THE KINGDOM OF CAMBODIA
MINISTRY OF PUBLIC WORKS AND TRANSPORT
PORT AUTHORITY OF SIHANOUKVILLE

PREPARATORY SURVEY FOR SIHANOUKVILLE PORT NEW CONTAINER TERMINAL DEVELOPMENT PROJECT

FINAL REPORT

JANUARY 2017

JAPAN INTERNATIONAL COOPERATION AGENCY

NIPPON KOEI CO., LTD.
ORIENTAL CONSULTANTS GLOBAL CO., LTD.

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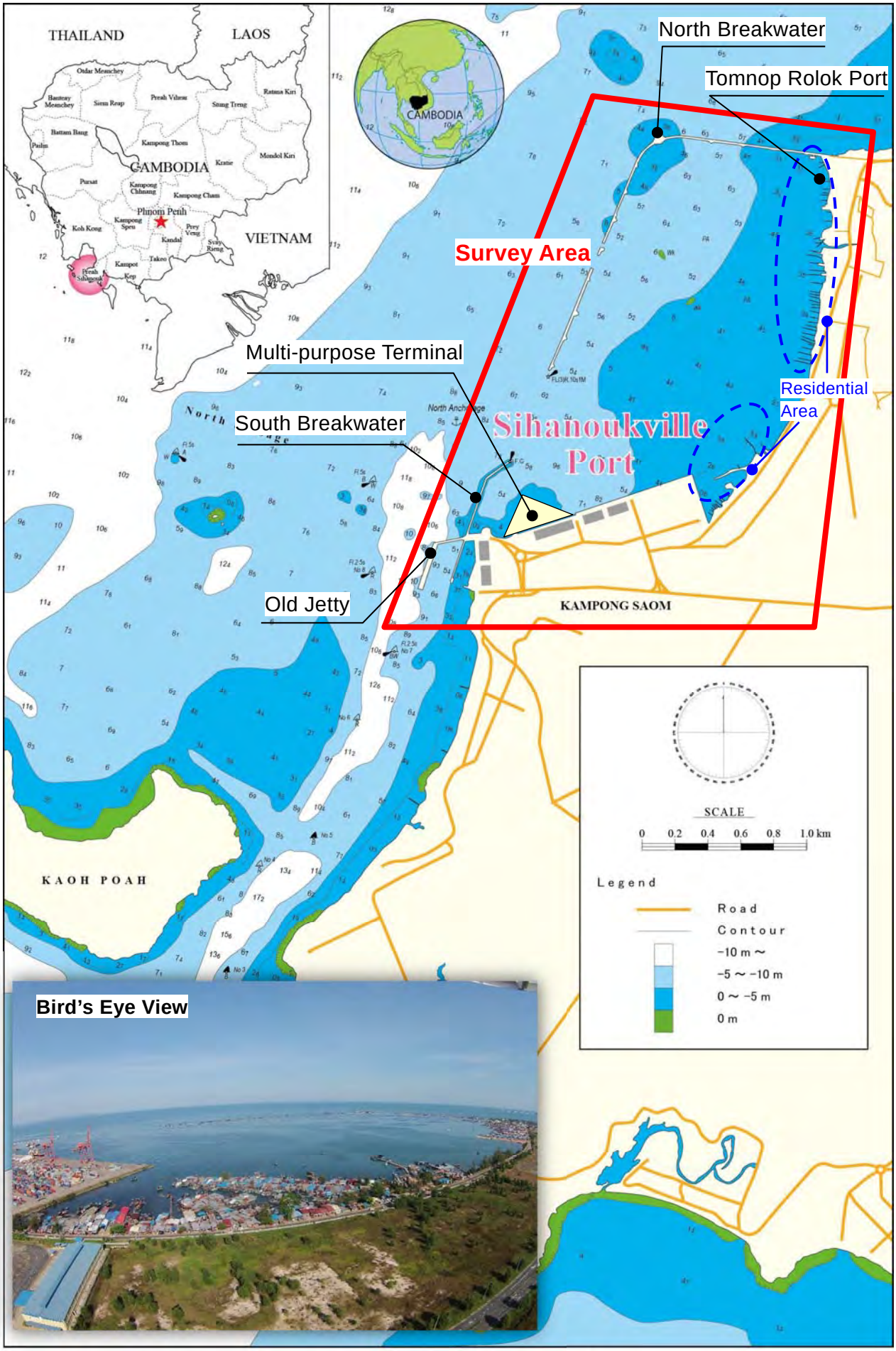
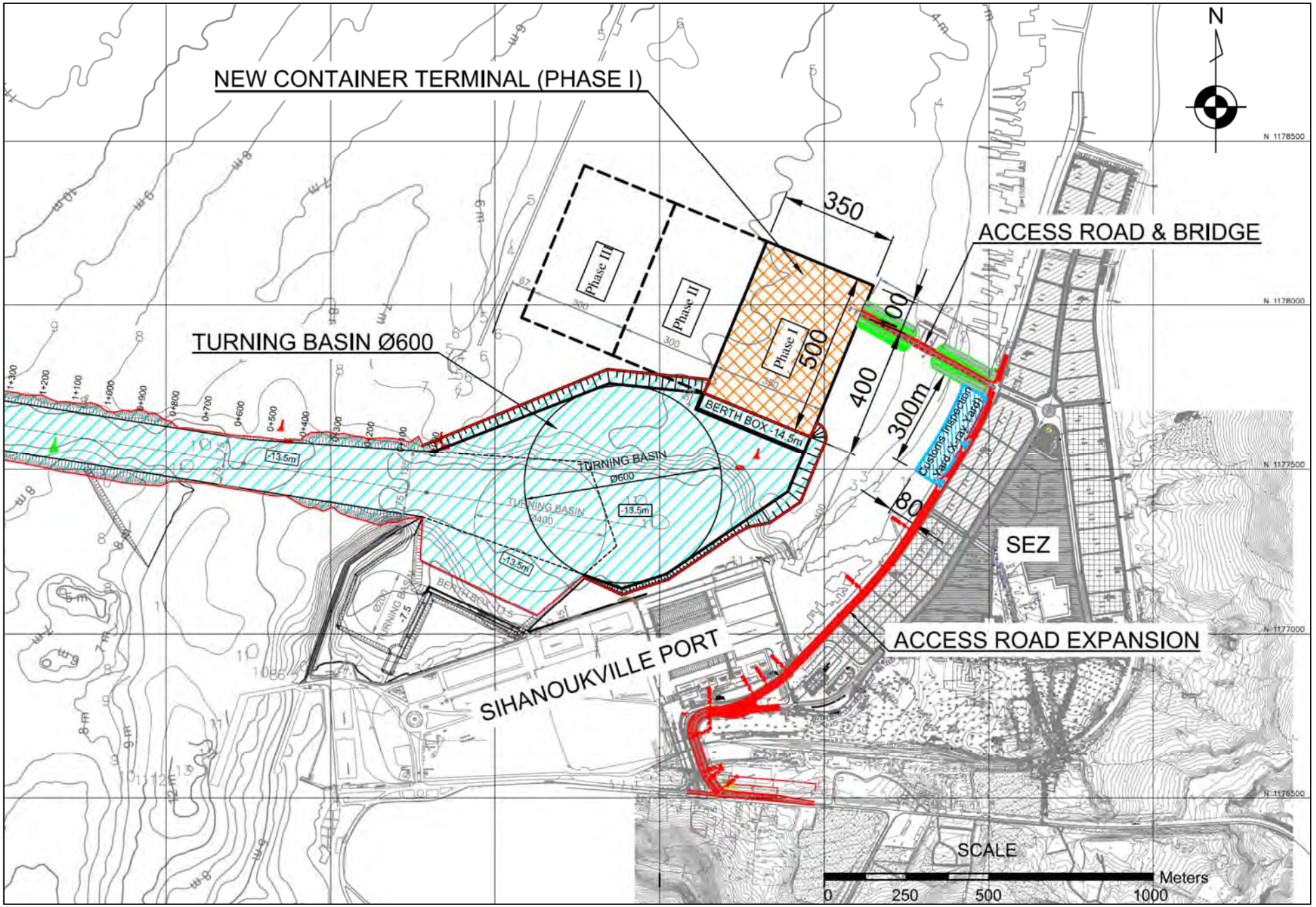
Exchange Rate

US$ 1.00 = JPY 104.57

(as of 13 July 2016)



Project Location Map



General Layout Plan of New Container Terminal

EXECUTIVE SUMMARY

1. INTRODUCTION

Background of the Survey

The Sihanoukville Port, located at the south end of the Cambodia Growth Corridor and in the Preah Sihanouk Province, is the sole international deep sea port in the Kingdom of Cambodia supporting the national economic and industrial activities.

The container transaction volume of Sihanoukville is increasing at 10% on an average over the last five years after 2009 due to strong economic growth led by the garment industry. On the other hand, the container throughput of Sihanoukville Port is reaching its handling capacity limit. Nevertheless, the operation body of the port, the Port Authority of Sihanoukville (PAS), has a short-term plan to strengthen the handling capacity by having additional cranes. The container throughput is expected to reach the handling capacity limit in 2023.

With the above mentioned economic circumstance, the development of new container terminal and associated structures in the Sihanoukville Port is planned as a yen loan project of the "Sihanoukville Port New Container Terminal Development Project".

Object of the Survey

In the course of the "Preparatory Survey for Sihanoukville Port New Container Terminal Development Project", the Japan International Cooperation Agency (JICA) Survey Team investigates the background, objective, contents of the project, and verify its necessity. After confirming the necessity, the JICA Survey Team surveys the necessary items for appraisal for the yen loan project such as the objective, feature, project cost, implementation schedule, implementation method, organization structure for project implementation, organization structure for operation and maintenance, and environment and social considerations.

Scope of the Project

The Project will develop the new container terminal and related structures in the Sihanoukville Port. Major components are confirmed between fact finding mission of JICA, MEF and PAS as mentioned below.

1) Construction of new container terminal.
2) Construction of access road including access bridge.
3) Dredging of channel and basin.
4) Construction of major terminal building.
5) Construction of customs inspection yard.
6) Procurement of cargo handling equipment and terminal operation system.
7) Consulting services.

2. DEMAND FORECAST

The comparison of the macro forecast and micro forecast is shown in Table 2-1. The middle case of macro forecast is estimated based on the assumption that the current condition of economic growth will continue in the future and its result is considered as the most realistic estimation. In addition, this result was compared and verified by micro forecast that was estimated for each commodity. Based on this, the JICA Survey Team adopted the middle case of macro forecast.

Table 2-1 Result of the Macro and Micro Forecast (Unit: Thousand TEUs)

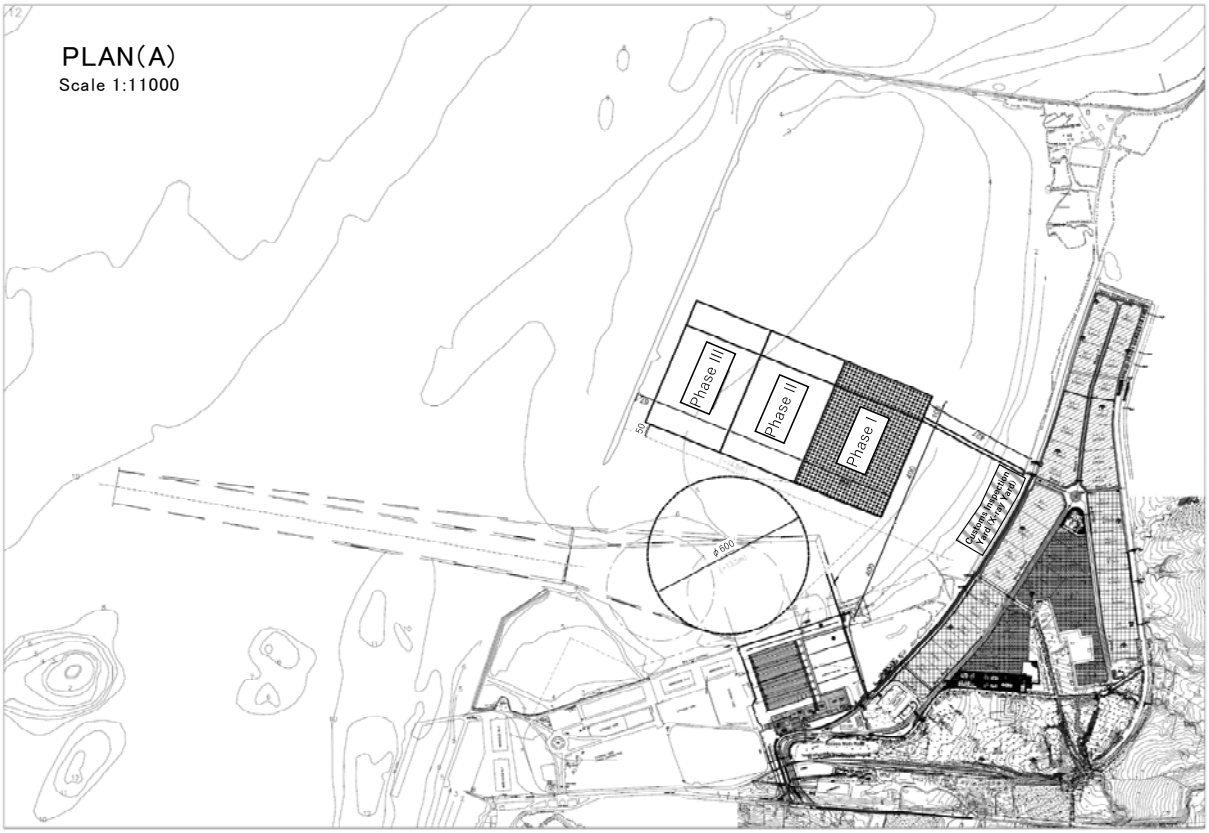
	2015	2020	2025	2030	2035	2040
Macro (Low)	391.8	589.4	752.3	932.9	1,081.5	1,253.8
Macro (Middle)	**391.8**	**681.9**	**927.3**	**1,225.6**	**1,486.9**	**1,817.7**
Macro (High)	391.8	803.7	1,236.6	1,809.9	2,354.2	3,062.3
Micro	391.8	705.5	980.5	1,226.7	1,515.3	1,819.0

Source: JICA Survey Team

3. PORT DEVELOPMENT PLAN

New container terminals are developed in three phases to cope with estimated increment demand of containers. The yard and berth of Phase I is constructed by 2023 as the medium-term plan. The target capacity of container is approximately 1.15 million TEUs, which enables the port meet the estimated demand in around 2030.

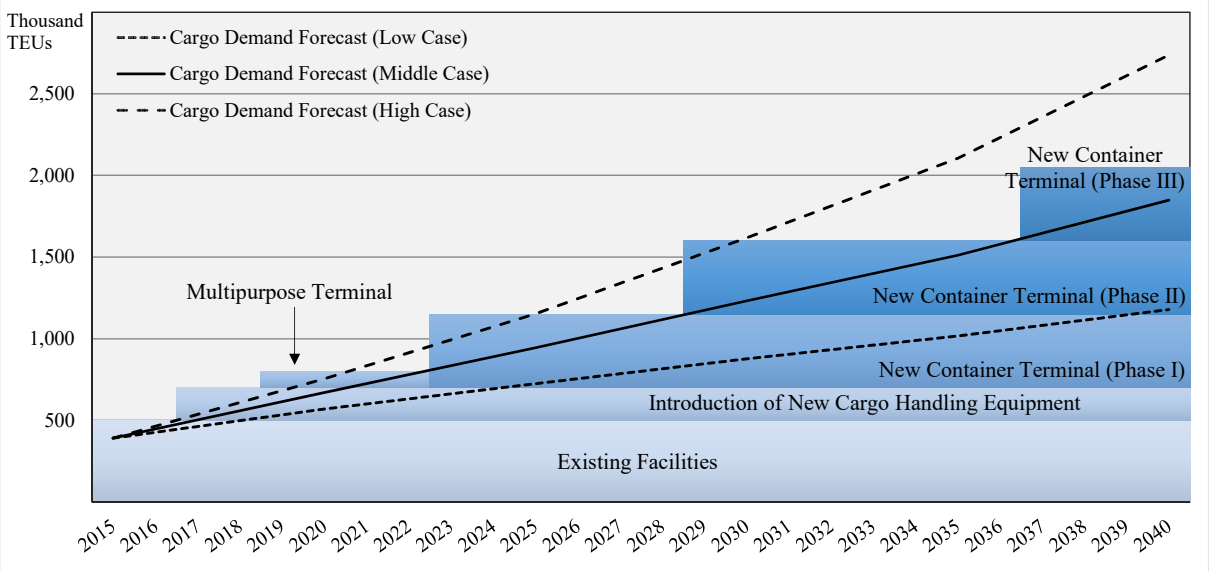
The remaining two yards and berths are constructed consecutively in the long-term plan (-2040) in order to cope with further increasing demand. In this study, the medium-term plan is mainly studied in anticipation of the long-term plan. Here, Phase I will be developed in the medium-term plan, and Phases II and III will be developed in the long-term plan as mentioned in Figure 3-1.



Source: JICA Survey Team

Figure 3-1 Layout of the Long-term Port Development Plan

Along with steady increase in container cargo in the future, it is expected that container cargo throughput will exceed the cargo handling capacity of the present port area (800,000 TEUs) in 2023. It is assumed that container cargo will not be handled at the multipurpose terminal after the opening of new container terminal. Under such circumstances, new container terminal development plans should be promptly formulated to meet increasing container cargo demand.



Source: JICA Survey Team

Figure 3-2 Stepwise Development Plan in accordance with Container Cargo Demand

4. PORT FACILITY DESIGN

Basic Concept of Design

Existing container terminal with depth of -10.5 m can accommodate only 25,000 DWT class container vessels (around 2,000 TEUs), so-called Under-Panamax size. On the other hand, the large-size trend of container vessels has been worldwide observed. In East Asia Region Route, 60,000 DWT class container vessels (around 4,000 TEUs) have drastically increased, and it is supposed that 60,000 DWT class container vessels will ply Sihanoukville Port along with steady increase in container cargoes. In order to meet the large-size vessel trend, PAS eagerly requested the berth facility to accommodate Over-Panamax size container vessels. It is fact that accommodating Over-Panamax size container vessels are considerable advantage of port sales for shipping lines.

- Target Vessel

  One Over-Panamax size container vessel for 1 berth
  Maximum. 60,000 DWT: Draft =13.8 m, LOA =285 m, Beam=40.0 m

  Two Under-Panamax size container vessel for 1 berth
  8,000 DWT~15,000 DWT: Draft= 7.3 m~ 9.0 m, LOA= 127 m~158 m, Beam=20.4 m~ 24.5 m

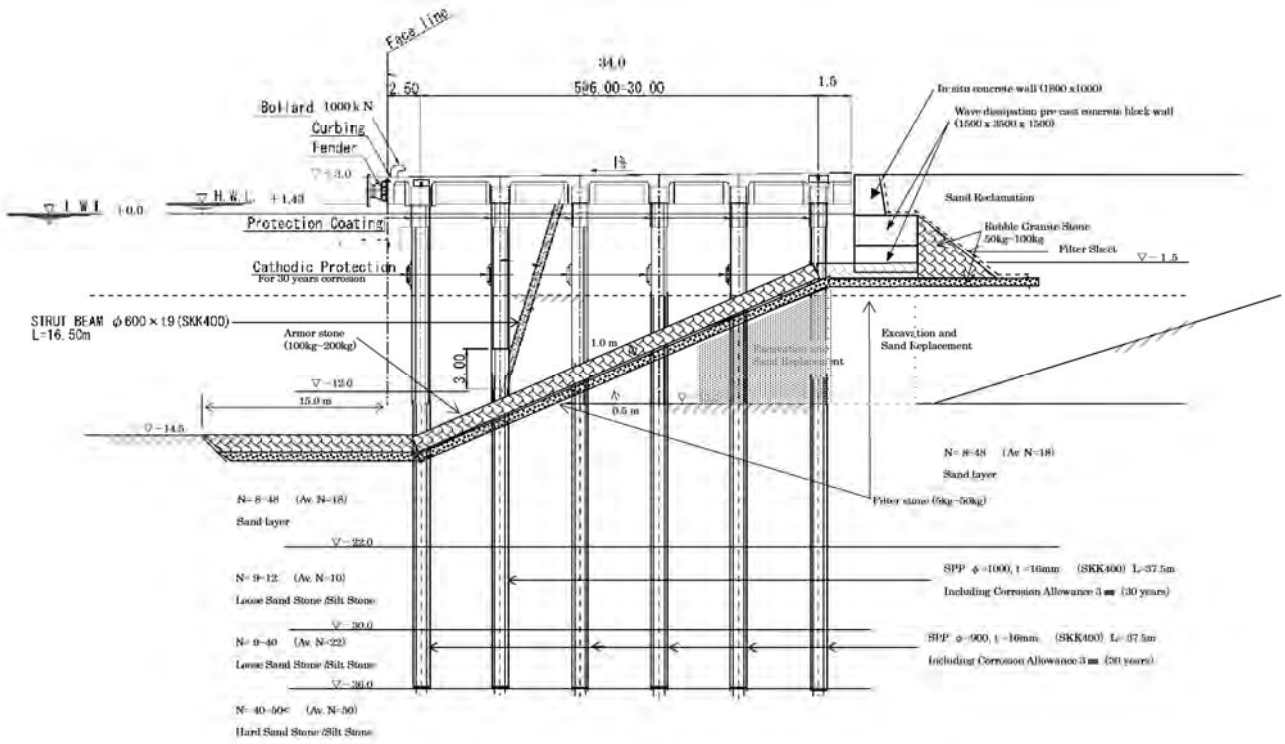
- Container Terminal Capacity: Phase I (350 m berth length), Phases II and III (300 m berth length)

  Phase I : 450,000 TEUs /year
  Phase II : 400,000 TEUs /year
  Phase III: 400,000 TEUs/year

Container Berth

The four alternatives were studied for the preliminary design of container berth considering structural and construction cost, maintenance aspects, environmental impact, construction aspects and etc. The alternatives are: 1) Steel Pipe Sheet Piles Structure, 2) Concrete Deck on Steel Pipe Pile, 3) Concrete Block Method, and 4) Concrete Deck on Steel Pipe Pile and Strut Beam.

In consideration of the quay structural comparison, Concrete Deck on the Steel Pipe Pile & Strut Beam is supposed to appropriate, its typical section as shown in Figure 4-1.



Source: JICA Survey Team

Figure 4-1 Typical Section of Quay Structure

5. BASIC DESIGN OF ACCESS ROAD AND BRIDGE

Alignment of Access Road and Bridge for Phase I

The road alignment has been planned to take advantage of the minimum amount of land between the road site and SEZ. Additionally, the current roadside housing and stores are not affected by this road plan.

The road alignment plan is shown in Figure 5-1.

Source: JICA Survey Team

Figure 5-1 Alignment Plan of Access Road to New Port

6. ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

Environmental Category under JICA ESC Guidelines

The project is not likely to have significant adverse impact on the environment in terms of its sectors, characteristics, and areas. Therefore, the Japan International Cooperation Agency (JICA) classified the proposed project as "Category B" under the JICA Guidelines for Environmental and Social Considerations (JICA ESC Guidelines) (April 2010).

Preliminary Environmental Impact Evaluation

The environmental impacts by the proposed project were preliminary evaluated based on the survey results. No items of A (serious impact is expected) were identified and 18 items of B (some negative impacts are expected) were identified.

Long-term Plan for Environmental and Social Considerations

There are large-scale communities of illegal occupants in the Sihanoukville Port with a population of 8,000. In terms of the long-term plan for environmental and social considerations, the illegal residential areas are significant problems for PAS from the viewpoints of safety and effective use of the port. Because there is a risk of accidents between container vessels and fishing boats and the residents occupy the water area, which should be developed for port operation in the future.

The proposed project does not include any involuntary resettlement; however, PAS has two alternatives of the resettlement plan in the i) alternative site inside PAS jurisdiction and ii) PAS's land near the airport.

The provincial government should play a lead role for the resettlement and the provincial governor stated his support on the resettlement during the second stakeholder's meeting in June 2016.

7. BUSINESS SCHEME FOR NEW CONTAINER TERMINAL

Four types of business schemes, namely Type (I): Public development, operation by PAS as a joint stock company, Type (II): Public infrastructures, private superstructures, and private operation, Type (III): Public infrastructures and superstructures, private operation and Type (IV): Public infrastructures, leased superstructures, operation by PAS as a joint stock company were examined.

As a result of discussions between PAS and the Survey Team, the first priority is given to Type (I), which is full development by PAS and direct operation by PAS as a joint stock company. The second priority is given to Type (IV), which is infrastructure development by PAS and direct operation by PAS using leased superstructure.

This priority is based on the fact that PAS will change to a joint stock company in the near future and be able to function as a private operator. It is also recognized that the present container terminal and new container terminal shall not be operated under competitive conditions but in a cooperative manner to make maximum use of their capacity.

Therefore, the development and operation scheme indicated in the Type (I) is applied in this study.

8. PROJECT EVALUATION

Economic Analysis

The estimated EIRR is at 15.76%, and a discount rate as threshold of the EIRR is set at 10.0%, which is generally used for infrastructure projects. Thus, the Project can be said to be feasible. In order to see whether the project is still feasible if some conditions change, a sensitivity analysis is made for the following three alternatives, viz., Case 1: Project cost increases by 10%, Case 2: Benefit volume

decreases by 10% and Case 3: Both Case 1and Case 2 occur simultaneously.

The result of the sensitivity analysis is derived in Table 9-1. Even in Case 3 of sensitivity analysis, the economic feasibility of the Project is exceeding threshold value i.e. EIRRs are above 10.0%. Therefore, the Project is recommended to be implemented as early as possible from the viewpoint of the national economy.

Table 8-1 Economic Result of Sensitivity Analysis

Case	Base	Case 1	Case 2	Case 3
EIRR	15.76%	13.98%	13.79%	12.06%

Source: JICA Survey Team

Financial Analysis

The estimated FIRR is at 8.13%. The Project can be said to be feasible. In order to see whether the project is still feasible if some conditions change, a sensitivity analysis is made for the following three alternatives, viz., Case 1: Project cost increases by 10%, Case 2: Benefit volume decreases by 10% and Case 3: Both Case 1and Case 2 occur simultaneously. Here, it is supposed that QC surcharge which is an additional handling fee levied by PAS since installation of QC will be lifted after the year 2030.

The results of the sensitivity analysis are derived in Table 9-2. Even in Case 3 of sensitivity analysis, the financial feasibility of the Project are exceeding threshold value. Therefore, the Project is recommended to be implemented as early as possible.

Table 8-2 Financial Result of Sensitivity Analysis

Case	Base	Case 1	Case 2	Case 3
FIRR	8.13%	6.46%	6.28%	4.52%

Source: JICA Survey Team

9. RECOMMENDATION

Implementation Procedures

PAS has already implemented ODA projects under five yen loan contracts, i.e. CP-P3, CP-P5, CP-P6, CP-P8, and CP-P10, and has enough knowledge on procedures and rules for the procurement. The project management unit (PMU) has been designated as the executing body for ODA projects. Prompt information-sharing among related organizations, i.e. MOE, MEF and MPWT is required, and establishment and coordination of procurement committee composed of the said organizations in a timely manner is recommended to implement the project as scheduled.

Financial Performance

It is important to reduce the operational costs by improving efficiency of operation and reforming organizations, and to lower non-operational costs.

The interest rates of MEF sub-loans should also be reduced to the level of ODA interest rates or to a similar level. At the very least, interest rates of sub-loans need to be reduced to the level of ODA rates during the construction period since ODA finances the amount of interests during construction, which means that the borrower does not have to pay interests during that time.

PAS should conduct vigorous promotional activities to attract the attention of the port business community before and after the development of the new container terminal. Besides, promoting the utilization of the port SEZ and oil supply base/multi-purpose terminal should be a given priority because those facilities will play a key role in improving the financial performance of PAS.

Port Operation and Management

Port facilities are generally required to maintain the necessary functions in service for a long time. It is important to implement more efficient maintenance and repair on a preventive basis to minimize the life-cycle costs of machineries/equipment. Accordingly, a manual for strategic maintenance and repair should be created.

The International Ship and Port Facility Security (ISPS) Code is an amendment to the Safety of Life at Sea (SOLAS) Convention on minimum security arrangements for ships, ports and government agencies. Cambodia is a contracting state to the International Convention for the Safety of Life at Sea Protocol of 1974 (SOLAS 74), but Cambodia has not complied with the requirements of the ISPS Code sufficiently. Fully complying with ISPS Code is required in order to keep the firm status as an international port.

In connection with the above issues, 1) appropriately required budget for security, 2) implementation of gate access control, 3) compulsory container weight measurement, and 4) set up of second restricted area for container cargo operation are required.

Social and Environment Issues

Stakeholders' understanding of the project is necessary for smoothly project implementation. PAS held stakeholders' meeting for the project, and objection against the Project was not confirmed. Disclosure of the project information should be executed continuously.

Before starting the project, information on the proposed construction work such as schedule and area of dredging work, traffic conditions, etc. should be disseminated/distributed to the local residents including fishermen who live adjacent to the port area.

Environmental Management Plan (EMP) should be prepared including mitigation measures and environmental monitoring plan according to approved EIA report by MOE and JICA Guidelines. It is recommended for PAS to monitor the environmental monitoring plans of construction work approved by EMP. The results of the monitoring are to be reported to MOE.

SUMMARY

1. INTRODUCTION

1.1. Background of the Survey

The Sihanoukville Port, located at the south end of the Cambodia Growth Corridor and in the Preah Sihanouk Province, is the sole international deep sea port in the Kingdom of Cambodia supporting the national economic and industrial activities.

The container transaction volume of Sihanoukville is increasing at 10% on an average over the last five years after 2009 due to strong economic growth led by the garment industry. On the other hand, the container throughput of Sihanoukville Port is reaching its handling capacity limit. Nevertheless, the operation body of the port, the Port Authority of Sihanoukville (PAS), has a short-term plan to strengthen the handling capacity by having additional cranes. The container throughput is expected to reach the handling capacity limit in 2023. Moreover, GDP growth rate of Cambodia has steadily recorded over 7% on an annual average over the last ten years and stronger economic activity is expected after the economic convergence of ASEAN in 2015.

With the above mentioned economic circumstance, the development of new container terminal and associated structures in the Sihanoukville Port is planned as a yen loan project of the "Sihanoukville Port New Container Terminal Development Project".

1.2. Object of the Survey

In the course of the "Preparatory Survey for Sihanoukville Port New Container Terminal Development Project", the Japan International Cooperation Agency (JICA) Survey Team investigates the background, objective, contents of the project, and verify its necessity. After confirming the necessity, the JICA Survey Team surveys the necessary items for appraisal for the yen loan project such as the objective, feature, project cost, implementation schedule, implementation method, organization structure for project implementation, organization structure for operation and maintenance, and environment and social considerations.

1.3. Survey Area

The survey area for the new container terminal is the calm water area surrounded by the south and north breakwater. The survey area for the access road is the Hun Sen Road and its connecting road and the road planning area. The survey area for the long-term port development plan is the whole port area managed by PAS.

1.4. Scope of the Project

The Project will develop the new container terminal and related structures in the Sihanoukville Port. Major components are confirmed between fact finding mission of JICA and MEF and PAS as mentioned below.

1) Construction of new container terminal.
2) Construction of access road including access bridge.
3) Dredging of channel and basin.
4) Construction of major terminal building.
5) Construction of customs inspection yard.
6) Procurement of cargo handling equipment and terminal operation system.
7) Consulting services.

1.5. Counterpart Organization

The counterpart organization is PAS. The related agencies to the project is the Ministry of Public Works and Transport (MPWT) and the Ministry of Economy and Finance (MEF).

2. SOCIOECONOMIC SITUATION

2.1. Demography

The total population of Cambodia is approximately 15.2 million (2014), with an annual population growth rate of 1.79% for the past 16 years (1998-2014).

2.2. Economy

The GDP growth is expected to reach about 7% in 2016, partly underpinned by a significant increase in government spending. Strong garment sector exports are expected to help offset the weakness in the agriculture sector, while the foreign direct investment-driven construction is expected to continue to be a major engine of growth. In the medium term, economic growth is expected to remain between 6% -7%.

2.3. Trade

Exports have increased at an average annual growth rate of 15.3% from 1997 to 2014 driven by high growth in garment and footwear exports.

2.4. Industry

The tertiary industry is the largest industry in Cambodia in terms of the added value, then followed by the secondary industry. The share of the added value of the primary sector is the smallest, although the largest percentage of people's work is in the agricultural sector. Manufacturing including textile, apparel, and footwear industry, which accounts to 24% of the total added value in Cambodia, is the largest sub-sector followed by trade.

2.5. Special Economic Zone

The Royal Government of Cambodia (RGC) has approved a total of 39 special economic zones (SEZs). The Phnom Penh SEZ, Sihanoukville SEZ, and Sihanoukville Port SEZ are constant users of the Sihanoukville Port presently, and several proposed or developing SEZs are potential users.

3. PRESENT SITUATION OF MAIN PORTS IN CAMBODIA

3.1. Land Transport Infrastructure

The cargos to or from Sihanoukville Port are transferred through road and railway networks.

(1) Road

The National Road No. 4 (NR 4) is the main route connecting Phnom Penh and Sihanoukville and also the logistical trunk route. Nevertheless, the travelling speed of container trucks is restricted by the mixed travelling with motorcycles or small vehicles, and by the low weight limits and narrow sections of bridges. The improvement plans of NRs were proposed by the NSDP Update 2014-2018 and the road network master plan for 2020.

(2) Railway

The southern line connects Phnom Penh and Sihanoukville, which was rehabilitated in 2014. Consequently, the container train service restarted their operation of three times per week and recorded a total container transport volume of 17,836 TEUs in 2014. In Sihanoukville, the rehabilitation of the container and rail terminal including the bulk siding inside the port was completed in 2016.

3.2. Issues in the Port Sector

Taking into account changes in the maritime situation in recent years, the current issues in the port sector are shown below.

1) Strengthening the function of ports as the center of Cambodian trade
   - Promotion of international gateway ports
   - Increasing port capacity to meet future demand
   - Modernizing port facilities

2) Providing efficient port service
   - Efficiency in a series of works (such as cargo handling and metage system)
   - Efficiency in the procedures of customs and vessel operations (such as enhancing information technologies)
   - Integration or simplification of customs declaration controlled by the General Department of Customs and Excise (GDCE) and import/export permit controlled by the Cambodia Import Export Inspection and Fraud Repression Department (CAMCONTROL)

3) Efficient port development and appropriate management
   - Preparing a national port master plan of the entire Cambodia
   - Implementation of strategic development of main ports
   - Establishment of appropriate public-private partnership
   - Introducing private operations/services
   - Publication and utilization of port statistics for policy makers, investors, port users, and researchers (including private port)

4) Improvement of organization and legal system
   - Improvement of maritime and port organization and clarification of division of roles
   - Establishment and revision of the legal system (such as port law and regulations regarding the administration on the development and management of private ports)

5) Securing port safety/security
   - Compliance with international code for the security of ships and port facilities (International Ship and Port Facility Security (ISPS) Code)

6) Preservation of environment and compliance with the concept of coastal zone management

3.3. Role of Sihanoukville Port

(1) Demarcation between Sihanoukville Port and Phnom Penh Port

In general, it is regarded that the transportation route is decided based on the cost and lead time. However, there are some portions which is not reasonable for the current market share of Sihanoukville Port and Phnom Penh Port. Based on the above, it is presumed that the transportation route is decided based on the factors related to the logistics performance as shown below.

- Efficiency of the customs clearance process
- Quality of trade and transport-related infrastructure
- Ease of arranging competitively priced shipments
- Competence and quality of logistics services
- Ability to track and trace consignments
- Frequency which shipments reach the consignee within the scheduled or expected time

However, it could be said that the abovementioned factors for Sihanoukville Port and Phnom Penh Port will not change drastically in the future.

In conclusion, it is considered that the current situations of export destination will be basically continued, which means that Sihanoukville Port will cover around the world (such as Europe, the Americas, and Asia) and Phnom Penh Port will be specialized for Asia and the Americas. Also for the import origin, it is thought that the current situations will be continued same as the export cargoes.

(2) Future Development Plan of Neighboring Port

The impact of the development plans of Oknha Mong Port and Steung Hav Port on the cargo handling volume of Sihanoukville Port is negligible due to the difference of target cargo type in Oknha Mong and the low feasibility of development in Stueng Hav.

Source: Structured Assessment of Protective Factors (SAPROF) for Sihanoukville Port Urgent Development for Oil Supply Base and Multipurpose Terminal (2009)

Figure 3-1 Location of Main Seaports

(3) Role of Sihanoukville Port

The increase in the ship size is the most efficient way in order to reduce the maritime transportation cost. In recent years, many large-scale ships are in service in major international route by various shipping companies. Therefore, in order to attract shipping companies, it is essential that ports should have large depths.

In general, the river ports have problems caused by sand sedimentation, and Phnom Penh Port also has limitation in water depth and channel width. Therefore, the maximum vessel size is limited to 1,500-2,000 DWT (100-200 TEUs). Phnom Penh Port functions as a regional hub for cargo transport among the ports located along Mekong River. However, the only ports that have direct international route to/from Phnom Penh are the ports in Viet Nam such as Ho Chi Minh and Cai Mep Thi Vai Port.

On the other hand, Sihanoukville is regarded as the only place where deep seaport can be built because most of the coastal areas in Cambodia are located on shoals. It is thought that Sihanoukville is the most appropriate location due to its natural conditions. In other words, Sihanoukville Port is the sole international deep seaport in Cambodia and has important roles as mentioned below.

1) Large-size bulk carriers (50,000 DWT) will be able to berth at the port after the start of operation of the multipurpose terminal in addition to container ships thereby making it possible to contribute to the mass transport of agriculture and forestry products.
2) Sihanoukville Port, located on the "Southern Coastal Sub-corridor" that connects southern Vietnam and Bangkok, plays a role as a connection point of the national economy corridor and foreign countries.
3) Port industry, including freight forwarding businesses in Sihanoukville Port, has a large effect on the economy and job creation in Preah Sihanouk and the surrounding areas. Furthermore, Sihanoukville Port has a role for supporting tourism which serves as a gateway by accepting a large number of foreign tourists.
4) Regarding the type of container ships, Sihanoukville Port is the sole international port to accommodate the large-sized ship such as 60,000 DWT class container vessels (around 4,000 TEUs) after the completion of this new container terminal development while Phnom Penh Port can only accommodate barges.

4. NATURAL CONDITION SURVEY

4.1. Topographic Survey

The topographic survey was conducted by subcontracting along the coastal road.

The Survey items are:

Horizontal and vertical control network	: 5 monuments
Topographic survey	: 51,000 m^2
Longitudinal survey	: 1,900 m
Cross section survey	: 39 sections at 50 m interval

4.2. Soil Investigation

The soil investigation was conducted by subcontracting in the proposed project site. The survey quantity is tabulated in Table 4-1.

Table 4-1 Quantity of Soil Investigation

Item			Quantity
Drilling depth (m)			137.3
Drilling depth in rock (m)			54.4
Field test	Vane shear test		15
	SPT		118
Undisturbed Sample			17
Laboratory test	Physical property test		126
	Mechanical property test	Shear test and consolidation test	17
		Compression test of core sample	9

Source: JICA Survey Team

The stratification along the wharf alignment is shown in Figure 4-1. It is realized that very soft alluvium formation is to be removed by dredging work up to -14 m and the bearing stratum is extremely inclined. Therefore, it seems that gravity-type wharf may not be adequate due to the structure's tilting during/post construction work.

On the other hand, the stratification along the center line in the reclamation area is shown in Figure 4-2. Alluvium formation is soft and could mainly settle by reclamation fill load, but its thickness is only 2-5 m. Therefore, consolidation settlement of the alluvium formation is expected to be approximately 60 cm within 3-4 months. It could also be concluded that utilization of vertical drain technique shall not be necessary.

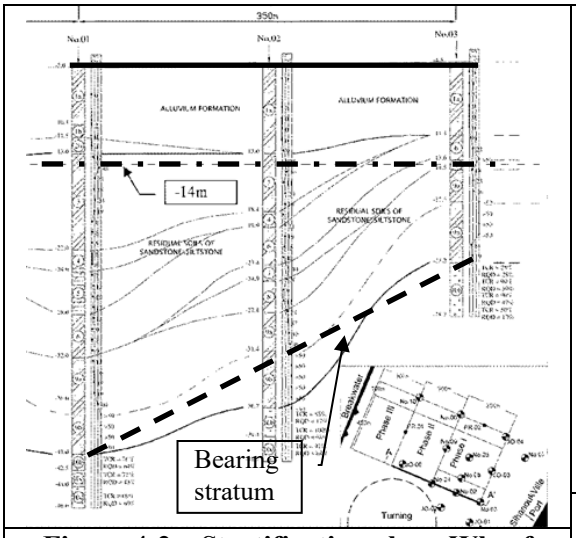


Figure 4-2 Stratification along Wharf

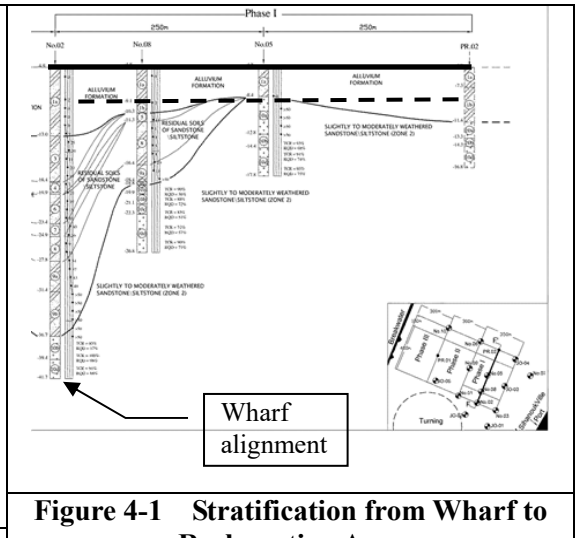
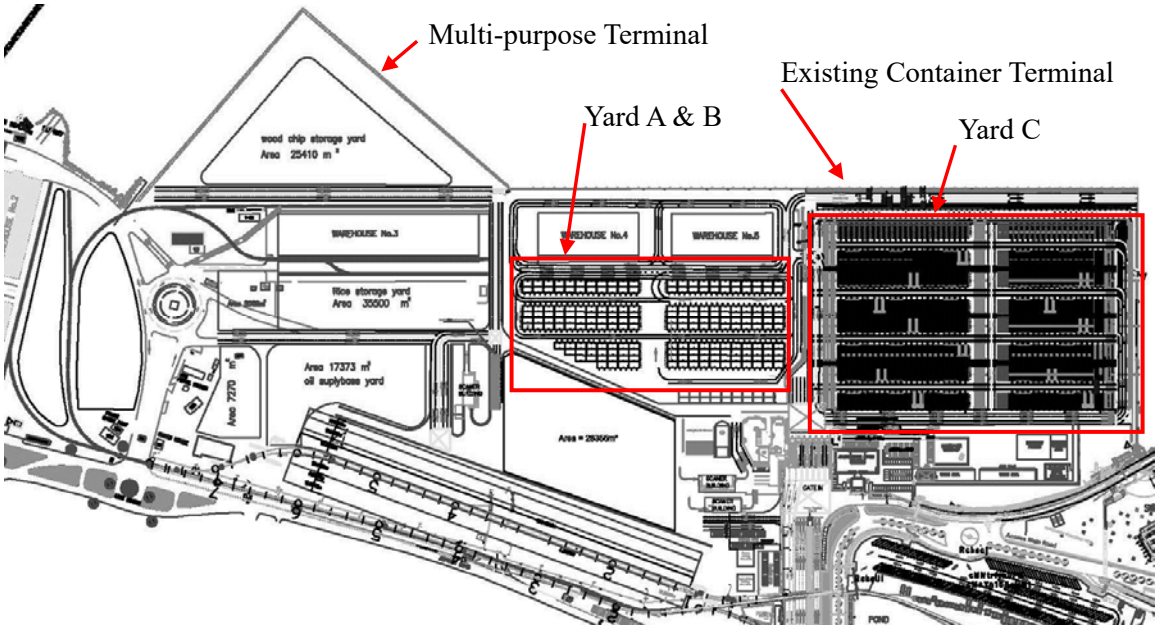


Figure 4-1 Stratification from Wharf to Reclamation Area

Source: JICA Survey Team

5. CARGO HANDLING CAPACITY OF THE EXISTING PORT

The terminal layout of Sihanoukville Port is shown in Figure 5-1. Currently, a Multi-purpose Terminal is under construction.



Source: PAS

Figure 5-1 Terminal Layout of Sihanoukville Port

The cargo handling capacity of the existing container yard with the present handling equipment was estimated to be around 500,000 TEUs. In accordance with the sharp increase in container cargoes in recent years, PAS will strengthen container handling capacity by installing new handling equipment and improving handling efficiency. Furthermore, the cargo handling capacity of the existing container terminal will increase to around 700,000 TEUs. Furthermore, PAS has a plan to handle container cargoes tentatively at the multipurpose terminal, which is under construction, until the start of operation of the new container terminal. Its cargo handling capacity was estimated at around 100,000 TEUs on condition that derricks are mounted on a container ship load and unload the container boxes.

Taking into account the said cargo handling capacity of the existing container terminal and the under-construction multipurpose terminal, 800,000 TEUs of container cargoes will be handled in the present port area.

6. DEMAND FORECAST

6.1. Methodology of Demand Forecast of Container Cargo

The macro method was applied to obtain the cargo forecast. Then, the result of macro forecast was verified by micro method, which forecasted the volume of each item of import and export by commodity individually. In the macro forecast, three growth scenario (high, middle, and low) were considered.

