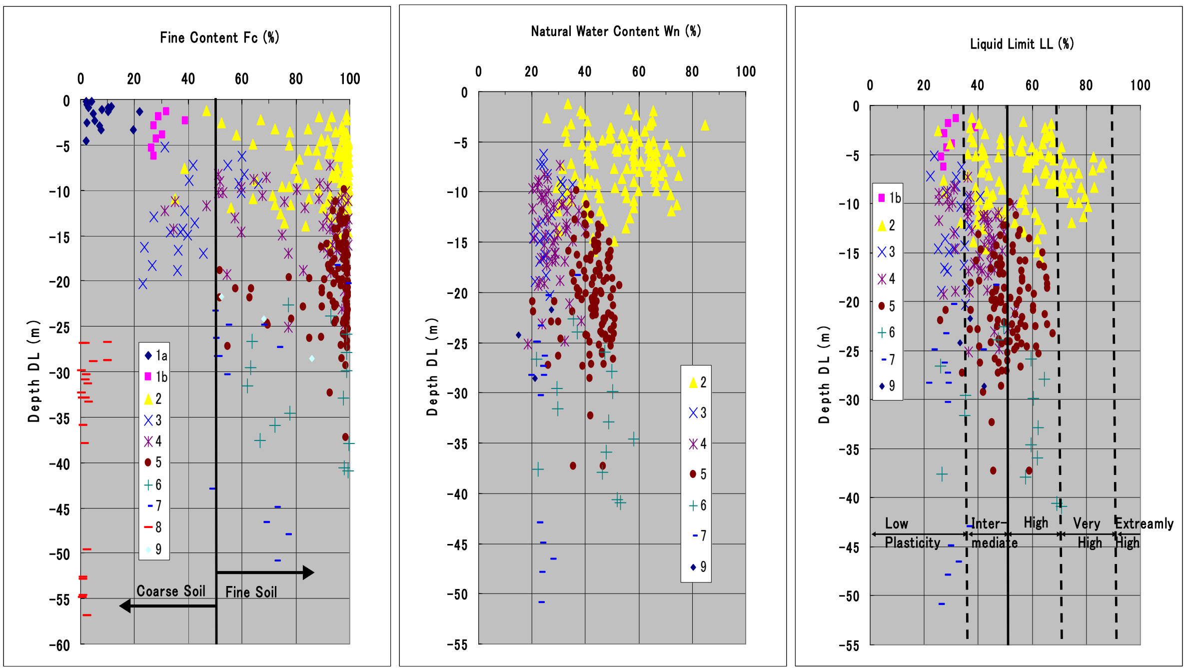


Figure 7.3.8 Fine Content, Natural Water Content and Liquid Limit with Depth (DL)

Table 7.3.6 Bulk Density and Void Ratio at Port Area and Off-shore Area

Layer Name	Bulk Density (g/cm3)			Void Ratio e0		
	Port Area	Off-shore Area	Whole Area	Port Area	Off-shore Area	Whole Area
Layer 2	1.71	1.61	1.69	1.41	1.74	1.46
Layer 3	1.91	-	1.91	0.82	-	0.82
Layer 4	1.95	1.94	1.95	0.76	0.82	0.76
Layer 5	1.76	1.83	1.76	1.23	1.03	1.21

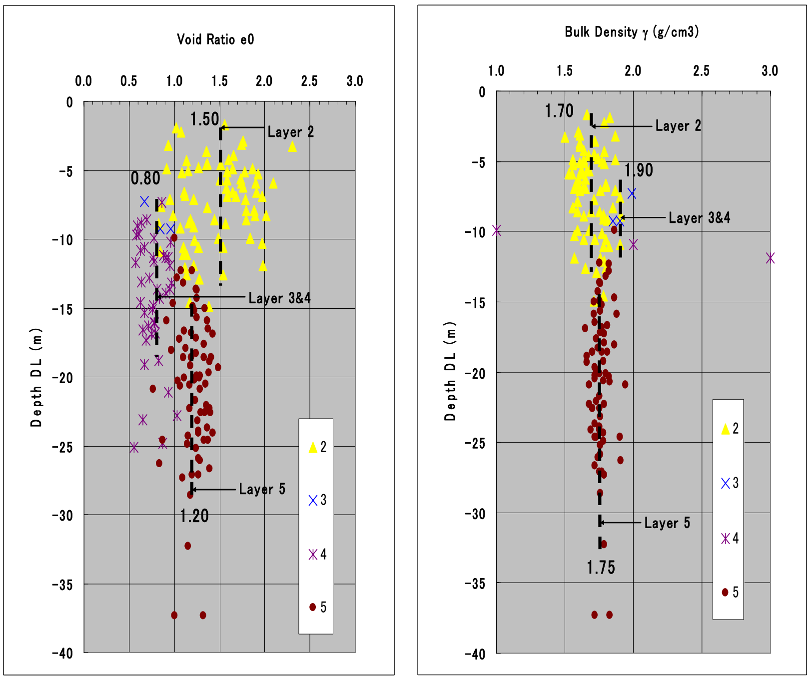


Figure 7.3.9 Void Ratio and Bulk Density with Depth (DL)

b) Mechanical Properties of Cohesive Soil

i) Shear Strength of Cohesive Soil

Unconfined compression test has been carried out in this survey, however that have not been carried out before in the existing surveys. In stead of unconfined compression test, direct shear tests were carried out in the existing surveys. In order to utilize the existing test result, shear strength (Cu, ϕu) obtained from direct shear test in the existing survey results are approximately converted to unconfined compression strength considering overburden pressure as follows;

$$qu = 2C = 2 \times (Cu + \sigma' \tan\phi u)$$

Where, qu: Unconfined compression strength, C: Cohesion, Cu, ϕu: Cohesion and friction angle obtained from direct shear test, σ': effective overburden pressure).

Unconfined compression strength and that failure strain are shown in Figure 7.3.10. Average unconfined compression strength of each layer at whole area is as follows;

Layer 2 : qu=0.3 kgf/cm2, Layer 3 & 4 : qu=0.5 kgf/cm2, Layer 5 : qu = 0.7 kgf/cm2

As shown in Figure 7.3.10, about half of failure strains (strain at peak strength of unconfined compression test) shows more than 7%. It means that about half of samples are disturbed during sampling, transportation and testing process. Therefore strength of half of samples shows the smaller strength than actual in-situ strength. Therefore the above average strength unconfined compression strength (qu) can be estimated to give the minimum or near minimum value of qu.

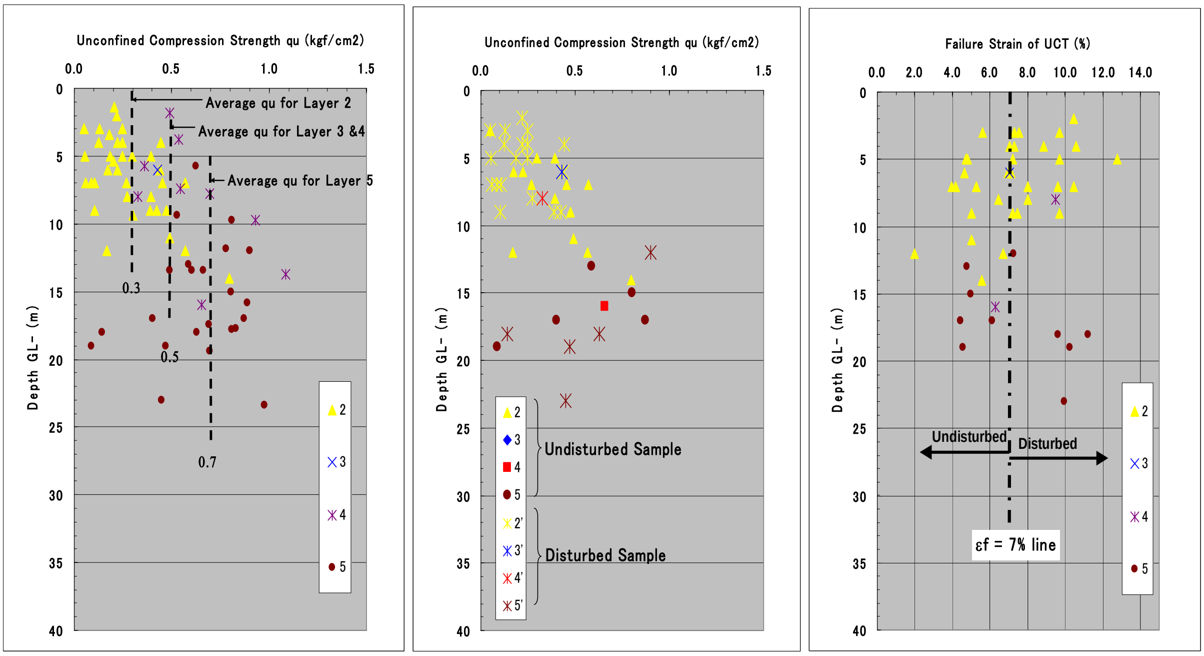


Figure 7.3.10 Unconfined Compression Strength and Failure Strain with Depth (GL: m)

Correlation between qu and SPT N-value are shown in Figure 7.3.11. Plot data are distributed between qu=N/4 line and N/12 line. Usually it is said that qu=N/8 proposed by Terzaghi and Peck (1948) gives minimum line of unconfined compression strength. However about half of plotted points are distributed under qu=N/8 line. From this fact, it can be considered that about half of qu results are underestimated due to disturbance of soil samples.

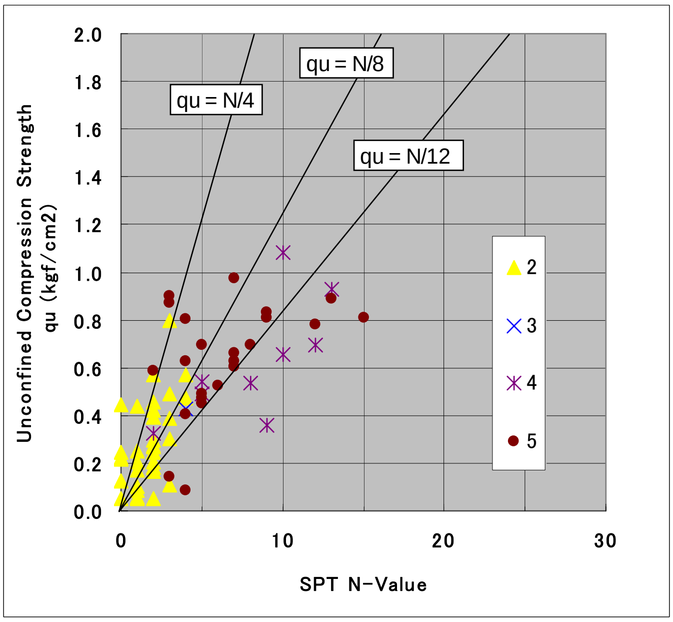


Figure 7.3.11 qu and SPT-N Relation

ii) Increase Rate of Undrained Strength (Cu/P)

From relationship between unconfined strength qu (= Cu/2) and pre-consolidation pressure Pc, increase rate of undrained strength (Cu/P) has been estimated.

As shown in Figure 7.3.12, the plotted data are distributed between Cu/P =0.1 line and 0.4 line in the qu- Pc graph. In case of in organic soil, Cu/P is usually between 0.25 and 0.45. However about half of plots are located below Cu/P=0.2 line. It is also considered that qu values are underestimated due to the disturbance of soil samples.

If the actual Cu/P is assumed as 0.3, as average Cu/P from the plots in Figure 7.3.12 is roughly about 0.2, Unconfined compression strength are roughly about 30 to 40% underestimated by the disturbance of soil samples.

Above estimation is carried out using the unconfined compression test and consolidation test results for Whole Area. About half of data are affected with disturbance and those values are underestimated. Therefore it has not much meaning to distinguish that samples are from Port Area or Off-shore Area.

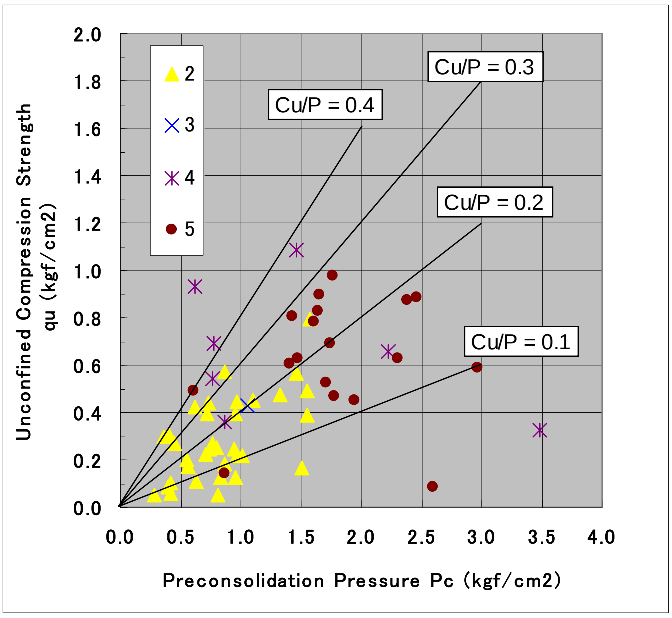


Figure 7.3.12 qu and Pc Relation

iii) Consolidation Characteristics of Cohesive Soil

(a) Preconsolidation Pressure Pc

Preconsolidation pressure Pc is distributing with depth as shown in Figure 7.3.13.

Possible consolidation settlement layers are Layer 2, 3&4 and 5 in the survey area. Remarkable point of these clay layers is that they are over consolidated. Even uppermost Layer 2 is also over-consolidated due to aging effect.

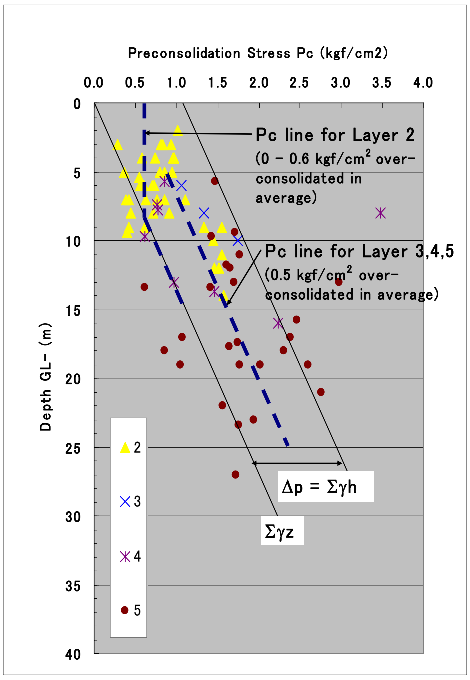


Figure 7.3.13 Pc with Depth (GL)

According to Figure 7.3.14, over consolidation ratio (OCR = σ0'/Pc, σ0'; existing overburden pressure) of above layers are ranging between 1 and 3. In average, the preconsolidation pressure of each layer can be approximately described as follows;

- Layer 2: Pc = 0.6kgf/cm2 (constant from GL 0 to -8m, normally consolidated (Pc = Σγz) deeper than -8m)
- Layer 3&4 and 5: Pc = Σγz + 0.5kgf/cm2

However even though above soil layers are over-consolidated, finally construction load about 1.2 kgf/cm2 will be working on them beyond the average Pc lines as shown in Figure 7.3.13.

Accordingly some extent of consolidation settlement due to above layers will be anticipated.

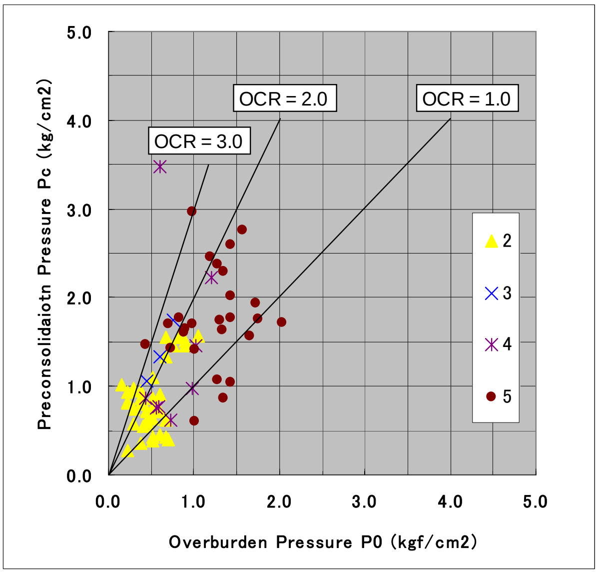


Figure 7.3.14 Pc and P0 Relation

(b) Compression Index Cc and Recompression Index Cr

Compression Index Cc and Recompression Index Cr are distributed with depth as shown in Figure 7.3.15.

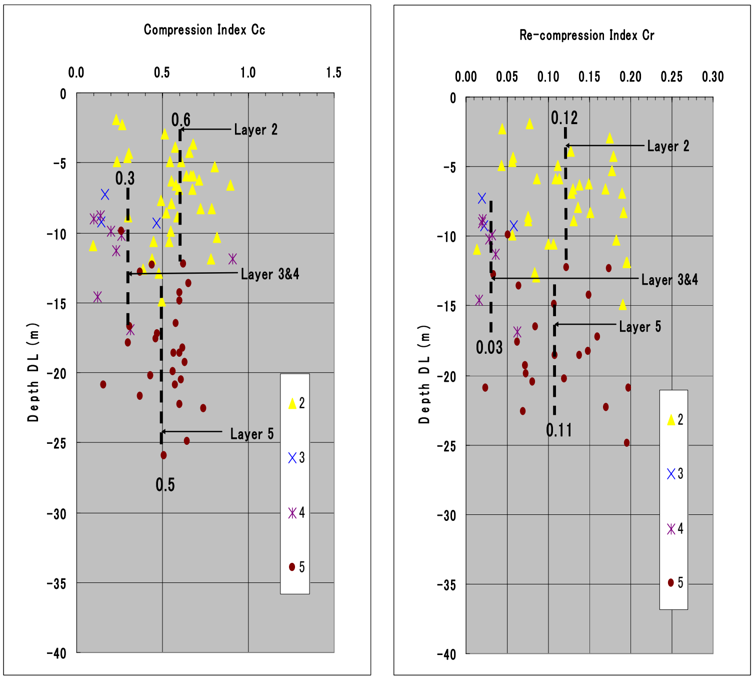


Figure 7.3.15 Cc and Cr with Depth (DL)

According to consolidation test results, the differences of Cc and Cr between Port Area and Off-shore Area are not so much that the average value of them for each layer at Whole Area is described as follows;

- Layer 2 : Cc = 0.6, Cr = 0.12
- Layer 3&4 : Cc = 0.3, Cr = 0.03
- Layer 5 : Cc = 0.5, Cr = 0.11

As shown in Figure 7.3.16, plots of Cr and Cc relation are distributing between Cr/Cc=0.1 and Cr/Cc=0.3. However for the evaluation of Cc, sample disturbance have to be taken into account. Usually Cc value becomes smaller than actual in-situ value when samples are affected by disturbance. Therefore it should be considered that above average value of Cc might give the smaller than actual in-situ one.

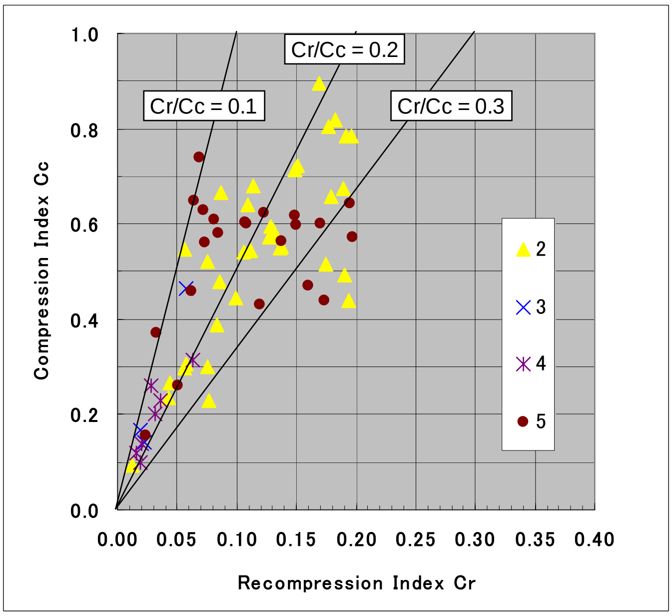


Figure 7.3.16 Cc and Cr Relation

There is a good correlation between Compression Index Cc and Plasticity Index Ip as shown in Figure 7.3.17. The figure shows the correlation Cc = (Ip-5)/55 can be applied for all layers at whole area of this survey area.

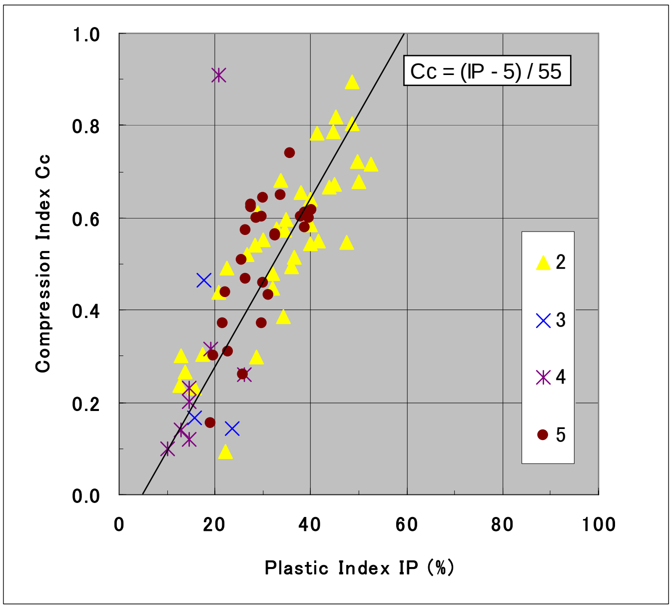


Figure 7.3.17 Cc and IP Relation

(c) Compression Ratio CR and Recompression Ratio RR

Compression Ratio CR and Recompression Ratio RR are generalized values of Cc and Cr transformed by the following formula; CR = Cc/ (1+e0), RR = Cr/ (1+e0).

As shown in Figure 7.3.18 average Value of CR and RR are as follows;

- Layer 2 : CR = 0.23, RR = 0.05
- Layer 3&4 : CR = 0.14, RR = 0.02
- Layer 5 : CR = 0.23, RR = 0.05

CR has some correlations with some index test results, for example, correlations between CR and IP is shown in Figure 7.3.19.

The figure shows the correlation CR = Ip/180 for Layer 2 and CR = IP/120 for Layer 3,4 and 5 under limited number of consolidation test results..

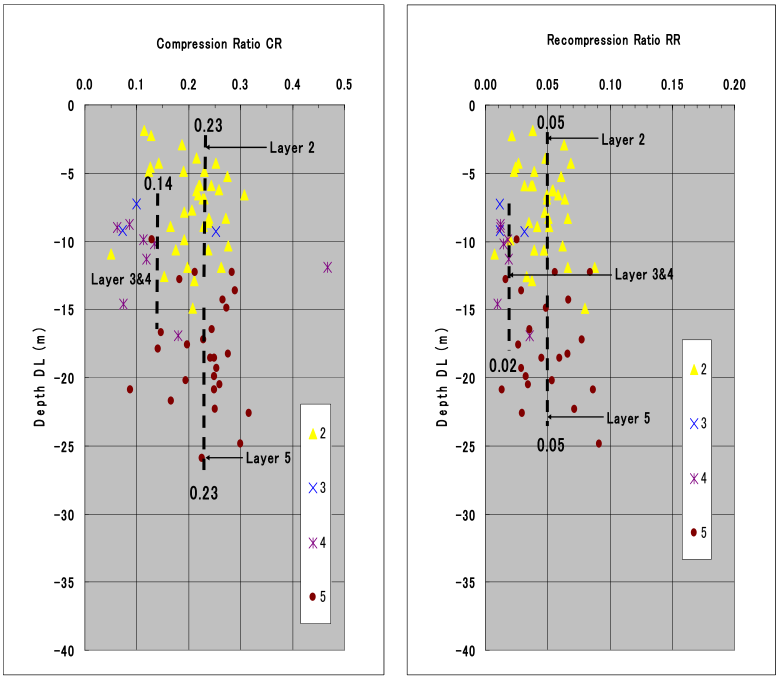


Figure 7.3.18 CR and RR with Depth (DL)

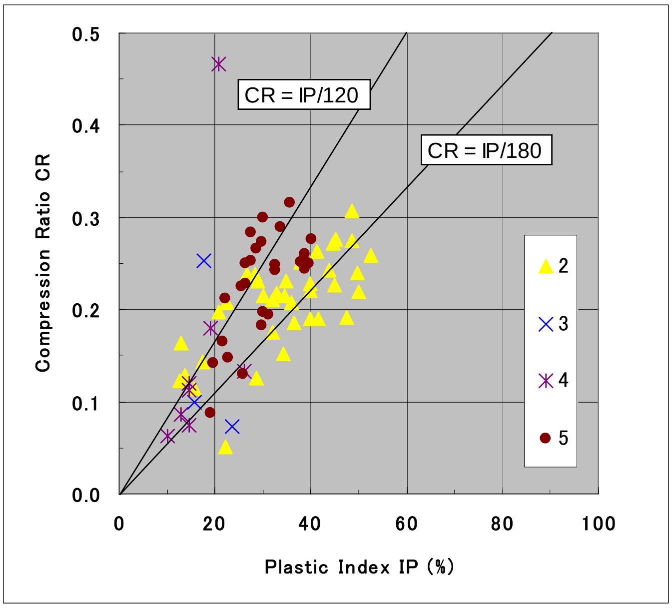


Figure 7.3.19 CR and IP Relation

(d) Coefficient of Consolidation Cv

Coefficient of consolidation Cv is one of the important consolidation factor which shows the speed of consolidation settlement. Cv is also not so much different depending on areas, Port Area and Off-shore Area. In Figure 7.3.20, Cv under load range between 1.0kgf/cm and 2.0kgf/cm2 are plotted with depth.

Average Cv value for each layer is as follows;

- Layer 2 : Cv = 0.6 x 10-3 cm/sec = 52 cm2/day
- Layer 3 : Cv = 2.3 x 10-3 cm/sec = 199 cm2/day
- Layer 4 : Cv = 1.3 x 10-3 cm/sec = 112 cm2/day
- Layer 5 : Cv = 0.8 x 10-3 cm/sec = 69 cm2/day

Above average values are selected based on Cv-Log P lines for each layer. These values look like a little conservative value for consolidation settlement evaluation. However reliability of some data including existing results is not so high that conservative value is considered to be appropriate for the evaluation at this stage.

And also the Layer 3 is actually classified as sand layer (Clayey Sand), however according to the sieve analysis result, which is already mentioned in other clauses, some of samples of this layer have more than 50% of fine content which is classified as silt or clay. Therefore it is better to count Layer 3 as fine soil layer when consolidation settlement should be considered from conservative point of view.

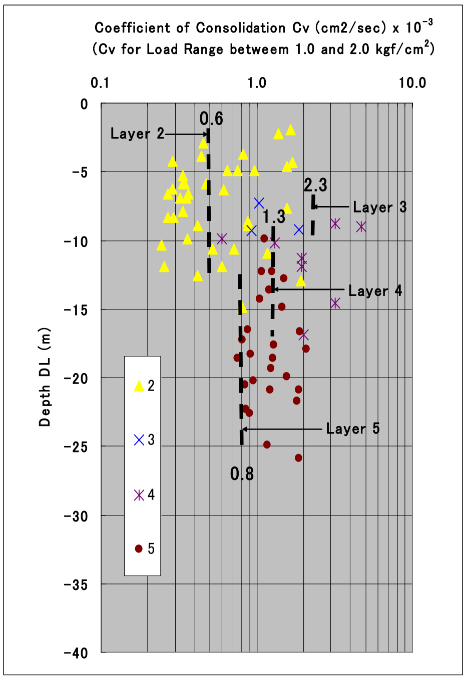


Figure 7.3.20 Cv with Depth (DL)

(d) Rate of Secondary Compression Cα (= Δεv/Δlogt)

In this study and existing investigation results, there has not been carried out any special consolidation tests for the evaluation of Secondary Compression Index Cα.

Therefore the following formula is applied for the evaluation of Cα;

$$C\alpha(NC)/\ CR\ = 0.04 + 0.01 \quad \text{(after Ladd et al, 2003)}$$
$$\text{Adopted here, } C\alpha(NC)/\ CR\ = 0.030$$

Rate of Secondary Compression Cα obtained from average Cc for each layer and above formula is as follows;

- Layer 2 : Cα(NC) = 0.030 x CR = 0.030 x 0.23 = 0.007
- Layer 3&4 : Cα(NC) = 0.030 x CR = 0.030 x 0.14 =0.004
- Layer 5 : Cα(NC) = 0.030 x CR = 0.030 x 0.23 = 0.007

(e) Correlations between soil parameters

Correlations between soil parameters can be found in some physical and mechanical properties based on this survey and existing survey results as shown in Appendix 7-3. Correlations are summarized and tabulated in Table 7.3.7.

Table 7.3.7 Correlations between soil properties

Soil Properties		Plasticity Index IP (%) =	Liquid Limit LL (%) =	Void Ratio e0 =	Compression Index Cc =	Compression Ratio CR = (Cc/1+e0) =	Coefficient of Consolidation Log Cv = (10-3 cm2/sec)
Wn (%)	Layer 2	7(Wn - 20)/ 8	1.1Wn	2.70Wn/ 100	(Wn - 20)/ 70	(Wn - 10)/ 250	1.0 - 0.2Wn/9
	3,4,5	8(Wn - 10)/ 9	1.1Wn + 8		(Wn - 20)/ 50	(Wn - 10)/ 140	
IP (%)	Layer 2	-	1.5IP + 10	-	(IP - 5)/ 55	IP/ 180	1.0 - IP/30
	3,4,5	-		-		IP/ 120	
LL (%)	Layer 2	-	-	-	(LL - 20)/ 80	(LL - 20)/ 230	
	3,4,5	-	-	-		(LL - 20)/ 140	
e0	Layer 2	-	-	-	-	(e0 - 0.3)/ 6	1.0 - 0.8e0
	3,4,5	-	-	-	-	(e0 - 0.3)/ 4	

(Based on JICA study and existing survey results)

(3) Bed Rock Conditions at survey Area

Bed rock identified in the study area is silt/ clay stone which is highly to moderately weathered, and completely weathered one is identified at only small area within 500m from shore line of south end of Cat Hai Island.

Top level of highly to moderately weathered rock is changing depending on the distance from shore line as follows;

Distance from Shore Line		Top Level of Weathered Rock (DL; m)
0.0 to 1.5 km	Port Area	: 20 m to 35 m
1.5 to 3.0 km		: 30 m to 40 m
3.0 to 5.5 km	Off-shore Area	: 35 m to 40 m
5.5km and more far		: 40m to more than 55m (It could not be identified within investigated depth)

Compression test result of rock core samples is shown in Figure 7.3.21. As shown in this figure, compression strength is ranging from Ru = 50 to 800kgf/cm2 depending on location and weathered conditions. Average compression strength of rock core samples is 350 kgf/cm2.

Bulk density of rock core samples are shown in Figure 7.3.21. Bulk density plots with depth are ranging between 2.4 and 2.7 g/cm3. Average bulk density is 2.60 g/cm3

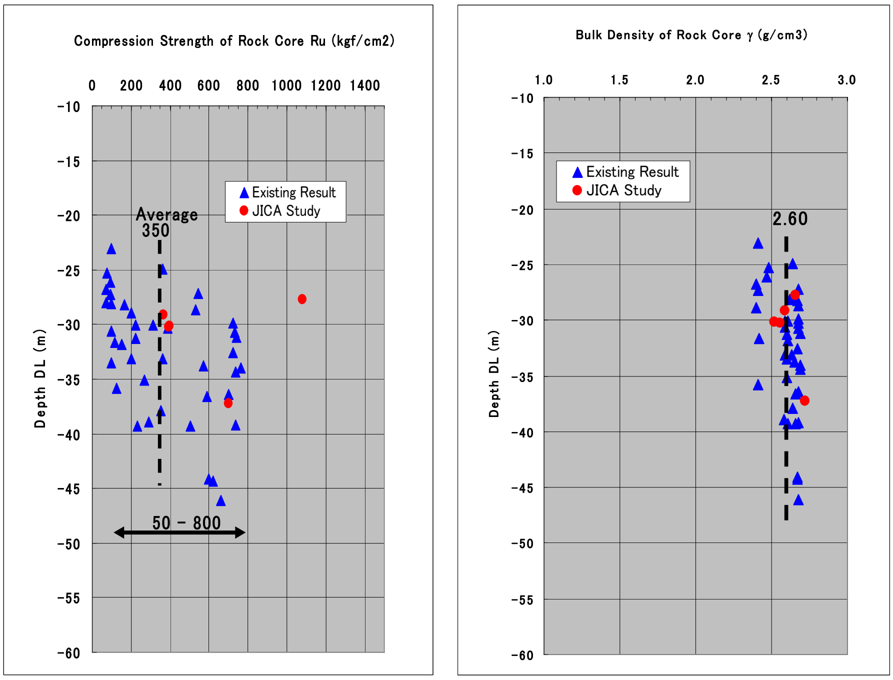


Figure 7.3.21 Ru and γ of Rock Core Sample with Depth (DL)

(4) Trial Calculation of Consolidation Settlement

Soil investigation result shows the cohesive soil layers, Layer 2, 3&4 and 5 are soft and firm layers which are possible layers of occurrence of consolidation settlement by reclamation load in port construction area. They are actually not very soft especially Layer 3&4 and 5 are firm. Layer 2, 3&4 and 5 are slightly to lightly over consolidated with 0 to 6tf/m2, 5tf/m2 and 5tf/m2 respectively. Therefore possibility of settlement should be checked to judge the necessity of soil treatment especially for Layer 3&4 and 5.

In this clause, trial settlement calculations for those layers are carried out assuming some provisional conditions based on soil investigation results and available information. And also calculation model are assumed based on soil investigation results as shown in Figure 7.3.22.

Concept of calculation of consolidation settlement for over-consolidated clay are shown in Figure 7.3.23

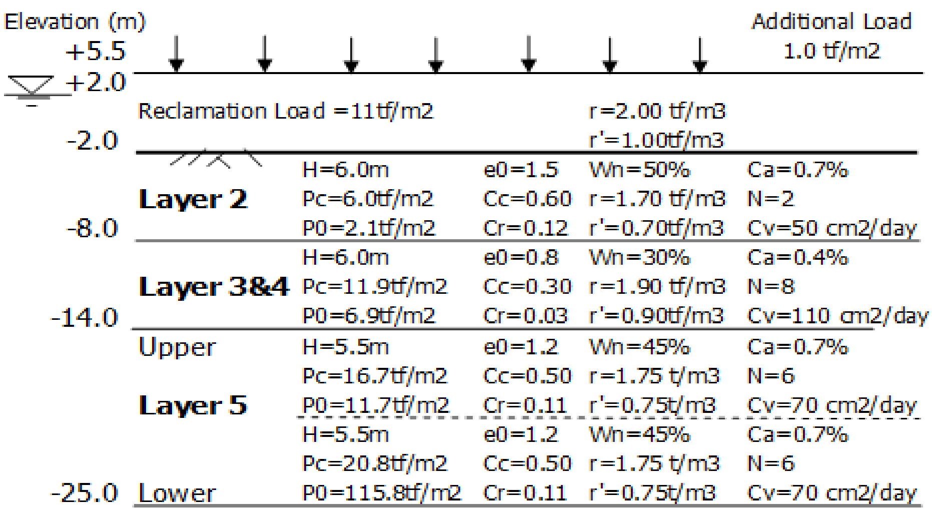
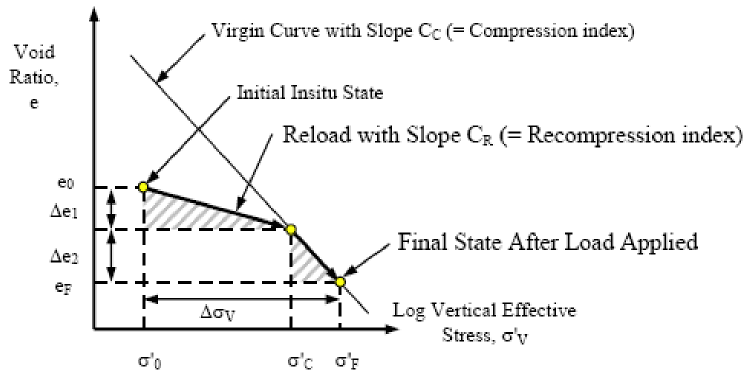


Figure 7.3.22 Model for Consolidation Settlement Calculation



*Total primary consolidation settlement

$$= \frac{C_R H}{1+e_0}\log\left(\frac{\sigma_c'}{\sigma_0'}\right) + \frac{C_c H}{1+e_0}\log\left(\frac{\sigma_0'+\Delta\sigma_v}{\sigma_c'}\right)$$

*Secondary compression

$$= \frac{C\alpha H}{1+e_0}\log\left(\frac{t_f}{t_p}\right)$$

(assumed tf/tp=6)

Figure 7.3.23 Concept of Calculation for Consolidation Settlement

As shown in Table 7.3.8, predicted total settlement by assumed calculation model and reclamation load is 1.4 meters which is consist of primary consolidation settlement 1.31 meters and secondary compression 0.12 meters.

Primary consolidation settlements of Layer 3&4 and Layer 5 are 23cm and 42cm respectively. And it will take more than one hundred years without any soil treatment to complete 90% of consolidation settlement under obtained coefficient of consolidation Cv by consolidation test results.

Settlement caused by Layer 3&4 and 5 is not so small to neglect them. Accordingly some treatment methods to both layers against their consolidation settlement should be considered if allowable residual settlement criteria can not accept those settlements by reclamation load.

Table 7.3.8 Consolidation Settlement Calculation Result

Layer	Primary Consolidation Settlement Sp (m)		Total of Sp by Layer (m)	Total Sp (m)	Secondary Compression Ss (m)	Total Ss (m)	Total Settlement Sp+Ss (m) by Layer	Total Settlement Sf (m)
	Sover	Snorm						
Layer 2	0.131	0.534	0.666	1.314	0.037	0.116	0.698	1.425
Layer 3&4	0.024	0.201	0.225		0.019		0.243	
Layer 5 Upper	0.043	0.190	0.233		0.030		0.263	
Layer 5 Lower	0.033	0.158	0.190		0.030		0.220	

Where, Sp: Primary consolidation settlement, Ss: Secondary compression, Sf: Final Settlement
Note: Above calculation result is based on some assumption on soil parameters, layers and load conditions. Further detailed investigations and calculations are essential to evaluate the consolidation settlement in the detail design stage.

(5) Summary and Comments on Subsoil Conditions

i) Soil Stratification

Typical soil stratification in survey area can be roughly classified by two area, Port Area (within about 3km from shore line of Cat Hai Island) and Off-Shore Area (more than 3km away from shore line) as follows;

Table 7.3.9 Typical Soil Stratification at Survey Area

(a) Port Area (within about 3km from shore line of Cat Hai Island)			(b) Off-Shore Area (more than 3km away from shore line)		
Layer 1	N=5.6	Loose poorly graded Sand (SP)	Layer 1	N=6.0	Loose poorly graded Sand (SP)
Layer 2	N=2.6	Soft fat clay with sand (CH)	Layer 2	N=1.1	Soft fat clay with sand (CH)
Layer 3	N=7.0	Loose- medium dense Clayey Sand (SC)	Layer 3	N=6.1	Loose-medium dense Clayey Sand (SC)
Layer 4	N=10.5	Firm sandy lean clay (CL)	Layer 5	N=5.3	Firm fat clay with sand (CH)
Layer 5	N=6.5	Firm fat clay with sand (CH)	Layer 6	N=14.0	Stiff- very stiff fat clay with sand (CH)
Layer 10	-	Moderately- highly weathered Silt/ Clay Stone	Layer 7	N=17.9	Stiff- very stiff sandy lean clay (CL)
-	-	-	Layer 8	N=50	Very dense poorly graded sand (SP)

N: SPT-N value

ii) Soil Parameters

Differences between soil parameters between Port Area and Off-shore area is not so much as explained the previous clauses. Therefore soil parameters selected as average values for Whole Area based on survey result including existing result are shown as follows;

Table 7.3.10 Soil Parameters Selected in Survey Area

Layer Name	Soil Type	SPT N	Wn (%)	γt (g/cm³)	Shear Strength			Consolidation						
					Cu (kgf/cm²)	ϕ' (o)	Cu/p	Cc	Cr	CR	RR	Cα (%)	Pc (kgf/cm²)	Cv (cm²/day)
Layer 1	Loose Sand	6	-	1.90	-	30	-	-	-	-	-	-	-	-
Layer 2	Soft Clay	2	50	1.70	0.15	0	0.30	0.6	0.12	0.23	0.05	0.7	0.6	50
Layer 3	Loose Clayey Sand	7	30	1.90	0.25	-	0.25	0.3	0.03	0.14	0.02	0.4	Σγh+0.5	110
Layer 4	Firm Clay	10	30	1.90	0.25	-	0.25	0.3	0.03	0.14	0.02	0.4	Σγh+0.5	110
Layer 5	Firm Clay	6	45	1.75	0.35	-	0.30	0.5	0.11	0.23	0.05	0.7	Σγh+0.5	70
Layer 6	Stiff- very Stiff Clay	14	40	1.80	0.9	-	-	-	-	-	-	-	-	-
Layer 7	Stiff- very Stiff Clay	23	25	2.00	1.4	-	-	-	-	-	-	-	-	-
Layer 8	Very Dense Sand	50	-	2.00	-	35	-	-	-	-	-	-	-	-
Layer 9	Completely Weathered Rock	50	-	2.20	-	35	-	-	-	-	-	-	-	-
Layer10	Moderately-Highly Weathered Rock			2.60	Ru=350 (50-800)	-	-	-	-	-	-	-	-	-

*) Some parameters which are not obtained in the survey are predicted based on the empirical correlations between soil properties.

iii) Consolidation Settlement in Reclamation Area and stability of Revetment

According to the Feasibility Study Report by TEDI, new port will be constructed by reclamation, so that primary consolidation settlement and consecutive secondary compression due to reclamation load on soft cohesive soils is one of important issues to be checked and solved to identify the necessity of soft ground treatment to meet the required construction period.

Soil investigation results show that Layer 2, 3&4 and 5 are soft and firm cohesive soil layer and are possible layers of consolidation settlement. As for Layer 3, sand content varies depending on locations, soils at some places have less than 50% of fine content but it is more than 50% at other places. Therefore from conservative point of views, Layer 3 should also be included as a possible layer for consolidation settlement.

Trial calculation shows that totally about 1.4 m subsidence will occur by reclamation load. If leaving them as it is without any soil treatment, of course, there are high possibilities to give harmful settlement to the structures which are constructed after reclamation work finished.

As for stability of revetment, uppermost soft clay layer (Layer 2) would not be able to support and maintain the stability of revetment. Therefore, based on soil investigation result, stability should be checked to clarify the necessity of soil treatment under revetment.

iv) Reliability of Soil Laboratory Test Result and Future Investigation

According to the survey results including the existing survey results, obtained test values are ranging very wide and more than half numbers of samples are affected by disturbance which is usually suffered during sampling, transportation, preservation and testing process. Therefore accuracy of soil test results of mechanical properties such as unconfined compression strength and consolidation parameters can be estimated as not high. It means the parameters selected this time may give conservative value (underestimated value) for shear strength and overestimated value for consolidation properties. This point is very important for design work to select the proper countermeasures against soft ground.

The number of borings is still not enough to cover all necessary reclamation area especially for exact locations of structures constructed after or during reclamation work. Therefore additional soil (boring investigation) will be necessary in the next stage. Especially, identification of in-situ actual shear strength of soft cohesive soil is important for proper economical structural design by applying in-situ tests such as CPTU (Cone Penetrometer Test with pore pressure measurement) and on-site vane share test, etc. to decrease the disturbance effect as much as possible.

The ground conditions are usually changing gradually and suddenly depending on locations therefore deviations of soil parameters between investigated points and uninvestigated points can not be avoided up to some extent. This deviation of design parameters should be solved and modified by monitoring the ground settlement and deformation during construction stage.

3) Seabed Material Sampling

a) Location and co-ordinates of seabed material sampling

Seabed material sampling has been carried out from 10th to 15th November 2009 at 80 locations as shown in the Figure 7.3.24. And those samples were sent to laboratory for chemical tests and physical property tests of soil.

b) Quantities of Seabed material sampling and Laboratory tests

Totally 80 Nos. of samples has been sent to laboratory to carry out the following tests;

- Chemical Test

  Organic Substance, COD, Copper, Cadmium, Arsenic, Chromium, Lead, Nickel, Zinc, Iron, Mercury, Manganese, Cyanides, Sulphate, Total Oil
- Physical Property Test

  Specific Gravity, Natural Moisture Content, Sieve Analysis, Atterberg Limit

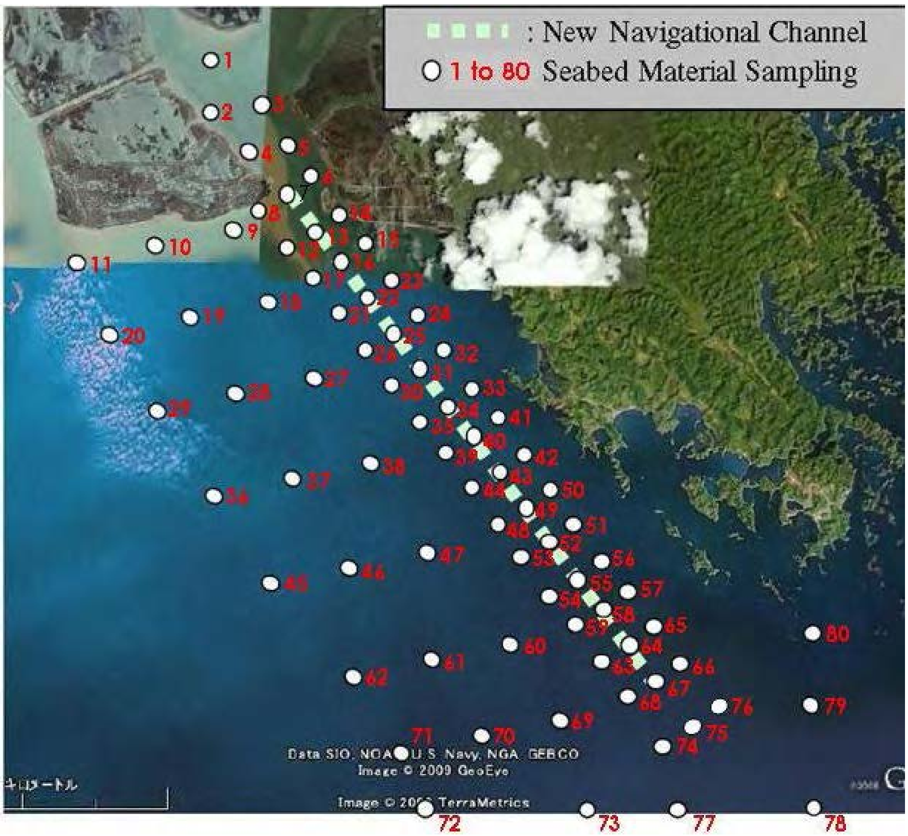


Figure 7.3.24 Location of Seabed Material Sampling

c) Laboratory Test Result

Chemical test and physical property test results are tabulated and each value at each sampling point is presented as graph chart in Appendix 7-4. Chemical content of seabed material surveyed this time are ranging as shown in Table 7.3.11. And also physical property values of seabed material surveyed this time are ranging as shown in Table 7.3.12.Among 80 samples, samples classified into sand or silty/clayey sand are only 10 samples.

Table 7.3.11 Chemical Test Result of Seabed Material

Item			Minimum	Maximum	Average (mg/kg dry)
Copper	Cu	:	5.39	69.06	22.96
Lead	Pb	:	15.89	95.46	49.56
Zinc	Zin	:	35.69	249.35	106.41
Cadmium	Cd	:	0.12	1.86	0.75
Arsenic	As	:	0.51	6.38	1.88
Mercury	Hg	:	0.13	1.47	0.45
Chromium	Cr	:	19.11	89.31	52.47
Nickel	Ni	:	10.00	52.90	29.03
Organic Substance		:	556	13,677	5,439
COD		:	432	4,301	2,195
Cyanide	CN	:	0.03	0.32	0.19
Total Oil		:	9.98	499.82	64.57
Sulphate	SO_4^{2-}	:	258	8,880	4,437
Iron II	Fe^{2+}	:	0.05	0.48	0.24
Iron III	Fe^{3+}	:	0.09	1.24	0.49
Manganese	Mn		0.00	0.07	0.02

Table 7.3.12 Physical Property Test Result of Seabed Material

Item			Minimum	Maximum	Average
Specific Gravity	Gs	:	2.65	2.71	2.68
Natural Moisture Content	Wn (%)	:	33.29	99.50	78.73
Fine Content	Fc (%)	:	0.81	99.82	77.51
Liquid Limit	LL (%)	:	23.62	73.54	46.65
Plastic Limit	PL (%)		2.63	29.51	22.12
Plastic Index	PI (%)		4.54	44.77	24.13

d) Seabed Sand Distribution

Sand distribution at seabed surface in this survey site based on this seabed material sampling result (carried out November, 2009), existing result (carried out by Nippon Koei, August, 2009) and boring investigation results are shown in Figure 7.3.25.

Surface sand is distributed at mainly west side of existing navigation channel with its width of 1km and length of 10km. According to boring investigation results, surface sand layer's thickness is ranging approximately between 0.5 meters and 5 meters with its average of about 2meters.

Shoal shallower than DL 0.0 meter distributed in 3km long from shore line of Cat Hai Island with 500 meter to 800 meter width is covered by sand distribution area as shown in Figure 7.3.25.

e) Physical Property of Seabed Materials along the Existing Navigation Channel

Physical property test result of seabed samples taken along the existing navigation channel is shown in Figure 7.3.26. In this graphs, existing data of boring (KL1 to KL12 carried out by TEDI in 2005) are included together with another existing data (carried out by Nippon Koei in August 2009).

According to Figure 7.3.26, physical properties of two data which were sampled in the same year by JICA Study this time and by Nippon Koei, shows almost similar tendency along the navigation channel. Two data shows clay or silt properties between 31km and 36 km chainage of navigation channel, but KL series data shows physical properties of sand. This is because most of sample of KL series were taken at deeper than 2meters, they were not taken at seabed surface. Therefore there might be some differences for KL series data from above two data.

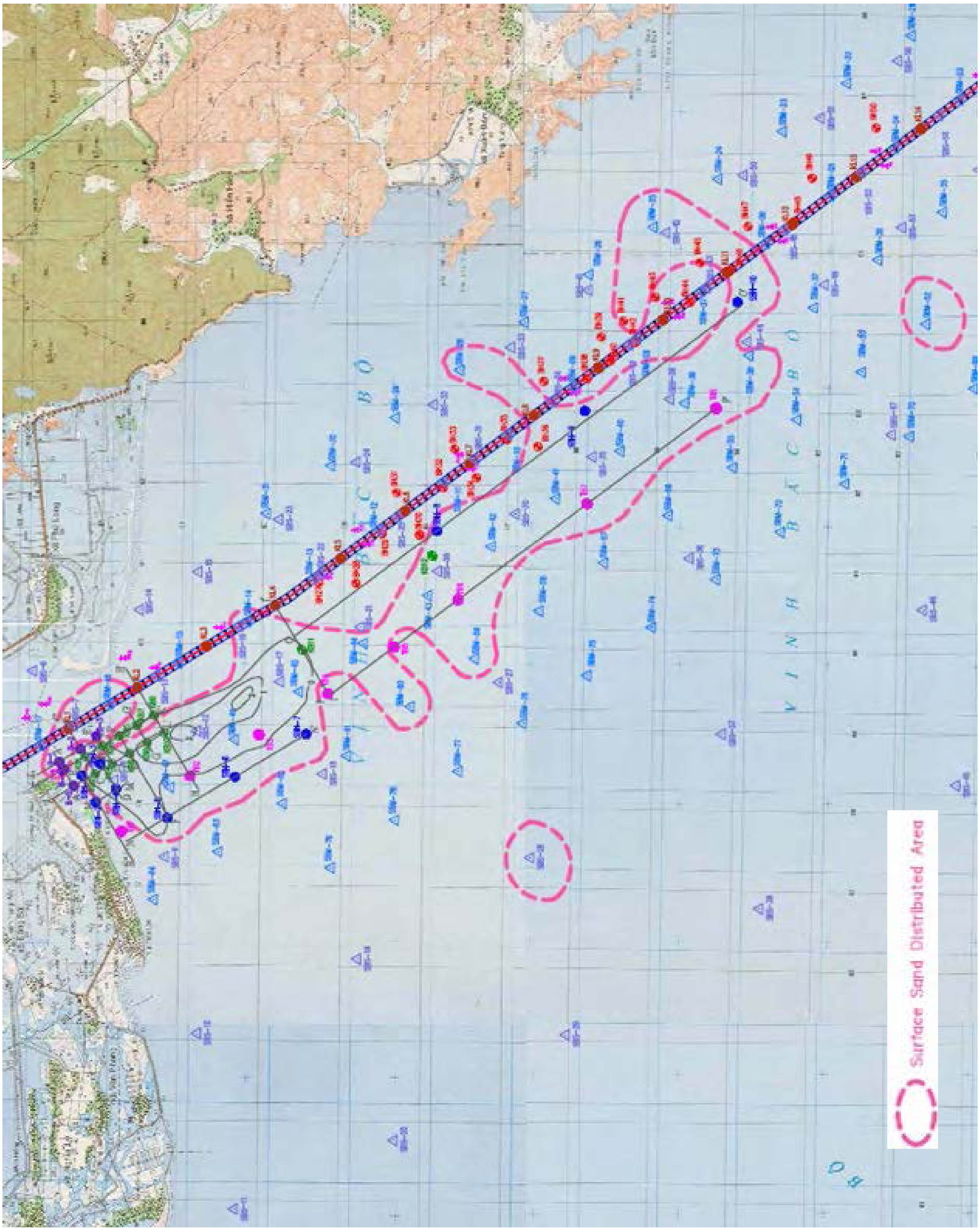
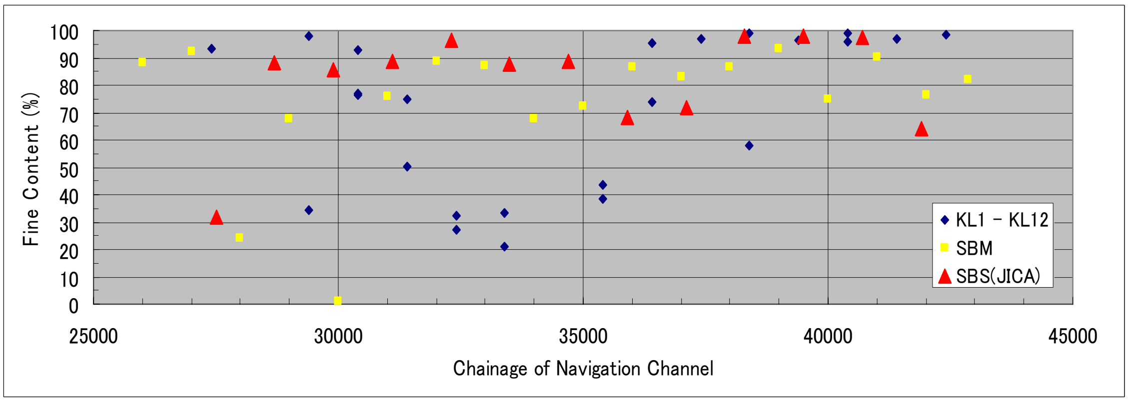
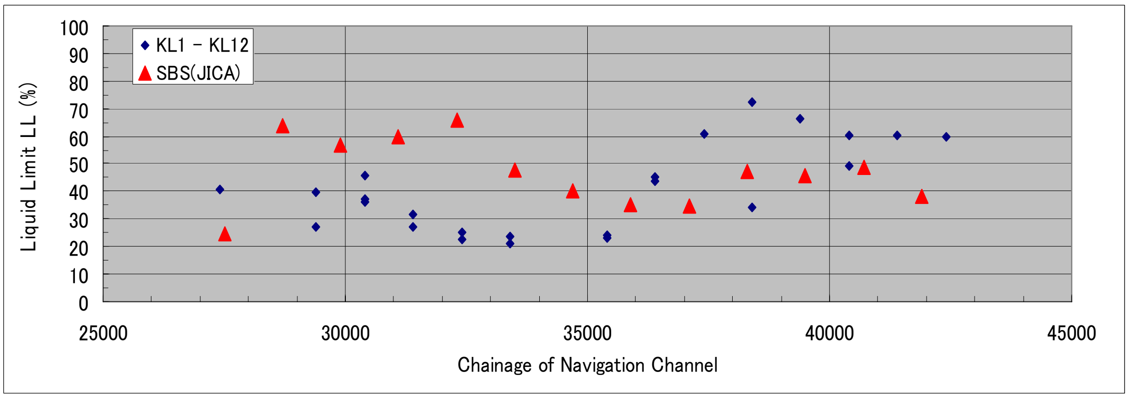
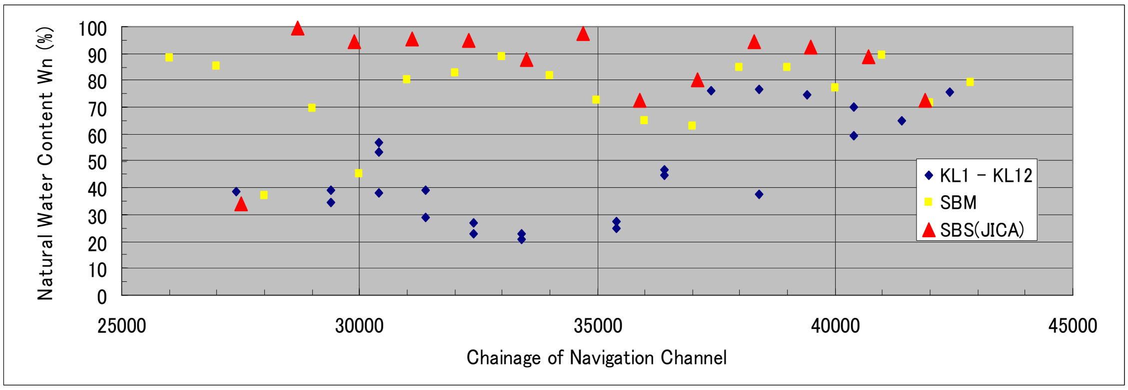
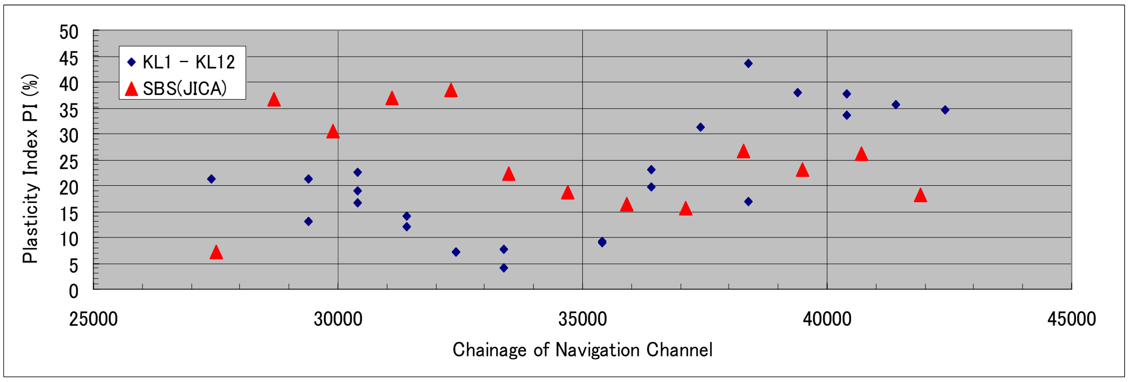


Figure 7.3.25 Surface Sand Distributed Area









(SBS: JICA Study in November, 2009, KL1-KL12: by TEDI in 2005, SBM: by Nippon Koei in August, 2009)

Figure 7.3.26 Physical Property Test Result of Seabed Material along the Navigation Channel

7.3.2 Hydrographic Surveys

1) Bathymetric Survey

a) Location of Bathymetric Surveys

The survey area is located along existing navigation channel from station Km26+000 to station Km47+000 with the width of 500m offset to both side from the center line of the existing navigation channel. (Refer to Figure 7.3.27)

Bathymetric survey has been carried out with two kinds of frequencies of echo, high (200 kHz) and low (30 kHz), to identify the fluid mud thickness on the seabed from 8th November to 19th November 2009.

Figure 7.3.27 Location of Bathymetric Survey Area

b) Quantities of Bathymetric Surveys

Bathymetric surveys have been carried out totally 420 km long with 1km long per section in every 50 m interval, which is perpendicular to navigation channel.

c) Bathymetric Survey Result

Seabed contour maps by dual frequency sounding are shown in Figure 7.3.28 and in Appendix 7-5.

Along the survey area, the depth is deeper from beginning of survey area (Km26+000) seaward, the lowest surveyed elevation is 17.8m below Chart Datum (-17.8m CD) at the end of survey area (Km47+000). All survey results are shown in Appendix 7-5.

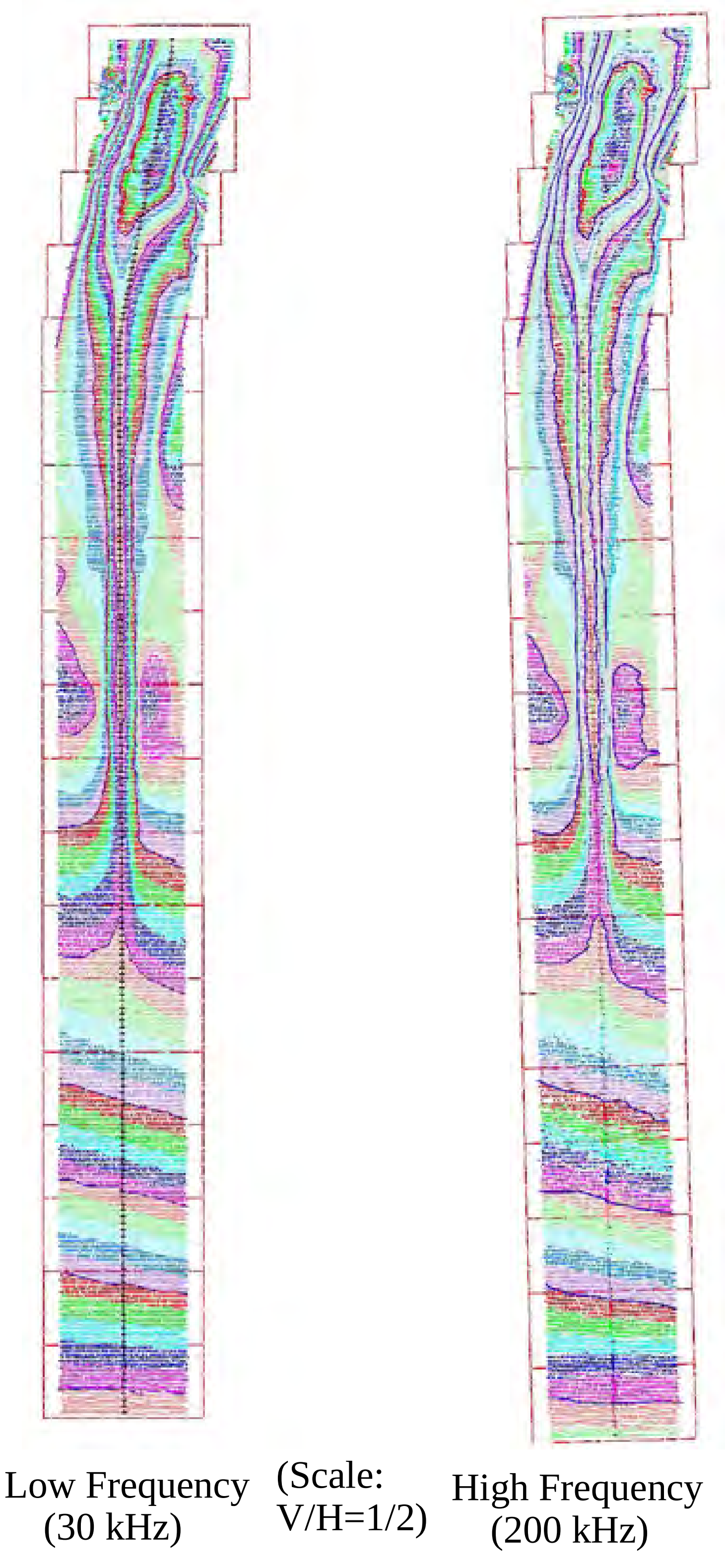


Figure 7.3.28 Bathymetric Survey Result with Echo of Dual Frequencies

As shown in Figure 7.3.29, along the navigation channel, clear dredging traces have been identified between Km 26+000 and Km 39+500.

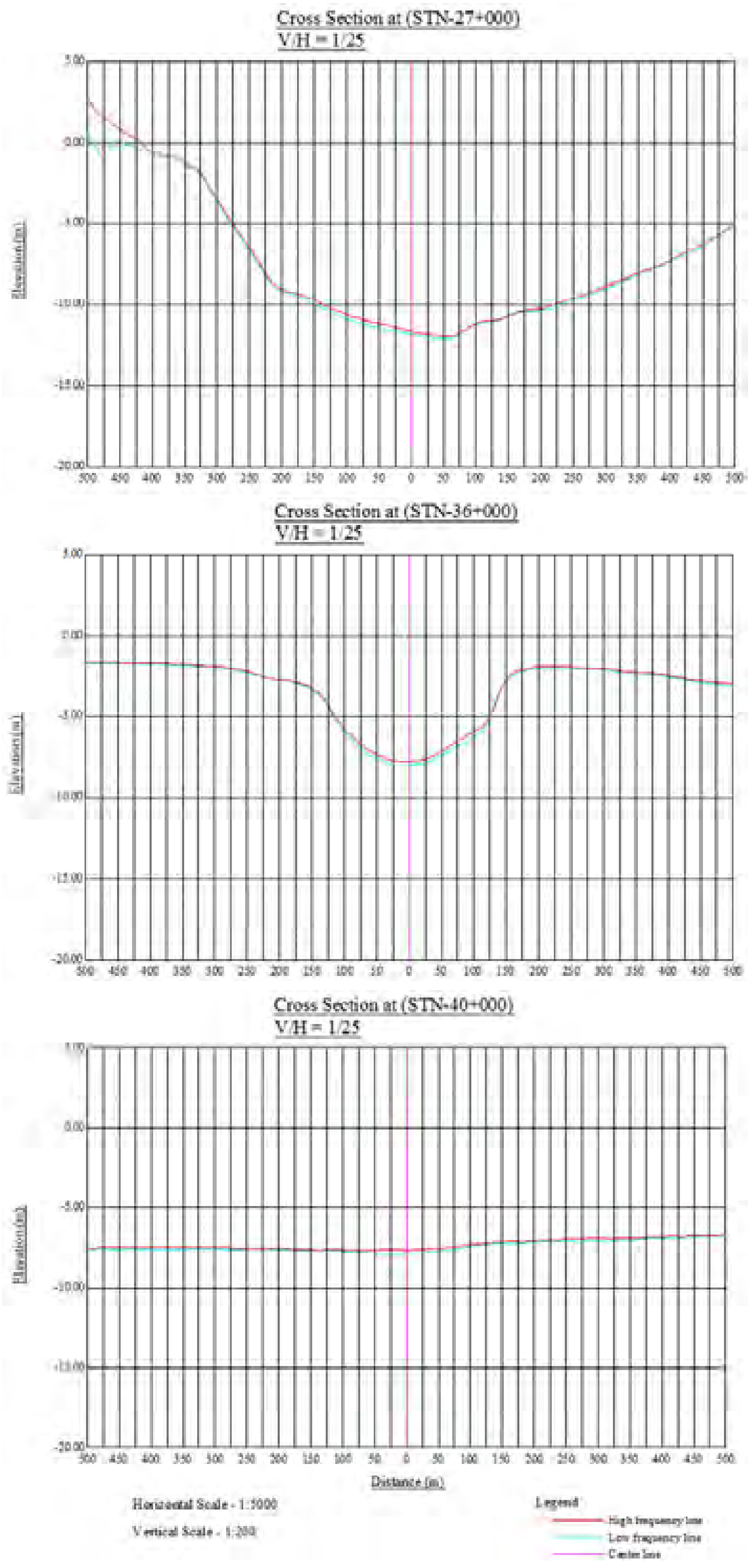


Figure 7.3.29 Cross Section of Navigation Channel

As shown in Figure 7.3.30, between Km 26+500 and Km 28+600 where tidal flow rate is higher than other sections due to narrow water flow area between Cat Ba and Cat Hai Island, seabed level along the navigation channel becomes between -12m and -10m CD which is much deeper than other sections. Then from Km 29+500 to Km 39+500, seabed level becomes constant with about -7m to -8m CD. Then from Km 39 +500, seabed level is gradually getting deeper then finally it reaches -17.8m CD at Km 47+000.

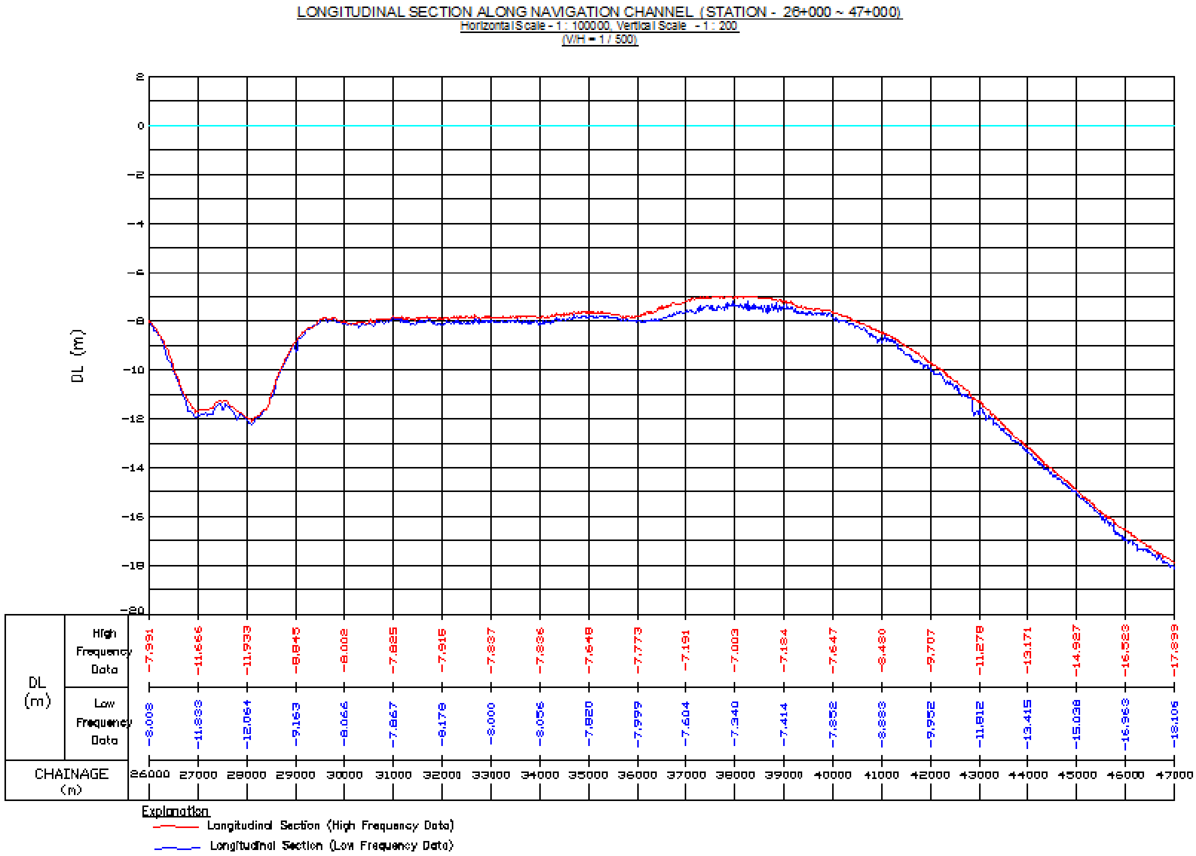


Figure 7.3.30 Longitudinal Section along the Existing Navigation Channel

According to dual frequency sounding (200 kHz and 30 kHz) survey result shown in Figure 7.3.31, fluid mud can be seen at almost whole bathymetric survey area. At Km 27+000 and from Km 32+000 to Km 41+300 km, existence of fluid mud, thickness of which is about from 20cm to 50cm, can be recognized continuously only along the center of navigation channel, then from Km 41+300 to Km 44+800, about 10cm to 50cm of fluid mud can be seen continuously at whole survey range, then from Km 44+800 to 45+800, thickness of fluid mud changes to less than 20cm at whole survey range in 1 km width, finally from Km 45+800 to Km 47+000, 10cm to 40cm thick fluid mud can be seen at whole survey range in 1km width. Between Km 34+000 and Km 39+500, no fluid mud area can be recognized remarkably.

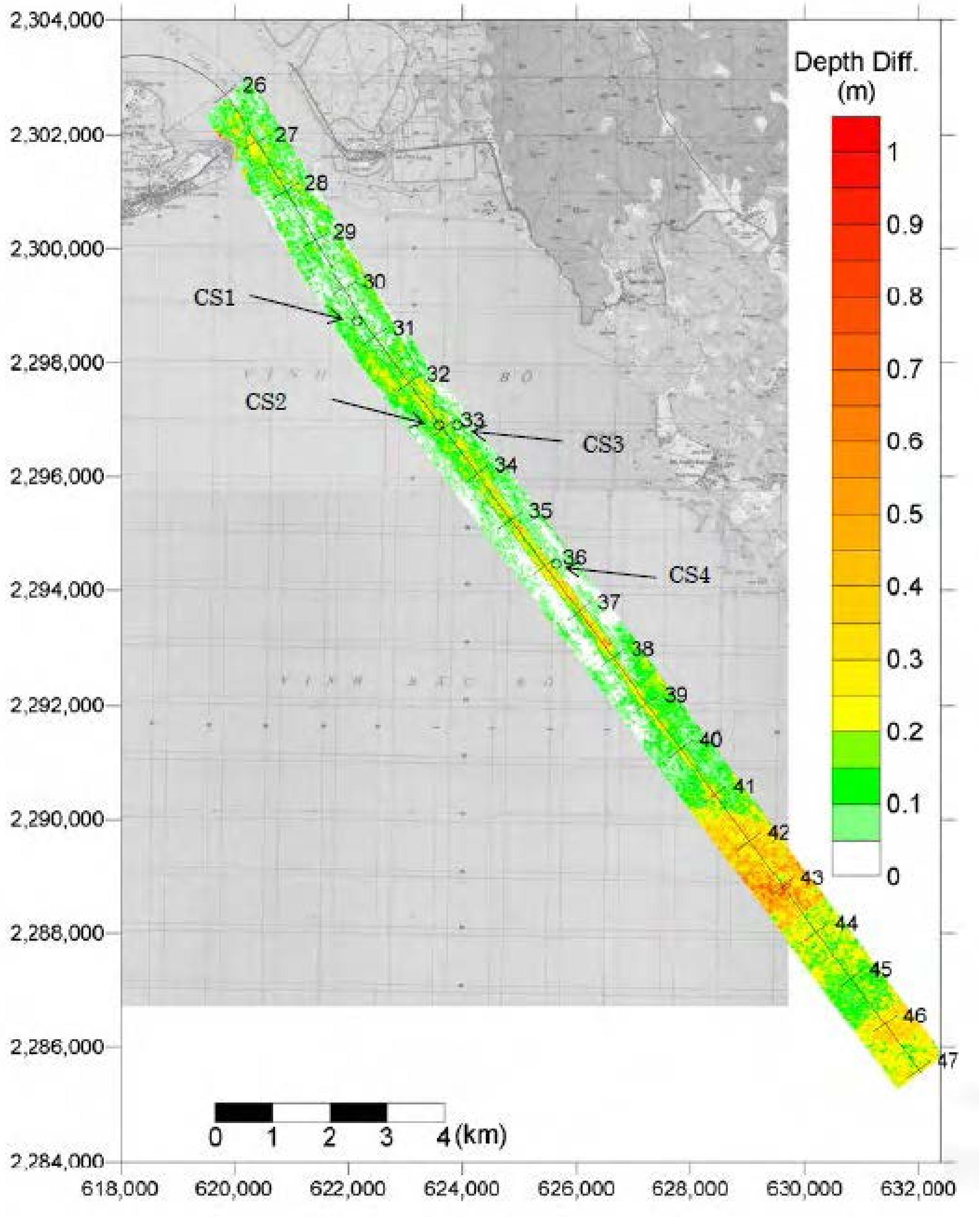


Figure 7.3.31 Depth Difference by Dual Frequency Sounding

2) Tidal Observation

a) Location and duration of tidal observation

In order to obtain the data for the design and engineering of the proposed port facilities, dredging of the channel and basin of the Lach Huyen Port Infrastructure construction, tidal observation has been carried out at Ben Got Jetty (E = 619886 m, N = 2301917 m, VN2000, CM 105045’, Zone 30) in Cat Hai Island with observation period for 15 consecutive days from 11h30’ 7th November to 15h50’ 22nd November 2009.

b) Tidal observation result

The tidal observation result is shown in Figure 7.3.32. The water levels were also collected at

Hon Dau National Hydrographic Station in the same time as water levels observed at Ben Got. Based on water level collected at Hon Dau station (Chart datum) and water level observed at Ben Got-Lach Huyen station (Local Chart datum) from 12h 7th November to 15h 22nd November 2009, two data are compared as shown in the following figure.

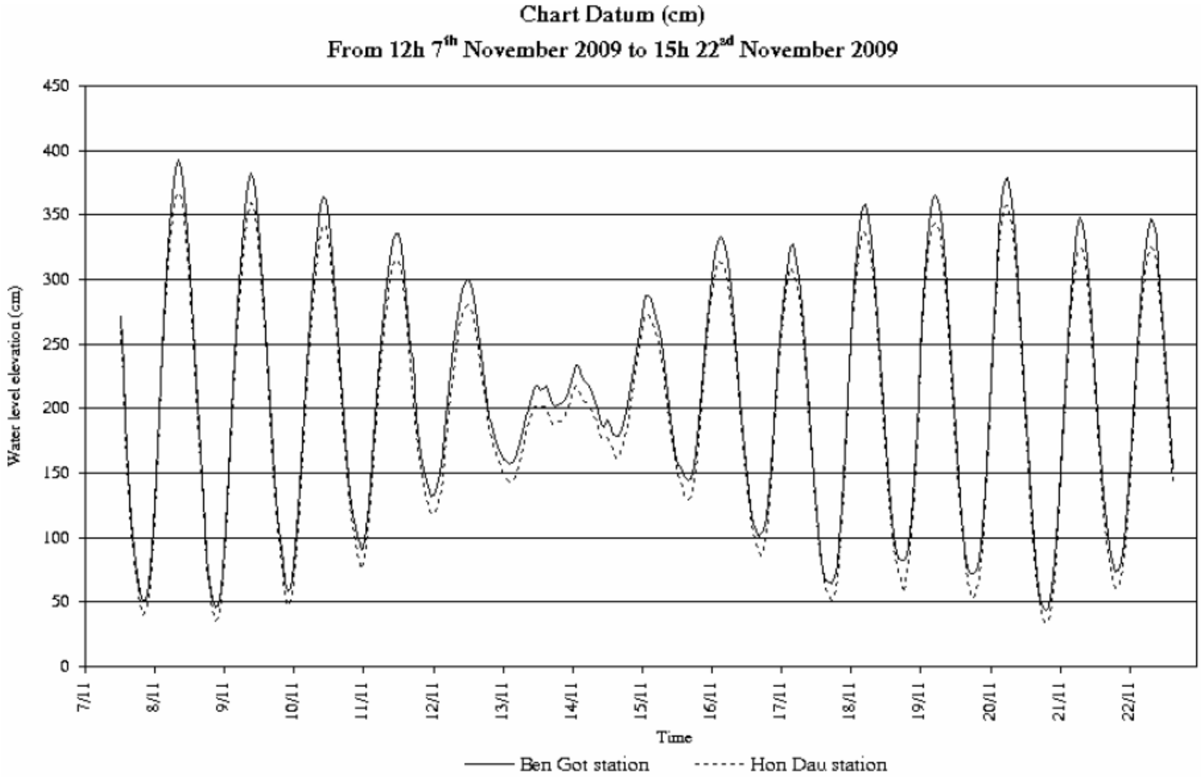


Figure 7.3.32 Tidal Observation Result (7th to 22nd Nov. 2009 at Ben Got Jetty)

The correlative equation is determined as following:

- H Ben Got = 1.024 x H Hon Dau + 7.948 (cm)
- Correlative coefficient R = 0.999

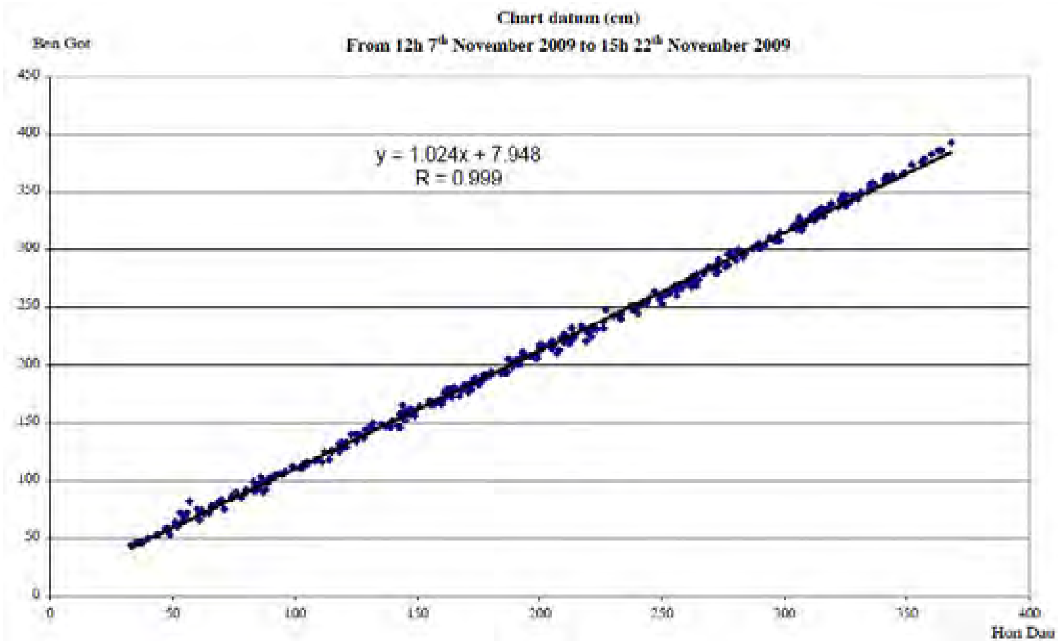


Figure 7.3.33 Correlation of Water Level between at Ben Got and at Hon Dau

c) Harmonic analysis result

Based on the tide observation records, harmonic analysis of tide has been executed and tidal constituents were calculated for the major four (4) constituents of tide including:

M2 - Principal Semidiurnal Lunar.
S2- Principal Semidiurnal Solar.
K1- Principal Diurnal Luni-Solar.
O1- Principal Diurnal Lunar.

Nearly Lowest Low Water Level (NLLW) is calculated as following:

- At Ben Got station:
  NLLW=M2+S2+K1+O1=6.5+2.5+82.6+78.6=170.2cm=1.70m below MSL

- At Hon Dau station:
  NLLW=M2+S2+K1+O1=5.3+2.4+80.4+76.9=165.0cm=1.65m below MSL

The above figures are a little different from Lowest Low Water Level at Hon Dau provided by Vietnam National Hydrographic Center (V.N.H.C) being of 1.86m. This LLWL is determined from water levels observed in many years at Hon Dau. The small difference may be caused by the following reasons:

- The Hon Dau station is located at open sea area of Hon Dau Island, while Ben Got station is located near Lach Huyen estuary.
- The water levels observation for this project and water levels used by V.N.H.C to determine LLWL are in different time periods.
- Short time of water level observation for this project (only 15 days)

7.3.3 Current Observations

1) Current Measurement

The objectives of the Current Survey are to measure the water current velocities, and to present the results in a form that can be used for the design. The Current Survey included the processing and analysis of the measured currents and tide levels at four locations; vector harmonic analysis to establish the tidal component of the currents and assessment of the no tidal residuals.

Current observations have been carried out using Acoustic Doppler Current Profiler (ADCP) instruments during the period of 10th November 2009 to 11th December 2009.

a) Location of Current Observations

The current observation points are located to the southwest of the Cat Ba islands Haiphong City (Refer to Figure 7.3.34). The site itself is the existing main navigation channel to Haiphong Port which lies just to the southeast of Cat Hai island and it is well protected from adverse sea conditions during the northeast monsoon period. The waters around the general vicinity of the access channel are busy with fishing activities.

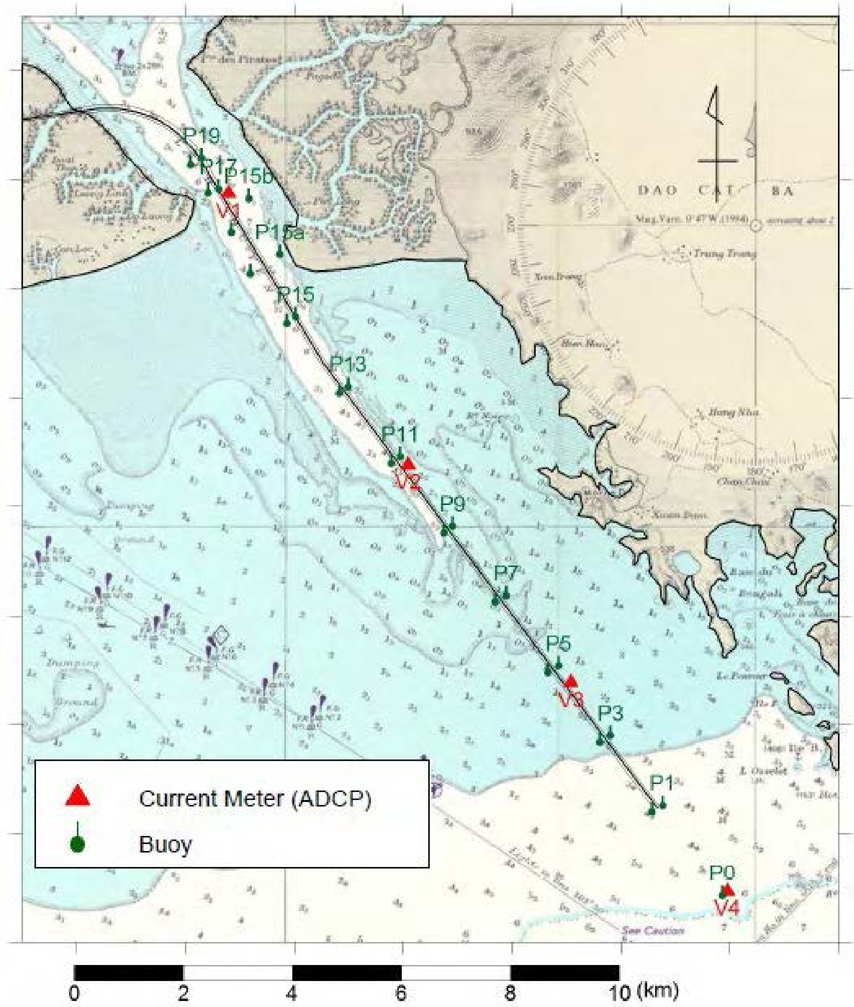


Figure 7.3.34 Locations of Current Observation Points

Table 7.3.13 Co-ordinates and Depth of Current Observation Points

Coordinate System : VN2000-105° 45'

East	North	Name	Depth m CD
620585	2301881	V1	-9.77 m CD
623743	2297059	V2	-3.83 m CD
626820	2292833	V3	-4.56 m CD
629550	2288929	V4	-10.66 m CD

b) Quantities of Current Observations

Current observations have been carried out at four locations during consecutive 30 days with 10 minutes interval.

Table 7.3.14 Principle Recording Parameters

Instrument	V1	V2	V3	V4
Operating Frequency	600 kHz	1,200 kHz	1,200 kHz	600 kHz
Recording Interval	10 minutes	10 minutes	10 minutes	10 minutes
Instrument Level	- 9.77 m CD	-3.83 m CD	-4.56 m CD	-10.66 m CD
Deployment Period	10th November - 11th December 2009	10th November - 11th December 2009	10th November - 11th December 2009	10th November - 11th December 2009

c) Result of Current Observations

(1) Presentation of Current Velocity Results

Current velocity vectors have been presented in Appendix 7-6.

(2) Description of Current Velocity Results

The V1 location has very strong current speeds up to a maximum of 1.8 m/s. Currents are constrained to flow within the channel between Cat Hai and Cat Ba islands, north-northwest on flood tides and ebbing towards the south-southeast. Around the times of low waters and high waters, the current speed reduces to close to zero. A rotation in the vectors was quite often observed, but the direction of rotation was not consistent: sometimes clockwise and other times anticlockwise.

Currents at the V2 location are strong, up to a maximum of 1.0 m/s on spring tides, though this is noticeably weaker than the V1 location. The current directions are much the same: flooding towards the north-northwest and ebbing towards the south-southeast. During neap tides, there is significant stratification of the currents (e.g. around noon on the 14th November, currents are ebbing in the upper half of the water column, but flooding in the lower half).

At the V3 location, current speeds are up to a maximum of 0.6 m/s at the sea surface on spring tides, up to 0.4 m/s near the seabed. This continues the progression of weaker currents away from the V1 location. Currents are very weak on neap tides, for example seldom faster than 0.1 m/s on 28th November. At the time of low water on spring tides, there was a reasonably well-developed anticlockwise rotation, with the rotation phased with depth (e.g. 17:00 – 20:00 3rd December).

Currents were very weak at the V4 location, mostly less than 0.1 m/s and only occasionally reaching 0.15 m/s.

(3) Wind-Driven Near-Surface Current Velocities

At all four locations, the top velocity vectors were often stronger than those immediately below, and they flowed towards the south-southwest. This is interpreted as caused by the effect of the dominant wind from the north east quadrant at this time of year.

(4) Comparison of Tidal and Non-Tidal Currents

There are usually a number of drivers of seawater currents. These include tidal gradients; density imbalances; winds blowing across the sea surface; Coriolis effects; and a number of usually smaller contributors. The relative importance varies with location and (often) with the season. Inspection of the current vectors and water surface levels as shown in Appendix 7-6 indicate that the tidal gradient was the main driver of the currents during this survey period. This section of the report quantifies this dominance.

The percentage values for all four locations and the selected water depths are tabulated below:

Table 7.3.15 Proportion of Currents Attributable to Tidal Forces

Vertical	V1	V2	V3	V4
Surface Currents	82.7%	79.9%	63.8%	47.6%
Mid-Depth Currents	83.5%	79.5%	63.6%	56.5%
Bottom Currents	80.2%	77.1%	59.3%	59.6%

It can be seen that the effects of the tide are most dominant at the V1 location (>80%) and decreases consistently towards the V4 location.

(5) Comparison of Tidal and Non-Tidal Drift Over Many Tidal Cycles

The mean velocities are tabulated below, presented as speed (cm/s) and direction (degrees clockwise from due north):

Table 7.3.16 Mean Measured Current Velocity Over Whole Recording Period

Vertical	V1		V2		V3		V4	
Surface Currents (cm/s & °)	8.9	123°	9.0	141°	2.9	142°	6.5	249°
Mid-Depth Currents (cm/s & °)	1.7	043°	4.5	135°	4.7	077°	4.0	050°
Bottom Currents (cm/s & °)	1.5	330°	1.3	181°	3.8	040°	3.8	046°

Much the strongest drift was in near-surface currents at the V1 and V2 locations, both towards the south east quadrant. By averaging over many tide cycles, this is a measure of the net near-surface flow towards the south east. The mean speeds at mid-depth and near the seabed were much smaller, showing a more balanced flow between flood and ebb tides. At the V3 location, there were gentle mean flows towards the south east (surface), east (mid-depth) and north east (bottom). At the V4 position, the mean surface current was gently towards the west south west; compared to east north east for the mid-depth and bottom currents.

(6) Residual Current Drift Over Many Tidal Cycles

The mean residual current velocities are tabulated below:

Table 7.3.17 Mean Residual Current Velocity Over Whole Recording Period

Vertical	V1		V2		V3		V4	
Surface Currents (cm/s & °)	0.86	335°	0.20	151°	0.15	248°	0.15	277°
Mid-Depth Currents (cm/s & °)	0.38	347°	0.23	220°	0.30	236°	0.43	263°
Bottom Currents (cm/s & °)	0.29	327°	0.20	227°	0.11	264°	0.20	263°

The net non-tidal drift at the V1 location was weak but consistently north north-west. This is interpreted tentatively as a minor density current replenishing salt up the channel.

The net non-tidal drift at the other three locations was also weak, mostly towards the south west. This is interpreted as the effect of winds blowing from the north east quadrant at this time of year.

(7) Comments

Tide levels are strongly diurnal. This area is an amphidromic zone for semidiurnal constituents. The measurements have confirmed very strong currents flow along the channel between Cat Hai and Cat Ba islands, up to 1.8 m/s at the V1 measurement location. Maximum current speeds decrease progressively along the line to the V4 measurement location.

Only minor stratification of currents was observed. Often the currents turned at the same time at all levels within the water column, indicating a reasonably well-mixed density structure at this time of year.

The currents were driven dominantly by the tides. The contribution of non-tidal current drivers (wind, density imbalance etc) was small compared to the currents caused by the tide.

2) Cylinder Sampling

a) Location of Cylinder Sampling Points and Quantities

To obtain the information of sedimentation along the navigation channel, Cylinder Sampling has been carried out on 11th November, 2009. The details of this works are as follows;

- Sampling at 04 locations: CS1, CS2, CS3, CS4 with cylinder sampling method (Refer to Figure 7.3.35). Detailed actual quantity of the field work is presented in Table 7.3.18.
- Laboratory testing was performed to characterize and assess the pertinent engineering properties of the on-site soils. Laboratory testing includes grain size analysis by sieving and hydrometer, water content, Atterberg limits, specific gravity. Detailed actual quantity of the laboratory test is presented in Table 7.3.19.

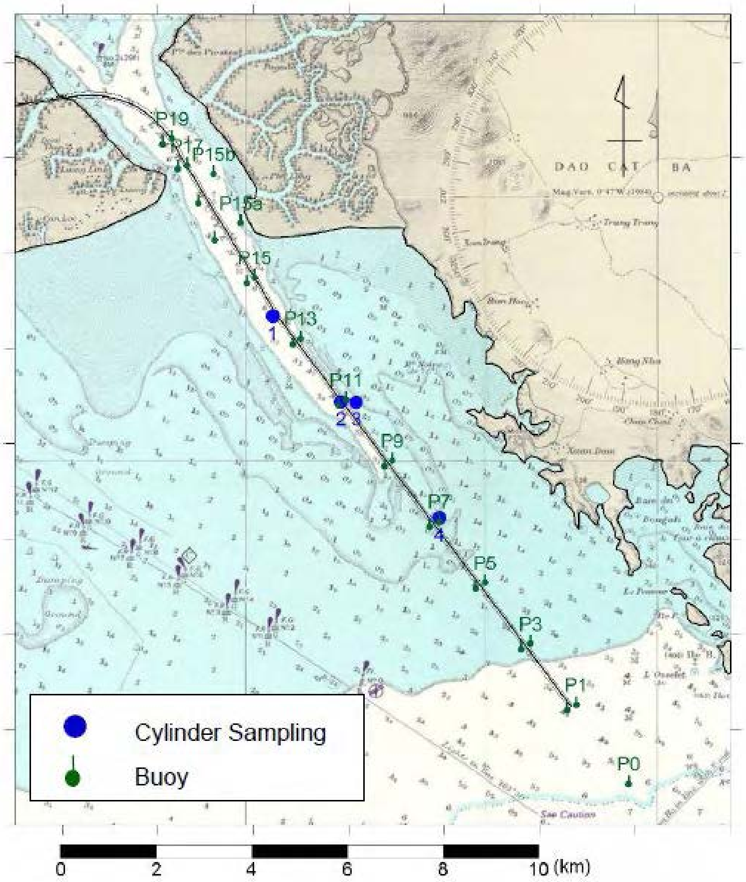


Figure 7.3.35 Location of Cylinder Sampling Points

Table 7.3.18 Quantities of Cylinder Sampling (Field Work)

No.	Location	Number of samples taken	Remarks
1	CS1	02	01 Upper, 01 Lower
2	CS2	02	01 Upper, 01 Lower
3	CS3	01	01Upper
4	CS4	02	01 Upper, 01 Lower
Total		07	

Table 7.3.19 Quantities of Cylinder Sampling (Laboratory Testing)

No.	Property/Test	Unit	Total
1	Water content	No	06
2	Specific gravity	No	07
3	Atterberg Limits	No	06
4	Grain Size Analysis by sieving	No	07
5	Grain Size Analysis by Hydrometer	No	06

Co-ordinates of the sampling points are listed in Table 7.3.20. Their locations are shown in investigation location plan as shown in Figure 7.3.35.

Table 7.3.20 Co-ordinates and elevation of the Cylinder Sampling points

No.	Borehole	Actual Coordinates (m) - VN2000		Remarks
		Northing	Easting	
1	SBH1	2298722	622166	Offshore
2	SBH2	2296913	623581	"
3	SBH3	2294475	625636	"
4	SBH4	2296909	623901	"

b) Equipment & sampling method

- Equipment

  Using a transparent acryl cylinder. Basic dimensions are as follows:

  Length : 1250mm;
  Inner diameter : 63mm;
  Weight (including 02 caps): 785g.

  One diver team with all necessary equipment (ship, air compressor, diver's instrument) was used.

- Sampling method

  Cylinder sampling was conducted manually with transparent acryl cylinder by a diver in the water as in the following figure:

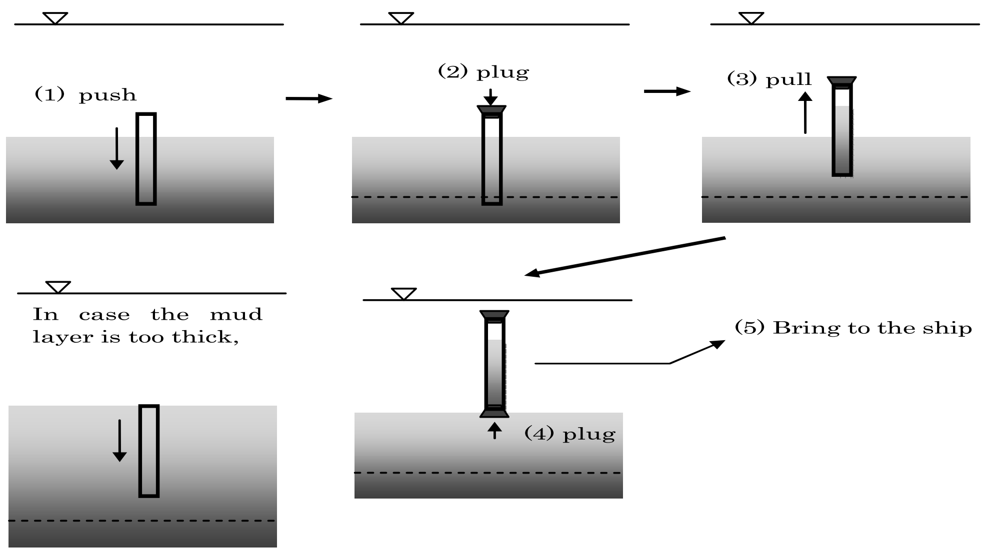


Figure 7.3.36 Procedure of Cylinder Sampling

c) Result of Laboratory Tests (Physical Property of Soil)

Laboratory test results of soil samples obtained by cylinder sampling are tabulated and shown in Table 7.3.21.

Table 7.3.21 Laboratory Test Result of Soil Samples obtained by Cylinder Sampling

No.	Location	Sample	Percent passed sieve size (mm)								Natural moisture content w (%)	Atterberg Limits				Particle density Δ (g/cm³)	Soil group	Description
			9.5	4.75	2.00	0.85	0.425	0.25	0.075	< 0.005		Liquid limit W_L(%)	Plastic limit Wp(%)	Plasticity index Ip (%)	Consistency (B)			
1	CS1	UPPER			100.00	99.8	98.86	98.15	94.20	38.53	63.90	63.31	26.82	36.49	1.02	2.67	CH	Brownish grey, Fat clay
2	CS1	LOWER			100.0	99.60	98.25	96.29	86.47	29.21	70.80	48.99	22.87	26.12	1.83	2.68	CL	Brownish grey, Lean clay
3	CS2	UPPER			100.0	99.98	99.82	99.18	98.11	35.21	88.30	60.18	26.74	33.44	1.84	2.69	CH	Brownish grey, Fat clay
4	CS2	LOWER			100.0	99.96	99.76	98.72	93.43	31.68	82.08	54.08	24.84	29.24	1.96	2.69	CH	Brownish grey, Fat clay
5	CS3	UPPER			100.0	99.6	99.10	97.04	2.26							2.66	SP	Yellowish brown, Poorly graded sand
6	CS4	UPPER			100.0	99.9	99.64	97.73	82.97	38.44	70.63	47.73	24.23	23.50	1.97	2.69	CL	Brownish grey, Lean clay with sand
7	CS4	LOWER			100.0	99.9	99.86	97.26	72.75	29.88	58.83	42.15	21.18	20.97	1.80	2.67	CL	Brownish grey, Lean clay with sand

3) Water Sampling

a) Location and co-ordinates of water sampling

Water sampling was conducted at four fixed points as the same location as current observation locations presented in the Figure 7.3.37 along the navigational channel to identified the suspended solid content in the sea water.