6.2. Results of Macro and Micro Forecast of Container Cargo

The comparison of the macro forecast and micro forecast is shown in Table 6-1. The middle case of macro forecast is estimated based on the assumption that the current condition of economic growth (GDP growth rate: about 7%) will continue in the future and its result is considered as the most realistic estimation. In addition, this result was compared and verified by micro forecast that

was estimated for each commodity. Based on this, the JICA Survey Team adopted the middle case of macro forecast.

Table 6-1 Result of the Macro and Micro Forecast

Unit: Thousand TEUs

	2015	2020	2025	2030	2035	2040
Macro (Low)	391.8	589.4	752.3	932.9	1,081.5	1,253.8
Macro (Middle)	**391.8**	**681.9**	**927.3**	**1,225.6**	**1,486.9**	**1,817.7**
Macro (High)	391.8	803.7	1,236.6	1,809.9	2,354.2	3,062.3
Micro	391.8	705.5	980.5	1,226.7	1,515.3	1,819.0

Source: JICA Survey Team

6.3. Review of Demand Forecast of General Cargo and Bulk Cargo

In the ongoing multipurpose terminal project, PAS initially envisaged handling the bulk and general cargo. However, since there is the surplus handling capacity, PAS plans to handle the container cargo also. Therefore, in addition to container cargo the demand forecast for the bulk and general cargo was reviewed and updated. The result of demand forecast of general cargo and bulk cargo is summarized in Table 6-2.

Table 6-2 Result of Demand Forecast of General Cargo and Bulk Cargo

Unit: Thousand Tons

	2015	2020	2025	2030	2035	2040
Export	39.4	218.6	310.2	493.8	848.7	1,518.3
Import	213.0	254.9	275.1	300.2	331.1	373.0
Total	**252.4**	**473.5**	**585.3**	**794.0**	**1,179.8**	**1,891.3**

Source: JICA Survey Team

7. PORT DEVELOPMENT PLAN

7.1. Scenario of Port Development Plan

7.1.1 Target Year of Port Development Plan

The target year of the development plan of the Sihanoukville Port is proposed as listed below. Here, construction period is not included in the development plan. For example, a new container terminal Phase I is scheduled to start operation since 2023, thus it is mentioned in Medium-term Plan (-2030).

Short-term Plan (-2023):	Installation of new handling equipment and development of the multipurpose terminal
Medium-term Plan (-2030):	Development of new container terminal (Phase I)
Long-term Plan (-2040):	Development of new container terminal (Phases II and III)
Extra Long-term Plan (2040-):	Stage I: Development of remaining inner area of the existing breakwater
	Stage II: Expansion to outer area of the existing breakwater

Note: The development of the new container terminal is divided into three phases: Phase I is conducted in the medium-term plan, and Phases II and III are planned in the long-term plan.

7.1.2 General Concept of Port Development Plan

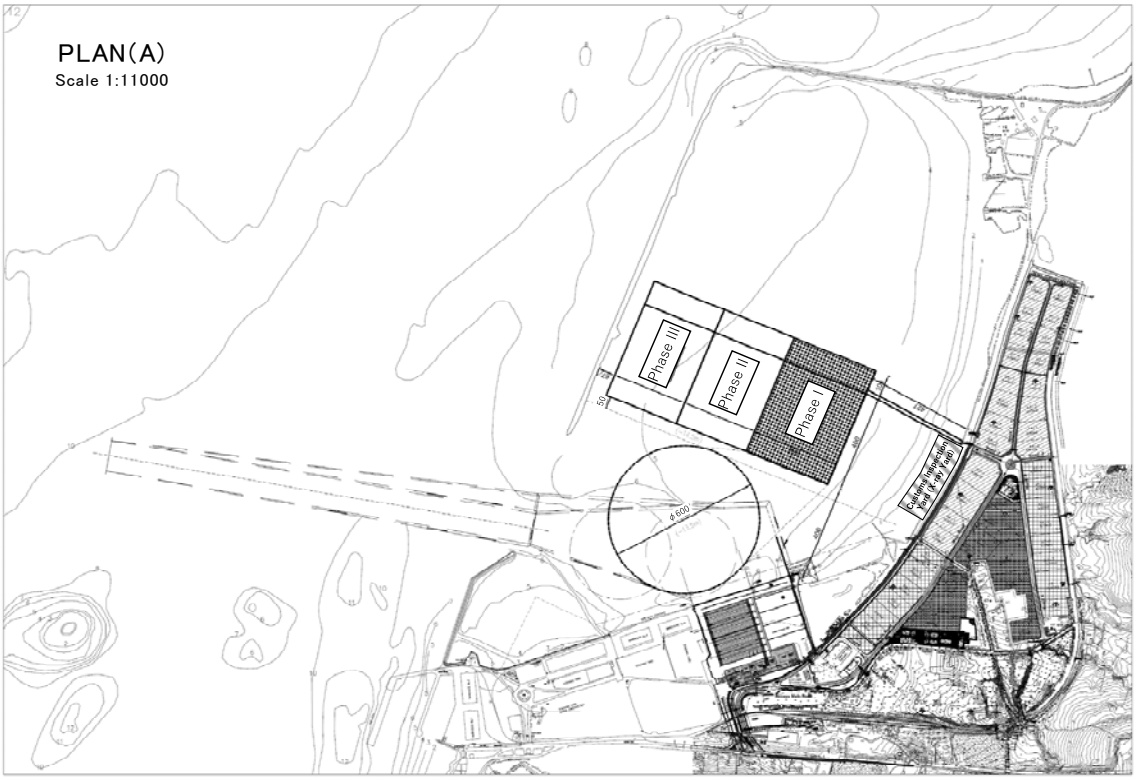
(1) Short-term Plan

The objective of the short-term plan is to install handling equipment for the existing container terminal and to develop the multipurpose terminal and the off dock yard. The target year of the short-term plan is 2023. The targeted annual handling capacity of containers is estimated to be around 800,000 TEUs.

(2) Medium-term and Long-term Plan

In the medium-term and long-term plan, new container terminals are developed in three phases to cope with estimated increment demand of containers. The yard and berth of Phase I is constructed by 2023 as the medium-term plan. The target capacity of container is approximately 1.15 million TEUs, which enables the port meet the estimated demand in around 2030.

The remaining two yards and berths are constructed consecutively in the long-term plan in order to cope with further increasing demand. In this study, the medium-term plan is mainly studied in anticipation of the long-term plan. The layout of long-term plan is shown in Figure 7-1.



Source: JICA Survey Team

Figure 7-1 Layout of the Long-term Port Development Plan

7.1.3 Study of Port Development of the Extra Long-term Plan

PAS planed extra-long term port development plan as mentioned in Figure 7-2. The JICA Survey Team confirmed its basic concept and have technical comment on it as mentioned below.

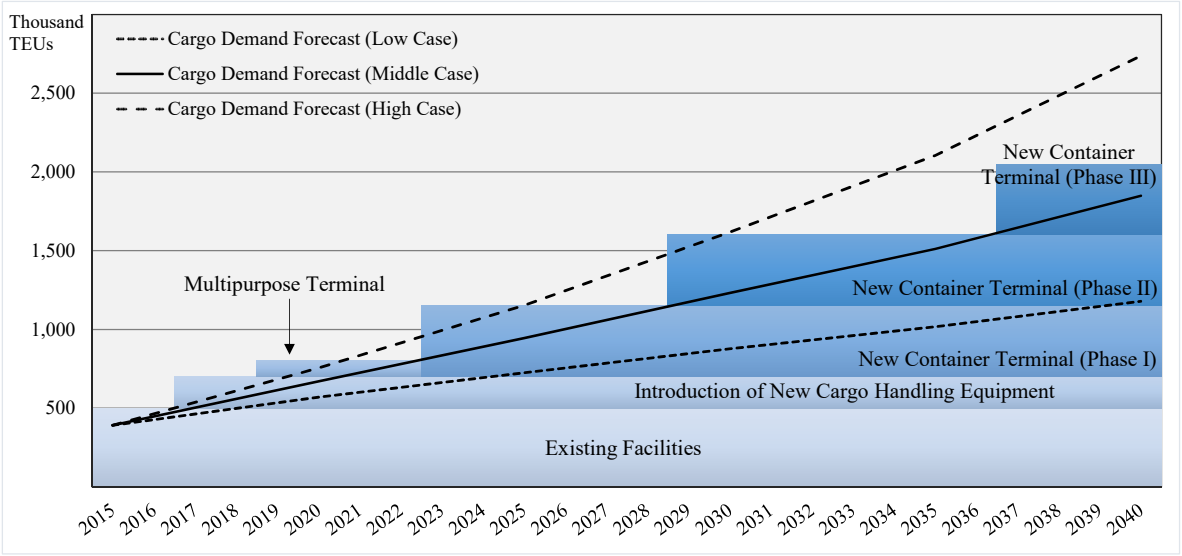
Source: PAS

Figure 7-2 Port Development Plan by PAS

- It is required to consider installation of outer breakwater, since it is difficult to ensure calmness area for new berths constructed at outside of existing breakwater,
- The planned berths are only for containers. It is necessary to consider use of not only containers but also bulk cargo,
- It is planned to develop large railways area at center of landfill area. It is required to confirm future cooperation between marine and railways transportation, and
- Access channel from central turning basin to existing main channel shall be considered.
- Several access routes to inland area shall be considered.

7.2. Necessity of New Container Terminal

Along with steady increase in container cargo in the future, it is expected that container cargo throughput will exceed the cargo handling capacity of the present port area (800,000 TEUs) in 2023. It is assumed that container cargo will not be handled at the multipurpose terminal after the opening of new container terminal. Under such circumstances, new container terminal development plans should be promptly formulated to meet increasing container cargo demand.



Source: JICA Survey Team

Figure 7-3 Stepwise Development Plan in accordance with Container Cargo Demand

8. PORT FACILITY DESIGN

8.1. Basic Concept of Design

Existing container terminal with depth of -10.5 m can accommodate only 25,000 DWT class container vessels (around 2,000 TEUs), so-called Under-Panamax size. On the other hand, the large-size trend of container vessels has been worldwide observed. In East Asia Region Route, 60,000 DWT class container vessels (around 4,000 TEUs) have drastically increased, and it is supposed that 60,000 DWT class container vessels will ply Sihanoukville Port along with steady increase in container cargoes. In order to meet the large-size vessel trend, PAS eagerly requested the berth facility to accommodate Over-Panamax size container vessels. It is fact that accommodating Over-Panamax size container vessels are considerable advantage of port sales for shipping lines.

1) Target Vessel

One Over-Panamax size container vessel for 1 berth
Maximum. 60,000 DWT: Draft =13.8 m, LOA =285 m, Beam=40.0 m

Two Under-Panamax size container vessel for 1 berth
8,000 DWT~15,000 DWT: Draft= 7.3 m~ 9.0 m, LOA= 127 m~158 m, Beam=20.4 m~ 24.5 m

2) Container Terminal Capacity: Phase I (350 m berth length), Phases II and III (300 m berth length)

Phase I : 450,000 TEUs /year
Phase II : 400,000 TEUs /year
Phase III : 400,000 TEUs/year

3) Container Handling Method

Quayside Container Crane (QC) + RTG + Tractor trailer

4) Tide

LWL=+0.0 m CDL
HWL=+1.43 m CDL
(for Multipurpose Terminal Project)

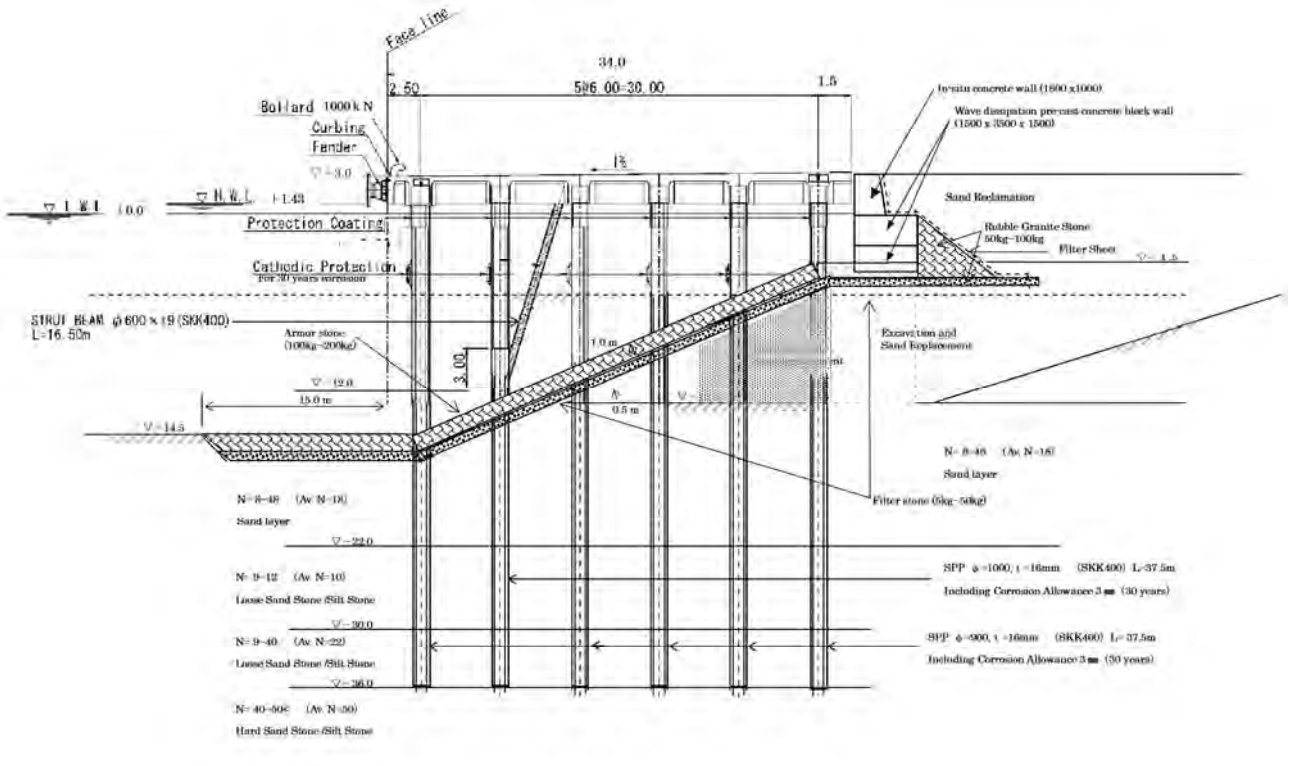
8.2. Container Berth

The four alternatives were studied for the preliminary design of container berth considering structural and construction cost, maintenance aspects, environmental impact, construction aspects and etc. The alternatives are: 1) Steel Pipe Sheet Piles Structure, 2) Concrete Deck on Steel Pipe Pile, 3) Concrete Block Method, and 4) Concrete Deck on Steel Pipe Pile and Strut Beam.

In consideration of the quay structural comparison, Concrete Deck on the Steel Pipe Pile & Strut Beam is supposed to appropriate, its typical section as shown in Figure 8-1.

However, its disadvantage should be well-considered. It is noted that other quay structure types exceed the Concrete Deck on the Steel Pipe Pile & Strut Beam in some aspects. The Consultant suggests to be adopted the Concrete Deck on the Steel Pipe Pile & Strut Beam structural method based on the comprehensive evaluation results. Especially the maintenance issues for the steel piles and the concrete deck explained that maintenance cost of the Concrete Deck on the Steel Pipe Pile & Strut Beam for 350 m in length is estimated about 1.2 million USD for 50 years.

In the comparison of the quay structural method, Construction cost for 350m of Concrete block structural method could be higher about 3.7 million USD than the Steel Pipe Pile & Strut Beam structural method. Therefore, the Concrete Deck on the Steel Pipe Pile & Strut Beam is still economical in consideration with the maintenance cost for 50 years.

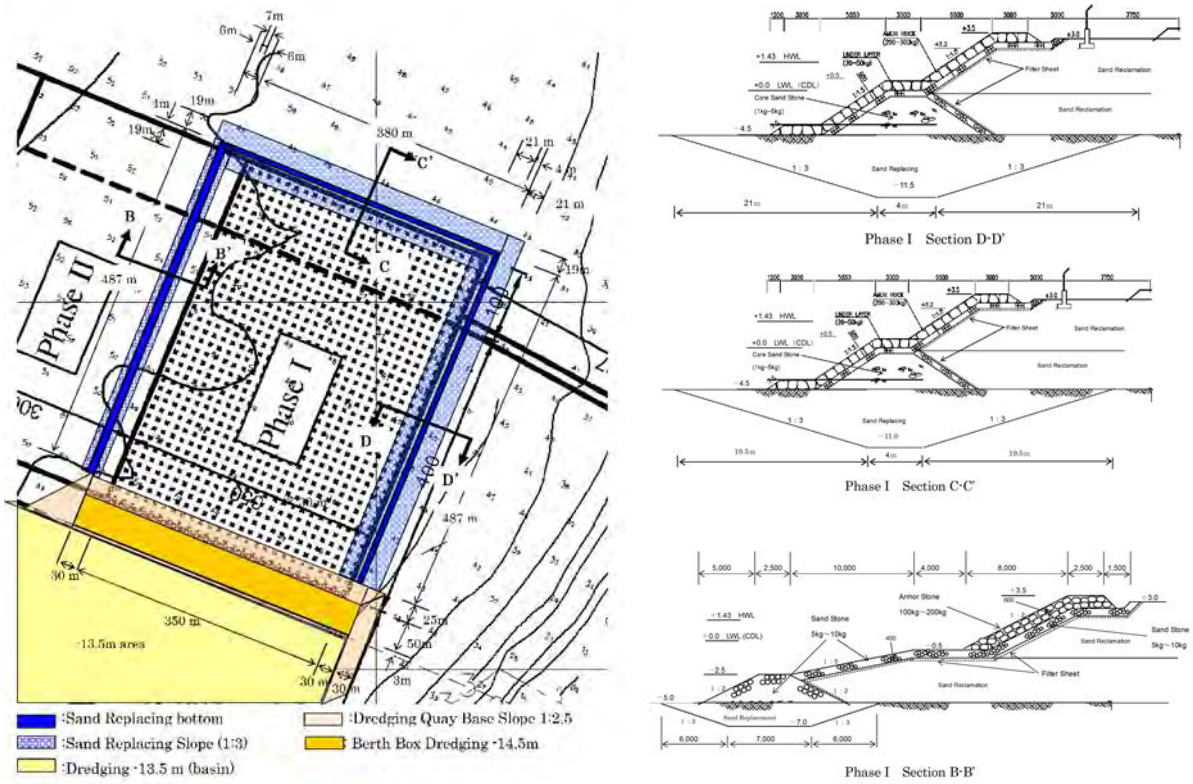


Source: JICA Survey Team

Figure 8-1 Typical Section of Quay Structure

8.3. Reclamation and Soil Improvement

The comparatively good dredged materials such as rock layer and sandy layer will be used to fill in the reclamation area. The special soil improvement is not considered. For the seawall construction for the protection of the reclaimed area, the very soft layer is planned to replace the good sand to keep the stability of the seawalls. The plan for sand replacement for the soft layer having 6.5 m thickness at the seawall area and seawall structural section is shown in Figure 8-2.

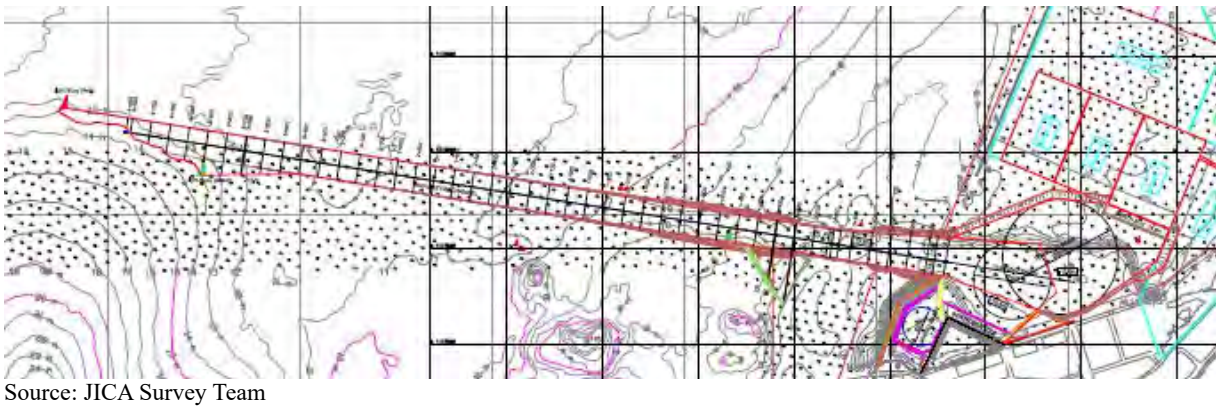


Source: JICA Survey Team

Figure 8-2 Sand Replacement Plan and Seawall Structure

8.4. Access Channel and Turning Basin

The general layout plan of dredging is shown in Figure 8-3. The length of access channel is approximately 4.5 km from the port entrance as Sta.0+000 to seaward up to -13.5 m contour line. The turning basin covers the area between the new container berth (Phase I) and MPT with water area of approximately 49 ha (486,000 m^2). The total volume of dredging is 3.98 million m^3.

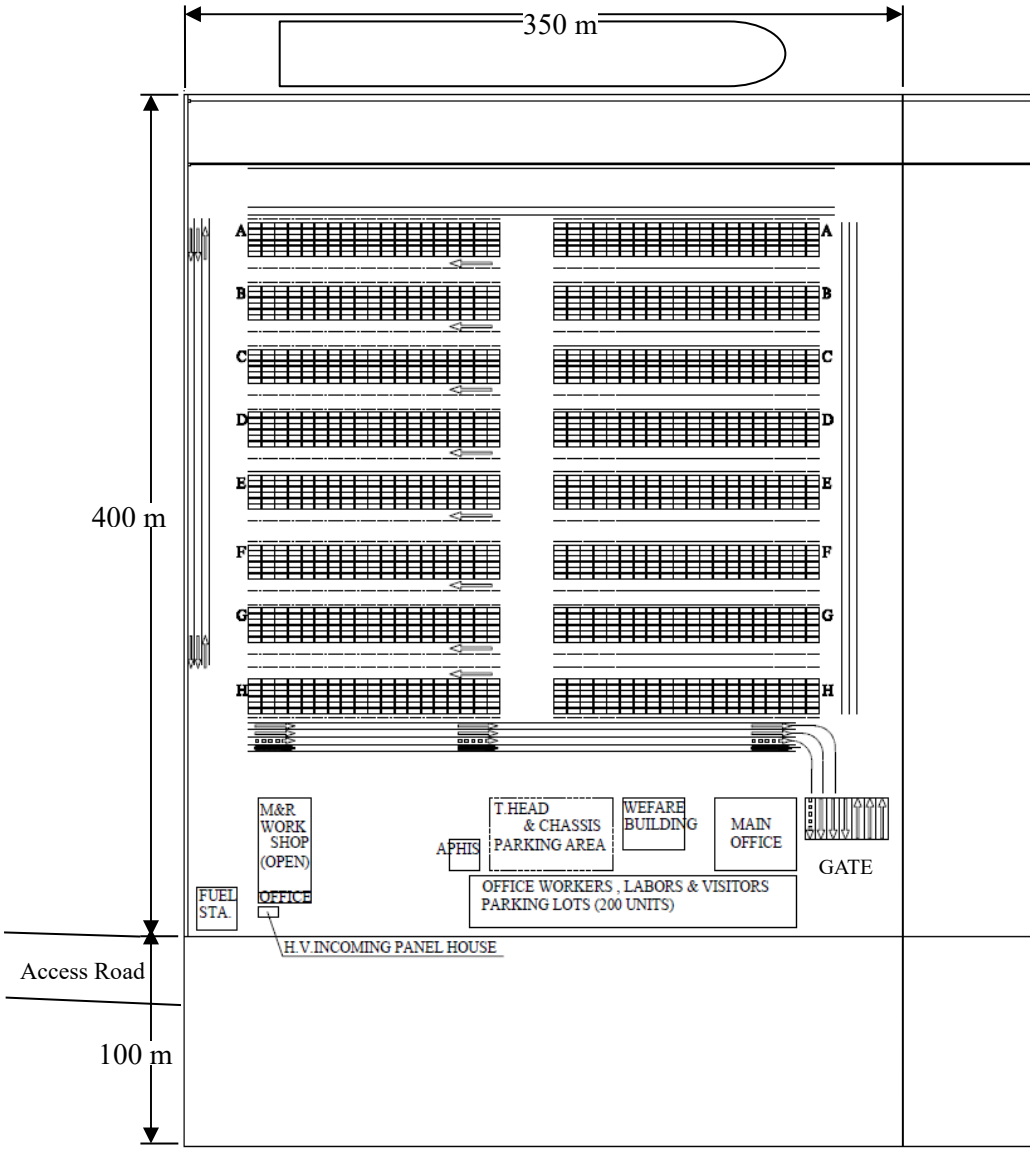


Source: JICA Survey Team

Figure 8-3 General Layout Plan of Dredging

8.5. Yard Layout of New Container Terminal

The Yard Layout of No. 1 Container Terminal in Phase I, is shown in Figure 8-4.



Source: JICA Survey Team

Figure 8-4 Yard Layout of Container Terminal No. 1 (Phase I)

8.6. Administration Building, Maintenance Building, Gate, Inspection Facility, and Required Facilities

The required facilities and equipment for the new container terminal are:

- Main Office (Administration Building): 2,500 m^2 , RC structure 4 stories
- Workers building: 600 m^2 (RC structure)
- Terminal Gate: 820 m^2 RC Structure (3 lanes for In, 4 lanes for out)
- Maintenance work shop: 1200 m^2 (RC structure, maintenance office in second stories)
- Fuel Station: 400 m^2 (Fuel reservoir tank & distributer)
- Generator house and sub-station : 300 m^2 (Three generators, panels & transformer)
- Parking Place of In-yard Car (Tractor head & Yard Chassis)
- Animal, Plant and Health Inspection Station
- Dangerous Goods Temporary Storage Plant (installed in the container storage area)
- Waiting Space for Road-chassis
- Over-height Maintenance Space
- Parking Area of Terminal-use Vehicles

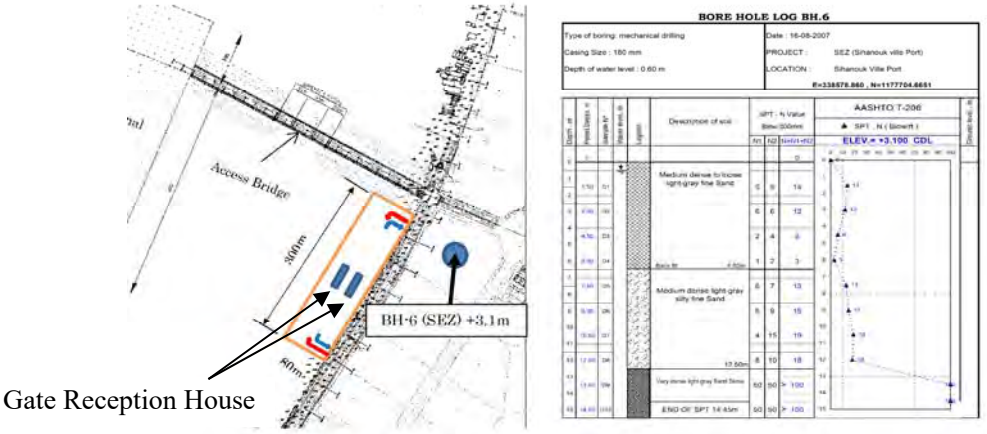
- Night Lighting Tower
- Container Freight Station (CFS) (installed outside of Container Terminal)

Each scale of facilities and equipment should be determined at the detailed design stage.

8.7. Customs Inspection Yard

Non-destructive inspection facilities such as the X-ray inspection facility should be installed outside of the Gate of the New Container Terminal together with the gate reception house which consists of Police, Custom and CAM-CONTROL, in order to shorten waiting time of the trailers at gates of the New Container Terminal. These inspection equipment and facilities are provided by Customs, PAS will be provided the inspection yard at designated location as shown in Figure 8-5. The scale of facilities and equipment should be determined at the detailed design stage.

For the Customs inspection yard at the landside near the planned access bridge, a soil investigation boring about 50 m from the planned area in the Port SEZ project was done in 2007 as shown in the results of borehole figure 8.5.



Source: JICA Survey Team

Figure 8-5 Location and Area of Customs Inspection Yard

8.8. Cargo Handling Equipment

(1) Quayside Container Crane (QC)

The quayside container cranes with outreach response to the Over-Panamax-type container ships of 40 m beam (16 rows on deck) stacking 6,000 TEUs containers must be selected. The main specifications are shown in Table 8-1.

Table 8-1 Main Particulars of Quayside Container Crane (QC)

Main Particulars	Unit	Value	Remarks
Rated Load	ton	40.6	(for container)
		40.6	(for hatch cover)
		50	(for cargo)
Span	m	30	
Outreach		44.2	
Supply Power	A.C. 6.6 kV, 50 Hz, 3 Phase		

Source: JICA Survey Team

(2) Rubber Tyred Transfer Crane (RTG)

The main specification of the rubber tyred gantry crane is that it has the capability to stack containers 1 over 5 high, and the other specifications are shown in Table 8-2.

Table 8-2 Main Particulars of Rubber Tyred Gantry Crane

Main Particulars	Unit	Value/Remarks
Rated Load	LT	40
Type of Spreader	m	Single lift (20/40 FT Telescopic Spreader)
Span	m	23.47
Container Arrangement	row	6 (0 + 6) Arrangement
Power Source		Diesel-Engine Generator Sets

Source: JICA Survey Team

8.9. Examination of the Advantage of Japanese Construction Technology

In this project, it has considered to apply Japan's engineering techniques for the construction of the berth structure of which were the Steel Pipe Strut Beam Method with the Heavy-duty Corrosion Lining (urethane elastomer lining) and the Wave Dissipation Concrete Block Wall.

The both of Japan's techniques could be economical structure than other method in order to secure the structural stability and operational calmness of the port. The Steel Pipe Strut Beam Method is taken an advantage to be able to make smaller dimension of the piles than the butter pile structural method. The Wave Dissipation Concrete Wall is only the berth structure to secure the calmness under the conditions of the proposed construction area. In addition to the above, the strut beam pipe are covered with a urethane elastomer at the factory to provide for an anti-corrosive function which is also Japan's special techniques that prevents the steel strut beams in its splash zone from corroding by seawater.

8.10. Climate Change Adaptation

(1) Storm and Cyclone

To cope with the high wave that attacks the port, the existing breakwater especially the north breakwater should improve for about 200 m in length from the port entrance. Therefore, the additional armor stone with concrete parapet construction have recommended in the project. This countermeasure is not directly concerned the new container terminal. Therefore, this countermeasure is not included in the project scope of works. However, it is effective countermeasure to ensure the calmness of the port. Hence, the additional armor stone with concrete parapet repairing works for the north breakwater is recommended in case that enough budget for this repairing work is secured in the detailed design stage.

(2) Rising Sea Tide

The reclamation area of the project is recommended to be filled to + 3.5 m (in average) which is about 30 cm higher than the existing container yard. The access road is also recommended to be filled to + 4.3 m. This countermeasure is expected to protect the residential area from the flood sue to a strong storm.

8.11. Approval Process of the Project

(1) Approval of Facility Construction

PAS, the implementation agency of the project, must request approval of construction from the Ministry of Public Works and Transport (MPWT). After the loan agreement exchange, PAS needs to prepare the application form including the project facilities description, coordinates of the facilities, and environmental impact assessment (EIA) approval letter.

(2) Contract for Electrical Power Supply

In this project, the electrical power would be provided by Electricite du Cambodge (EDC). PAS needs to contract with EDC to supply the necessary capacity of electrical power. The consultants will assist to evaluate the power demand and power supply system between the substations of EDC and the project.

(3) Approval of Environmental and Social Considerations

All port construction projects and project involving dredging work of more than 50,000 m^3 must prepare an EIA report and obtain approval from MOE.

9. BASIC DESIGN OF ACCESS ROAD AND BRIDGE

9.1. Alignment of Access Road and Bridge for Phase I

The road alignment has been planned to take advantage of the minimum amount of land between the road site and SEZ. Additionally, the current roadside housing and stores are not affected by this road plan.

The road alignment plan is shown in Figure 9-1.

Source: JICA Survey Team

Figure 9-1 Alignment Plan of Access Road to New Port

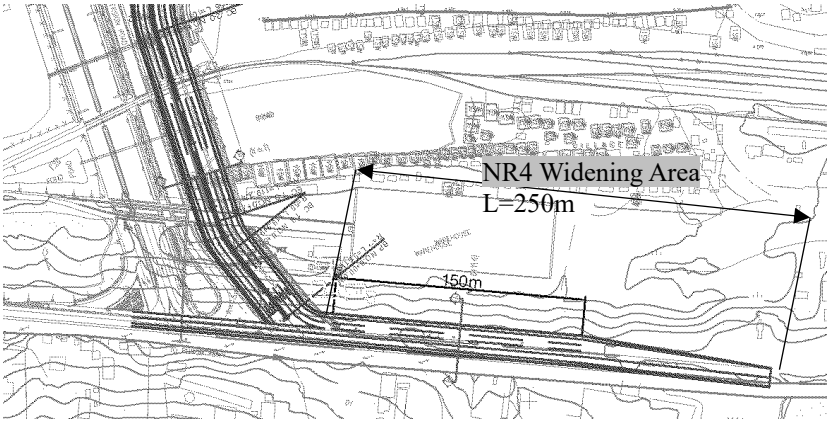
9.2. Intersection of NR4

The National Highway Route 4 intersection is selected as the starting point for the access road since it has minimal impact caused by traffic increase from the new port.

At the intersection of NR4, traffic congestion arises when the traffic towards the port is concentrated due to traffic from Phnom Penh taking a right turn.

Therefore, the plan to add two more lanes for the right turn towards the New Port and SEZ has been decided upon in order to alleviate NR4 traffic. The plan is to widen the 250m length lane and the 150m divergent lane.

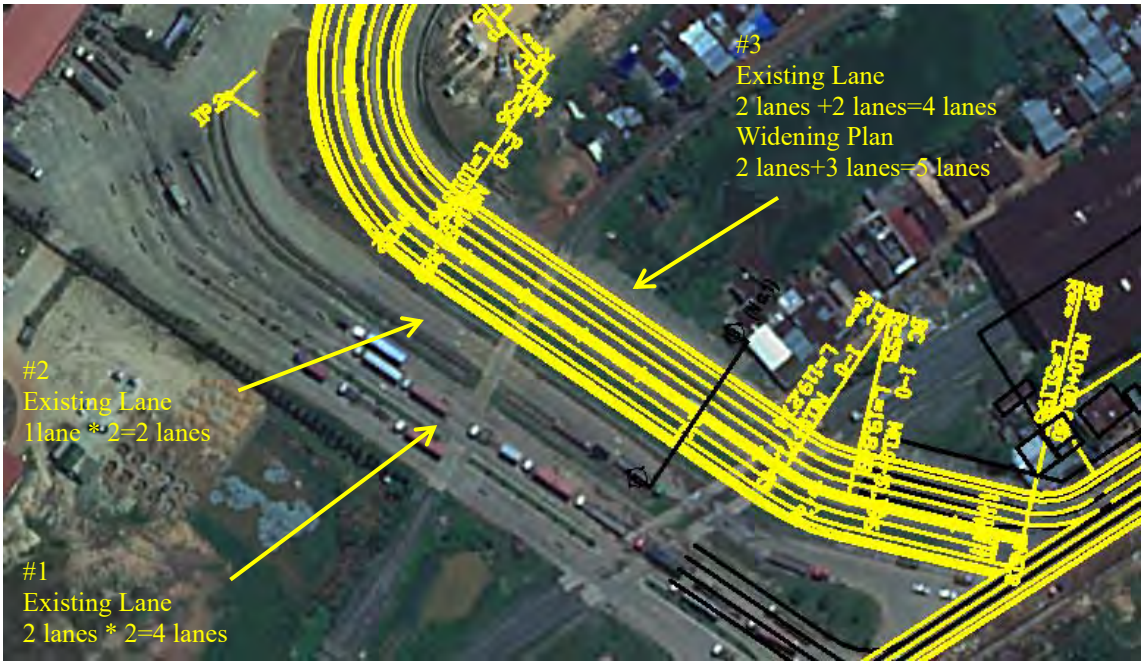
Intersection plan of NR4 is shown in Figure 9-2;



Source: JICA Survey Team

Figure 9-2 Intersection Plan of NR4

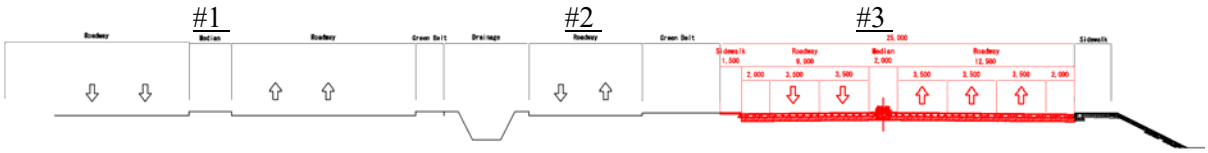
When widening the area between NR4 and the existing port entrance to cater for the additional lane the existing green belt will be modified. The plan is shown in Figure 9-3.



Source: JICA Survey Team

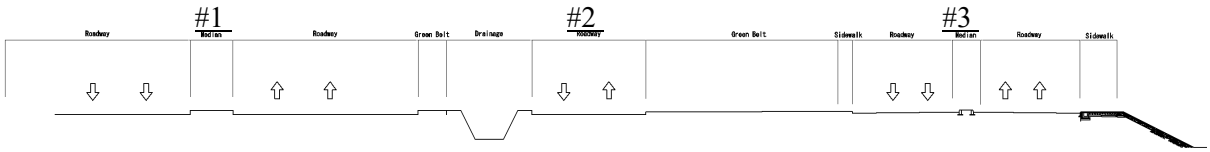
Figure 9-3 Intersection of the National Highway Route 4

The current lane configuration is composed of # 1, # 2 and # 3 as indicated below. The area between # 2 and # 3 shall be treated as green belt. The green belt is aimed at reducing the cost impact as much as possible to the project because widening maintenance has been carried out in the project of SEZ development during 2015. For this purpose, the existing 4 lane road shall be upgraded to a 5 lane road by changing the green belt to roadway. We foresee that it shall facilitate the traffic flow by this option. Existing cross section and plan cross section is shown in Figure 9-4 and Figure 9-5.



Source: JICA Survey Team

Figure 9-4 Plan Cross Section



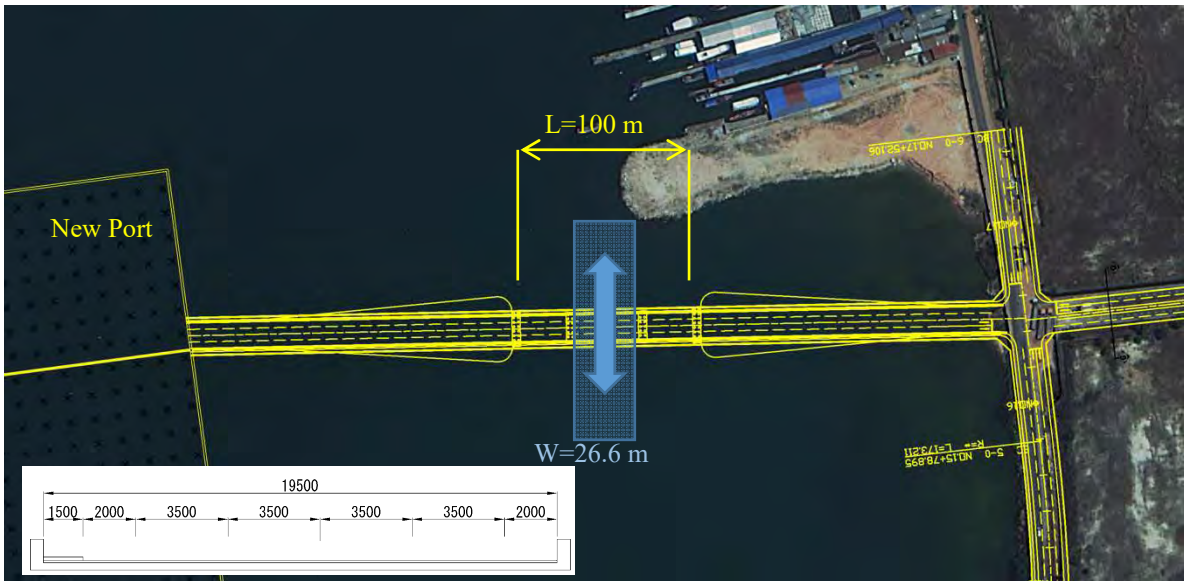
Source: JICA Survey Team

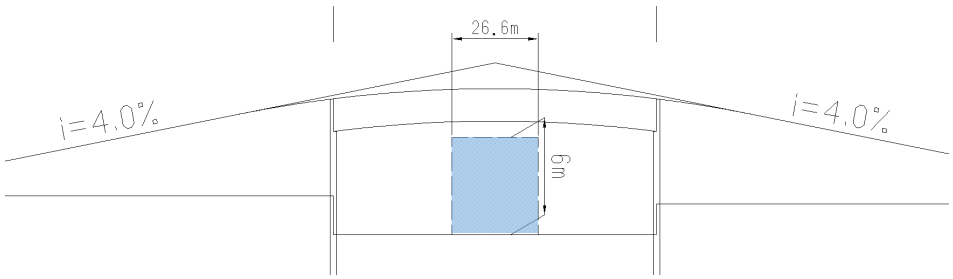
Figure 9-5 Existing Cross Section

9.3. Bridge Design for Phase I

An access bridge for the terminal is planned from the access road to the new container terminal, where small fishing vessels can pass beneath the bridge. The bridge is planned at 19.5 m in width (two lanes for each way with one walkway), the bridge is 100 m in length and made of R.C. structural piers and P.C. structural beams.

1) Bridge Length: 100.0 m





Source: JICA Survey Team

Figure 9-6 Bridge Length and Clearance Width

2) Design Criteria: Specifications for Highway Bridges (Japan Road Association)

3) Approach Slope Grade: 4.0%

Due to the reason that the majority of traffic is large trailer, low-gradient has been adopted in the planning.

4) Clearance height of under Bridge: H=6.0 m

Clearance of 6.0 m has been adopted for small fishing boats to pass after considering the consultation with PAS.

9.4. Future Road Plan for Connection to the New Container Terminal

The majority of the sections will not be affected by the road widening. The only affected area is the Residential Area located on the existing road, in a section stretching a few kilometres closer to Sihanoukville Port. Based on the above reasons, a bypass development plan is the policy for this section as a result of the improvement when the ease of maintenance is considered.

The bypass section with a major impact is shown below:

Source: JICA Survey Team

Figure 9-7 Section of Bypass Road Maintenance

Considerations of carrying out the bypass plan are shown below.

- In order to implement the road development as early as possible, the road design has to be considered to minimize environment and social impacts.
- Adequate geometric configuration will be secured for the increasing number of cargo vehicles.
- A more effective connection will be made for access to the new port.
- National land which is parallel with the existing railway will be exploited as much as possible.

The bypass road development plan will be proposed on the basis of the considerations above.

10. CONSTRUCTION PLAN AND COST ESTIMATE

11. ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

11.1. Summary of the Proposed Project

(1) Items of the Proposed Project

The items of the proposed project and its location are shown in Table 11-1.

Table 11-1 Items of the Proposed Project

No.	Items	Details
1	Development of a new container terminal	Size of the terminal: 350 m x 500 m
2	Development of access road	Road widening
3	Dredging of access channel and turning basin	Dredging volume: about 4 million m^3
4	Construction of administration building and maintenance building	- Administration building - Maintenance building - Water supply and electrical works
5	Construction of customs inspection yard	Near access bridge

Source: JICA Survey Team

(2) Main Construction Works of the Proposed Project

The main construction works of the proposed project, which might give impacts on the surrounding environment, are as follows:

- Base dredging work of a new container terminal;
- Spillway of reclamation work of the new container terminal;
- Dredging works of access channel and turning basin; and
- Dumping works of dredged materials.

(3) Environmental Category under the JICA ESC Guidelines

The project is not likely to have significant adverse impact on the environment in terms of its sectors, characteristics, and areas. Therefore, the Japan International Cooperation Agency (JICA) classified the proposed project as "Category B" under the JICA Guidelines for Environmental and Social Considerations (JICA ESC Guidelines)(April 2010). Category B means:

The Category B projects' potential adverse impacts on the environment and society are less adverse than those of Category A projects. Generally, they are site-specific; few, if any, are irreversible; and in most cases, normal mitigation measures can be designed more readily.

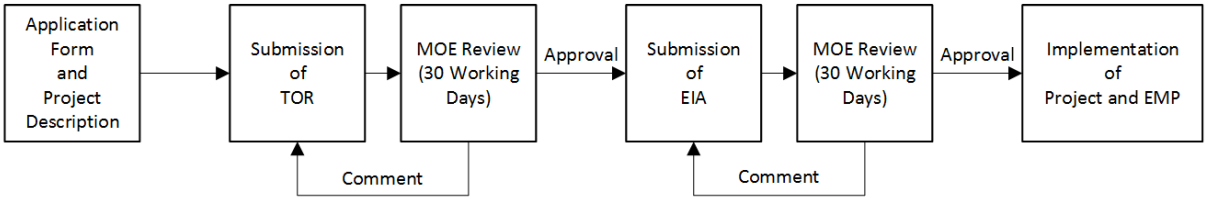
11.2. Legal Framework Related to Environmental and Social Considerations

(1) Cambodia Side

All port construction projects and projects involving dredging work of more than 50,000 m^3 must prepare an environmental impact assessment (EIA) report and obtain an approval from the Ministry of Environment (MOE).

According to the Registration of Consultancy Company for Preparation of Environmental and Social Impact Assessment (2014), the EIA report should be prepared only by the consultants authorized by MOE and should obtain an approval from MOE before starting any construction work.