The water sampling was carried out at three depths per point at four locations in 2 times, first time: 18th November and second time: 8th December 2009.

b) Quantities of water sampling and testing

Water sampling and suspended solid analysis: 24 samples = 4 locations x 3 layers x 2 times.

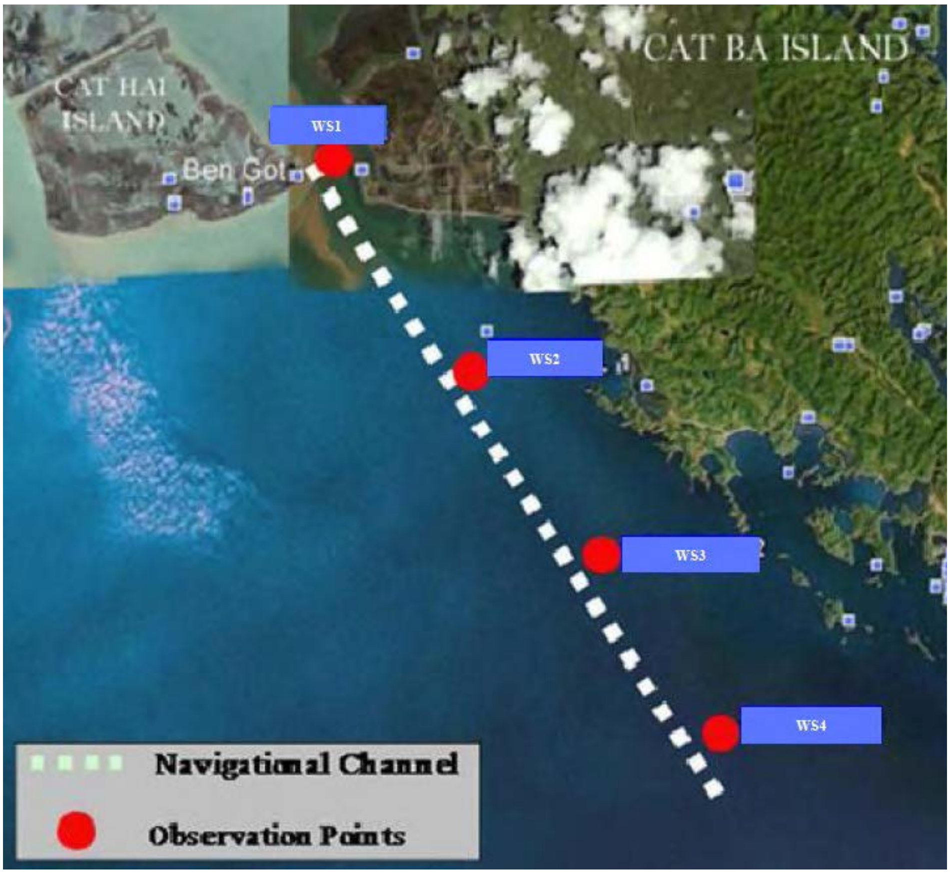


Figure 7.3.37 Location of Water Sampling Points

c) Result of Suspended Solid Content Test

Results of suspended solid content of sea water samples obtained on 18th November and 8th December are tabulated and shown in Table 7.3.22 and Figure 7.3.38 respectively.

Table 7.3.22 Total Suspended Solid (SS) Test Result

Location	By Nippon Koei			By JICA Study					
	7th September, 2009			18th November, 2009			8th December, 2009		
	Upper	Middle	Lower	Upper	Middle	Lower	Upper	Middle	Lower
WS1 (at or near Buoy No. 17)	63	120	55	247	230	424	103	131	122
WS2 (at or near Buoy No. 11)	55	69	61	130	150	160	93	102	129
WS3 (at or near Buoy No. 5)	16	31	288	110	90	170	119	156	266
WS4 (at or near Buoy No. 0)	-	-	-	71	73	110	97	98	108

According to SS test results, slight tendencies can be seen as follows;

(1) There are not so much differences in SS values among three measurements, sampled in September, November and December.

(2) SS value becoming bigger when the location is closer to an estuary of Lach Huyen River.

(3) Sample taken at the lower of each points tends to show bigger SS value than SS values at upper depths, it might be due to influence of fluid mud existing on the seabed with about 20cm to 50 cm thick.

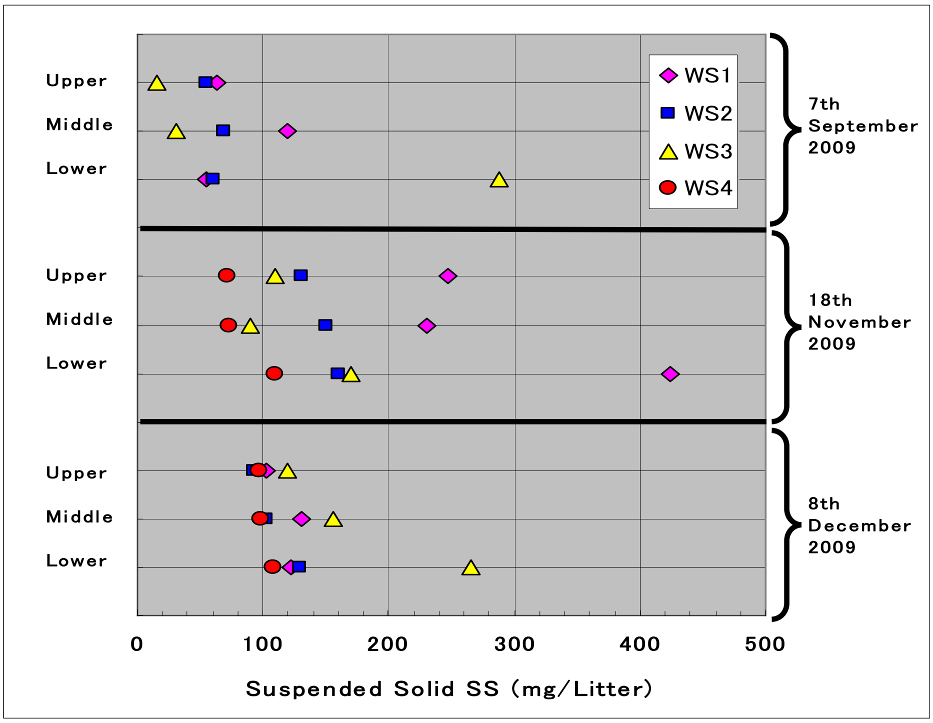


Figure 7.3.38 Total Suspended Solid (SS) Test Result

8. Sedimentation Simulation

8.1 Sedimentation in Lach Huyen Channel

Lach Huyen channel had finished dredging in November, 2005 and has been brought into operation since early 2006. The channel was dredged by the depth of -8 m (the control depth =-7.2m) and the width of 100m for ships of 10,000 DWT. Lach Huyen port development plan includes channel deepening by the depth of -14 m for 100,000 DWT. Because the channel deepening will induce more sedimentation, prediction of future sedimentation is needed to grasp volume of maintenance dredging and propose effective countermeasures to minimize sedimentation.

In this chapter, characteristics of sedimentation on the present situation of Lach Huyen channel are analyzed by using bathymetric survey results, and sedimentation with the planed topography is predicted by numerical simulations.

8.1.1 Topography of Lach Huyen channel

The latest topography of Lach Huyen channel was surveyed in November, 2009, with dual-frequency echo sounder. The topography map measured by high frequency of 200 kHz is shown in Figure 8.1.1 and the depth difference between the topography measured by 200 kHz and that by 30 kHz is shown in Figure 8.1.2. In the two figures, the numbers of 26-47along the channel indicate distance from Hai Phong port for the reference. Figure 8.1.3 shows topography on the center line of the channel, and Figure 8.1.4 and Figure 8.1.5 show cross-sections of the channel.

From the figures, characteristics on the channel topography are obtained as follows.

- The area from Km27 to Km29, the narrowest area between Cat Hai and Cat Ba island, is approximately -12 m in depth and deeper than other part of the channel.
- In the area from Km30 to Km36, topography along the center line of channel is almost flat with -8 m in depth.
- In the area from Km36 to Km40, the bed level is slightly shallower than the area from Km30-36 and its shape is like a mound. The sallowest position is located in Km38-Km39 with -7 m in depth.
- The area from Km40 to the offshore is getting deeper toward offshore.
- The cross-section profiles of Km27 to Km29 are the shape of large depression being naturally formed.
- On the cross-section profiles of Km30 to Km 38, the channel shape is kept. Particularly, although the both sides of the channel on the cross-sections of Km35 to Km37 are shallow with about -3 m in depth, the channel bottom is kept about -8 m in depth.
- On the cross-sections of Km39 to Km42, the channel shape is not clear and the depth difference between the shoulder and the bottom of the channel is quite small.

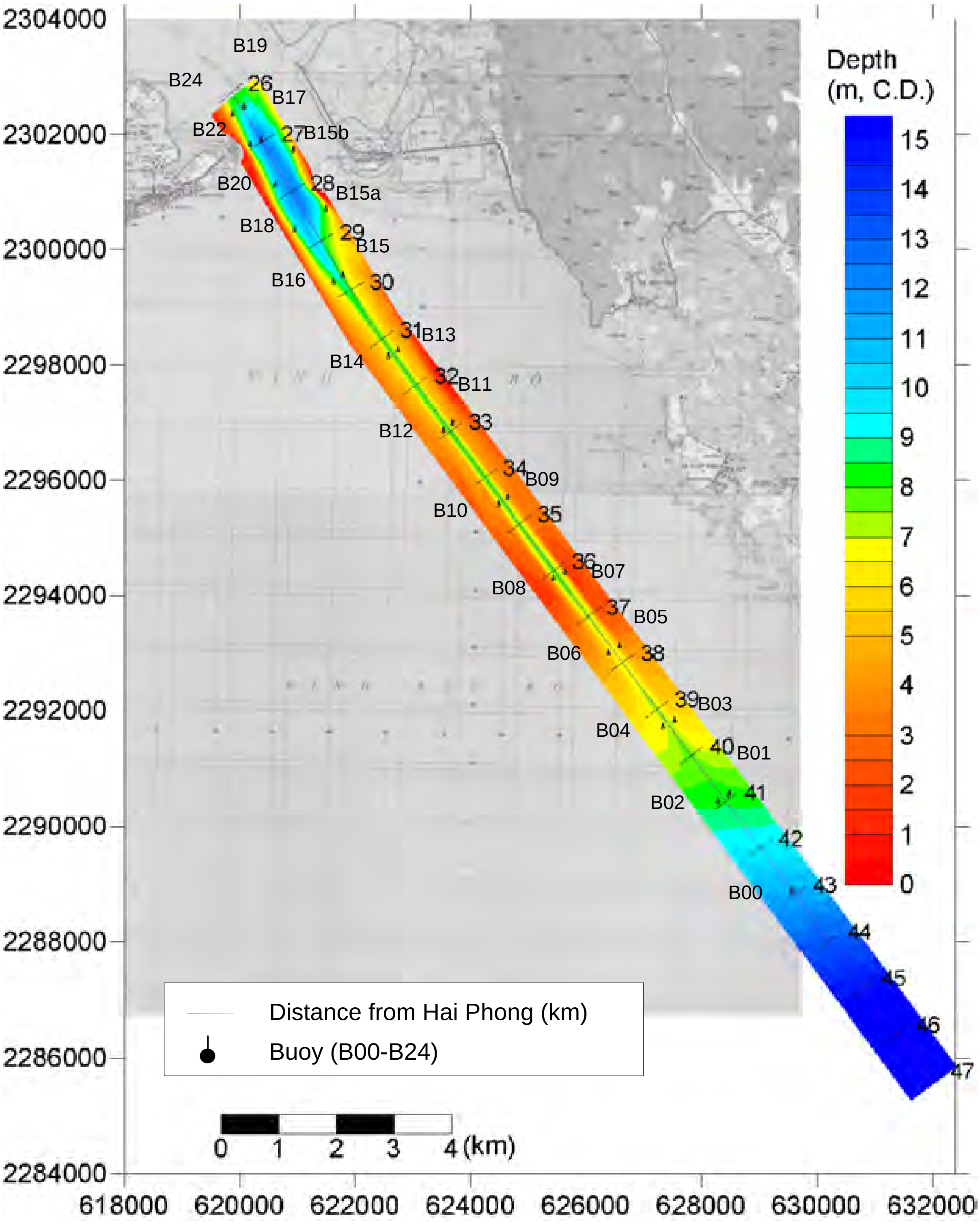


Figure 8.1.1 Depth Contour map of 2009-11 (200kHz) and location of buoys

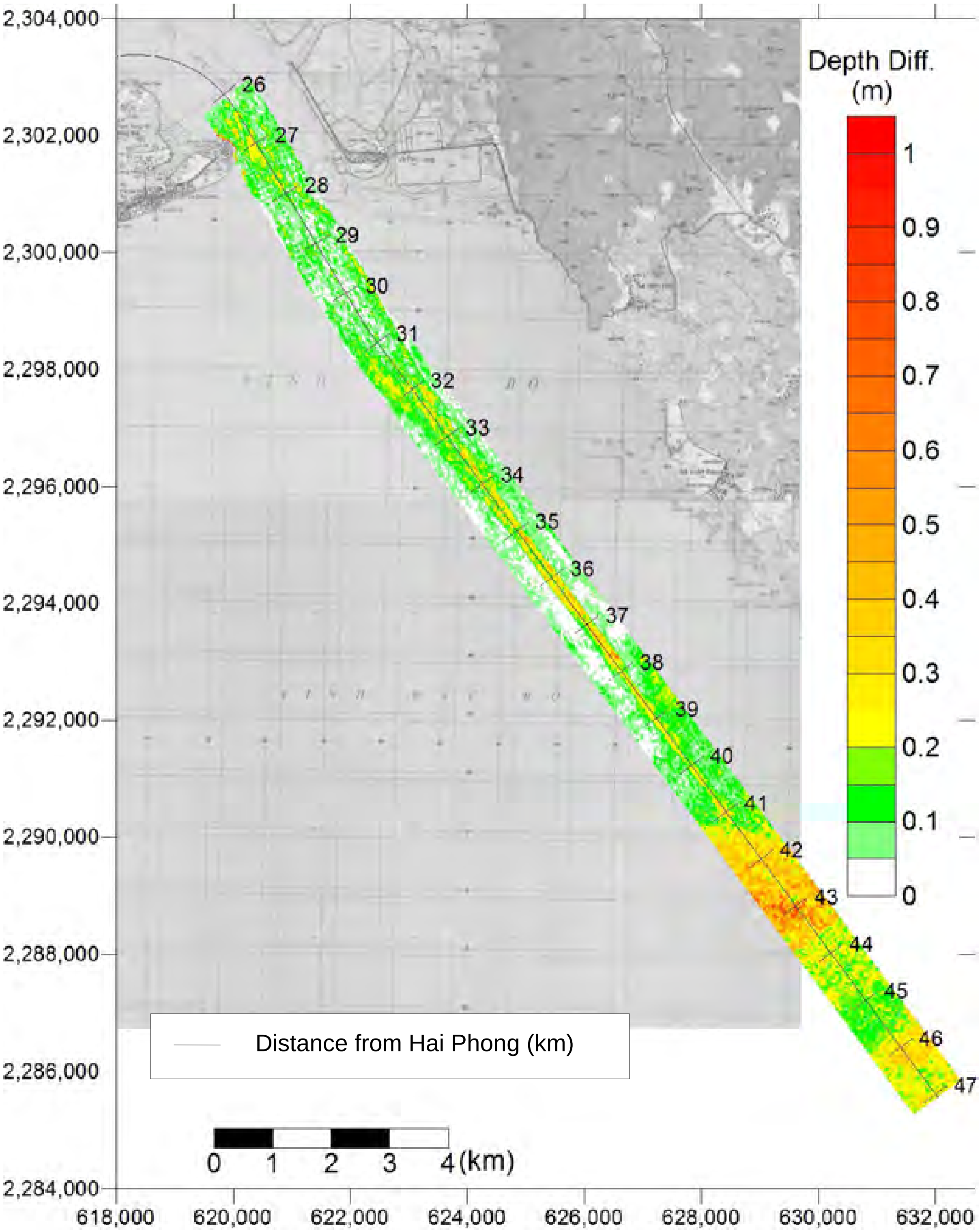


Figure 8.1.2 Depth difference between high (200kHz) and low (30kHz) frequency

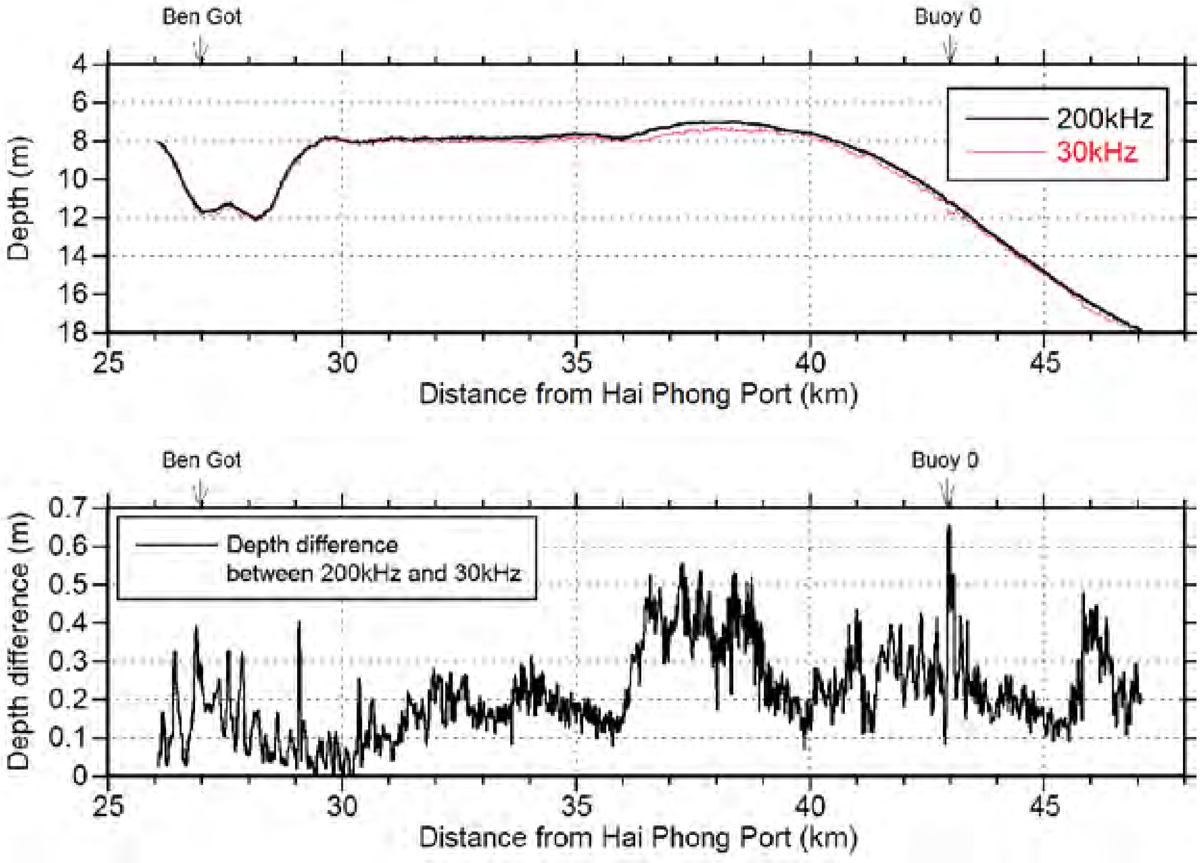


Figure 8.1.3 Topography on the center line of the channel and depth difference between high (200kHz) and low (30kHz) frequency

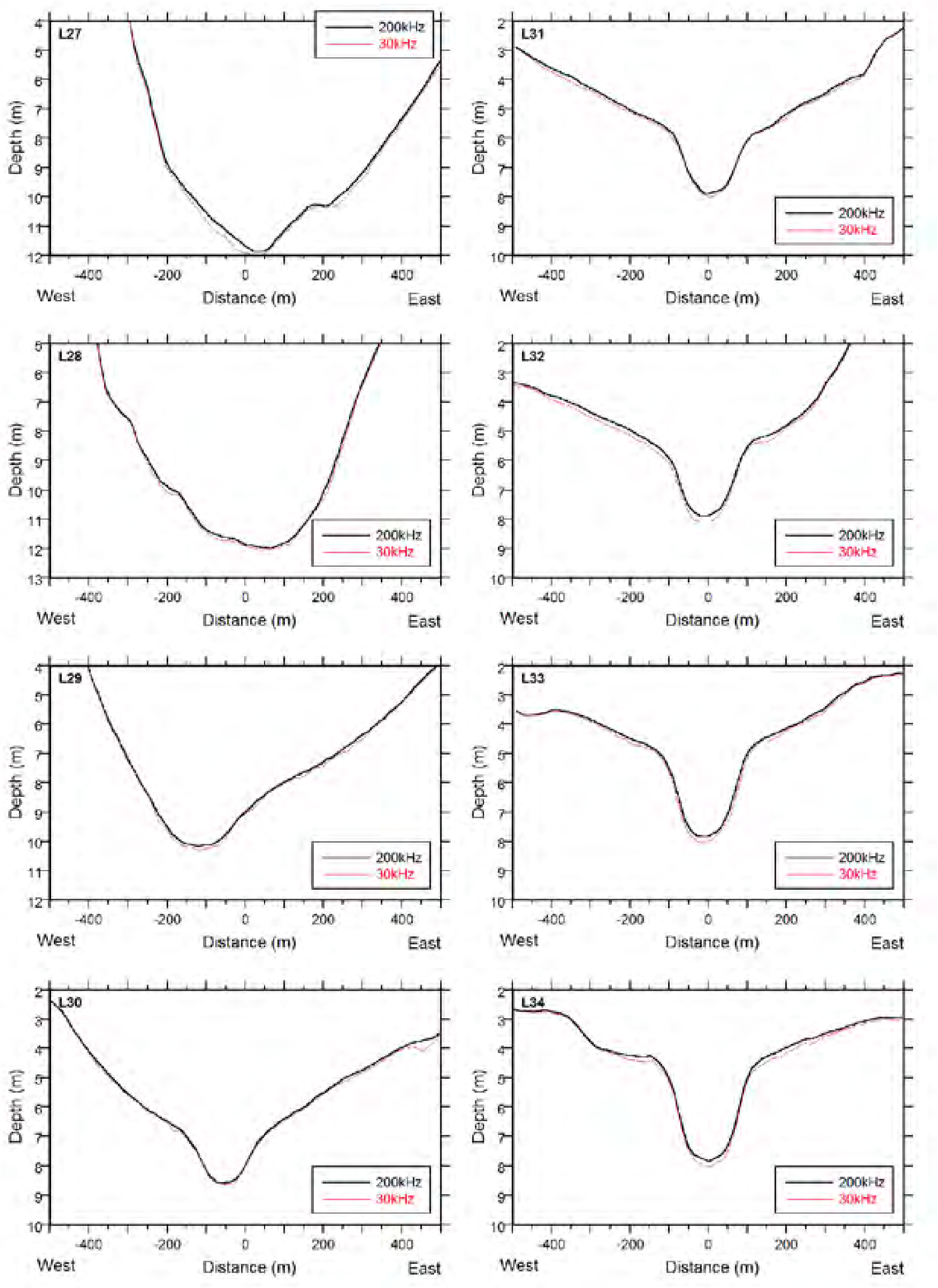


Figure 8.1.4 Channel cross-sections of 200 kHz and 30 kHz (Location 27-34)

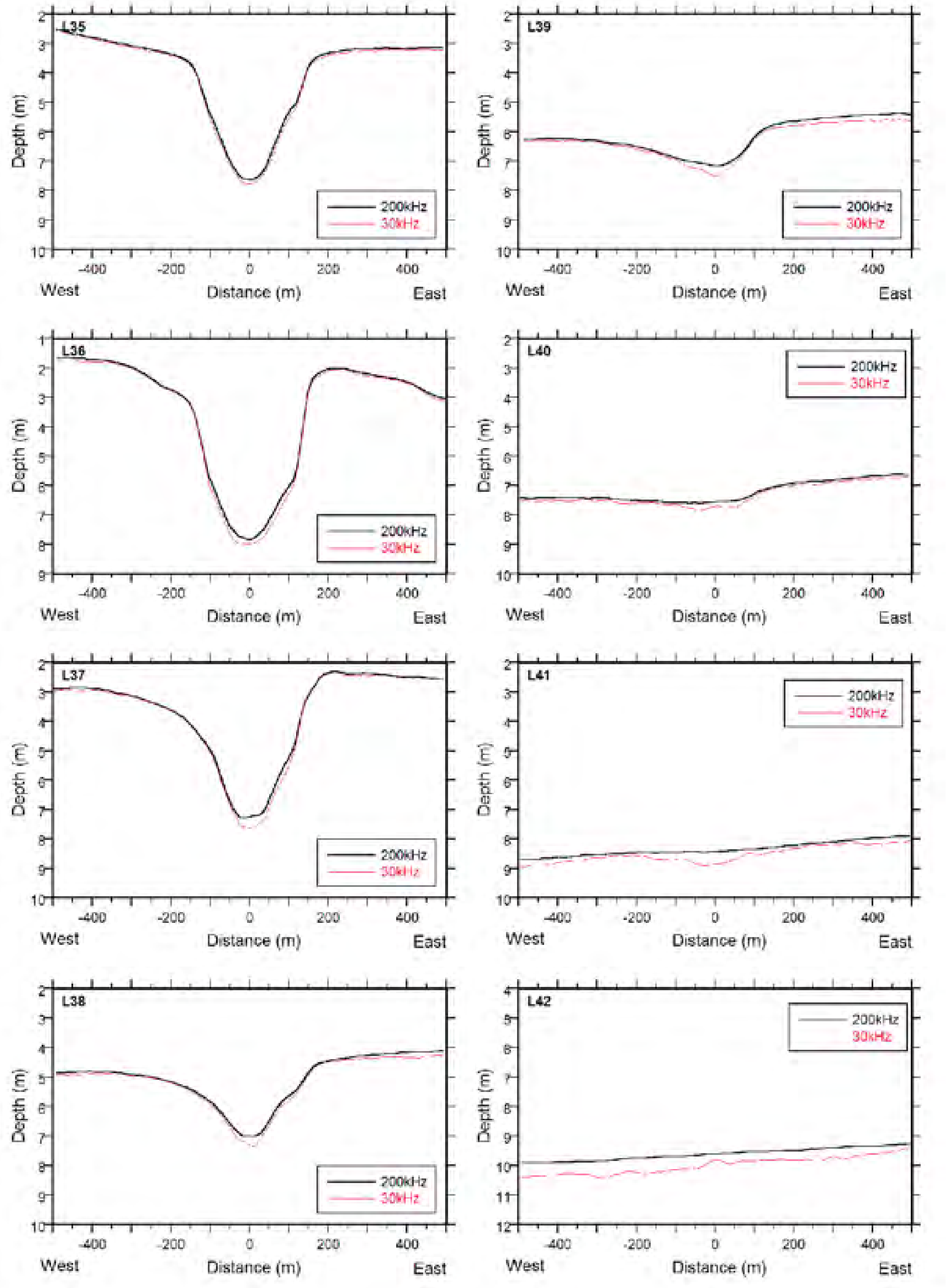


Figure 8.1.5 Channel cross-sections of 200 kHz and 30 kHz (Location 35-42)

8.1.2 Sediment around Lach Huyen channel

In general, the depth difference between the two frequencies indicates the thickness of fluid mud. As shown in Figure 8.1.2 and the bottom of Figure 8.1.3, the fluid mud thickness is characterized as follows,

- Along the channel, the depth difference between high and low frequency is 0.1-0.2m of Km26-36, 0.2-0.4m of Km36-39, and 0.3m of Km40 to offshore, approximately.
- As shown in Figure 8.1.4 and Figure 8.1.5, the depth difference is relatively large in the center of the channel comparing to out the channel.

Shown in Figure 8.1.6 and Figure 8.1.7 are the spatial distribution of particle size of the sediment and mud contents, respectively. These are the results of sediment sampling carried out at 80 points in November, 2009. The number on each circle in Figure 8.1.6 indicates grain size in micrometer. As shown in the figures, most of sediments on the center of the channel are silt or clay, the averaged grain size of which is 22 μm. Also, it is seen that the grain size is getting smaller and the mud content is getting higher in the offshore area. These tendencies indicate that the quite fine sediment is deposited on the channel bottom, particularly the offshore part of the channel.

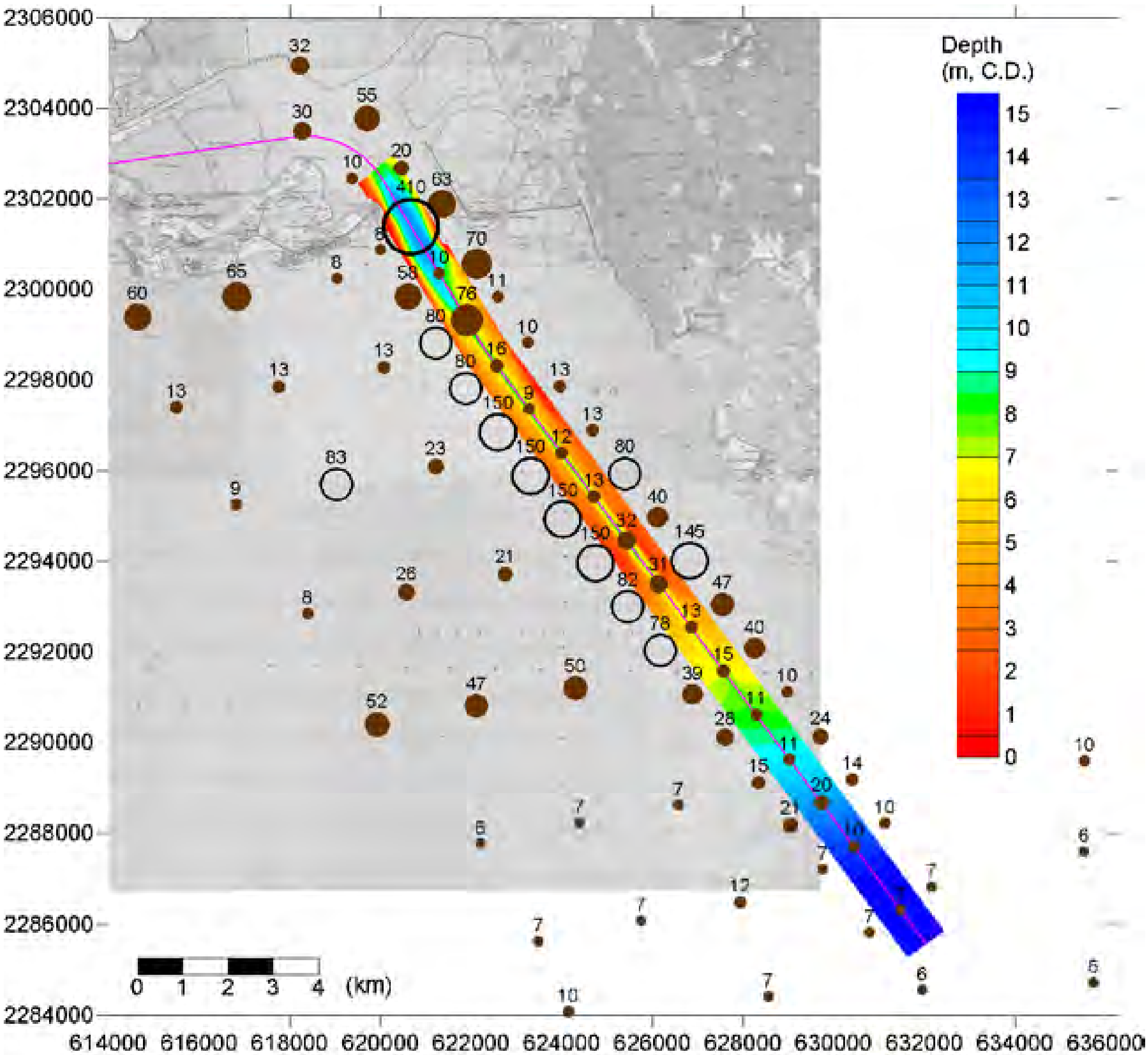


Figure 8.1.6 Distribution of grain size, d_{50} (μm). The filled circle indicates mud (d_{50} <75μm) and the blank circle sand (d_{50} >75μm)

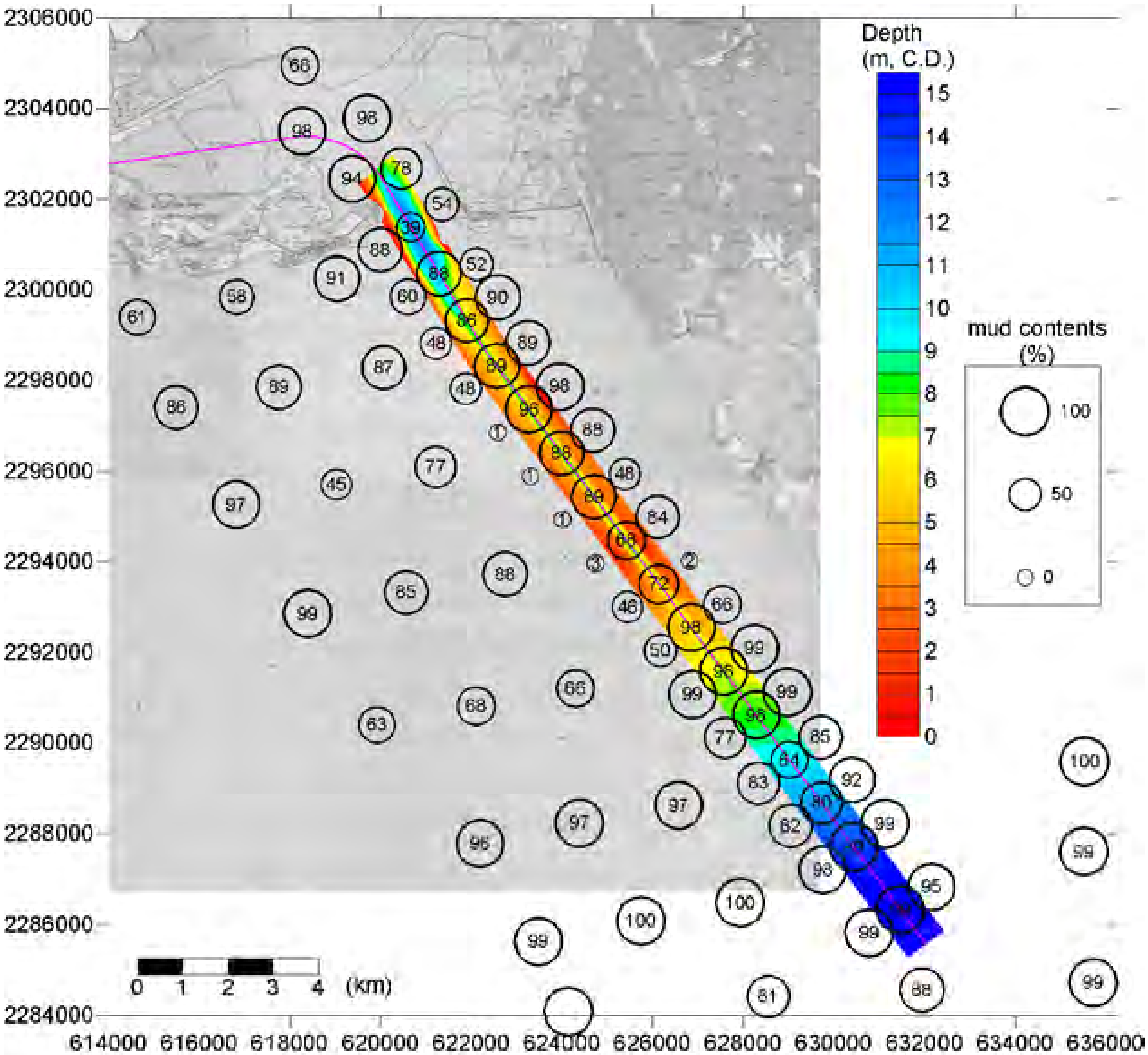


Figure 8.1.7 Distribution of mud contents (%) in the sampled sediment

8.1.3 Analysis of Bathymetric survey data

1) Data Collection

The bathymetric survey results in and around the Lach Huyen channel have been collected as listed Table 8.1.1. The bathymetric survey results are analyzed in this section to understand sedimentation process in the channel. The contour maps of the survey results are shown in Figure 8.1.8 with depth differentiation in color. The contour maps are drawn by VN2000 coordinate system. The six color maps are shown in the figure with shifting 1000 m in horizontal axis. The numbers of 26-43 show the distance from Hai Phong Port along the channel.

The depth of the present access channel was dredged to -8.0 m or deeper in October 2005, so that the color should be green. The color of yellow to red indicates the depth shallower than –7.5 m because of sedimentation. The area around Km36-40 was 7.5 m or deeper below the datum in November 2006. However, the survey in November 2009 revealed the depth nearly 6.5 to 7 m, though the change in color may be difficult to discern. On the other hand, in the area around Km29-30, the color of light blue (the depth range is 9.5-10 m) extended offshore with time, indicating that the area has been eroded.

Table 8.1.1 Collected bathymetric survey data

No.	Date of survey	Description
1	2006-11-16	
2	2007-06-13	
3	2007-12	
4	2008-06-25	
5	2008-12-25	
6	2009-11a	High Frequency (200kHz)

The changes in the water depth in and around the access channels are graphically presented in Figure 8.1.9. In the figure, net depth change based on the survey in November 2006 is shown. The colors of yellow to red show accretion and those of light blue to blue show erosion.

The area around Km27 to Km32 shows erosion tendency both in and out the channel. The area around Km 32-34 shows erosion out the channel and accretion in the channel. The area around Km34-38 shows almost accretion. This section was partly dredged to the width of 200m though the channel width is about 100m in the other part of the channel. In the area of Km38-41, the majority of the access channel has been accreted 0.5-1.0m, while the seabed next to the channel is eroded.

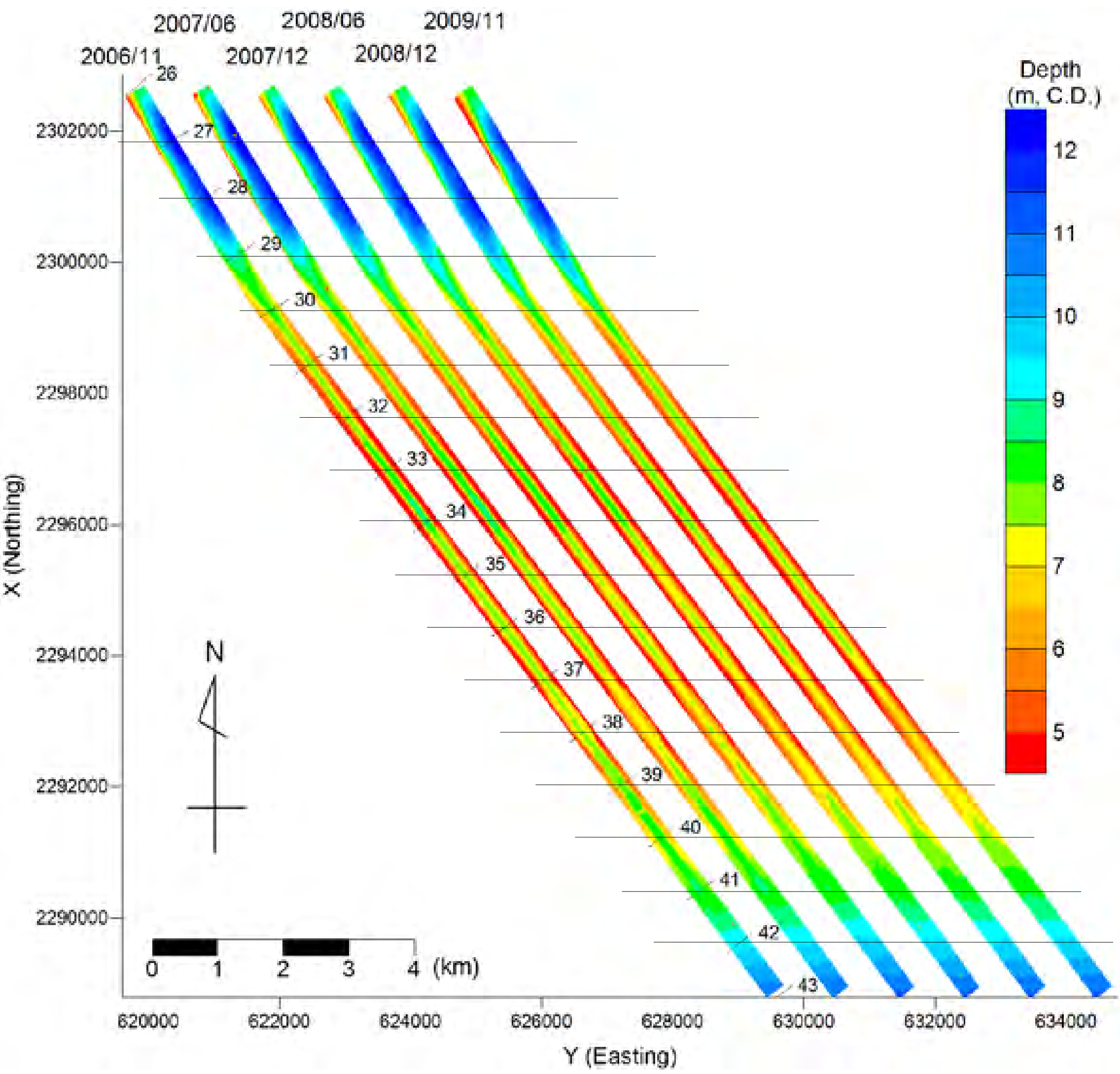


Figure 8.1.8 Depth Contour maps of collected data

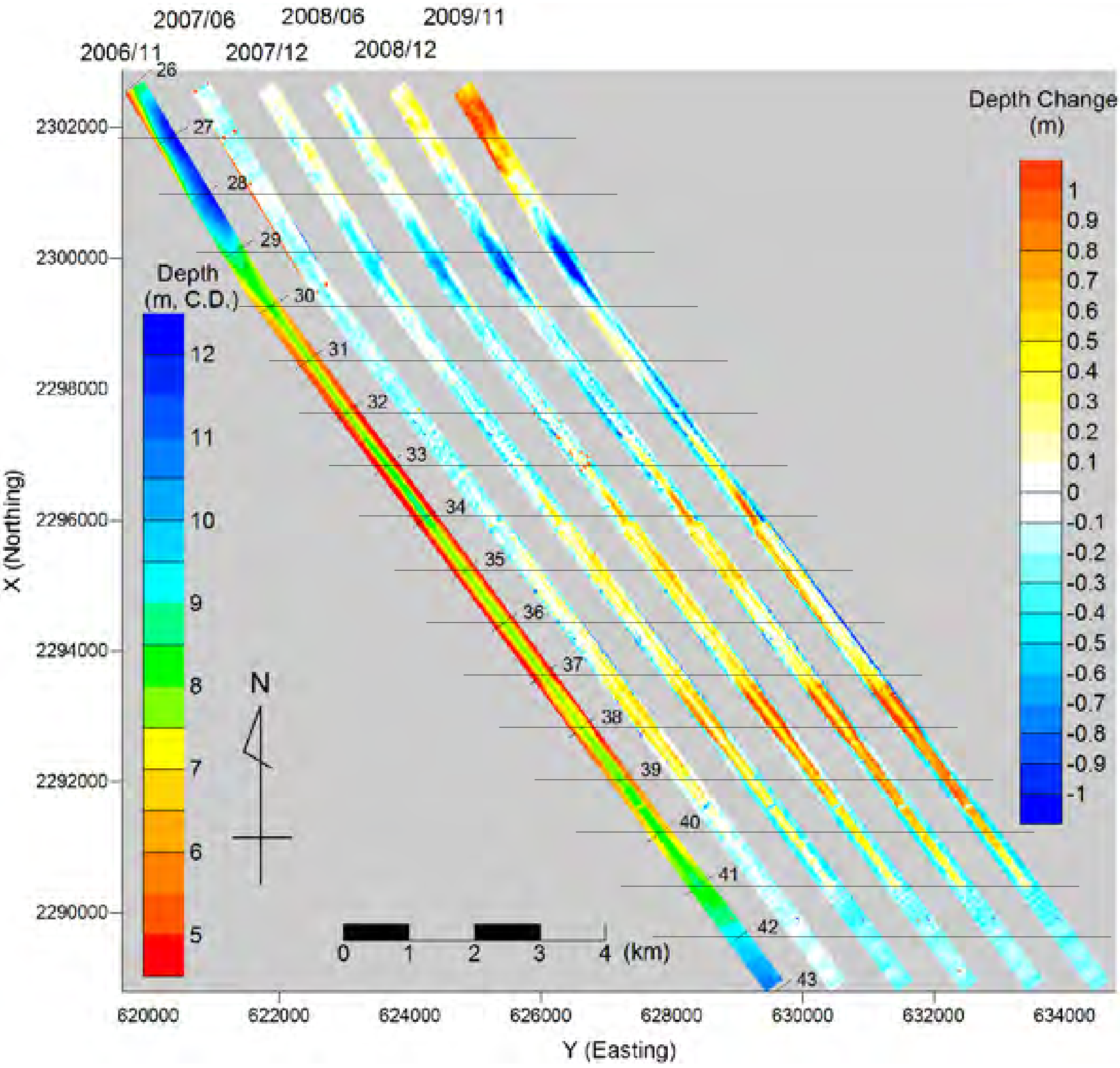


Figure 8.1.9 Net depth change from topography of 2006/11 (Accretion is positive)

2) Depth changes in Longitudinal Cross section

The changes in water depth within the channel are shown in Figure 8.1.10 in the form of longitudinal cross section obtained by successive bathymetric surveys. The top of the figure shows longitudinal profile on the center line of the channel and the bottom shows the net depth change plotted based on the profile in November 2006.

The survey in November 2006 shows the channel bottom one year after completion of the initial dredging work. The figure indicates that significant sedimentation has occurred in the area of Km36-42 and slight erosion has occurred in the area of Km29-32. Around Km34, the depth in November 2006 was partly deep and has been flat by December 2008. After that, sedimentation around Km34 seems to be reduced. From these characteristics, it is confirmed that sedimentation in Lach Huyen channel is significant in the offshore part of the channel.

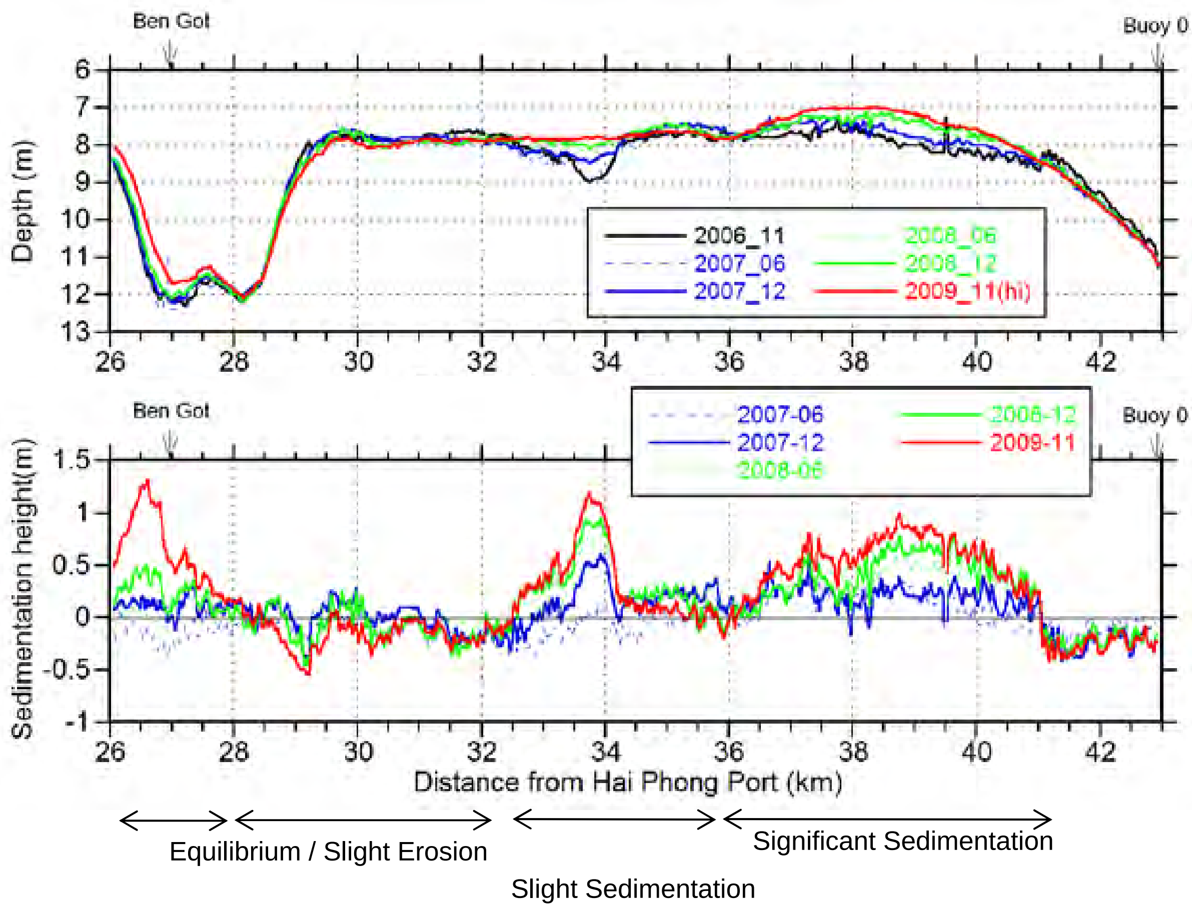


Figure 8.1.10 Topography on the center line of the channel and sedimentation height based on 2006-11

3) Depth changes in Transverse Profiles of the Channel

In the present report, the locations along the channel are designated with the numbers that shows distance from Hai Phong port as shown in Figure 8.1.1. The transverse profiles of the channel at Location 27 to 42 measured in different dates are shown in Figure 8.1.11 and Figure 8.1.12.

The seabed level outside the channel exhibits some fluctuations, which are gradually getting deeper from the data in November 2006 to those in November 2009.

The changes in seabed level inside the channel are different from location to location. On locations of 29 and 30, the seabed level of the channel center is slightly getting deeper. On locations of 38 to 41, the seabed level is getting shallower.

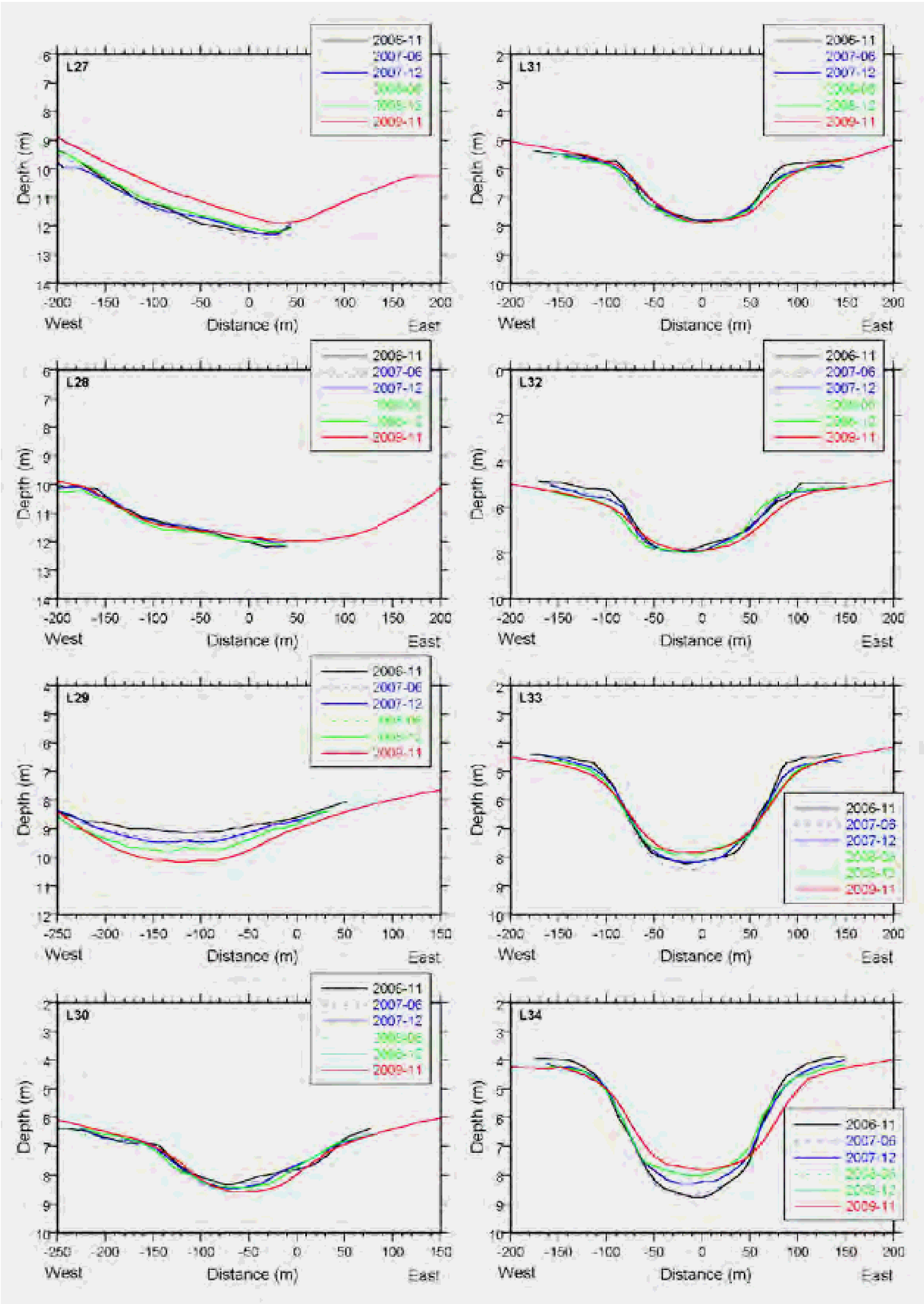


Figure 8.1.11 Cross-section of the channel (Location 27-34)

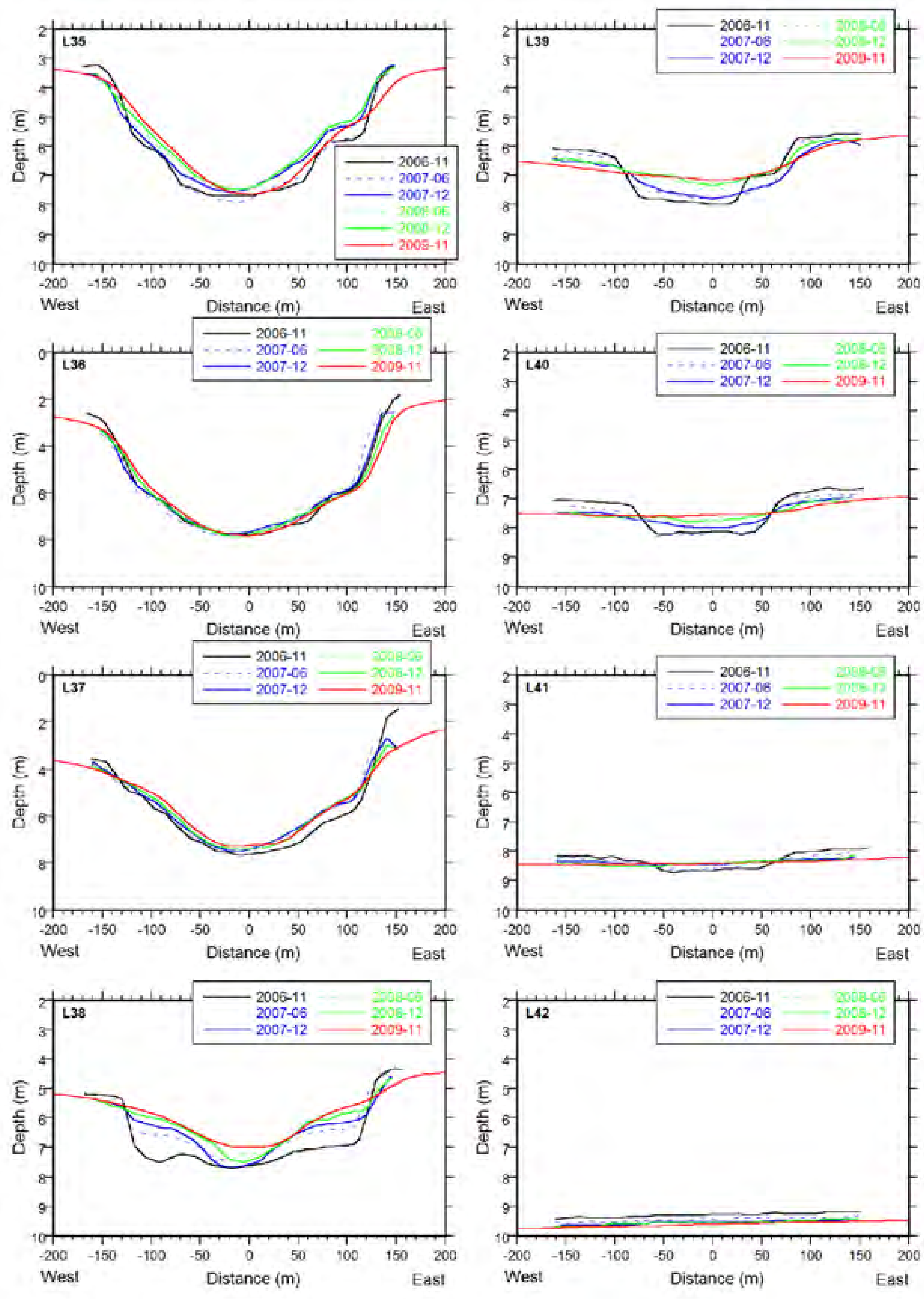


Figure 8.1.12 Cross-section of the channel (Line 35-42)

4) Sedimentation Speed

Sedimentation speed at locations of Km27 to Km42 has been analyzed. Figure 8.1.13 shows the change in depth at locations of Km27 to Km42 with respect to the survey date. The lines in the figure are results of regression analysis and indicate that the depth changes linearly with time at each location. Seasonal effect due to rainy and dry season is not so clear in the change in depth.

Figure 8.1.14 shows the sedimentation speed at each location. The sedimentation speed is different from place to place as described in the section d). The sedimentation speed is relatively fast in Km37 to Km42, the offshore part of the channel. The sedimentation speed is negative in Km29 to Km32, which shows erosion. In Km33 to Km35, the sedimentation speed is fast because the area is partly deeper and refilled.

The averaged sedimentation height was calculated by integration of the net accretion area along the channel. The result is shown in Figure 8.1.15. In the figure, the averaged sedimentation height is plotted with respect to elapsed months after the completion of initial dredging in the end of October 2005. The plotted data include the data written in the report by JOPCA (2009) (JOPCA-collected) with the data collected by this study (SAPROF-collected). The curve in the figure is the regression curve of the all data. As shown in the figure, the averaged sedimentation height gradually increases with the elapsed months, but decreasing the sedimentation speed. The annual sedimentation speed estimated by the regression curve is shown in Figure 8.1.16. In the figure, the sedimentation in first year is much higher than that in second year or later. According to the survey data of October 2005 shown in Figure 8.1.17, however, it is confirmed that the high sedimentation in the first year is induced by that the excessive dredged area around Km34 to Km41 had been refilled. On the topography of November 2006, the excessive dredged area is almost refilled, and therefore it is considered that the sedimentation speed decreased significantly after November 2006.

From the analysis described above, characteristics in sedimentation in Lach Huyen channel are summarized as follows.

- Most of sediments around the channel are mud (silt and clay), and the sedimentation is induced by siltation.
- Sedimentation speed is different from place to place along the channel, and the location of significant sedimentation is from Km37 to Km41, the offshore part of the channel.
- In the area of Km29 to Km32, no sedimentation has been occurred in the present situation. Because the area is located near the entrance of Lach Huyen estuary, the strong tidal currents usually act on the bottom and do not allow sediment to deposit.

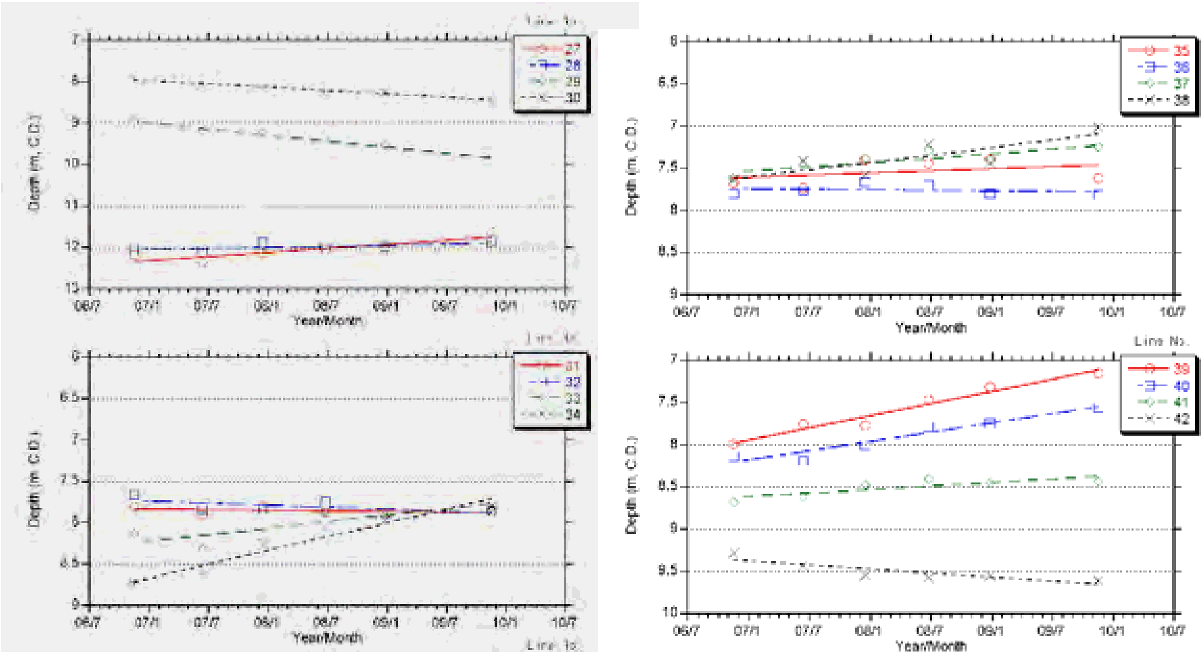


Figure 8.1.13 Change in depth at location Km27 – Km42.

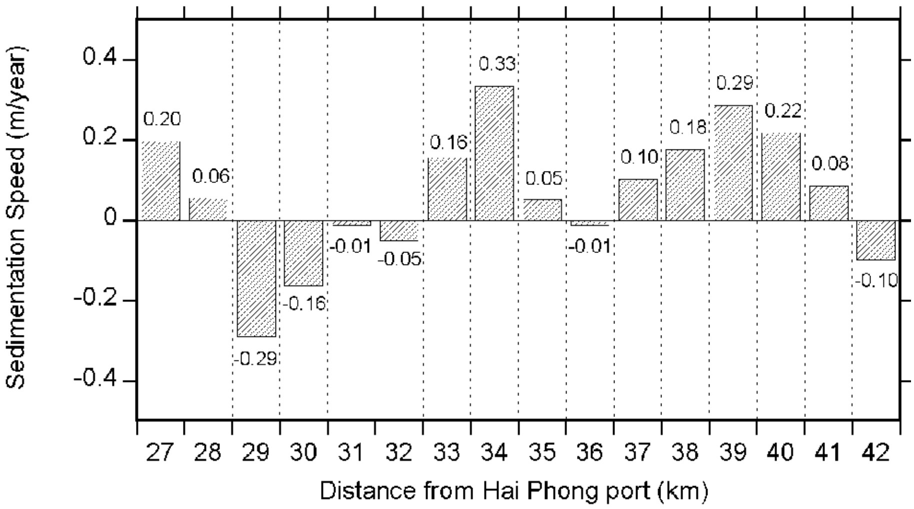


Figure 8.1.14 Recent sedimentation speed of Lach Huyen Channel

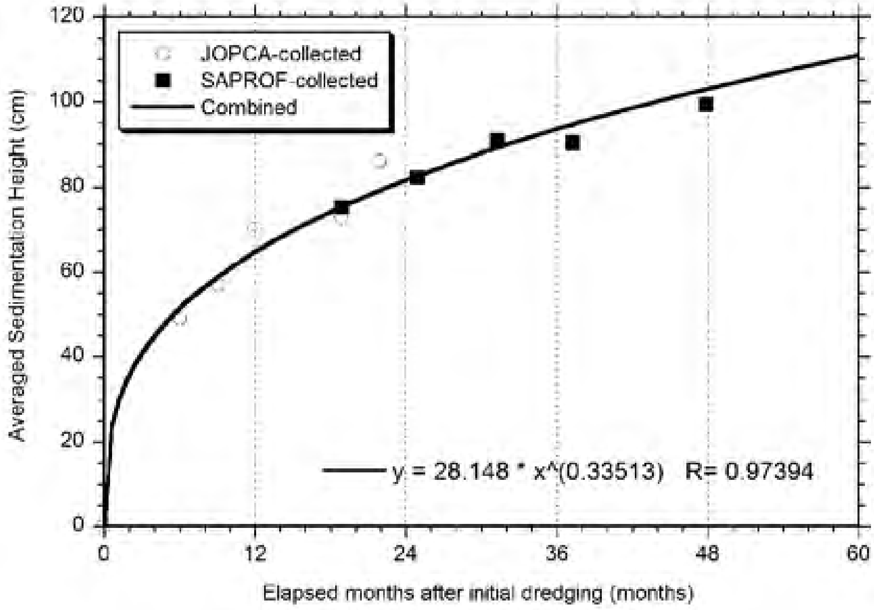


Figure 8.1.15 Averaged sedimentation height and the regression curve

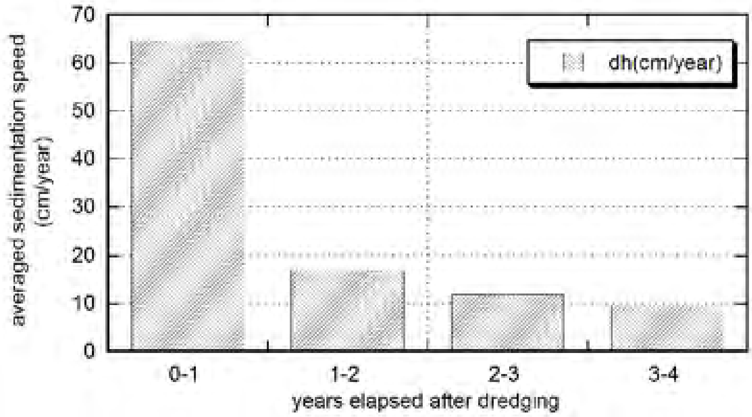


Figure 8.1.16 Averaged sedimentation speed every year after dredging

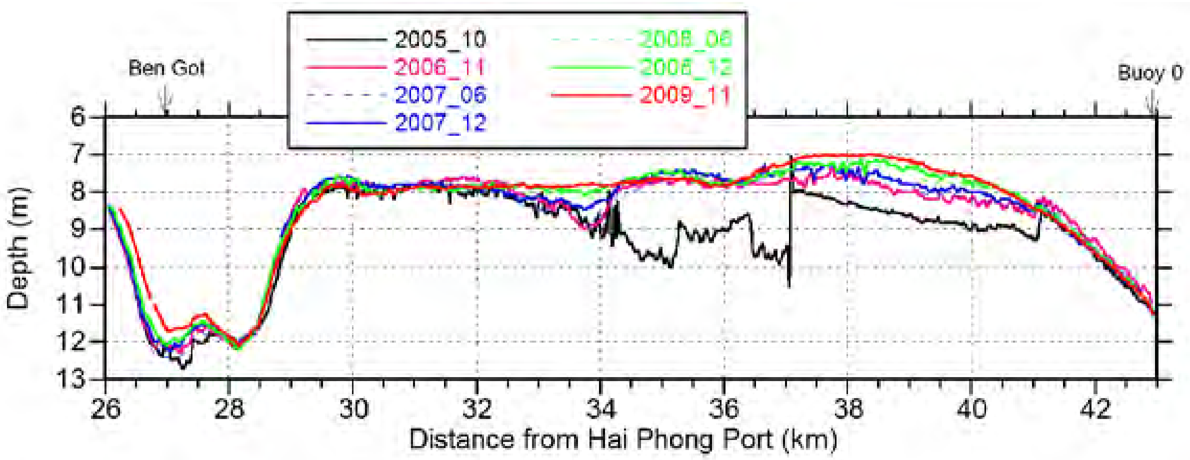


Figure 8.1.17 Longitudinal cross-section along the channel including the data of October 2005

8.2 Numerical Simulation

8.2.1 General

In order to predict sedimentation in Lach Huyen channel, numerical simulations have been carried out. As seen in the results of sediment sampling, very fine material of silt or clay is deposited in the bottom of the channel. Therefore, the sedimentation in Lach Huyen channel is supposed to be induced by siltation. The siltation is a phenomenon that the cohesive sediment such as silt and clay is moved up from the seabed by waves and currents and flows into channel bottom. As the cohesive sediment is typically transported as suspended load, the advection-diffusion sediment transport model is applied to simulate the sedimentation.

In Lach Huyen area, tidal range is approximately 3.5m and the tidal current flows along the channel. In particular, the area between Ben Got and Cat Ba island, the entrance of Lach Huyen estuary, is locally deep in depth because of the strong tidal currents usually occurs. Also, waves from south to south-east often attack the area, agitating the mud on the sea bed into suspension. Actually, on the date when the survey team carried out the cylinder sampling of sediment, waves were about 1 - 1.5 m in height and the color of sea water was yellow everywhere the area due to suspended mud. Therefore, it is considered that the main factor for sedimentation in Lach Huyen channel is mud transport due to waves and currents. The simulations in this study described below treats the mud transport due to waves and currents. It is considered that river discharge is also important in rainy season, but it is not included in the simulations because the no seasonal effects appeared in the sedimentation speed analyzed in previous section, and the river discharge of Chanh river which directly flows into Lach Huyen estuary is small.

8.2.2 Methodology

In this study, mud transport due to waves and currents has been calculated to estimate the sedimentation of the channel. Waves, currents, and sediment transport are calculated by using the following numerical models. The outline of the models is summarized below.

1) Wave transformation model

For numerical analysis of wave transformation, the energy balance equation with addition of the wave diffraction term and the energy dissipation term by breaking is employed. The basic equation of the model is written as,

$$\frac{\partial}{\partial x}(SV_x)+\frac{\partial}{\partial y}(SV_y)+\frac{\partial}{\partial \theta}(SV_\theta)=\frac{\kappa}{2\sigma}\left\{(cc_g\cos^2\theta S_y)_y-\frac{1}{2}cc_g\cos^2\theta S_{yy}\right\}-\varepsilon_b S \qquad (8.1)$$

where, $S(f,\theta)$ is the directional wave spectral density, (x,y) are the horizontal coordinates, θ the wave direction measured counterclockwise from the x axis, ε_b the coefficient of energy dissipation, and the characteristic velocities, (V_x, V_y, V_θ), are defined as follows:

$$V_x = c_g\cos\theta \qquad (8.2)$$

$$V_y = c_g\sin\theta \qquad (8.3)$$

$$V_\theta = \frac{c_g}{c}\left(\frac{\partial c}{\partial x}\sin\theta-\frac{\partial c}{\partial y}\cos\theta\right) \qquad (8.4)$$

where c is the wave celerity and c_g the group velocity. The first term in the right side of Eq.(8.1) is the additional term for representing wave diffraction, where σ is the wave angular frequency and κ is the coefficient to optimize the degree of diffraction, the typical value of which is 2.5.

2) Current model

The numerical model for current simulation is based on a finite-difference numerical representation of the two-dimensional (2-D) depth-integrated continuity and momentum equations of water motion. Cells are defined on a staggered and rectilinear grid. Momentum equations are solved in a time-stepping manner first, followed by solution of the continuity equation, in which the updated velocities calculated by the momentum equations are applied.

The governing equations of the 2-D, depth-integrated continuity and momentum equations are:

$$\frac{\partial(h+\eta)}{\partial t}+\frac{\partial Q_x}{\partial x}+\frac{\partial Q_y}{\partial y}=0 \quad (8.5)$$

$$\frac{\partial Q_x}{\partial t}+\frac{\partial(UQ_x)}{\partial x}+\frac{\partial(VQ_x)}{\partial y}=-g(h+\eta)\frac{\partial\eta}{\partial x}+\frac{\partial}{\partial x}\left(D_x\frac{\partial Q_x}{\partial x}\right)+\frac{\partial}{\partial y}\left(D_y\frac{\partial Q_x}{\partial y}\right)+fQ_y-\frac{\tau_{bx}}{\rho_w}+\frac{\tau_{Sx}}{\rho_w} \quad (8.6)$$

$$\frac{\partial Q_y}{\partial t}+\frac{\partial(UQ_y)}{\partial x}+\frac{\partial(VQ_y)}{\partial y}=-g(h+\eta)\frac{\partial\eta}{\partial y}+\frac{\partial}{\partial x}\left(D_x\frac{\partial Q_y}{\partial x}\right)+\frac{\partial}{\partial y}\left(D_y\frac{\partial Q_y}{\partial y}\right)-fQ_x-\frac{\tau_{by}}{\rho_w}+\frac{\tau_{Sy}}{\rho_w} \quad (8.7)$$

where t is the time, (x,y) are the horizontal coordinates, η is the water surface elevation, U is the depth-averaged velocity in x-direction, V is the depth-averaged velocity in y-direction, η is the water depth, (Q_x,Q_y) are the flow rate per unit width in x- and y-direction, g is the gravitational acceleration, (D_x,D_y) are horizontal diffusion coefficients, ρ_w is the water density, f is the Coriolis parameter, $(\tau_{bx}$, $\tau_{by})$ are the bottom stress parallel to x- and y-axis, and $(\tau_{Sx}$, $\tau_{Sy})$ are the wave stress parallel to x- and y-axis.

3) Sediment transport and morphology change

The mud transport is usually treated as suspended load, the basic equation of which is the advection-diffusion equation of sediment concentration written as,

$$\frac{\partial C}{\partial t}+\frac{\partial CUh}{\partial x}+\frac{\partial CVh}{\partial y}=\frac{\partial}{\partial x}\left(K_x h\frac{\partial C}{\partial x}\right)+\frac{\partial}{\partial x}\left(K_y h\frac{\partial C}{\partial y}\right)+(E-D) \quad (8.8)$$

where C is the depth-averaged concentration, $(U\ ,V\ )$ is the depth-averaged horizontal velocity in x- and y-direction, h is the water depth, (K_x, K_y) is the horizontal diffusion coefficients in x- and y-direction, E is the erosion rate, and D is the deposition rate (= $C_b w_f$, C_b is the bottom concentration and w_f is the sediment falling velocity). The erosion rate is estimated as,

$$E=M\left(\frac{\tau-\tau_{cr}}{\tau_{cr}}\right) \quad (8.9)$$

where τ is the bed shear stress, τ_{cr} is the critical shear stress for erosion, and M is the empirical coefficient (kg/m^2/s). Eq. (8.8) is solved on the concentration, C, by using the calculated velocities and bed shear stress.

The bed shear stress for sediment transport is estimated by sediment grain size and local forcing conditions. In the present model, the following formula proposes by Soulsby (1997) is used. The maximum shear stress under wave and current motion is,

$$\tau_{\max s}=\sqrt{(\tau_{ms}+\tau_{ws}\cos\phi)^2+(\tau_{ws}\sin\phi)^2} \quad (8.10)$$

where τ_{ms} is the mean shear stress defined as,

$$\tau_{ms} = \tau_{cs}\left[1 + 1.2\left(\frac{\tau_{ws}}{\tau_{cs} + \tau_{ws}}\right)^{3.2}\right] \tag{8.11}$$

ϕ is the angle between directions of wave and current. τ_{cs} and τ_{ws} are the shear stress due to current and wave, respectively.

$$\tau_{cs} = \frac{1}{2}\rho_w f_c |U|^2 \tag{8.12}$$

$$\tau_{ws} = \frac{1}{2}\rho_w f_w u_w^2 \tag{8.13}$$

Here, $|U|$ is the current speed ($= \sqrt{U^2 + V^2}$), u_w is the wave orbital velocity amplitude, f_c and f_w are the friction factor and defined as,

$$f_c = 2\left[\frac{\kappa}{1 + \ln(k_s/30d)}\right]^2 \tag{8.14}$$

$$f_w = \exp\left[-5.977 + 5.213\left(\frac{A_w}{k_s}\right)^{-0.194}\right] \qquad \mathit{for}\ \frac{A_w}{k_s} > 1.57$$

$$f_w = 0.3 \qquad \mathit{for}\ \frac{A_w}{k_s} < 1.57 \tag{8.15}$$

where κ is the Karman constant, d is the total depth ($= h + \eta$), A_w is the orbital diameter by wave ($= u_w T/\pi$), k_s is the roughness height estimated as $k_s = 2.5D$, and D is the sediment grain size. The shear stress τ in Eq.(8.8) is estimated as $\tau_{\max s}$ of Eq.(8.10).

The bed level change is calculated by the sediment continuity equation written as,

$$\frac{dh}{dt} = \frac{1}{1-\lambda}\left(\frac{\partial q_x}{\partial x} + \frac{\partial q_y}{\partial x}\right) = \frac{1}{1-\lambda}(E - D) \tag{8.16}$$

where λ is the sediment porosity, and (q_x, q_y) are the sediment transport rate in x- and y-direction.

8.2.3 Model setup

1) Computational domain

For numerical simulations of wave, current, and topography change, a computational domain was prepared based on chart data of Hai Phong area and bathymetric survey data around the channel. The topography maps of computational domain are shown in Figure 8.2.1 and Figure 8.2.2. As shown in the figure, two computational domains were prepared. The large domain consists of 500 x 500 m cells and the small one consists of 50 x 50 m cells. The Lach Huyen channel is located center parallel to the y-axis in the figure.

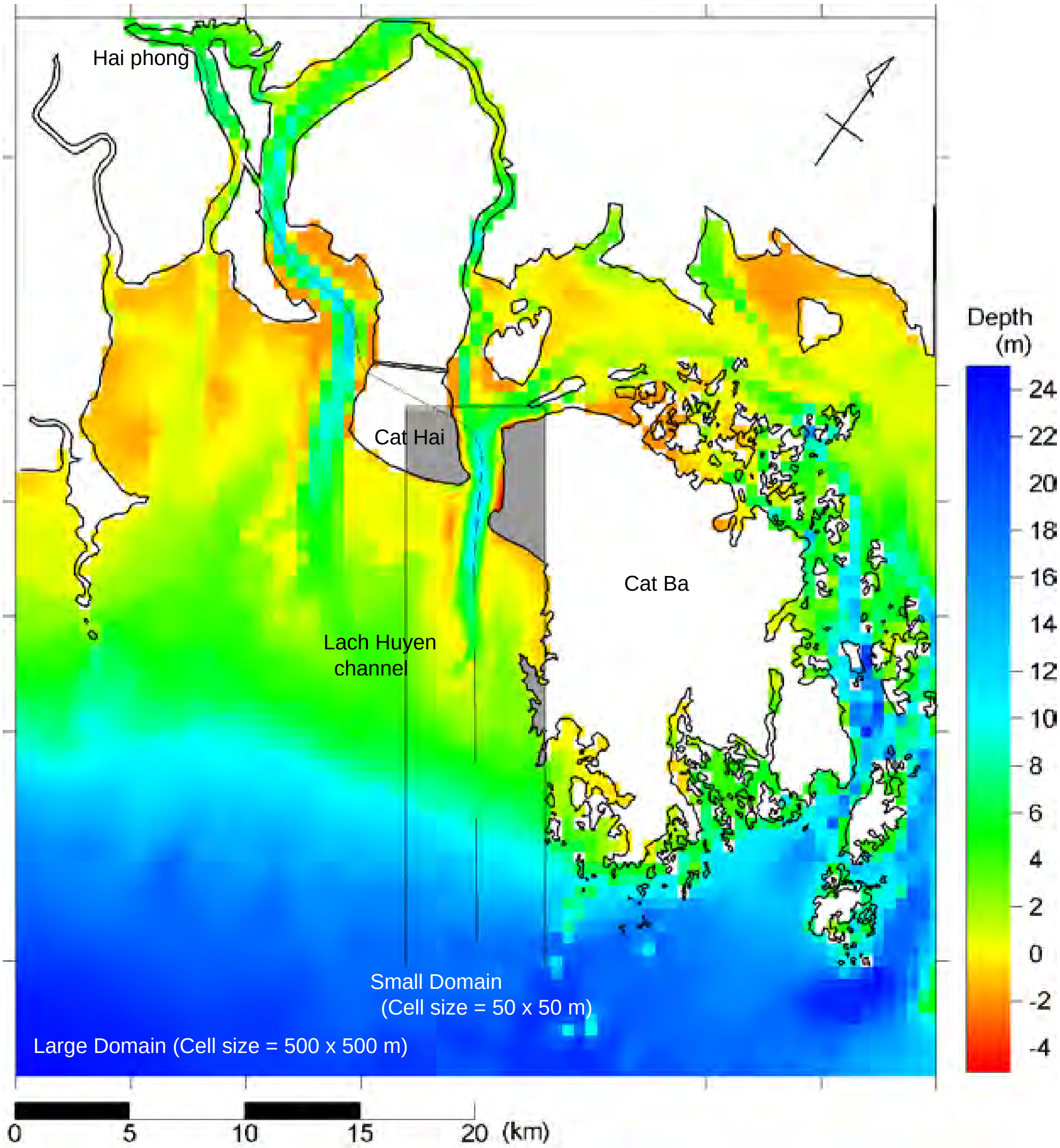


Figure 8.2.1 Topography data for tidal current simulation (Large domain)

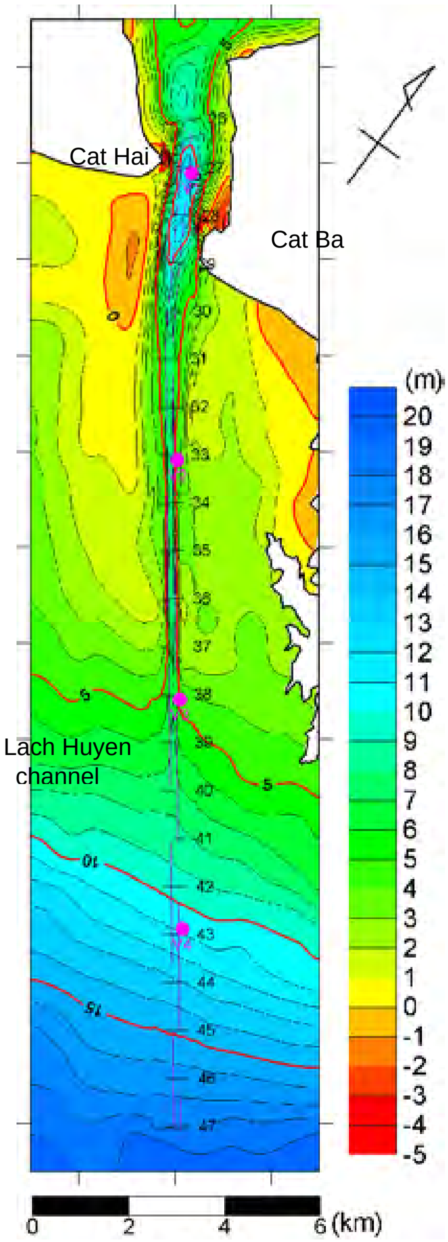


Figure 8.2.2 Topography data for numerical simulation (Small domain)

2) Computational conditions

a) Water surface elevation

To compute tidal currents, time series of water surface elevation is needed for boundary condition. In this study, the water surface elevation for boundary condition is calculated by NAO.99b tidal prediction system developed by Matsumoto et. al. (2000) [1]. Figure 8.2.3 is an example of the predicted tide by the NAO.99b at the location of 107°00’00’’E and 20°30’00’’N.

The time series of water surface elevation is used as the boundary condition for the large computational domain. The boundary condition for the small domain is given by the output of simulation with the large domain.

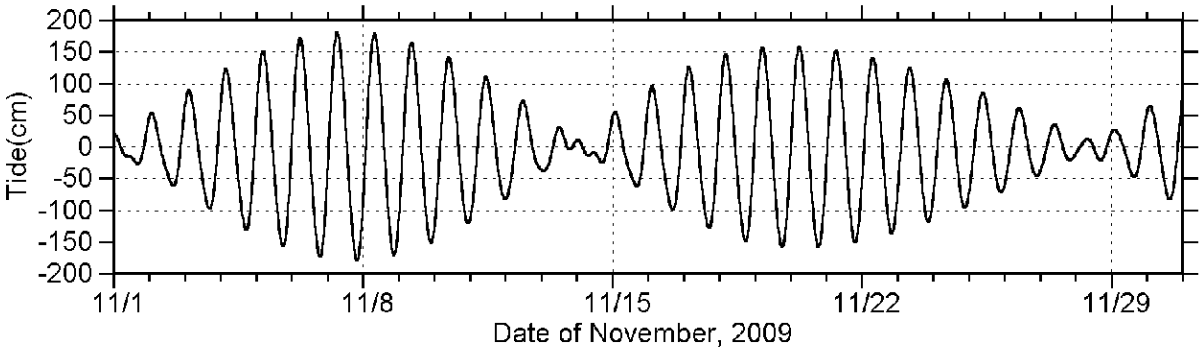


Figure 8.2.3 Time series of water surface elevation set as boundary condition

b) Incident wave

To compute wave transformation, properties of offshore wave height, period, and direction are needed. In this study, energy-averaged wave is used for the representative wave. The energy-averaged wave is calculated by using the joint frequency of wave height and direction as shown in Table 8.2.1. According to the FS-report by TEDI, the data in the table are based on long term observation of 1961 to 1983 at Hon Dau station.

The energy averaged wave height is calculated as,

$$H_e = \frac{\sum p_i (H_i^2 T_i)}{\sum p_i T_i} = 0.95 \text{ (m)}$$

where p_i is the probability of occurrence in the rank i of wave height, H_i is the wave height of rank i, and T_i is the wave period in the rank i. The wave period of the energy-averaged wave is obtained by the relation between wave height and period of T=1.5539H+3.9222.

$$T_e = 5.4 \text{ (sec.)}$$

[1] Matsumoto, K., T. Takanezawa, and M. Ooe (2000), Ocean Tide Models Developed by Assimilating TOPEX/POSEIDON Altimeter Data into Hydrodynamical Model: A Global Model and a Regional Model Around Japan, Journal of Oceanography, 56, 567-581

The probability of appearance in wave direction is shown in Figure 8.2.4. As shown in the figure, the dominant wave direction is E to S, but high waves seem much prevail from SE and S directions. As Lach Huyen channel is sheltered by Cat Ba Island against waves from E-direction, the wave from S direction is considered as the representative wave that affects sedimentation in the channel.

The probability of non-exceedance of wave height is shown in Figure 8.2.5. The probability of non-exceedance for the energy averaged wave is approximately 70 %.

Table 8.2.1 Joint frequency of wave height and direction based on data observed at Hon Dau 1961-1983

Dir / Height(m)	N	NE	E	SE	S	SW	W	NW	Total	Probability of non-exceedance (%)
0-0.25									4281 (18.046)	18.05
0.25-0.5	221 (0.932)	178 (0.750)	544 (2.293)	785 (3.309)	197 (0.830)	38 (0.160)	30 (0.126)	47 (0.198)	2040 (8.599)	26.65
0.50-0.75	647 (2.727)	757 (3.191)	1988 (8.380)	2399 (10.113)	722 (3.043)	181 (0.763)	42 (0.177)	117 (0.493)	6853 (28.888)	55.53
0.75-1.00	344 (1.450)	421 (1.775)	1300 (5.480)	1219 (5.138)	498 (2.099)	131 (0.552)	7 (0.030)	23 (0.097)	3943 (16.621)	72.15
1.00-1.50	310 (1.307)	376 (1.585)	1524 (6.424)	1263 (5.324)	1092 (4.603)	357 (1.505)	11 (0.046)	18 (0.076)	4951 (20.870)	93.02
1.50-2.00	45 (0.190)	75 (0.316)	355 (1.496)	291 (1.227)	444 (1.872)	135 (0.569)	4 (0.017)	1 (0.004)	1350 (5.691)	98.71
2.00-2.50	12 (0.051)	11 (0.046)	46 (0.194)	56 (0.236)	81 (0.341)	22 (0.093)	1 (0.004)	1 (0.004)	230 (0.970)	99.68
2.50-3.00	3 (0.013)	2 (0.008)	11 (0.046)	13 (0.055)	7 (0.030)	3 (0.013)		2 (0.008)	41 (0.173)	99.86
3.00-3.50			6 (0.025)	6 (0.025)	6 (0.025)	3 (0.013)		1 (0.004)	22 (0.093)	99.95
3.50-4.00			2 (0.008)	1 (0.004)					3 (0.013)	99.96
4.00-5.00										
5.00-6.00										
6.00-7.00										
7.00-8.00										
8.00-9.00				3 (0.013)	1 (0.004)	2 (0.008)			6 (0.025)	99.99
9.00-10.0			1 (0.004)		1 (0.004)	1 (0.004)			3 (0.013)	100.00
>10.00										
Total	1582 (6.669)	1820 (7.672)	5777 (24.352)	6036 (25.444)	3049 (12.853)	873 (3.680)	95 (0.400)	210 (0.885)	23723	

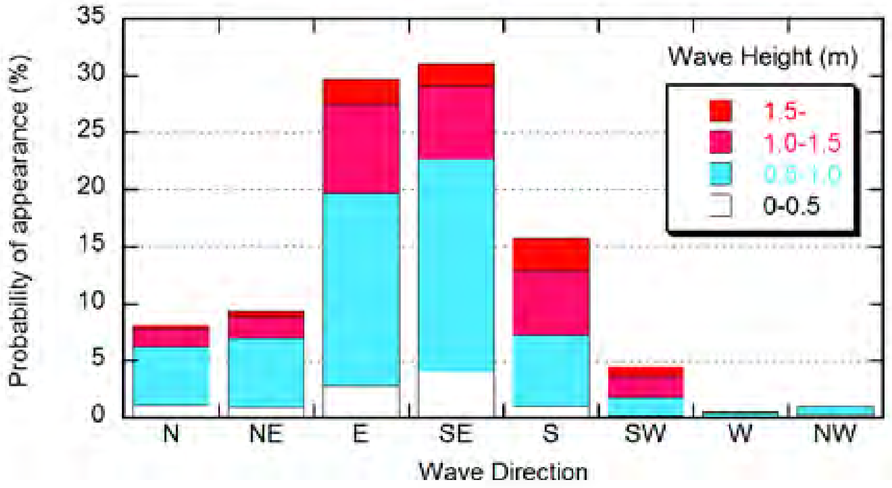


Figure 8.2.4 Probability of appearance in wave direction

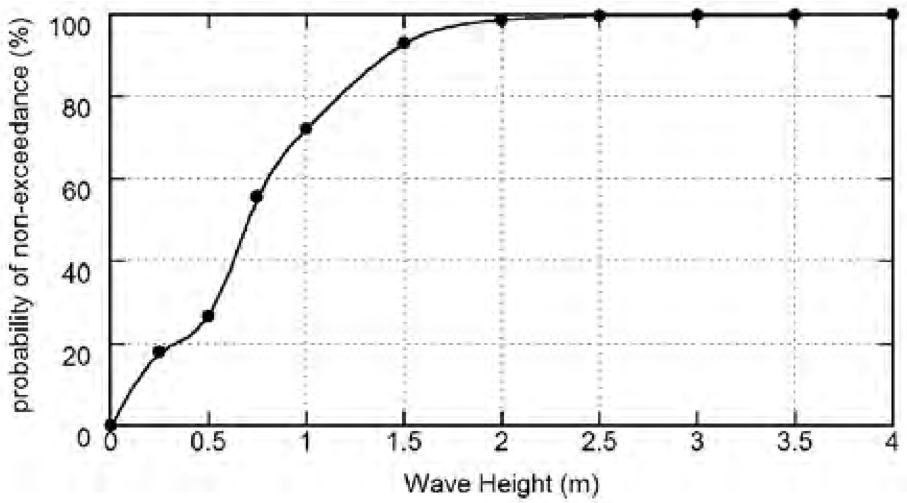


Figure 8.2.5 Probability of non-exceedance of wave height

c) Sediment property

As described in 8.1.2, most of sediment around Lach Huyen channel is silt and clay. For sedimentation simulation, sediment with 22 μm in particle size and 2680 kg/m3 in density is used as the representative sediment. According to the Stokes formula, the settling velocity of the particle is 0.39 mm/s in 20 degrees of water temperature.

8.2.4 Sedimentation simulation on the present situation

To verify and calibrate the numerical models, numerical simulations have been carried out on the present situation. The target of reproduction is the sedimentation speed along the channel as shown in 8.1.3, which is the averaged sedimentation speed after second year shown in Figure 8.2.16.

1) Tidal current

An example of tidal current simulations is shown below. Figure 8.2.6 shows vector maps of ebb and flood tidal current on a spring tide. As shown in the figure, the main direction of the current is along the channel, and the strong current occurs near the narrowest area between Ben Got and Cat Ba island.

Figure 8.2.7 and Figure 8.2.8 show the comparison between measured and calculated current velocities at 4 points. The current survey was carried out by multi-layer measurement, and the result indicated no stratification in the tidal currents. Therefore, the comparison is made by the depth-averaged current velocity. From the figures, the calculated current velocities are slightly under estimation compared to the measurements, but give reasonable results.

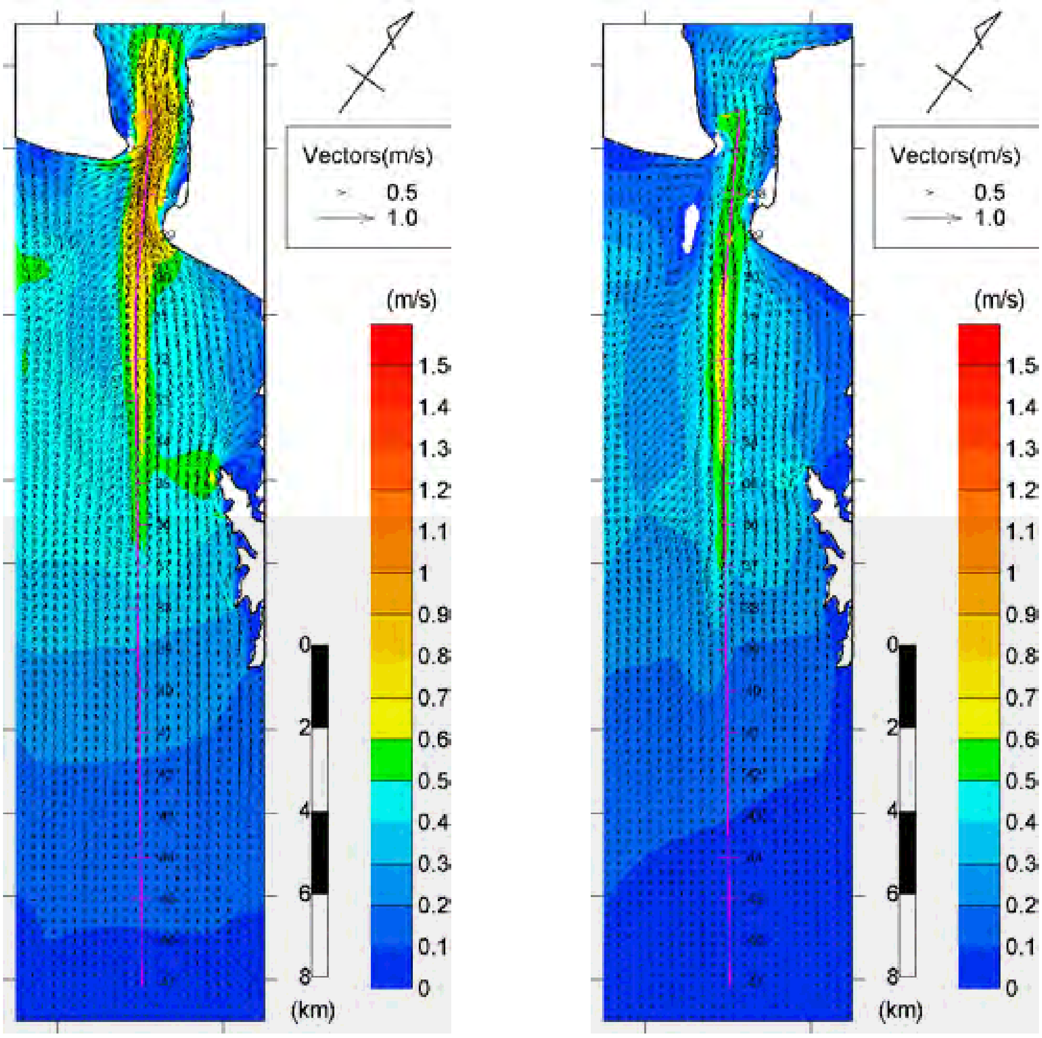


Figure 8.2.6 Flood and ebb tidal current on spring tide (11/7 2:00 11/7 16:00)

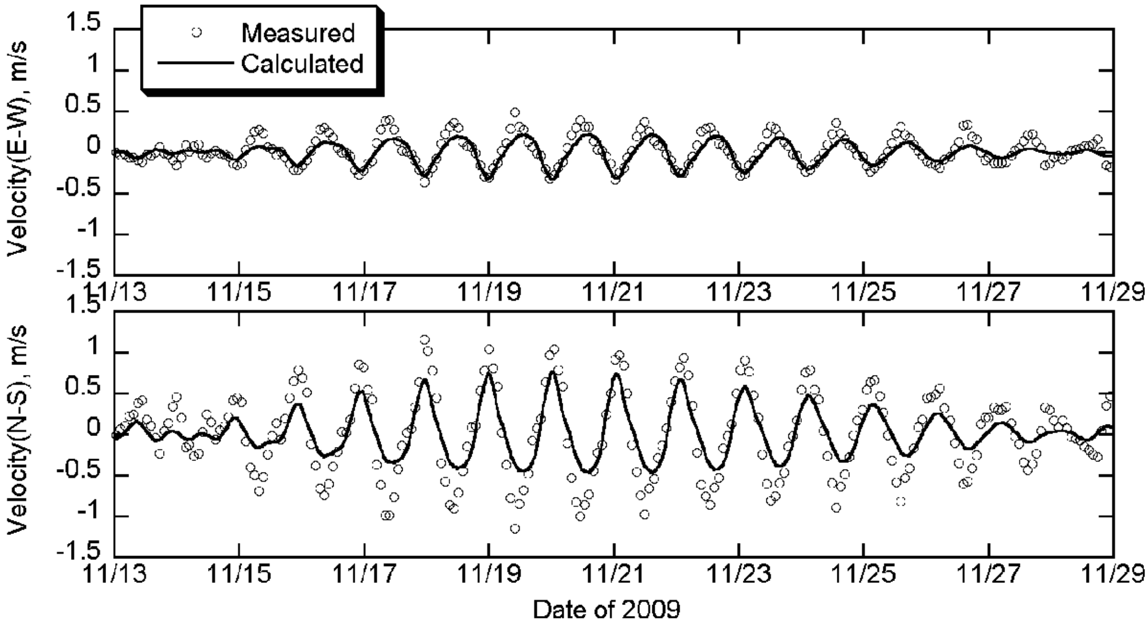


Figure 8.2.7 Comparison between measured and calculated tidal currents (Station V1)

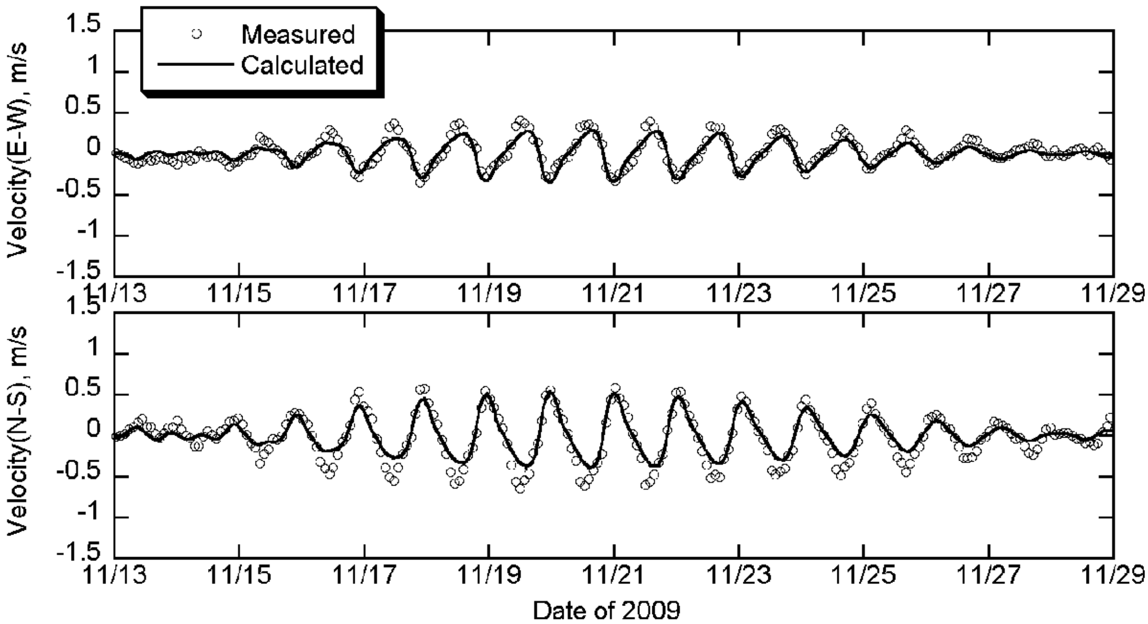


Figure 8.2.8 Comparison between measured and calculated tidal currents (Station V2)

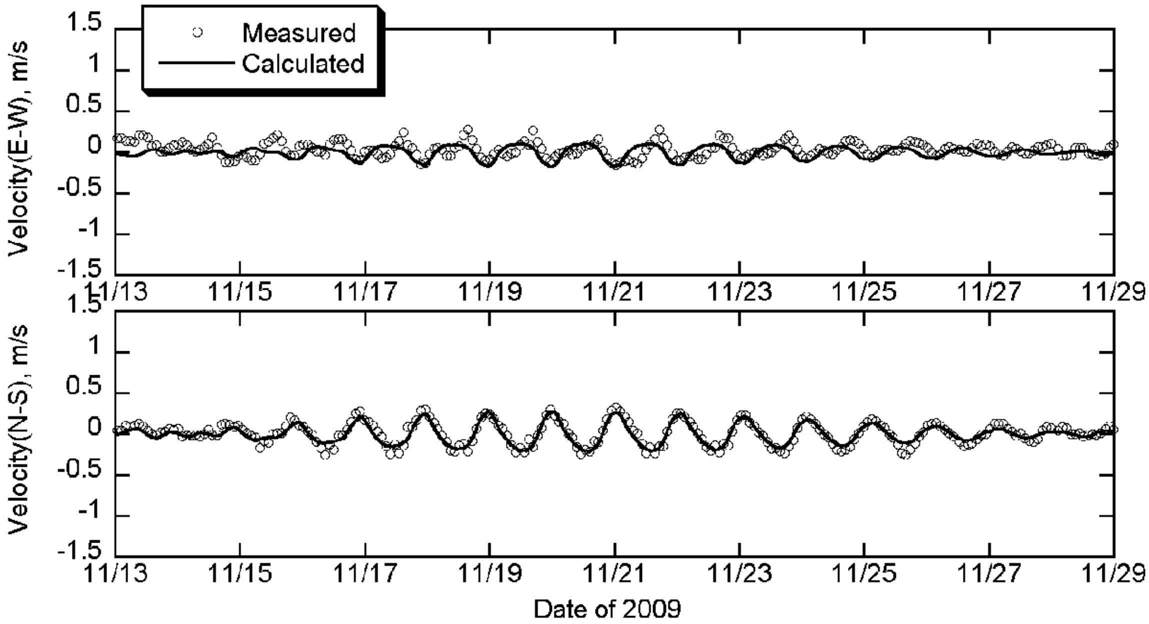


Figure 8.2.9 Comparison between measured and calculated tidal currents (Station V3)

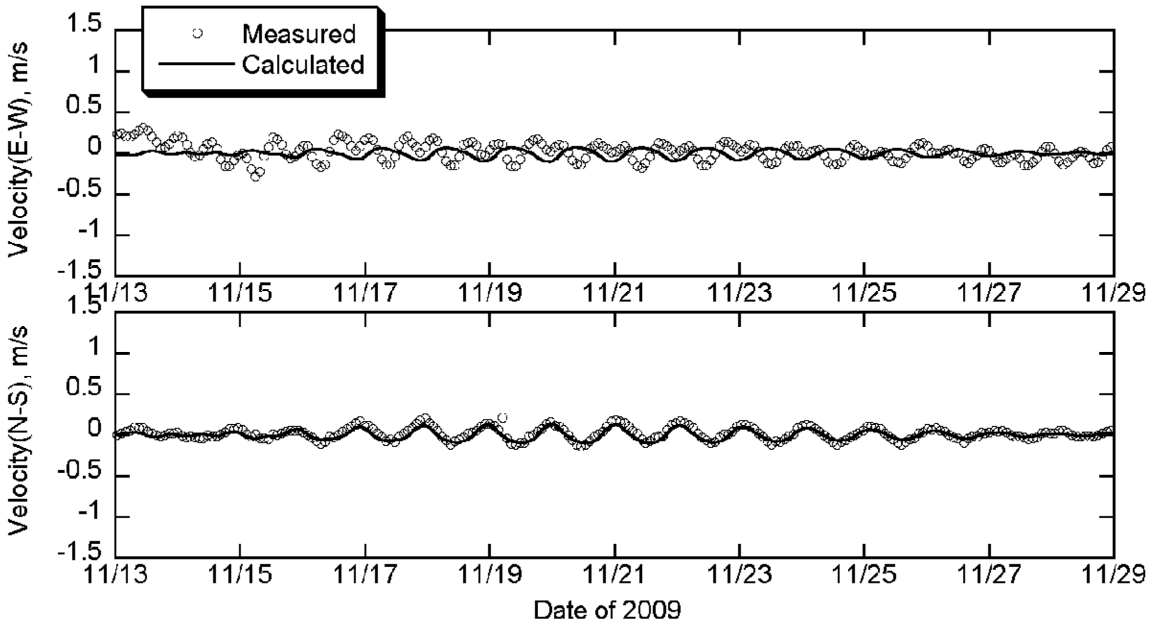


Figure 8.2.10 Comparison between measured and calculated tidal currents (Station V4)

2) Wave transformation

Wave is the one of the most important factor for sedimentation because the strong shear stress due to high waves moves sediments up into suspension. The suspended sediments are transported by currents such as tidal current or wave-induced currents and settle down on the locations which the bed shear stresses become weak.