The project owner needs to pass the approval process in two steps, i.e., 1) submission of the project description and work plan of baseline survey to MOE and receipt of approval from MOE, and 2) submission of EIA report to MOE and receipt of approval from MOE. The project owner must revise the documents, if MOE issued the comments on the approval process. The workflow is shown in Figure 11-1.



[Abbreviation]
TOR: Terms of Reference
EIA: Full Environmental Impact Assessment
MOE: Ministry of Environment
EMP: Environmental Management Plan

Source: Ministry of Environment

Figure 11-1 Flowchart of EIA Application and Approval Procedure in Cambodia

(2) JICA Side

The JICA ESC Guidelines aims to encourage a recipient government to conduct appropriate environmental and social examinations at various stages of the feasibility study or project preparation as well as appropriate participation of stakeholders to ensure transparent procedures and decision-making. Adequate support and confirmation by JICA are also stipulated in the JICA ESC Guidelines.

The gaps between the JICA ESC Guidelines and Cambodian laws and regulations of 1) EIA procedure and 2) land acquisition and resettlement were analyzed in the course of the survey.

11.3. Baseline Data of Natural and Social Environment

The baseline data of natural and social environment was surveyed through review of the existing documents and data. The surveyed items are as follows:

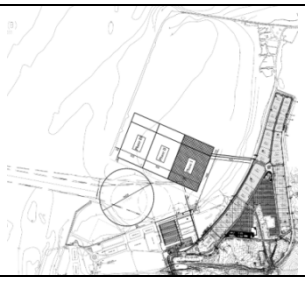
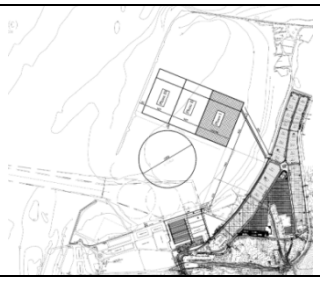
- Natural Environment
  - Weather
  - Topography
  - Water quality
  - Sediment quality
  - National park and protected area
  - Terrestrial fauna and flora
  - Marine fauna and flora
  - Land use
- Social Environment
  - Population
  - Fishing in the coastal area of Preah Sihanouk Province
  - Beach and resort area
  - Residential area along coastal road
  - Residential area around SEZ
  - Fishery

11.4. Comparison of Alternative Plans

11.4.1 Alternatives of Berth Layout

The three alternatives of berth layout in Phases I-III were studied and Plan A with the least dredging volume was selected. The results of the study on the three alternatives of berth layout in Phases I-III are shown in Table 11-2.

Table 11-2 Comparison of Alternatives of Layout Plan

Contents	Alternatives		
	Plan A	Plan B	Plan C
Design			
	Offset distance is 400 m (50 m + 300 m + 50 m)	Offset distance is 210 m consistent to PAS's future plan.	Offset distance is 700 m considering the development of two future berths.
Technical Evaluation	Excellent	Good	Poor
Environmental Evaluation	Good	Good	Poor
Overall	Recommended	-	-

Source: JICA Survey Team

11.4.2 Alternatives of Structural Type of Berth

The four alternatives of structural type of berth in Phase I were studied and Plan-4 of concrete deck on steel pipe pile and strut beam was selected. The results of the study of the four alternatives of structural type of berth in Phase I are shown in Table 11-3.

Table 11-3 Comparison of Alternatives on Structural Type of Berth

Contents	Alternatives			
	Plan-1	Plan-2	Plan-3	Plan-4
Concept	Steel Pipe Sheet Pile Structure	Concrete Deck on Steel Pipe Pile	Concrete Block Method	Concrete Deck on Steel Pipe Pile and Strut Beam
Technical Evaluation	3	2	4	1 (Best Alternative)
Environmental Evaluation	Good	Good	Poor	Good
Overall	-	-	-	Recommended

Source: JICA Survey Team

11.4.3 Alternatives of Structural Type of Access to New Container Terminal

The two alternatives of structural type of access to the new container terminal from the coast were studied and Plan-1 of bridge type was selected. On the condition of completion of Phase III, the water area inside the breakwater will be divided by the planned berth. In the north-south direction, the current can flow and fishing boats can also pass through Plan-1 only.

Table 11-4 Comparison of Alternatives on Structural Type of Access to New Container Terminal

Contents	Alternatives	
	Plan-1	Plan-2
Concept	Bridge	Embankment
Technical Evaluation	2 (High Cost)	1
Environmental Evaluation	Good	Poor
Overall	Recommended	-

Source: JICA Survey Team

11.4.4 Zero Option

In case that the proposed project is not implemented, containers over the capacity of existing container terminal and multipurpose terminal cannot be handled. There is no option for increase of container handling capacity except for the proposed project.

11.5. Scoping Result

Scoping was conducted to identify the issues to be addressed in the following stages. No items of A (serious impact is expected) were identified. However, there are 15 items of B- (some negative impact is expected) and 3 items of C (extent of impact is unknown) identified, as follows:

Table 11-5 Scoping Result

No.	Impact Factors	BC and DC phase	O Phase
1	Involuntary resettlement/land acquisition (if needed)	D	D
2	Local economies such as employment, livelihood, etc.	B-/+B	B-/+B
3	Land use and utilization of local resources	B-	B-
4	Social institutions such as social infrastructure and local decision-making institutions	D	D
5	Existing social infrastructures and services	B-	B-
6	The poor, indigenous, or ethnic people	C	C
7	Misdistribution of benefits and damages	B-	B-
8	Cultural heritage	D	D
9	Gender	D	D
10	Children's rights	D	D
11	Local conflicts of interest	B-	B-
12	Water usage or water rights and communal rights	B-	B-
13	Public health	B-	D
14	Hazards (risk) infectious diseases such as HIV/AIDS	B-	D
15	Topography and geographical features	D	D
16	Soil erosion	D	D
17	Groundwater	D	D
18	Hydrological situation	D	D
19	Coastal zone	B-	D
20	Flora, fauna, and biodiversity	B-	B-
21	Landscape	D	D
22	Global warming	D	D
23	Air pollution	B-	B-
24	Water pollution	B-	D
25	Soil contamination	C	C
26	Waste	B-	B-
27	Noise and vibrations	B-	B-
28	Ground subsidence	D	D
29	Offensive odors	D	D
30	Bottom sediment	C	D
31	Accidents	B-	B-

Source: JICA Survey Team

11.6. Terms of Reference for Environmental and Social Consideration Survey

Based on the scoping result, necessary ESC survey items were identified. The survey plan was submitted to MOE in May 2016, and MOE comments were reported to the JICA Survey Team in July 2016. The items of MOE's comments are as follows:

- Physical resources
  - Hydrology
  - Sedimentation
  - Seawater quality
  - Mud analysis
  - Air, noise, and vibration

- Biological resources
  - Fishery
- Socioeconomic resources
  - Socioeconomic study
- Public consultation
  - Attendance
- Other points
  - Cumulative impacts
  - Methodology of the economic analysis and environmental value

11.7. Preliminary Result of the Field Survey

The site survey is being conducted by subcontracting to Phnom Penh International Consultants (PPIC Co., Ltd.). As of the beginning of December 2016, some parts of the site survey are still ongoing in the field because the JICA Survey Team and PPIC should correspond to additional requests of MOE. The completed survey items are as follows:

- Natural Environment
  - Seawater quality
  - Sediment quality
  - Water quality inflow rivers to the existing port area
  - Aquatic flora and fauna
  - Terrestrial fauna and flora
- Social Environment
  - Condition of local society
  - Fishing activity
  - Aquaculture
  - Tourism

11.8. Preliminary Environmental Impact Evaluation

The environmental impacts by the proposed project were preliminary evaluated based on the survey results. No items of A (serious impact is expected) were identified. There are 18 items of B- (some negative impacts are expected) identified as follows:

Table 11-6 Scoping and Preliminary Impact Evaluation

No.	Impact Factors	Scoping		Impact Evaluation	
		BC and DC phase	O Phase	BC and DC phase	O Phase
2	Local economies such as employment, livelihood, etc.	B-/+B	B-/+B	B-/+B	B-/+B
3	Land use and utilization of local resources	B-	B-	B-	B-
5	Existing social infrastructures and services	B-	B-	B-	B-
6	The poor, indigenous, or ethnic people	C	C	B-	B-
7	Misdistribution of benefits and damages	B-	B-	B-	B-
11	Local conflicts of interest	B-	B-	B-	B-
12	Water usage or water rights and communal rights	B-	B-	B-	B-
13	Public health	B-	D	B-	D
14	Hazards (risk) infectious diseases such as HIV/AIDS	B-	D	B-	D
19	Coastal zone	B-	D	B-	D
20	Flora, fauna, and biodiversity	B-	B-	B-	B-
22	Air pollution	B-	B-	B-	B-
23	Water pollution	B-	D	B-	D
24	Soil contamination	C	C	D	D
25	Waste	B-	B-	B-	B-
26	Noise and vibrations	B-	B-	B-	D
29	Bottom sediment	C	D	B-	D
30	Accidents	B-	B-	B-	B-

Source: JICA Survey Team

11.9. Environmental Mitigation Measures (EMP)

The proposed environmental mitigation plan (EMP) and draft cost estimates for the implementation of the EMP are prepared to mitigate the identified environmental impacts. Detailed EMPs are mentioned in Table 11.9-1.

11.10. Proposed Environmental Monitoring Plan (EMoP)

Unexpected problems may possibly appear in the stage of planning and also in operation. Monitoring plan aims to provide detailed monitoring program, which covers the whole project and to timely prepare for any problem, whenever it happens. It is important to monitor and record the environmental change continuously since unforeseeable matters could happen in this large-scale development project. The proposed monitoring items are mentioned in Table 11.10-1.

11.11. Public Consultation

11.11.1 Stakeholder's Meeting

The stakeholder's meeting was conducted three times attended by residents around the proposed project site. The contents of the meetings are as follows:

- 1st meeting: Project components and site survey plan
- 2nd meeting: Basic design of the proposed structures and process of environmental impact assessment
- 3rd meeting : Proposed final design and results of the environmental impact assessment

There were no contrary opinions for the implementation of the proposed port project explained in the stakeholder's meetings.

11.11.2 Recommendation of Work Items for ESC in the Next Project Stages

Three work items for ESC in the following project stages are recommended below based on the observations from the stakeholder's meeting.

- Explanation to stakeholders (fishermen) during the construction phase;
- Explanation to stakeholders (fishermen) before the start of construction; and
- Monitoring of water quality (aquaculture beside the breakwater) during construction phase.

11.12. Long-term Plan for Environmental and Social Considerations

There are large-scale communities of illegal occupants in the Sihanoukville Port with a population of 8,000. The illegal residential areas are significant problems for the Sihanoukville Autonomous Port (*Port Autonome de Sihanoukville:* PAS) from the viewpoints of safety and effective use of the port because there is a risk of accident among container vessels, fishing boats and residents occupying the water area, which should be developed for port operation in the future.

The proposed project does not include any involuntary resettlement; however, PAS has two alternatives of resettlement plan in the i) alternative site inside PAS jurisdiction and ii) PAS's land near the airport.

The provincial government should play a lead role in resettlement where the provincial governor stated his support during the second stakeholder's meeting in June 2016.

12. BUSINESS SCHEME FOR NEW CONTAINER TERMINAL

There are two possible financial schemes for the development of the new container terminal in Sihanoukville Port. One is the ordinary scheme, where PAS develops and operates the new container terminal by its own capacity through financial assistance of international or bilateral aid agencies. The other is the Public-Private Partnership (PPP) scheme, where PAS develops basic infrastructure and invites private operators to develop and operate the new container terminal. In the latter scheme, port facilities to be developed by PAS and private operators are decided according to the financial capacity of private operators and necessity of public involvement. Possible alternatives for the development of the new container terminal are shown in Table 12-1.

Supposedly, one operator manages the present and new container terminals, where types (I) and (IV) are alternatives for the development and operation. In case of two operators, types (II) and (III) are possible alternatives subject to the establishment of port authority as a regulator.

Table 12-1 Port Investment Alternative Plans for the Development of New Container Terminal

	Types	Investment and Operation Body	Advantages and Disadvantages
(I)	Direct Management (Public development, Operation by PAS as a joint stock company)	1) PAS develops all infrastructures and superstructures. 2) PAS operates all container terminals.	A) PAS can manage all terminals. A) PAS can maximize its revenue. D) PAS needsto make a large investment. D) No competitive operation will continue for the time being.
(II)	PPP (1) (Public infrastructure, Private superstructures, and Private operation)	1) PAS develops channel, road and land reclamation, 2) Private body develops quays, paves yard, and installs QCs, RTGs and other equipment. 3) Private body operates a new terminal.	A) PAS can considerably reduce investment. A) Competition between new and old terminals may improve productivity of both terminals. D) Competition between new and old terminals may bring large deficit to the old terminal. D) Private operator needs to make a profit and recover its investment. PAS's revenue will thus be reduced.
(III)	PPP (2) (Public infrastructures and superstructures, Private operation)	1) PAS develops channel, road, land reclamation, quays, and yards, and installs QCs, RTGs. 2) Private body manages new container terminal under operation concession.	A) Private operator prepares operation system and maintains equipment. A) Competition between new and old terminals may improve productivity of both terminals. D) PAS needs to make a large investment, D) PAS's revenue will be reduced. D) Competition between new and old terminals may bring large deficit to the old terminal. D) It may be required to invite another private operator for the existing terminal.
(IV)	PPP (3) (Public infrastructures, Leased superstructures, Operation by PAS as a joint stock company)	1) PAS develops channel, road, land reclamation, quays, and yards. 2) Private lease company installs QCs, RTGs. 3) PAS operates all container terminals.	A) PAS can manage all terminals. A) PAS can fairly reduce investment and amount of long-term loan. D) PAS makes a contract with a lease company and shares some part of revenue. D) Profit of PAS will be lower than a case of Type (I) D) No competitive operation will continue for the time being.

Source: JICA Survey Team

As a result of discussions between PAS and the Survey Team, the first priority is given to Type (I), which is full development by PAS and direct operation by PAS as a joint stock company. The second priority is given to Type (IV), which is infrastructure development by PAS and direct operation by PAS using leased superstructure.

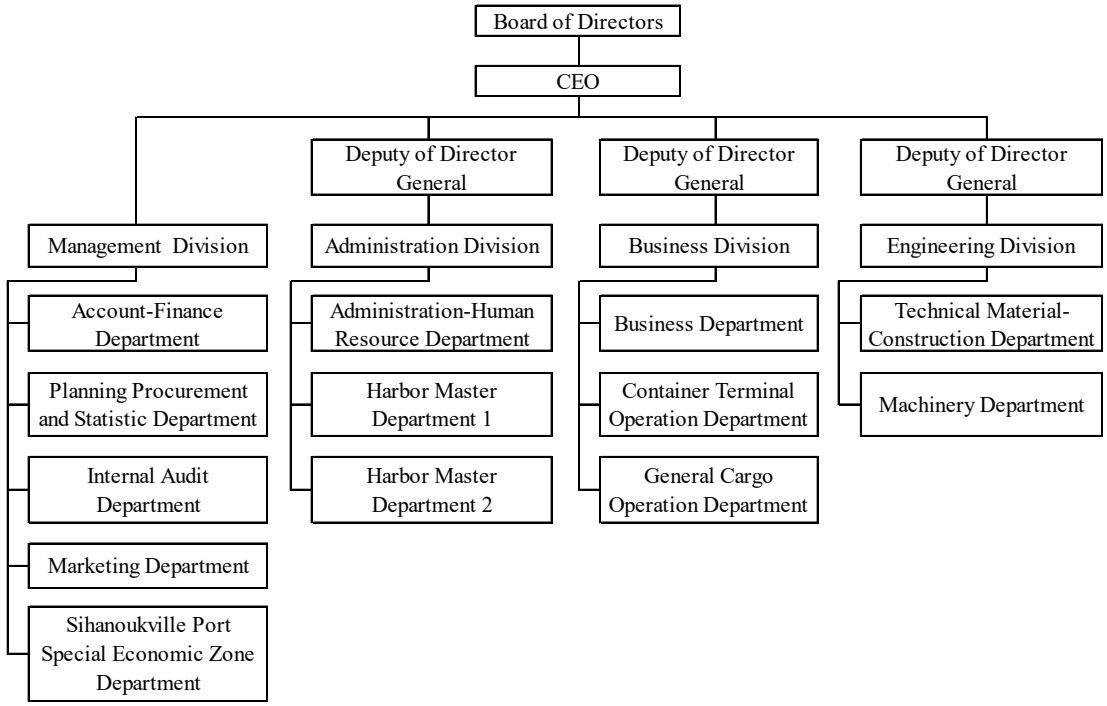
This priority is based on the fact that PAS will change to a joint stock company in the near future and be able to function as a private operator. It is also recognized that the present container terminal and new container terminal shall not be operated under competitive conditions but in a cooperative manner to make maximum use of their capacity.

Therefore, the development and operation scheme indicated in the Type (I) is applied in this study.

13. PORT OPERATION AND MANAGEMENT

13.1. Confirmation of Present Condition

The organizational chart of PAS is shown in Figure 13-1. The organization consists of four divisions with 13 departments arranged under these divisions.



Source: PAS

Figure 13-1 PAS Organization

13.1.1 Maintenance and Repair

1) Present Situation of Maintenance and Repair

a) Port facilities

The guidelines created by an ASEAN-Japan Port Technology Group meeting serve as the basis for port facilities maintenance and repair. However, regular inspections of port facility have not been implemented. Inspections are only conducted when TMCD receives a report of an abnormality or damage from port users. Then appropriate repair works are carried out as necessary.

b) Cargo Handling Equipment

For the maintenance and management of cargo handling machines/equipment, the cargo

handling machines/equipment other than vehicles are subjected to general start-up checks, weekly/monthly checks, or regular checks every two or three months. The vehicles are subjected to regular checks every travel distance of 5,000 km. They are basically maintained and managed well, e.g., lubrication and greasing are properly applied.

2) Necessity of Creating a Manual for Strategic Maintenance and Repair

Port facilities are generally required to maintain the necessary functions in service for a long time. Not only the initial structural designs are important to meet this requirement, but also appropriate maintenance and repair of those facilities in service are essential for satisfying it.

In order to maintain/improve the level of service at the port facilities, it is necessary to reduce maintenance and repair costs. However, with a limited budget, it would be impossible to meet the expected demand for repairs in the future under the current system in which failures are only addressed once they occur. It is therefore important to implement more efficient maintenance and repair on a preventive basis to minimize the life-cycle costs of machinery/equipment. Accordingly, a manual for strategic maintenance and repair should be created.

13.2. Examination of Required Standard Regarding Safety and Security

13.2.1 Present Condition

The first version of SOLAS was passed in 1914 in response to the sinking of the Titanic. It prescribed numbers of lifeboats and other emergency equipment along with safety procedures, including continuous radio watches. The 1914 treaty never entered into force due to the outbreak of the First World War. Further versions were adopted in 1929 and 1948.

The International Ship and Port Facility Security (ISPS) Code is an amendment to the Safety of Life at Sea (SOLAS) Convention on minimum security arrangements for ships, ports and government agencies. Having come into force in 2004, it prescribes responsibilities to governments, shipping companies, shipboard personnel, and port/facility personnel to "detect security threats and take preventative measures against security incidents affecting ships or port facilities used in international trade.

Cambodia is a contracting state to the International Convention for the Safety of Life at Sea Protocol of 1974 (SOLAS 74), but Cambodia has not fully complied with the requirements of the ISPS Code even though the prime minister instructed the Minister of Transport to work towards compliance in 2007.

The United States Coast Guard visited Cambodia from 9-13 September 2013 and reviewed security measures related to the ISPS Code. The Coast Guard concluded that Cambodia is not implementing the ISPS Code and is not maintaining effective anti-terrorism measures. The Coast Guard decided to remove the exemption from condition of entry to their Port Security Advisory.

The Port Security Advisory (3-14) from the United States Coast Guard went into effect for all vessels that arrive in the United States on or after 26 September 2014 after visiting ports in Cambodia as one of their last five ports of call. All vessels arriving in the United States that visited ports which do not have effective anti-terrorism measures during their last five ports calls must take actions to raise their ship security level during their stay in those countries as a condition of entry into US ports. There has been no obvious damage to Cambodian maritime trade to date as Cambodian ports do not have liner service between US ports. However, if Cambodia does not comply with the ISPS Code in the future, negative impacts could occur.

13.2.2 Improvement Plan

In consideration of inadequate present condition of port security, the following improvement plans are proposed:

1) Need for Budget
2) Implementation of Gate Access Control

3) Compulsory Container Weight Measurement
4) Set Up of Second Restricted Area for Container Cargo Operation

13.3. Confirmation of Electric Supply Plant

13.3.1 Present Condition of the Existing Container Terminal

PAS has five units of 1,000 kVA Diesel-Engine Generator Set (D-G Set), which supply power to four sets of quayside container crane (QC).

PAS is planning to procure an electric power of 20 MW from EDC, which is a public enterprise under the "Electricity Authority of Cambodia" in Sihanoukville, and has asked the EDC to supply 20 MW (10 MW for container terminal and 10 MW for SEZ) to PAS.

EDC has already replied that it can supply power of 20 MW to PAS around April 2017. At present, PAS is waiting for official confirmation from EDC.

13.3.2 Electric Supply Plan of the New Container Terminal

1) License Issue

PAS does not have a license to be a power supplier. Therefore, the electrical construction work which can only be conducted by a licensed power supplier will be outsourced to an electrical construction company which has the proper licenses.

2) Power Supply Plan of the New Container Terminal

Regarding the power supply to the new container terminal, PAS is planning to install the power receiving facility and to perform the construction scope for high-voltage wiring work in the same manner as the Multi-purpose Terminal.

14. FINANCIAL PROSPECTS OF PAS

15. PROJECT IMPLEMENTATION PLAN

15.1. Procurement Plan of the Project Fund

15.2. Implementation Schedule

15.3. Organization of Project Implementation

15.3.1 Proposal of Management System

The JICA Survey Team believed that the operation and management system for the new container terminal would be shifted from the present public build and public operation system to a pubic private partnership system.

However, PAS's basic way of thinking is that the public sector should both build and operate port facilities as long as a moderate business profit is secured. Since the result of the FIRR indicates that it would be feasible for the public sector to build and management the new container terminal, PAS does not intend to introduce the public private partnership method for the new container terminal.

Necessary organization for new container terminal management and operation mainly consists of a Container Terminal Operation Department, Technical Material Construction Department and

Security Office.

The terminal operation hour is assumed as 16 hours with two-shift system a day in accordance with average berthing hours. Table 15-3 shows the implementation organization and manpower breakdown for new container terminal management and operation in 2026. Total of three teams are needed in 2026 to maintain seven days a week with two work shift except for security office which is required four teams to cope with 24-hour operation.

Table 15-1 Implementing Organization for the New Container Terminal Operation in 2026

	Shift				Total
	1st	2nd	3rd	Reserve	
Container Terminal Operation Department					
Labour Management Section	66	63		63	192
Planning Section	3				3
Ship Planning & Supervison	4	1		1	6
Yard Planning & Cotroll	4	2		2	8
Documentaion	5	2		2	9
Container Terminal Management System	5	2		2	9
Technical Material Construction Department					
Equipment Maintenance Section	11	2		2	15
Workshop Section	11	2		2	15
Security Office	18	16	10	16	60
Total					317

Source: JICA Survey Team

15.3.2 Confirmation of Necessity of Technical Support

To increase the efficiency of port operation and competitiveness of Sihanoukville port, following technical supports are needed.

1) Improvement of Tide Observation System
2) Establishment of Hydrography Office in PAS
3) Creating a Manual for Strategic Maintenance and Repair of Port Facilities
4) Introduction of EDI System

16. PROJECT EVALUATION

16.1. Project Effect

Performance targets and minimum performance levels are mentioned in table below:

Table 16-1 Key Performance Indicators and Target Volume

Annual throughput	200,000 TEUs per annual two years after starting operation * 450,000 TEUs per annual five years after starting operation
Productivity	17.5 moves per hour per crane gross 52.5 (25x2.1) moves per hour per vessel gross
Truck turnaround time	2 hours
Container dwell time	Export: 2 days, Import 3 days

Source: JICA Survey Team

16.2. Economic Analysis

Economic benefit concept; items and measurement are applied and used in the economic analysis from a report of “The Project Study for Strengthening Competitiveness and Development of Sihanoukville Port (SSCD)”.

16.2.1 Economic Benefits of the Project

(1) Benefit Items

Considering the above mentioned "With-case" and "Without-case", the following economic benefits of the Project are measurable quantitatively.

1) The saving of transportation costs
2) The saving of port congestion surcharges

(2) Calculation of Benefit

The evaluation of benefit is conducted as economic price converted by SCF on the basis of a middle demand forecast scenario.

1) Saving of Transportation Cost

Table 16-2 Cost Saving of Transportation per Container

Time cost to EU	25 USD per 20' box	49 USD per 40' box
Freight Difference of EU (Share: percentage)	100 USD of Export (39.5%)	60 USD of Import (2.45%)
Freight Difference of E-Asia (Share: percentage)	50 USD of Export (21.9%)	50 USD of Export (34.3%)

Source: A Study Team of SSCD

Table 16-3 Maritime Transportation Cost per Container

Case of 2 days voyage	20 feet container box	40 feet container box
2,000 TEU Ship	157.9 USD	236.9 USD
4,000 TEU Ship	123.6 USD	185.3 USD
Difference	34.3 USD	51.6 USD

Source: Manual of Cost Benefit Analysis for Port Development, 2004, MLIT, Japan

Savings of land transportation cost and time for the overflowing import containers are deemed as a benefit to the national economy, and the saving cost is assumed at 338 USD/TEU exclusive of fees such as boarder clearance based on the interview survey.

2) Saving of Port Congestion Surcharge

This economic analysis is made on the assumption that congestion surcharges will be imposed at a rate of USD 60 per 20' container and USD 120 per 40' container if the demand for container throughput exceeds 800,000 TEUs at Sihanoukville Port, and those will be increased by 15% if the demand exceeds 1,200,000 TEUs.

16.2.2 Economic Cost of the Project

16.2.3 Economic Evaluation of the Project

(1) Result of EIRR and Sensitivity Analysis

The estimated EIRR is at 15.76%, and a discount rate as threshold of the EIRR is set at 10.0%, which is generally used for infrastructure projects. Thus, the Project can be said to be feasible. In order to see whether the project is still feasible if some conditions change, a sensitivity analysis is made for the following three alternatives, viz., Case 1: Project cost increases by 10%, Case 2: Benefit volume decreases by 10% and Case 3: Both Case 1and Case 2 occur simultaneously. The result of the sensitivity analysis is derived as follows.

Table 16-4 Economic Result of Sensitivity Analysis

Case	Base	Case 1	Case 2	Case 3
EIRR	15.76%	13.98%	13.79%	12.06%

Source: JICA Survey Team

Even in Case 3 of sensitivity analysis, the economic feasibility of the Project is exceeding threshold value i.e. EIRRs are above 10.0%. Therefore, the Project is recommended to be implemented as early as possible from the viewpoint of the national economy.

16.3. Financial Analysis

The purpose of the financial analysis is to assess the financial feasibility of the Project on the target year, from the viewpoint of the financial soundness. In this clause, the financial revenues and expenditures as costs are calculated with market price and to evaluate whether the revenues exceed those that could be expended from capital cost of investment of the Project.

16.3.1 Revenues of the Project

16.3.2 Financial Evaluation of the Project

(1) Result of FIRR and Sensitivity Analysis

The estimated FIRR is at 8.13%. Thus, the Project can be said to be feasible. In order to see whether the project is still feasible if some conditions change, a sensitivity analysis is made for the following three alternatives, viz., Case 1: Project cost increases by 10%, Case 2: Benefit volume decreases by 10% and Case 3: Both Case 1and Case 2 occur simultaneously.

In addition, to evaluate the Project, the JICA Survey Team set three scenarios taking user's requests of lifting of QC surcharge, which is an additional handling fee levied by PAS since installation of QC, into considerations as follows:

Base Scenario: supposed that QC surcharge will be lifted after the year 2030,
Scenario 1: lifted after 2023, and
Scenario 2: no reduction in QC surcharge.

The results of the sensitivity analysis are derived as follows.

Table 16-5 Financial Result of Sensitivity Analysis

Case	Base	Case 1	Case 2	Case 3
Base Scenario FIRR	8.13%	6.46%	6.28%	4.52%
Scenario 1 FIRR	7.56%	5.94%	5.77%	4.05%
Scenario 2 FIRR	9.11%	7.53%	7.36%	5.74%

Source: JICA Survey Team

Even in Case 3 of sensitivity analysis, the financial feasibility of the Project are exceeding threshold value. Therefore, the Project is recommended to be implemented as early as possible.

17. RECOMMENDATION

17.1. Recommendation

➢ Implementation Procedures

PAS has already implemented ODA projects under five yen loan contracts, i.e. CP-P3, CP-P5, CP-P6, CP-P8, and CP-P10, and has enough knowledge on procedures and rules for the procurement. The project management unit (PMU) has been designated as the executing body for ODA projects. Prompt information-sharing among related organizations, i.e. MOE, MEF and MPWT is required, and establishment and coordination of procurement committee composed of the said organizations in a timely manner is recommended to implement the project as scheduled.

➢ Financial Performance

It is important to reduce the operational costs by improving efficiency of operation and reforming organizations, and to lower non-operational costs.

The interest rates of MEF sub-loans should also be reduced to the level of ODA interest rates or to a similar level. At the very least, interest rates of sub-loans need to be reduced to the level of ODA rates during the construction period since ODA finances the amount of interests during construction, which means that the borrower does not have to pay interests during that time.

PAS should conduct vigorous promotional activities to attract the attention of the port business community before and after the development of the new container terminal. Besides, promoting the utilization of the port SEZ and oil supply base/multi-purpose terminal should be a given priority because those facilities will play a key role in improving the financial performance of PAS.

➢ Port Operation and Management

Port facilities are generally required to maintain the necessary functions in service for a long time. It is important to implement more efficient maintenance and repair on a preventive basis to minimize the life-cycle costs of machineries/equipment. Accordingly, a manual for strategic maintenance and repair should be created.

The International Ship and Port Facility Security (ISPS) Code is an amendment to the Safety of Life at Sea (SOLAS) Convention on minimum security arrangements for ships, ports and government agencies. Cambodia is a contracting state to the International Convention for the Safety of Life at Sea Protocol of 1974 (SOLAS 74), but Cambodia has not complied with the requirements of the ISPS Code sufficiently. Fully complying with ISPS Code is required in order to keep the firm status as an international port.

In connection with the above issues, 1) appropriately required budget for security, 2) implementation of gate access control, 3) compulsory container weight measurement, and 4) set up of second restricted area for container cargo operation are required.

➢ Social and Environment Issues

Stakeholders' understanding of the project is necessary for smoothly project implementation. PAS held stakeholders' meeting for the project, and objection against the Project was not confirmed. Disclosure of the project information should be executed continuously.

Before starting the project, information on the proposed construction work such as schedule and area of dredging work, traffic conditions, etc. should be disseminated/distributed to the local residents including fishermen who live adjacent to the port area.

Environmental Management Plan (EMP) should be prepared including mitigation measures and environmental monitoring plan according to approved EIA report by MOE and JICA Guidelines. It is recommended for PAS to monitor the environmental monitoring plans of construction work approved by EMP. The results of the monitoring are to be reported to MOE.

17.2. Potential Risks in the Project Implementation

The JICA Survey Team has identified some risks that may prevent the implementation of the Project or deteriorate the beneficial effects of the Project. Detailed description of the risks and countermeasures against such risks are mentioned in Chapter 17. Overall, if the countermeasures are implemented successfully, there will be no critical risks with high probability that may cause serious delay of the Project or deteriorate the Project's beneficial effects.

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LIST OF ABBREVIATIONS AND ACRONYMS

AC	:	Asphalt Concrete
A.C.	:	Alternate Current
ADB	:	Asian Development Bank
AEC	:	ASEAN Economic Community
AH	:	Asian Highway
ASEAN	:	Association of Southeast Asian Nations
BOD	:	Biological Oxygen Demand
CAMCONTROL	:	Cambodia Import Export Inspection and Fraud Repression Department
C/P	:	Counterpart
CC	:	Container Cargo
CD	:	Chart Datum
CDC	:	Council for the Development of Cambodia
CDL	:	Construction Datum Level
CDM	:	Cement Deep Mixing
CEO	:	Chief Executive Officer
CD-ROM	:	Compact Disk – Read Only Memory
CFA	:	Chartered Financial Analyst
CFS	:	Container Freight Station
CHE	:	Container Handling Equipment
CIF	:	Cost, Insurance and Freight
CMIT	:	Cai Mep International Terminal
CO	:	Carbon Monoxide
COD	:	Chemical Oxygen Demand
CPM	:	Critical Path Method
CPA	:	Certify Public Accountant
CRF	:	Cambodian Rice Federation
CT	:	Container Terminal
Cv	:	Consolidation Coefficient
CW	:	Construction Work
CY	:	Container Yard
DA	:	Designated Authority
DBST	:	Double Bituminous Surface Treatment
D/D	:	Detail Design
DEIA	:	Department of Environmental Impact Assessment
DF/R	:	Draft Final Report
D-G	:	Diesel-Engine Generator
DL	:	Depth Level
DO	:	Dissolved Oxygen
DWT	:	Deadweight Tons
EBIT	:	Earnings before Interest and Taxes
EBITDA	:	Earnings before Interest, Taxes, Depreciation and Amortization
EDC	:	Electricite du Cambodge

EDI	:	Electronic Data Intercharge
EDR	:	Entry Documents Required
EEC	:	Eastern Economic Corridor
EIA	:	Environmental Impact Assessment
EIR	:	Equipment Interchange Receipt
EIRR	:	Economic Internal Rate of Return
E.L.	:	Elevation
EMP	:	Environmental Management Plan
EMoP	:	Environmental Monitoring Plan
ENC	:	Electrical Nautical Chart
EPZ	:	Export Processing Zone
ES	:	Engineering Service
ESC	:	Environmental and Social Considerations
EU	:	European Union
FDI	:	Foreign Direct Investment
FIRR	:	Financial Internal Rate of Return
FL	:	Forklift
FNU	:	Formazin Nephelometric Unit
FOB		Free On Board
FTA	:	Free Trade Agreement
GDCE	:	General Department of Customs and Excise
GDP	:	Gross Domestic Product
GMAC	:	Garment Manufacturers Association in Cambodia
GMS	:	Greater Mekong Sub-region
GOJ	:	Government of Japan
GPS	:	Global Positioning System
HCM	:	Ho Chi Minh
HIV-AIDS	:	Human Immunodeficiency Virus – Acquired Immune Deficiency Syndrome
H.W.L	:	High Water Level
ICB	:	International Competitive Bidding
ICD	:	Inland Container Depot
IDP	:	Industrial Development Policy
IEAT	:	Industrial Estate Authority of Thailand
IFC	:	International Fiancé Cooperation
IFI	:	International Financial Institution
IMF	:	International Monetary Fund
IMO	:	International Maritime Organization
IPCC	:	Intergovernmental Panel on Climate Change
Ip	:	Plasticity Index
IPO	:	Initial Public Offering
ISO	:	International Organization for Standardization
ISPS	:	International Ship and Port Facility Security
ISQG	:	Interim Sediment Quality Guideline

IUCN	:	International Union for Conservation of Nature and Natural Resources
JICA	:	Japan International Cooperation Agency
JUB	:	Boring Jack-up Barge
L/A	:	Loan Agreement
LDC	:	Least Developed Country
LOA	:	Length Overall
Lo/Lo	:	Lift on / Lift off
LPI	:	Logistics Performance Index
LT	:	Long Ton
L.W.L.	:	Lowest Water Level
MAFF	:	Ministry of Agriculture, Forestry and Fisheries
MARPOL	:	International Convention for the Prevention of Pollution from Ships
MD	:	Machinery Department
MEF	:	Ministry of Economy and Finance
MLIT	:	Ministry of Land, Infrastructure, Transport and Tourism
MOE	:	Ministry of the Environment
MOP	:	Ministry of Planning
MP	:	Master Plan
MPT	:	Multi-purpose Terminal
MPWT	:	Ministry of Public Works and Transport
MTSA	:	Maritime Transport Security Act
NGO	:	Nongovernmental Organization
NIS	:	National Institute of Statistics
NO_2	:	Nitrogen Dioxide
NPM	:	Net Profit Margin
NR	:	National Road
NSDP	:	National Strategic Development Plan
NTU	:	Nephelometric Turbidity Unit
O&M	:	Operation and Maintenance
OD	:	Origin/Destination
ODA	:	Official Development Assistance
OECD	:	Organisation for Economic Co-operation and Development
OFID	:	OPEC Fund for International Development
OP	:	Operational Policy
PAS	:	Port Authority of Sihanoukville
PDCA	:	Plan-Do-Check-Action
PEL	:	Probable Effect Level
PENPPAS	:	Project for Establishment of National Port Policy and Administration System
PERT	:	Program Evaluation and Review Technique
PFSO	:	Port Facility Security Officer
PFSP	:	Port Facility Security Plan
PM	:	Particulate Matter
PMED	:	Provincial and Municipal Environment Department

PMU	:	Project Management Unit
PPAP	:	Phnom Penh Autonomous Port
PPP	:	Public-Private Partnership
PQ	:	Pre-Qualification
PSC	:	Port Security Committee
QBS	:	Quality-Based Selection
QC	:	Quayside Container Crane
RAP	:	Resettlement Action Plan
RGC	:	Royal Government of Cambodia
ROA	:	Return on Assets
ROE	:	Return on Equity
PPSEZ	:	Phnom Penh Special Economic Zone
RQD	:	Rock Quality Designation
RS	:	Reach Stacker
RTG	:	Rubber Tyred Gantry Crane
SCF	:	Standard Conversion Factor
SDRI	:	Cambodia's Leading Independent Development Policy Research Institute
SEP	:	Self-Elevated Platform
SEZ	:	Special Economic Zone
SO_2	:	Sulphur Dioxide
SOLAS	:	Safety of Life at Sea
SPC	:	Special Purpose Company
SPT	:	Standard Penetration Test
SS	:	Suspended Solids
SSCD	:	The Project for the Study on Strengthening Competitiveness and Development of the Sihanoukville Port
ST	:	Short Ton
TCIT	:	Tan Cang Cai Mep International Terminal
TEU	:	Twenty Footer Equivalent Unit
TMCD	:	Technical Material Construction Department
TOR	:	Terms of Reference
TOS	:	Terminal Operation System
TPP	:	Trans-Pacific Partnership
TSP	:	Total Suspended Particles
TSS	:	Total Suspended Solids
TV	:	Television
UKC	:	Under Keel Clearance
UNEP	:	United Nations Environment Programme
US	:	United States
USA	:	United States of America
VAT	:	Value Added Tax
VTMS	:	Vessel Traffic Management System
WB	:	World Bank
WHO	:	World Health Organization

W.S.G.	:	Water Side Gantry (Rail)
WTO	:	World Trade Organization
YC	:	Yard Chassis

ABBREVIATIONS OF MEASURES

Length

mm	=	millimeter
cm	=	centimeter
m	=	meter
km	=	kilometer
ft	=	feet

Area

ha	=	hectare
m^2	=	square meter
km^2	=	square kilometre

Volume

L, lit	=	liter
m^3	=	cubic meter
m^3/s, cms	=	cubic meter per second
CM	=	cubic meter
MCM	=	million cubic meter
BCM	=	billion cubic meter
m^3/d, cmd	=	cubic meter per day
TEU	=	Twenty-Foot Container Equivalent Unit

Weight

mg	=	milligram
g	=	gram
kg	=	kilogram
t	=	ton
MT	=	metric ton

Time

s	=	second
hr	=	hour
d	=	day
yr	=	year

Money

KHR	=	Cambodian riel
US$	=	U.S. dollar
USD	=	U.S. dollar

Energy

Hz	=	hertz
kW	=	kilowatt
kWh	=	kilowatt-hour
kV	=	kilovolt
kVA	=	kilovolt-ampere
MW	=	megawatt

Others

%	=	percent
no., nos.	=	number
°C	=	degree Celsius
hp	=	horsepower

1. INTRODUCTION

1.1. Background of the Survey

The Sihanoukville Port, located at the south end of the Cambodia Growth Corridor and in the Preah Sihanouk Province, is the sole international deep sea port in the Kingdom of Cambodia (hereinafter referred to as "Cambodia"), supporting the national economic and industrial activities.

The container transaction volume of Sihanoukville is increasing a 10% on an average over the last five years after 2009, due to strong economic growth led by the garment industry. On the other hand, the container throughput of Sihanoukville Port is reaching to its handling capacity limit. Nevertheless, the operation body of the port, the Port Authority of Sihanoukville (PAS), has a short-term plan to strengthen the handling capacity by having additional cranes. The container throughput is expected to reach the handling capacity limit in 2023. Moreover, the real GDP growth rate of Cambodia has steadily recorded over 7% on an annual average over the last ten years, and stronger economic activity is expected after the economic convergence of the ASEAN in 2015 is expected.

With the above mentioned economic circumstance, the development of new container terminal and associated structures in the Sihanoukville Port is planned as a yen loan project of the "Sihanoukville Port New Container Terminal Development Project (hereinafter referred to as "the Project")".

1.2. Object of the Survey

In the course of the "Preparatory Survey for Sihanoukville Port New Container Terminal Development Project (hereinafter referred to as "the Survey")", the JICA Survey Team investigates the background, objective, and contents of the Project, and verify its necessity. After confirming the necessity, the JICA Survey Team surveys the necessary items for appraisal for a yen loan project, such as the objective, feature, project cost, implementation schedule, implementation method, organization structure for project implementation, organization structure for operation and maintenance, and environment and social considerations.

1.3. Survey Area

The survey area for the new container terminal is the calm water area surrounded by the south and north breakwater. The survey area for the access road is the Hun Sen Road and its connecting road, and the road planning area. The survey area for the port development plan (long term) is the whole port area managed by PAS.

1.4. Scope of the Project

The Project will develop the new container terminal and related structures in the Sihanoukville Port. Major components are confirmed between fact finding mission of JICA, MEF and PAS as mentioned below.

1) Construction of new container terminal.
2) Construction of access road including access bridge.
3) Dredging of channel and basin.
4) Construction of major terminal building.
5) Construction of customs inspection yard.
6) Procurement of cargo handling equipment and terminal operation system.
7) Consulting services.

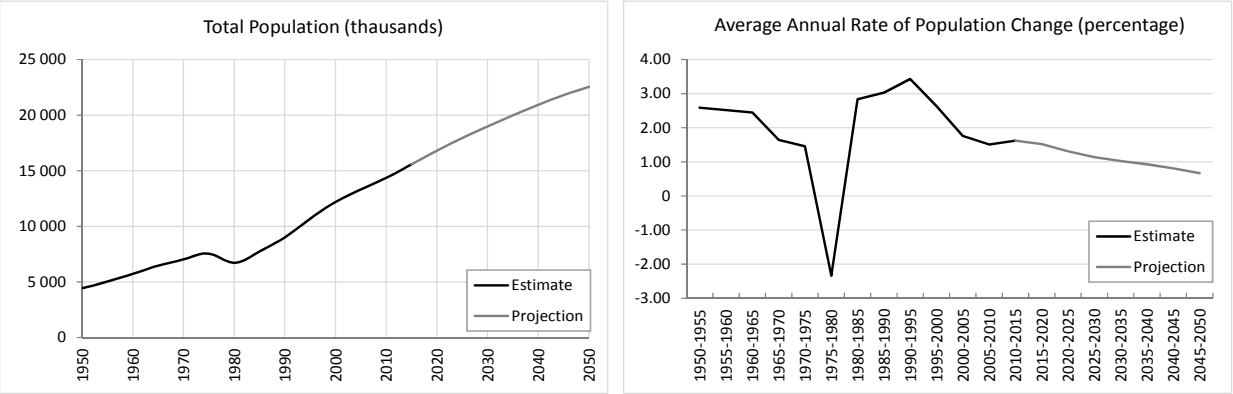
1.5. Counterpart Organization

The counterpart organization is PAS. The related agencies to the Project is the Ministry of Public Works and Transport (MPWT), and Ministry of Economy and Finance (MEF).

2. SOCIOECONOMIC SITUATION

2.1. Demography

The total population of Cambodia is approximately 15.2 million (2014), with an annual population growth rate of 1.79% for the past 16 years (1998-2014)[1]. The population keeps increasing except during the civil war. The population growth rate has been gradually declining after the recovery from civil war loss, and is projected to drop to 1.0% in the 2030s as shown in Figure 2.1-1.



Source: United Nations, Department of Economic and Social Affairs, Population Division (2015). World Population Prospects, 2015 Revision.

Figure 2.1-1 Estimates and Projections of Population and its Growth Rate

2.2. Economy

(1) Current Condition

The current condition of Cambodia's economy was reported by the World Bank Group[2]. The economic performance, prospects, and risks are summarized below.

- The GDP growth is expected to reach about 7% in 2016, partly underpinned by a significant increase in government spending. Strong garment sector exports are expected to help offset the weakness in the agriculture sector, while the foreign direct investment-driven construction is expected to continue to be a major engine of growth.
- Further reduction of poverty is expected for both urban and rural households.
- In the medium term, growth is expected to remain between 6%-7%. The narrow production of garment exports, which is heavily concentrated in the European Union (EU) and the United States (US) markets, is exposed to increasing competition. With the Trans-Pacific Partnership (TPP) and the free trade agreement (FTA) between Viet Nam and the EU, there are significant risks of investment and export diversion away from Cambodia unless key constraints such as high energy costs, regulatory impediments to doing business, and infrastructure bottlenecks are successfully addressed.
- The rapidly expanding financial sector has been supportive of growth.
- The downside risks include potential labor issues, continuous appreciation of the US dollar in the context of dollarization, slower economic recovery in Europe, and spillovers from the slowdown of the Chinese economy.

Major economic indicators are shown in Figure 2.2-1.