The numerical analysis of wave transformation is presented here. Waves incident to Gulf of Tonkin change their heights and directions due to the refraction phenomenon in response to the bathymetric change within the Gulf. Behind the islands, waves are further transformed by the diffraction phenomenon. As waves come near to the shore, waves are attenuated by breaking.

The selected representative waves is the energy-averaged waves of H_0 = 0.95 m with the period of T= 5.4 s, where the wave height is defined in terms of significant height. The computed wave distributions are shown in Figure 8.2.11. In the figure, wave height and direction are shown with respect to incident wave directions of E, ESE, SE, SSE, S, and SSW.

As seen in the figure, the wave height around the access channel is relatively low when the incident wave direction is E or ESE, while the one is relatively high in SSE or S. In the figure of S in wave direction, waves show a certain degree of concentration along the channel, in particular left side of the channel. The concentration of waves at the location is considered due to existence of a shoal developed at south-east of Cat Hai island. Along the channel, wave height gradually decreases from offshore to onshore, and waves do not penetrate inside the Lach Huyen estuary beyond the narrow section.

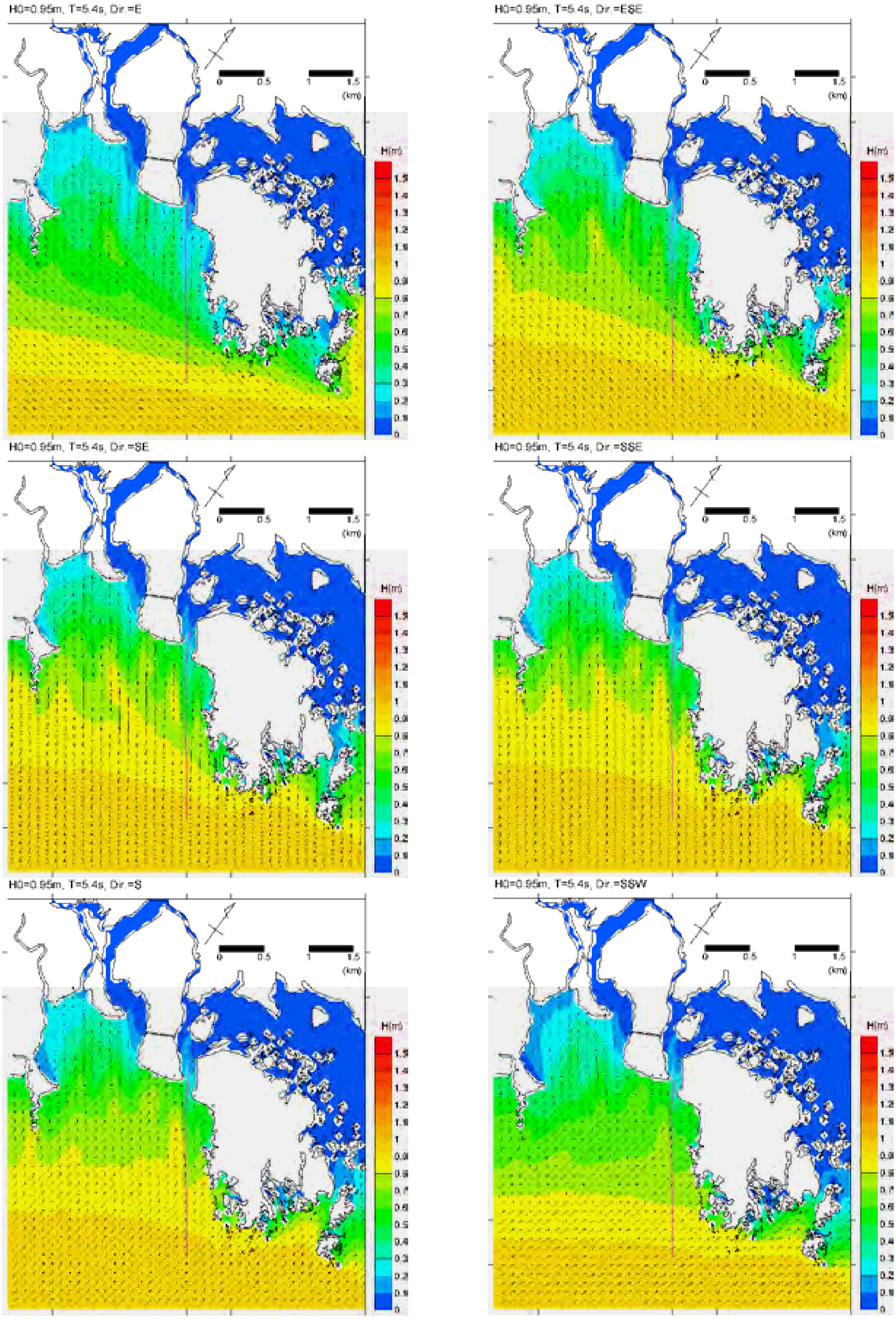


Figure 8.2.11 Calculated wave height and direction with respect to incident wave directions of E to SSW

3) Sedimentation process

On the present situation of Lach Huyen channel, sedimentation due to tidal current alone and that due to wave plus tidal current were calculated to examine the each effect on the sedimentation. Both calculations were conducted for the 15 days sedimentation including neap and spring tide. Also, on the case of wave plus tidal current, the energy averaged wave of 0.95 m in height, 5.4 s in period, and S in wave direction is given with the variation of tide level. Figure 8.2.12 shows the resultant depth change for 15 days on the center line of Lach Huyen channel.

As shown in the figure, it is seen that erosion is occurred in case of tide alone, whereas significant accretion in case of tide plus wave. The results indicate that wave is dominant for the sedimentation in Lach Huyen channel. Figure 8.2.13 shows the calculated suspended concentration in case of tide alone and that of tide plus wave. In case tide plus wave, the suspended mud with high concentration is distributed around Lach Huyen channel, while low concentration in case tide alone. The result also indicates that a large amount of suspended mud flows into the channel when high wave comes.

As described in 8.1.3, the results of analysis of bathymetric survey data indicate that sedimentation is significant in the area from Km36 to the offshore and slight erosion has been occurred in the area of Km28 to Km32. The erosion in the area of Km28 to Km32 is explained as the effect that the strong tidal current flushes the sediment out as shown in the top of Figure 8.2.13. As the mud of silt and clay widely distributed in the area, the sediment flowing into the channel at high wave is almost mud, the settling velocity of which is very slow. In addition, the suspended mud forms so-called fluid mud in the deposition process when waves become calm. The fluid mud is high concentration layer near the channel bottom and it takes much time to completely consolidate. Therefore, the fluid mud is easy to re-suspend, moves along the channel with tidal current, and finally settle down at the location where the shear stress due to current is very weak, that is, the offshore part of the channel.

Figure 8.2.14 shows the longitudinal profile of the channel, net depth change based on the survey in November 2006, and the bed shear stress averaged 15 days of tidal current simulation. From the figure, the characteristics of sedimentation seem to deeply relate to the averaged shear stress. The averaged shear stress is greater than 0.06 N/m2 in the onshore area of Km32 and no sedimentation has occurred. Also, the peak of sedimentation is appeared around Km39, where another peak around Km34 can be negligible because the depth of November 2006 is locally deep, and the shear stress is less than 0.015 N/m^2 in the offshore area of Km39.

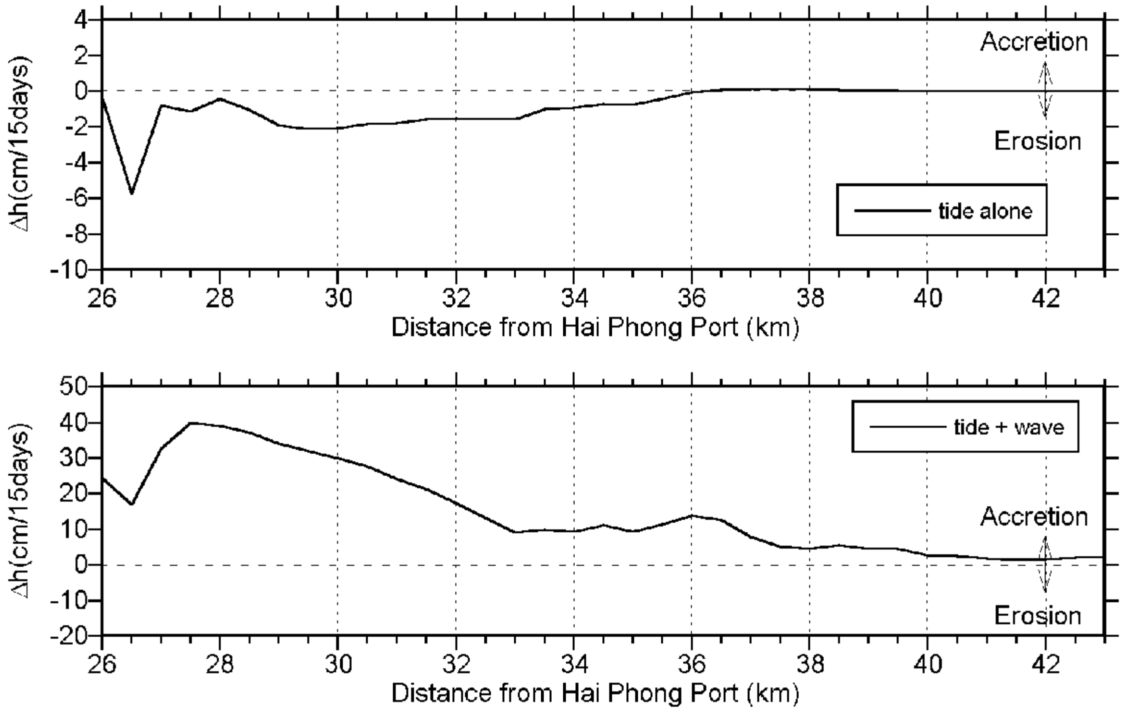


Figure 8.2.12 Simulated net depth change on the center line of the channel. (Top=tide alone. Bottom=tide + wave)

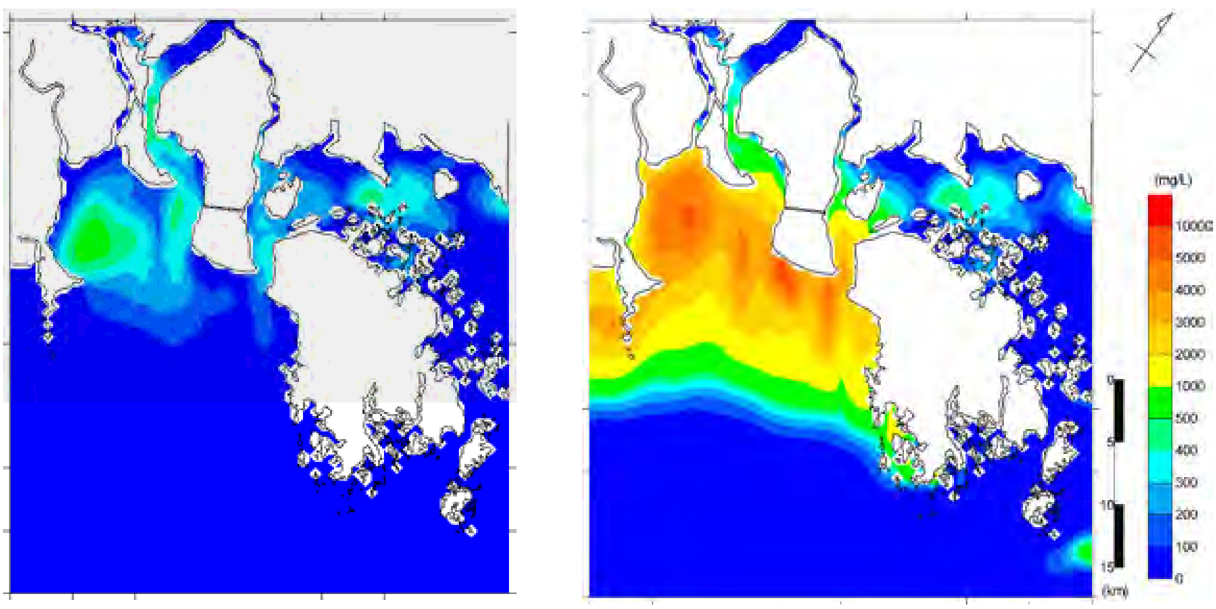


Figure 8.2.13 Concentration at maximum flood current (Left=tide alone, Right=tide + wave)

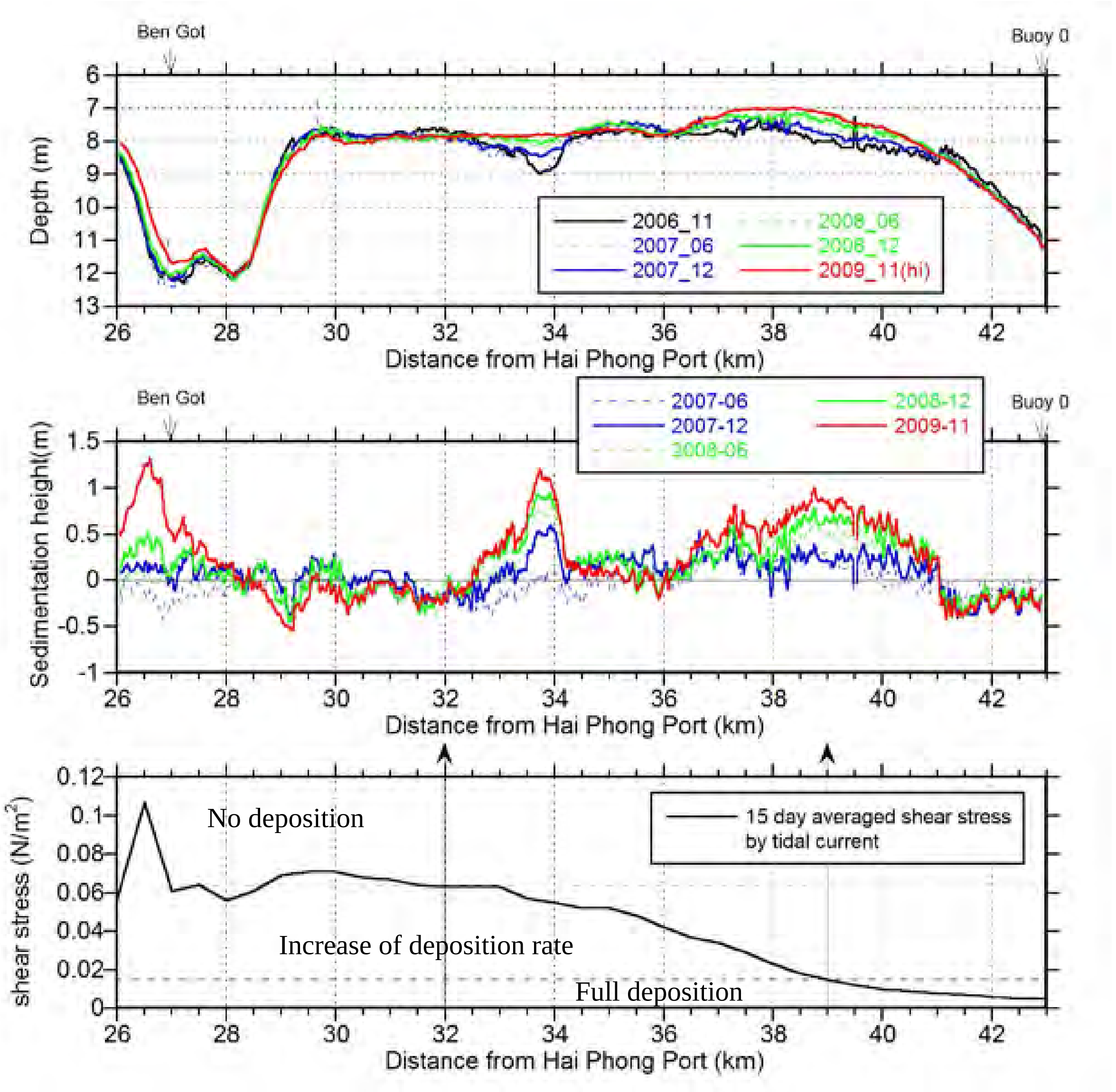


Figure 8.2.14 Longitudinal profile of the channel (top), net depth change based on the survey of November 2006, and 15 day averaged shear stress estimated by tidal current simulation

4) Reproduction of the sedimentation speed

As shown in the previous section, both tidal current and wave affect on the sedimentation process in Lach Huyen channel. In this study, to reproduce actual sedimentation speed along the channel, both simulation results are combined as follows,

$$V_{sed} = \alpha \times \Delta h_t + \beta \times \Delta h_{tw} \times P \qquad (8.17)$$

where V_{sed} is the sedimentation speed (m/year), Δh_t is the net depth change of 15 days simulated with tide alone, Δh_{tw} is the net depth change of 15 days simulated with tide plus wave, α is the coefficient determined by probability of appearance of calm days, β is the coefficient determined by ratio between the total wave energy flux a year and total wave energy flux acted in the simulation, and P is the probability of sediment to deposit and defined as,

$$P = \begin{cases} 1.0 & for\ \bar{\tau} < \tau_{cd} \\ 1-(\bar{\tau}-\tau_{cd})/(\tau_{ce}-\tau_{cd}) & for\ \tau_{cd} < \bar{\tau} < \tau_{ce} \\ 0.0 & for\ \bar{\tau} > \tau_{ce} \end{cases} \quad (8.18)$$

where $\bar{\tau}$ is the 15 day averaged bed shear stress due to tidal current, τ_{cd} is the critical shear stress for full deposition, and τ_{ce} is the critical shear stress for no deposition. The τ_{cd} and τ_{ce} are determined as τ_{cd} =0.015 N/m^2 and τ_{ce} =0.06 N/m^2 by the relation between the actual sedimentation and $\bar{\tau}$ as shown in Figure 8.2.14. The change in P with respect to $\bar{\tau}$ is shown in Figure 8.2.15. The parameter functions as to reproduce the phenomenon that no deposition occurs where the tidal current is strong and deposition occurs where the tidal current is weak.

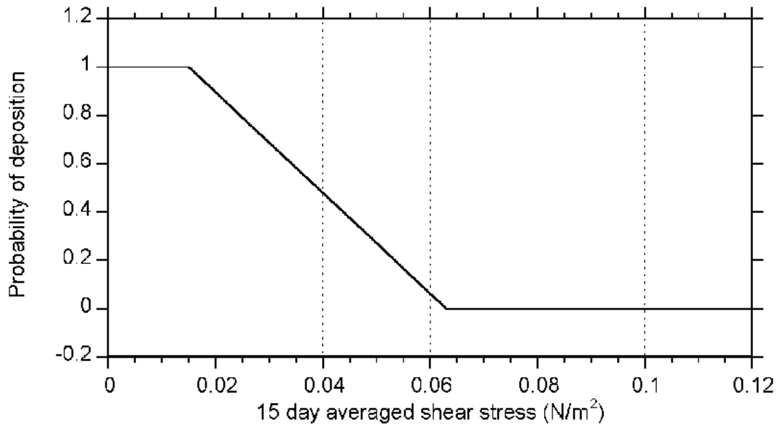


Figure 8.2.15 Probability of deposition

The sedimentation speed estimated by the above method is shown in Figure 8.2.16. In the figure, the case with present topography (Case 1) and the case with smoothed topography of 8 m in the channel depth are shown and compared to the measured data. From the figure, it is confirmed that the estimated sedimentation speed well reproduces the sedimentation pattern along the channel such as slight erosion in the area of Km29-33 and accretion in the offshore area of the channel.

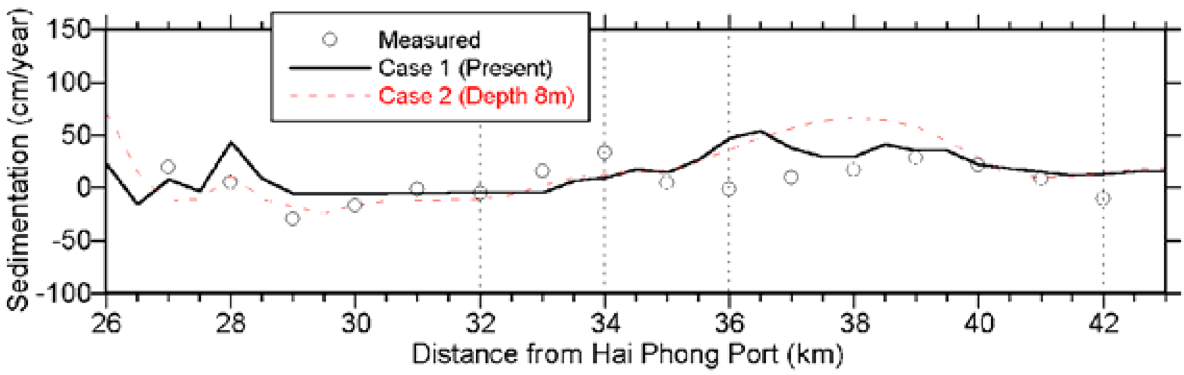


Figure 8.2.16 Comparison between measured and computed sedimentation speed with present topography (Case 1) and the smoothed topography with 8 m in depth (Case 2)

8.2.5 Numerical prediction of future sedimentation

In Lach Huyen channel, channel deepening and widening are planned with the development of the new port facilities. In general, channel deepening will induce further sedimentation and affect smooth port operation. According to the FS-report by TEDI, the sand protection dike of 7,000m along the channel is proposed to reduce the sedimentation. In this study, therefore, numerical simulations of future sedimentation have been carried out to predict volume of sedimentation and to examine reasonable position and length of the sand protection dike.

1) Prediction cases

The cases of numerical simulations are tabulated in Table 8.2.2. The each case contains two simulations which the forcing condition is different, and the sedimentation speed is estimated by the method described in the previous section. The case 1 and 2 are the cases of present situation with about 8 m in channel depth and 100 m in channel width. The cases have been already shown in the previous section in which the reproduction is verified.

The results of case 3 through 7b are presented in this section for the predictions of future sedimentation. The planning depth of the channel is 14 m and the width is 160 m in the area of Km27 to Km36 and 210 m from Km36 to the offshore. The three locations of the sand protection dike are examined in case 5 through 7. The locations of the dike, which are referred as Dike 1, Dike 2, and Dike 3 are shown in Figure 8.2.17. In simulations of case 5, 6, and 7, the sand protection dike is treated as an impermeable wall and in case 7b, the crown height of the dike is set to + 2.0 m, which is the same level as M.W.L., and allows the transmission of wave, current, and sediment transport across the dike when the water level is higher than M.W.L.

Table 8.2.2 List of prediction cases

Case	Channel depth	Forcing Condition	Realization Duration	Port facility / Protection measures
1	7.5m	Tide alone	15 days	None / None, Present situation
		Tide + Wave	15 days	
2	8.0m	Tide alone	15 days	None / None, the smoothed channel bottom with 8m in depth.
		Tide + Wave	15 days	
3	14.0m	Tide alone	15 days	None / None
		Tide + Wave	15 days	
4	14.0m	Tide alone	15 days	Port / None
		Tide + Wave	15 days	
5	14.0m	Tide alone	15 days	Port / Dike1
		Tide + Wave	15 days	
6	14.0m	Tide alone	15 days	Port / Dike2
		Tide + Wave	15 days	
7	14.0m	Tide alone	15 days	Port / Dike3
		Tide + Wave	15 days	
7b	14.0m	Tide alone	15 days	Port / Dike3 with the crown height of + 2.0m C.D.
		Tide + Wave	15 days	

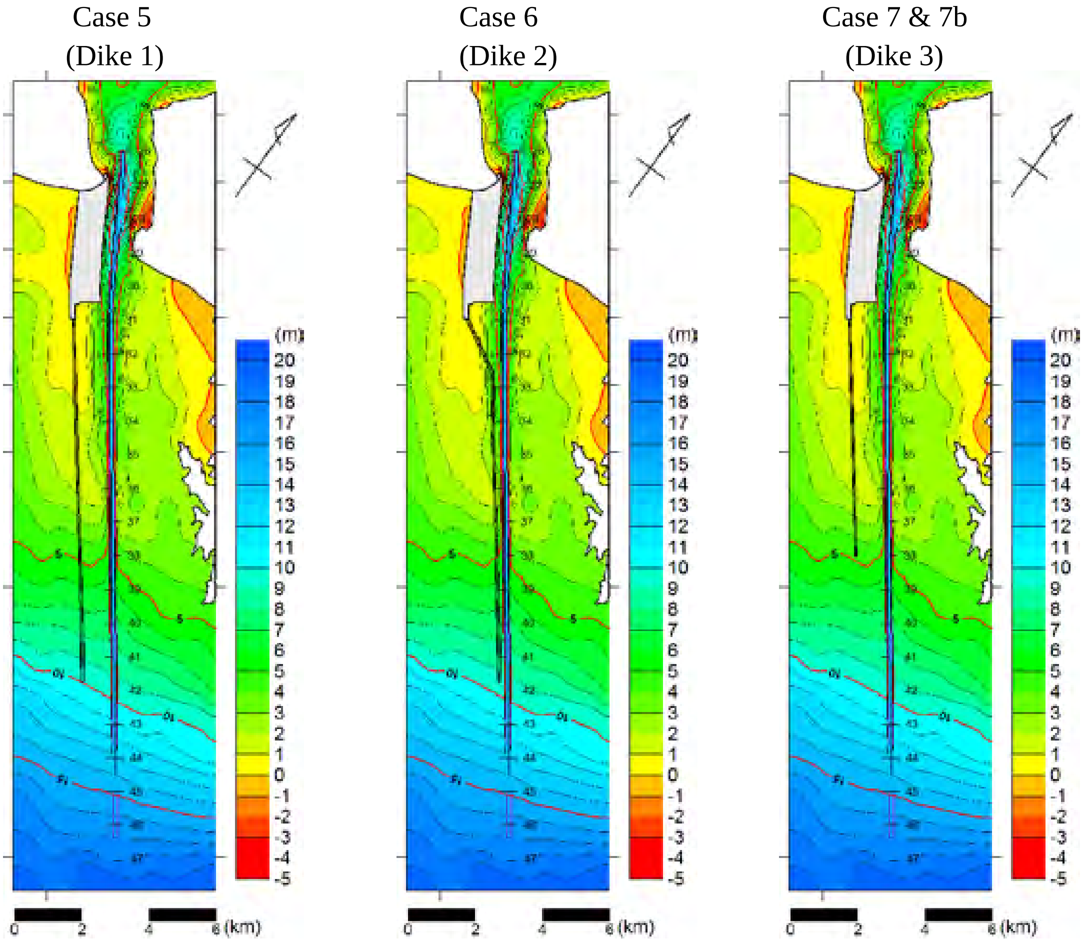


Figure 8.2.17 Positions of the sand protection dike

2) Simulation results

The longitudinal distributions of sedimentation speed estimated on case 3 to 7b are shown in Figure 8.2.18. Also, the comparison of total sedimentation volume is shown in Figure 8.2.19. The total sedimentation volume is calculated by the sedimentation speed, channel width, and channel length.

As shown in the figures, the sedimentation volume of case 3 is the highest and that of case 6 is the lowest. On case 4 which includes just the port facility and no dike, the sedimentation volume is slightly less than case 3 which does not include any structure. The cases of 5 through 7 include the port facility and the sand protection dike. The function of the dike is to prevent the suspended mud generated out the channel from flowing into the channel. Comparing the sedimentation volume among case 5, 6, and 7, it is confirmed that the longer the dike is and the closer to the channel the dike locates, the more effective it is to reduce sedimentation.

The case 7b is the case that the crown height of the dike is set as same as M.W.L. (=+2.0 m, C.D.) and allows wave, current, and sediment transport to pass over the dike when the water level is higher than M.W.L. Comparing the sedimentation volume between case 7 and 7b, the volume of case 7b is larger than case 7, but the difference is not so large.

The summary of the sedimentation volume is shown in Table 8.2.3. In the table, the sedimentation volumes of the first year and that after second year are shown. The sedimentation of 1.2M cubic meters in the first year of present situation (Case 1&2) is the value estimated by analyzing bathymetric survey data. The value is 4.6 times larger than the value after second year. The time variation of sedimentation speed may have been induced by attack of extreme high wave or an effect which some excessive dredging area are rapidly refilled as shown in Figure 8.1.17. As the simulations presented here are based on the actual sedimentation speed after the second year, the rapid sedimentation for the first year is not reproduced. The sedimentation for the first year is, however, generally larger than that of the second year or later, and it should be included the estimation of future sedimentation. Therefore, the values for the first year in the prediction cases (Case 3 – 7b) are estimated by 4.6 times larger than the second year.

Consequently, the simulation results indicate that the construction of the sand protection dike is effective in reducing sedimentation. The details of length, arrangement, and structure should be determined to minimize the life-cycle cost between initial and maintenance cost.

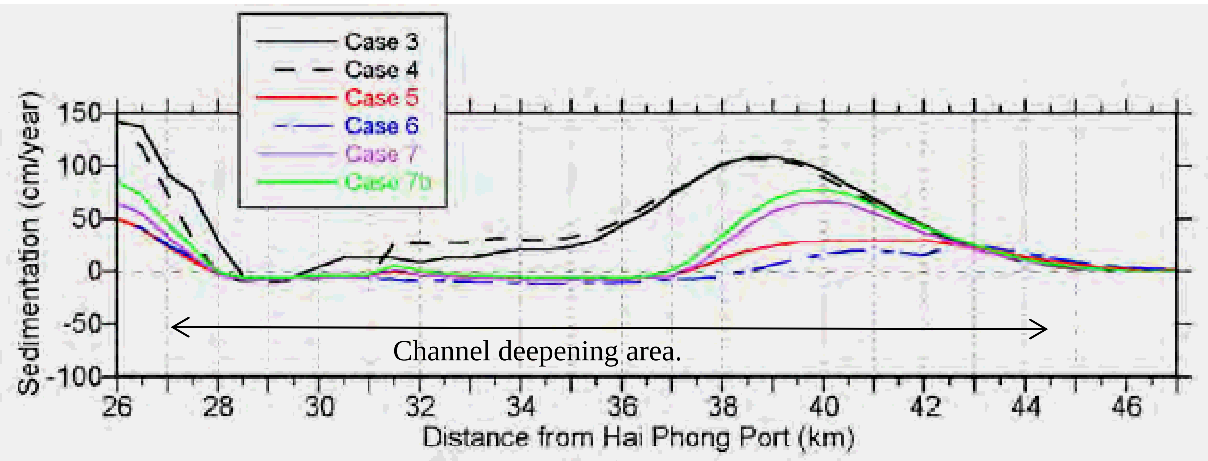


Figure 8.2.18 Predicted sedimentation speed with 14 m in channel depth

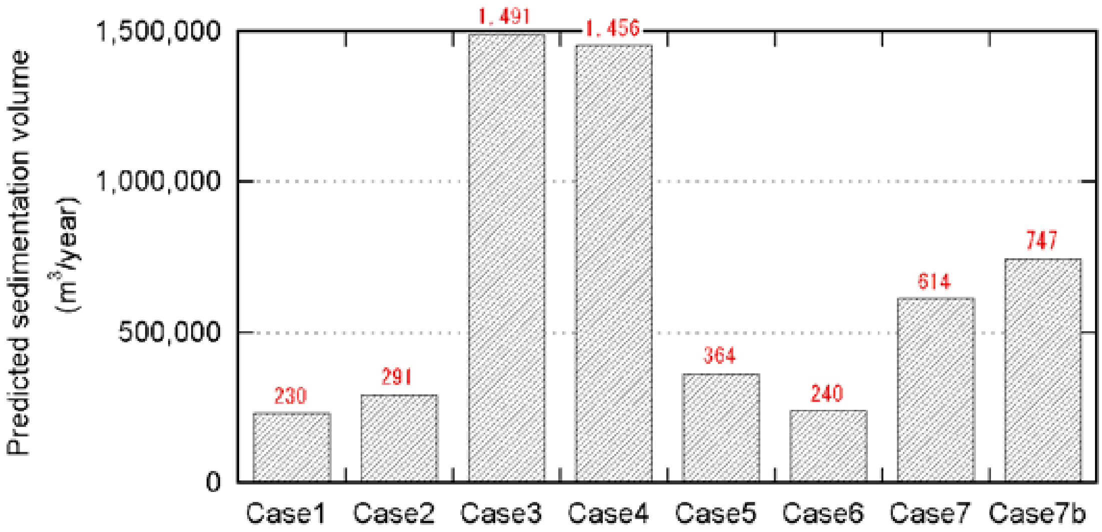


Figure 8.2.19 Predicted total sedimentation volume

Table 8.2.3 Summary of sedimentation

Case	Description	1st year (m^3/y)	After 2nd year(m^3/y)
1&2	8m in depth approximately, Present situation	1,200,000*	260,000
3	14 m, without any structures	6,873,000	1,491,000
4	14 m, with port facilities	6,712,000	1,456,000
5	14m, with port and dike of 10,000m, 1.5km apart from channel	1,678,000	364,000
6	14m,with port and dike of 11,000m, close to channel	1,107,000	240,000
7	14m,with port and dike of 7,000m	2,829,000	614,000
7b	14m, with port and dike of 7,000m (hc=+2m, C.D.)	3,442,000	747,000

*) Estimated by analyzing bathymetric survey data.

3) Sedimentation under construction

Sedimentation will be occurred even under construction work of the port, the sand protection dike, and channel deepening. Figure 8.2.20 shows a plan of work schedule assuming that the channel depth is 14 m and the arrangement of sand protection dike is case 7b. As shown in the figure, it takes 32 months for the completion of initial dredging and 40 months for construction of the dike. To estimate the channel depth at the completion of construction work, sedimentation under construction has been examined below.

These scenarios of dredging method as shown in Figure 8.2.21 were examined. Scenario 1 is the method to dredge from the port area to the offshore, Scenario 2 is the method which is seaward dredging by the location of Km36 at first and shoreward dredging from the offshore end of the channel, and Scenario 3 is the method to dredge from the offshore end to the port area. The sedimentation under construction for the three scenarios are calculated under the following assumptions,

- The effect of the sand protection dike is not included in the estimation because the completion of the dike will be at the end of 2015.
- Therefore, the sedimentation speed along the channel is estimated by the simulation result of

case 3 which is just dredged by 14 m in depth without any structures.

- In each dredging area a year, the sedimentation is calculated from its completion of dredging to the end of 2015.
- The time step of the calculation is 6 months and the sedimentation after dredging is accumulated in the estimation.

Construction Schedule for Lach Huyen Port Project

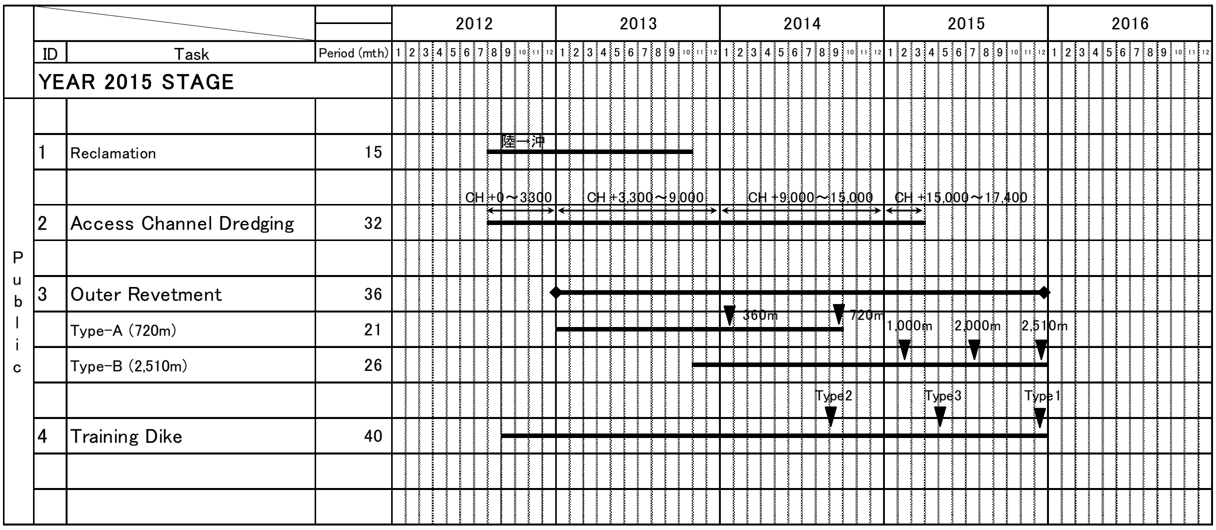


Figure 8.2.20 A plan of construction schedule for Lach Huyen port project

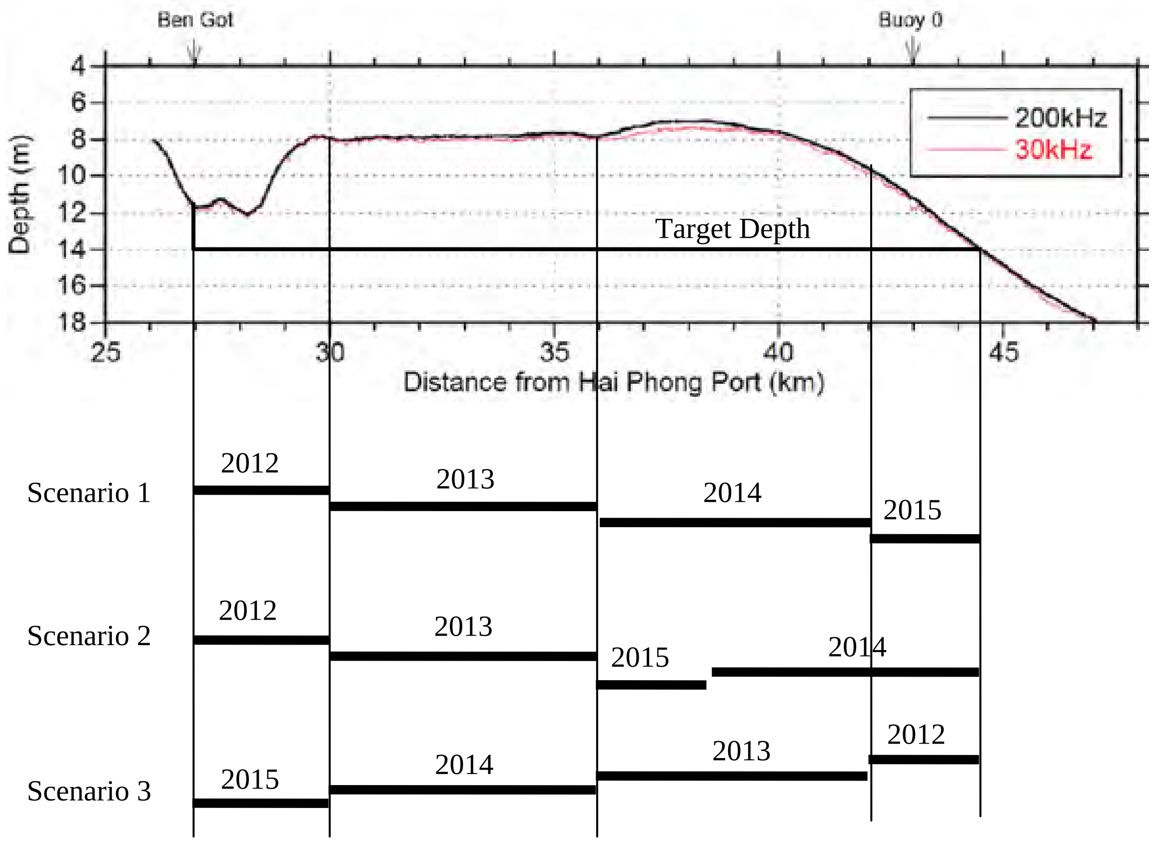


Figure 8.2.21 Scenarios of initial dredging

The sedimentation height along the channel estimated by the above assumptions is shown in Figure 8.2.22 and the averaged sedimentation height and total sedimentation volume are summarized in Table 8.2.4. From these results, the characteristics of sedimentation under construction are obtained as follows:

- Comparing among three scenarios, Scenario 2 shows the lowest sedimentation and Scenario 3 shows the highest.
- The peak of sedimentation appeared around Km39, the height of which is about 1.4m in scenario 1 and 2, and 2.5m in scenario 3.
- In Scenario 2, the reason of the lowest sedimentation is that the term after dredging is short in the area of Km36 to Km42 which shows the largest sedimentation.

These characteristics indicate that the channel depth around Km39 will be shallower than 14m at the completion of initial dredging. Also, the sedimentation under construction may be higher than the estimation because the sedimentation just after dredging tends to be high. Therefore, sedimentation during the construction works should be carefully monitored.

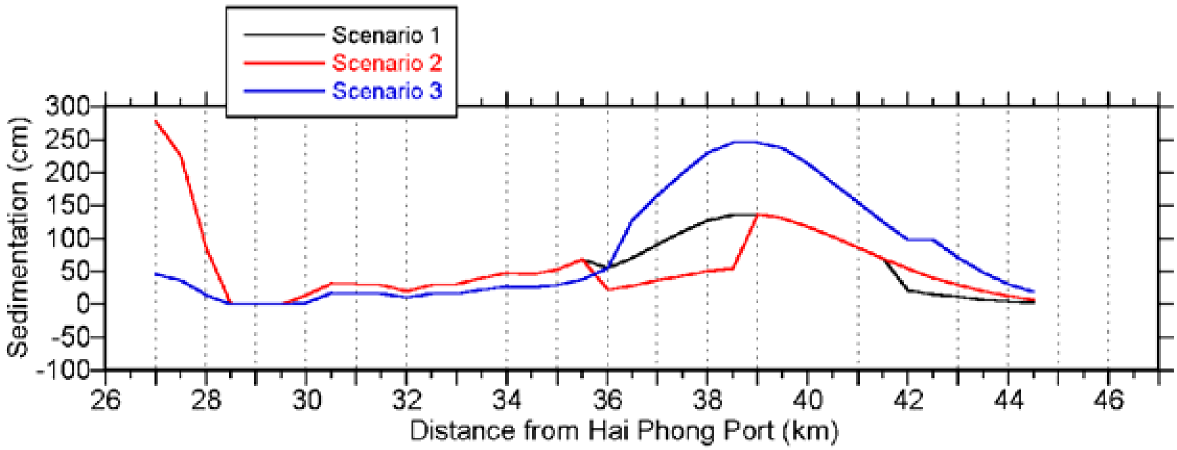


Figure 8.2.22 Estimated sedimentation height under construction, from August 2012 to December 2015

Table 8.2.4 Averaged sedimentation height and total sedimentation volume at the completion of construction (December, 2015)

Scenario	Averaged sedimentation height (cm)	Volume (m^3)
Scenario 1	68.3	2,203,709
Scenario 2	60.0	1,933,947
Scenario 3	90.5	2,919,638

4) Concluding remarks

In this study, numerical simulations were carried out to predict sedimentation of Lach Huyen channel. On the topography of present situation, which is approximately 8 m in channel depth, the sedimentation speed along the channel was reproduced by calibration of the models. After the reproduction phase, sedimentation for the channel deepened by 14 m is predicted and some arrangements of the sand protection dike to reduce sedimentation were tested. Also, sedimentation under construction was examined by using the simulation results. The conclusions obtained here are as follows:

- The sedimentation speed of the present situation is well reproduced in the numerical models on the total sedimentation volume and sedimentation pattern along the channel.
- The simulation results show that the sedimentation volume increased by increasing the channel depth and the sand protection dike is effective in reducing sedimentation.
- Also, as the sand protection dike functions to prevent the suspended mud from flowing into the channel, the longer and the closer to the channel the dike is, the more effective it is in reducing sedimentation. However, the details of length, arrangement, and structure should be determined to minimize the life-cycle cost between initial and maintenance cost.

The sedimentation volume predicted in this study is based on the actual sedimentation speed which is analyzed on the bathymetric survey data of Nov. 2006 to Nov. 2009. The term is the second year or later after the completion of initial dredging. The sedimentation speed is relatively slow and the depth of the channel is almost maintained in 8 m. However, the bathymetric survey data of Oct. 2005 and Nov. 2006 shows the rapid sedimentation in the first year after initial dredging. It is considered that the rapid sedimentation is mainly caused by that the partly deep area on the topography just after initial dredging was refilled rapidly, but the detail mechanism of the rapid sedimentation in the first year has not been clear yet. Therefore, the possibility that the rapid sedimentation occurs every year remains if the maintenance dredging is annually carried out. Thus, there is a risk of rapid sedimentation on the planned channel deepening, and therefore continuous monitoring during and after the port construction work are necessary to check and verify the sedimentation rate.

9. Natural and Social Environmental Conditions

9.1 Overall Information and Compliance for the JBIC Environmental and Social Considerations

9.1.1 Reviewed Reports

As a part of Japanese ODA loan procedures, the SAPROF study team has reviewed the approved environmental impact assessment (EIA) report*1 prepared by Center for Hydrography & Meteorology Network and Environment, MONRE (HYMENET) assigned by VINAMARINE Project Management Unit III in 2008. The proposed EIA and resettlement action plan (RAP) of the connecting highway between Tan Vu and Lach Huyen Port were also reviewed. The detailed comments on the highway EIA and RAP are described in Section 10. Review on Past Studies of Tan Vu-Lach Huyen Highway. Some selected reports were also reviewed to complement the EIA reports for the purpose of the verification of JBIC Environmental and Social Consideration (the JBIC Guideline). The following table is the list of reviewed reports and expected reports for the port project.