[1] Estimated in Cambodia Socio-Economic Survey 2014 (CSES 2014), National Institute of Statistics.
[2] Cambodia Economic Update, World Bank Group, April 2016.

Source: Cambodia Economic Update, World Bank Group, April 2016.

Figure 2.2-1 Major Economic Indicators of Cambodia

(2) ASEAN Economic Community

The ASEAN Community comprising the ASEAN Political-Security Community, the ASEAN Economic Community (AEC), and the ASEAN Socio-Cultural Community was established with the 2015 Kuala Lumpur Declaration[3] on 31 December 2015. The key characteristics of AEC are: (a) a single market and production base, (b) a highly competitive economic region, (c) a region of equitable

[3] http://asean.org/asean-economic-community/

economic development, and (d) a region fully integrated into the global economy.

The benefits and challenges of Cambodia as a member of AEC were organized by the Ministry of Commerce, Cambodia[4]. The benefits are:

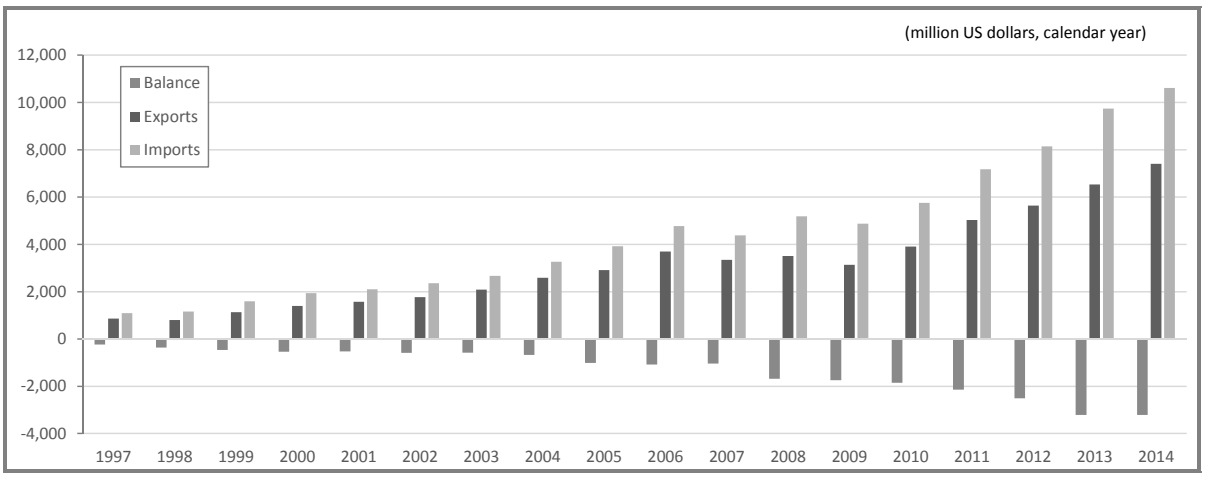
- AEC should lead to a 5.3% increase in regional welfare due to elimination of non-tariff barriers, lower trade costs, and anticipated increases in foreign direct investment;
- In terms of ASEAN businesses, Cambodia stand to benefit from larger market access and lower input and transaction costs;
- In terms of ASEAN professionals and labor, free regional mobility of skilled labor will benefit countries having skills shortages, such as Cambodia;
- In terms of ASEAN consumers including Cambodia, they are the majority that benefit from access to cheaper and wider range of imported goods and services, a more competitive domestic market environment and consumer protection; and
- In addition, for Cambodia as a Least Developed Country (LDC) in ASEAN, EU allow Cambodia to use inputs from ASEAN member states, except Brunei and Singapore, to produce goods in Cambodia and export to EU market duty-free and quota-free.

The challenges are:

- Loss of import revenues when import tariffs are eliminated or reduced;
- Carrying out reform to comply with ASEAN agreements resulting in increased transparency, reduction of cost for doing business;
- Goods production meeting to international standards;
- Improvement of education to meet demand; and
- Limited financial resources to participate actively in all ASEAN economic activities.

2.3. Trade

Cambodia became the 148th member of the World Trade Organization (WTO) in October 2004, the second least developed country (LDC) member of the WTO. Although Cambodia has been running a negative trade balance as indicated in Figure 2.3-1, exports have increased at an average annual growth rate of 15.3% from 1997 to 2014 driven by high growth in garment and footwear exports.



Source: Key Indicators for Asia and the Pacific 2015, ADB.

Figure 2.3-1 External Trade of Cambodia

Table 2.3-1 compared external trade and its growth rate among the five Indochinese countries. Industrialized countries such as Thailand and Viet Nam showed higher merchandise export than the other three. Cambodia belongs to the three least developed countries, and its export growth showed modest increase compared with the other two.

[4] AEC 2015: Benefits and Challenges for Cambodia, Ministry of Commerce of Cambodia.

Table 2.3-1 External Trade and its Growth Rate of the Indochinese Countries

(million US dollars, calendar year) (%)

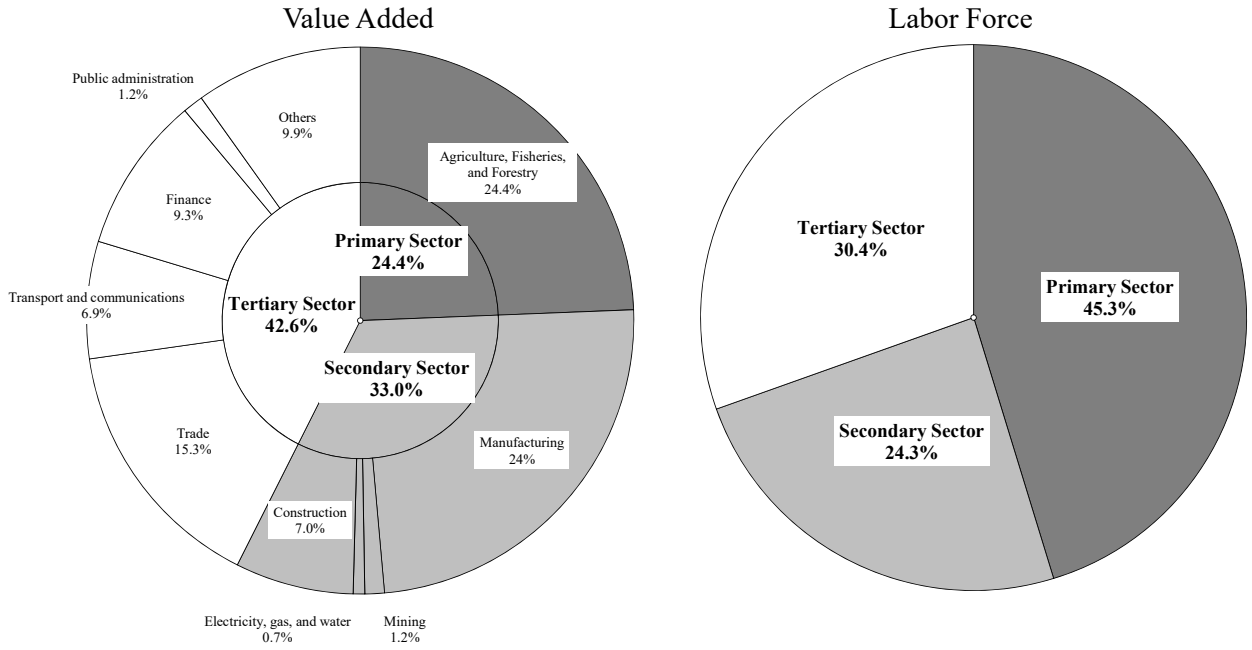
Year		2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Average Growth Rate
Balance	Cambodia	-1,010	-1,079	-1,042	-1,681	-1,740	-1,850	-2,145	-2,506	-3,214	-3,208	
	Lao PDR	-329	-178	-142	-311	-408	-314	-215	-784	-817	-1,609	
	Myanmar	2,038	2,196	2,801	3,026	2,647	3,553	236	793	-57	-2,618	
	Thailand	3,402	13,670	26,640	17,348	32,620	29,751	16,989	6,670	6,661	24,582	
	Viet Nam	-2,439	-2,776	-10,438	-12,783	-7,607	-5,136	-450	8,714	8,713	12,126	
Exports	Cambodia	2,908	3,692	3,341	3,503	3,138	3,906	5,035	5,633	6,530	7,408	11.6
	Lao PDR	553	882	923	1,092	1,053	1,746	2,190	2,271	2,264	2,662	24.3
	Myanmar	3,810	4,531	5,766	6,303	6,260	7,847	8,263	8,935	10,063	10,144	16.4
	Thailand	109,362	127,941	151,258	175,233	150,819	191,647	219,118	225,745	225,409	224,792	6.8
	Viet Nam	32,447	39,826	48,561	62,685	57,096	72,237	96,906	114,529	132,032	150,217	19.5
Imports	Cambodia	3,918	4,771	4,383	5,185	4,878	5,756	7,180	8,139	9,744	10,616	13.3
	Lao PDR	882	1,060	1,065	1,403	1,461	2,060	2,404	3,055	3,081	4,271	20.5
	Myanmar	1,772	2,335	2,966	3,276	3,613	4,294	8,027	8,142	10,120	12,762	25.8
	Thailand	105,960	114,272	124,618	157,885	118,199	161,897	202,130	219,075	218,748	200,210	6.5
	Viet Nam	34,886	42,602	58,999	75,468	64,703	77,373	97,356	105,815	123,319	138,091	17.4

Source: Key Indicators for Asia and the Pacific 2015, ADB.

2.4. Industry

The tertiary industry is the largest industry in Cambodia in terms of the added value, then followed by the secondary industry as shown in Figure 2.4-1. The share of the added value of the primary sector is the smallest, although the largest percentage of people's work is in the agricultural sector. Manufacturing including textile, apparel, and footwear industry, which accounts to 24% of the total added value in Cambodia, is the largest sub-sector followed by trade.

It should be noted that the added value of some sub-sectors shown in the graph is not accurate. For example, fisheries included in primary sector seems to be overestimated. According to the information from the Ministry of Agriculture, Forestry and Fisheries (MAFF), the added value of fisheries is estimated from the number of fishing boats multiplied by assumed unit catch.



Source: ADB Key Indicators for Asia and the Pacific (2015)

Figure 2.4-1 Percentage of Value Added and Labor Force by Each Sector

Table 2.4-1 and Figure 2.4-2 show the trend of added value of each sector. The share of the primary industry has been decreasing and that of the secondary industry has been increasing, whereas that of the tertiary industry remains unchanged. The added value itself of the primary sector has been increasing as shown in Table 2.4-1.

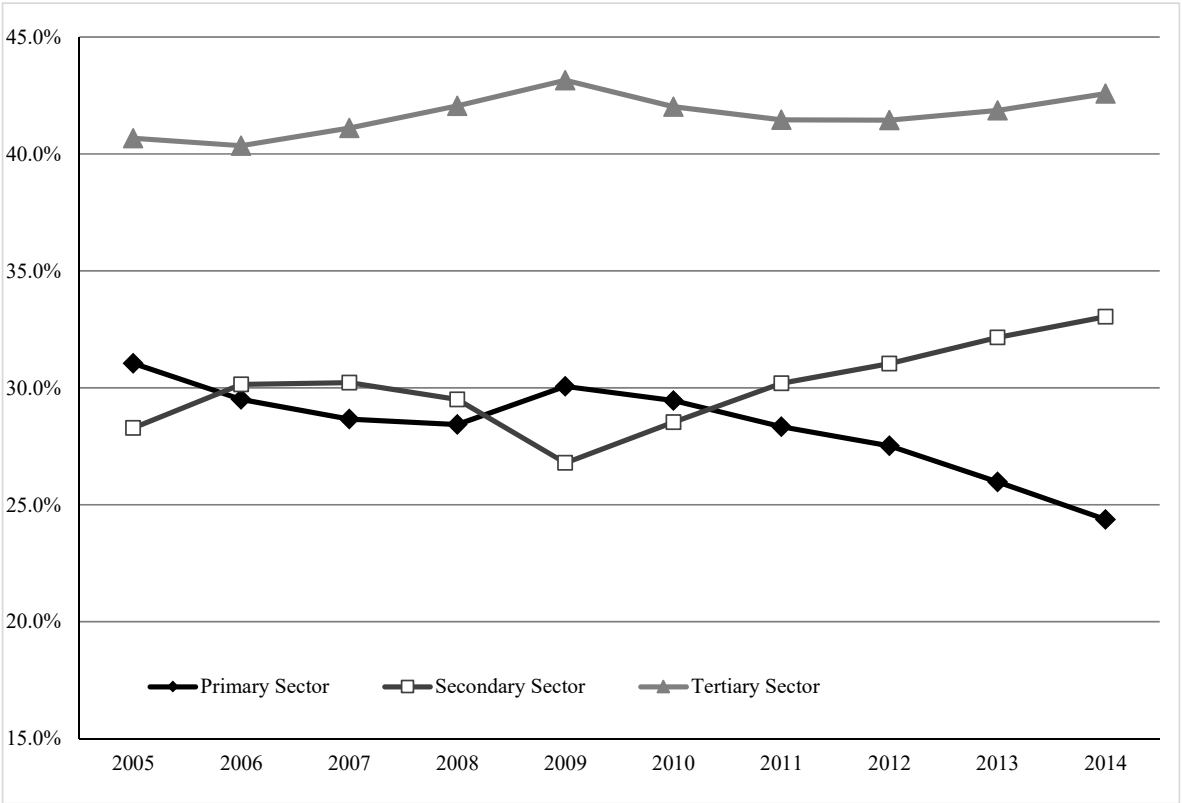
The most highly increasing sub-sector in the past five years is mining, although its share is rather small. The other sub-sectors that showed significant growth are construction, finance, and manufacturing.

Table 2.4-1 Trend of Value Added by Each Sector

billion riels; calendar year

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Primary Sector	**6,475.5**	**6,830.3**	**7,173.8**	**7,583.8**	**7,994.7**	**8,311.0**	**8,567.0**	**8,935.9**	**9,075.9**	**9,101.4**
Secondary Sector	**5,899.7**	**6,977.5**	**7,563.9**	**7,869.8**	**7,123.3**	**8,048.7**	**9,129.8**	**10,075.6**	**11,234.6**	**12,340.6**
Manufacturing	4,308.6	5,059.8	5,509.3	5,681.1	4,800.5	6,179.2	7,094.6	7,702.5	8,477.8	9,041.3
Mining	87.0	100.9	108.7	125.9	151.1	193.4	231.7	293.1	346.5	431.0
Electricity, gas, and water	103.0	135.5	151.2	164.1	178.0	190.8	200.5	216.3	231.5	253.9
Construction	1,401.1	1,681.2	1,794.7	1,898.8	1,993.7	1,485.3	1,603.0	1,863.6	2,178.8	2,614.4
Tertiary Sector	**8,483.5**	**9,341.5**	**10,288.8**	**11,217.4**	**11,477.2**	**11,858.4**	**12,534.3**	**13,457.8**	**14,625.8**	**15,903.3**
Trade	2,865.9	3,132.9	3,438.5	3,766.5	3,893.2	4,234.6	4,453.4	4,829.3	5,318.4	5,728.7
Transport and communications	1,491.1	1,523.0	1,632.7	1,748.6	1,816.8	1,962.2	2,076.0	2,202.4	2,398.9	2,584.2
Finance	1,924.9	2,167.7	2,436.0	2,611.9	2,594.0	2,329.0	2,481.0	2,808.1	3,039.3	3,454.7
Public administration	337.1	333.2	333.6	348.6	352.1	392.6	405.2	411.3	428.7	450.1
Others	1,864.5	2,184.7	2,448.0	2,741.8	2,821.0	2,940.0	3,118.8	3,206.6	3,440.5	3,685.5
Less: Imputed bank service charges	216.2	239.8	299.8	341.8	382.8	418.8	457.1	530.1	599.0	652.2
Taxes less subsidies on products	1,366.6	1,470.2	2,142.8	2,338.3	2,480.1	2,604.1	2,778.6	2,994.2	3,242.0	3,545.0
Total	**20,858.7**	**23,149.3**	**25,026.6**	**26,671.0**	**26,595.1**	**28,218.0**	**30,231.2**	**32,469.2**	**34,936.3**	**37,345.3**
Total (Including Less and Subsidies)	**22,009.1**	**24,379.7**	**26,869.5**	**28,667.5**	**28,692.4**	**30,403.3**	**32,552.7**	**34,933.3**	**37,579.2**	**40,238.1**

Source: ADB Key Indicators for Asia and the Pacific (2015)



Source: ADB Key Indicators for Asia and the Pacific (2015)

Figure 2.4-2 Trend of Percentage of Value Added by Each Sector

2.5. Special Economic Zone

2.5.1 Special Economic Zone in Cambodia

A sub-decree on the establishment and management of special economic zones (SEZs) was adopted in December 2005. The Royal Government of Cambodia (RGC) has approved a total of 39 SEZs located mainly along the border with Thailand and Viet Nam and at the port city of Preah Sihanouk, as shown in Table 2.5-1 and Figure 2.5-1.

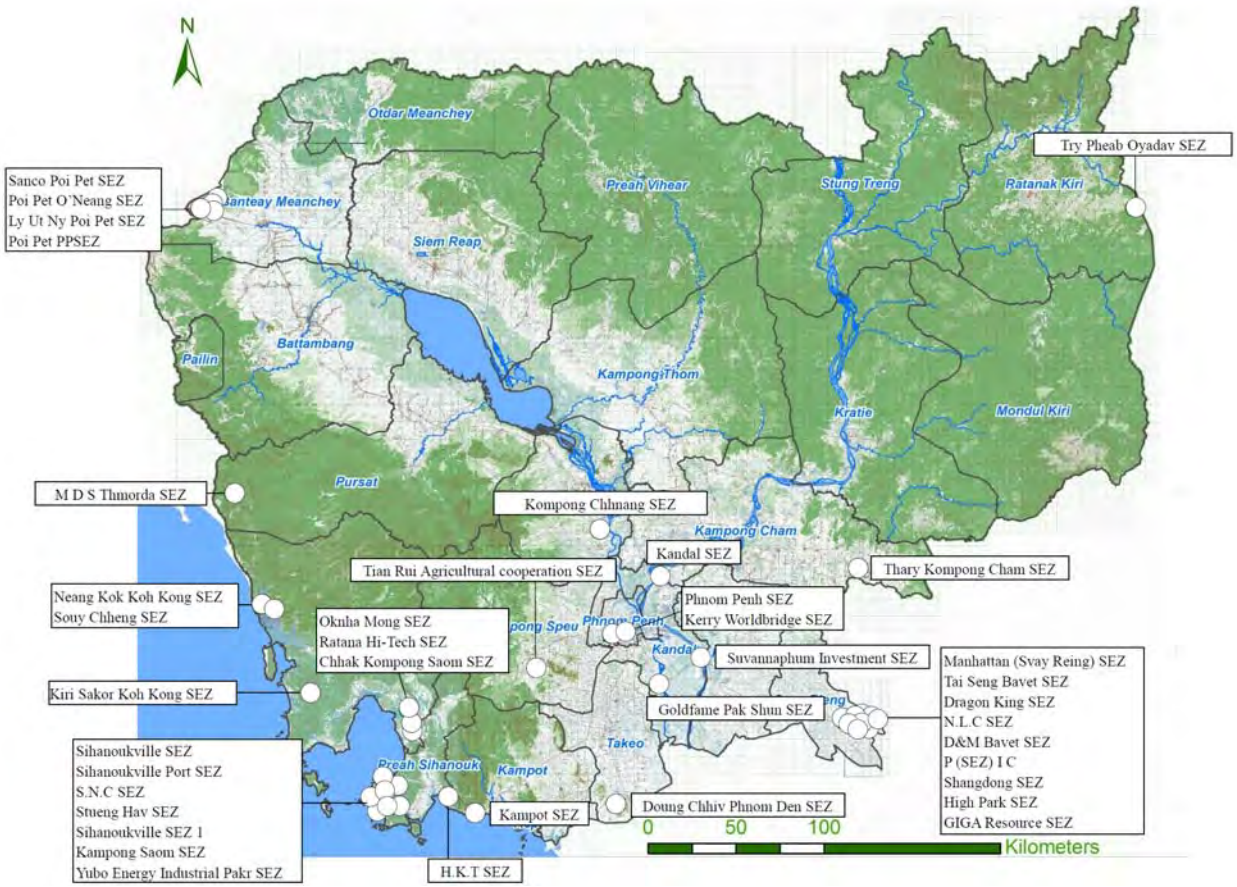
Table 2.5-1 Special Economic Zones in Cambodia (January 2016)

No.	Name of SEZ	Developer	Area (ha)	Status	Location
1	Neang Kok Koh Kong SEZ	Koh Kong SEZ Co., Ltd.	335	Infrastructure Development: Fencing	Neang Kok Village, Pakkhlong Commune, Mundul Seyma Destrict, Koh Kong Province
2	Manhattan (Svay Reing) SEZ	Manhattan International Co., Ltd.	157	The company already built the infrastructure connecting the power grid from Viet Nam and expanded it to the 2nd phase of project development	Bavet Commune, Chantrea District, Svay Rieng Province
3	Phnom Penh SEZ	Phnom Penh SEZ Co., Ltd.	357	Infrastructure Development: building fence, roads, administrative building, entrance, electricity, water, and telecommunication system	Khan Dangkao, Phnom Penh and Ang Snuol District, Kandal Province
4	Tai Seng Bavet SEZ	Tai Seng Bavet SEZ Co., Ltd	99	Infrastructure Development: fencing, landfill, and connecting electricity into the zone	Bavet District, Svay Rieng Province
5	Sihanoukville SEZ	Sihanoukville Special Economy Zone Co., Ltd.	1,113	Infrastructure Development	Pou Thoung Village, Betrang Commune and Smach deang Village, Ream Commune, Prey Nop District, Sihanoukville Province
6	Sihanoukville Port SEZ	Sihanoukville Port SEZ	70	Infrastructure Development	Tomnop Rolok Area, Sangkat Lek1 and Lek3, Sihanoukville City, Sihanoukville Province
7	Dragon King SEZ	Dragon King Special Economic Zone Co., Ltd.	107	Infrastructure Development	Road No.1, Ang Sela Village, Prey Angkunh Commune, Bavet City, Svay Rieng Province
8	Sanco Poi Pet SEZ	Sanco Cambo Investment Group	67	Infrastructure Development	Phsar Kandal Village, Sangkat Phsar Kandal Poi Pet City, Banteay Meanchey Province
9	Suoy Chheng SEZ	Suoy Chheng Investment Co., Ltd.	100	Infrastructure Development	Neang Kok Village, Pakkhlong Commune, Mundul Seyma Destrict, Koh Kong Province
10	S.N.C SEZ	SNC Lavalin (Cambodia) Holding Limited	150	Infrastructure Development	Sangkat Bet Trang, Khan Prey Nob, Sihanoukville
11	Stueng Hav SEZ	Attwood Investment Group Co., Ltd	192	Infrastructure Development	Sangkat O Tres, Stueng Hav District, Sihanoukville
12	N.L.C SEZ	N.L.C. Import Export Co., Ltd.	105	Infrastructure Development	Phum Prey Phdao abd Phum Thlok, Khum Chrok Mtes, Srok Svay Teab, Sray Rieng Province
13	Poi Pet O'Neang SEA	Chhay Chhay Investment Ltd	467	Infrastructure Development: fencing, entrance gate, and electric pole	Poipet Commune and Nimit Commune, Ou Chrov District, Banteay Meanchey Province

No.	Name of SEZ	Developer	Area (ha)	Status	Location
14	Doung Chhiv Phnom Den SEZ	Doung Chhiv Special Economic Zone Ltd.	79	Infrastructure Development: Landfill and fencing	Kiri Vong District, Takeo Province
15	Kampot SEZ	Kampot SEZ Co., Ltd.	145	Infrastructure Development: landfill and building Kampot Seaport	Koh Toch Commune, Kampot district, Kampot Province
16	Sihanoukville SEZ 1	Cambodia International Investment Development Group Co., Ltd.	178	Infrastructure Development	Stung Hav District, Sihanoukville Province
17	Oknha Mong SEZ	Oknha Mong Port Co., Ltd	100	Infrastructure Development	Srea Ambel District, Koh Kong Province
18	Goldfame Pak Shun SEZ	Goldfame Pak Shun SEZ Co., Ltd	80	Infrastructure Development: fencing	Sa Ang District, Kandal Province
19	Thary Kompong Cham SEZ	Thary Investment Co., Ltd	142	Infrastructure Development	Da Commune, Memot District, Kampong Cham Province
20	D&M Bavet SEZ	D&M Bavet SEZ Co., Ltd	118	Infrastructure Development	Bavet Commune, Chantrea District, Svay Rieng Province
21	Kiri Sakor Koh Kong SEZ	Koh Kong SEZ Co., Ltd	1,750	Infrastructure Development	Khum Prek Kasach, Srock Kirisakor, Koh Kong
22	Kampong Saom SEZ	Cambodia Catering and Supply Co., Ltd.	255	Infrastructure Development	Village 4, Ortres Commune, Stung Hav District, Sihanoukville Province
23	P (SEZ) I C	Pacific (SEZ) Investment Co., Ltd.	108	Infrastructure Development	Salatean and Preytob Villages, Chhrokmates Commune, Svayteab District, Svay Rieng Province
24	M D S Thmorda S E Z	M D S Thmorda S E Z Co., Ltd.	2,265	Infrastructure Development	Khum Thmorda, Srock Veal Veng, Pursat Province
25	Kandal SEZ	Kandal S.E.Z Co., Ltd.	105	Infrastructure Development	Puk Rouesey and Prek Om Pel Commune, Khsach Kandal District, Kandal Province
26	H.K.T SEZ	H.K.T Special Economic Zone Co., Ltd.	345	Infrastructure Development	Prek Torl and Terk Tlar Commune, Prey Nub District, Sihanoukville Province
27	Kompong Chhnang SEZ	Zhong Jian Jin Bian Jing Ji Te Qu Ltd.	470	*No data available*	Boueng Kok village, Lor Peang village, So Vong village, Ta Jes Commune, Kampong Tralarge District, Kampong Chhnang Provine.
28	Try Pheap Oyadav SEZ	Try Pheap Oyadav SEZ Co., Ltd.	2,265	*No data available*	Pork Nger Village, Pork Nger Commune, Oyadav District, Ratanakiri Province
29	Shangdong SEZ	Shandong Sunshell International (Cambodia) Co., Ltd.	96	Infrastructure Development	Road No.1, Chrey Thom Village, Prey Angkuy, Bavet City, Svay Rieng Province
30	High Park SEZ	High-Park SEZ Development Co., Ltd.	263	Infrastructure Development	Thnorl Cheat Village, Jrork Mtes Sangkat, Bavet City, Svay Rieng Province
31	Suvannaphum Investment SEZ	Suvannaphum Investment Co., Ltd.	200	Infrastructure Development	Samrorng Kaer Village, Samrorng Thom Commune, Kean Svay District, Kandal
32	Ratana Hi-Tech SEZ	Ratana Resource Investment (Cambodia) Corporation.	616	*No data available*	Jroy Svay Commune, Sre Ambel District, Koh Kong

No.	Name of SEZ	Developer	Area (ha)	Status	Location
33	GIGA Resource SEZ	GIGA Resource (Cambodia) Co., Ltd.	122	*No data available*	Derm Po Village, Kandeang Reay Commune, Svay Teap District, Svay Rieng
34	Chhak kampong Soam SEZ	Chhak Kampong Soam SEZ Co., Ltd.	185	*No data available*	Chroy Svay Commune, Sre Ambel District, Koh Kong Province
35	Kerry Worldbridge SEZ	Kerry Worldbridge Logistic Limited.	62	*No data available*	Damnak Sangkeo Village and Prek Rotaing Village, Sangkat Prek Kampeous, Khan Dangkor, Phnom Penh City
36	Ly Ut Ny Poi Pet SEZ	Ly Ut Ny Import Export Co., Ltd.	110	Infrastructure Development	Kon Damrey Village, Nimet Commune, O'Jrov District, Banteay Meanchey Province
37	Yubo Energy Industrial Park SEZ	Yubo Energy Industrial Park Co., Ltd.	53	*No data available*	Village 1, Sangkat Tom Nop Rolok, Stoung Hao District, Sihanoukville Province
38	Poi Pet PPSEZ	Poi Pet PPSEZ Co., Ltd.	53	*No data available*	Sangkat Phsar Kandal, Poi Pet City, Banteay Meanchey Province.
39	Tian Rui (Cambodia) Agricultural Cooperation SEZ	Tian Rui (Cambodia) Agricultural Cooperation SEZ Co., Ltd.	79	*No data available*	Pring Toek Village, O Ta Pong Village, Rokar Koh Commune, Kong Pisey District, Kampong Speur Province

Source: Council for the Development of Cambodia (CDC)



Source: JICA Survey Team (based on the Map of Special Economic Zones in Cambodia by Open Development Cambodia)

Figure 2.5-1 Location of SEZs in Cambodia

Businesses within the SEZs benefit from a number of incentives such as up to nine years tax holiday, 0% value-added tax (VAT), full import duty exemption for raw materials/machinery/equipment, no export tax, employment of expat workers allowed up to 10% of the total workforce, permanent visa for families of investors, up to 99-year lease, and free repatriation of profit.

In addition, for SEZ located within 20 km from the official border including international ports, Special Customs Procedures stipulated in the Prakas No.3841, Ministry of Economy and Finance (MEF), 11 September 2008 is applied as follows:

(Imports)

- Only duplicated copies of goods are required at the border check point (no requirement for submission of customs declaration);
- No customs seal shall be affixed;
- At the SEZ gate, only Customs Summarized Declaration is to be submitted, as the goods shall be transported through the seamless route;
- The goods are allowed to be transported to investor's premises (if customs officers preliminarily verify the identification of involved staff, mean of transport, and related documents); and
- Importer can use the imported goods without the presence of customs officers.

(Exports)

- If no irregularity is found when the customs procedure is conducted in the SEZ, goods shall be immediately released to the border with copy of relevant export documents; and
- At border check point, the customs export documents are presented to customs officers for verification. The goods shall be released for export, if no irregularity is found.

The SEZs offer a 'One-Stop Service' for imports and exports, with government officials stationed on-site providing administrative services. Applications to establish factories within the SEZs can be dealt with on-site as well as administrative clearances: company registration and investment licenses/approvals, work permits and labor books for both expat and local workers, and legal and administrative assistance. However, it should be noted that not all on-site services are always provided.

2.5.2 Outlines of Major SEZs

Outlines of major operating SEZs on the growth corridor between are given below. Although SEZs located near the border cities of Bavet, Poipet, and Koh Kong attract many manufacturers, they will not be constant users of Sihanoukville Port due to the proximity of ports to the neighboring countries.

(1) Phnom Penh SEZ

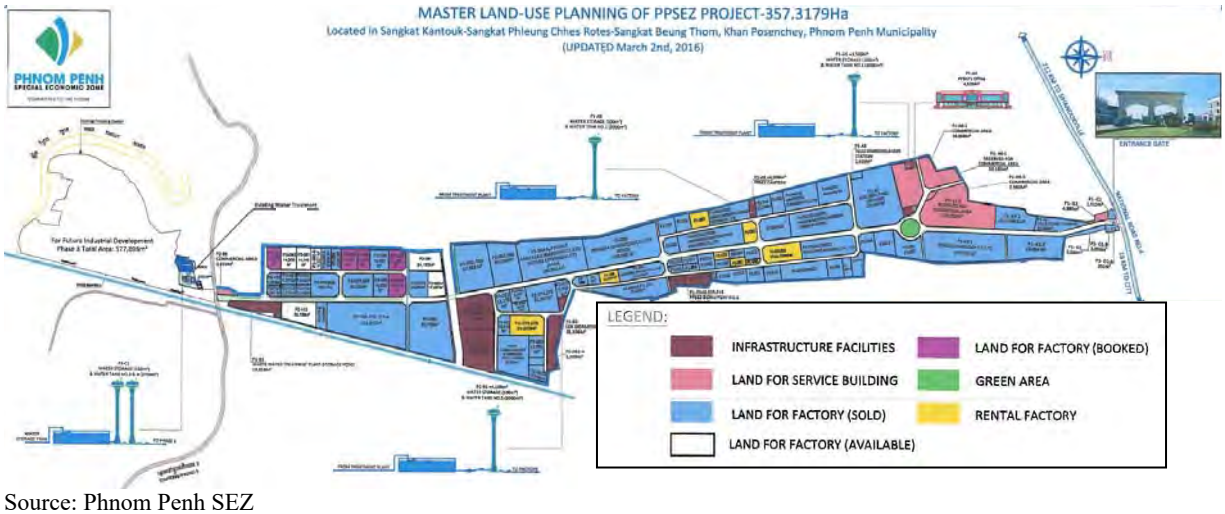
Phnom Penh SEZ was established in 2006 as a Cambodian-Japanese joint venture private project on the outskirts of the capital Phnom Penh along the National Road No.4 (NR4) and the South Line of National Railway, 8 km away from Phnom Penh Airport. Cambodia holds 78% of the capital, with the remaining 22% belonging to Japan.

Totaling of 357 ha, Phnom Penh SEZ is being developed in three phases with phase I providing 58 factory lots, and 20 ha set aside for residential and commercial development to support and provide the factories their management and workforce. Currently, available factory lots range from 0.4 ha to 1.6 ha. The whole zone is protected against flood by dikes and equipped with a drainage system. The SEZ has its own electricity and water supply system.

The land lease to foreign individuals and companies is allowed for up to maximum of 99 years. The lease is renewable for another 99 years and transferable. The SEZ is equipped with an on-site dry port. Phnom Penh SEZ has also achieved both ISO 9001 and ISO 14001 certificates in early 2010.

There are a total of 76 companies from Japan, South Korea, Singapore, Malaysia, and Taiwan registered to enter the SEZ. Japanese companies account to 55% of the total companies. The industry for automobiles/motorbikes parts, wire harness, plastics industry, garment and shoes manufacturing factories, food industry, and steel fabrication industry was added to the involved sectors.

With the first phase of development finalized and all lots fully purchased, booked, or with factories in operation, phase II of the development was launched ahead of schedule in February 2011. As of March 2016, the lots of phase II are almost fully purchased or booked and only six lots are on sale. After the lots of phase III has been all purchased or booked, Phnom Penh SEZ Co., Ltd. plans for further development as phase IV. Figure 2.5-2 shows the layout of Phnom Penh SEZ, as of March 2016.



Source: Phnom Penh SEZ

Figure 2.5-2 Layout of Phnom Penh SEZ (As of March 2016)

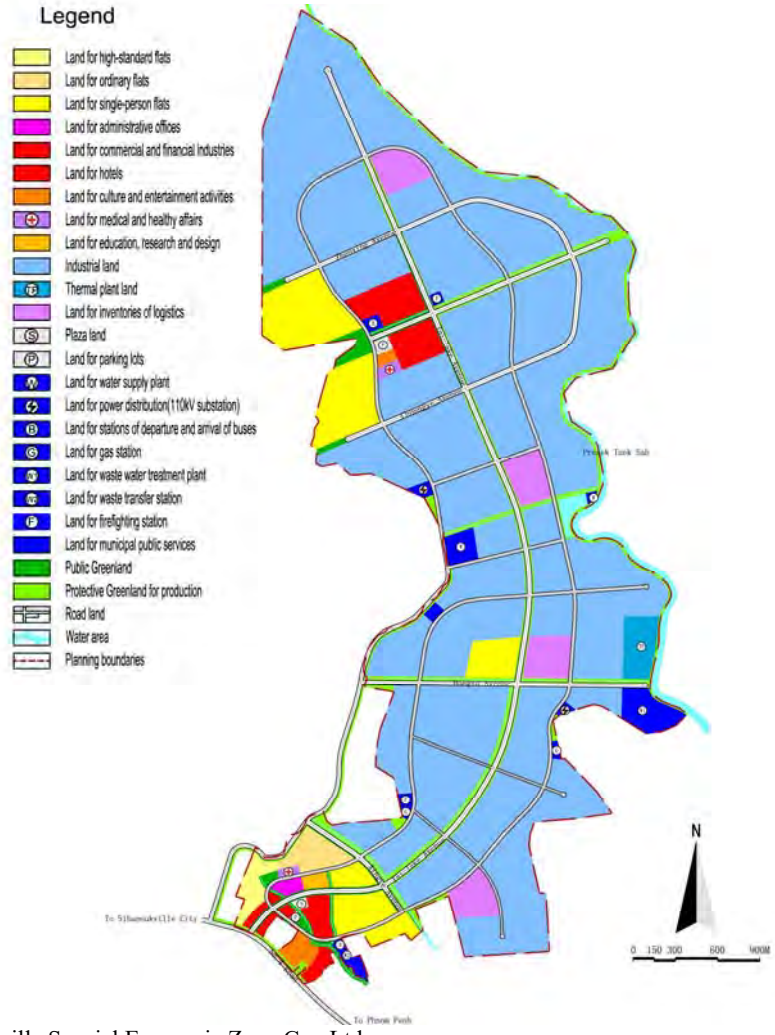
(2) Sihanoukville SEZ

Sihanoukville SEZ is one of the first batches of overseas economic zones approved by the Ministry of Commerce of the People's Republic of China (PRC). Chinese companies which operate in the SEZ can utilize the privilege of soft loan and subsidy in the prior period of investment provided by the Government of PRC.

The SEZ is located along NR4 within 20 km from Sihanoukville Port making the SEZ entitled to utilize the abovementioned simplified customs procedures. The total area of the SEZ is 1,113 ha, of which 528 ha is being developed in the first phase. Around half of the total area have been leased already where 102 factories are operating or preparing to operate as of August 2016. These factories include textiles and clothing, hardware and machinery, light industry, and home appliances. The time frame of the project's second phase is not fixed yet.

The SEZ has its own water plant, power plant, and sewage treatment plant and is also connected to the city network, which guarantee the water and electricity supply for investors the whole day. One-stop service has been established to provide series of supporting services within the zone. The SEZ has hotel, dormitories, and living area for 10,000 workers and also provides lease service of ready built factories.

Factories operating in the SEZ normally use Sihanoukville Port. However, they also use Phnom Penh Port occasionally. Figure 2.5-3 shows the layout of Sihanoukville SEZ.



Source: Sihanoukville Special Economic Zone Co., Ltd.

Figure 2.5-3 Layout of Sihanoukville SEZ (Phase I)

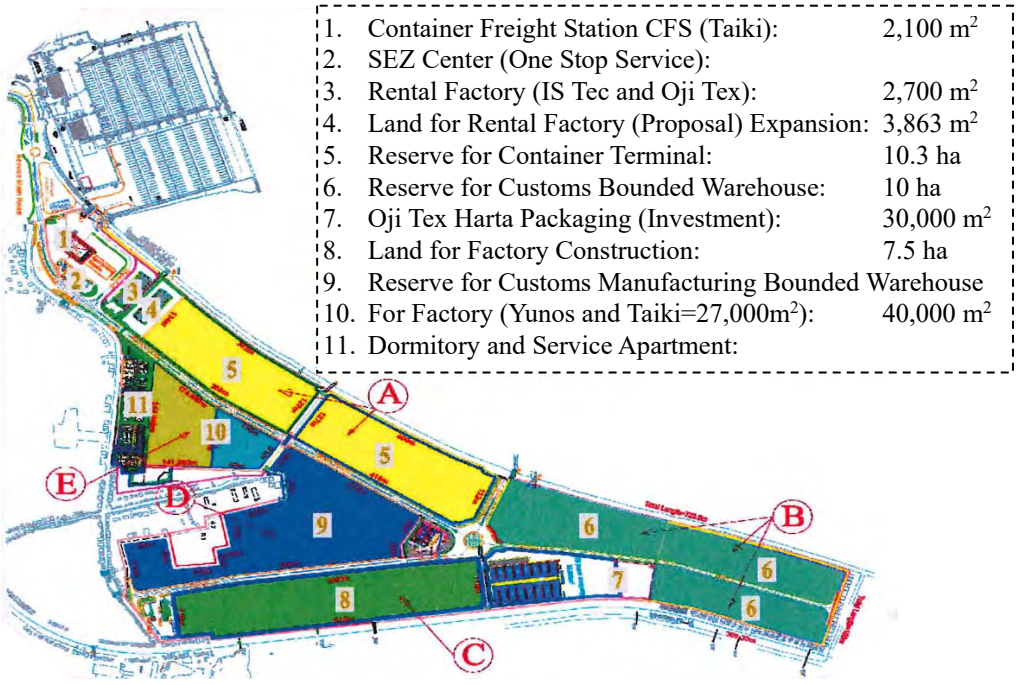
(3) Sihanoukville Port SEZ

The Sihanoukville Port SEZ was established for materializing the concept proposed in "the Master Plan (MP) Study for Phnom Penh - Sihanoukville Growth Corridor Development" carried out by JICA in 2003. One of the MP's concepts was to establish a special promotion zone, which develops new industries in Cambodia in order to diversify the export commodities and accumulate new technologies by promoting FDI in Preah Sihanouk.

Sihanoukville Port SEZ was developed by PAS utilizing Japan's official development assistance (ODA) loan and operated directly by PAS since seamless logistics service between the port and SEZ is a source of competitiveness. The SEZ is the only Cambodian SEZ which is located just adjoining an international deep seaport. It is expected to attract foreign investors especially for export-oriented and non-traditional industries. The SEZ was completed in 2011. As of June 2016, OJITEX HARTA PACKAGING LTD. is operating in designated Lot, IS-TEC (Cambodia) Co., Ltd. is operating in Rental Factory and Taiki (Cambodia) Co., Ltd is operating in Container Freight Station (CFS). PAS has eagerly attracted foreign investors and held seminars for investors in neighboring countries and in Japan.

The area of the SEZ is 70 ha furnished with one-stop service station, container freight station (CFS), SEZ administration center (bank/post office/vocational training rooms), maintenance house, and service apartment and dormitory. The SEZ has a water supply system with a capacity of 2,000 m^3/day, power supply system, and wastewater disposal system with 2,000 m^3/day capacity. The roads are designed for heavy trucks with a design speed of 35 km/h.

The Royal Government of Cambodia has launched in 26 August 2015 an industrial development policy (IDP), which sets out a road map promoting investment and broadening the country's manufacturing base. In this policy, it is mentioned that Sihanoukville Port SEZ including the country's largest port will be developed and transformed into a multi-purpose SEZ following the concept of a special administrative region; and to be an economic pole and industrial, trade, and tourism hub in line with sustainable and environmentally sound development concepts.[5] Figure 2.5-4 shows the general layout plan and land use in Sihanoukville Port SEZ.



Source: Sihanoukville Port SEZ

Figure 2.5-4 General Layout Plan and Land Use in Sihanoukville Port SEZ

[5] Cambodia IDP 2015-2025 approved by the Council of Ministers, 06 March 2015

3. PRESENT SITUATION OF MAIN PORTS IN CAMBODIA

3.1. Basic Policy and Institutional Framework for Cambodian Port Sector

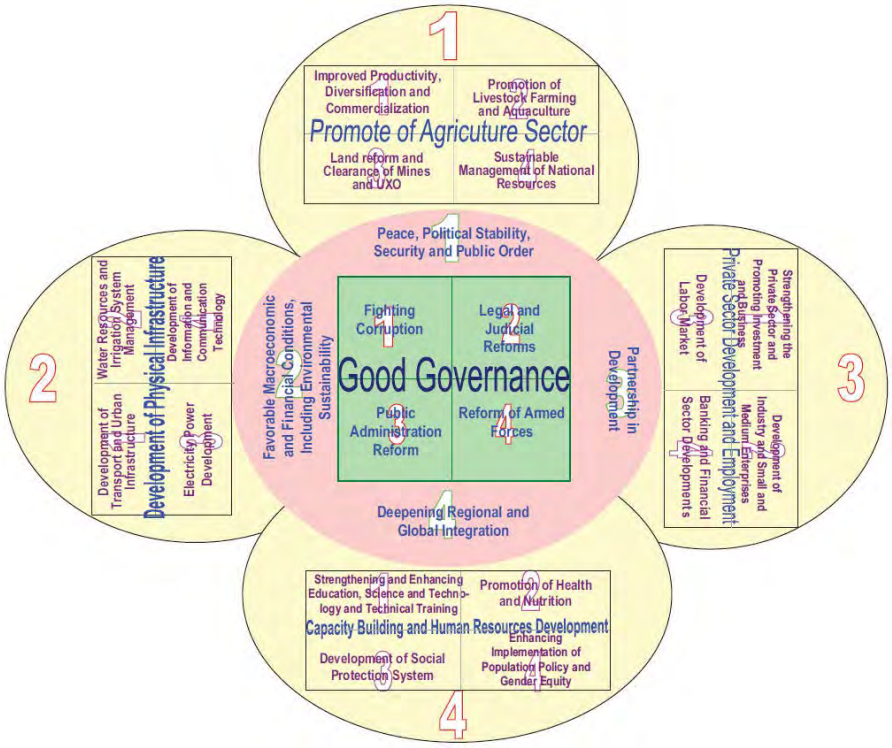
3.1.1 Rectangular Strategy III

(1) Outline

The Rectangular Strategy is a national development strategy document of the Kingdom of Cambodia. The Rectangular Strategy III in 2013 presented the social and economic policy issues, taking advantage of the structures of Rectangular Strategies I and II that ended successfully.

Rectangular Strategy III consists of four strategic objectives and four implementation guidelines ("promotion of agriculture sector", "development of physical infrastructure", "private sector development and employment", and "capacity building and human resource development") to achieve the objectives, taking into account the achievements and challenges of Rectangular Strategy II. The four strategic objectives are as follows:

1. Ensuring an average annual economic growth of 7%. This growth should be sustainable, inclusive, equitable, and resilient to shocks through diversifying the economic base to achieve a more broad-based and competitive structure with low and manageable inflation, stable exchange rate, and steady growth in international reserves.
2. Creating more jobs for people especially the youth through further improvement in Cambodia's competitiveness to attract and encourage both domestic and foreign investments.
3. Achieving more than one percentage point reduction in poverty incidence annually, while placing higher priority on the development of human resources and sustainable management, and use of environmental and natural resources.
4. Further strengthening of institutional capacity and governance at both national and sub-national levels, and ensuring the effectiveness and efficiency of public services to better serve the people.



Source: MOP

Figure 3.1-1 Conceptual Illustration of the Rectangular Policy

(2) Description Related to Sihanoukville Port

Although Sihanoukville Port is not specifically referred to in the strategy, continuous high priority is put on infrastructure development including port expansion as shown in the box below.

Designing and implementing the Master Plan for Transport Infrastructure Development to connect all parts of the country and with the neighboring countries through developing multimodal and cross border transport systems along with an efficient and competitive logistics system aimed at promoting investment, trade, tourism, and rural development, with focus on the completion of railroad restoration and development, further development of airport and seaport infrastructure, assessment of the potential for investment in inland waterway transport as well as finding alternatives to monopolistic transport services, and intensified implementation of various cross-border agreements and protocols signed by Cambodia.

The strategy points out the importance of the establishment of legal and regulatory framework for transport infrastructure as shown in the sentence below.

Preparing necessary policies and legal framework for the management and development of infrastructure such as the Law on Roads and related regulations addressing road standards and quality, Law on Ports, and the Law on Road Transport, to facilitate the implementation of Master Plan for Transport Infrastructure Development.

Besides the sentences which directly refer to transport infrastructure including port, there are many sentences in the strategy having close relationship with Sihanoukville Port.

Even with the addition to the above, the Royal Government of Cambodia intends to liberalize the trade, diversify the industry, and drastically increase rice exports. This will increase the importance of the port sector of Cambodia.

3.1.2 National Strategic Development Plan 2014-2018

The National Strategic Development Plan Update (NSDP Update) 2014-2018 has been prepared focusing on identifying who is responsible for implementing the priority policy or policies in each area of the Rectangular Strategy III; what specific actions the responsible institution(s) has/have planned to implement the priority policy or policies; and the responsible institution(s) best estimate on how much it will cost to implement the planned actions during 2014-2018.

It has been described specifically below for Sihanoukville Port, as the Ministry of Public Works and Transport (MPWT) faces challenge although major achievements have been made by NSDP 2009-2013.

The service quality is still requiring, the market of Preah Sihanouk Autonomous Port is still small so the price of services and sea transport is still high.

The action plans for the maritime transport sector listed in NSDP Update are as follows:

- *Formulate the Cambodian Maritime Code.*
- *Formulate Prakas on port entry permit given to foreign vessels to call ports in Cambodia.*
- *Formulate sub-decree on establishing national system for response and cooperation in case of oil-spill at the sea.*
- *Formulate sub-decree on crew book and certificate of competency.*
- *Enforce laws, provisions, and rules of agreement related to maritime transport.*
- *Complete the electric marine chart and the multi-purpose terminal in Preah Sihanouk Port.*
- *Enhance the promotion of Preah Sihanouk Port Special Economic Zone (SEZ) and fulfill all rents.*
- *Provide user-friendly services for vessels.*

3.1.3 Cambodia Industrial Development Policy 2015-2025

The Royal Government of Cambodia (RGC) has prepared and adopted the "Cambodia Industrial Development Policy 2015-2025" as a guide to promote the country's industrial development that will help maintain sustainable and inclusive high economic growth through economic diversification, strengthening competitiveness and promoting productivity. The main contents of this policy in order to achieve the goals are as follows.

To realize the vision of this policy, RGC has set the targets as shown below:

- Increasing the GDP share of industrial sector to 30% by 2025 (24.1% of GDP in 2013) with the manufacturing sector growing from 15.5% in 2013 to 20% in 2025;
- Diversifying export products by increasing the export of manufacturing products to 15% of all exports by 2025 without depending on only the textile products; and
- Increasing export of processed agricultural products to 12% of all exports by 2025 as well as exporting new products.

To implement the strategic framework, RGC has put the key policy measures. Main policy regarding the establishment and development of industrial infrastructure are mentioned as below:

- Create a coordinating mechanism for investing in transport infrastructure (road, rail, air and port) by linking to targeted industrial areas;
- Increase investment in physical infrastructure and improve transport mode and services in order to facilitate and support business operations;
- Improve and maintain infrastructure to support SEZs, including road networks which are crucial for developing industries in Sihanoukville where international ports are located; and
- Upgrade new facilities in Phnom Penh Port and Sihanoukville Port for facilitate larger volume of shipping.

3.1.4 National Port Policy

The Project for Establishment of National Port Policy and Administration System (PENPPAS) was implemented by the Japan International Cooperation Agency (JICA) from 2009 to 2011 based on "The Master Plan for Maritime and Port Sector" aiming the following:

- Establishment of the draft national port policy and its planning process,
- Development of the framework on collection of statistics required for national port policy planning, and
- Establishment of roadmap and essential features for enactment of port related regulation.

Proposals on the policy and institutional framework of port sector by PENPPAS are summarized as follows:

- The goals/objectives of Cambodian Port Policy are as follows:
    a) Facilitating economic development and foreign investment through encouraging international trade, and
    b) Establishment of rational port system in Cambodia.
- Basic concept of port system reform
- The primary actions are the following:
    a) Establishment of a port management body;
    b) Stationing of a harbor master at each international port;
    c) Organization of maritime and port administration, the MPWT;
    d) Market-oriented decision on port dues and charges;
    e) Private participation in port operation and port transport business;
    f) Administration on port development planning and construction; and
    g) Supervision on port operations.

On the other hand, the master plan for the port sector in Cambodia has been currently under consideration, supported by the South Korean government. However, there is no approved plan as of now.

3.1.5 Issues in the Port Sector

The issues in the port sector in Cambodia were arranged in previous studies such as "The Study on the Master Plan for Maritime and Port Sector (by JICA, 2007)". Taking into account changes in the maritime situation in recent years, the current issues for strengthening the international competitiveness in the port sector are shown below.

1) Strengthening the function of ports as the center of Cambodian trade
   - Promotion of international gateway ports
   - Increasing port capacity to meet future demand
   - Modernizing port facilities
2) Providing efficient port service
   - Efficiency in a series of works (such as cargo handling and metage system)
   - Efficiency in the procedures of customs and vessel operations (such as enhancing information technologies)
   - Integration or simplification of customs declaration controlled by the General Department of Customs and Excise (GDCE) and import/export permit controlled by the Cambodia Import Export Inspection and Fraud Repression Department (CAMCONTROL)
3) Efficient port development and appropriate management
   - Preparing a national port master plan of the entire Cambodia
   - Implementation of strategic development of main ports
   - Establishment of appropriate public-private partnership
   - Introducing private operations/services
   - Publication and utilization of port statistics for policy makers, investors, port users, and researchers (including private port)
4) Improvement of organization and legal system
   - Improvement of maritime and port organization and clarification of division of roles
   - Establishment and revision of the legal system (such as port law and regulations regarding the administration on the development and management of private ports)
5) Securing port safety/security
   - Compliance with international code for the security of ships and port facilities (International Ship and Port Facility Security (ISPS) Code)
6) Preservation of environment and compliance with the concept of coastal zone management

3.2. Land Transport Infrastructure

The cargoes to or from Sihanoukville Port are transferred through road and railway networks. The present and future networks of roads and railways are summarized in this section.

3.2.1 Road

(1) Present State of Roads in Cambodia

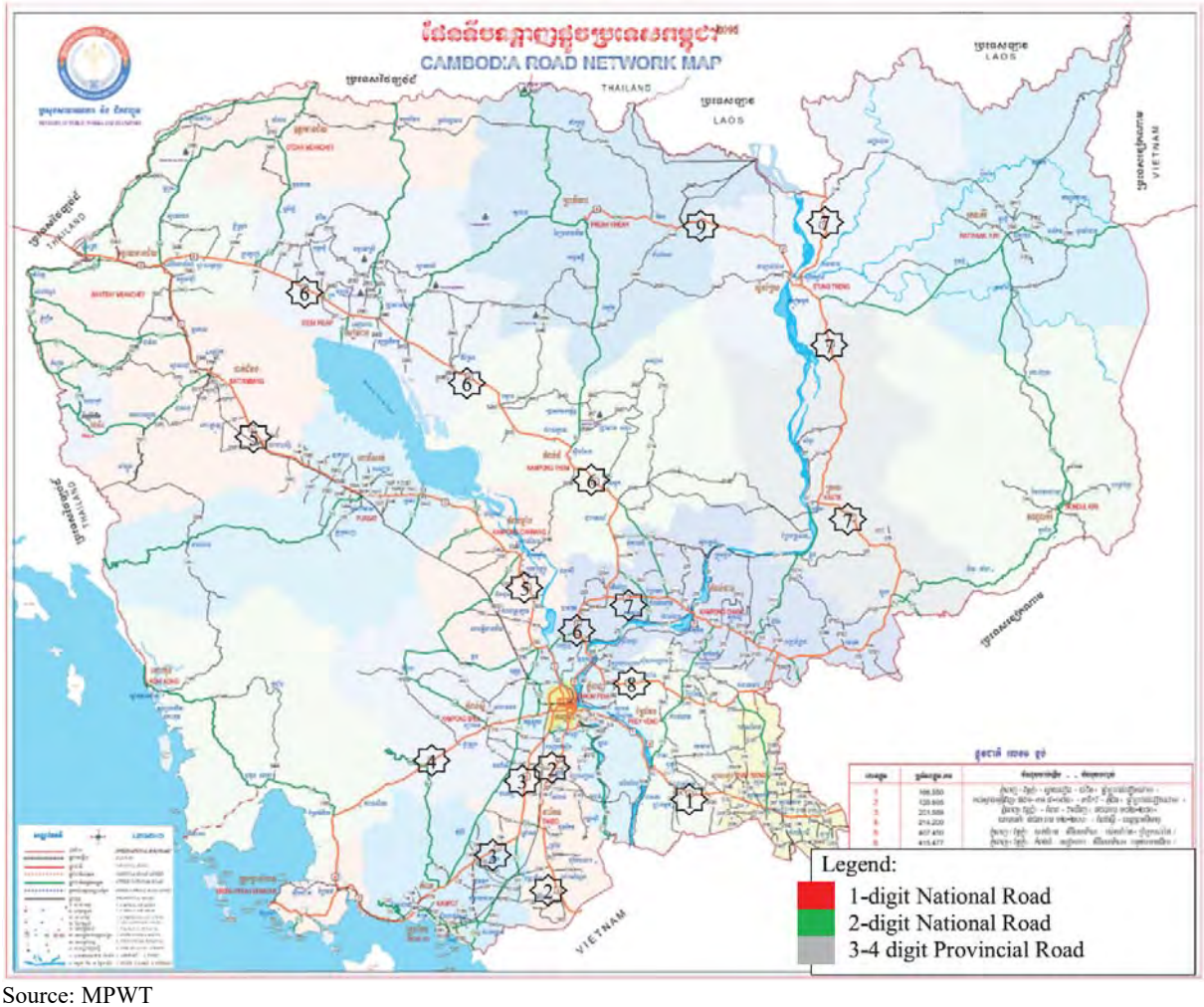
1) National and Provincial Road Network

The road network in Cambodia, as of September 2014, has a total network length of more than 55,000 km, consisting of national roads (NRs), provincial roads, and rural roads. The total length of the NR network including both one and two-digit roads is 11,000 km, and the management authority is MPWT. Table 3.2-1 shows Cambodia's road network lengths. Figure 3.2-1 shows the Cambodia's road network map.

Table 3.2-1 Road Network Length

Road Classification	Length (km)	Road Percentage	Number of Road Network	Number of Bridge	Bridge Percentage	Bridge Length (m)	Bridge Length Percentage	Management Authority
NR (1-digit)	2,243	4.06%	9	589	14.5%	17,643	23.1%	MPWT
NR (2-digit)	8,864	16.05%	146	698	17.2%	15,710	20.6%	MPWT
Provincial Road (3-4 digit)	4,407	7.98%	236	904	22.3%	16,309	21.4%	Under discussion
Rural Road	39,728	71.92%	13,355	1,869	46.0%	26,559	34.8%	MRD
Total length	55,242	100.00%	13,746	4,060	100.0%	76,221	100.0%	

Source: MPWT



Source: MPWT

Figure 3.2-1 National and Provincial Road Network Map

2) International Road Network

There are three international roads running across Cambodia. According to their width and pavement type, these are divided into five road classifications, as follows:

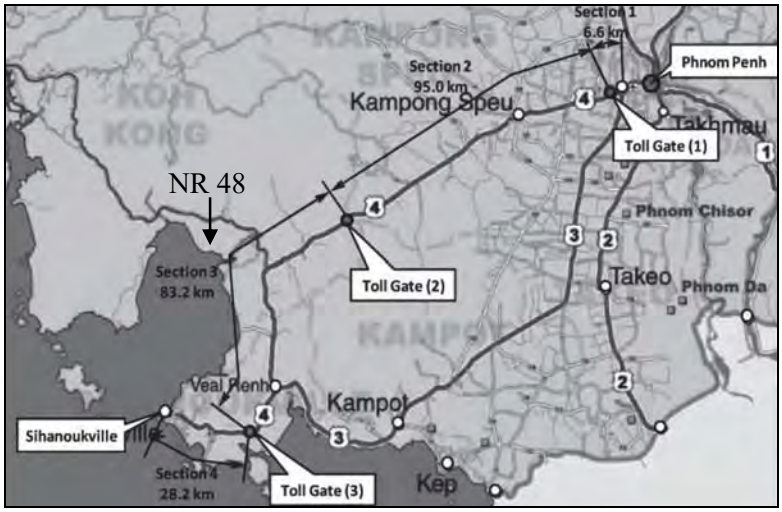
- Primary: Roads used exclusively by automobiles and made of asphalt concrete (AC) or concrete pavement;
- Class I: Highways with four or more lanes and made of AC or concrete pavement;
- Class II: Roads with two or more lanes and made of AC or concrete pavement;
- Class III: Narrow two lanes roads and made of double bituminous surface treatment (DBST) pavement; and
- Below Class III.

The Cambodia road network falls within Class II, III, and below Class III, which is considered a low standard. To promote transport within the region (reduce time and cost), Cambodia must upgrade or build primary or Class I roads, which Cambodia is developing now.

(2) Main Route between Sihanoukville and Phnom Penh

1) NR 4

NR 4 as an economic corridor towards the development of Cambodia is the main route connecting Phnom Penh and Sihanoukville as illustrated in Figure 3.2-2. Many factories, logistics companies, as well as the Phnom Penh Special Economic Zone (SEZ) are located along NR 4. NR 4 has a total length of 213 km, and is paved with AC. The operations and maintenance of NR 4 is conducted by a private company. The toll fee, which is collected at the toll gates located at three points, is devoted to the operations and maintenance of NR 4.



Source: MPWT

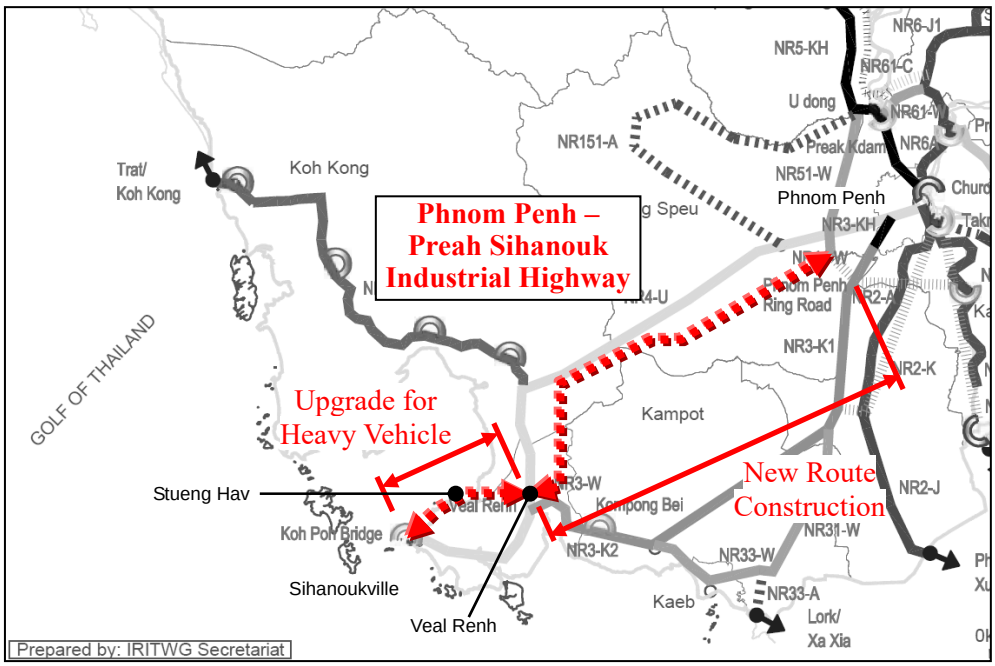
Figure 3.2-2 Location Map of NR 4

In accordance with the NSDP Update 2014-2018, NR around major cities will be improved from two lanes to four lanes. The MPWT has proposed the road network master plan for 2020 in which construction for improvement will be implemented between Sihanoukville and the connection point with NR 48. From these projects, the current situation where the travelling speed is restricted by other vehicles travelling on road such as motorcycles, small vehicles, and tractors is expected to be improved in the future.

On the other hand, the weight limit of bridges on NR4 is 25 tons at most and these bridges might obstruct the container transportation. This is because the allowable maximum weight of a container is above the load limit of these bridges. It is thought that if a sea container has been loaded up to the maximum weight, the reliability and integrity of bridge will not be secured.

2) Logistics Trunk Route in Preah Sihanouk

Under the "Master Plan on Integrated Strategy of Coastal Area for Cambodia's Continual Development and Feasibility Study on Sihanoukville Development Master Plan (2010)", the regional industrial and logistical corridor between Phnom Penh to Veal Renh was proposed. Under this proposal, the corridor extends from Phnom Penh to Veal Renh along NR 4, and Veal Renh to Sihanoukville via Stueng Hav. This corridor is shown in Figure 3.2-3.



Source: JICA Survey Team based on the information from MPWT

Figure 3.2-3 Industrial/Logistics Corridor between the Sihanoukville Port and Phnom Penh

The section between Veal Renh and Sihanoukville Port via Stueng Hav is paved with damage-prone DBST pavement, and hence the road surface of this section is continuously deteriorating in many areas. Also, there are 21 existing bridges along this section and the most are not wide enough for heavy vehicles, hence all contra-flowing vehicles must slow down to pass over the bridges.

Therefore, the above described conditions of roads and bridges must be improved, with the expected increase in logistical volume in the future.

(3) New Developments/Plans Related to Road in the Whole Cambodia

1) Neak Loeung or Tsubasa Bridge

One of the most important routes in Cambodia and stretches from Phnom Penh to the southern part of Cambodia is the NR 1. It forms part of the Asian Highway Route AH-1 and connects Ho Chi Minh City and Bangkok through Phnom Penh. NR 1 was improved by Asian Development Bank (ADB) and Japanese grant aid. To accelerate the mobility of goods and passengers and generate substantial benefits to Indochina and the Greater Mekong Sub-region (GMS), the Japanese government provided financial and technical support to build the longest and largest cable-stayed bridge at Neak Loeung. The bridge is named “Tsubasa”. It is a Japanese word which means “wing” in English. This name was derived from the shape of a bridge that looks like two birds spreading their wings, which they resemble Cambodia and Japan. Table 3.2-2 shows the technical information of Neak Loeung/Tsubasa Bridge.

This bridge was opened to general public transport/traffic (except container transport) on 6 April 2015. According to Phnom Penh Autonomous Port (PPAP), the amount of cargo has been increased

slightly compared with before the completion of this bridge. However, for the fundamental solution, it is necessary not only to develop the physical infrastructures but also to enhance "soft" measures such as the system of customs clearance.

Table 3.2-2 Technical Information of Neak Loeung or Tsubasa Bridge

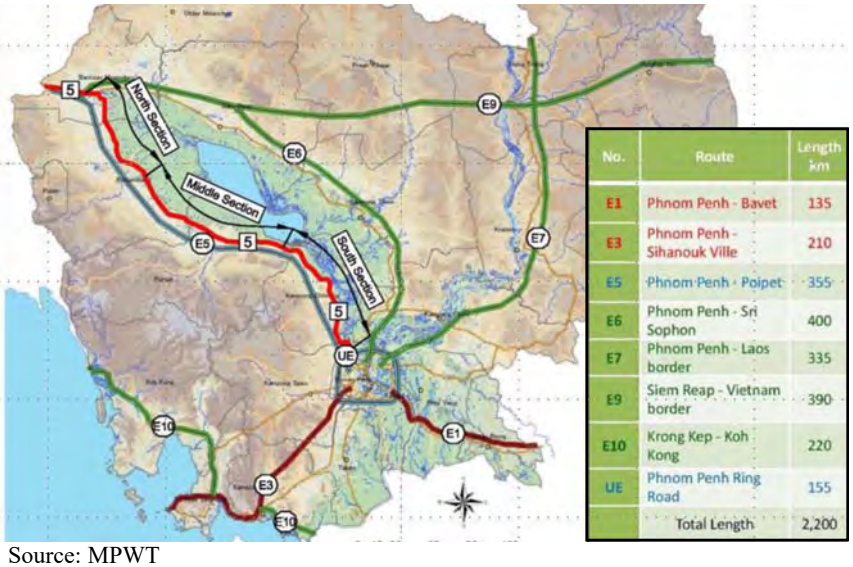
Construction Period:		From December 2010 to March 2015 (51 months)
Main Bridge	Bridge Type:	Cable-stayed bridge
	Length:	640 m
	Span Length:	155 m + 330 m + 155 m = 640 m
	Height of Pylon/ Pier:	130 m (from E.L.0 m)
	Clearance:	37.50 m (from highest water line (HWL))
	Type of Foundation:	Cast-in-place piles
Approach Road	No. of Lanes:	Two lanes
	Design Speed:	80 km/h

Source: MPWT

2) Expressway Master Plan

The expressway master plan of Cambodia had been started with the technical assistance of Henan Province, China. The study came up with 2,230 km of Cambodia Expressway Network. China's master plan report recommended to develop 2,230 km of national expressway network by 2040 with the investment amount of approximately USD 26 billion. But for the short-term plan, by 2020 the country needs to build about 850 km in length requiring some USD 9 billion. Such development is not only in response to the country's rapid economic growth, but also for the preparation for Association of Southeast Asian Nations (ASEAN) integration.

Under these circumstances, JICA implemented the "Preliminary Data Collection Survey for Expressway Development in the Kingdom of Cambodia" in 2013 to collect and compile the fundamental information which was used to discuss with the senior management of MPWT on the necessity for formulating a master plan for the national expressway network of Cambodia. The survey recommended that a national expressway network, with a total length of 2,200 km, should be planned and constructed. Among these plan, No. E1 connecting Phnom Penh and Bavet is thought as a first priority section. Development of E1 is expected to reduce the travel time from 6 hours to 2.5 hours between Phnom Penh and Ho Chi Minh. There is a possibility to shift a part of the inland water transportation in Phnom Penh Port to the cross border transportation by the development of E1. On the other hand, it is thought that the impact to Sihanoukville Port is smaller than Phnom Penh Port. The expressway development plan by Japan is described in Figure 3.2-4 and Table 3.2-3.



No.	Route	Length km
E1	Phnom Penh - Bavet	135
E3	Phnom Penh - Sihanouk Ville	210
E5	Phnom Penh - Poipet	355
E6	Phnom Penh - Sri Sophon	400
E7	Phnom Penh - Laos border	335
E9	Siem Reap - Vietnam border	390
E10	Krong Kep - Koh Kong	220
UE	Phnom Penh Ring Road	155
	Total Length	2,200

Source: MPWT

Figure 3.2-4 Expressway Development Plan Proposed by Japan

Table 3.2-3 Expressway Development Plan Proposed by Japan

No.	Route		Pavement Type	Length, km	Schedule
	From	To			
E1	Phnom Penh (PP) Ring Road No. 3	Bavet (Along NR1)	AC	135	Short Term
E3	PP Ring Road No. 3	Sihanoukville (Along NR4)	AC	210	Short Term
UE	PP Ring Road	-	AC	155	Medium Term
E5	PP Ring Road No. 3	Poi Pet	AC	355	Medium Term
E6	PP Ring Road No. 3	Sisophon	AC	400	Long Term
E7	PP Ring Road No. 3	Lao Border (Along NR7)	AC	335	Long Term
E9	Siem Reap	Vietnam Border (Along NR9)	AC	390	Long Term
E10	Kep	Koh Kong (Along NR33 & NR44)	AC	220	Long Term
Total				2,200	Long Term

Source: MPWT

3) Bilateral Agreement Regarding with Direct Land Transportation of Cross-border

The road is used for transportation of import and export cargoes to Vietnam and Thailand due to the development of the "South Corridor" from Ho Chi Min to Bangkok. The gates of the South Corridor are Bavet on the Vietnam border and Poipet on the Thailand border.

In the recent years, the direct land transportation without cross-border applications and transshipment of cargo to/from Vietnam and Thailand has been increasing due to bilateral agreements on land transport. The quota, the sum of the through traffic of buses and trucks, is agreed between neighboring counties. It was 500 units between Cambodia and Vietnam/Thailand as of March 2016, and each country can allocate its quota to transport companies by its own decision. There is a certain tendency to be allocated to the bus to cope with tourism demand. The competent authority of each country is allowed to issue the certificate for through traffic up to the quota with submission of the list of certified buses and trucks to the other party.

In the region where land transport between Cambodia and Thailand/Vietnam has been thriving such as Phnom Penh, the change of the transport mode due to this bilateral agreement shall be considered on port development. However, it is thought that there is no significant impact to Sihanoukville Port as of now.

3.2.2 Railway

(1) Present State of Railway in Cambodia

The existing railway network in Cambodia consists of the Northern and Southern lines. The Northern Line was constructed during the 1920s and extends to a distance of 388 km from Phnom Penh to Poipet at the Cambodia's border with Thailand. The southern line, which has a total length of 264 km, was built in the late 1960s and links Phnom Penh with Sihanoukville.

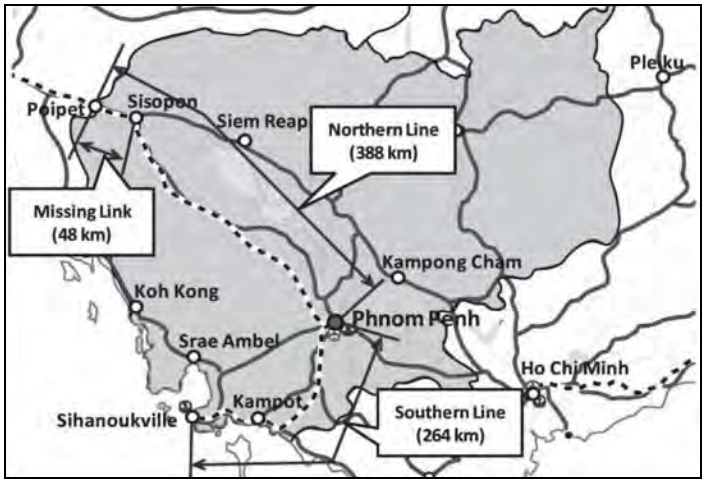
The rehabilitation of the railway network commenced in 2006 with aid from ADB and the Government of Australia in order to support the railway network which was destroyed during the civil war. The ADB and the Government of Australia provided USD 84 million and USD 21.5 million, respectively. The budget to fund the railway rehabilitation is shown in Table 3.2-4.

Table 3.2-4 Budget to Fund Railway Rehabilitation (USD in Millions)

Source of Funds	Original Project	Complement Finance	Total
ADB	42.00	42.00	84.00
OFID	13.00	-	13.00
Government of Australia	-	21.50	21.50
Government of Malaysia	2.80	0.00	2.80
Government of Cambodia	15.20	5.10	20.30
Total	**73.00**	**68.60**	**141.60**

Source: MPWT

The project aims to reconstruct and repair the railway network, which extends from Cambodia's border with Thailand through Phnom Penh, and to Sihanoukville where the country's main seaport is located. The existing railway network is shown in Figure 3.2-5.



Source: MPWT

Figure 3.2-5 Existing Railway Network

(2) Northern Line

The Northern Line connecting Phnom Penh to Poipet on the border with Thailand has a total length of 386 km including a missing link of 48 km. A part of the missing link of 42 km had been rehabilitated and the remained 6 km at Poipet from the border with Thailand awaits resettlement clearance. Most of the Northern Line has been superannuated, lost, and discontinued since 2008.

Of the Northern Line, approximately 200 km and 50 stations have been destroyed by landmines, and most of bridges are in poor condition. The line, except the rehabilitated 48 km section between Sisophon and Poipet, was planned to be reconstructed by the end of 2013 with funding from ADB, but it has been delayed due to budget deficit. As of May 2014, only 32% of the Northern Line had been rehabilitated. As of early 2015, the government planned to earmark USD 10 million to rehabilitate the line, since the contractor abandoned the rehabilitation work in 2012. The objective of this rehabilitation is to enable the operation of slow speed trains.

(3) Southern Line

The Southern Line connects Phnom Penh with Cambodia’s international seaport in Sihanoukville. About 110 km (41.5% of the 264 km total length,) of the Southern Line was destroyed by civil war, land mines, and floods; and 16 bridges (17.02%) as well as drainage were damaged by floods and seawater. Most of signal and communication systems were destroyed like the Northern Line. With the compounded problems of war damage, neglect, and underfunding, the Southern Line discontinued operation from the end of 2010. As of 31 May 2014, sections from Phnom Penh to Sihanoukville had been rehabilitated by French-based firm TSO7 but train operation could not achieve maximum average speed of 50 km/h as specified in the rehabilitation specification. Some of the structures (bridge, box culvert, and pipe culvert) have been repaired but remain far from condition that would allow trains to operate at as-specified speed. In Sihanoukville, the rehabilitation of the container and rail terminal including the bulk siding inside the port have been completed by a Chinese company, as of 2016. On the other hand, the container train service between Phnom Penh and Sihanoukville restarted in 2014. This operates three times per week and the total volume of container transported by train was 17,836 TEUs in 2014.

The test operation of passenger flights between Phnom Penh and Sihanoukville was performed in April 2016, although the schedule of full scale (regular) operation is not yet determined in the future. During this test operation, the travel time was 8 hours and the fare was USD 6.

(4) Railway Master Plan

The Railway Mater Plan Project was funded by the Korea International Cooperation Agency (KOICA). This master plan is to encourage integrated national development, economic growth, and balanced development among regions within the Kingdom of Cambodia. The railway master plan network is described in Figure 3.2-6.

	Section	L(km)		Section	L(km)
Main Line	A PHNOM PENH ~ SISOPHON ~POIPET ~ THAILAND	384	High Speed Line	A PHNOM PENH ~ SISOPHON ~POIPET ~ THAILAND	400
	B PHNOM PENH ~ SIHANOUK VILLE	260		B PHNOM PENH ~ SIHANOUK VILLE	243
	C SISOPHON ~ SIEM REAP ~CHEUNG PREY	326		C SISOPHON ~ SIEM REAP ~CHEUNG PREY	314
	D BAT DOENG ~ KAMPONG CHAM ~ SNUOL ~ VIETNAM	249		D BAT DOENG ~ KAMPONG CHAM ~ SNUOL ~ VIETNAM	236
	E SNUOL ~ KRATIE ~ STUNG TRENG ~ LAOS	249	Industrial Line	OTDAR MEANCHEY ~ PREAH VIHEAR	181
Branch Line	1 PREY CHRUK ~ OTDAR MEANCHEY	74		PREAH VIHEAR ~ STUNG TRENG	113
	2 KAMPONG THOM ~ PREAH VIHEAR	139		MONDUL KIRI ~ RATANAK KIRI	151
	3 STUNG TRENG ~ RATANAK KIRI	158		KAMPONG SEILA ~ VEAL RING	48
	4 KAMPONG CHAM ~ KRATIE	115		SVAY RIENG ~ SUONG	90
	5 SNUOL ~ MONDUL KIRI	101	Airport & Port Line	PHNOM PENH NEW PORT LINE	42
	6 BATTAMBANG ~ PAILIN	75		KAMPONG CHHNANG AIRPORT LINE	21
	7 PHNOM PENH ~ KOH KONG	248		KAMPOT PORT LINE	4
	8 PROTEAS LANG ~ SVAY RIENG	170		SIEM REAP NEW AIRPORT LINE	3

Source: MPWT

Figure 3.2-6 Railway Master Plan Network

The project execution plan in consideration of project priorities and the economic analysis results proposed in the master plan is shown in Table 3.2-5.

Table 3.2-5 Project Execution Plan

Short-term Plan (2014-2020)	Mid-term Plan (2021-2030)	Long-term Plan (2031 or later)
- Main Line D: Build an international network and develop eastern areas - Main Line A: Activate the existing northern lines	- Main Line B: Link with Sihanoukville and develop southern areas - Main Line C: Develop central and eastern areas, and develop tourism	- High Speed Rail: High speed services - Main Line E: Link with Laos and develop eastern areas - Branch Line: Develop potential areas - Double track

Source: MPWT

3.3. Ports in Cambodia

3.3.1 Present Situation of Port Sector

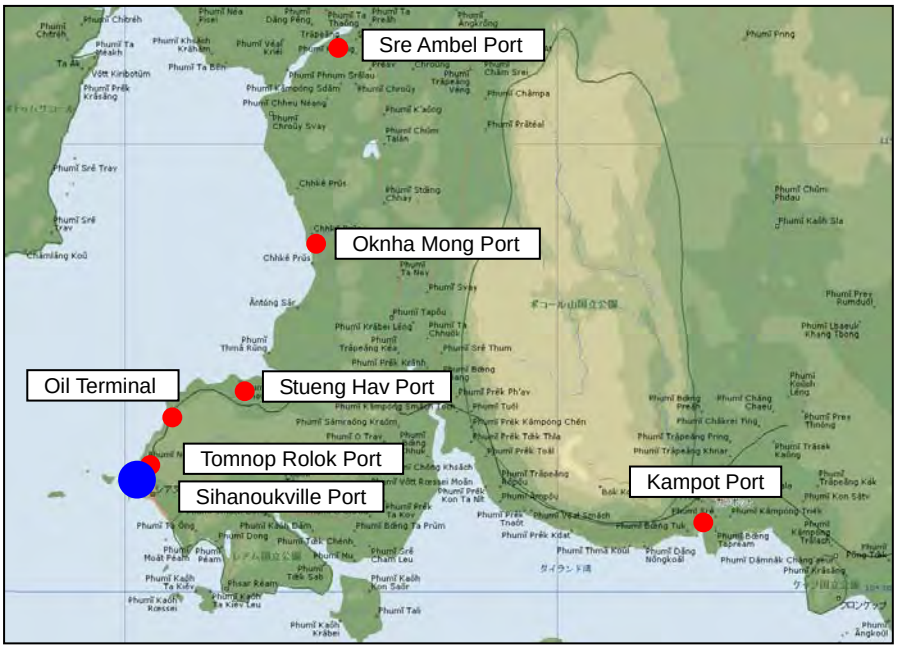
As shown in Table 3.3-1, according to the Study on the Master Plan for the Maritime and Port Sectors in the Kingdom of Cambodia, the ports in Cambodia are generally composed of two autonomous ports, three private ports, nine provincial ports, one municipal port, and 42 district ports. Figure 3.3-1 shows the location map of major sea ports in Cambodia. At present, container service is only operated at Sihanoukville Port and Phnom Penh Port.

The outline and present status (cargo handling and container traffic) of each main port are shown in the following sections. In addition to the fundamental products such as garments, along with the energetic development of SEZ in Cambodia as shown in Figure 2.5-1 and Table 2.5-1, the volume of container cargo has increased remarkably in Sihanoukville Port and Phnom Penh Port in recent years.

Table 3.3-1 Ports in Cambodia

Type	Name of Port	Management Body / Location
Autonomous	Sihanoukville Port	Sihanoukville Autonomous Port
〃	Phnom Penh Port	Phnom Penh Autonomous Port
Private	Sre Ambel Port	Koh Kong Province / Sre Ambel District
〃	Oknha Mong Port	Private Company / Sre Ambel District
〃	Oil Terminals	Private Company / Sihanoukville
Province	Stueng Hav Port	Koh Kong Province / Stueng Hav District
Municipality	Tomnop Rolok Port	Sihanoukville City
Province	Kampot Port	Kampot Province / Kampot
〃	Kompong Cham Port	Kompong Cham Province / Upper Mekong 105 km from PP
〃	Kratie Port	Kratie Province / Upper Mekong 220 km from PP
〃	Stung Treng Port	Stung Treng Province / Upper Mekong 370 km from PP
〃	Kampong Chhnang Port	Kampong Chhnang Province / Tonle Sap River 90 km from PP
〃	Chong Kneas Port	Siem Reap Province / Tonle Sap 260 km from PP
〃	Battambang Port	Battambang Province / Sangke River west of Tonle Sap
〃	Neak Loeang Terminal	Ferry Terminal / Lower Mekong 60 km from PP
District	42 ports	32 ports along the Mekong River 10 ports along the Tonle Sap River

Source: The Study Team revised based on the Study on the Master Plan for Maritime and Port Sectors in Cambodia (2007).



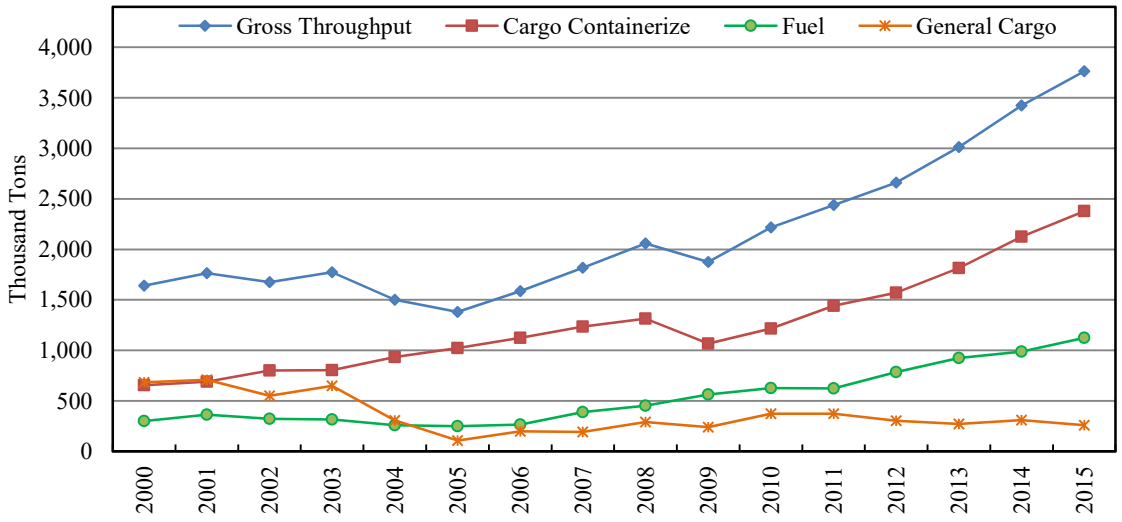
Source: Structured Assessment of Protective Factors (SAPROF) for Sihanoukville Port Urgent Development for Oil Supply Base and Multipurpose Terminal (2009)

Figure 3.3-1 Location of Main Seaports

3.3.2 Sihanoukville Port

1) Cargo Handling

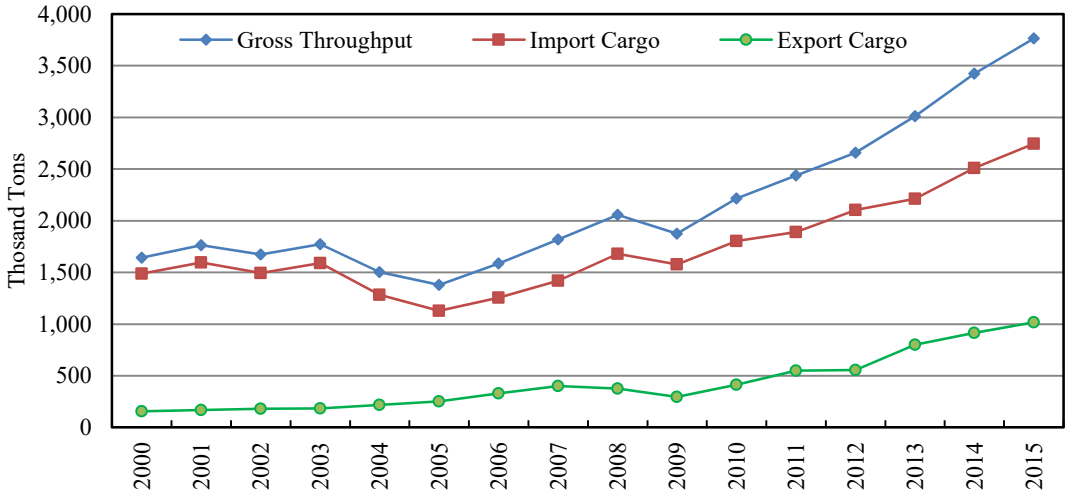
Figure 3.3-2 shows the cargo handling volumes at Sihanoukville Port from 2000 to 2015. The total cargo volume increased almost two times from 1.64 million tons to 3.76 million tons during this period because of increase of container cargos and fuels. On the other hand, general cargo decreased nearly half in 2015 compared with that of 2000.



Source: PAS

Figure 3.3-2 Cargo Throughput of Each Type at Sihanoukville Port

As for the trend of cargo volume of import and export, both types of cargo volumes increased between 2000 and 2015, as shown in Figure 3.3-3. However, the import volume always shows higher trend compared with the export volume and that the difference is over 2.5 times in 2015.



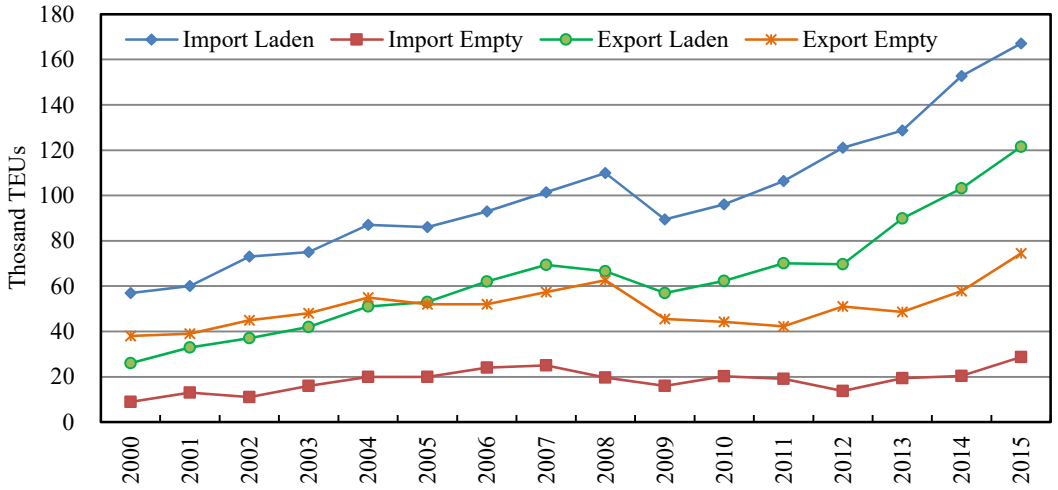
Source: PAS

Figure 3.3-3 Cargo Throughput of Import and Export at Sihanoukville Port

2) Container Traffic

Container traffic steadily increased from 130,000 TEUs in 2000 to 392,000 TEUs in 2015 as shown in Figure 3.3-4. The annual average increase rate from 2014 to 2015 was 17.3%.

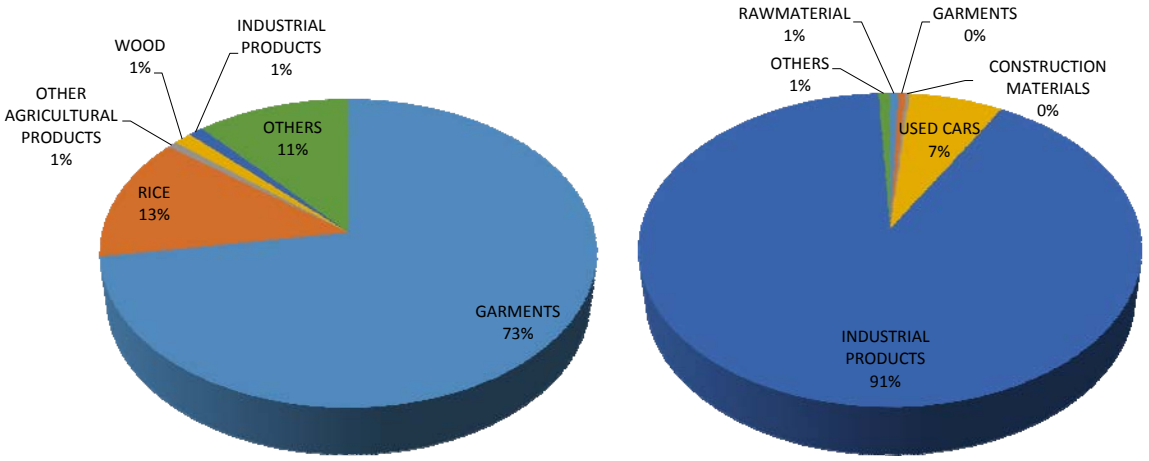
Then, the ratios of empty containers of import and export in 2015 were 17% and 61%, respectively (see).



Source: PAS

Figure 3.3-4 Trends of Empty and Laden Container

The compositions of the container cargo in 2015 are shown in Figure 3.3-5. As shown in the figure, the exported items are garments, rice, other agricultural products, wood, industrial products, and others; and the largest volume of exported items are garments. Then, as for imported items, almost all are industrial products such as spare parts and second is used cars. Other items are raw material, garments, construction materials, and others.