*1: Environmental Impact Assessment Report, Lach Huyen gateway port infrastructure construction project, approved by MONRE No.2231/QD-BTNMT, Hanoi 31 Oct. 2008

Table 9.1.1 List of Reviewed Reports

Reviewed Report	
Environmental Impact Assessment Report/ Lach Huyen Gateway Port Construction Project (2010-2015), September 2008	Prepared by HYMENET assigned by PMU III, VINAMARINE
Other reviewed reports	
Feasibility Study of Lach Huyen Gateway Port Construction Project	Transport Engineering Design Incorporation (TEDI) assigned by PMU I, VINAMARINE
Port Capacity Reinforcement Plan In Northern Vietnam, September 2009	Prepared by Nippon Koei Co.Ltd. & Associates assigned by MOT
General Construction Plan of Hai Phong City to 2025 and 2050	Prepared by Planning Institute of Hai Phong assigned by Hai Phong People’s committee

9.1.2 Legal Framework of Environmental and Social Consideration in Vietnam

In general, Vietnam legal systems for environmental and social consideration are well developed to avoid unnecessary losses and to secure adequate compensation for the losses as fair philosophy as most of developed countries. Considering the fundamentals of the environmental and social consideration are defined by 1992 Constitution of the Socialist Republic of Vietnam amended in 2001. Under the constitution, the primary laws relevant to the environmental and social consideration are Environmental Protection Law No.52 (2005) and Land Law No.13 (2003). Due to the complexity of the issues and continuous changes in economic development, relevant regulations have been continuously issued to appropriately apply the legislations. Followings are the articles specifically stating the environmental and social consideration in the constitution of Vietnam.

- Article 17: The state’s ownership of the land and other natural resources under the ownership of the entire people
- Article 18: State’s power to allocate the rite to use
- Article 23: Assurance of Properly and Compensation
- Article 29: Environmental Protection

1) Relevant legislation on Environmental Protection Law, 2005

Year/ Objective	Law and Regulation
2005/ LAW	Environmental Protection Law No.52/2005/QH111
1998/ LAW	Water Resources Law 1998, effective in January 1st 1999
2008/ pursuant to Law on Environmental Protection, Dec.#21/2008/ND-CP, Dec.#80/2006/ND-CP	Circular No. 05/2008/TT-BTNMT guiding strategic environmental assessment, environmental impact assessment and environmental protection commitment, 08 December 2008
2008/ pursuant to Law on Environmental Protection, and amending Dec.#80/2006/ND-CP	Decree No.21/2008/ND-CP dated February 28th 2008 of the Government on amendment of some articles of Decree No.80/2006/ND-CP dated August 9th 2006 guiding the implementation of Environment Protection Law.
2008	Decision No.16/2008/QD-BTNMT dated December 18th 2006 of the Ministry of Natural Resources and Environment on obligatory application of Vietnamese standards on environment
2007/ pursuant to Law on Environmental Protection, Law on Water Resources	Decree No.88/2007/ND-CP dated May 28th 2007 of the Government on drainage for urban and industrial zones
2007	Decree No.59/2007/ND-CP dated April 9th 2007 of the Government on solid waste management
2007	Decree No.88/2007/ND-CP dated May 28th 2007 of the Government on drainage for urban and industrial zones
2006/ pursuant to Law on Environmental Protection, and amending Dec.#80/2006/ND-CP	Decree No.80/2006/ND-CP detailing and guiding the implementation of a number of articles of the Law on Environmental Protection
2006/ pursuant to Law on Environmental Protection	Decree No.80/2006/ND-CP detailing and guiding the implementation of a number of articles of the Law on Environmental Protection
2006	Decision No.22/2006/QD-BTNMT dated December 18th 2006 of the Ministry of Natural Resources and Environment on obligatory application of Vietnamese standards on environment
2006	Decision No.23/2006/QD=BTNMT dated December 26th 2006 of the Ministry of Natural Resources and Environment on list of dangerous waste
2006	Circular No.12/2006/TT-BTNMT dated December 26th 2006 of the Ministry of Natural Resources and Environment guiding the procedures for application, registration, licensing, code issuance for managing dangerous waste.
2002	Decision No.35/2002/QD-BKHCNMT dated June 25th 2002 of the Ministry of Science, Technology, and Environment on list of obligatory application of Vietnamese environment standards

2) Relevant legislation on Land Law, 2003

Year/ Objective	Law and Regulation
2003/ LAW	Land Law No.13/2003/QH111
2010/ pursuant to Land Law, Cir.#14/2009/TT-BTNMT, Cir.#14/2008/TT-BTNMT, Dec.#69/2009/ND-CP Dec.#84/2007/ND-CP	Decision No. 130/2010/QD-UBND on compensation on support & resettlement policy on Hai Phong City
2009/ pursuant to Land Law, pursuant to Dec.#69/2009/ND-CP, Dec.#84/2007/ND-CP	Circular No. 14/2009/TT-BTNMT detailing the compensation, support and resettlement and order of and procedures for land recovery, allocation and lease
2009/ pursuant to Land Law	Decree No.69/2009/ND-CP to amend a number of provisions on land use planning land rental rates land reclamation and resettlement and compensation
2008/ pursuant to Land Law, Dec.#84/2007/ND-CP	Circular No. 14/2008/TTLT/BTC-BTNMT Joint circular on guiding the implementation of a number of articles of the Government’s Decree No.84/2007/DN-CP
2007/ pursuant to Land Law	Decree No.84/2007/ND-CP dated May 25th 2007 of the Government on granting land use right certificate, land collection, land use right, procedures for compensation, support, resettlement where the land acquired by the State and complain denunciation
2004/ pursuant to Land Law	Decree No. 197/2004/ND-CP on compensation, support and resettlement when land is recovered by the State. 03 December 2004
2004/ pursuant to Land Law	Decree No. 188/2004/ND-CP on methods of determining land prices and assorted-land price brackets. - 16 November 2004
2004/ pursuant to Land Law	Decree No. 181/2004/ND-CP on the implementation of the Land Law. - 29 October 2004

3) Other regulations related to the Lach Huyen Port Development Projects

- Decree No.71/2006/ND-CP on seaport management and maritime navigation channel dated July 25th 2006
- Decree No.131/2006/ND-CP on Issuance of Regulation on Management and Utilization of Official Development Assistance dated November 9th 2006

4) Decisions related to the Lach Huyen Port Development Projects

- Decision No.202/QD-TTg dated October 12, 1999 of the Prime Minister on approval of Master Plan for Vietnam seaports system to 2010.
- Decision No.04/2001/QD-TTg dated January 10, 2001 of the Prime Minister on approval of revised planning of Hai Phong city to 2020.
- Resolution No.32/NQ-TW dated August 5, 2003 of the Politburo on constructing and developing Hai Phong city in the process of industrialization and modernization.
- Decision No.885/QD-TTg dated August 22, 2004 of the Prime Minister on approval of the detailed planning for northern seaport group (Group 1) to 2010 and orientation for development to 2020.

- Decision No.2561/QD-BGTVT dated August 25, 2004 of the Ministry of Transport on allowing the preparation of Feasibility Study for Lach Huyen Gateway Port Construction Project.
- Decision No.766/QD-CHHVN dated December 31, 2004 of the Vietnam Maritime Administration on assigning the representatives of the Project Owner for making Feasibility Study for the Lach Huyen Gateway Port Construction Project.
- Decision No.2570/QD-BGTVT dated July 27, 2005 of the Ministry of Transport on approval of outline, cost estimation for survey and FS preparation for Lach Huyen Gateway Port Construction Project.
- Decision No.694/QD=CHHVN dated October 23, 2007 of Vietnam Maritime Administration on transfer of projects from the Maritime PMU I to Maritime PMU III.
- Letter No.8327/TTr-BGTVT dated December 25, 2007 of the Ministry of Transport on proposal for approving in principle the investment of Lach Huyen Gateway Port Project.
- Decision No.06/2008/QD-TTG dated January 10, establishing and promulgating regulation on operation of Dinh Vu-Cat Hai Economic Zone
- Decision No 2231/QD-BTNMT dated Oct 31, 2008 of Ministry of Natural Resources and Environment, approving environmental impact assessment of Lach Huyen International Gateway Port Project, Hai Phong.
- Decision No. 3793/QD-BGTVT dated Dec 22, 2008 of Ministry of Transport, approving Construction Project of Hai Phong International Gateway Port (starting phase).
- Decision No.34/2009/QD-TTG dated March 02, 2009, approving the Master Plan on Development of the Tonkin Gulf Coastal Economic Belt up to 2020
- Decision No.1808/QD-CT dated Sep 11, 2009 of Hai Phong City People Committee, approving steering committee establishment of the city on Hai Phong International Gateway Port Project
- Decision No.1448/QD/TTG dated September 16, 2009, approving adjustment on general plan on developing Hai Phong city up to 2025 and vision to 2050

9.1.3 Compliance with the JBIC Guideline of the Proposed Port Project

In principal, JICA respects the legal framework of the borrower’s environmental and social considerations. However in the case of the borrower’s legal framework and common practices for such consideration are significantly different from regional practices or/and internationally acceptable level, JICA may request the responsible authorities of the ODA recipient(s) to reconsider the acceptable level of environmental and social consideration to grant the ODA. Due to the recent reorganization of the Japanese ODA agencies in 2008, specifically JICA and Japan Bank for International Cooperation (JBIC), “Guidelines for Confirmation of Environmental and Social Consideration, April 2002 by JBIC” (the JBIC Guideline) is applied for the proposed Lach Huyen Port project.

1) Principles of the JBIC Guideline and Vietnamese Requirement

Principles of the JBIC Guideline and comparison of the JBIC Guideline’s and Vietnamese regulations on environmental and social consideration are shown in Appendix 9-1. By the definition of the effective law and regulations of Vietnam, coverage and requirements of the EIA meet the JBIC Guideline except the analysis of the alternatives. Although the requirement of the Vietnamese EIA does not fulfill the definition of the JBIC Guideline, the analyses of the alternatives are certainly examined in the “Feasibility study report” of the assessed project, which is required for the appraisal of the EIA. The view point of such alternative analyses may not specifically focus on preventing or minimizing adverse impact and choosing a better project option for environmental and social considerations. Thus, additional analysis for alternatives may be needed in case the assessment of the alternatives by the feasibility study does not suit the JIBC Guideline. Following are the principles of the JBIC Guideline.

Table 9.1.2 Principles of the JBIC Guideline (Summary)

Principles	JBIC Policy
a) Examination of Measures	· Examination of multiple alternative proposals to prevent or minimize adverse impact and to choose a better project option for environmental and social considerations (Priority is the prevention of the impact, and when it's not possible, minimization and reduction are considered next. Compensation measures must be examined only when impact cannot be prevented · Preparation of appropriate follow-up plans and systems, costs of such plans and systems, and financial methods to fund such costs
b)Scope of Impact to be Examined	· Examination of environmental impact (air, water, soil, waste, accidents, water usage, ecosystems, and biota) and social concerns (involuntary resettlement, the indigenous people, cultural heritage, landscape, gender, children's rights and communicable diseases, and trans-boundary and global environmental problems)
c) Compliance with Laws, Standards and Plans	· Compliance with national and local laws, ordinances and standards relating to environmental and social considerations as well as environmental and social consideration policies and plans of the jurisdiction over the project · Principal avoidance of protected areas specifically designated by laws or ordinances of the government for the conservation of nature or cultural heritage
d) Social Acceptability and Social Impacts	· Appropriate acceptability of the project in the country and locality of the project site · Sufficient consultations with stakeholders, appropriate disclosure of project and impact information, incorporation of the outcome of such consultations into the project plan/design · Appropriate consideration for vulnerable social groups, such as women, children, the elderly, the poor, and ethnic minorities
e) Involuntary Resettlement	· Avoidance of involuntary resettlement and loss of means of livelihood, where feasible, exploration of all viable alternatives and effective measures to minimize impact and to compensate for losses, and agreeable measures for the loss · Assurance of sufficient compensation for the project affected people's losses (land and monetary compensation) and supporting the means for an alternative sustainable livelihood, and providing the expenses necessary for relocation and the re-establishment of a community at relocation sites at least as same level as pre-project condition in timely manner · Appropriate participation by the affected people and their communities in planning, implementation and monitoring the counter/compensation measures
f) Indigenous People	· Special safety guard for indigenous people to respect their rights in relation to land and resources in accordance with the spirit of the relevant international declarations and treaties · The consent of indigenous people
g) Monitoring	· <Desirable> by the project proponents to monitor: (i) whether any situations that were unforeseeable before the project began have arisen, (ii) the implementation situation and the effectiveness of the mitigation measures prepared in advance, and that they then take appropriate measures based on the results of such monitoring · <Desirable> making results of the monitoring process available by project proponents to project stakeholders · <Desirable> assurance of a forum for discussion and examination of countermeasures with the participation of stakeholders in the relevant project in the case of the improper care for the environmental and social considerations after the project implementation

2) Compliance of the Approved Lach Huyen Port EIA with the JIBC Guideline

Considering the compliance of the EIA report of Lach Huyen Gateway Port Construction Project (2010-2015), it principally complies with the JBIC Guideline except the proper consideration for the coastal fishing activities, which is beyond the Vietnamese safeguard policies at this moment. Such issues were pointed out by JICA at the fact finding mission in April 2010. Although there are few legal frameworks to address such issues under the present Vietnamese laws and regulations, the responsible agency to handle such issues is likely to be correspondent people's committees such as province or municipality and relevant districts and communes, which follows the safeguard policy of effective land law. Although MPMU II is not the responsible agency to develop the safeguard policy for coastal fishing activities, as the responsible implementation agency of the Lach Huyen port construction, MPMU II agreed to propose the additional safety guard measures with the consultation with Hai Phong City and Cat Hai district PC as well as other necessary authorities, if any, by the end of April 2010 to meet the JIBC Guide line.

In addition to the consideration for coastal fishing activities, slight gaps between Vietnamese involuntary resettlement policy and the world bank's involuntary resettlement policy (OP 4.12) is reported by a resettlement action plan* of "Tan Vu-Lach Huyen Highway Project" and the ongoing resettlement policy framework of "Northern Delta Transport Development Project**" by MOT supported by the world bank. Considering the applicable policy frameworks for the Lach Huyen port, the resettlement policy framework of the Northern Delta Transport Development Project should be applied due to the consistency of the ODA projects in the same region.

* Volume-IV: Resettlement Action Plan/ Planning Construction Investment Project, Tan Vu-Lach Huyen Highway Project in Hai Phong City, 14 July 2009 prepared by Japan Bridge & Structure Institute, HYDER Consulting, and Highway Engineering Consultants Joint Stock Company
** Project Appraisal Document on a Proposed Credit in the Amount of SDR 104.4 Million To the Social Republic of Vietnam for a Northern Delta Transport Development Project, 19 May, 2008, Transport, Energy and Mining Unit, Sustainable Development Department, East Asia and Pacific Region, The World Bank
<http://web.worldbank.org/external/projects/main?pagePK=64283627&piPK=73230&theSitePK=40941&menuPK=228424&Projectid=P095129>

The detailed consideration of the safeguard policy for the coastal fishing activities and involuntary resettlement is described in PART-2: Medium Term Port Development Plan, Chapter 13. Consideration of Natural and Social Environment and the recommendable frameworks are given in PART-3: Implementation Plan as Japan's ODA Loan Project, Chapter 22.Mitigation Measures for Environmental Impacts.

Following are the summary of the compliance with the JBIC Guideline and the approved EIA and relevant documents.

Table 9.1.3 Summary of the compliance with the JBIC Guideline and the port EIA

Principles	Remarks
a) Examination of Measures	· Although the requirement of the Vietnamese EIA does not fulfill the definition of the JBIC Guideline, the analyses of the alternatives are examined in the feasibility study of Lach Huyen Gateway Port Construction Project, which is the attachment of the EIA report for the approval. · Three (3) alternative locations are comparatively evaluated from economic, environmental and social viewpoints on comprehensive manner. It is concluded that Lach Huyen as the most appropriate location. The other two alternative locations are 1) Cam Pha in Quang Ninh Province located north of Lach Huyen and 2) south of Do Son located south west of Lach Huyen, also located in Hai Phong. In environmental and social view points, Cam Pha and Do Son were not selected due to the significant impacts by the inland waterway access to the port through the world heritage-Ha Long Bay and the significant impacts on beach

Principles	Remarks
	resort oriented eco-tourism development respectively. · In addition to the selection of the project site, selection of the port structure and facilities were technically examined. Such technical consideration does not focus on the reduction of the environmental and social impacts, but in general the economical and technical options could be considered as the favorable options environmentally and socially.
b) Scope of Impact to be Examined	· Potential impacts on natural environment are well covered though it lacks the seasonal information. The seasonal information shall be added and monitored under the responsibility of the implementation agency and operator, which will be conducted in detailed design stage and specified in environmental management plan. · Potential impacts on social environment are also covered except coastal fishing activities as mentioned above. This SAPROF study conducted two sample surveys to understand the potential impacts on the coastal fishing. · Due to the change in design to add public portion on the Cat Hai island and the reclaimed land, the impacts on the extended portion on the Cat Hai island are additionally examined in this SAPROF study.
c) Compliance with Laws, Standards and Plans	· The approved EIA is fully compatible with the effective national law, regulations and standards. The Lach Huyen port is one of the key components of the general plan on developing Hai Phong city up to 2025 and vision to 2050.
d) Social Acceptability and Social Impacts	· Throughout the public consultation required by law and additional public hearing requested by JICA and conducted by MPMU II in April 2010, it confirmed that the port development projects are fully accepted by the community. At the additional public hearing in April 2010, announcement of the concrete project schedule and consideration for the costal fishermen were requested by the representatives of the local communities. MPMU II agrees to address the mentioned opinions with the collaboration with responsible authorities.
e) Involuntary Resettlement	· Due to the offshore construction, there are minimal requirements for the involuntary resettlement except coastal fishing activities. · Though some land clearance is required for the public facilities added by the change of design, the additionally required land clearance on Cat Hai island does not require any house resettlement but some community woods, tombs and aquaculture ponds. Though the specific land acquisition plan was not completed by the end of April 2010, people's committee of the Cat Hai dist, the responsible authority for the land clearance, has already consulted with the relatives of the potentially resettled tombs and received general acceptance of the resettlement. · The additional safeguard policies for coastal fishing activities is ongoing process of development at the end of April 2010, but such policies shall adequately treat project affected people due to the MPMU II and people's committee of the Hai Phong city's proactive intentions to treat people adequately.
f) Indigenous People	· It is not applicable for the proposed project.
g) Monitoring	· The monitoring program is strictly required by Vietnamese law and described in the EIA report, which is likely to meet the JBIC Guideline. · Reporting of the environmental monitoring and assurance of the adequate environmental management are also required by Vietnamese law and regulation, which secure the environmental and social consideration after the project implementation.

9.2 Natural Environment

Natural environmental condition in and around the Cat Hai Island, the target area for the Lach Huyen Gateway Port Development Project is described below principally based on the Chapter 2 on baseline (existing) condition as described in the finally approved EIA Report (2008) formulated by HYMENET (Center for Hydrography & Meteorology Network and Environment of MONRE). The final EIA report was approved by MONRE (Approval Letter No. 2231/QD-BTNMT dated 31 October 2008) for the project scale of the Lach Huyen Gateway Port corresponding to the capacity requirement for 2010-2015 as also indicated in the title of the EIA report (port development with the first 2 berths for container cargo and general cargo and the related works).

9.2.1 Location

Lach Huyen gateway port is planned as offshore extension of the southeastern corner part of the Cat Hai Island belonging to the Cat Hai District of Hai Phong city. The planned port area is located on the right side of Lach Huyen Estuary and Cat Ba Island (also belonging to the Cat Hai District) is located on the left side of the Estuary. Most of the western part of both the terrestrial and coastal seawater environment (Lan Ha Bay and also the southern part of Ha Long Bay) of Cat Ba Island is a well-known protected ecotourism area (Cat Ba National Park/Man and Biosphere reserve of UNESCO). Phu Long area in the eastern part of Cat Ba Island (that also includes the ferry terminal of Cai Vien) is the closest region to the Cat Hai Island across the Lach Huyen Estuary that also includes the vicinity of the planned gateway port development area located toward the south of the existing passenger boat terminal of Ben Got. This area also has the narrowest width of Lach Huyen Estuary of about 1000m (in between Cat Hai and Cat Ba islands).

This Lach Huyen Estuary is a part of the access channel for ships and vessels for Hai Phong port (existing port located inland along the right river bank of Cam River) to the open sea, as of the existing condition. This offshore access channel is a dredged one and at present its depth is about 7.8m.

Accordingly the shipping activity with vessel movement along Lach Huyen Estuary (offshore transport industrial activity) and the nearby Cat Ba Island in which most of its western part is a protected area (Cat Ba Nation Park, a nature reserve area) has been coexisting over a long period of time with no apparent adverse effects on the protected national park of Cat Ba Island.

9.2.2 Meteorological Features

1) Temperature

Cai Hai Island is located in the tropical wind region; its weather condition is moderate, less severe than neighboring inland mainland areas. Air temperature (literally known as temperature), in overall, is similar to tropical zone and is quite high (>210C) and does not vary much during months in a year. The average annual temperature varies in between 23°C to 24°C. There are two seasons per year and the temperature differ 11-12°C in each season.

- Winter season (November to March): Average temperature is below 20°C. January has the lowest temperature that varies in between 16°C-17°C with 10°C being the lowest.
- Summer season (May to October): Average temperature is 25°C. July has the highest temperature that varies in between 28°C-29°C with 32°C-33°C being the highest.

2) Rainfall

Similar to temperature variation induced 2 seasons of winter and summer, there are also 2 season induced by change in rainfall, namely rainy season and dry season in Cat Hai Island with rainy season from May to October and dry season from November to April. The average rainfall in the area ranges from 1,700 to 1,800 in which 85-90% of precipitation occurs in the rainy season.

High intensity rainfall due to tropical storm occurs during in the beginning of summer, normally in the afternoon. In particular in July and August, high intensity rainfall caused by tropical converge occurs for extended period of days that causes flooding. High intensity rainfall is a feature of summer season in general.

The rainfall distribution in the dry seasons is quite stable, interspersed with drizzle rain. Number of rainy days in a year defined as a day with a rainfall ≥ 0.1mm in Cat Hai area is about 113 rainy days accounting for 31% of days in a year. Drizzly rain is a feature confined to the northern regions of Vietnam. In drizzly days, the humidity is very high, approximately 100%. The number of drizzly days in Cat Hai is quite low compared to the nearby coastal areas in the mainland like Bai Chay and is about 11 days per year (Bai Chay has about 24 days per year) and concentrate mainly in February, March and April. The volume of drizzly rain is not much but it contributes significantly to the wellbeing of floral ecosystem. However, drizzly rain causes certain adverse effects, in particular on waterway transport, due to its poor visibility.

3) Air Humidity and Evaporation

The most humid time in a year in Cat Hai area and its surrounding mainland areas like Bai Chay is from February to August and the air humidity ranges at about 85 to 90% or even higher. This is the highest humid region of the country. Although the average air humidity is quite high, it still decreases very rapidly and becomes dry in winter season. In Cat Hai in particular, the survey data in 1999 in National Park registered the lowest value of 16% (December).

The average annual evaporation is about 700mm. During the dry season, the evaporation is higher than precipitation as could be expected that results in dryness and water shortage as well.

4) Solar Radiation

The pattern of solar radiation in the Cat Hai area is quite well defined though its annual distribution is still varied. The total quantity of solar radiation in a year is 107-108 kcal/cm2. Solar radiation at the end of winter and beginning of spring is only about 40 to 50% of summer months. The cloud thickness above Cat Hai Island is quite large, especially in winter days that very significantly hinder solar radiation.

Cat Hai area has in total about 1,650 to 1,750 sunny hours per year, higher than nearby coastal mainland area like Bai Chay. In summer, the total number of sunny hours is about 160-220 hours per month. In the beginning of spring, this decreases to only about 50 to 60 hours per month.

5) Wind

In Vietnam, in general, there are 2 major wind directions, namely, Northeast in the winter and Southwest in the summer. However, due to the regional location and topographical feature, the predominant wind direction could change. Moreover, due to the specific location of Cat Hai island, which is protected by larger Cat Ba island, the predominant wind direction in summer is Southeast or South. Besides the above feature, sea wind also plays an important role to regulate the weather condition in the island. This explains why this area is nominally warmer in the winter and cooler in the summer resulting in rather moderate weather condition throughout the year as noted above under temperature. The average wind speed in Cat Hai Island is rather stable throughout the year that ranges from 3.0 to 3.9 m/sec. High (maximum) wind speed at times causes significant adverse effects on normal socioeconomic activities, which ranges from 10 to more than 20 m/sec in Cat Hai Island. High wind speed in winter is normally caused by northeast wind during the end of the season. In the summer, high wind speed is nominally caused by thunder storms and tropical cyclones. During the spring and autumn, the high wind speed is caused by thunder storms.

6) Some Specific Weather Conditions

a) Fog

Though fog represents a good and stable climatic condition it limits visibility and hence affects safety in transportation. Number of foggy days recorded in nearby mainland coastal areas like Bai Chay varies from 13 to 30 days per year. Still, in Cat Hai area foggy condition is very rare and was recorded only 2 times over the past 5 years.

b) Rain storm

Rain storm is basically electric transmission between two clouds or between cloud and ground resulting in irradiation and thunderbolt. In Cat Hai area rainstorm occurs 40 to 45 days on average in a year same as other nearby coastal mainland areas like Bai Chay. Most rain storm days months are during the three months from June to August in which the number of rain storm days in a month ranges from 7 to 9 days. Rainstorm results in development of a large volume of cloud, rain, and whirlwind. This should be carefully taken into consideration in construction planning in particular.

c) Tropical cyclone

Tropical cyclone comprises both storm and tropical low pressure resulting in great atmosphere turbulence. This causes 3 most typical natural calamities, namely, strong whirlwind, heavy rain and rise in water level in coastal sea waters and rivers.

The most affected area by tropical cyclone is the northern coastal area with the frequency of about 0.62 times/100km/per year. Cat Hai Island, in general, is affected by 6-11 tropical cyclones in every decade (10 years). The maximum wind speed recorded during typical tropical cyclone is about 40 to 50m/s. Potential rise in sea level due to tropical cyclone need to be duly considered in the planning, design and operation of port facilities in Cat Hai Island.

9.2.3 Hydrographical Features

1) Tidal Condition

Tidal condition in Cat Hai island is defined as homogenous tidal condition with up (high) once and down (low) once tides level every day. The tide water level follows sine-wave form. The time of rising tide is slightly shorter than the time of falling tide. The tidal volume has 2 periods in a month with amplitude of 2.6-3.6m. The tidal condition in Cat Hai Island is almost same as in Hon Dau Island. The average monthly tidal variation is normally over 3.5m. The water level observed at Hon Dau is as follows:

- Average water level: 1.9m
- Highest water level: 4.21m (22/10/2985)
- Lowest water level: -0.07m (21/12/1964)
- Highest amplitude of tide: 3.94m (23/12/ 1968)

2) Wave Condition

High wave condition generally occurs in May and November while strongest wave condition occurs in July and September (h=5.6m).

3) River Flow

The river flow at Hai Phong coastal area is affected by river flow of Cam River, Bach Dang River, Chanh River and tidal level and hence very complicated. There is a strong interaction among factors including water level, river-bed's topography, wave, wind, and tide. Based on the results of past surveys and studies at the Bach Dang Estuary and the surrounding coastal area, during winter when the wind and wave conditions are stable, the river flow is mainly influenced by tidal flow and differences in water level.

When the tide goes down in the Nam Trieu and Lach Huyen estuary, the flow in rivers may reach even up to l m/s. The average flow velocity in rivers is in the range of 40 to 60m/s. In reality, such high flow speed when tide level goes down results in erosion in riverbed. It is also noted that the river flow, even when the tide goes down, runs toward the Lach Huyen direction.

9.2.4 Environmental Condition in Cat Hai Island and its Vicinity

1) Ambient Air Environment (including noise and vibration)

The ambient air quality (including noise and vibration) was measured as part of the baseline primary data collection for the EIA Study at 5 sampling locations in Cat Hai Island in May 2006. The relevant meteorological factors (temperature, humidity, wind direction and velocity) were also measured at the sites in addition to the ambient air sampling work and noise and vibration measurements. The air quality parameters measured in laboratory are CO, NO2, SO2, dust (suspended particulate matter) and lead. The analysis results as expected confirmed that the ambient air environmental quality in Cat Hai Island is very clean with low noise and vibration effects, which fully satisfied the relevant national standards of Vietnam on ambient air quality (TCVN 5937-2005) and noise and vibration (TCVN 5949-1999 on noise and TCVN 6962-2001 on vibration).

It is noted that Cat Hai Island is very small and surrounded by open sea environment facilitating active air exchange between land and sea. Moreover, at present there is no significant economic or industrial activity to cause any significant air quality deterioration or noise and vibration. Major activity is confined to the 2 areas of ferry terminal in Ninh Tiep and passenger terminal in Ben Got only, where the frequency of ferry and passenger vessel transport is rather low.

2) Soil Condition

The soil condition (surface earth soil) was measured as part of the baseline primary data collection for the EIA Study at 5 sampling locations in Cat Hai Island in May 2006. To assess the soil condition including its quality the following parameters were measured. They are, soil composition, weight, oil and 6 heavy metals (Cu, Pb, Zn, Cd, As, Hg).

With respect to soil composition, the size$\geq$0.02mm is most prevalent (mostly more than 80%), while the size $\leq$0.002 is least prevalent (mostly less than 5%). Hence the soil type is regarded as relatively coarse in nature. Regarding soil quality it is assessed as uncontaminated with respect all heavy metallic parameters measured and fully in compliance with the national soil quality standards of Vietnam (TCVN 7209-2002) and hence the soil quality is regarded as of natural condition.

3) Groundwater Quality

The public potable water supply system is not yet available in Cat Hai Island (the project area), and therefore the water for daily life is sourced from the dug-wells of 3-7m depth. The groundwater quality was measured as part of the baseline primary data collection for the EIA Study at 5 locations of existing dug-wells in Cat Hai Island in May 2006. The groundwater quality parameters measured include: pH, NO3, Fe, Hg, Pb, Zn, Total coliform and Fecal coliform. The groundwater quality is assessed as good with respect to all physical and chemical parameters measured and in conformity with the relevant national standards of Vietnam (TCVN 5944-1995). However, significant bacteriological contamination is noted. Accordingly, the groundwater is assessed as non-potable for direct consumption. Still, it is regarded as potable after boiling.

4) Coastal Estuarine Seawater Quality

The coastal seawater quality was measured as part of the baseline primary data collection for the EIA Study at 5 offshore sampling locations along the Lach Huyen Estuary in May 2006. These 5 offshore locations are basically along the access canal for existing Hai Phong Port and its vicinity (geographically located in between Cat Hai and Cat Ba islands), which is also the offshore location planned for the port development. The samples were taken at 3 different seawater depth levels, the surface, mid-depth, and near seabed (bottom). The seawater quality parameters analyzed included pH, temperature, turbidity, DO, TSS, BOD5, NH3-N, Cl-, F-, fenol, SO4-, CN-, Mn, Fe, As, Cd, Pb, Cr6+, Cr3+, Cu, Zn, Hg, total oil and total coliform.

The result of analysis indicated that the quality of the seawater in the project area is quite satisfactory and basically meets the relevant national standards of Vietnam (TCVN 5943-1995), in particular for industrial offshore water use like port water use. Still, considering the fact that this offshore area (Lach Huyen Estuary) is not yet a port water use area but is actually located in the proximity to the Cat Ba Island, most of which is protected national park (even though the protected area is located along the western part of Cat Ba Island opposite to the coast of Lach Huyen Estuary), the coastal seawater quality is assessed as slightly polluted for coastal water located in the proximity of an important national park (Cat Ba National Park). In particular seawater quality is evaluated as slightly deterioration with respect to ammonium level (NH3N), heavy metallic content of lead (Pb) and oil content in water. Seawater pollution due to oil content (even though pollution is still slight) in Lach Huyen Estuary is an issue potentially directly related to maritime transport including this project formulation.

5) Sediment Quality in Estuarine Seabed

The seabed material (sediment) quality sampling was done as part of the baseline primary data collection for the EIA Study in May 2006 at the same seabed locations of the 5 seawater quality sampling locations along the Lach Huyen Estuary as described above (item (d)). The seabed (sediment) quality parameters measured included 6 heavy metals (Cu, Pb, Zn, Cd, As and Hg) and total oil content in sediment.

No analysis of the results are included in the EIA Report that could be also attribute to lack of national standards in Vietnam concerned to sediment quality. Still as guidance the results of sediment quality were evaluated using the Sediment (dredged material) Quality Standards of Netherlands as given in the reference document of the World Bank (WB) “Environmental Considerations for Ports and Harbor Developments” (1990). Consequently, it is confirmed that all 6 heavy metals and oil content measured in all 5 location are within the limit of “Reference Value” according to the above standards of Netherlands, representing sediment quality under natural condition. Accordingly, the seabed sediment in the planned project area is regarded as unpolluted (in natural condition).

In addition seabed material quality in the planned dredging and reclamation area for this planned project was measured as part of this update natural condition survey at 80 number of seabed locations as also described in Chapter 7. The results of seabed material quality are also given in Section 7.3.1 of Chapter 7. The results obtained (with respect to the statistically relevant values) were evaluated using the Standards of Netherlands as shown in Table 9.2.1 of below. Accordingly, it is concluded that the seabed surface targeted for dredging in overall is not significantly contaminated and hence the dredged material is suited for unrestricted disposal management.

Table 9.2.1 Evaluation of Lach Huyen Port Seabed Quality

Parameter	Statistically Relevant Values (mg/kg)			Standards of Netherlands* (mg/kg)			Remarks
	Range	Mean	Median	Reference Value	Testing Value	Signaling Value	
Cu (Copper)	5.39~ 69.09	22.96	37.23	36	90	400	Slight contamination
Pb (Lead)	15.89~ 95.46	49.56	55.68	85	530	1000	Extremely slight contamination
Zn (Zinc)	35.69~ 249.35	106.41	142.52	140	1000	2500	Slight contamination
Cd (Cadmium)	0.12~ 1.86	0.75	0.99	0.8	7.5	30	Slight contamination
As (Arsenic)	0.51~ 6.38	1.88	3.45	29	85	150	No contamination (Natural condition)
Hg (Mercury)	0.13~ 1.47	0.45	0.80	0.3	1.6	15	Slight contamination
Cr (Chromium)	19.11~ 89.31	52.47	54.21	100	480	1000	No contamination (Natural condition)
Ni (Nickel)	10.00~ 52.90	29.03	31.45	35	45	200	Somewhat slight contamination
Total Oil Content	9.98~ 499.82	64.57	254.90	50	3000	5000	Slight contamination

*Source: Environmental considerations for ports and harbor developments (1990), World Bank technical paper 126
Reference value: Limit of guidance value representative to natural condition
Testing value: Limit of guidance value representative to allowable contamination
Signaling value: Guidance value representative to high level of contamination

6) Ecological Condition

Ecological condition survey targeting the aquatic seawater (estuarine seawater) and seabed environment of Lach Huyen Estuary of the project area and also the wetland coastal area of Phu Long region in Cat Ba Island (Cai Vieng ferry and passenger port terminal area of Cat Ba Island belongs to Phu Long region), the coastal region of Cat Ba Island located closest to the planned port area (the narrowest strait of Lach Huyen Estuary separating Cat Hai and Cat Ba Islands with a width of about 1000m) was also conducted in May 2006 as a very significant component of the baseline primary data collection for the EIA Study.

The proximity of Cat Ba Island to the planned port area in which most of its western terrestrial and coastal marine water environment is a protected national park (Cat Ba National Park) as also noted under Item (1) on Location also imparts the importance for the conduct of baseline (existing) ecological condition survey in the project area and its vicinity. Still, this survey was conducted only once in May 2006 (in fact all environmental surveys mentioned above are conducted only once in the same month of May 2006). This one time only survey without accounting for any seasonal variation (dry season and wet season, to be the least) is an important limitation of the ecological condition survey to have a broad interpretation of the results obtained. In addition to the primary sampling work, available past study data were also used in the EIA Report to elaborate both the existing (baseline) estuarine seawater and coastal wetland (Phu Long coast of Cat Ba Island) ecological condition of the project area and its vicinity.

The seawater and seabed areas targeted for surveys on aquatic marine ecology are the same 5 locations of Lach Huyen Estuary for seawater and sediment quality sampling as described under foregone items of (d) and (e). The marine (estuarine) ecological parameters measured included; phytoplankton and zooplankton in estuarine seawaters and benthos in estuarine seabed. Wetland ecological condition survey in Phu Long region of Cat Ba Island focused entirely on coastal floral ecology along 2 transects in perpendicular directions that also included seaweed species in the area. Regarding the ecological condition of higher order marine organisms like fish basically available secondary data were referred for the EIA Study. Still, all survey results, in consideration to the limited one time sampling and the 5 sampling locations that are rather close to each other, were comprehensively analyzed in the EIA Report with reference to other available past survey results in Lach Huyen Estuary and its vicinity.

a) Phytoplankton in Estuarine Seawaters

Phytoplankton species are very small flora. They are very significant to marine ecological system as the primary producers for producing organic substance from inorganic substance (with photosynthesis) and are important source of food for larva and other young individual marine fauna including zooplankton. Phytoplankton species are unicellular in nature though they can connect with each other and become a chain. In case of blooms due high availability of nutrients (consequent to water pollution), they can connect and become a floating membrane on the water surface and create even red tide. Therefore, they are considered as important biological indicators of water environmental quality with their excessive concentration visually serving as indicators of water environmental pollution.

In total 135 species of phytoplankton are identified based on the survey results, which is in agreement with previous surveys in the area. No water quality deterioration that could be attributed to excessive concentration of phytoplankton is evident in Lach Huyen Estuary.

b) Zooplankton in Estuarine Seawaters

Zooplankton is very important to the food chain as the basic food source of animal origin (phytoplankton is the primary food source of vegetable origin) for the development of diverse fauna ecosystem composed of fish and other higher order marine fauna. They are the basic animals in the chain of food consumption (primary consumers) and they consume phytoplankton and organic humus thereby converting primary food sources (vegetable origin) into higher form of meat (animal origin). Then they become the food for other higher order marine fauna such as shrimps, crabs and fish. Therefore, in order to understand the species characteristics in marine seawater environment analysis of zooplankton is very important (similar to phytoplankton).

In total 22 species of zooplankton were identified in the 5 sampling locations surveyed, which is quite few in comparison to previous studies in the same area. In previous surveys covering Bach Dang Estuary in total 61 species were identified. The limited space of sampling (basically within the narrow strait of Lach Huyen Estuary confined by Cat Hai and Cat Ba islands and its vicinity) in combination with only one time sampling is considered as the reason for the low number of zooplankton species identified by this survey.

c) Benthos in Estuarine Seabed

Of the 5 seabed sampling seabed locations, seabed benthos was identified in 4 locations only. The location with no benthos is composed of seabed with sandy soil condition, which could be the reason for the nonexistence of seabed benthos in this location. In this survey for EIA Study, in total 41 seabed benthos fauna species were indentified in the Lach Huyen Estuary seabed area. This represents about 29% of the total species of benthos fauna reported to be in existence in the wider Bach Dang Estuary area. Again the limited space of sampling in combination with only one time sampling is considered as the reason for the low number of benthos fauna species identified by this survey.

d) Wetland Flora in Phu Long Region

In Lach Huyen Area, wetland flora in natural condition is still predominant only along the Phu Long Coast of Cat Ba Island. The wetland flora existed in Cat Hai Island has already been destroyed long ago for aquaculture ponds (conversion to totally manmade unnatural ecosystem). The survey found 23 different floral species in Phu Long Coast, which is a muddy clayey wetland area. Of these 23 flora species, there are some species with high ecological and economic value as the area has very significant concentration of mangrove vegetation. Such ecologically important mangrove species identified included *Avicennia lanata, Excoecaria agallocha, Kandelia candel, Rhizophora stylosa* and *Annona glabra*. These mangrove species in addition to their intangible indirect economic benefits such as serving as spawning grounds for a variety of marine fauna like fish and shrimps and servicing as natural barrier against coastal erosion, also has direct economic benefits such as use of mangrove stems as firewood and charcoal, mangrove barks for extraction of tannin, mangrove flowers for raising honey bees and others. The other floral species identified mostly belong to the species type of sea grass and shrubs.

e) Sea Fish

Gateway of Bach Dang Estuary is funnel shaped with little fluctuation in morphology and structure of fish species. No primary sampling work to identify fish species was conduced for this EIA Study. Instead available data from the previous studies were used that was complimented with interview survey with fishermen and local people in Cat Hai market and Phu Long market.

The available data by Nguyen Nhat Thi (1991) showed that there are about 101 fish species in the Bach Dang Estuary and surrounding coastal water environment. In general, the fish species composition is quite rich. However, due to the fast moving characteristics of fish, the number of fish species which can be captured is not many, only about 20 species at a time during most previous surveys.

The fish variety in Bach Dang Estuary could be divided into 2 main groups:

(1) Fish species inhabiting the estuary: This is the group of species that has the ability to adapt to the very significant change in salinity and seasonal temperature, the characteristics peculiar to the Estuary. Fish species such as *Clupanodon, Thrissa, Coilia, Salanx acuticeps, Glossogobius, Hemiramphus itermedius* are representative ones belonging to this group.

(2) Offshore fish species using the estuary as breeding grounds in breeding season: In this group there are a lot of fish species with high economic value and their sizes are quite big. Such typical fish species of economic value caught by fishermen include *Scoliodon shorhachowah, Sardinella jussieu, Harengula nymphaea, Priacanthus tayenus, Caranx malabaricus, Selaroides leptopis, Lutianus, erythropterus, Nemipterus japanicus, Pomadaisys hasta, Upeneus moluccens, Rastrelligen kanagurta, Scomberomorus commersoni* and others.

f) Overall Ecological Status

Even though the approved EIA Report (2008) did not clearly make any overall ecological evaluation it is understood based on subsequent discussions conducted with HYMENET that the survey results including available results of pervious studies indicated there is no known existence of rare or endangered fauna or flora (marine biota) in the target project area for the port and its vicinity. This implies the target seabed areas for dredging and reclamation for the port development project are also not habitat for any rare or endangered marine biota. Accordingly, any short-term adverse effects due to dredging works on aquatic marine biota including the limited permanent loss of seabed area (in particular, as habitat of seabed benthos) consequent to the reclamation for the port terminals is evaluated as not that significant in consideration to the availability of vast similar unaffected seabed areas that would continue remain as habitat for marine biota including seabed benthos. This evaluation could also be made from past experience of similar works conducted for port development (and also for IWT navigation channels) both in Vietnam and other countries.

9.3 Social Environment

9.3.1 Socio Environmental Condition of the Proposed Port and Connecting Road and Bridge

Due to the physical and economical boundaries within the expected project area for the Lach Huyen port and Tan Vu-Lach Huyen Highway projects, the affected area would be categorized into six (6) zones (Figure 9.3.1)

(1) Hoan Chau Commune (south west end of the Cat Hai island)

(2) Nghia Lo Commune (west end of the Cat Hai island)

(3) Van Phong Commune (central and south end of the Cat Hai island)

(4) Dong Bai Commune (north east end of the Cat Hai island)

(5) Cat Hai TT (the central village and south east end of the Cat Hai island)

(6) Phu Long Commune (west end of Cat Ba island and facing the new port berths)

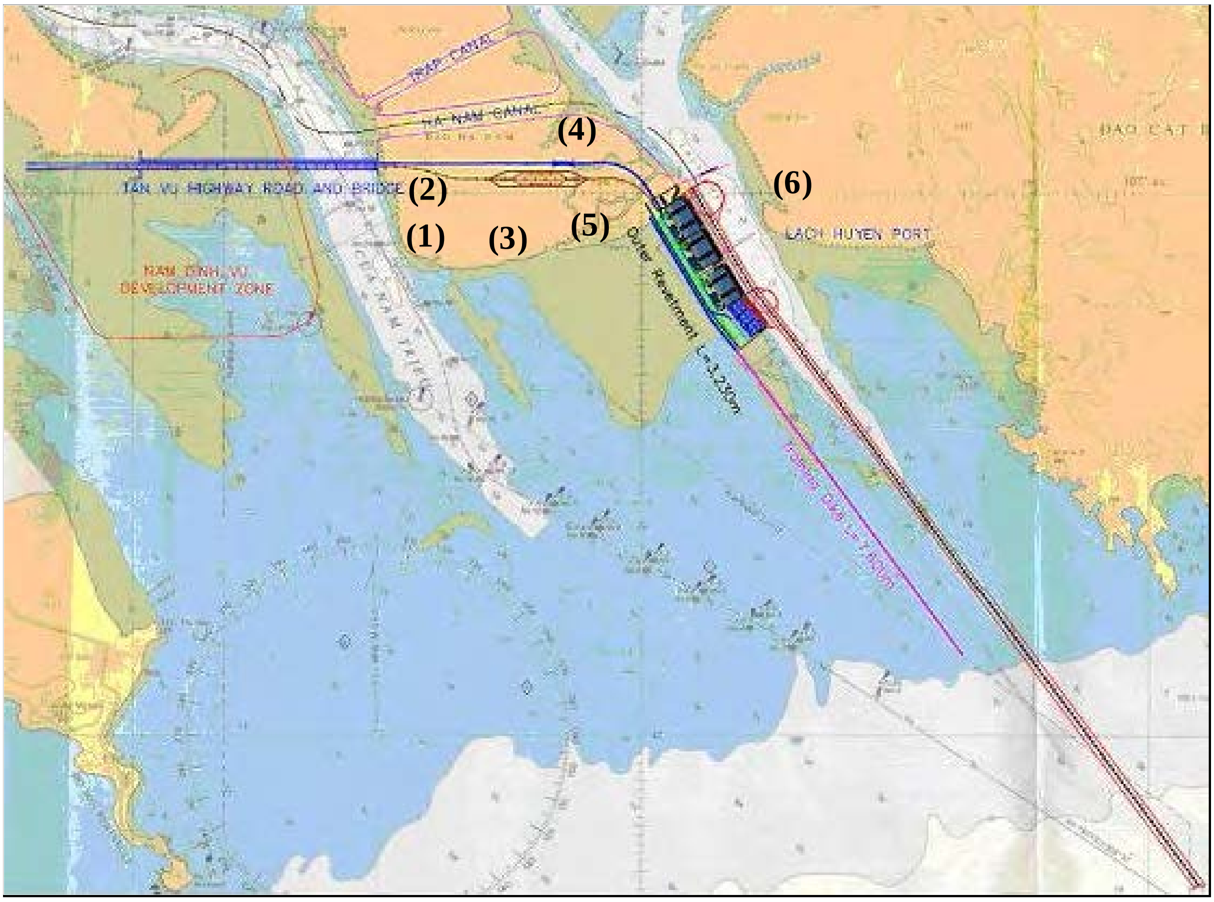


Figure 9.3.1 Potentially Affected Area for the Lach Huyen Gateway Port Project

General description of the potentially affected area is as follows:

1) Hoan Chau Commune, Cat Hai island

Hoan Chau commune is located at the south west end of the Cat Hai island. Primary occupation of this commune is aquaculture (180 out of 340 household) on the island and coastal fishing (70/340). Unlike other communes, there are only 5ha salt pan in the commune. Due to the limited job opportunities, most of the young people leave the commune to work in the cities and continue study in universities in major cities and work out side of the island. This commune will not be physically affected by either the port or Tan Vu-Lach Huyen highway project. However, particularly, some fishermen would be directly affected by the port and sand control dike structures. Based on the discussion with commune officers and representative of the local people's committee, both port and highway projects are well noticed and accepted by both local authorities and people.

Seaweed on the Concrete Dike along the southern coast and Aquaculture Pond (right)

Interviewing with Officials

2) Nghia Lo Commune, Cat Hai island

Nghia Lo commune is located at the west end of the Cat Hai island where the Dinh Vu-Cat Hai ferry arrives. Primary occupation of this commune is salt production and aquaculture. Though this is the west gate of the Cat Hai island, there are not many business activities for tourists or other services except the salt production and aquaculture. As same as the other communes, most of the young people leave the island after the high school education due to lack of new job opportunities. This commune will not be physically affected by the port project but will be physically affected by the Tan Vu-Lach Huyen highway project. Based on the hearing with project affected people by the highway project, both port and highway projects are well noticed and welcomed as long as an adequate safeguard policy is applied for recovery of property and livelihood.

Ferry Terminal

Typical Salt Pan

3) Van Phong Commune, Cat Hai island

Van Phong commune is located at the south central of the Cat Hai island. Primary occupation of this commune is salt production and aquaculture. There are also some fishermen depending on coastal fishing only in coastal area with small boats. As same as the other communes, most of the young people leave the island after the high school education due to lack of new job opportunities. This commune will not be physically affected by either the port or Tan Vu-Lach Huyen highway project. However, particularly, some fishermen would be directly affected by the port and sand control dike structures. Based on the hearing with the chief representative of the Van Phong commune, residents of the commune will appreciate the both port and highway projects and wish to contribute to the economic development of Hai Phong city and the nation.


Typical Salt Pan in Van Phong


Interviewing with the Head of Van Phong

4) Dong Bai Commune, Cat Hai island

Dong Bai commune is located at the north east end of the Cat Hai island. Primary occupation of this commune is salt production and aquaculture. There are also some fishermen using fishing net along the coast and coastal fishing. As same as the other communes, there are not many job opportunities except traditional salt, aquaculture, fish source (nước mắm) production. Dong Bai commune will not be physically affected by the port project but will be physically affected by the Tan Vu-Lach Huyen highway project. Some fishermen would be directly affected by the port and sand control dike structures. Based on the hearing with the commune officials and potentially resettled persons in the commune, residents of the commune are fully supportive for the both port and highway projects and expected to have better living standard and better job opportunities.


Fish net along the coast


Salt pan and Residence of Dong Bai

5) Cat Hai TT, Cat Hai island

Cat Hai TT (town) is the central area and located at the southeast end of the Cat Hai island. Occupation of Cat Hai TT varies such as the traditional salt production, aquaculture and coastal fishing and nontraditional in commerce and variety of services. However, as same as the other communes, there is lack of new job opportunities for young people. Cat Hai TT will be physically affected by either the port or Tan Vu-Lach Huyen highway project. Also, some fishermen would be directly affected by the port and sand control dike structures. In addition to the residents of Cat Hai TT, there are some immigrant fishermen living in Got harbor, the east gate of the Cat Hai island, who depend on the coastal and offshore (Ha Long bay and south of Cat Ba island) fishing and seasonally go back to their hometown. Some immigrant fisherman conducting coastal fishing at the proposed site would be directly affected by the proposed port development project. Based on the public hearing in April 2010 at Cat Hai TT and EIA report, residents of the commune welcome both port and highway projects and are expecting good business and job opportunities.