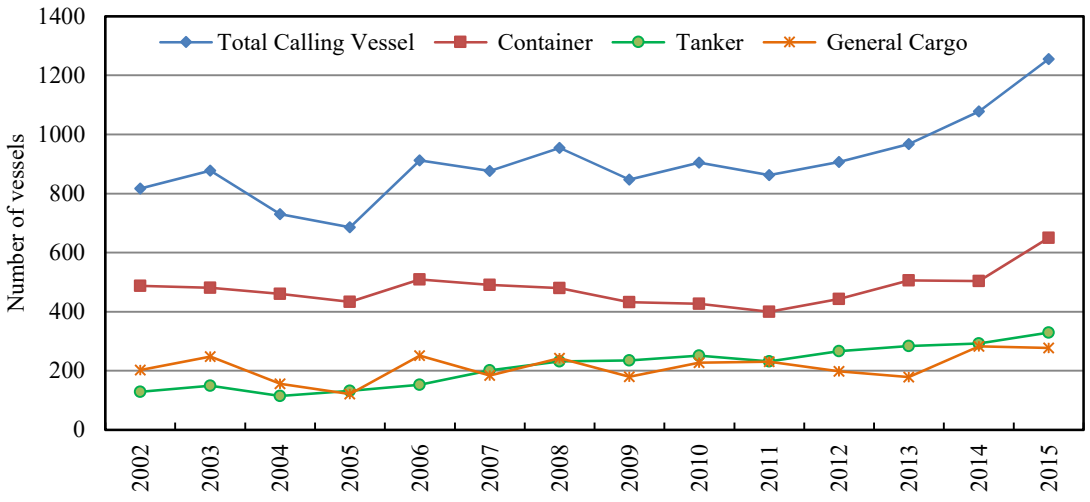
(a) Exported Items (b) Imported Items

Source: PAS

Figure 3.3-5 Compositions of the Container Cargo in 2015

3) Number of Calling Vessel

Figure 3.3-6 shows the number of calling vessels to Sihanoukville Port from 2002 to 2015. As shown in the figure, the number of calling vessels in 2002 was 817 and it steadily increased to 1,256 in 2015, even though the number of vessels largely decreased in 2004 and 2005.The vessel type having the highest number among the three is the container vessels; nevertheless, the number of tankers increased more than container and general cargo vessels.



Source: PAS

Figure 3.3-6 Trend in the Number of Calling Vessel to Sihanoukville Port

3.3.3 Phnom Penh Port

Phnom Penh Port, as well as Sihanoukville Port, has an important role as backbone of Cambodian logistics supporting the national economic development. This port is operated by PPAP under the jurisdiction of the Ministry of Public Works and Transport (MPWT) and the Ministry of Economy and Finance (MEF).

The new container terminal was developed with the increase of container cargo and has operated since January 2013. The container cargoes were handled at the existing terminal before 2013.

(1) Outline

1) Existing Container Terminal

As shown in Figure 3.3-7, the existing container terminal has a 300 m long quay. At the present, the general cargo are handled mainly at the existing terminal. The water depth is -6.2 m (at lowest water line (LWL)) and the water elevations in the rainy and dry seasons are +9.81 m and +0.74 m, respectively. The quay of the existing container terminal has a limit for accommodation of calling vessels because of such difference of seasonal water elevation, waterway conditions, and limited clearance between the bridge and the vessel. The summary of facilities of the existing container terminal is shown in Table 3.3-2.

Source: The Preparatory Survey on Phnom Penh Autonomous Port New Container Terminal's Special Economic Zone and Associated Facilities Construction Project in Kingdom of Cambodia (September 2013), JICA

Figure 3.3-7 General Layout of the Existing Container Terminal

Table 3.3-2 Summary of Facilities of the Existing Container Terminal

	Dimension	Remarks
Quay	20 m x 300 m	
Water Depth	-6.2 m	At LWL
Berthing Capacity	5	At one time
Warehouse	3	
Area of Container Yard	1.4 ha	
Others	Reefer containers for storage of refrigerated cargos	

Source: JICA Survey Team based on the information from PPAP

PPAP has secured an inland container depot (ICD) located about 4 km from the container terminal (TS3) as shown in Figure 3.3-8 due to lack of yard area. This ICD was established in July 2007 and has an area of about 93,000 m^2 with two warehouses.

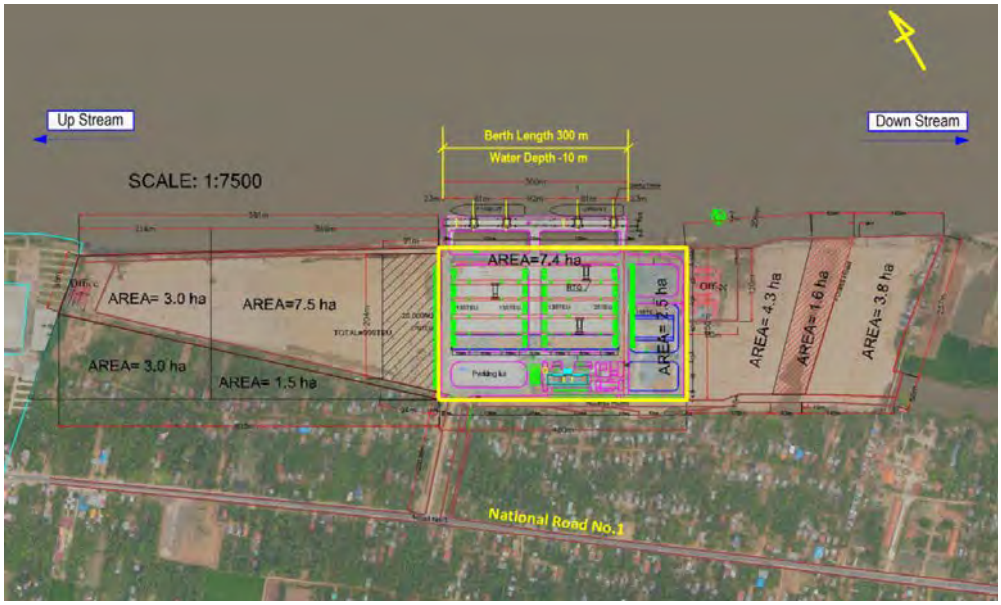
Source: The Preparatory Survey on Phnom Penh Autonomous Port New Container Terminal's Special Economic Zone and Associated Facilities Construction Project in Kingdom of Cambodia (September 2013), JICA

Figure 3.3-8 General Layout of the Inland Container Depot

2) New Container Terminal

As shown in Figure 3.3-9, the new container terminal has 300 m long quay and -10 m depth. And the capacity of the container throughput on planning is 150,000 TEUs/year. The construction of the new container terminal was completed in 2012 and the operation started after the cargo handling equipment was procured in January 2013.

The water levels during the rainy and dry seasons are +8.60 m and +0.65 m, respectively. Due to seasonal fluctuations of water levels, the depths in front of the quay and in the basin varies. The maximum depth during the dry season is -5 m to -6 m and the width of the channel is also limited. Therefore, the large vessels cannot be berthed in the new container terminal and the maximum vessel size is 1,500-2,000 DWT (100-200 TEUs) although the depth in front of the quay is about 10 m during the rainy season. The summary of facilities of the new container terminal is shown in Table 3.3-3.



Source: The Preparatory Survey on Phnom Penh Autonomous Port New Container Terminal's Special Economic Zone and Associated Facilities Construction Project in Kingdom of Cambodia (September 2013), JICA

Figure 3.3-9 General Layout of the New Container Terminal

Table 3.3-3 Summary of Facilities of the New Container Terminal

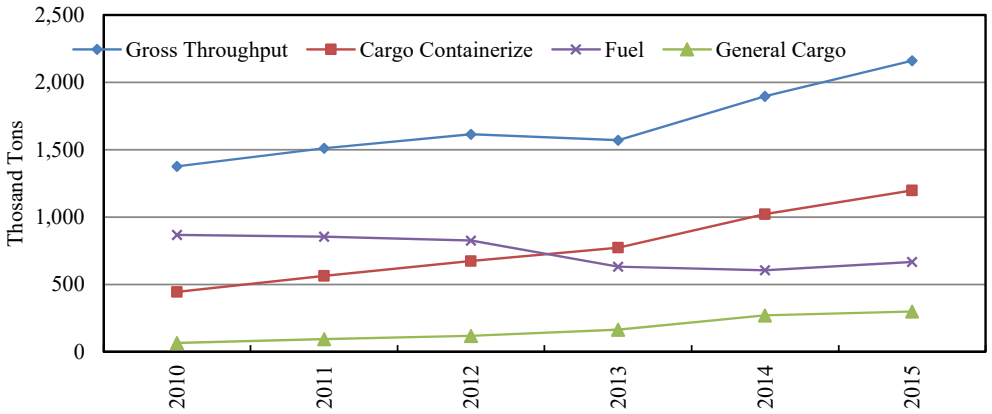
	Dimension	Remarks
Quay	22 m x 300 m	
Water depth	-10.0 m	At LWL
Berthing capacity	5	At one time
Rubber-tired gantry (RTG) cranes	4	Chinese products
Quayside gantry cranes	3	Korean products
Floating crane	2	British products
Reach stackers	3	
Bonded warehouse	1 (2 ha)	
Open warehouse	1 (7 ha)	
Cargo handling efficiency	18 to 20 boxes/hour	

Source: JICA Survey Team based on the information from PPAP

(2) Present Status

1) Cargo Handling

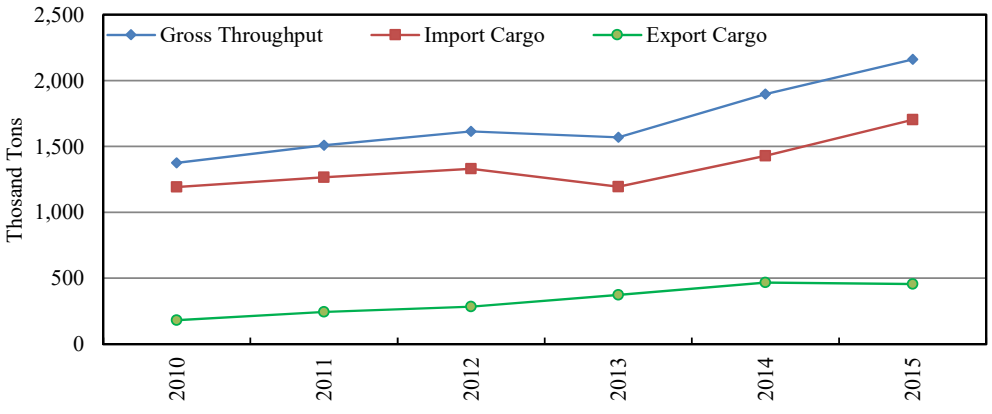
Figure 3.3-10 shows the cargo handling volumes at Phnom Penh Port from 2010 to 2015. The total cargo volume increased almost three times from 0.51 million tons to 1.50 million tons during this period in proportion to the growth of container cargo.



Source: PPAP

Figure 3.3-10 Cargo Throughput of Each Type at Phnom Penh Port

As for the trend of cargo volume of import and export, both types of cargo volumes increased between 2010 and 2015, as shown in Figure 3.3-11. However, the import volume always shows higher trend compared with the export volume and that the difference is around twice during this period.

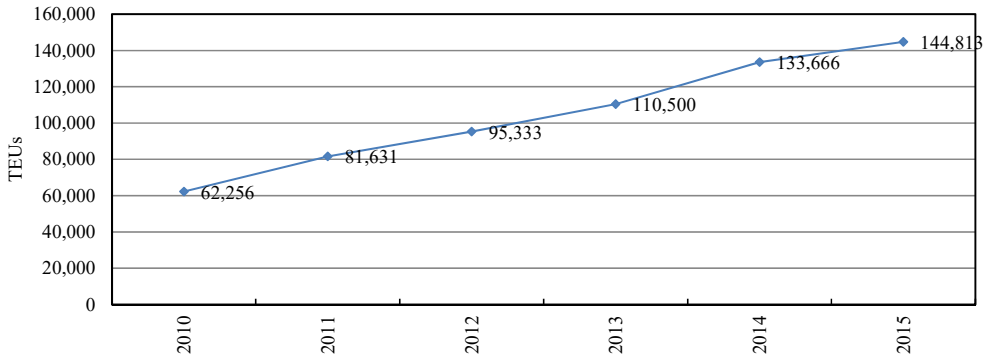


Source: PPAP

Figure 3.3-11 Cargo Throughput of Import and Export at Phnom Penh Port

2) Container Traffic

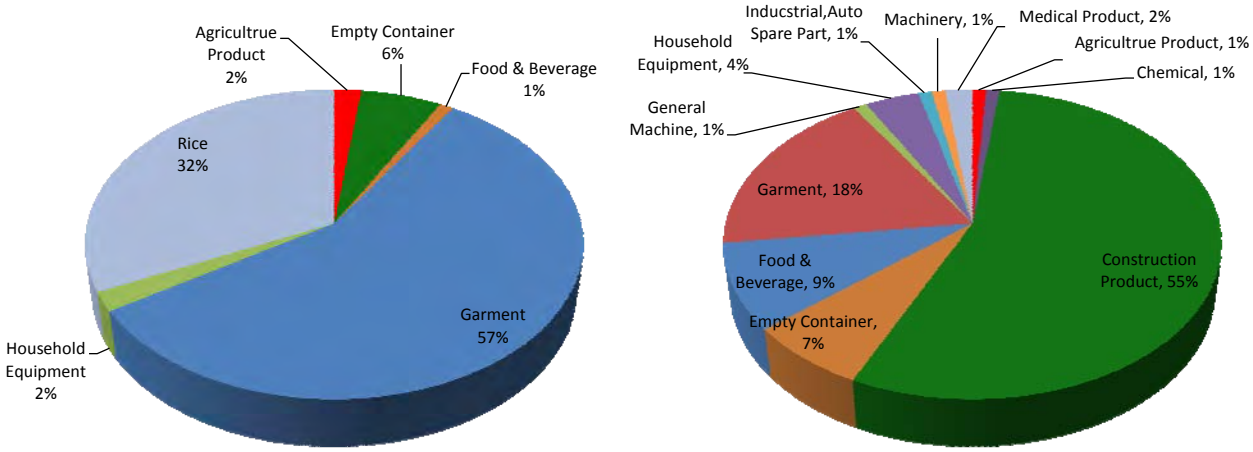
Container traffic steadily increased from 62,000 TEUs in 2010 to 145,000 TEUs in 2015 as shown in Figure 3.3-12. The annual average increase rate from 2014 to 2015 was 8.3%.



Source: PPAP

Figure 3.3-12 Trends of Container Traffic

The compositions of the container cargo in 2015 are shown in Figure 3.3-13. As shown in the figure (a), the major exported items are garment and rice. Then, as for imported items in the figure (b), the items with large volume are construction product and garment.



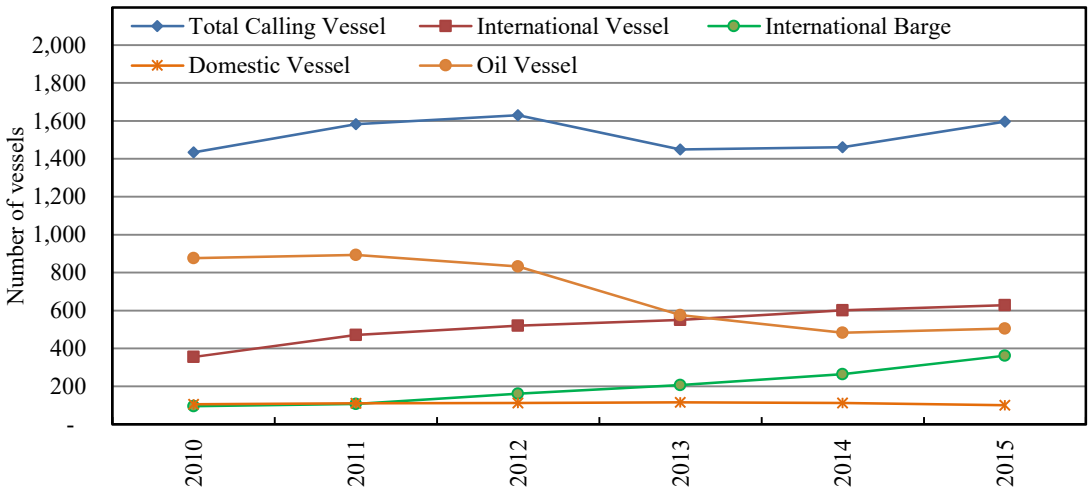
(a) Exported Items (b) Imported Items

Source: PPAP

Figure 3.3-13 Compositions of the Container Cargo in 2015

3) Number of Calling Vessel

Figure 3.3-14 shows the number of calling vessels to Phnom Penh Port from 2010 to 2015. The number of calling vessels was 1,435 in 2010 and increased to 1,596 in 2015.



Source: PPAP

Figure 3.3-14 Trend of Number of Calling Vessel to Phnom Penh Port

(3) Future Plan

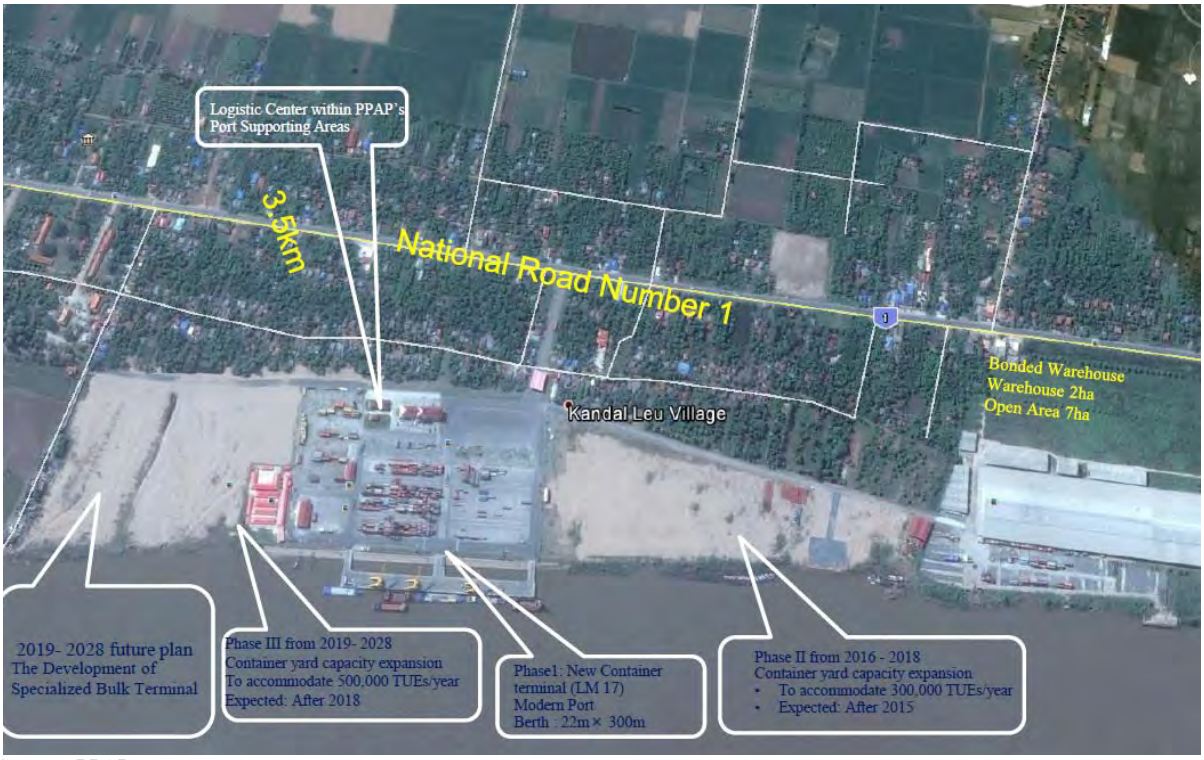
The 300 m section, which is currently operating, has been developed as Phase I by Chinese Yuan-denominated loans. And PPAP plans the additional development of Phase II and Phase III. The handling cargo volume of 2016 is expected to exceed the current capacity, and already the construction of Phase II is proceeding by PPAP funds. Furthermore, in conjunction with the development of Phase III, the terminal for the bulk cargo is also planned.

Table 3.3-4 shows the outline of future development plans and Figure 3.3-15 shows the layout of future development plans.

Table 3.3-4 Outline of Future Development Plan of New Container Terminal

		Construction Period	Capacity*	Source of Fund Procurement
Phase I	New Container Terminal	Construction has completed	150,000 TEUs (150,000 TEUs)	Chinese Yuan-denominated loans
Phase II	Container Yard Expansion	Planned from 2016 to 2018	150,000 TEUs (300,000 TEUs)	PPAP funds
Phase III	Container Yard Expansion	Planned from 2019 to 2028	200,000 TEUs (500,000 TEUs)	(undecided)
Bulk Terminal	Specialized Bulk Terminal	Planned from 2019 to 2028	-	(undecided)

Note: Capacity means the additional capacity of each phase. The total capacity is shown inside the parentheses.
Source: PPAP



Source: PPAP

Figure 3.3-15 Layout of Future Development Plan of New Container Terminal Oknha Mong Port

3.3.4 Oknha Mong Port

(1) Outline

Oknha Mong Port was the first private seaport in Cambodia with investment from Mong Reththy Group. It is located in Keo Phos Village, Chroy Svay Commune, Sre Ambel District, Koh Kong Province; and is 75.57 km away from Preah Sihanouk. It has an important role as the logistic center to support Oknha Mong SEZ.

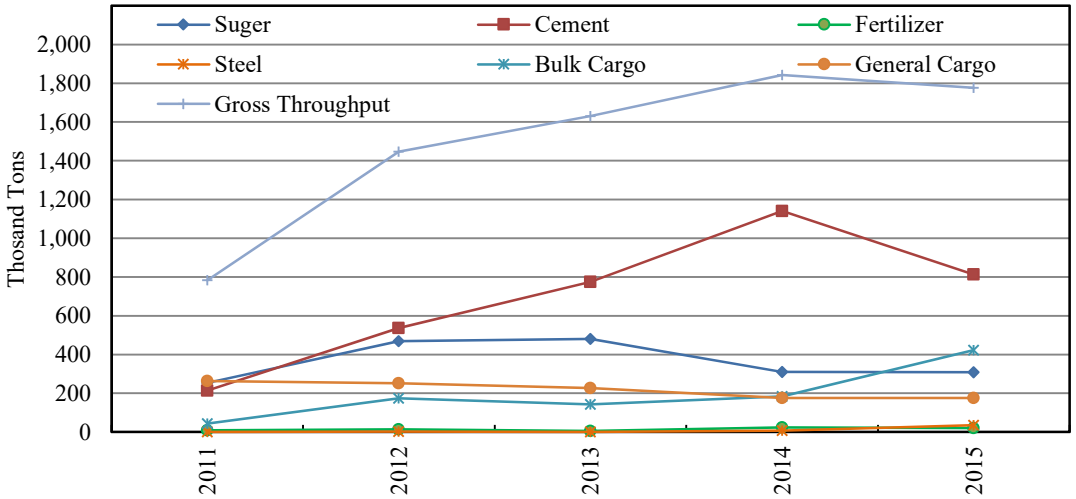
The port construction started on 01 January 2003, and operations commenced on 01 August 2004. The port has a land area of 64 ha while the total terminal area is about 26 ha. Total berth length is 1,111 m with a width of 200 m and a water depth of 5.5 m. The port has six warehouses (1 unit of 1,200 m^2, 3 units of 5,600 m^2, and 2 units of 7,000 m^2) and open storage areas of 3 ha. It has 5 cranes (2 of 25-ton capacity), 5 forklifts, 15 trucks (for operating at the port area), and 2 dredging barges.

(2) Present Status

1) Cargo Handling

Figure 3.3-16 shows the cargo handling volumes at Oknha Mong Port from 2011 to 2015. At the present, the container cargo are not handled at Oknha Mong Port.

The total cargo volume increased more than twice from 784,000 tons to 1,776,000 tons during this period. The main item is the cement and its ratio to the total volume is about 50%. However, it is expected that import volume of cement will decrease because the cement factories in Kampot are promoting a plan to increase the production capacity to about two times. Therefore, the demand of domestic production at low cost than imported cement will increase and demand of import will decrease. The volume of other items has remained almost constant during this period.



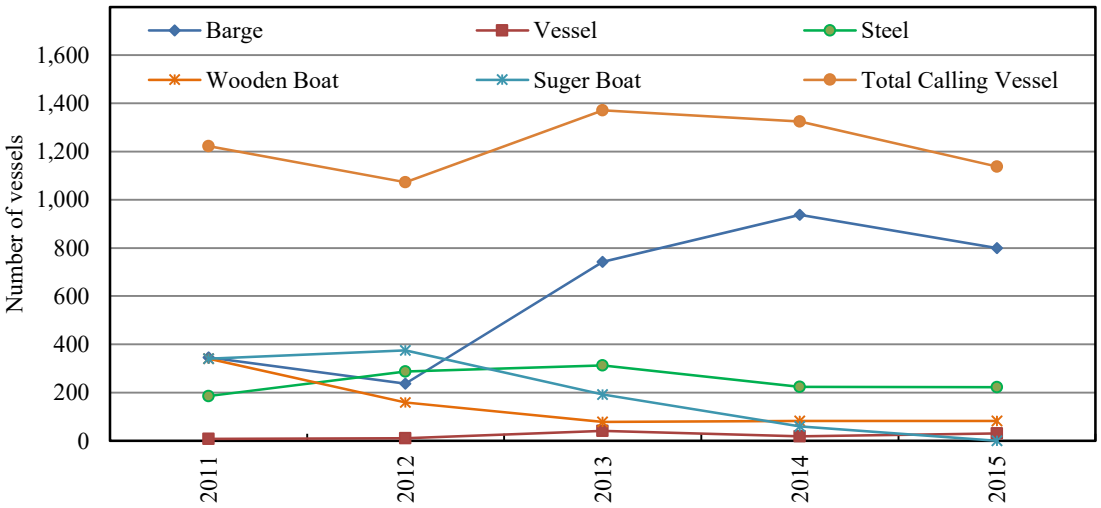
Source: Oknha Mong Port Co.,Ltd.

Figure 3.3-16 Cargo Handled at Oknha Mong Port

2) Number of Calling Vessel

Figure 3.3-17 shows the number of calling vessels to Oknha Mong Port from 2011 to 2015. The number of barge in 2011 was 346 and steadily increased to 800 in 2015. The number of other vessel decreased or was constant during this period.

The cement is carried from Bangkok, Thailand by convoys consisting of one tugboat and four barges with about 1,000 ton capacity each. The monthly import volume is approximately 50,000 tons to 100,000 tons. Sugar, fruits, and general cargoes are carried by the vessel, wooden boat, or sugar boat depending on the season. A very small amount of steel (30 to 100 tons) for construction works is shipped by light carriers.

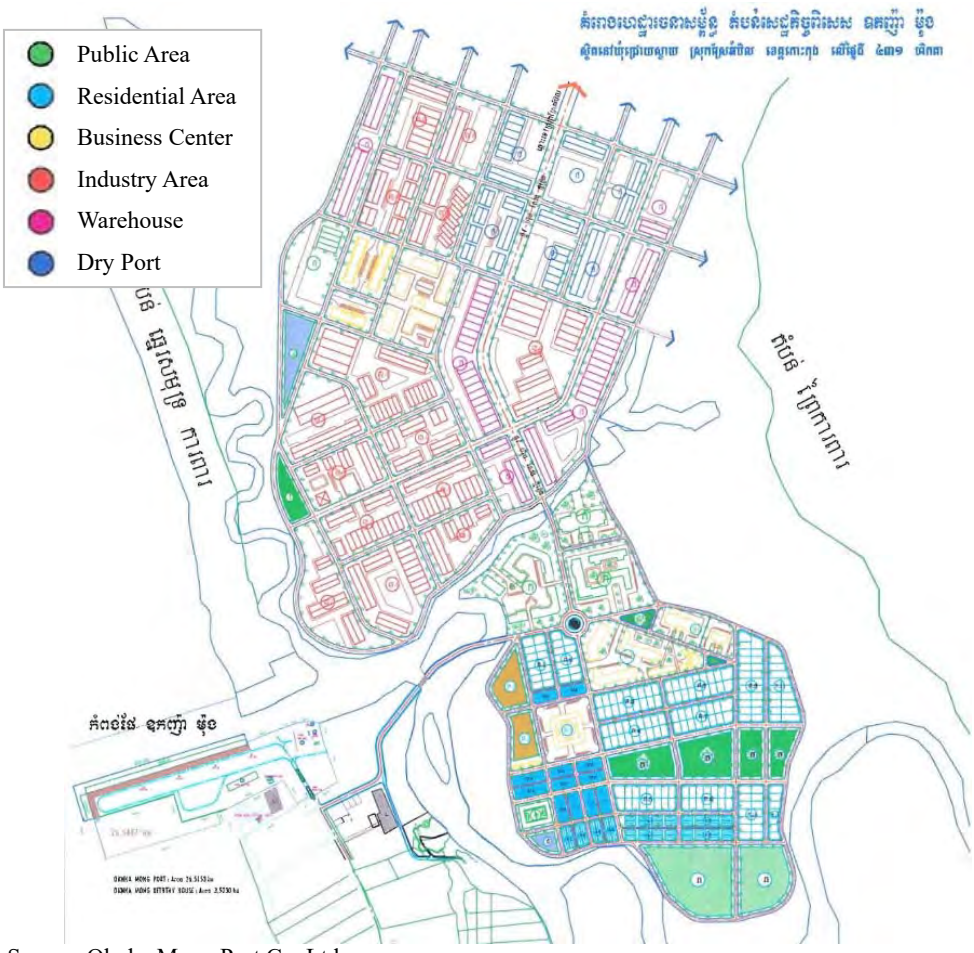


Source: Oknha Mong Port Co.,Ltd.

Figure 3.3-17 Trend of Number of Calling Vessel to Oknha Mong Port

(3) Future Plan of SEZ

The development of SEZ has been planned behind the Oknha Mong Port, so this port has an important role as the logistic center to support Oknha Mong SEZ. The license from the Council for the Development of Cambodia (CDC) was acquired already on 4 January 2007 but the sub-decree was not acquired yet. The total area of SEZ is 100 ha and the construction is ongoing according to the latest information from CDC. Figure 3.3-18 shows the plan layout of Oknha Mong SEZ and Port.



Source: Oknha Mong Port Co.,Ltd.

Figure 3.3-18 Layout Plan of Oknha Mong SEZ and Port

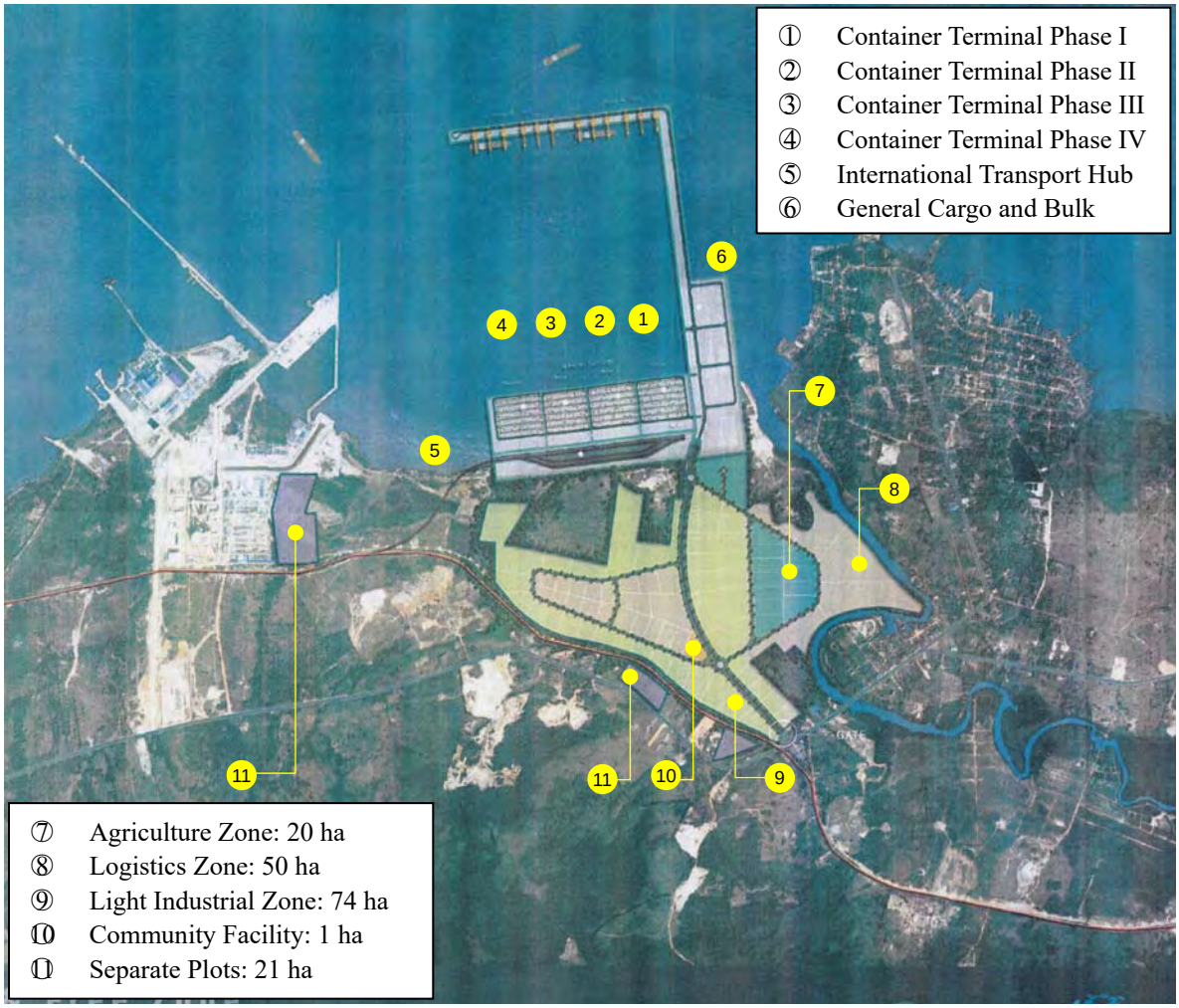
3.3.5 Stueng Hav Port

Stueng Hav Port currently functions as fishing port and there are about 2,000 fishery boats. The construction of the fishing port near the Stueng Hav SEZ project site started during the Pol Pot Regime with the cooperation of China.

The project of SEZ and Port in Stueng Hav was launched in 2006 by LCH Investment Group Co. Ltd. The project is based on the vision to develop an SEZ and port allowing for a low cost base of operations combined with port access. This plan consists of approximately 1,000 ha and is a registered SEZ with a 90 MW power plant concession. Currently, LCH Investment Group is building two break-bulk ports that will focus on regional trade. According to the website of LCH Investment Group Co. Ltd., it is thought that Stueng Hav is perfectly positioned for agriculture processing, heavy industry, and as an on-shore oil and gas supply base.

The 30 km new road which connects Stueng Hav to NR 4 was opened in April 2007. The construction of SEZ's gate was also completed but the construction of other facilities is still in progress such as the reclamation work. It is presumed that LCH intends to control the construction schedule in consideration of the economic condition.

According to their plan, development of a port with a maximum depth of 12 m will be built. There are four stages (Phases I to IV) for the container terminal development as a future plan. The layout plan of Stueng Hav SEZ and port is shown in Figure 3.3-19.



Source: LCH Investment Group Co. Ltd. and Attwood Import Export Co. Ltd.

Figure 3.3-19 Layout Plan of Stueng Hav SEZ and Port

3.4. Development Situation of Neighboring Countries

3.4.1 Development Situation of Major Ports

As the major port in the neighboring countries (Vietnam and Thailand), the present situation of the development in Ho Chi Minh Port, Cai Mep-Thi Vai Port, and Laem-Chabang Port are shown below:

(1) Ho Chi Minh Port

Ho Chi Minh Port which is located about 80 km upstream of the riverbank zone from the estuary consists of such as Tan Cang Sai Gon Port, Sai Gon Port, Ben Nghe Port. It is a vital logistics infrastructure for economic activity in the southern economic hub region which is located in Vietnam's largest city Ho Chi Minh. A yearly transition related to container cargo volume from 2012 to 2014 in Tan Cang Sai Gon Port which has the largest container cargo volume in Ho Chi Minh Port is shown in Table 3.4-1.

Table 3.4-1 Handling Volume of Container Cargo in Ho Chi Minh Port

Unit: TEUs

	Container Handling Volume
2012	2,956,550
2013	3,255,000
2014	3,827,115

Source: Vietnam Port Authority

As shown in Table 3.4-1, while container handling volume tends to increase, there is a limitation in water depth due to the fact of being a river port. Thus, the maximum ship size is limited to about 36,000DWT (2,500-3,000 TEUs) including Tan Cang Sai Gon Port.

(2) Cai Mep-Thi Vai Port

In order to deal with the rapidly increasing cargo volume around Ho Chi Minh and accommodate the large-sized ship, the construction project for Cai Mep-Thi Vai Port has been in progress. Cai Mep-Thi Vai Port is located at Baria-Vung Tau ministry which is about 60 km southeast away from Ho Chi Minh. A yearly transition related to container cargo volume from 2012 to 2014 in Tan Cang Cai Mep International Terminal (TCIT) and Cai Mep International Terminal (CMIT) which are main ports in Cai Mep-Thi Vai Port is shown in Table 3.4-2. These terminal has started the operation in 2011.

Table 3.4-2 Handling Volume of Container Cargo in Cai Mep-Thi Vai Port

Unit: TEUs

	TCIT	CMIT
2012	543,548	306,247
2013	644,354	609,372
2014	922,885	402,714

Source: Vietnam Port Authority

And Cai Mep-Thi Vai International Port Construction Project was concluded in March 2013 as the Yen-denominated loan project. It is expected to contribute to economic development promotion in Southern Vietnam and international competitiveness reinforcement.

(3) Laem-Chabang Port

Laem-Chabang port is a deep sea port located in Chonburi Province which is about 135 km southeast away from Bangkok. Laem-Chabang Port opened in 1991 as an alternative port of Bangkok port, it plays an important role as a base of international logistics currently. A yearly transition related to container cargo volume from 2012 to 2015 in Laem-Chabang port is shown in Table 3.4-3.

Table 3.4-3 Handling Volume of Container Cargo in Laem-Chabang Port

Unit: TEUs

	Container Handling Volume
2012	5,830,000
2013	6,041,000
2014	6,583,000
2015	6,820,000

Source: Containerization International Yearbook

In addition, an expansion project of Laem-Chabang Port is in progress. In order to boost economic growth, EEC (Eastern Economic Corridor) project is legalized by Thailand government in July 2016. As 5 years plan from 2017 to 2021, 300 billion Baht is planned to be invested in EEC project.[1]

3.4.2 Development Situation of Main Industrial Estate

The present situation of the industrial development in Vietnam and Thailand are shown below:

(1) Industrial Estate in Vietnam

The industrial estates approved by government are located 223 places in Vietnam, and which have already been development the infrastructures and operated by tenant companies are 171 places.[2] From 1991, Vietnam government designated a lot of strategic regions across the country such as export processing zone, industrial estate, hi-tech zone. Due to the delay of developing the infrastructures without designated areas such as industrial estate and convenience of advance procedures and import/export management, foreign countries advanced overwhelmingly into export processing zones or in the industrial estate. Most of the type of companies operating in Vietnam is assembling and processing, however, almost its raw materials and parts depends on import. Therefore, Japanese companies focus attention on required time including the shipping time from entering the port to delivering to the factory considering road situation and customs clearing.

Moreover, “preferential taxation” for the foreign companies advanced in Vietnam is 20% concerning the corporate standard tax rate.[3] Preferential taxation rate is decided depend on such as business field, regions, a number of employees. The tax-exempt period, half reduction period and preferential tax rate applicable period are different depend on defined business field (export processing, the general manufacturing, service industry, high tech companies). There is also industrial estates which have unique incentive.

(2) Industrial Estate in Thailand

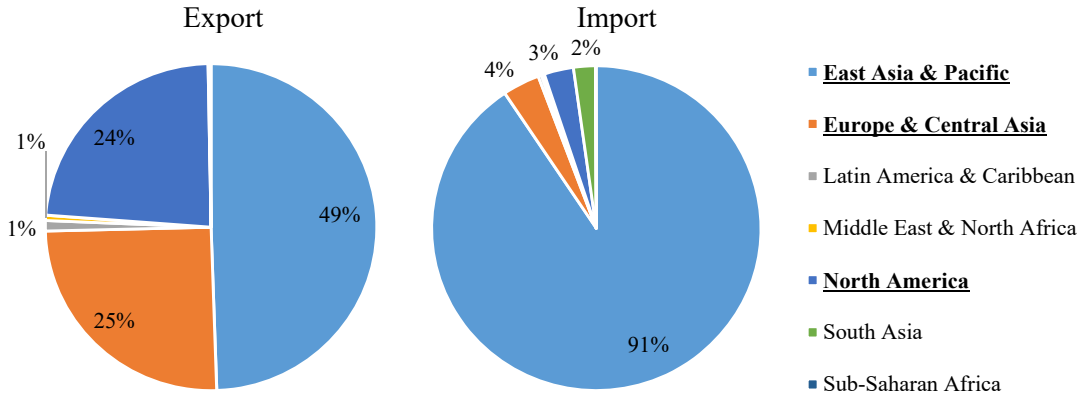
In Thailand, there are 3 zones to manage the office in the industrial areas. The first one is industrial estate superintended by Industrial Estate Authority of Thailand (IEAT), the second one is industrial estate not superintended by IEAT, which is constructed and managed by private companies, third one is out of industrial estate. Although it tends to be more expensive to enter the industrial estate, there are a variety of benefits depend on industry in terms of not only infrastructure development but also such as corporation tax, land purchase, ownership, foreign capital ratio (more than 50% possible), machinery and equipment imports (maximum 50% of the tax reduction), exemption of import duty on raw materials for export and benefits on foreign workers. Industrial estate operated in Thailand has been confirmed 78 locations,[4] and industrial estate under IEAT management has accounted for 55 locations.[5]

[1] THE NATION, July 2016
[2] The preparatory survey on utility management of environment friendly industrial parks in Vietnam (PPP infrastructure projects) final report, July 2011
[3] JETRO, online, Accessed October 2016
[4] JETRO, Thailand Industrial Research Report, March 2015
[5] I-EA-T (Industrial Estate Authority of Thailand), online, Accessed October 2016

3.5. Role of Sihanoukville Port

3.5.1 Demarcation between Sihanoukville Port and Phnom Penh Port

The partner shares (trade value base) of export and import in the entire Cambodia are shown in Figure 3.5-1. For exports, East Asia and Pacific accounts for a large percentage (49%), followed by Europe and Central Asia (25%), and North America (24%). For imports, the origin is mostly from East Asia and Pacific; and its ratio is more than 90%.

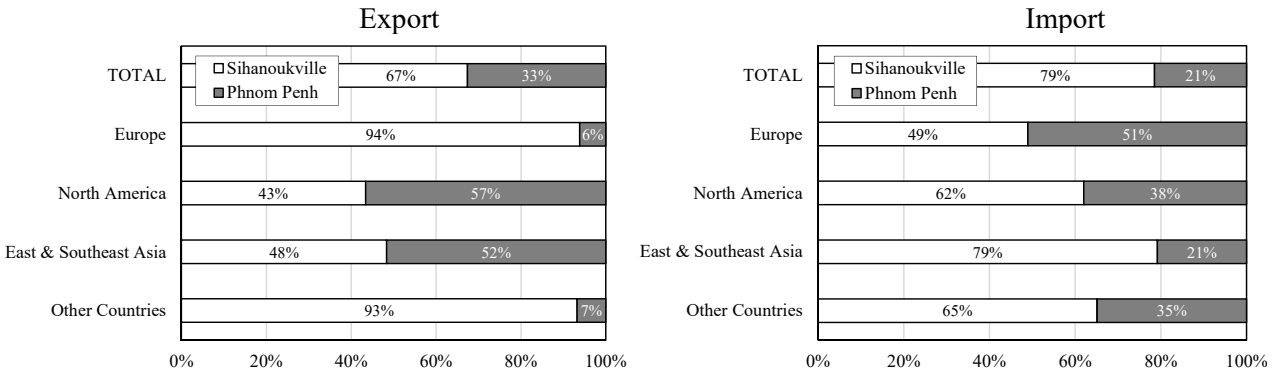


Source: WITS (World Integrated Trade Solution)

Figure 3.5-1 Partner Share of Export and Import in the Entire Cambodia (2014)

The comparison of Sihanoukville Port and Phnom Penh Port was mentioned in SSCD regarding the cost and lead time for transportation between Phnom Penh and major export destination or import origin via each port. For the transportation cost and lead time between Phnom Penh and major export destination or import origin via each port are shown in Appendix 3.1 to 3.4.

Figure 3.5-2 shows the market share (cargo volume base) of Sihanoukville Port and Phnom Penh Port by destination/origin in 2015.



Source: PAS and PPAP

Figure 3.5-2 Container Market Share of Sihanoukville Port and Phnom Penh Port (2015)

The market share of Sihanoukville Port and Phnom Penh Port is almost the same for export to East & Southeast Asia. For import from East & Southeast Asia, Sihanoukville has a larger share despite its higher transportation cost. For export to the Americas, Phnom Penh Port has a larger share since the transportation cost through Phnom Penh is estimated to be slightly lower. For export to Europe, virtually all containers are loaded in Sihanoukville Port, whereas the estimated costs via the two ports are almost the same.

In general, it is regarded that the transportation route is decided based on the cost and lead time. However, there are some portions which is not reasonable for the current market share of Sihanoukville Port and Phnom Penh Port. Based on the above, it is presumed that the transportation route is decided based on the factors related to the logistics performance as shown below.

- Efficiency of the customs clearance process (Customs)
- Quality of trade and transport-related infrastructure (Infrastructure)
- Ease of arranging competitively priced shipments (International shipments)
- Competence and quality of logistics services (Logistics competence)
- Ability to track and trace consignments Logistics competence (Tracking & tracing)
- Frequency which shipments reach the consignee within the scheduled or expected time (Timeliness)

Figure 3.5-3 shows the distribution of total score of Logistics Performance Index (LPI) in 2016. The rank of Cambodia is 94th in 2016 and it is lower compared with Thailand (45th) or Vietnam (64th).

Source: World Bank LPI 2016

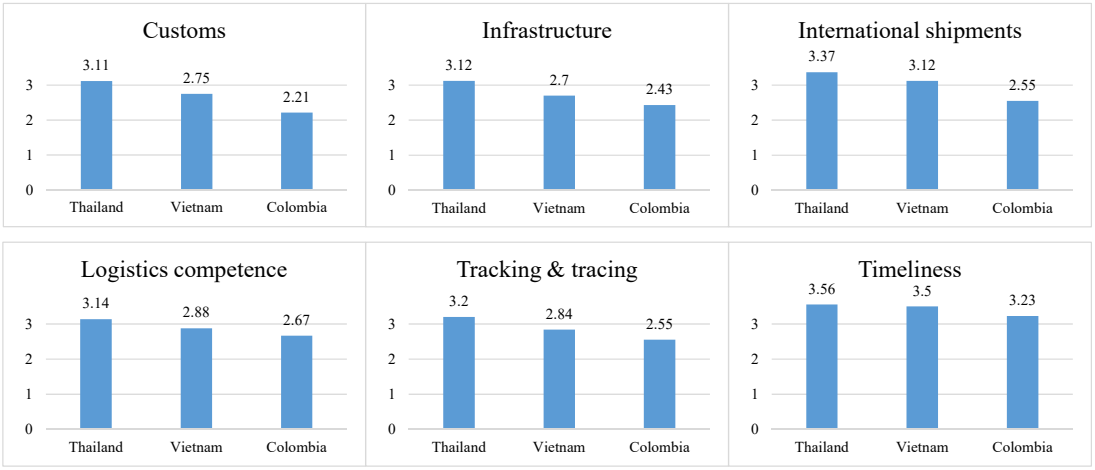
Figure 3.5-3 Distribution of Total Score of LPI around Cambodia

Figure 3.5-4 shows the comparison of factors related to LPI in Cambodia, Thailand, and Vietnam. The each score of Cambodia is lower when it is compared with Thailand and Vietnam, especially about the "Customs" and "Infrastructure".

However, the programs regarding the improvement of trade and logistics including the customs system in Cambodia has been supported by WB[6], JICA[7] and so on. Also it is expected the port's infrastructure will be improved by the on-going and future projects in Sihanoukville Port and Phnom Penh Port. Thus, it is thought that the difference between Cambodia and these neighboring countries will be smaller in the future.

[6] The Trade Related Assistance Program in Cambodia, which is managed by the World Bank and supported by a multi donor trust fund, has focused on customs and border reform to establish linkages with its ASEAN trading partners. The World Bank is helping establish a "National Single Window", an automated solution combining different border agencies into one electronic platform for use by traders and businesses.

[7] In order to improve the customs clearance system, JICA has supported for recent years, such as the implementation of "The Project for Capacity Development on Container Terminal Management and Operation in Sihanoukville Port", dispatch of experts, holding the seminars, site visit to other country and so on. It is expected that the results of these efforts will be seen in the near future.



Source: World Bank LPI 2016

Figure 3.5-4 Comparison of Factors Related to LPI in Cambodia, Thailand, and Vietnam

As mentioned above, the transportation route and calling port are decided in consideration of the factors related to the logistics performance. However, in terms of the demarcation of Sihanoukville Port and Phnom Penh Port, which are located in same country, it could be said that these factors will not change drastically in the future.

In addition, the demand forecast of Phnom Penh Port and the market share in the future were calculated using the same method mentioned in chapter 6 (6.3 Macro Forecast of Container Cargo). Based on this calculation result, it was verified that the market share of Sihanoukville Port and Phnom Penh Port is almost same as current ratio although there are small fluctuations depending on the year. The detailed calculation result is shown in Appendix-3.5.

On the other hand, there is a tendency that the part of cargo from Phnom Penh to Vietnam shift from the water transport via Phnom Penh Port to the cross-border transport. For latest 5 years, the ratio of cross-border transport to whole cargo has been 30% - 40% and it is thought that this trend will be continued in the future. However, it could be said that the impact on the cargo handling of Sihanoukville Port would be small in consideration of the position relation with the border and current status of distribution trend.

Table 3.5-1 Trends of Cargos from Phnom Penh to Vietnam (not include empty containers)

	2008	2009	2010	2011	2012	2013	2014
Water Transport at PPAP	29,366	28,510	45,645	61,040	71,588	78,425	98,547
Cross-border Transport	2,845	7,380	22,542	31,173	34,013	45,562	51,152
Ratio of Cross-border	8.8%	20.6%	33.1%	33.8%	32.2%	36.7%	34.2%

Source: PPAP and General Department of Customs and Excise

In conclusion, it is considered that the current situations of export destination will be basically continued, which means that Sihanoukville Port will cover around the world (such as Europe, the Americas, and Asia) and Phnom Penh Port will be specialized for Asia and the Americas. Also for the import origin, it is thought that the current situations will be continued same as the export cargoes.

3.5.2 Future Development Plan of Neighboring Port

(1) Oknha Mong Port and SEZ

The future development plan regarding SEZ has been planned in Oknha Mong. However, the development of SEZ has not been formally approved because the sub-decrees has not been issued by the Cambodian government yet. Therefore, it could be said that the feasibility of this plan is not clear or the implementation period would be quite long. And it is thought that the conflict between Oknha Mong Port and the new container terminal of Sihanoukville Port will not occur because major handling cargo are general/bulk cargo such as cement and fertilizer.

(2) Stueng Hav Port and SEZ

The gargantuan development project regarding the exclusive port and SEZ has been planned in Stueng Hav. However, there are some issues for the implementation of this plan, for example, a huge amount of sediment should be dredged in order to ensure the planned water depth (12 m). In fact, the progress of the development has not been seen except for the road and gate. Therefore, it could be said that the impact on this project would be minimal because the feasibility of this plan is not clear or the implementation period would be quite long, same as Oknha Mong.

3.5.3 Role of Sihanoukville Port

The increase in the ship size is the most efficient way in order to reduce the maritime transportation cost. In recent years, many large-scale ships are in service in major international route by various shipping companies. Therefore, in order to attract shipping companies, it is essential that ports should have large depths.

In general, the river ports have problems caused by sand sedimentation, and Phnom Penh Port also has limitation in water depth and channel width. Therefore, the maximum vessel size is limited to 1,500-2,000 DWT (100-200 TEUs). Phnom Penh Port functions as a regional hub for cargo transport among the ports located along Mekong River. However, the only ports that have direct international route to/from Phnom Penh are the ports in Viet Nam such as Ho Chi Minh Port and Cai Mep Thi Vai Port.

On the other hand, Sihanoukville is regarded as the only place where deep seaport can be built because most of the coastal areas in Cambodia are located on shoals. It is thought that Sihanoukville is the most appropriate location due to its natural conditions. In other words, Sihanoukville Port is the sole international deep seaport in Cambodia and has important roles as mentioned below.

1) Sihanoukville Port serves as the logistic center supporting the national economic and industrial activities in the entire county including the SEZs in Preah Sihanouk. And the large-sized bulk carrier (50,000 DWT) will be able to berth in addition to the container ship after the start of operation of the multi-purpose terminal. Thereby, it makes possible to contribute to the mass transport of agriculture and forestry products.

2) NR 4, NR 3, and a railway connect between Sihanoukville and Phnom Penh, and the expressway development has been planned for the future. Therefore, this route should be regarded as an economic corridor to support the logistics and industries in Cambodia. In addition, linkage coastal area connecting the southern Vietnam through the Sihanoukville from Bangkok has been called as the "Southern Coastal Sub-corridor[8]". It could be said that Sihanoukville Port plays the role of a nodal point, which connects the national economy corridor and foreign countries.

3) Port industries including the forwarding business relating to Sihanoukville Port has led a large effect on the economy and job creation to Preah Sihanouk and the surrounding areas. Furthermore, passenger ferries are also in service and the number of calling vessels has been increasing in recent years. Sihanoukville Port supports tourism as a gateway by accepting a large number of foreign tourists.

4) Regarding the type of container ships, Sihanoukville Port is the sole international port to accommodate the large-sized ship such as 60,000 DWT class container vessels (around 4,000 TEUs) after the completion of this new container terminal development while Phnom Penh Port can only accommodate barges.

[8] In the GMS economic cooperation which has been started by the initiative of ADB, Southern Coastal Sub-corridor was planned as a part of Southern Economic Corridor, in order to develop the linkage coastal area multilaterally. This sub-corridor ranges from Bangkok, Thailand to Nankang, Vietnam and its length is 924 km.

4. NATURAL CONDITION SURVEY [1]

4.1. Topographic Survey

4.1.1 Abstract

(1) Survey Site and Scope of Work

The survey site is shown by Figure 4.1-1 and the scope of work is shown by Table 4.1-1. Table 4.1-2 shows the survey equipment list.

Source: JICA Survey Team

Figure 4.1-1 Survey Site

Table 4.1-1 Scope of Work

No.	Item	Description	Remark
1	Establishment of Main Horizontal/Vertical control network	5 monuments	at approximately 500 m intervals
2	Topographic Survey (20m interval including existing facilities such as drainage, electricity post, houses, boundary line, etc.)	51,000 m^2 ; 1.0m interval contour.	Scale 1/2,500
3	Longitudinal Survey (center of road)	1,900 m long; 20m interval	Scale: V=1/2,500 H=1/500
4	Cross Surveying (50m interval)	39 Sections	Scale: V=1/250; H=1/20
5	Mappings including data processing, editing and drawing fit for Auto CAD format compatible.	1:2500, Topographic survey map with CD-ROM. 1:2500, Longitudinal survey drawings with CD-ROM 1:2500, 50 m interval cross sectioned drawings with CD-ROM Latest Satellite Photos (Topographic Survey Area)	2 sets 2 sets 2 sets 1 set

Source: JICA Survey Team

[1] All more detail data is in the Topographic Survey Report (2016)

(2) Survey Eqipments

Table 4.1-2 Survey Equpment List

ITEM	TYPE	DESCRIPTION
1	GTS-229 and surveying accessories	Topographic survey equipment: Total station
2	RTK GPS Huace Nav X90	Real-Time Kinematic Positioning System
3	Sokkia C3o	Topographic survey equipment: Levelling instrument
4	Garmin GPS Map 76Cx	Handheld GPS

Source: JICA Survey Team

(3) Horizontal/Vertical Control Network and Datum Transformation Parameters

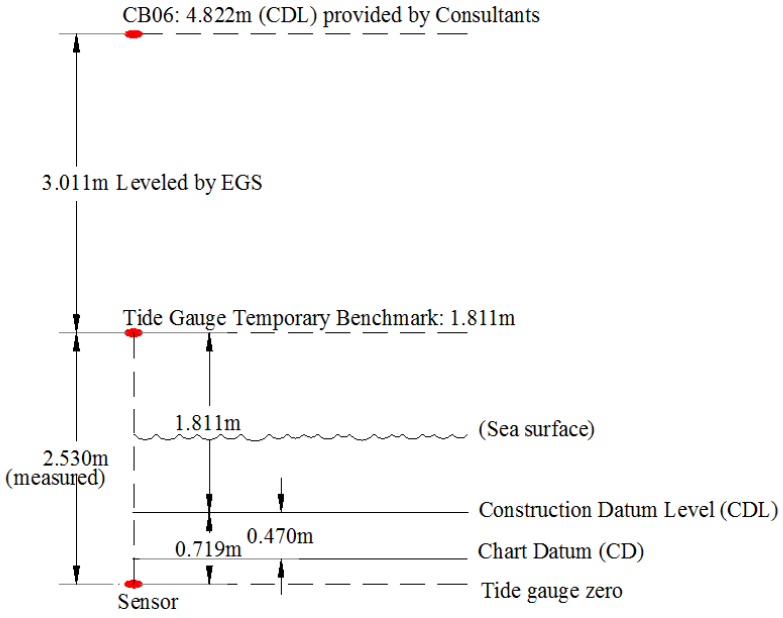
Horizontal control network used in this project are the followings:

Datum Name	:	INDIAN 1960
Ellipsoid	:	EVEREST 1830
Semi-major Axis (a)	:	6377276.34500000
Reciprocal Flattening (1/f)	:	300.8017
Projection Method	:	Universal Traverse Mercator
False Northing (meters)	:	0
False Easting (meters)	:	500,000
Latitude of Origin of Projection	:	0° 00’00” E
Scale Factor	:	0.9996

Datum Transformation parameters are the followings.

Shifts to WGS84:	dX(m)	: 208.007
	dY(m)	: 866.399
	dZ(m)	: 320.071

Vertical control used in this project is CDL and relationship between CDL and CD is shown below.



Source: JICA Survey Team

Figure 4.1-2 CDL and CD Relationship

Table 4.1-3 shows the list of Horizontal/Vertical control points used in this project. Adjusted result for of vertical/horizontal control networks are shown Topographic Survey Report (2016).

Table 4.1-3 Horizontal/Vertical Control Points

No	Name	Indian 1960		Elevation (m)	
		Northing	Easting		
1	Station CB06	336,381.788	1,176,834.836	+5.292 CD	+4.822 CDL
2	Station CB08/1	337,424.844	1,177,103.517	+3.457 CD	+2.987 CDL
3	Lun Beacon	-	-	+3.210 CD	+2.740 CDL

Source: JICA Survey Team

(4) Field Survey

After horizontal network and vertical network are established, Topographical survey with total area of 69,000 m^2 and Longitudinal survey with distance of 1,950 m and Cross Section survey with 40 section at 50 m intervals are carried out.

4.1.2 Survey Results

(1) Bench Mark and Monuments

Newly established bench mark and monuments are summarized in Table 4.1-4.

Table 4.1-4 List of Control Points

Point Name	INDIAN1960_CM 105^O_ZONE6^O		Elevation (m)	
	Easting	Northing	CDL	CD
GPS01	337861.027	1176852.643	3.321	3.791
GPS02	338782.913	1178556.707	2.606	3.076
TP01	338194.778	1177209.97	3.345	3.815
TP02	338506.741	1177705.62	3.018	3.488
TP03	338632.530	1178127.194	3.003	3.473

Note; Details of benchmark and monuments are shown in survey station sheets in Topographic Survey Report (2016)
Source: JICA Survey Team

(2) Survey Drawing

1) Topographic drawings:

- Drawing SHP-TOPO-2.5K : Overview of the Topographic Map scale 1/2500
- Drawing SHP-TOPO-1K-01/01 : scale 1/1000
- Drawing SHP-TOPO-1K-02/02 : scale 1/1000
- Drawing SHP-TOPO-1K-03/04 : scale 1/1000
- Drawing SHP-TOPO-1K-04/04 : scale 1/1000

Topographic drawings are shown in Appendix 4.1

2) Longitudinal Drawing:

- Drawing SHP-Longitudinal : scale H: 1/1000, V: 1/200

3) Cross Section Drawing:

- Drawing SHP-CS-01/05 : scale H:1/200, V:1/200
- Drawing SHP-CS-02/05 : scale H:1/200, V:1/200
- Drawing SHP-CS-03/05 : scale H:1/200, V:1/200
- Drawing SHP-CS-04/05 : scale H:1/200, V:1/200
- Drawing SHP-CS-05/05 : scale H:1/200, V:1/200

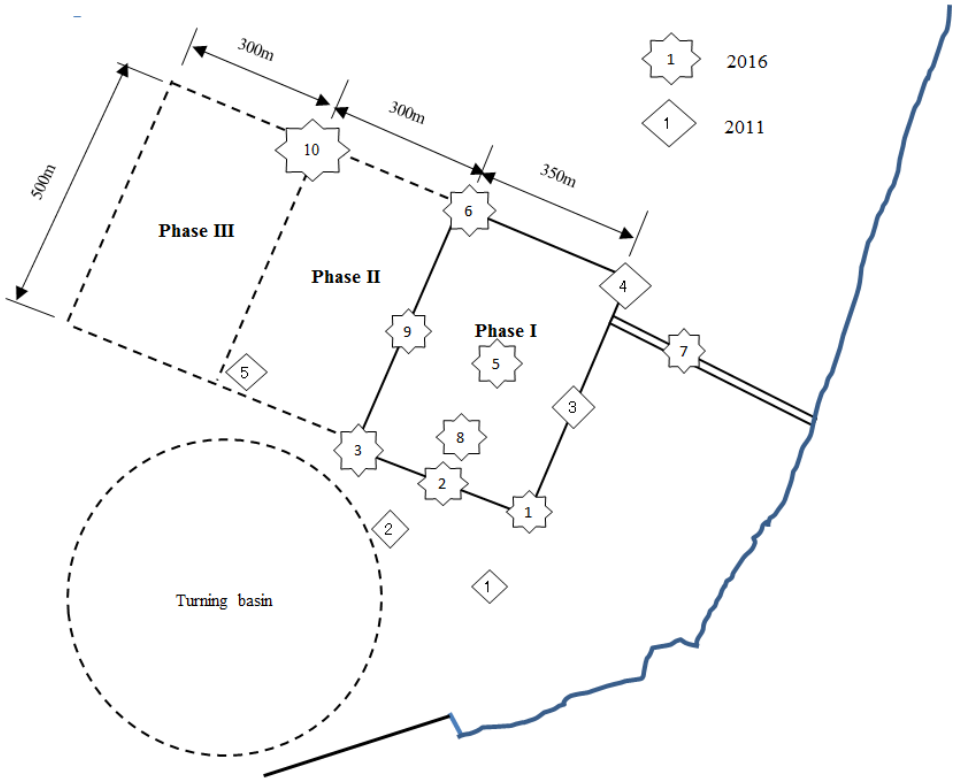
Cross Section drawings are shown in Appendix 4.2

4.2. Soil Investigation[2]

4.2.1 Abstract

(1) Boring Locations

Soil investigation through bore hole drillings and laboratory tests of physical tests and mechanical tests on undisturbed samples were carried out as shown by Figure 4.2-1. Location of each borings are decided by consideration of the planned structures such as the wharf, the seawall enclosing the reclamation area, reclamation work as well as building of the access bridge and by taking consideration of the past data carried out in 2011. Coordinates of each bore holes are shown by Table 4.2-1 and Table 4.2-2, respectively.



Note; 7 borings that were planned initially have been changed to 9 bore holes by consideration of the stratifications. Bor.No.4 has not been carried out because it was cleared that there will be no problematic soil layer for dredging work up to the planned dredging depth.

Source: JICA Survey Team

Figure 4.2-1 Boring Locations Carried Out in 2016 and 2011

[2] Detail data on soil investigation are based on the reports in Geotechnical Investigation Report (2016)

Table 4.2-1 Coordinates of Bor. Holes (2016)

Bor. No.	Northing (m)	Easting (m)
BH-01	1,177,725	337,633
BH-02	1,177,662	337,799
BH-03	1,177,598	337,961
BH-05	1,177,900	337,887
BH-06	1,178,194	337,830
BH-07	1,177,898	338,263
BH-08	1,177,760	337,834
BH-09	1,177,962	337,732
BH-10	1,178,309	337,551

Note; No.4 cancelled.
Source: JICA Survey Team

Table 4.2-2 Coordinate of Bor. Holes in 2011

Bor. No.	Northing (m)	Easting (m)
JO-01	1,177,461	337,899
JO-02	1,177,562	337,696
JO-03	1,177,809	338,039
JO-04	1,178,040	338,133
JO-05	1,177,856	337,435
JO-06	1,177,048	336,313

Source: Geotechnical Investigation Final Report, Appendix A; Bore hole location plan

(2) Quantity of Boring Works and Laboratory Tests

Drilling work is carried out on the Self-Elevated Platform (SEP), where all the boring equipment has been fabricated as shown by Figure 4.2-2 and Figure 4.2-3. SEP would improve the efficiency of boring work and the quality of undisturbed samples as well. Field Vane Shear Test (ASTM D 2573-01) and Standard penetration test (SPT) (ASTM D 1586-99) were carried out for gaining the shear strength of soft clay layer and sandy soil, respectively.

Source: JICA Survey Team

Figure 4.2-2 Boring Jack-up Barge (JUB)

Source: JICA Survey Team

Figure 4.2-3 Boring Work

All the bore logs and the results of laboratory test are shown by Appendix 4.3 and 4.4. Quantity of the boring and the laboratory test are summarized by Table 4.2-3.

Table 4.2-3 Quantity of the Boring Works

Bor. No.	Drilling depth (m)	Drilling depth in rock (m)	Field test		Undistu-rbed Sample	Laboratory test		
			Vane shear test	SPT		Physical property test	Mechanical property test	
							Shear test & consolidation test	Compression test of core sample
BH-01	36.0	5.0	7	32	2	34	2	1
BH-02	31.8	5.0	-	30	2	29	2	1
BH-03	18.7	5.0	-	18	2	19	2	1
BH-05	3.6	9.4	4	6	2	3	2	1
BH-06	6.3	7.0	4	6	2	8	2	1
BH-07	10.7	5.0	-	8	2	9	2	1
BH-08	14.0	8.0	-	10	2	13	2	1
BH-09	4.7	5.0	-	2	1	2	1	1
BH-10	11.5	5.0	-	6	2	9	2	1
Total	137.3	54.4	15	118	17	126	17	9

Note (1); BH-04 cancelled.

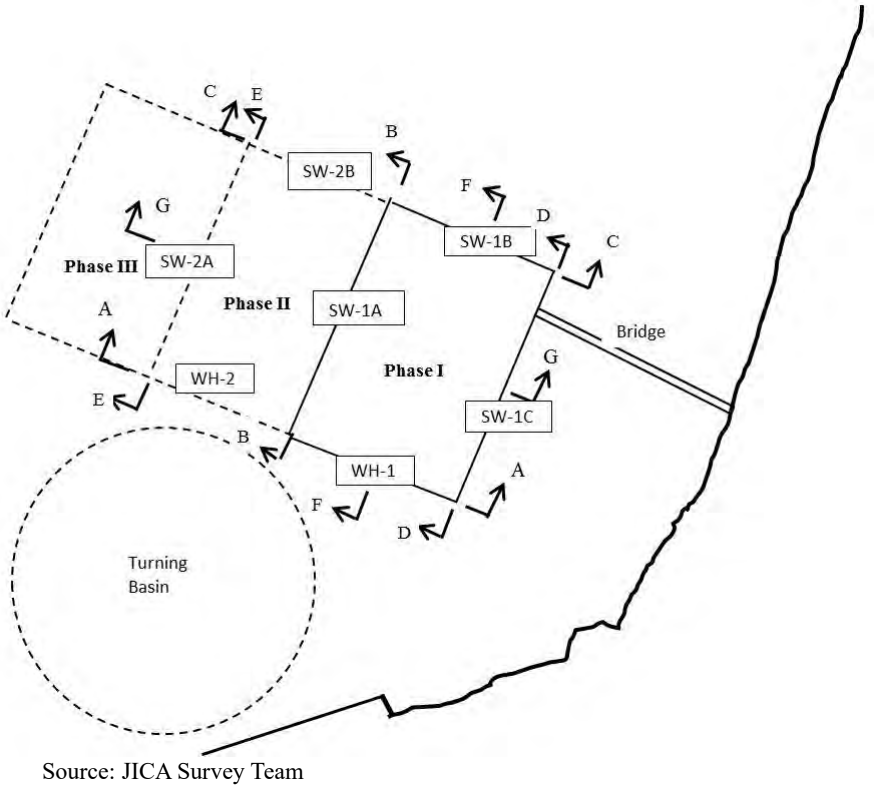
Note (2); Physical tests; the tests of Specific Gravity, Unit Weight, Grain Size Analysis, Natural Water Content and Consistency Limit.

Note (3); Shear test is unconfined compression test

Source: JICA Survey Team

4.2.2 Stratification of Typical Section and the Associated Geotechnical Issues

All the boring logs are shown in Appendix 4.3. Name of stratifications along the wharf, seawalls and sections of reclamation area are shown by Figure 4.2-4, where WH and SW stand for "Wharf" and "Seawall", respectively and each seawall for Phase 1 are named as SW-1A, SW-1B and SW-1C and SW-2A, SW-2B and SW-3B for the Phase 2. Name of "Bor. No PR" is presumed boring log by surrounding boring logs.



Source: JICA Survey Team

Figure 4.2-4 Locations of the Structures

(1) Stratification along the Wharf of WH-1 and WH-2

Figure 4.2-5 shows the stratification along WH-1 and WH-2 based on the bore logs, where layer <1> and layer <2> belong to Alluvium Formation and layer <3> to layer <10> belong to Sedimentary Quartzite zone. Distribution of N values with depth are shown beside the bore logs.

Sea bed height is approximately -5 m and the thickness of Alluvium Formation composed of <1a> and <1b> seems to be rather uniform with thickness of 7 to 9 m. The thickness of Sedimentary Quartzite Zone composed of layer <3> to layer <9a> changes extremely from 6 m to 22 m, where N value with depth change from 5 to 40. In particular, N values at Bor.No.01 ranges from 5 to 10, which is classified as loose to medium according to Terzaghi - Peck, at deeper layers than -19 m. It seems necessary to pay attention on this "loose to medium layers" since they distribute along the wharf alignment.

A broken curve line are indicated at bottom of layer <9a> in Figure 4.2-5 for the purpose of distribution of bearing stratum layers of pile foundations, where N values deeper layer than this curve line indicates the one lager than 50. It must be emphasized that layer <9a> change the depth extremely along the wharf alignment.

Depth of -14m line is indicated in Figure 4.2-5 as well. This depth line indicates the dredging depth for the berth box.

(2) Seawall Building along Enclosing Alignments of Phase I and Phase II

Figure 4.2-6 to Figure 4.2-9 shows the stratifications along seawalls at Phase I and Phase II.

Geotechnical common feature along these enclosing seawalls are on the distribution of Alluvium Formation consisted of soft layer of <1a> with SPT of zero and <1b> with SPT$\geqq$1. The former is very loose silty sand with zero shear strength and the latter has a little shear strength. According to the grain size distribution of <1a> and <1b>, percentages of their sand fractions are approximately 65% and 68%, respectively. That is to say, this alluvium formation could be defined as "Intermediate soil", which has both characteristics of sand and silt/clay. Therefore "Intermediate soil has both cohesion and friction angle as shear strength of soil and would settle but its settlement rate seems rather fast.

Sedimentary Quartzite zone, that indicate sand stone/silt stone with SPT of 5 to 25, distribute underneath the alluvium formation. Thickness of this layer changes extremely within the area of Phase I and II.

(3) Stratification within the Reclamation Area of Both Phase I and Phase II

Figure 4.2-10 shows the stratification along the center section of reclamation area in Phase I. Thickness of soft layer of <1a> and <1b> changes from 3.6 m at No.05, 6.5 m at Bor.PR.02 and 8.1 m at Bor.No.02. Thickness of sandy layer with SPT of approximately 5 to 25 changes from 0m at No.05 to 15 m at No.02.

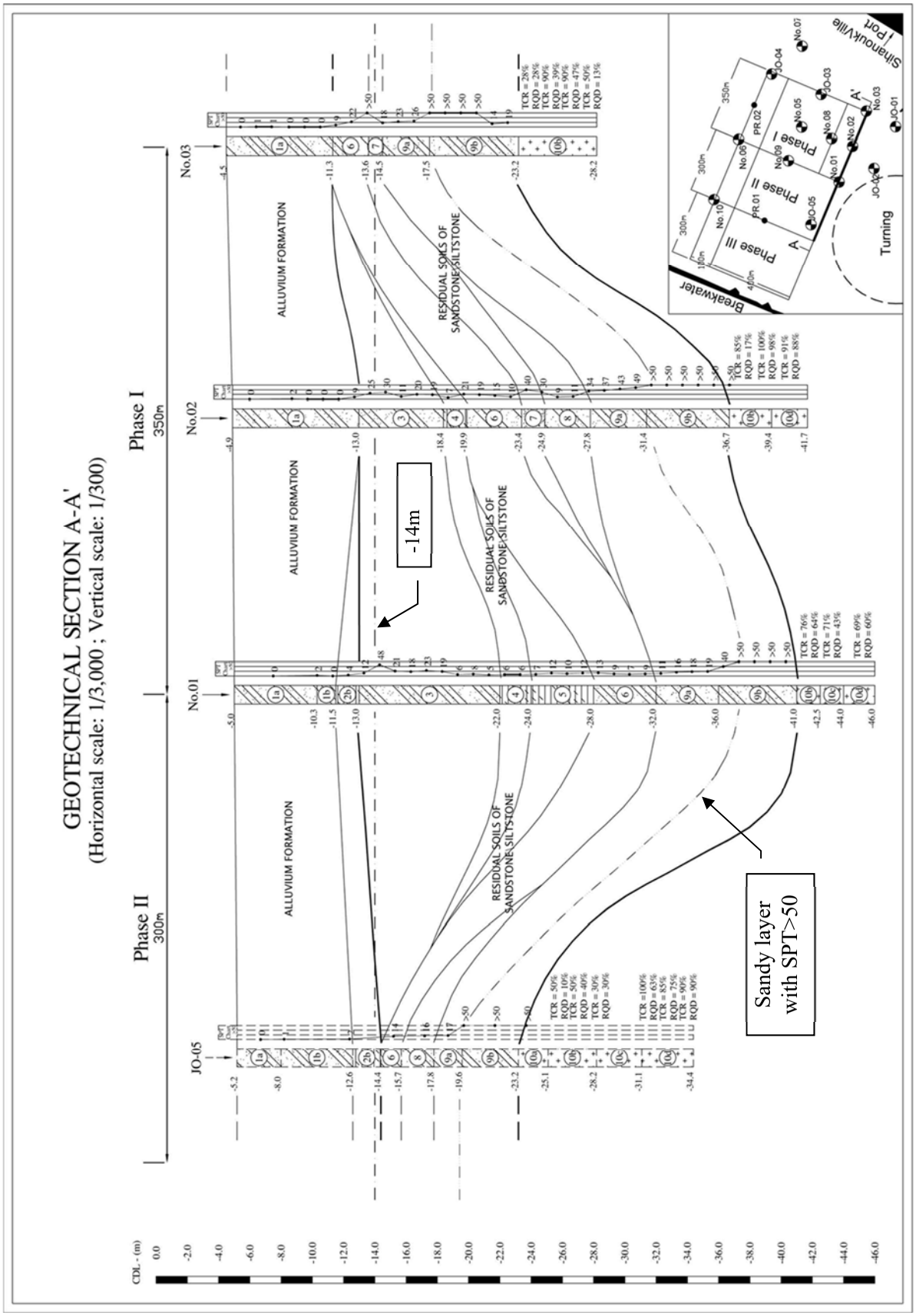
Figure 4.2-11 shows the stratification along the center section of reclamation area in Phase I and II. The thickness of <1a> and <1b> distribute from 4 m to 7 m in Phase I and 5 m to 9 m in Phase II.

(4) Foundation for the Access Bridge

Figure 4.2-12 shows Bor. Log of No.7, at which bridge foundation for the access bridge being planned to build. As shown by the figure, there distribute the very soft sandy layer up to nearly 8 m from the sea bottom and its underneath dense grained sand with thickness of around 2.5 m, and then turn completely to highly weathered sand stone with SPT bigger than 50.

TCR and RQD of weathered sand stone are shown by Table 4.2-4 and the state of cores in the box are shown by Figure 4.2-13. As shown by Figure 4.2-1 and Table 4.2-4, the depth with N value larger than 40 is at around -14 m and then N value of larger than 50 at around -17 m in depth.

Note; TCR Total Core Recovery) is the percentage ratio of core length recovered to the total length of core run. Thus, TCR shows the quality of core sample.
RQD is the total length of solid core pieces, of which each greater than 100 mm between natural fractures, expressed as a percentage of the total length of core run. Thus, RQD means the continuity of the core samples.



Source: JICA Survey Team

Figure 4.2-5 Geotechnical Section A-A'

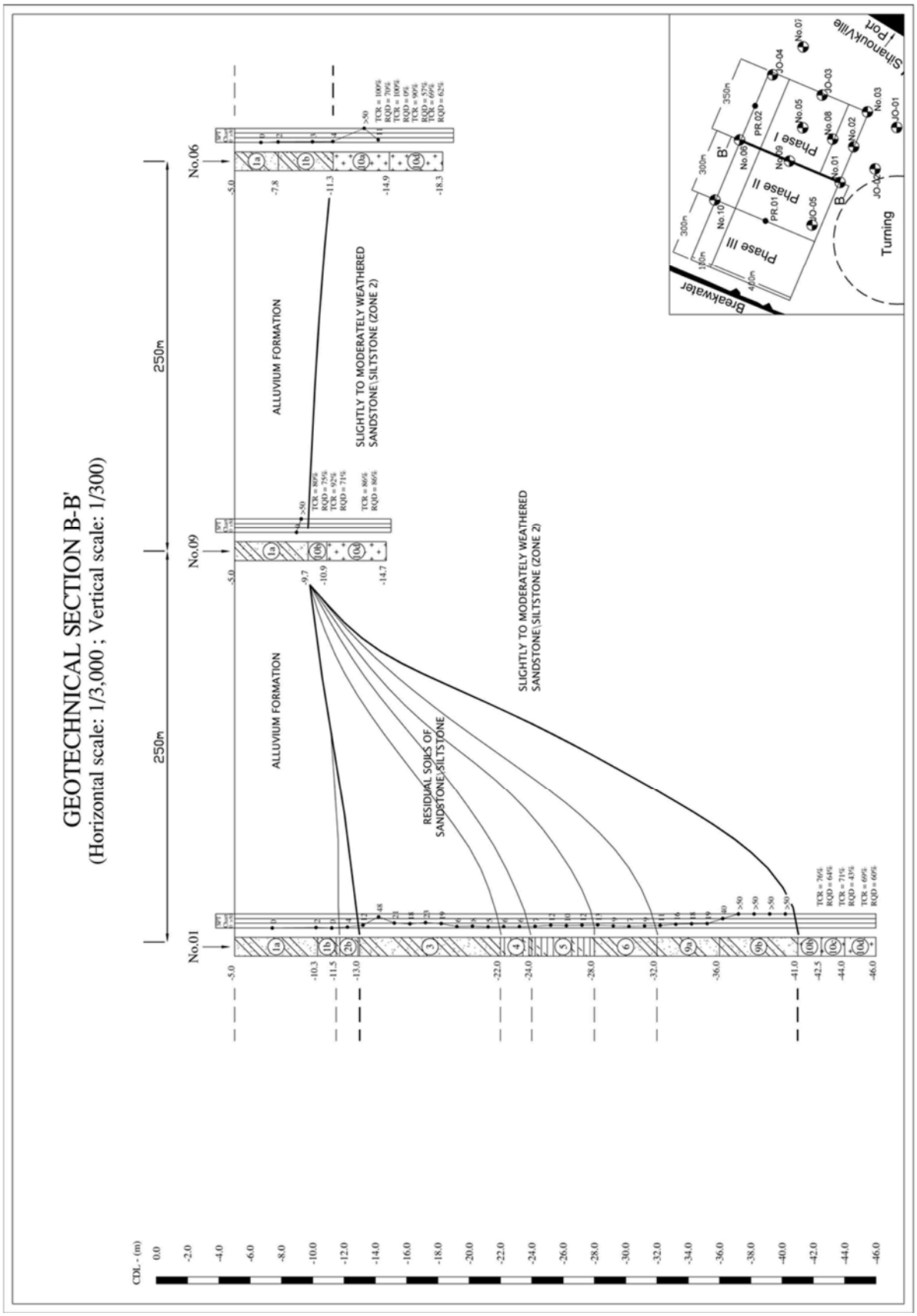
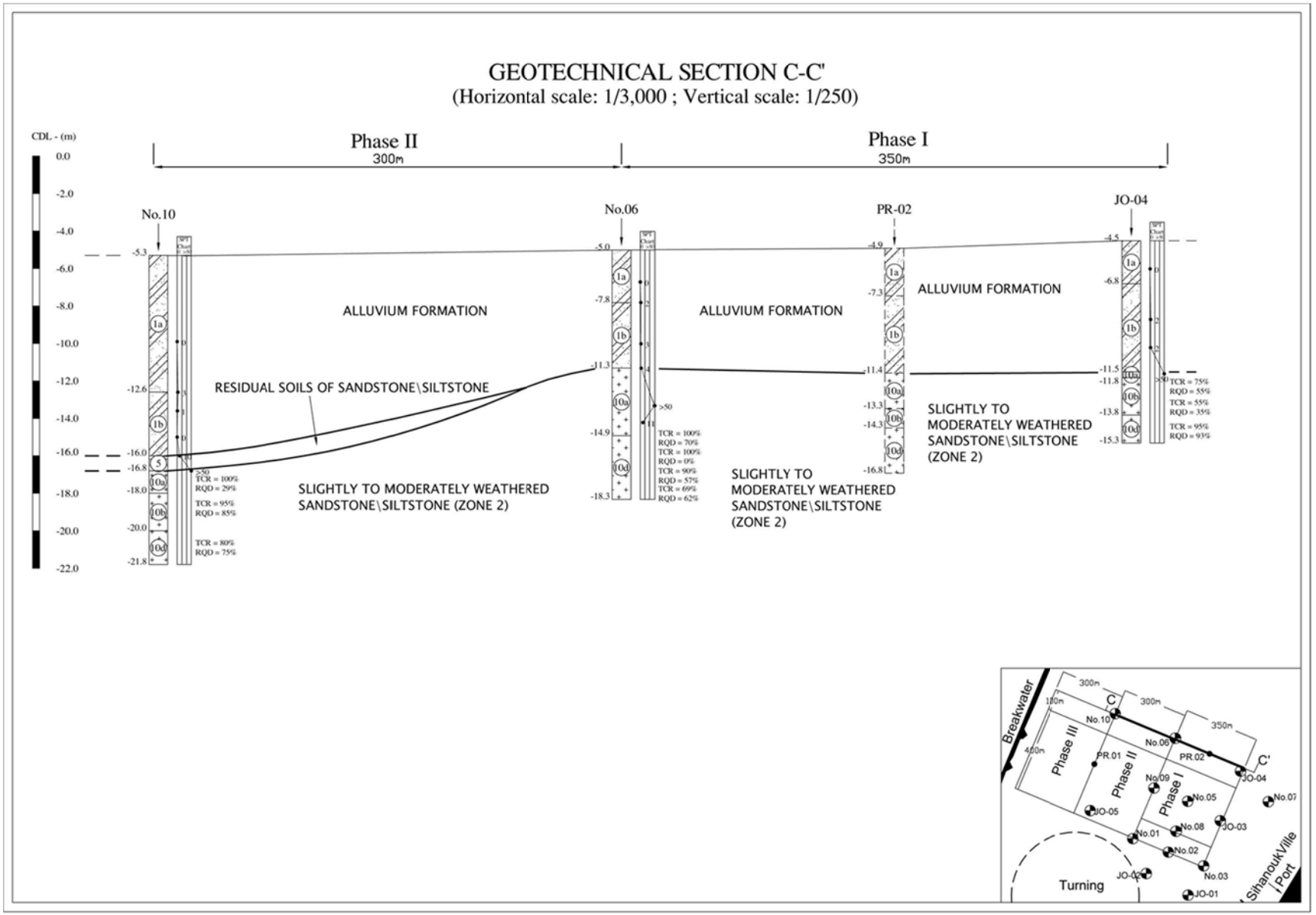


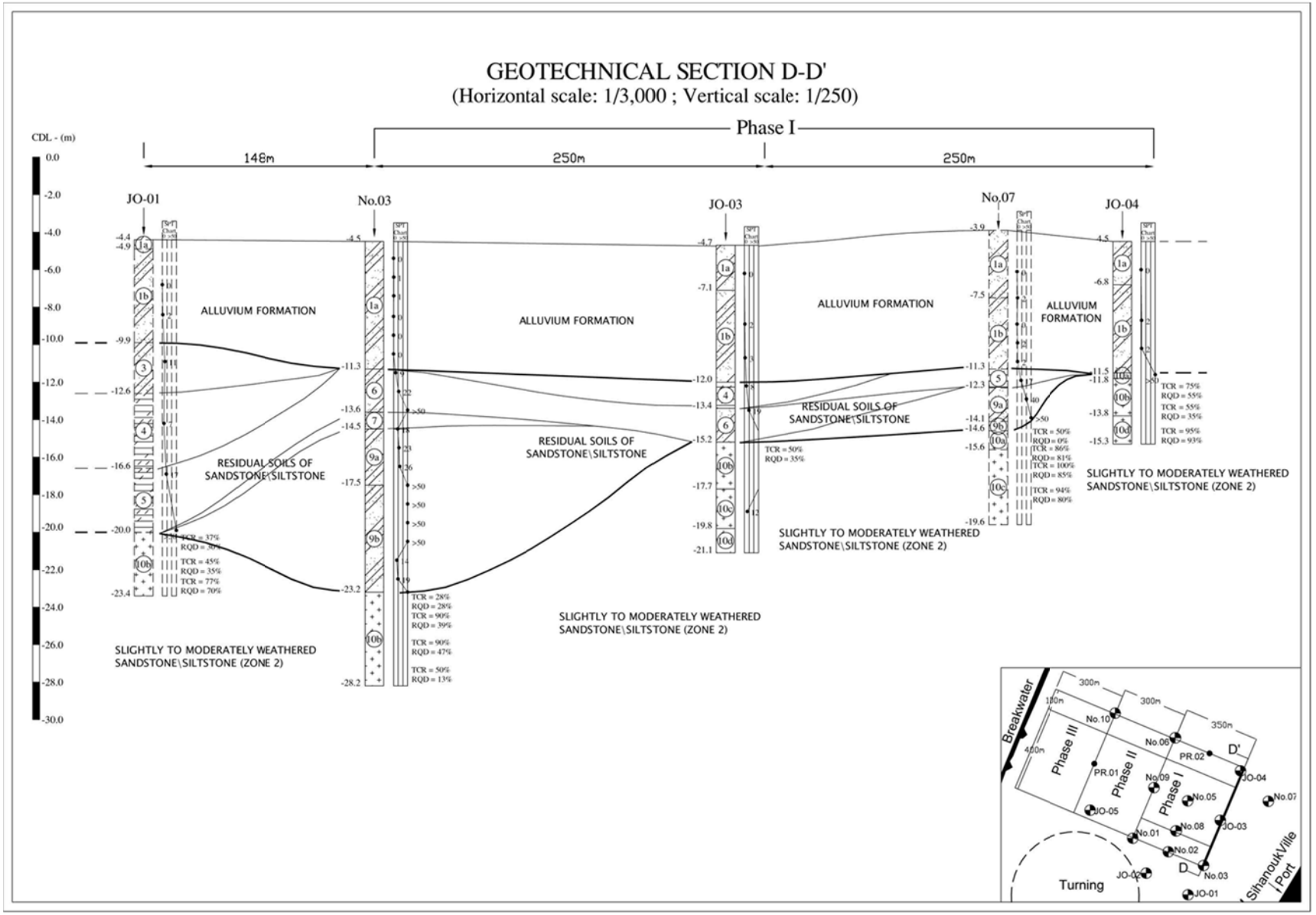
Figure 4.2-6 Geotechnical Section B-B'

Source: JICA Survey Team



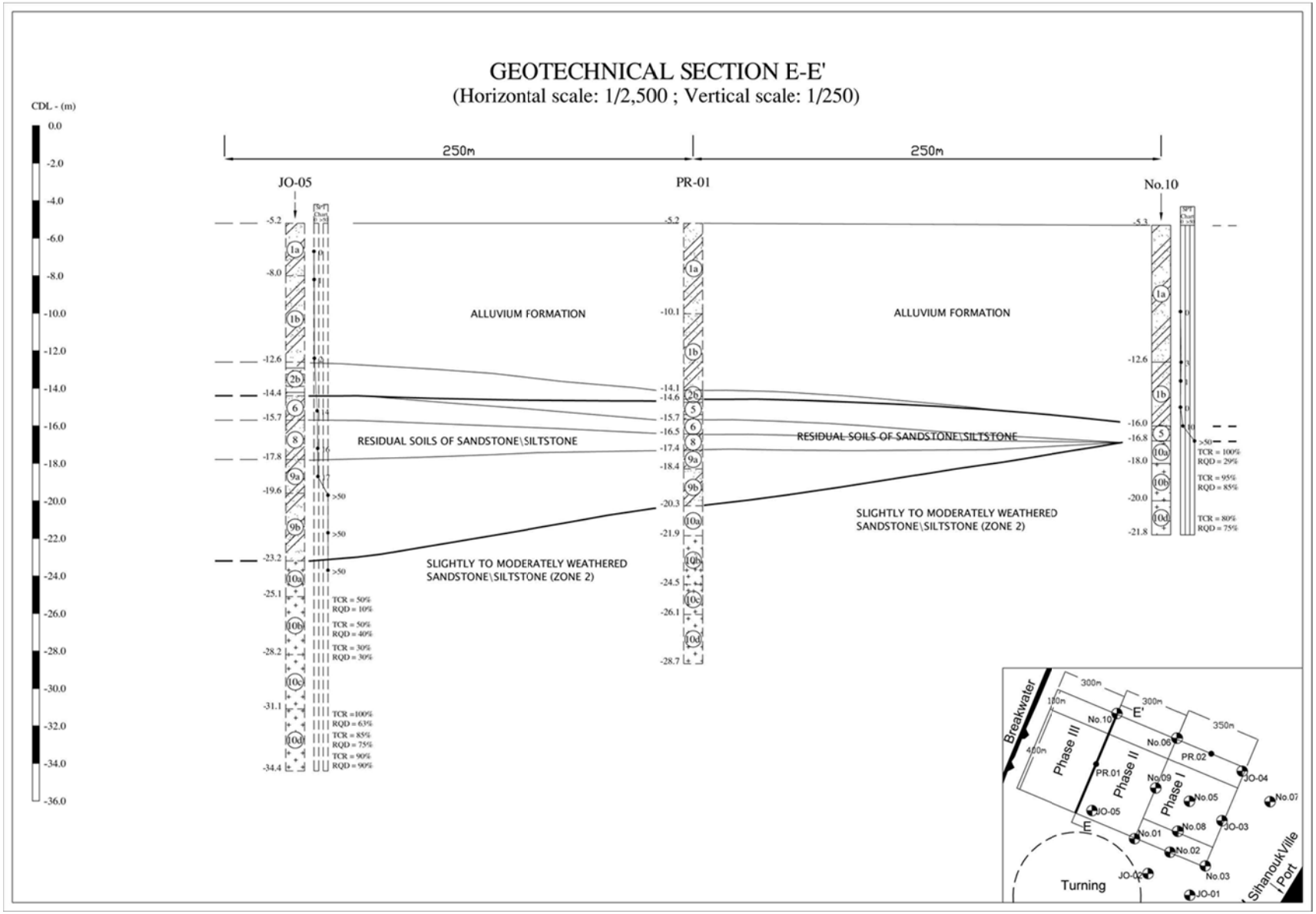
Source: JICA Survey Team

Figure 4.2-7 Geotechnical Section C-C'