	
Small fishing boats along the coast	Immigrant fishing boats in the Got harbor

6) Phu Long Commune, Cat Ba island

Phu Long is located as west end of Cat Ba island and is the only directly affected commune in Cat Ba island. Cat Ba island is one of the most famous islands in the region for the part of the Ha Long bay, the UNESCO world heritage. However, unlike the popular destination of the tourists and world heritage side of the island, the west coast of the Cat Ba island is very quit and hosts the traditional coastal fishing and aquaculture for the locals. As similar to the Cat Hai island, there are not many new job opportunities for young people in the community so that young people tend to go finding a job in central town in Cat Ba island or major cities. Phu Long commune will not be physically affected by either the port or Tan Vu-Lach Huyen highway project. However, some coastal fishermen would be directly affected by the port and sand control dike structures. Some fisherman are also using fishing net along the coat, which have already been banned for the preparation for the Lach Huyen port project and compensated for the loss of the net fishing right by the Cat Hai district. Based on the discussion with fishermen at a small port in Phu Long, they are generally supportive for the port development project and interested in the development of the regional economy. However, due to the inefficient information disclosure in the community, residents including potentially affected fishermen are not quite familiar with the project itself.

	
Coastal and offshore fishing boats at Phu Long harbor	Residence along the main street in Phu Long

9.3.2 Legal Updates after the Approval of the Lach Huyen Port EIA

Summary of the effective law and regulations are shown in section 9.1.2. Since the EIA of the Lach Huyen port was approved in 2008 and there are some changes in port design, MPMU II is likely to require additional EIA. In the case of the preparation of the additional EIA and land acquisition, which is additionally required due to the change in design, newer law and regulation might be applied. Followings are the legal updates relevant to the social environment.

1) Legal Updates Relevant to Law on Environmental Protection 2005

There are no updates relevant to the law on environmental protection so that it is not necessary to consider the applicability of the presently approved EIA and the upcoming additional EIA. Though MONRE has been working on an improvement of a guideline on law on environmental protection, it will not be applicable for the upcoming additional EIA due to the time gap between the effective date of a regulation and applicable date of the regulation.

2) Legal Updates Relevant to Land Law 2003

There are several key updates relevant to land law 2003. Followings are the list of the key updates that should be addressed to prepare the land acquisition plan.

- Decision No. 130/2010/QD-UBND on compensation on support & resettlement policy on Hai Phong City
- Circular No. 14/2009/TT-BTNMT detailing the compensation, support and resettlement and order of and procedures for land recovery, allocation and lease
- Decree No.69/2009/ND-CP to amend a number of provisions on land use planning land rental rates land reclamation and resettlement and compensation

Decision No.130/2010/QD-UBND of Hai Phong city was prepared to adapt and follow the requirement of Circular No.14/2009/TT-BTNMT, which requires municipal governments to prepare the locally adapted safeguard policy on resettlement and compensation. Decision No.130/2010/QD-UBND follows the most updated law and regulations and gives some local specifications such as land price. Circular No.14/2009/TT-BTNMT and Decree No.69/2009/ND-CP were developed and put into force to improve the practicability and applicability of previous regulations including the safeguard policy on involuntary resettlement, Decree No. 197/2004/ND-CP on compensation, support and resettlement when land is recovered by the State. Though Decree No. 197/2004/ND-CP is still effective, the latter circular and decree specify the applicable condition and repeal previous conditions to meet realistic needs and improve the safeguard policy close to international standards. Specifically, the involvement of the project affected people such as requirement of public hearing and improvement of the resettlement plan with the public opinions is clearly stated in Decree No.69/2009/ND-CP while Decree No.197/2004/ND-CP only required notification.

However, there are still some gap between the JBIC standards, which refers the World Bank's involuntary resentment policy (WB OP4.12), especially in the condition of eligibility and compensation. As stated in Article 1 of Decree No. 197/2004/ND-CP, the donors safeguard policies shall be applied in case such policies are different from Vietnamese and donors' policies and government of Vietnam agrees to apply the donors' policies. Therefore, the JBIC Guideline/WB OP4.12 is likely to be applied for the proposed Lach Huyen port project. As described in section 9.1.3 2) Compliance of the Approved Lach Huyen Port EIA with the JIBC Guideline, the safeguard policy of Northern Delta Transport Development Project, which adapted WB OP4.12, shall be referred for the Lach Huyen port due to the consistency of the ODA projects in the same region and same time.

9.3.3 Confirmation of the Impacts on Social Environment with the Checklist of JBIC Guideline

The result of the approve EIA review is summarized with the JBIC Guideline checklist below.

1. Permits and Explanation
(1) Explanation to the Public

- **Adequate explanation of project and its impact, public acceptance**

  Adequate explanation was given and opinion of the potentially affected people (PAP) was collected by both responsible local authorities and PAP's communities (fatherland front committee), which are required by Law and relevant regulations. In addition to the required public consultation by the Vietnamese law, the responsible implementation agency-MPMU II voluntary conducted a public consultation to have PAP understand the project further and encourage active participation of the project in April 2010. Record of the publish hearing is shown in Appendix 9-2

- **Proper responses made to comments from the public and regulatory authorities**

  The local authorities and communities' responses are recorded and mentioned in the approved EIA. The regulatory authorities' comments are also given in the approval letter of the project EIA. In general, projects are well supported by the potentially affected communities. In addition, Based on the public hearing in April, announcement of the project's concrete schedule and consideration for the coastal fishing were requested by the representatives of the Cat Hai TT. MPMU II agrees to provide the concrete schedule shortly and work together with responsible authorities for the consideration of the potentially affected fishermen

4. Social Environment
(1) Resettlement

- **Possibility of involuntary resettlement, any effort made to minimize the impacts**

  There is no resettlement required for the project. However, due to the change in design, land acquisition is required for public related facilities, which requires resettlement of toms and aquaculture ponds and land clearance of a community forest.

- **Adequate explanation on relocation and compensation given to affected persons prior to resettlement**

  Hai Phong city, Cat Hai district and commune authorities, who are responsible for the resettlement and land acquisition by law and regulation, have already consulted with project affected people (PAP) for fishpond and relatives of the toms and acquired general acceptance of the project and relocation.

- **Adequate resettlement plan, including proper compensation, restoration of livelihoods and living standards developed based on socioeconomic studies on resettlement**

  There are no resettlement plan available for the approved EIA due to the requirement of public own land at the original port development study. Due to the change in design to add public facilities, relevant authorities of Cat Hai district and MPMU II are preparing a resettlement plan/land acquisition plan, which is required by law and regulation to secure proper compensation and restoration of livelihoods and living standards.

- **Attention to vulnerable groups or persons, including women, children, the elderly, people below the poverty line, ethnic minorities, and indigenous peoples for the resettlement plan**

There are no vulnerable groups or persons in the affected area. However, special attention to immigrant fishermen coming from outside of the Cat Hai district and living on the boat might be needed. Responsible authorities and MPMU II are working on the safeguard policy on coastal fining activities, which is likely to include such affected fishermen.

- **Agreements with the affected persons obtained prior to resettlement**

Though the detailed condition will be settled in detail design stage, general agreements were given by the PAP through initial consultation by the local authorities.

- **Framework for proper implementation of resettlement, capability of resettlement and security of budget**

People's committee of Hai Phong city is responsible for the resettlement/land acquisition and has capability to implement the resettlement/land acquisition throughout the variety of resettlement activities in the area. The budget will be secured and transferred from the MOT, responsible ministry of the project owner, to Hai Phong city.

- **Availability of a monitoring plan for the impacts of resettlement**

Preparation of monitoring is mandate by law and monitoring will be included in the land acquisition plan, which is under the process of the preparation as of the end of April 2010.

(2) Living and Livelihood

- **Possibility to adversely affect the living conditions of inhabitants, adequate measures considered to reduce the impacts**

Any price including daily food and other commodities is likely to increase due to the project implementation and substantial business activities at and around the project site. Separation of the immigrant workers and local residence at the initial stage and gradual merger are proposed for local residence to adapt such price rise

- **Possibility of changes in water uses (including fisheries and recreational uses) in the surrounding areas due to project will adversely affect the livelihoods of inhabitants**

Proposed project will eliminate some part of coastal fishing area. Though the consideration for such fishermen was initially omitted due to the small scale of activities, this SAPROF study confirmed the regular fishing activities at the proposed project area. Result of the coastal fishing survey is described in section 9.3.4 Fishing Activities around the Proposed Project Site. Responsible authorities of Hai Phong city and MPMU II are working on the safeguard policy for such fishing activities as of the end of April 2010.

- **Possibility to adversely affect the existing water traffic and road traffic in the surrounding areas**

The sand control dike (7,600m long) is likely to prevent daily transport by small transport boats/fishing boats between Cat Hai and Cat Ba. However, such impacts will be minimal and traffic will be taken over by the existing water traffic between the God port, Cat Hai and Cat Ba with road transport naturally.

- **Possibility of diseases, including communicable diseases, such as HIV/AID introduced due to immigration of workers associated with the project, any considerations given to public health**

During the construction and operation stages, a large number of construction workers and port workers may introduce some transmittable diseases such as HIV/AIDS, which are verified in Vietnam, in the communities. Not only for workers but also local communities, awareness education and prevention measures will be provided by the relevant authorities with the collaboration of local communities, contractors of the project and operator of the port. In addition, separation measures of immigrant workers and local residence, such as construction workers' temporally township, are recommended in the approved EIA. Detailed measures will be proposed in detail design stage.

(3) Heritage

- **Possibility of damaging the local archeological, historical, cultural, and religious heritage sites, Adequate measures considered to protect these sites in accordance with the country's laws**

  There are no heritage sites in the proposed sites.

(4) Landscape

- **Possibility to adversely affect the local landscape, and necessary measures taken**

  Though offshore land fill will significantly change the landscape of the local communities, the change will be rather considered as positive change in landscape. The change of the landscape could be considered as the symbol of the contemporary development area as categorized as Hai Phong development master plan.

(5) Ethnic Minorities and Indigenous Peoples

- **Complying with the country's laws for rights of ethnic minorities and indigenous peoples**

  Though there are no concerned people in the project area, the proposed project will fully comply with minority protection if it's necessary.

- **Considerations given to reduce the impacts on culture and lifestyle of ethnic minorities and indigenous peoples**

  There are no concerned communities in the project area.

5. Others

(1) Impacts during Construction

- **Adequate measures considered to reduce impacts during construction (e.g., noise, vibrations, turbid water, dust, exhaust gases, and wastes)**

  The necessary mitigation measures are examined in the EIA Report. The contractor shall be obligated to strictly adhere to EHS (environment, health and safety) aspects of the construction works in integral manner with due formulation and execution of EHS management and monitoring.

- **Adequate measures considered to reduce impacts for the natural environment (ecosystem)**

  With due EHS management and monitoring by contractor as above adverse effects could be mitigated.

- **Adequate measures considered to reduce impacts for social environment**

Adequate measures will be applied to prevent the adverse effects on the local communities for the construction period, especially consideration for local communities and immigrant workers communities. Temporally township for immigrant workers and occasional opportunities, such as meeting or festival, to bridge the gap between locals and immigrant workers are proposed by the responsible authorities.

- **Possibility of health and safety education (e.g., traffic safety, public health) provided for project personnel, including workers if they are necessary**

EHS management program and monitoring shall be implemented by construction contractors supervised by relevant authorities.

9.3.4 Fishing Activities around the Proposed Project Site

As a part of reviewing process, JICA SAPROF experts have consulted with HYMENET, the EIA consultant for the Lach Huyen Gateway Port Construction Project Study, and requested a sample survey to understand the actual status of the fishing activities at the proposed project site. HYMENET and the JICA SAPROF experts (Natural Environment and Socio-Environment) conducted two field surveys at the site from 24 to 27 November, 2009 and from 30 March to 2 April (Table 9.3.1).

Table 9.3.1 List of the Interviewed Stake holders and Field Survey

24 Nov. Haiphong	Planning Institute of Haiphong Institute of Marine Environment and Resources
25 Nov. TanVu-DinhVu	Nam Hai Commune Authority Dong Hai II Commune Authority Border Guard Post at Dong Hai II A Fisherman at Nam Hai Four Fisherman off shore south of DinhVu around proposed alignment area
26 Nov. CatBa & CatHai	Division for Agriculture and Rural Development, Cat Hai District A Fisherman at Phu Long, Cat Ba Four Fisherman at TT Cat Hai in the harbor, Cat Hai
27 Nov. CatHai	Hoang Chau Commune Authority, Cat Hai Van Phong Commune Authority, Cat Hai
30 Mar. Haiphong	Department of Agriculture and Rural Development, Haiphong City Department of Land Management, Haiphong City
31 Mar. Haiphong	Department of natural Resources and Environment (DONRE) Department of transport, Haiphong city Transport and Tourism Joint Stock Company Field survey (Tan-vu/Dinh-vu)
1 Apr. Cat Ba/Cat Hai	Division for Agriculture and Rural Development of Cat Hai District Field survey (Cat Ba & Cat Hai)
2 Apr. Cat Hai	Field survey

1) Summary of the Hearing with Local Authorities

a) Department of Agriculture and Rural Development, Haiphong City

- Total area of aquatic cultivation in Haiphong at the present is 13500 ha, from these:

  Fresh water aquatic cultivation: 5000ha;
  Brackish water aquatic cultivation: 8500ha;
  Saltwater aquatic cultivation: 300ha;

- In addition to these, there are

  570 houseboats and 11500 float cage are used for aquatic cultivation;
  70 place for molluse cultivation.

- Total production of aquatic cultivation is 45600 tones, from these:

  Fresh water aquatic cultivation: 21200 tones;
  Brackish and saltwater cultivation: 24400 tones.

- Aquatic cultivation production of some major districts:

  Cat Hai District: 6500 T/year;
  Hai An District: 4100 T/year;
  Thuy Nguyen District: 3392 T/year;
  Duong Kinh District: 1000 T/year;
  Do Son District: 2050 T/year;
  Kien Thuy District: 1900 T/year;

- Number of fishing boats: 4090, from these:

  Engine capacity less than 20 HP: 2850;
  Engine capacity of 20 - 50 HP: 517;
  Engine capacity of 50 - 90 HP: 390;
  Engine capacity of 90 - 150 HP: 234;
  Engine capacity of 150 - 250 HP: 83.

- Main fishing zones:

  Zone 1:
  From Ba Lat Estuary of the red river to Do Son. Fishing in this zone is forbidden from May to July because this period is breeding season.
  Zone 2:
  From Cat Ba to Long Chau island (around zero point).
  Zone 3:
  Around Bach Long Vi island. This zone is one of the most productive fishing zones in the North of Viet Nam.

- Fishing season

  There are two fishing season in a year.
  First season starts from November and ends in next year April. In this season fishing is mostly offshore and main product is surface fish.
  Second season starts from April and ends in November.

- Fishing duration

  In the past fishermen normally go to fishing only for one day because they do not have enough oil for longer time. At the present fish men can go to fishing for some days and months because offshore service is rather good organized. Fishermen can buy oil and other necessary goods (fresh water, food etc.) and sell their fishing products on sea at fishing place with reasonable price.

b) Division for Agriculture and Rural Development, Cat Hai District in Cat Ba island

- Clearance and compensation for the Lach Huyen port project: all coastal area has already been cleared and compensation for such clearance has already been granted since 2002.
- Owner of each rod net received 5 mill. VND for compensation to move the net from the project area.

- Proposed relocation places for people affected by the project: Tien Hai, Cai Vieng II, Phu Long communes
- Exception of the coastal fishing activities: due to the traditional practices, only coast along the east area of Dong Bai commune and a part of Phu Long commune are not cleared yet. Such are will be cleared when the actual project construction is started.
- Legal reference: Fishery law (1995?), Decree 128 on administrative fine on aquaculture
- Restriction of the fishing means: Fishing trap is restricted by regulation to protect the biological resources. Issue of the fishing trap along the coast has stopped since 2002.
- List of the licensees for the fishing trap: even after the ban on fishing trap in 2002, division for agriculture and rural development of Cat Hai district has been tracking the historical ownership and approximate location of the licensed traps. A list of the licensees was provided
- Salt production area: more than 100 Ha in Cat Hai district
- Production of salt: 10,000 t/year
- Sales price of salt: 1,000 VND/kg
- Aquaculture area: more than 500 Ha in Cat Hai district
- Average income of the aquaculture: 30 million VND/Ha-year
- Lease price of aquaculture pond: 1.0-1.5 million VND/Ha-year


Fishing Trap Along The Coast


Aquaculture Pond in Cat Ba

c) Nam Hai Commune Authority

- Area of Jurisdiction: 4,000 ha
- Population: 10,000
- Average income level: 600,000 VND/capita-year

2) Summary of the Hearing with Potentially Affected Fishermen

a) A Fisherman at Nam Hai

- Origin of residence: Quang Ninh Province and Thuy Nguyen District of Hai Phong
- Activities and number of boats: roughly 50 fishing boats in the TT Cat Hai harbor, mostly from Quang Ninh Province and Thuy Nguyen District of Hai Phong
- Fishing area: ZERO-LINE, roughly 18 miles from the shore line within Bac Bo Bay
- Fishing area of Cat Hai fishermen: close to shore line only
- Primary fishing product: shrimp, small fish, octopus with fishing trap
- Average net income/month-boat: 5-7 million VND/month-boat with two fishermen except fuel and other fishing relevant expenditure
- Cost of boat: 200 million VND/new fishing boat

- Any concern: only 30% of the fish yield in the recent years compared to previous average due to degradation of water quality, increase of fishing boats, better fishing traps
- Any wish for another job opportunity: Little idea due to no skill except fish
- Opinion for the new port: Rather neutral, but interested in schedule and project area

	
Fishing Port at Nam Hai	Interviewing with a Nam Hai Fisherman

b) Four Fisherman off shore south of Dinh Vu around proposed alignment area

- Origin of residence: Nam Hai
- Fishing area: Coastal area for fish trap, ZERO-LINE
- Primary fishing product: shrimp, small fish, octopus
- Fish sales:

Fish sales:	Shrimp:	18,000 VND/kg
	Small fish:	10,000 VND/kg
	Octopus:	100,000 VND/kg

- Average net income/month-boat: 6-7 million VND/month-boat with two fishermen except fuel and other fishing relevant expenditure
- Any concern: only 30 – 40% of the fish yield in the recent years compared to previous average after the coastal development activities
- Opinion for the new port: Rather neutral, but very limited idea about the project

	
Traditional Fishing net off shore Dinh Vu	Fish yield in the coastal area

c) A Fisherman at Phu Long, Cat Ba Island

- Origin of residence: Phu Long
- Fishing area: coastal are in Bac Bo Bay
- Primary fishing product: shrimp, small fish, octopus with fishing trap

- Average net income/month-boat: 10 million VND/month-boat with two fishermen except fuel and other fishing relevant expenditure
- Opinion for the new port: Rather supportive and expecting positive benefits from the economical development in the region, but very limited information about the project though radio and news paper only

	
Fishing Port at Phu Long, Cat Ba Island	Fresh Fish from Coastal Area

d) Four Fisherman at TT Cat Hai in the harbor, Cat Hai

- Origin of residence: Quang Ninh Province and Thuy Nguyen District of Hai Phong
- Activities and number of boats: roughly 50 fishing boats in the TT Cat Hai harbor, mostly from Quang Ninh Province and Thuy Nguyen District of Hai Phong
- Fishing area: ZERO-LINE, roughly 18 miles from the shore line within Bac Bo Bay
- Fishing area of Cat Hai fishermen: close to shore line only
- Primary fishing product: shrimp, small fish, octopus with fishing trap
- Average net income/month-boat: 5-7 million VND/month-boat with two fishermen except fuel and other fishing relevant expenditure
- Cost of boat: 200 million VND/new fishing boat
- Any concern: only 30% of the fish yield in the recent years compared to previous average due to degradation of water quality, increase of fishing boats, better fishing traps
- Any wish for another job opportunity: Little idea due to no skill except fish
- Opinion for the new port: Rather neutral, but concern about their possibility to adapt and benefit from the regional development due to the limited skills

	
Fishing Boat with Traps (front) and Coastal Fishing Boat (behind left)	Interviewing with Visiting Fishermen

10. Review on Past Studies of Tan Vu – Lach Huyen Highway

10.1 Introduction

In the Northern Vietnam, Haiphong Port and Cai Lan Port have been operated to sustain the economic activities in this region. The cargo volume of these ports is expected to reach 110 million to 130 million ton in 2020, and thus the capacity will be overflowed. However, it is difficult to expand these ports from the technical and social points of view. In these circumstances, the development of Lach Huyen Port has been planned.

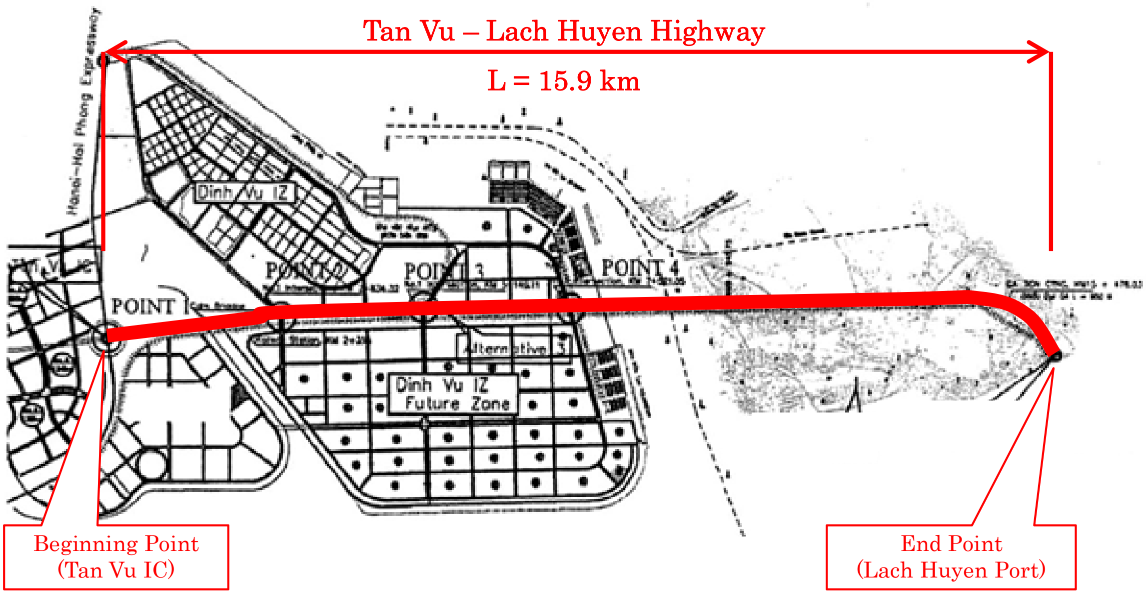
Lach Huyen Port will be constructed in Cat Hai Island, where is located at approximately 16km east of the mainland. In order to connect the mainland and Lach Huyen Port, it is required to construct the new highway (hereinafter referred to as “Tan Vu – Lach Huyen Highway”) including the bridge at Nam Trieu River.

To date, 3 studies have been carried out regarding Tan Vu – Lach Huyen Highway. In this SAPROF, their studies will be reviewed, and the consultant’s recommendations will be provided as well.

The major objectives for the review are as follows.

- The project should be revised as an ODA project although it has been planned as a BOT project.
- The plan and design should be modified for the purpose of shortening the construction period since Tan Vu – Lach Huyen Highway must be operated at the same time of the Lach Huyen Port operation.

The location map of the Tan Vu – Lach Huyen Highway is shown in Figure 10.1.1.



Source: Planning Construction Investment Project Tan Vu - Lach Huyen Highway Project in Hai Phong City, VIDIFI, 2009

Figure 10.1.1 Location Map

10.2 Outline of the Relevant Studies

10.2.1 Hai Phong - Lach Huyen Gateway Port Construction Investment Project (VINAMARINE's Study)

The feasibility study on Lach Huyen Gateway Port was carried out by Vietnam Maritime Bureau (VINAMARINE) in 2006. In the study, the following plans were proposed regarding Tan Vu – Lach Huyen Highway.

- Two links, namely Hai Phong Direction and Quang Ninh Direction, will be connected with Lach Huyen Gateway Port.
- 6-lane or 4-lane highway will be required to Hai Phong Direction by 2020 in case of "without railway" or "with railway", respectively.
- Both 6-lane highway and railway will be required to Hai Phong Direction after 2020.
- 2-lane highway will be required to Quang Ninh Direction by 2020 where the northern industrial zone is operated.
- 6-lane highway will be required to Quang Ninh Direction after 2020.
- As the structure type of main bridge at Nam Trieu River, 1,140 m of cable-stayed bridge (40m+260m+540m+260m+40m) will be planned.

10.2.2 Planning Construction Investment Project Tan Vu - Lach Huyen Highway Project in Hai Phong City (VIDIFI's Study)

In April 2007, the Government of Vietnam approved the development of Tan Vu – Lach Huyen Highway by BOT scheme, and appointed the Vietnam Development Bank (VDB) as the implementation agency of the project.

The feasibility study including EIA and RAP has been carried out by the Vietnam Infrastructure Development and Finance Investment, JSC (VIDIFI, JSC), who was the investor of the project in the BOT scheme. However, the report has not been approved by MOT although the final report was already submitted to MOT.

In the study, such design conditions as cross section, route alignment, bridge length, bridge type, intersection plan in Dinh Vu, etc. were proposed, and approved by the Planning Institute of Haiphong.

On December 4 2009, the Prime Minister decided that the project would be transferred from VBD to MOT, and thus the project will be implemented founded by Japanese ODA Loan instead of BOT scheme.

10.2.3 Port Capacity Reinforcement Plan in Northern Vietnam (MOT's Study)

This study was carried out by MOT in 2009. Objectives of the study were to study and review the current studies such as "VINAMARINE's Study" and "VIDIFI's Study".

The study covered the review of Tan Vu - Lach Huyen Highway development including Cat Hai Bridge as well as Hai Phong, Dinh Vu and Hon Gai Ports development.

Regarding Tan Vu - Lach Huyen Highway, another plan was proposed in terms of route alignment, bridge length, bridge type, intersection plan and so forth.

The final report was submitted in September 2009, and approved by MOT.

10.3 Summary of the Relevant Studies

Summary of each study item in "VIDIFI's Study" and "MOT's Study" is shown in Table 10.3.1.

Table 10.3.1 Summary of Relevant Studies

Item	VIDIFI's Study (July 2009)	MOT's Study (September 2009)
Implementation Schedule	36 months.	30 months.
Traffic Demand Forecast	4-lane in 2016. 6-lane without railway, 4-lane with railway in 2022.	6-lane.
Route Alignment	Follow the Hai Phong City Master Plan.	Not follow the Hai Phong City Master Plan to avoid residential areas.
Connection to Lach Huyen Port	Follow the port location proposed in VINAMARINE's Study.	2 alternatives were proposed.
Consistency with Dinh Vu IZ Master Plan	2 flyovers were planned at intersections.	No intersection, interchange and flyover are planned.
Soft Soil Treatment	Sand drain, with geo-textile and counterweight Soft soil replacement	
Bridge Length	L=5.44 km.	L=1.78 km.
Navigation Clearance	W 100 m × H 12 m × 2 Design vessel is 1000DWT	W 80 m × H 12 m × 2 Design vessel is less than 1000DWT
Bridge Type Main Bridge	PC box girder with V-shaped pier. 1 Box with rib slab. Maximum span length is 150 m.	PC box girder. Separate 2 boxes. Maximum span length is 90 m.
Approach Bridge	PC Super-Tee Girder. Span length is continuously 40 m.	
Foundation Type Main Bridge	Cast in place concrete pile D 1200.	
Approach Bridge	Cast in place concrete pile D 1200.	
Construction Method	Open cut method with temporary dyke.	Not considered.
Construction Cost	29 billion Japanese Yen	23 billion Japanese Yen
Social Environment Resettlement	331 houses in Cat Hai.	19 houses in Cat Hai.
Fishery	Small impact to fishery.	Propose additional survey and investigation.
Unexploded bomb	Not considered.	Not considered.
Natural Environment	Complete EIA, but not approved by MONRE.	Not considered.

10.4 Review of the Relevant Studies and the Consultant's Recommendation

10.4.1 Implementation Schedule

In VIDIFI's Study, the total construction period of the Tan Vu - Lach Huyen Highway was estimated as 36 months. It was proposed that the construction would be divided into 3 packages, namely earthwork (1) section (Dinh Vu area), bridge section and earthwork (2) section (Cat Hai area). The construction period of each package was estimated as 33 months, 36 months and 22 months for earthwork (1) section, bridge section and earthwork (2) section, respectively.

Meanwhile, in MOT's Study, it was proposed to reduce the construction period to 30 months by shortening the main bridge length from 5.44km to 1.78km.

The operation of Lach Huyen Port together with Tan Vu – Lach Huyen Highway is expected to be commenced in January 2015. In order to meet this schedule, the countermeasure to shorten the construction period should be studied in the further design.

The draft implementation schedule of the project is shown in Table 10.4.1.

Table 10.4.1 Implementation Schedule (Draft)

Item			Month	2010				2011				2012				2013				2014				2015			
				I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
1	F/S Stage	Saprof	6	■	■		☆L/A																				
2	D/D Stage	Procurment	3			■																					
		Detail Design	12				■	■	■	■																	
		Tender Document	3							■																	
3	Construction Stage	Procurment	15							■	■	■	■	■													
		Land Acquision	12								■	■	■	■													
		Resettlement	12								■	■	■	■													
		Construction	30												■	■	■	■	■	■	■	■	■	■			

Source: Study Team

10.4.2 Traffic Demand Forecast

The future traffic demand was forecasted for 2 sections, i.e. "Beginning Point – Dinh Vu Island" and "Dinh Vu Island – End Point" in VIDIFI's Study. The forecasted future traffic demand and required lane number are shown in Table 10.4.2.

Table 10.4.2 Future Traffic Demand and Required Lane Number in VIDIFI's Study

Section	Peak Hour	Direction	Year					
			2015		2022		2032	
			Future Traffic Demand	Required Lane Number	Future Traffic Demand	Required Lane Number	Future Traffic Demand	Required Lane Number
Beginning Point – Dinh Vu Island	AM	To Beginning Point	2,272	2	4,242	3	5,195	3
		From Beginning Point	1,304	2	2,751	3	3,949	3
Dinh Vu Island – End Point	AM	From End Point	1,680	2	3,143	3	3,459	3
		To End Point	583	2	1,450	3	1,826	3

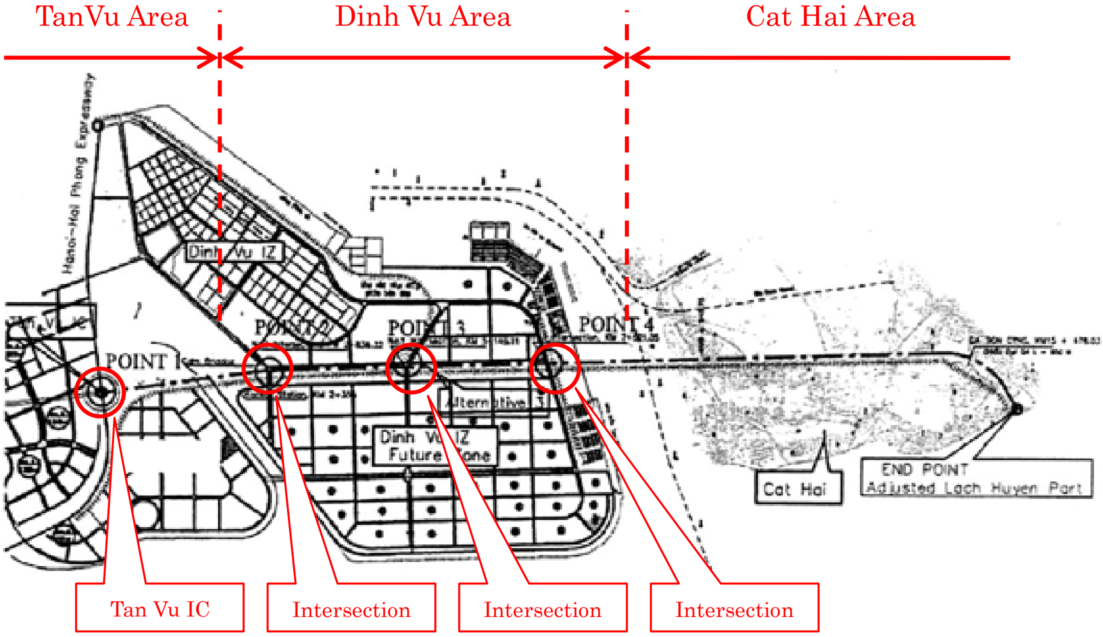
Source: Planning Construction Investment Project Tan Vu - Lach Huyen Highway Project in Hai Phong City, VIDIFI, 2009

The following items should be studied in the further design.

1) Traffic Demand Forecast at each Intersection

In VIDIFI's Study, the flyovers were proposed at 2 intersections in Dinh Vu Island without traffic capacity analysis at respective intersections.

It is recommended that the traffic demand forecast will be made for not only the highway but also crossing roads to analyze the capacity of respective intersections. Based on the intersection analysis, the type of intersections in terms of at-grade intersection, grade-separated intersection and interchange shall be determined.



Source: Planning Construction Investment Project Tan Vu - Lach Huyen Highway Project in Hai Phong City, VIDIFI, 2009

Figure 10.4.1 Location of Intersections in Dinh Vu

2) Toll Road or Non-toll Road

Tan Vu - Lach Huyen Highway was planned as a toll road since this project was expected to be implemented by BOT scheme. The future traffic demand was, therefore, forecasted as a toll road.

However, Tan Vu - Lach Huyen Highway is likely to be operated as a non-toll road since the project was transferred to MOT, and is expected to be implemented by Japanese ODA Loan.

Tolling system for Tan Vu - Lach Huyen Highway shall be studied in the further design. In order to determine the tolling system, the traffic demand forecast should be made for both toll road and non-toll road.

3) Railway Plan

Hai Phong City Master Plan shows the extension of Hanoi – Haiphong Railway to Lach Huyen Port. It was planned that the alignment of the railway will run along Tan Vu - Lach Huyen Highway (see Figure 10.4.2).

The traffic demand forecast for respective target years should be made in consideration of the traffic assignment between highway and railway as well as the construction schedule of the railway.

Source: Hai Phong City Master Plan

Figure 10.4.2 Railway Plan

10.4.3 Route Alignment

The alignment of Tan Vu - Lach Huyen Highway was proposed in VIDIFI's Study, and approved by the Planning Institute of Haiphong since it was planned based on the Hai Phong City Master Plan (see Figure 10.4.3).

It was planned in the Hai Phong City Master plan that the land use classification will be changed to port related land use in whole Cat Hai Island. Thus the alignment was determined without respect to the land acquisition, and a number of houses will be affected by the highway.

In Figure 10.4.3, Cat Hai Island is classified into three colors. Purple, blue and green color means port facility, port-related parking and green zone, respectively.

Source: Hai Phong City Master Plan

Figure 10.4.3 Hai Phong City Master Plan

Meanwhile, another alignment, which has S-curve, was proposed in MOT's Study in order to reduce the number of affected houses as many as possible. It does not follow the Hai Phong City Master Plan, and has not been approved by the Planning Institute of Haiphong.

The following studies should be carried out in the further design.

- The time schedule of the resettlement in Cat Hai should be confirmed although it is stated in VIDIFI's Study that the land acquisition/resettlement in Cat Hai will be completed by the commencement of the highway construction.
- The alignment should be determined in consideration of future land use plan.
- The land acquisition/resettlement should be reduced as many as possible since land acquisition/resettlement issue sometimes delays schedule of the project.
- It is planned that Tan Vu - Lach Huyen Highway is connected to Hanoi – Haiphong Expressway. In case the completion of the Expressway is delayed, another connected road should be studied, although the Expressway is scheduled to be completed by January 2015.

Figure 10.4.4 shows VIDIFI's alignment, MOT's alignment as well as another alignment proposed in this SAPROF (hereinafter referred to as "SAPROF's alignment").

SAPROF's alignment will make the number of affected house zero, and has an appropriate alignment as a highway (there is no S-curve, straight line in large part). However, it is one of the alternatives. The alignment should be studied in detail based on the required surveys/investigations in the further design.

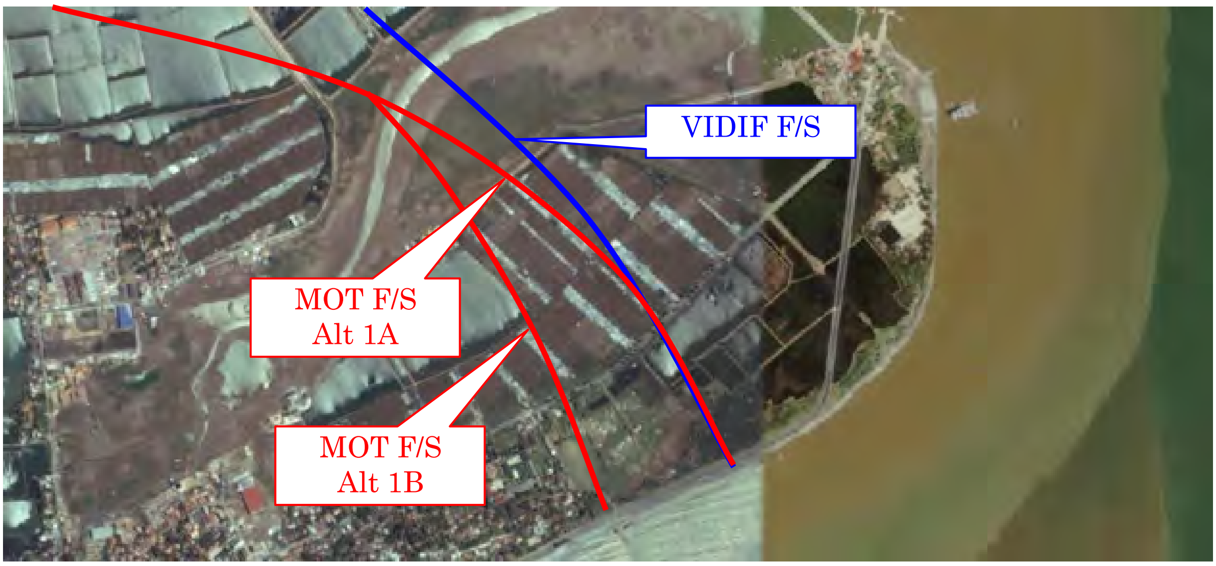
Source: SAPROF Team

Figure 10.4.4 Alternative Options in Cat Hai

10.4.4 Connection to Lach Huyen Port

The end point of Tan Vu - Lach Huyen Highway should be determined according to the location of Lach Huyen Port. It is proposed in this SAPROF that the location of Lach Huyen Port is changed from the original design (Hai Phong - Lach Huyen Gateway Port Construction Investment Project) to 140 m east.

The connection point to Lach Huyen Port in respective studies is shown in Figure 10.4.5.

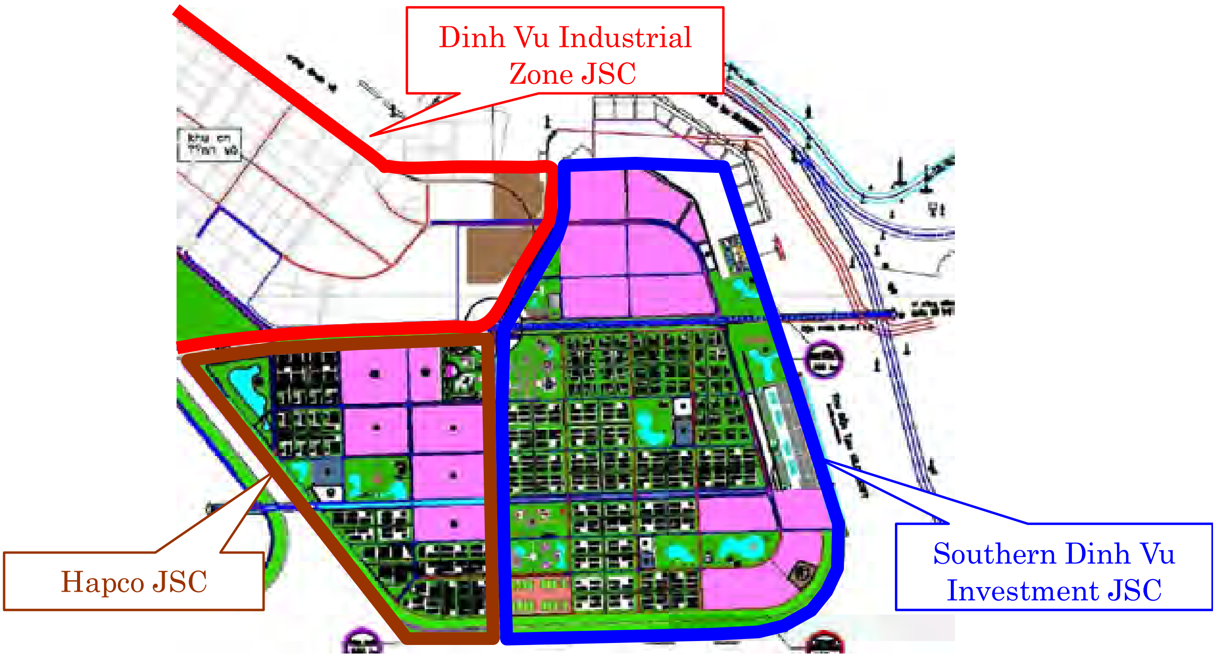


Source: SAPROF Team

Figure 10.4.5 Connection Point to Lach Huyen Port

10.4.5 Consistency with Dinh Vu Industrial Zone Plan

Dinh Vu Industrial Zone is planned to be expanded to east and south, and be operated by 3 companies, namely Dinh Vu Industrial Zone JSC, Southern Dinh Vu Investment JSC and Hapco JSC (see Figure 10.4.6).



Source: SAPROF Team

Figure 10.4.6 Dinh Vu Industrial Zone

Dinh Vu Industrial Zone JSC has been operating existing Dinh Vu Industrial Zone. The expansion areas are schedule to be operated from 2015 by Southern Dinh Vu Investment JSC and Hapco JSC, respectively. Land reclamation of these areas is, however, being delayed. It might be completed in 2025.

The design of Tan Vu - Lach Huyen Highway within the Dinh Vu Industrial Zone should be conducted in consideration of the following points.

- Construction schedule of the 3 Dinh Vu Industrial Zones
- Road plan within each Industrial Zone
- Land use plan for each Industrial Zone

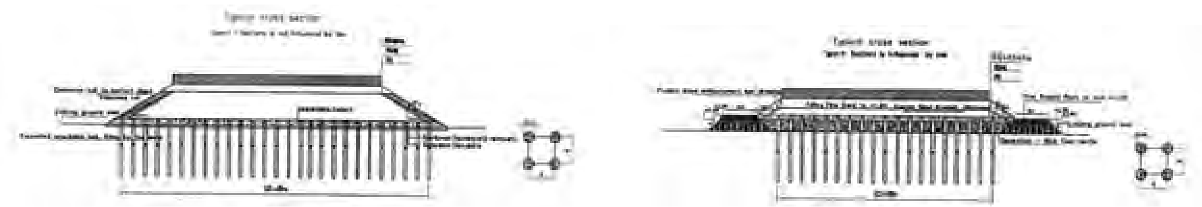
In addition, as stated in "10.4.2 Traffic Demand Forecast", 2 flyovers were planned in Dinh Vu Industrial Zone, and approved by the Planning Institute of Haiphong. In the further design, the intersection types should be studied based on the future traffic demand and traffic capacity analysis at respective intersections. The stage construction shall be one of the options, for instance at-grade intersection at initial stage and grade-separated intersection at next stage.

10.4.6 Soft Soil Treatment

In VIDIFI's Study, a series of geotechnical investigations were conducted. As the result of investigations, the necessity of soft soil treatment was confirmed for embankment sections in Tan Vu - Lach Huyen Highway.

2 types of soft soil treatment method were recommended in VIDIFI's Study, namely sand drain and soft soil replacement.

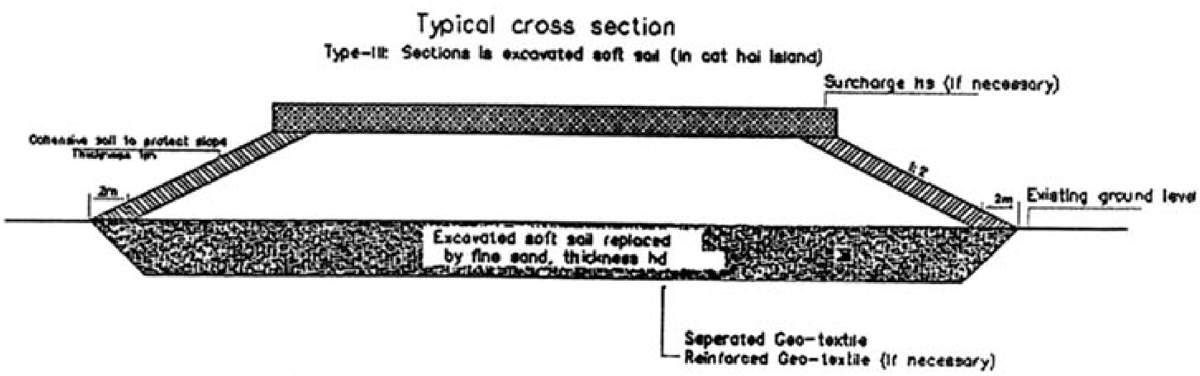
Sand drain method was recommended for sections whose embankment height is more than 2.5m (see Figure 10.4.7).



Source: Planning Construction Investment Project Tan Vu - Lach Huyen Highway Project in Hai Phong City, VIDIFI, 2009

Figure 10.4.7 Typical Cross Section of Soft Soil Treatment (Sand Drain)

Soft soil replacement method was recommended for sections whose embankment height is less than 2.5m (see Figure 10.4.8). It will be mainly applied in Cat Hai Island.



Source: Planning Construction Investment Project Tan Vu - Lach Huyen Highway Project in Hai Phong City, VIDIFI, 2009

Figure 10.4.8 Typical Cross Section of Soft Soil Treatment (Soft Soil Replacement)

Above-mentioned soft soil treatment methods are generally appropriate from the economical point of view. In addition to the economical, the following points should be considered in this project.

- The construction period should be shortened as much as possible since Lach Huyen Port together with Tan Vu - Lach Huyen Highway is scheduled to be completed in December 2014.
- This project is expected to be implemented by STEP (Special Term for Economic Partnership), which is one of the ODA load scheme. In order to apply STEP, the technologies and know-how of Japanese firms should be applied to the construction.

Soft soil treatment method should be determined from the comprehensive point of view including short construction period and application of STEP in further design. Soft soil improvement by Cement Deep Mixing Method shall be one of the alternatives.

10.4.7 Bridge Length

In previous studies, various alternatives of bridge length are compared.

1) VIDIFI's Study

VIDIFI's Study has shown comparative study on three alternatives as follows;

- Alternative 2: Bridge Length is 4.5 km
- Alternative 3A: Bridge Length is 5.44 km
- Alternative 3B: Bridge Length is 3.3 km and Flyover 0.3 km

In their conclusion, Alternative 3A is recommended because of reliability of construction, especially avoiding the risk of a soft ground in Dinh Vu IZ future area. However, there is a possibility to select the second recommended Alternative 3B, because sea dykes along the out line of Dinh Vu IZ future area is under construction now, and land reclamation in this area will be completed until 2015 according to confirmation with Investors.

2) MOT's Study

In MOT's Study, plans of three alternatives have drawn, as follows;

- Alternative 1: Bridge Length 1.9 km
- Alternative 2: Bridge Length 1.8 km
- Alternative 3: Bridge Length 1.9 km

Alternative 2 is recommended because of the lowest construction cost and operation technology suitable to capacity and ability of Vietnamese investors. However, there are no agreements with relative agencies, such as adjusting to the plan by Planning Institute of Haiphong and the others.

3) Recommendation

Recommended alternatives of this study team with consideration for the latest situation of various conditions, three alternatives for bridge length should be compared in the further study, as follows;

- Alternative 1: Bridge Length is 5.44 km (VIDIFI's Alternative 3A)

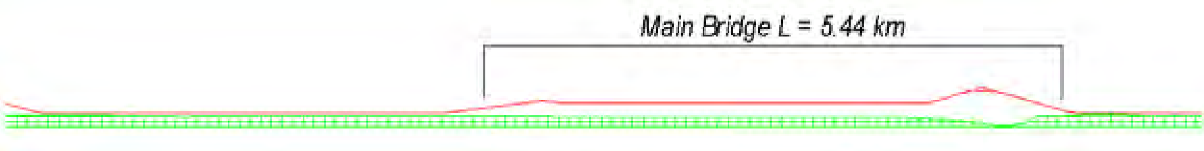


Figure 10.4.9 Alternative 1

- Alternative 2: Bridge Length is 2.54 km and Flyover 0.45 km

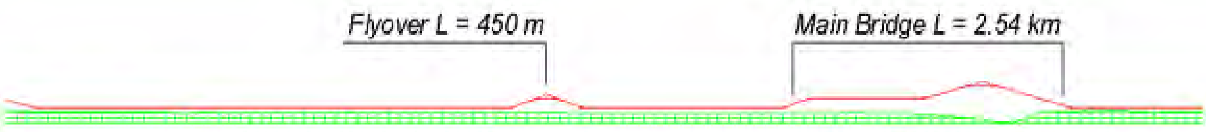


Figure 10.4.10 Alternative 2

- Alternative3: Bridge Length 1.78 km(MOT's Alternative 2)

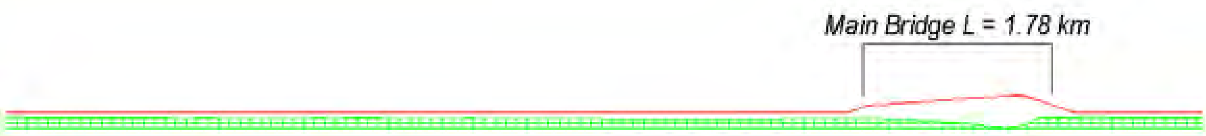


Figure 10.4.11 Alternative 3

Bridge length should be determined with consideration of various conditions as follows;

(1) Construction Schedule of the land reclamation for Dinh Vu IZ future zone

Master Plan for Dinh Vu IZ is planned by Planning Institute of Haiphong, and development area is divided into three areas. For each area, the investor is already decided, and construction is on going. According to the confirmation with these investors, the land reclamation will be finished in 2014. However, in consideration with current economic situation, the construction schedule is still not sure.

(2) Necessity of Flyover in Dinh Vu IZ

Future IC and 2 flyovers in DVIZ are planned VIDIFI's Study, however traffic demand forecast in DVIZ is not clear, so necessity of them should be verified based on traffic analysis.

(3) Construction Cost

In the case of shortening bridge length, access road in DVIZ should be constructed as causeway of embankment. If future area of DVIZ will not be completed until starting the construction of embankment, the cost of causeway will be higher. Therefore, comparison study on cost estimates between viaduct and causeway is significant, and total construction cost should be the lowest.

(4) Construction Schedule

The access road must be completed by the end of 2014 in order to be in time for provision of container terminal in Lach Huyen Port. Consequently, construction period will be expected almost two and half years, 30 months, therefore, the rapid construction methods are required to select optimum solution.

10.4.8 Navigation Clearance

The maximum span length depends on the navigation clearance. Therefore, consultants have to make sure design vessel and size of clearance. In previous Study, navigation clearance has shown as follows;

1) VIDIFI's Study

- The scale of navigation clearance is determined by MOT considering 1,000DWT vessels based on the recommendation letter by VINAMARINE, No.478/CHHVN-BCB, dated on 19 March 2009.

- Size of clearance is 2×W 100 m × H 12 m

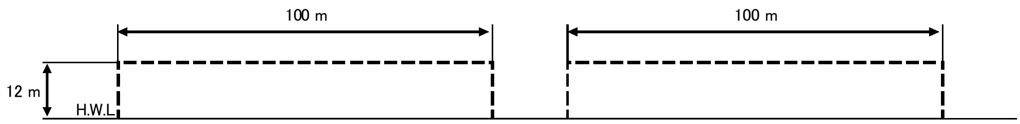


Figure 10.4.12 Navigation Clearance (In VIDIFI's Study)

2) MOT's Study

- Design vessel size is less than 1,000 DWT with the 12 m air draft from H.W.L.
- Width of 80 m × 2 traffic

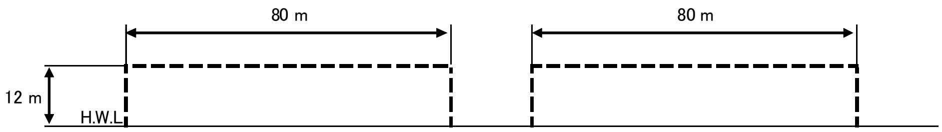


Figure 10.4.13 Navigation Clearance (In MOT's Study)

3) Recommendation

After completion of Lach Huyen Port, official navigation route is not through under the Cat Hai Bridge. Consequently, vessels of inland river transport should be considered for navigation clearance, so design vessel is less than 1,000 DWT. According to the size of design vessel, 1,000 DWT, and confirmation with MOT and VINAMARINE, the width of navigation clearance of 100 m × 1 for two ways is acceptable. Moreover, 80 m for one way × 2 is also enough to keep navigation route. At present, recommended alternatives of navigation clearance are two options, as follows;

- Alternative 1: 100 m for two ways

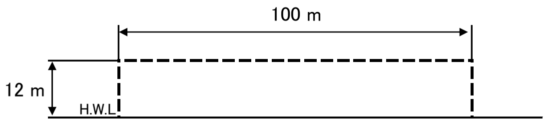


Figure 10.4.14 Alternative 1

- Alternative 2: 80 m for one way × 2

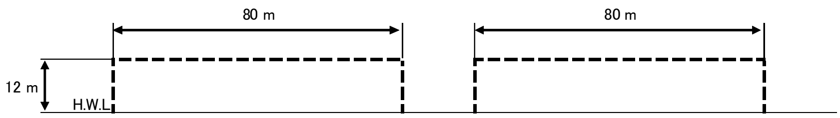


Figure 10.4.15 Alternative 2

The size of navigation clearance should be determined again by official letter from MOT and VINAMARINE.

10.4.9 Bridge Type

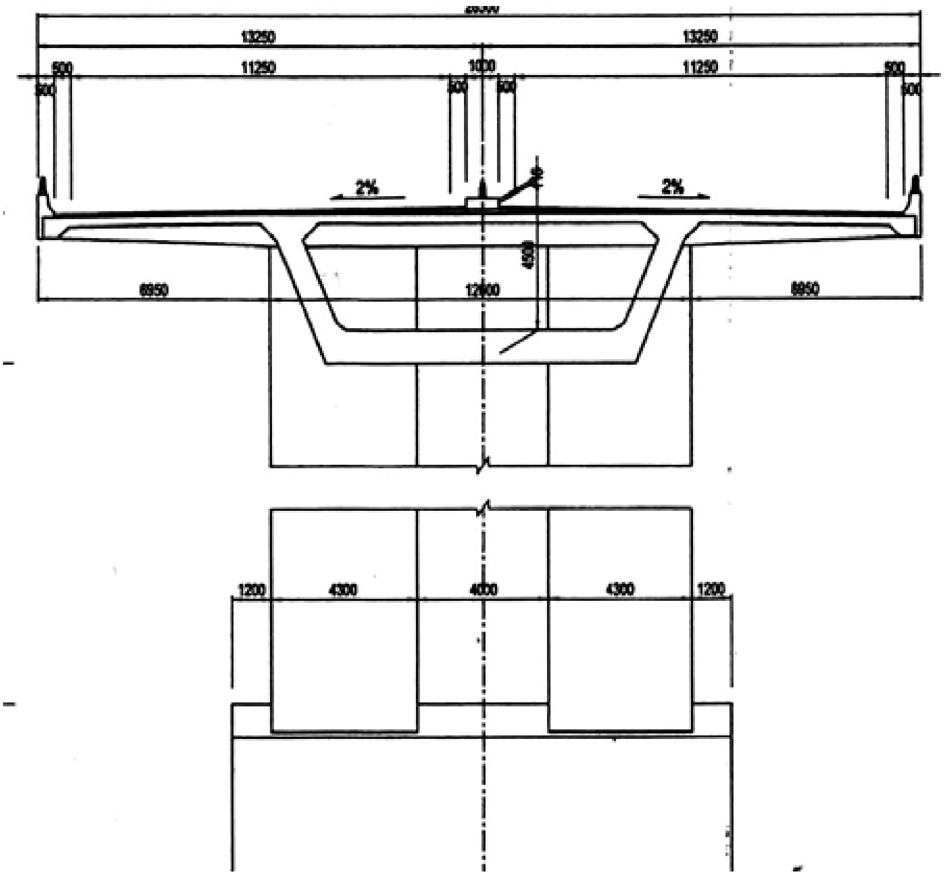
1) Main Bridge

Adopted girder types in previous studies are following 2 types.

a) VIDIFI's Study

- PC Box Girder with V-shaped Pier with the maximum span length 150 m is recommended.

Cross section of girder is unified 1 box with slab rib, as follow;

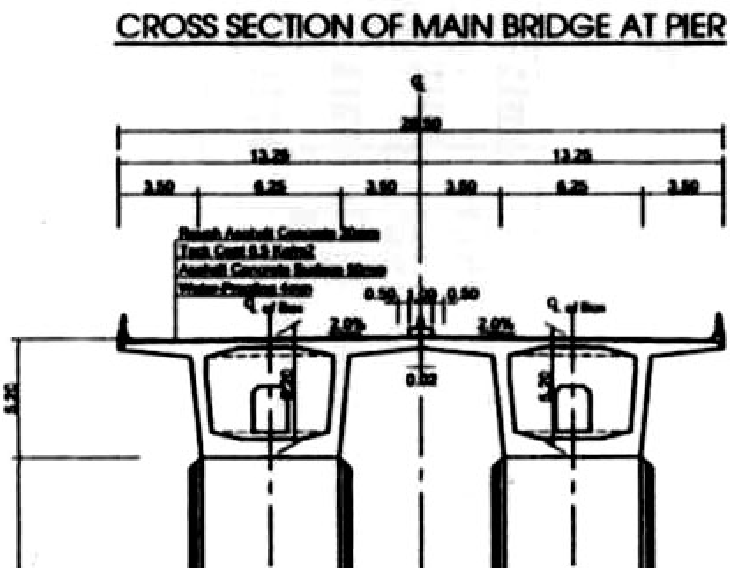


Source: Planning Construction Investment Project Tan Vu - Lach Huyen Highway Project in Hai Phong City, VIDIFI, 2009

Figure 10.4.16 Cross Section of Main Bridge (In VIDIFI's Study)

b) MOT's Study

- PC Box Girder with the maximum span length 90 m is recommended. Cross section of girder is separated 2 box, as follow;



Source: Port Capacity Reinforcement Plan in Northern Vietnam, MOT, 2009

Figure 10.4.17 Cross Section of Main Bridge (In MOT's Study)

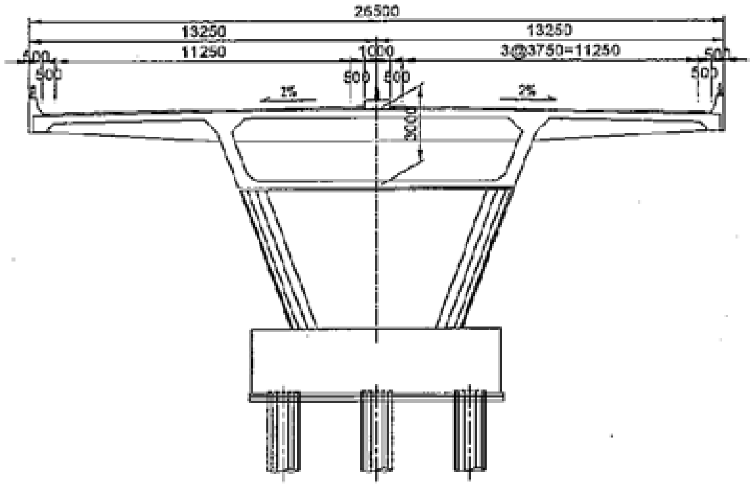
c) Recommendation

The type of bridge, PC Box Girder with V shaped pier, is also approved by MOT because of aesthetics view points. However, we should consider following aspects;

- Construction Cost
- Construction Period
- Constructability of Girder Election
- Introduction of STEP

Study team recommends carrying out further comparative study for two options of cross section structure, as follows;

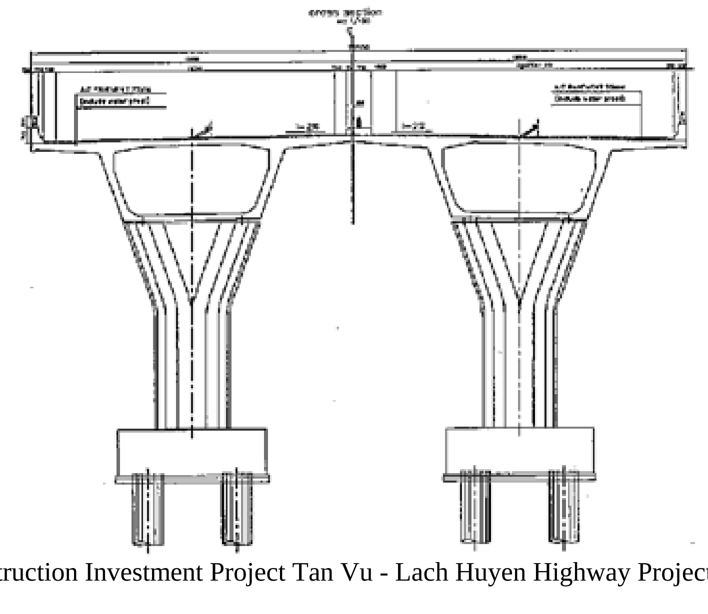
- Alternative 1: Unified 1-Box Girder



Source: Planning Construction Investment Project Tan Vu - Lach Huyen Highway Project in Hai Phong City, VIDIFI, 2009

Figure 10.4.18 Alternative 1

- Alternative 2: Separate 2-Box Girder



Source: Planning Construction Investment Project Tan Vu - Lach Huyen Highway Project in Hai Phong City, VIDIFI, 2009

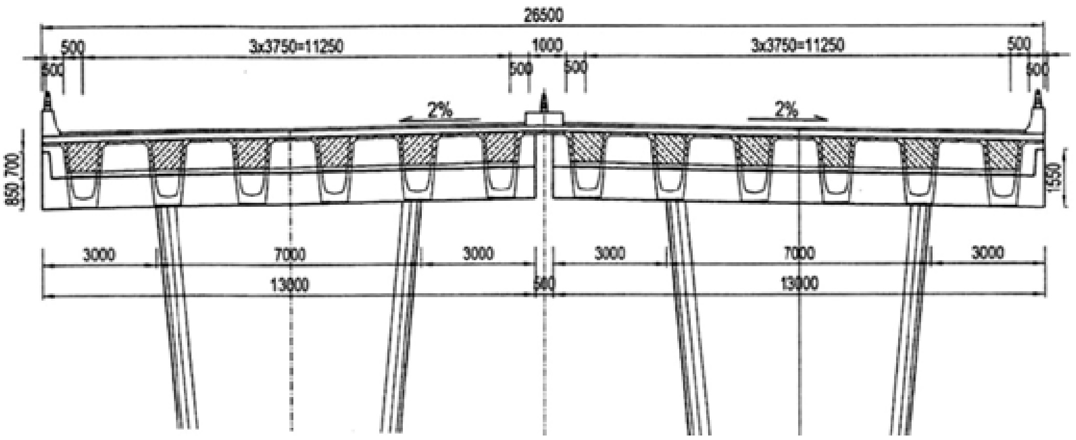
Figure 10.4.19 Alternative 2

In the case of cast in place method, Alternative 1, 1 box girder will be selected, on the other hand, in the case of precast method which is desirable for rapid construction, Alternative 2, 2-box girder will be adopted. Precast method is also acceptable for introduction of STEP.

2) Approach Bridge

In VIDIFI's Study and MOT's Study, the type of approaching bridge is recommended as PC Super-T Girder with span length of 40 m.

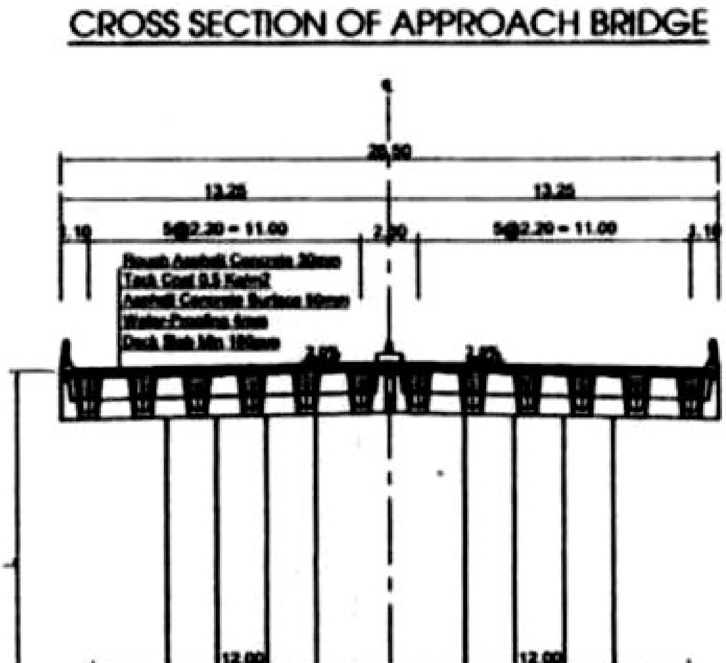
a) VIDIFI's Study



Source: Planning Construction Investment Project Tan Vu - Lach Huyen Highway Project in Hai Phong City, VIDIFI, 2009

Figure 10.4.20 Cross Section of Approach Bridge (In VIDIFI's Study)

b) MOT's Study



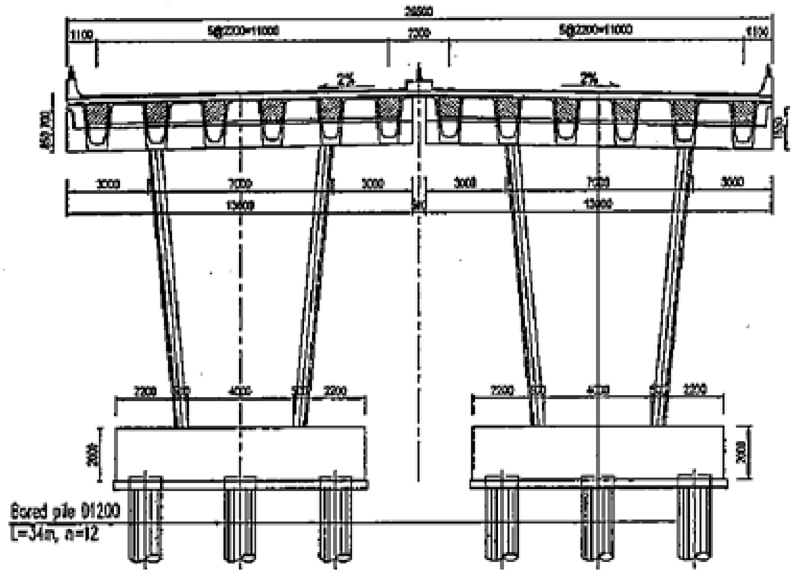
Source: Port Capacity Reinforcement Plan in Northern Vietnam, MOT, 2009

Figure 10.4.21 Cross Section of Approach Bridge (In MOT's Study)

c) Recommendation

Super-Tee Girder type is very standard in Vietnam. However, this type sometimes has some problems on reliability for structural stability, such as cracks in parts of the end of girder or the connection of slab. Therefore, study team recommends PC I Type Girder as effective alternatives in order to shorten the construction period and improve quality and durability of the superstructure against damage from salt water.

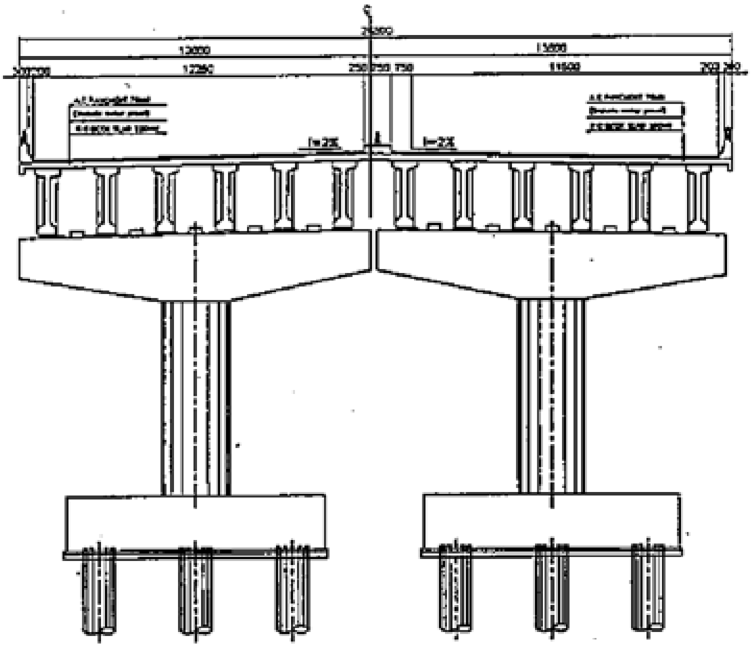
- Alternative 1: PC Super-T Girder with span length of 40 m



Source: Planning Construction Investment Project Tan Vu - Lach Huyen Highway Project in Hai Phong City, VIDIFI, 2009

Figure 10.4.22 Alternative 1

- Alternative 2: PC I Girder with span length of 40 m



Source: Planning Construction Investment Project Tan Vu - Lach Huyen Highway Project in Hai Phong City, VIDIFI, 2009

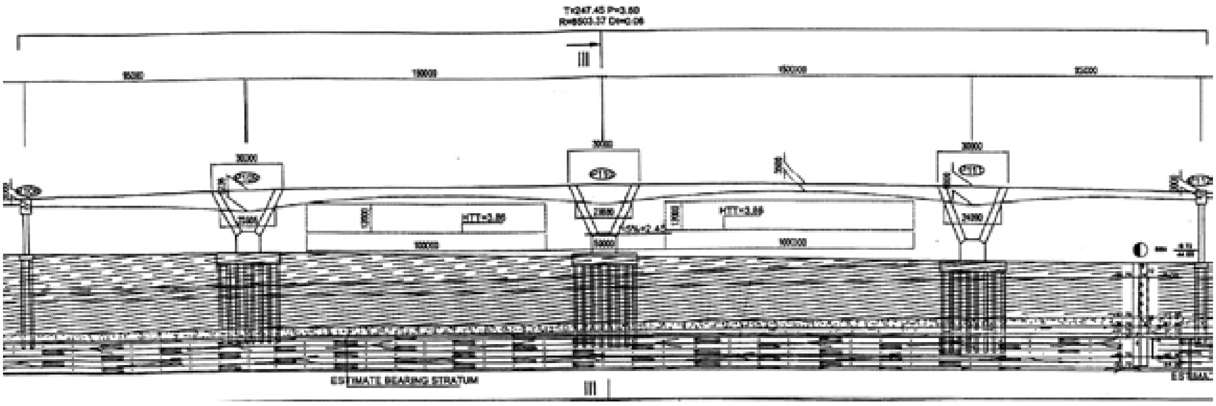
Figure 10.4.23 Alternative 2

3) Span Layout

In previous studies, according to the width of navigation clearance, maximum span length of main bridge is determined as follows;

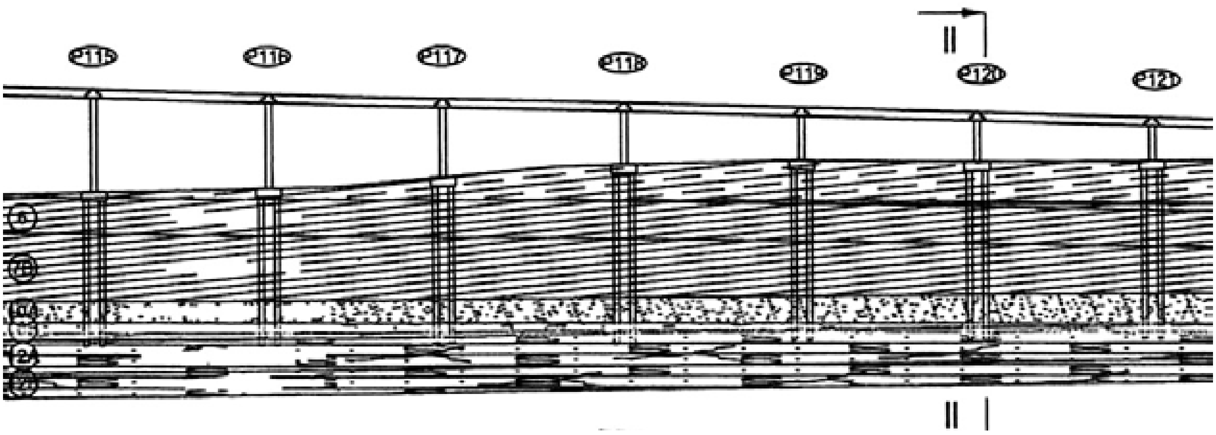
a) VIDIFI's Study

Maximum span length of main bridge is 150 m× 2. Standard span length of approach bridge is 40 m.



Source: Planning Construction Investment Project Tan Vu - Lach Huyen Highway Project in Hai Phong City, VIDIFI, 2009

Figure 10.4.24 Main Bridge Span Layout (In VIDIFI's Study)

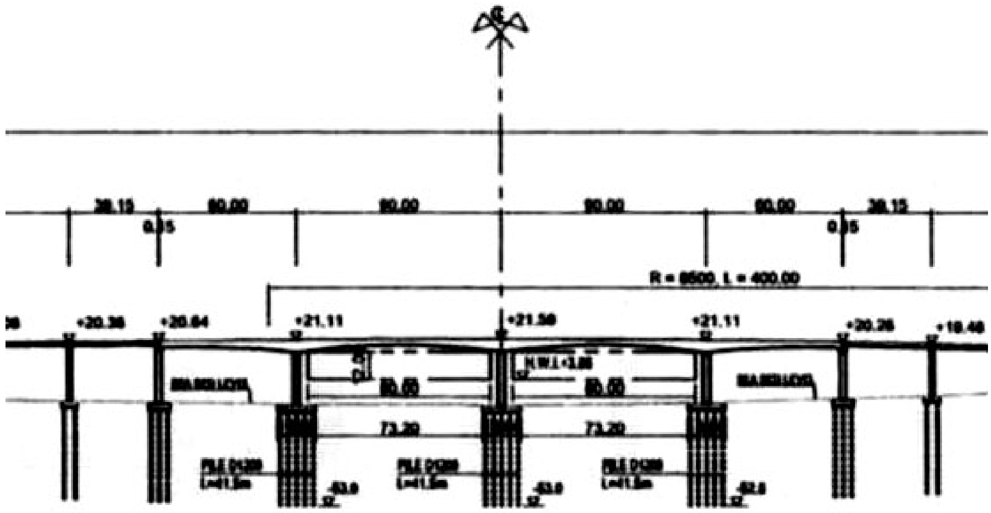


Source: Planning Construction Investment Project Tan Vu - Lach Huyen Highway Project in Hai Phong City, VIDIFI, 2009

Figure 10.4.25 Approach Bridge Span Layout (In VIDIFI's Study)

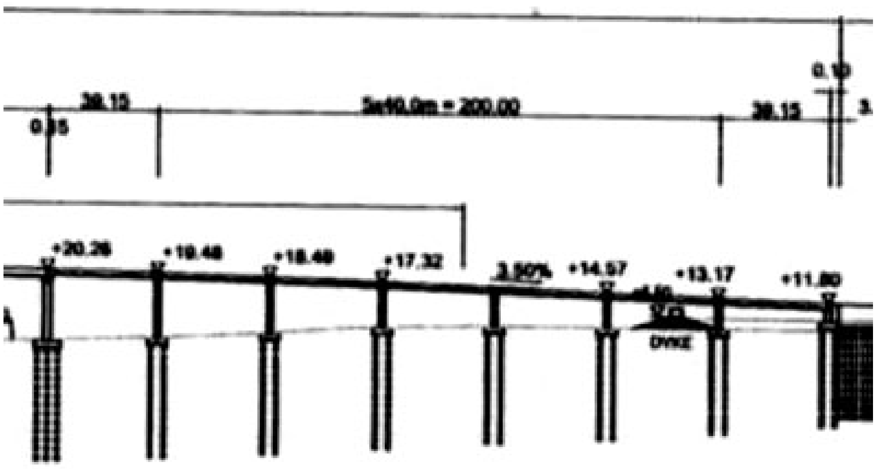
b) MOT's Study

Maximum span length is 90 m × 2. Standard span length of approach bridge is 40 m. as the same as VIDIFI's Study.



Source: Port Capacity Reinforcement Plan in Northern Vietnam, MOT, 2009

Figure 10.4.26 Main Bridge Span Layout (In MOT's Study)



Source: Port Capacity Reinforcement Plan in Northern Vietnam, MOT, 2009

Figure 10.4.27 Approach Bridge Span Layout (In MOT's Study)

c) Recommendation

According to two alternatives of navigation clearance, maximum span length of main bridge should be shortened. Recommended alternatives of main bridge span confutation are as follows;

- Alternative 1: Maximum Span Length 130 m × 1

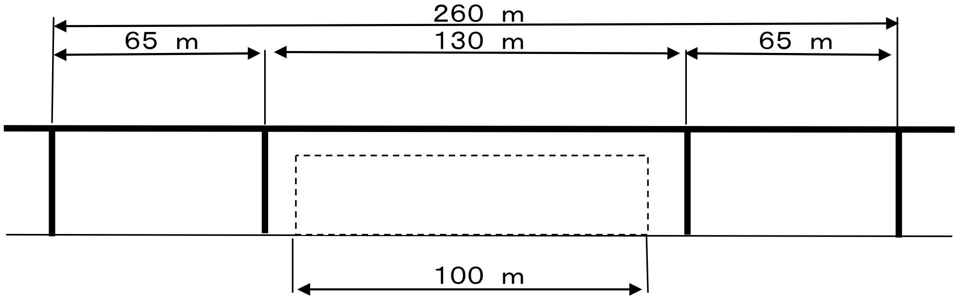


Figure 10.4.28 Alternative 1

- Alternative 2: Maximum Span Length 110 m × 2

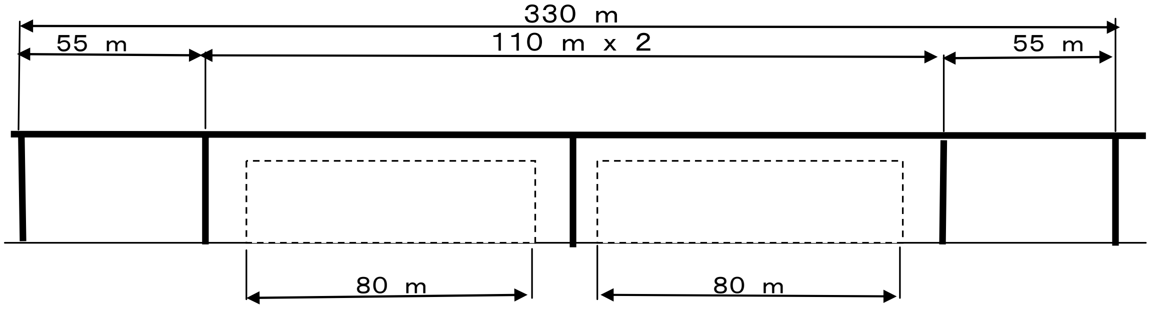


Figure 10.4.29 Alternative 2

After confirmation of reducing the width of navigation clearance, comparative study on above two alternatives should be carried out. Moreover, the location of the center line of navigation route is adjustable, so that the center line of navigation clearance could be moved to more suitable location where has deeper water depth.

Standard span length of Approach Bridge, 40 m, seems to be appropriate. However, if PC I Girder will be selected as optimum bridge type, standard span length with 45 m might be competitive alternative.

Span layout of whole bridges should be reconsidered according to change of the width and the location of navigation clearance.

4) Possibility of Steel Bridge

Optimum bridge type seems to be basically PC Bridge. According to the past experience, the construction cost of Steel Bridge will be more expensive than PC Bridge. However, Steel Bridge has any possibility to shorten construction period against PC Bridge. If PC Bridge can not meet implementation schedule of Lach-Huyen Port, there is any possibility to adopt Steel Bridge. In the case of Steel Bridge, following points should be considered carefully.

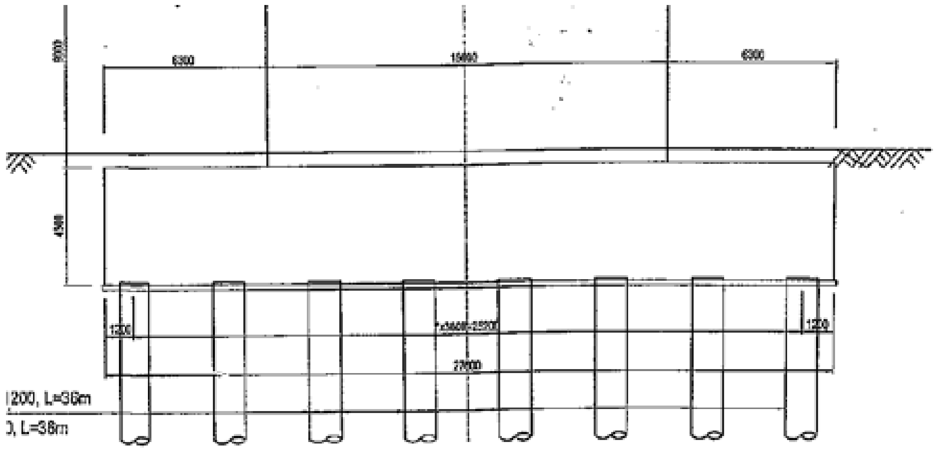
- Construction Cost
- Maintenance Cost
- Protection Method for Salt Damage

10.4.10 Foundation Type

1) Main Bridge

In previous both studies, foundation type of main bridge are cast in place concrete pile (borehole pile) with diameter 1200 mm, as follows;

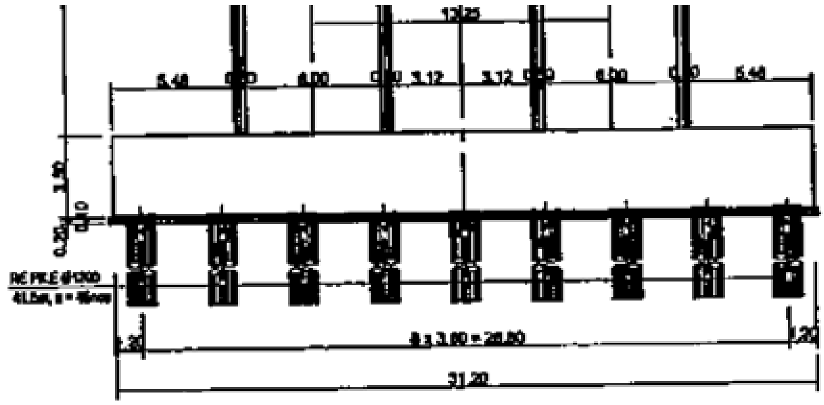
a) VIDIFI's Study



Source: Planning Construction Investment Project Tan Vu - Lach Huyen Highway Project in Hai Phong City, VIDIFI, 2009

Figure 10.4.30 Main Bridge Foundation Type (In VIDIFI's Study)

b) MOT's Study



Source: Port Capacity Reinforcement Plan in Northern Vietnam, MOT, 2009

Figure 10.4.31 Main Bridge Foundation Type (In MOT's Study)

c) Recommendation

Cat in place concrete pile with diameter 1200 mm is suitable for foundation type of main bridge. However, in order to reduce the size of pile cap, steel pipe sheet pile foundation type could be appropriate, so that comparative study between borehole pile and steel pipe sheet pile should be carried out.

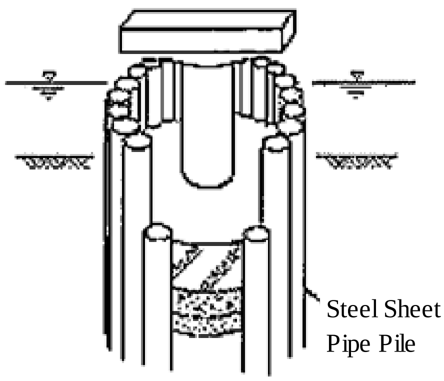
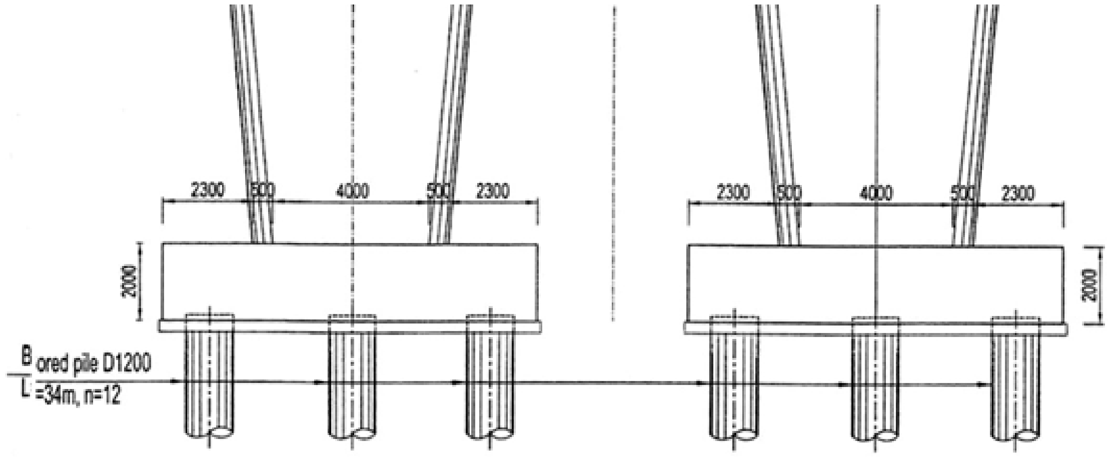


Figure 10.4.32 Main Bridge Foundation Type (Steel Pipe Sheet Pile)

2) Approach Bridge

Foundation type of approach bridge is also cast in place concrete pile (borehole pile) with diameter 1200 mm, as follows;

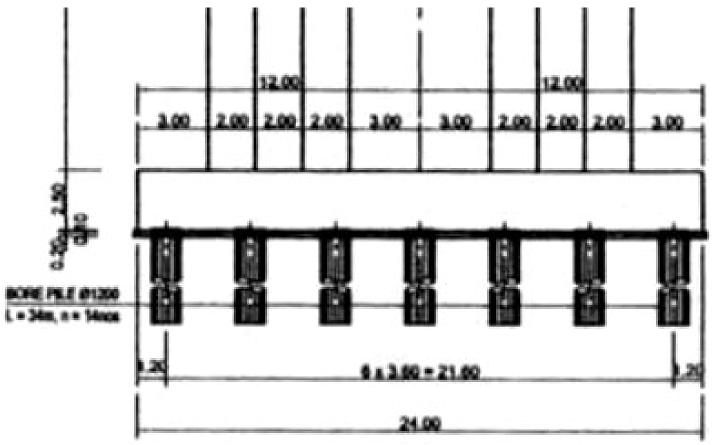
a) VIDIFI's Study



Source: Planning Construction Investment Project Tan Vu - Lach Huyen Highway Project in Hai Phong City, VIDIFI, 2009

Figure 10.4.33 Approach Bridge Foundation Type (In VIDIFI's Study)

b) MOT's Study



Source: Port Capacity Reinforcement Plan in Northern Vietnam, MOT, 2009

Figure 10.4.34 Approach Bridge Foundation Type (In MOT's Study)

c) Recommendation

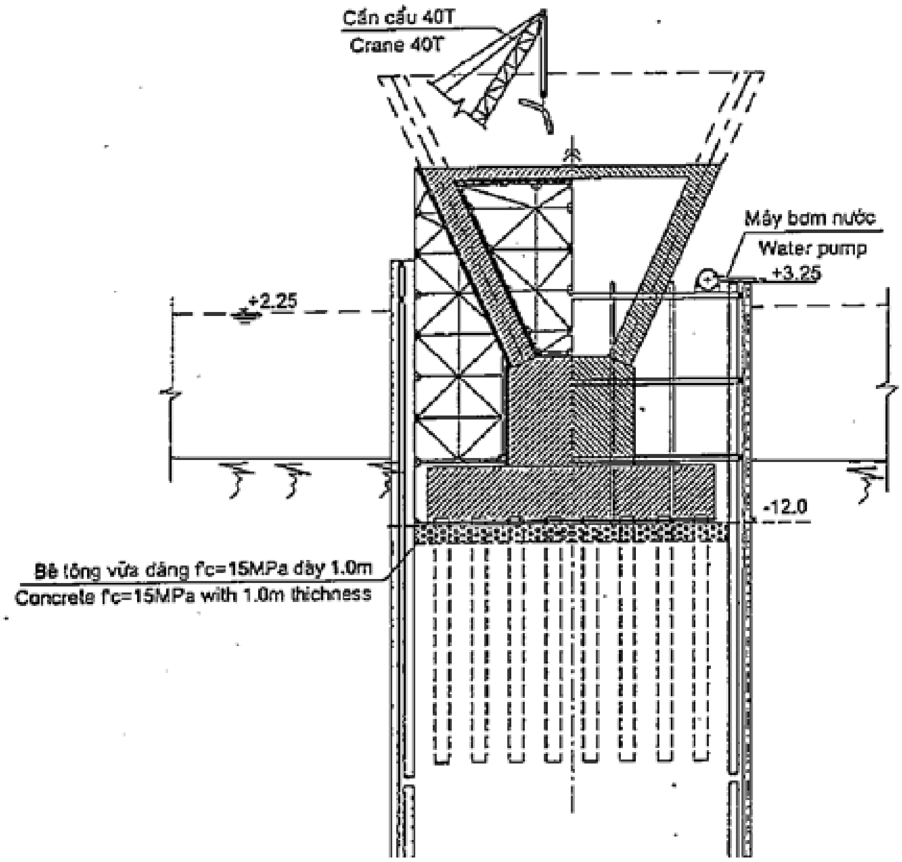
Cast in place concrete pile with diameter 1200 mm is suitable for approach bridge foundation.

3) Construction Method

In VIDIFI's Study, construction methods of foundation are as follows;

a) VIDIFI's Study

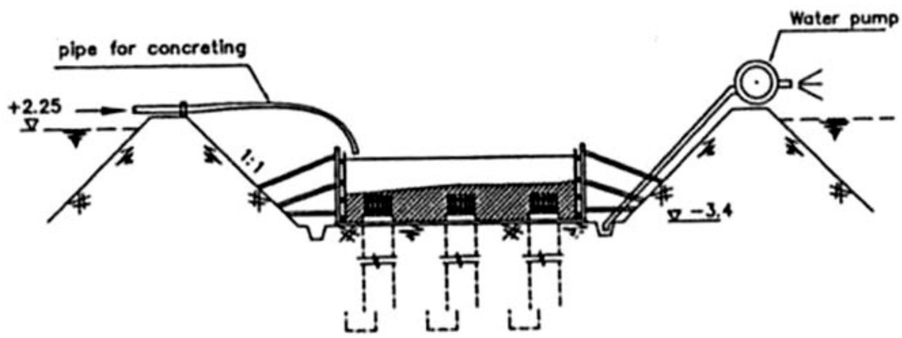
Construction method of main bridge is sheet pile method.



Source: Planning Construction Investment Project Tan Vu - Lach Huyen Highway Project in Hai Phong City, VIDIFI, 2009

Figure 10.4.35 Construction Method of Main Bridge Foundation (In VIDIFI's Study)

Construction method of approach bridge is open cut method with temporary dyke.



Source: Planning Construction Investment Project Tan Vu - Lach Huyen Highway Project in Hai Phong City, VIDIFI, 2009

Figure 10.4.36 Construction Method of Approach Bridge Foundation (In VIDIFI's Study)

b) Recommendation

Construction method of main bridge is appropriate for operations in the sea water, however if steel pipe sheet pile will be adopted, constructability will be better than borehole pile. About approach bridge, open cut method with temporary dyke needs long construction period and large impact of environment. In order to reduce the construction period and environmental impact, sheet pile method seems to be better. On selection of construction method, all factors, such as cost, construction period and environment, should be considered

10.4.11 Cost Estimates

The cost estimates in VIDIFI's Study and MOT's Study are shown in Table 10.4.3.

Table 10.4.3 Cost Estimates in VIDIFI's Study and MOT's Study

		VIDIFI's Study	MOT's Study
Length	Total Length	15.9 km	15.3 km
	Approach (Tan Vu Side)	4.5 km	7.8 km
	Bridge	5.44 km	1.78 km
	Approach (Cat Hai Side)	6.0 km	5.7 km
Bridge	Bridge Type	PC Box Girder + PC Super Tee	PC Box Girder + PC Super Tee
	Max. Span Length	150 m	90 m
	Navigation Clearance	100 m × 12 m × 2 ways	80 m × 12 m × 2 ways
Cost	Total Construction Cost	29 Billion Yen	23 Billion Yen
	Approach (Tan Vu Side)	4.4 Billion Yen	9.1 Billion Yen
	Bridge + Other Structures	21.7 Billion Yen (Main Br.: 3.3, Approach Br.: 16.5)	7.2 Billion Yen (Main Br.: 1.5, Approach Br.: 4.5)
	Approach (Cat Hai Side)	2.9 Billion Yen	6.7 Billion Yen
Construction Period		36 months	30 months

The cost shall be revised in the further design of Tan Vu - Lach Huyen Highway.

10.4.12 Natural Environment

As a part of Japanese ODA loan procedures, the SAPROF study team has reviewed the proposed EIA of the connecting highway between Tan Vu and Lach Huyen Port were reviewed. Some selected reports were also reviewed to complement the EIA reports for the purpose of the verification of the JBIC Guideline. The following table is the list of reviewed reports and expected reports for the highway project.

Table 10.4.4 List of Reviewed Reports

Reviewed Report	
Volume-III: Environmental Impact Assessment/ Planning Construction Investment Project, Tan Vu-Lach Huyen Highway Project in Hai Phong City, 14 July 2009	Prepared by JBSI, HYDER, HECO
Other reviewed reports	
Port Capacity Reinforcement Plan In Northern Vietnam, September 2009	Prepared by Nippon Koei Co.Ltd. & Associates assigned by MOT
General Construction Plan of Hai Phong City to 2025 and 2050	Prepared by Planning Institute of Hai Phong assigned by Hai Phong People's committee

Though the EIA was completed and process of approval in November 2009, VIDIFI withdrew the approval request due to the transfer of the project taken over by PMU2, MOT. PMU2 is on the process of completing EIA as of May 2010. Following the law on environmental protection (2005), MOT will be the responsible authority to approve the EIA. MOT has already started the arrangement of the EIA appraisal committee defined by law on environmental protection including MONRE and environmental experts.

Legal framework of environmental consideration shall refer to section 9.1.3. In addition to the mentioned legal framework, the following decisions shall be considered for the incorporation of the proposed highway project.

- Decision 2457/QD-BTNMT dated December 23, 2009, Ministry of Natural Resources and Environment, approving environmental impact assessment of South Dinh Vu Development Joint Stock Company (SDVDC)
- Decision 570/QD-BTNMT dated March 24, 2010, Ministry of Natural Resources and Environment, approving environmental impact assessment of HAPACO (Hai Phong Industrial Zone Joint Stock Company)

Above two decisions enables SDVDC and HAPACO to reclaim the land as shown in figure 10.4.6. Due to the global scale economic crisis in 2008-2009, the progress of the development seemed slower than their original plan, but both SDVDC and HAPACO have actively work on process of the land reclamation.

The existing EIA Study was conducted for alternative 3A that assumed the reclamation work for Nam Dinh Vu industrial estate implementation schedule as unknown. However, the reclamation work has already started and ongoing. So consideration for Alternative 3B that assumed reclamation as given condition may also have to be given due consideration. Regardless of this alternative issue whether to assume the planned reclamation in Nam Dinh V as a given condition or not review of available EIA Report indicated following significant issues.

Even though 3 alternative alignments including the perceived unknown status of the planned reclamation of Nam Dinh Vu (South Dinh Vu) were taken into account as alternative studies (as Alternative 3A and 3B), no alternative study on the type of bridge was conducted. Type of alternative bridges include for example cable stayed long span bridge that would virtually eliminate any interference with the water and sediment flow in the estuary underneath the bridge and relatively short span bridge that may interfere with the water and sediment flow underneath but still be very economical. It seems the chosen bridge type fall under the category in between the two that could be classified as relatively long span. Still, no conduct of alternative technical studies on the type of bridge is regarded as important basic limitation of the project design for the bridge.

The road and bridge itself would not cause any significant direct reduction in the surrounding wetland areas and need to be clearly separated from the planned ongoing reclamation works for industrial estates that result in permanent irreversible change in land use from aquatic environment (coastal wetland) to terrestrial environment.

All sampling for water and air environmental quality was done only once in August 2008 that has the limitation regarding not just one time sampling but also the season of sampling being least critical rainy season. Moreover the timing (it is presumed to be done also in August 2008) and methodology used for the conduct of ecosystem surveys described in Appendix 3-2 (data collection report prepared by the Center for Advanced Science and Technology Application, Science and Technology Department of Quang Ninh Province) is not clear. Clear description on the methodology used (and also confirmation on survey time period was the same as other sampling work in August 2008 or not) for ecological surveys is recommended while revising EIA Report. Still, the Appendix 3-2 under Section III well summarized the ecosystem value of mangrove forestation thereby emphasizing the need for its protection.

In addition to the revision according to the modification of the highway design, the following items shall be studied.

- Impact to ecosystem, flood, tidal level, etc shall be studied.
- EIA on land reclamation in expansion area of Dinh Vu industrial Zone is under preparation, it shall be confirmed during the further design.

10.4.13 Social Environment

In addition to the EIA report, the resettlement action plan (RAP) of the connecting highway between Tan Vu and Lach Huyen Port was also reviewed for the review of social environmental impacts.

- Volume-IV: Resettlement Action Plan/ Planning Construction Investment Project, Tan Vu-Lach Huyen Highway Project in Hai Phong City, 14 July 2009

As same as EIA report, RAP was prepared and the process of the approval, but it was withdrawn due to the transfer of the project taken over by PMU2, MOT. PMU2 is on the process of completing EIA and RAP as of May 2010 for the consideration of the social environment. Legal framework of social consideration shall refer to section 9.1.3.

Although the number of project affected people (PAP) and household (PAH) in EIA and RAP were slightly different, PMU2 reported the collect number before the completion of updated EIA and RAP for the JICA's fact finding mission in March. Such collection was recorded in minutes of discussions on Lach Huyen Port Infrastructure Construction Project between JICA and the government of Vietnam dated on 19 March, 2010. Based on the minutes of discussions, PAP and PAH are as follows:

	Hai An District		Cat Hai Island			Total
	Tran Cat Ward	Dong Hai 2	Nghia Lo Com.	Dong Bai Com.	Cat Hai town	
1. Acquired household and land						
# of houses to be resettled	0	0	51	27	0	78
Acquired land (m^2)						878,700
Residential land (m^2)						28,900
Aquaculture land (m^2)						801,600
Salt pan (m^2)						44,700
Other (m^2)						3,500
# of trees to be removed	73	1	4,823	1,923	236	7,056
# of graves to be resettled	0	0	278	0	117	395
Concrete road (m^2)	0	0	1,520	2,800	0	4,320
Asphalt road (m^2)	0	0	0	0	600	600
Power poles	0	0	16	0	5	21
Culverts	4	3	3	2	1	13
2. Affected households & people						
# of PA Households	45	41	115	40	55	296
# of PA People	127	150	489	260	159	1,185

Considering the compliance of the proposed EIA and RAP reports, they principally comply with the JBIC Guideline except the proper consideration for existing ferry and passenger boat operators and the coastal fishing activities that is beyond the Vietnamese safeguard policies under law on neither land nor fishery at this moment. Such issues were pointed out by JICA at the fact finding mission in April 2010. Although there are few legal frameworks to address such issues under the present Vietnamese laws and regulations, the responsible agency to handle such issues is likely to be correspondent people's committees such as Hai Phong city and relevant districts and communes, which follows the safeguard policy of effective land law.

In addition to the consideration for coastal fishing activities, slight gaps between Vietnamese involuntary resettlement policy and the world bank's involuntary resettlement policy (OP 4.12) is reported by the RAP and the ongoing resettlement policy framework of "Northern Delta Transport Development Project*" by MOT supported by the world bank. Considering the applicable policy frameworks for the Lach Huyen port, the resettlement policy framework of the Northern Delta Transport Development Project should be applied due to the consistency of the ODA projects in the same region.

* Project Appraisal Document on a Proposed Credit in the Amount of SDR 104.4 Million To the Social Republic of Vietnam for a Northern Delta Transport Development Project, 19 May, 2008, Transport, Energy and Mining Unit, Sustainable Development Department, East Asia and Pacific Region, The World Bank <http://web.worldbank.org/external/projects/main?pagePK=64283627&piPK=73230&theSitePK=40941&menuPK=228424&Projectid=P095129>

The detailed consideration of the safeguard policy for the coastal fishing activities and involuntary resettlement shall be made by another SAPROF study focusing on the Tan Vu-Lach Huyen highway construction. The alignment, bridge length and bridge type of Tan Vu - Lach Huyen Highway might be modified by the highway SAPROF. The RAP shall be revised accordingly.

In addition, confirmation of unexploded ordnance (UXO) clearance shall be required for the safety implementation of the highway. Though there is no description of such matter in EIA or RAP, verification of UXO clearance was required for the approval of the Lach Huyen port EIA. As a part of port and highway projects, such verification shall be coordinated between PMU2 and MPMU II and conducted during the detailed design stage.