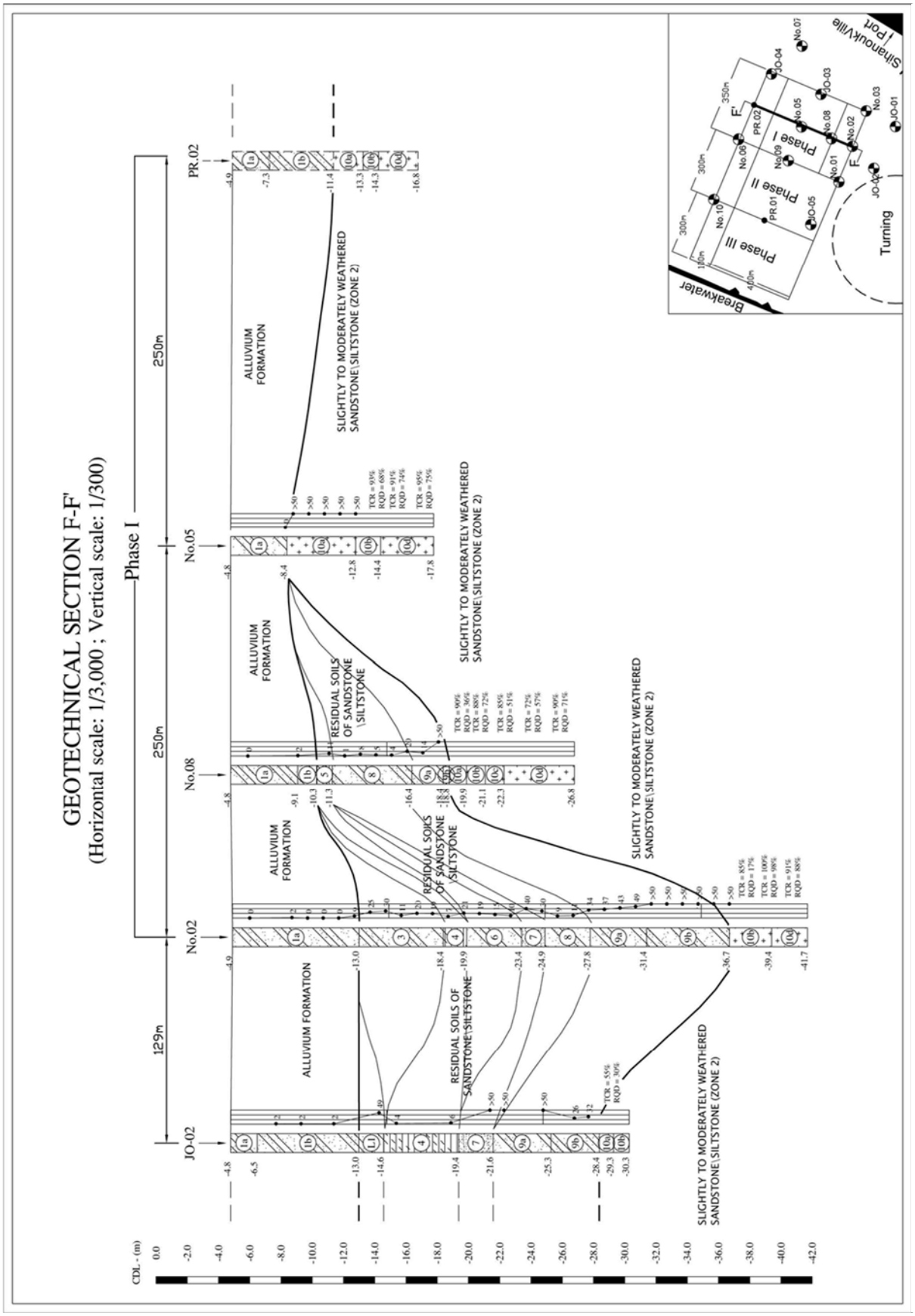
Source: JICA Survey Team

Figure 4.2-8 Geotechnical Section D-D'



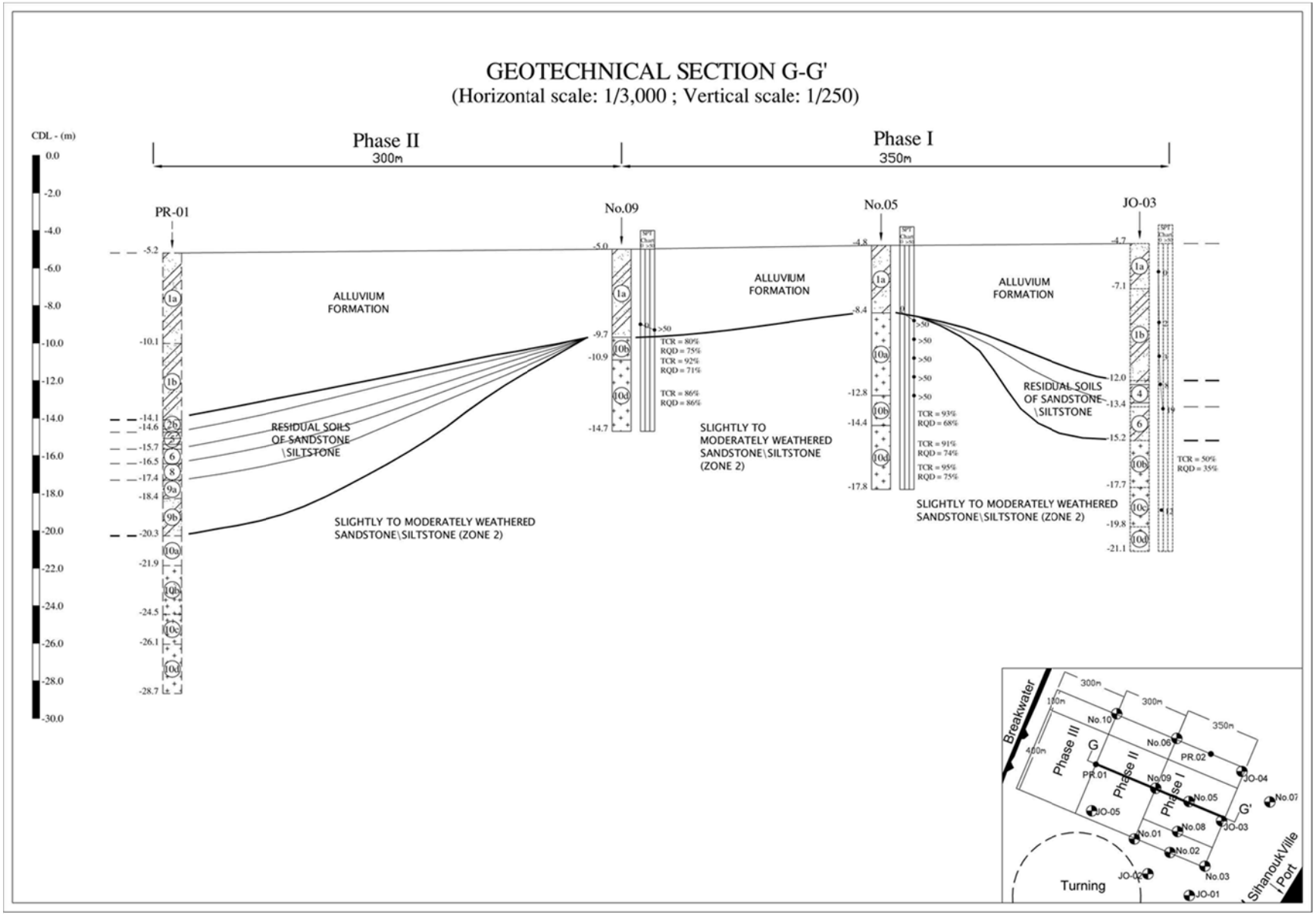
Source: JICA Survey Team

Figure 4.2-9 Geotechnical Section E-E'



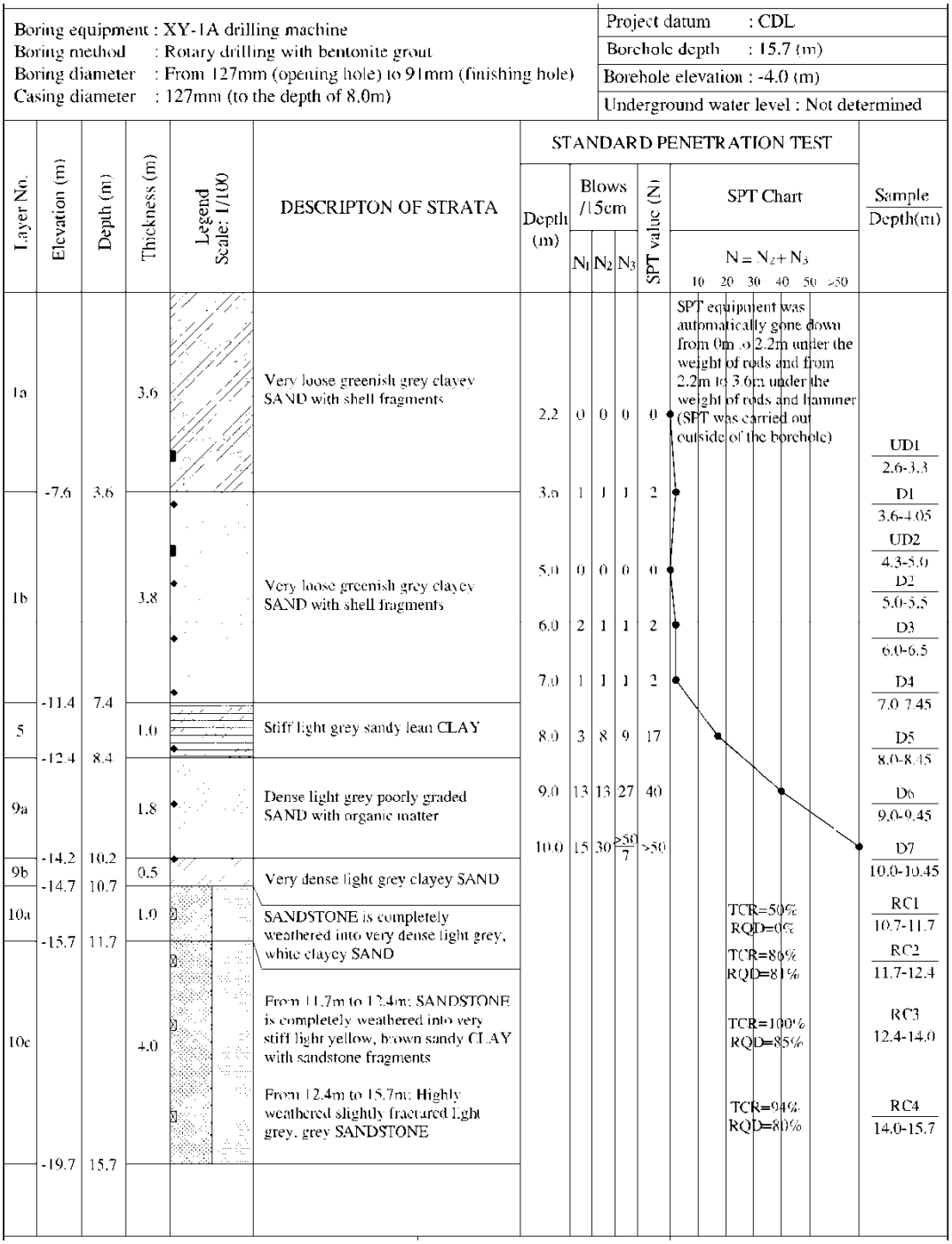
Source: JICA Survey Team

Figure 4.2-10 Geotechnical Section F-F'



Source: JICA Survey Team

Figure 4.2-11 Geotechnical Section G-G'



Source: JICA Survey Team

Figure 4.2-12 Bor. Log at Access Bridge Foundation

Table 4.2-4 TCR and RQD in Coring Samples

Borehole No.	Seabed Level **CDL** - (m)	Core Run No.	Rock Coring Depth from Seabed - (m)		Rock Coring Level **CDL** - (m)		Total Core Recovery **TCR** (%)	Rock Quality Designation **RQD** (%)
			From	To	From	To		
No.07	-3.9	1	10.7	11.7	-14.6	-15.6	50	0
		2	11.7	12.4	-15.6	-16.3	86	81
		3	12.4	14.0	-16.3	-17.9	100	85
		4	14.0	15.7	-17.9	-19.6	94	80

Source: JICA Survey Team

Source: JICA Survey Team

Figure 4.2-13 State of Rock Cores at Bor.No.7

4.2.3 Soil Properties

The subsurface material within the vicinity of the project site are classified as Alluvium and Sedimentary Quartzite formation. Based on the weathering grade, Sedimentary Quartzite formation[3] is further stratified into various zones as shown as the followings.

Formation	Soil layer /Zone
1.Alluvium	i) Sandy/silty Sand/Clayey Sand/ ii) Marine sandy Clay/ silty Clay/sandy silty Clay
2.Sedimentary Quartzite zone	i) Residual soil zone with wreathing grade VI; ii) Completely weathered zone (1) with weathering grade V iii) Highly weathered zone (2) with weathering grade III-IV; iv) Completely weathered zone (2) with weathering grade V; v) Slightly to moderately weathered zone (2) with weathering grade II-III

Taking the above classification into account, Alluvium formation and Sedimentary Quartzite is classified at each bore log as shown by Table 4.2-5. It is understood that Alluvium formation is composed of loose/soft clayey sand layer such as the boring rod would fall freely by its own weight or with SPT hammer. Therefore, in general, building the structure such as seawalls would need to consider the slope stability and consolidation settlement. In particular, layer <1a> distributes uniformly at all boring points with thickness of approximately 5 m and on the contrary, <1b> distribute at Bor.No.01 along the wharf alignment and at the points of Bor.No.6, Bor.No.7, Bor.No.8 and Bor.No.10 along the section C. Therefore total thickness of layer <1> seems to be larger than other area.

Sedimentary Quartzite is composed of mainly weathered medium dense sandy layer with N value of bigger than 5 to 30. The thickness of these layers change extremely through whole area of the project.

(1) Alluvium Formation

Soil properties of the Alluvium Formation, in particular the layer <1>, separately <1a> and <1b>, are summarized in Table 4.2-6. The geotechnical features of both layers are the followings.

i) Sieve test results shows that the average content of the sand particle for <1a> and <1b> are 69% and 79%, respectively. It should be understood that <1a> layer could be defined

[3] Appendix 4.2.X, Preparatory survey for Sihanoukville port new container terminal development project in the Kingdome of Cambodia, June 2016,p.27.

as "Intermediate soil" as stated above and <1b> as sand layer according to the following classification[4].

Definition	Sand content (%)	Plasticity Index (Ip)
Clay	50-60	Ip > 20-30
Intermediate	50-80	Ip = NP-30
Sand	> 70-90	Ip < Np

ii) The average natural water contents for both layer are 42% and 34%, and their liquid limit are 35% and 33% respectively. Therefore, layer <1> seems to be deposited very softly.

iii) The average of Plasticity Index (Ip) indicate the value of 9 and 8, respectively. Therefore, as understood above, layer <1a> could be defined as "Intermediate soil" and <1b> is as "sand".

iv) Average shear strength of layer <1a> and <1b> are 12 kPa and 18 kPa, respectively. However, as sand content of both layers are nearly 70% and 80%, it is commonly understood that sampled specimen with large sand fraction would be likely to have certain amount of disturbance through sampling process, transportation of specimens and trimming of specimen for unconfined compression test. Therefore, actual shear strength seems to be larger than the one mentioned above.
Figure 4.2-14 shows the comparison with shear strength by unconfined compression test and the field vane test at Bor.No.1, Bor.No.5 and Bor.No.6. Both relationships with depth seem to be similar in spite of the expected disturbance of specimens and ignorance of friction angle portion in the shear strength through field vane test. It might be understood that the reduction of cohesion of clay due to disturbance of specimen and ignorance of friction portion might be similar amount of loss in the evaluation of shear strength.

v) As shown by Table 4.2-5, average Cc of layer <1a> and <1b> are approximately 0.3. And Cv for them are 0.8 x 10^{-3} cm^2/sec (= 0.05 cm^2/min). Figure 4.2-15 shows the relationship between Ip and Cc. As realized by the figure, Cc obtained by the laboratory test looks larger than the referred value. This reason could be due to the difficulty to determine the slope angle along the straight line on the e~log P curve obtained by the consolidation test, where the curve has no straight line because of the disturbance of the specimen. On the contrary, C_v seems to be underestimated when compared on Figure 4.2-16 because of disturbance of the test specimen.

As the summarized soil properties of Alluvium Formation, layer <1>-a, <1>-b and <2>-b are very soft sandy layer, that behave like sand foundation.

(2) Sedimentary Quartzite Zone

Table 4.2-5 shows the Sedimentary Quartzite zone consisted of layer <3> to layer <9>, which are medium dense sand to very dense sand layers, and layer <10> the weathered sandstone zone. The thickness of those layers change depending on the bore hole locations.

N values distribute from approximately 5 to 35 for layer <3> to layer <9> and larger than 50 for layer <10>. Therefore, these layers would settle, but not large, due to large load burden such as concrete block of wharf structure.

Sand content for all the layers range from 30% to 80%, in particular layer <3> has sand content of 80%. According to Figure 4.2-17 that relationship between sand content and permeability of soil, k, the permeability in case of sand content of 80% is presumed as permeability of 10^{-6} cm/sec, which is smaller than 10^{-3} cm/sec of sand material as the drainage layer. Therefore, in spite of sandy layers through whole Sedimentary Quartzite Zone, their permeability seems not to be sufficient as the drainage layer.

[4] Intermediate soil, sand or clay, Geotech-Note 2, JGS, Gihodo, p.8. (in Japanese)

Table 4.2-5 Feature of Stratum Around the Project Area

Stratum	Feature of soil			Thickness (m) Bor. hole No									Sand content	Remarks
	Soil properies	Layers		1	2	3	5	6	7	8	9	10		
Alluvium formation	Sand/ silty Sand/Marine sandy clay	<1>	a	5.3	8.1	6.8	3.6	2.8	3.6	4.3	4.7	7.3	65	Boring rod only for SPT free-fall by its own weight
			Ave.	5.2										
			b	1.2	0	0	0	3.5	3.8	1.2	0	3.4	68	Boring rod with hamer before SPT free-fall by its own weight
			Ave.	1.5										
	Sandy clay	<2>	b	1.5	-	-	-	-	-	-	-	-	43	
Sedimentary Quartzite	Medium desnse clayey sand	<3>		9	5.4	-	-	-	-	-	-	-	81	N range 5-48, N- ave. 10-20
	Firm sandy lean clay	<4>		2	1.5	-	-	-	-	-	-	-	29	N range 4-8. N-Ave:6
	Very still to stiff sandy lean clay	<5>		4	-	-	-	-	1	1	-	0.8	30	SPT range 7-22, Ave.;12-18
	Medium desnse clayey sand	<6>		4	3.5	2.3	-	-	-	-	-	-	69	N range 7-40
	Very desnse to dense poorly grades sand	<7>		-	1.5	0.9	-	-	-	-	-	-	85	N range 30 to >50
	Firm to stiff sandy lean clay	<8>		-	2.9	-	-	-	-	5.1	-	-	48	N range 4-16
	Medium dense to dense clayey sand	<9>	a	4	3.6	3	-	-	1.8	2	-	-	79	N range 16 to >50
	Very dense silty sand		b	5	5.3	5.7	-	-	0.5	0.4	-	-	84	N; >50
	Completely weathered sand/clay	<10>	a	-	-	-	4.4	3.6	1	1.1	-	1.2	77	
	Highly weathered sandstone		b	1.5	2.7	5	1.6	0	-	1.2	1.2	2	-	
	Completely weathered sandstone		c	1.5	-	-	-	-	4	1.2	-	-	-	
	Slightly to moderately weathered sandstone		d	2	2.3		3.4	3.4		4.5	3.8	1.8	-	

Source: JICA Survey Team

Table 4.2-6 Summery of Soil Properties for Alluvium Formation

Bor. No	Layer No.	Depth (in CDL)	Sieve test result (%)		Wn (%)	Consistency (%)			γ (g/cm3)	Shear strength (kPa)		Consolidation Index			
			sand	silt/ clay		WL	PL	Ip		Cu	Sv	e0	Pc (kPa)	Cc	Cv (10-3 cm2/sec)
1	1a	-6.75	76	24	37	31	23	8	1.79	11.12	12.7	1.06	7.3	0.28	0.840
		-9.25	49	51	44	47	32	14	1.66	21.81	17.8	1.34	6	0.45	0.825
2		-6.9	67	33	42	41	32	9	1.69	11.27	-	1.27	5.6	0.34	0.847
		-9.35	70	30	49	42	33	9	1.64	13.52	-	1.47	5.3	0.46	0.815
3		-6.05	79	21	33	32	22	10	1.8	12.20	-	0.99	8.9	0.24	0.923
		-8.15	77	23	22	22	14	7	1.99	17.98	-	0.64	14	0.20	0.963
5		-6.75	74	26	38	28	20	8	1.7	8.97	13.1	1.14	7.5	0.16	0.819
		-8.15	63	37	38	32	23	9	1.7	11.47	17.8	1.12	7.7	0.26	0.926
7		-6.85	76	24	36	23	14	8	1.8	9.11	-	1.04	8.2	0.22	0.846
8		-7.15	(32)	(78)	53	38	24	13	1.65	11.12	-	1.50	5.8	0.37	0.764
9		-8.35	74	26	53	39	31	8	1.54	9.95	-	1.69	5.6	0.40	0.789
10		-9.55	58	42	56	46	63	9	1.55	9.80	-	1.72	4.8	0.46	0.700
Average (1a)			**69**	**31**	**42**	**35**	**28**	**9**	**1.7**	**12.36**	**-**	**1.25**	**7.2**	**0.32**	**0.838**
6	1b	-8.65	82	18	25	22	14	7	1.91	15.48	16	0.76	12.7	0.21	0.956
		-10.85	80	20	41	42	33	9	1.65	16.61	26.7	1.33	7	0.21	0.843
7		-8.55	77	23	26	24	15	8	1.92	13.08	-	0.78	12.2	0.21	0.949
10		-14.65	67	33	42	45	35	9	1.67	26.80	-	1.32	6.6	0.44	0.742
Average(1b)			**77**	**24**	**34**	**33**	**24**	**8**	**1.79**	**18.00**	**-**	**1.04**	**9.6**	**0.27**	**0.873**

Note(1); Wn; Natural water content, Wl;Liquid limit, Ip; Plastic limit,γ; Density of soil, Vo; Initial void ratio, qu; unconfined compression test result, C=qu/2.
Note(2); Sieve test result of Bor. No.8 is omitted due to indistinct values compared with other data.
Note(3); Cv (1a) = 0.838 x 10-3 cm^2/sec = 72.4 cm^2/day = 0.050 cm^2/min,
Cv (1b) = 0.873 x 10-3 cm^2/sec = 75.4 cm^2/day = 0.052 cm^2/min,
Source: JICA Survey Team

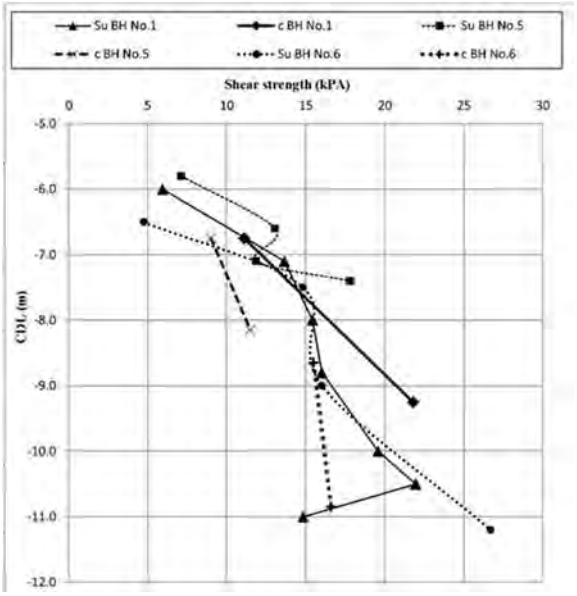


Figure 4.2-14 Shear Strength by Qu Test and Field Vane Test

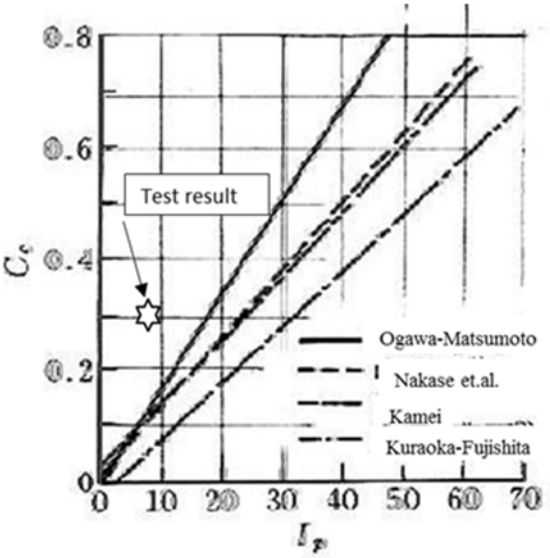
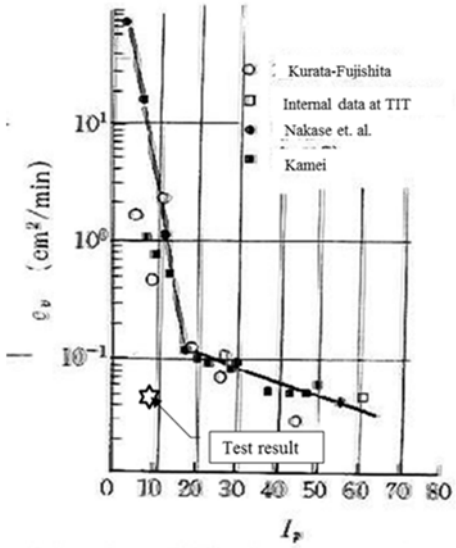
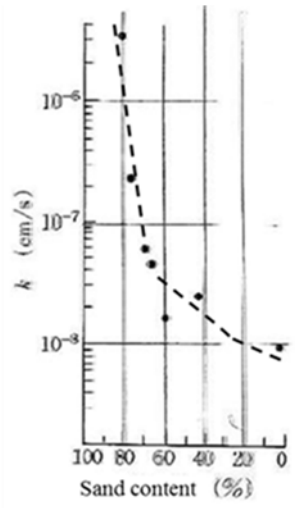


Figure 4.2-15 Ip & Cc Relationship



Source: Intermediate soil, published by Japan Geotechnical Society, P.15 (in Japanese)

Figure 4.2-16 Ip & Cv Relationship



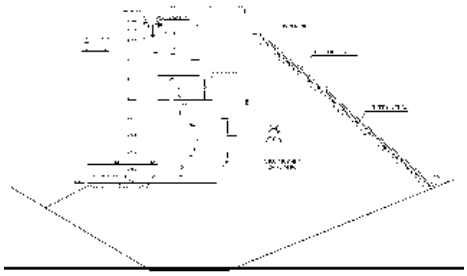
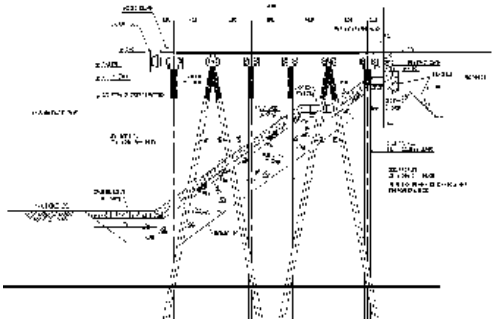
Source: Intermediate soil, published by Japan Geotechnical Society, P.17 (in Japanese)

Figure 4.2-17 Relationship between Sand Content & k

4.2.4 Soil Investigation on Each Structure Being Built

(1) Wharf

Taking a consideration of the planned water depth of -14 m at the front of wharf and the construction experiences in the past at the Sihanoukville port, a concrete gravity wharf and the pile structure seems to be possible system as shown by Figure 4.2-18, where general features for both types are described.

	Gravity type wharf (-14 m)	Pile type wharf (-14 m)
Typical Section of structure		
Geotechnical issues	-To gain sufficient bearing capacity at the bottom of gravity structure. -Gravity type structure is likely to tilt due to instant compression during building work and due to the post construction settlement by consolidation.	-Embedment depth of pile into the stiff foundation shall be essential against vertical and lateral bearing capacity. -Investigation on stability of seawall against slip failure and residual settlement by consolidation shall be essential.

Source: JICA Survey Team

Figure 4.2-18 Typical Wharf Structure Types to be Considered

1) Gravity Type Wharf (-14 m)

As shown by Figure 4.2-5, thickness of Sedimentary Quartzite zone consisted of layer <3> to layer <9> with range of N values from 5 to 35 changes extremely along the wharf alignment. According to Terzaghi- Peck, range of N value means roughly on the state of soil as followings.

N	State description
0~4	very loose
4~10	loose
10~30	medium
30~50	dense
>50	very dense

Therefore, these layers could be possible to settle by the loading of wharf structure during long period. As layer <3> to layer <9> are understood as the sandy layers as shown by Bor.log. No1 to No.3, it seems to be rationale to utilize Equation 4.2-1 proposed by De Beer[5] for calculation of compression of sand layer. Table 4.2-7 shows the settlement distribution along the wharf alignment. It is realized that settlement at Bor.No1 to No.3 ranges from 0.13 m to 0.02 m. As the differential settlement between these distances seems nearly 10 cm, it might be rather difficult to set up the concrete blocks evenly during/post construction.

$$Si = 1.5 \int_0^H \frac{Pv}{qc}\, log10\left(1 + \frac{\sigma z}{Pv} Pv\right) dz \quad \cdots\cdots\cdots\cdots\cdots\cdots \text{Equa.4.2-1}$$

Here, P_v = Effective over-burden pressure
q_c = 40 x N (tf/m2)[6]
σ_z = propagated stress by the structure
H = thickness of soil

[5] H. Yamaguchi, Soil mechanics, Gihodo Shuppan, pp.353-356.(in Japanese)
[6] Interpretation and application of soil test results, Geotechnical engineering library No.4, JGS,p.59(in Japanese)

Table 4.2-7 Computed Settlement Along Wharf Alignment

Bor.No	H	Nave.	Pv	ΔP			s (m)
				Load (tf/m^2)	I σ	ΔP(tf/m^2)	
1	5	20	11.5	25.3	0.55	13.915	0.037
	17	10	14	25.3	0.14	3.542	0.087
	Total settlement						**0.12**
2	4	21	7.7	25.3	0.63	15.939	0.027
	13.4	23	13.79	25.3	0.15	3.795	0.032
	Total settlement						**0.06**
3	3.5	22	7.5	25.3	0.6	15.18	0.022
	Total settlement						**0.02**

Source: JICA Survey Team

2) Pile Type Wharf (-14 m)

Structure of wharf utilizing piling system is composed by concrete platform with supporting piles and seawall behind it. It is understood by Figure 4.2-4, that driving steal piles into layers of the Sedimentary Quartzite zone seems not to be difficult and thickness with rather strong layers distribute along the alignment to gain lateral reaction could be sufficiently distributed.

The structure of seawall behind the concrete platform could be the similar to the one enclosing reclamation area.

(2) Seawall (1A, 1B, 1C)

For making sure of the stability of the slope and of minimizing a post construction settlement, replacement of soft soil layer to good soil such as sand material is commonly utilized for reclamation on the soft ground. Table 4.2-8 shows the thickness of layer <1a> and <1b>, which are deposited softly in spite of large content of sand fraction. Their thickness changes depending on the locations, such as 3.6 m to 8.1 m. Therefore, typical super-structure of seawall could be designed as shown by Figure 4.2-17, where soft soil layer should be replaced by good sandy soil.

Figure 4.2-19 shows the seawall locations, where each typical sections are described by Figure 4.2-20 to 4.2-22. In particular, the role of seawall B~B is to be built for tentative use until phase II would start, therefore slope angel is designed to be more gentle so as to make the replacement volume being minimized.

Table 4.2-8 Thickness to be Replaced

Bor.No	Layer to be replaced		
	1a	1b	Total
No.1	5.3	1.2	6.5
No2	8.1	0	8.1
No3	6.8	0	6.8
No4	1.3	4.7	6.0
No5	3.6	0	3.6
No6	1.7	3.5	5.2
No.8	4.3	1.7	6.0
No.9	5	1.2	6.2

Source: JICA Survey Team

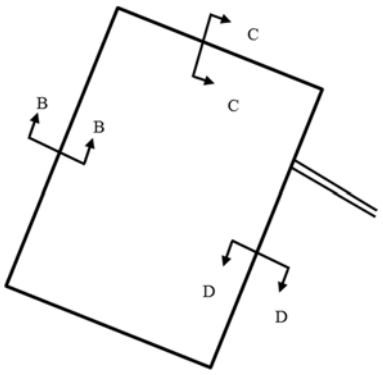
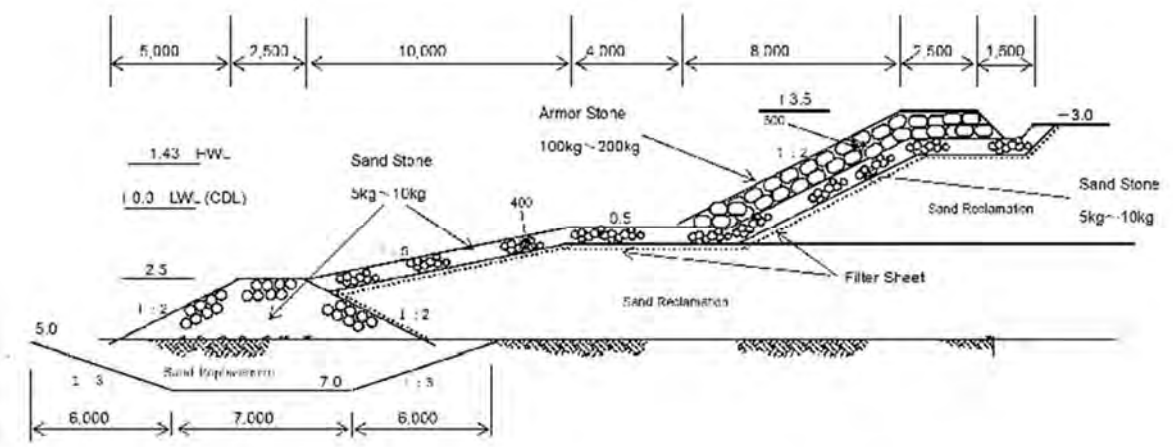


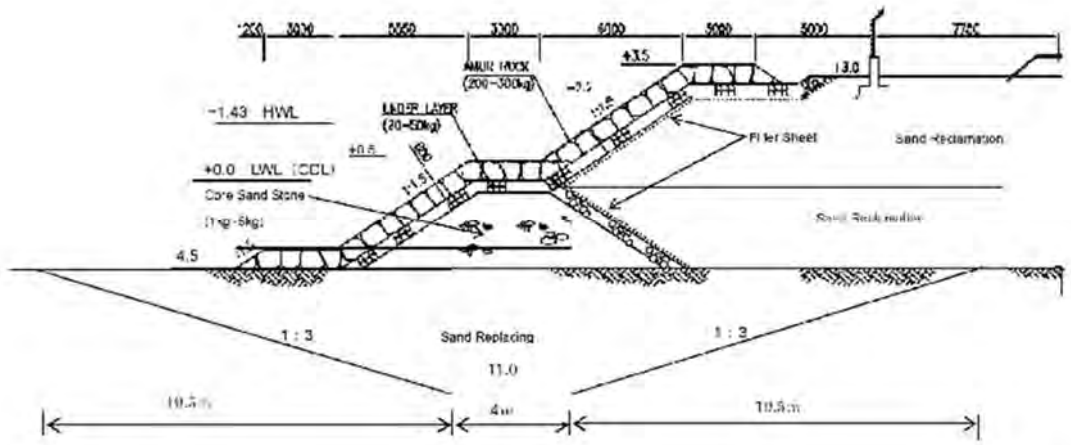
Figure 4.2-19 Locations of Seawall Section (Phase I)

Source: JICA Survey Team



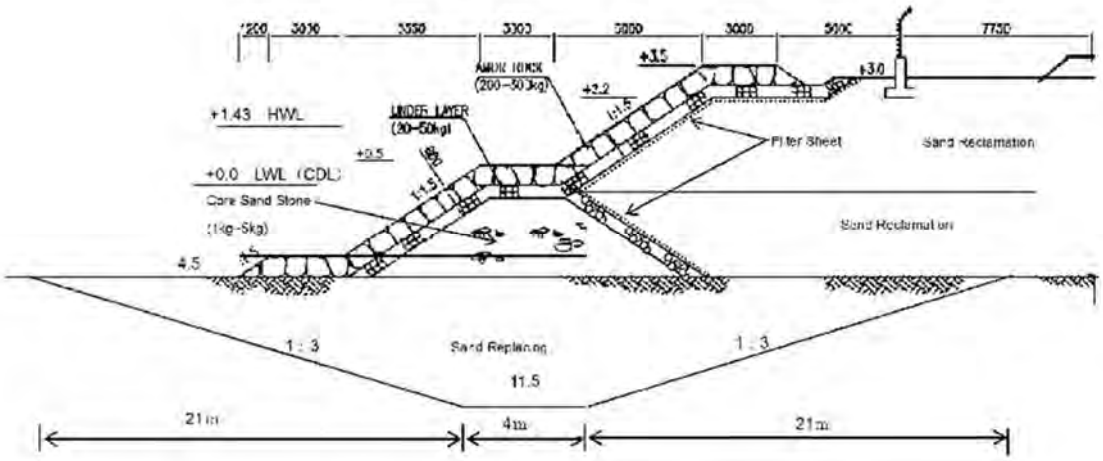
Source: JICA Survey Team

Figure 4.2-20 Seawall Structure at B-B'



Source: JICA Survey Team

Figure 4.2-21 Seawall Structure at C-C'



Source: JICA Survey Team

Figure 4.2-22 Seawall Structure at D-D'

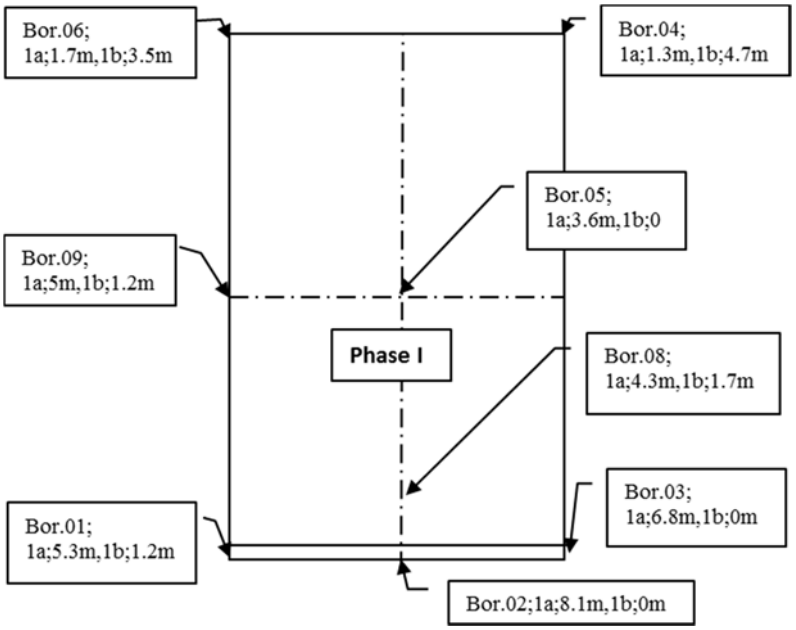
(3) Reclamation Area

Consolidation settlement for soft clay layer is calculated by Equation 4.2-2 assuming the model layer in the reclamation area. As layer 1, composed of layer <1a> and <1b>, would settle by reclamation fill, it is necessary to determine the parameter to be used in Equation 4.2-2.

$$S_f = Cc \times \frac{H}{1+e0} \times \log\left(1 + \frac{\Delta P}{Pc}\right) \cdots\cdots\cdots\cdots\cdots\cdots \text{Equa.4.2-2}$$

Here, C_c, Compression Index, H; thickness of clay layer, e_0; Initial void ratio, Δp; load, P_c; Consolidation yield stress.

Figure 4.2-23 shows the thickness of layer 1a and layer 1b at the locations of bore holes in Phase I. Table 4.2-9 shows the averaged thickness of <1a> and <1b>, which are calculated by considering weighted mean by each area represented by each bore hole and Table 4.2-10 shows the other key parameters by taking the consideration on discussion in 4.2.3 (1).



Source: JICA Survey Team

Figure 4.2-23 Thickness of 1a and 1b at Boring Locations (Phase I)

Table 4.2-9 Average Thickness of Layer 1

Project area	Bor. Hole	Thickness (m)	
		1a	1b
Phase I	No.1	5.3	1.2
	No2	~~8.1~~	0
	No3	6.8	0
	No4	~~1.3~~	4.7
	No5	3.6	0
	No6	1.7	3.5
	No.8	4.3	1.7
	No.9	5	1.2
	Average	4.45	1.67

Source: JICA Survey Team

Table 4.2-10 Soil Parameters

Soil parameters of layer 1a & 1b		
Unit weight (γ) (t/m^3)	1.7	1.8
Initial void ratio (e_0)	1.25	1.04
Compression Index (C_c)	0.2	0.2
Consolidation coefficient (cm^2/day)	0.28	0.28

Source: JICA Survey Team

As stated in 4.2.3 (2), consolidation coefficient (Cv) obtained by the laboratory test seems too small compared with the one from the reference. Then, permeability of soil (k) for layer <3>, which distribute as the drainage layer for above layer <1>, is presumed by Figure 4.2-13 as 10-6 cm/sec. This value is rather smaller than the one of sand material, 10-3 cm/sec. Thus, drainage condition for consolidation of layer <1> is concluded as “Single drainage” condition.

(4) Access Bridge Foundation

It is understood that the bearing stratum and lateral bearing capacity seems to be sufficient at around deeper than -13 m as explained in 4.2.4 (1).

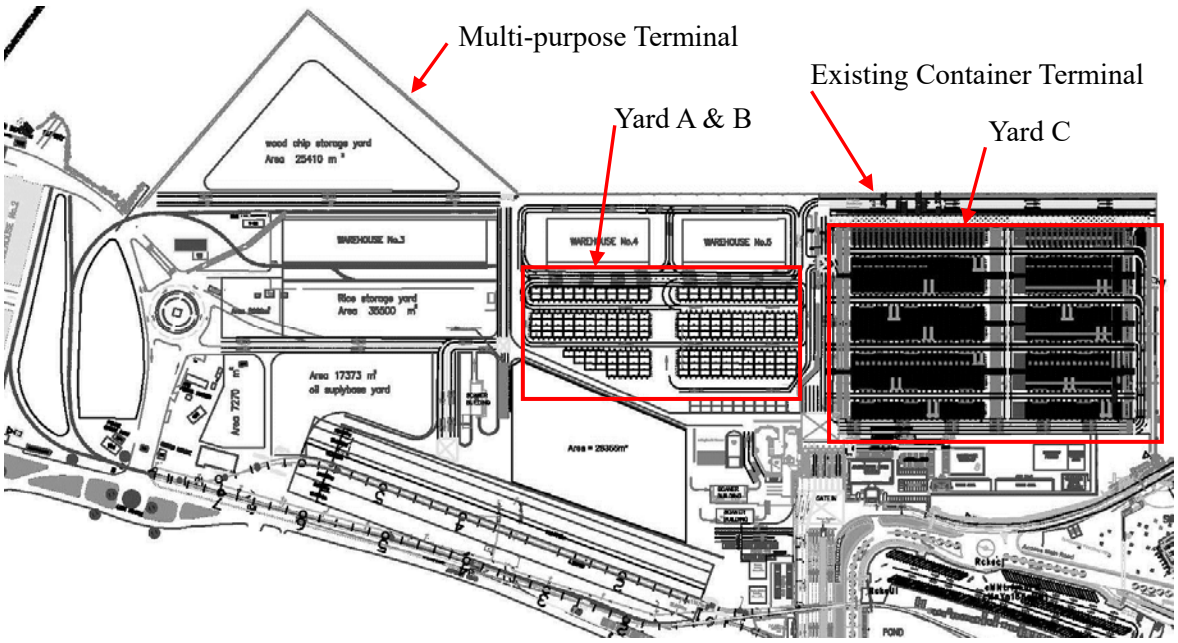
5. CARGO HANDLING CAPACITY OF EXISTING PORT

5.1. Capacity of Present Container Terminal Facilities and Future Procurement Plan

The development status and capacity of the existing container terminal are described below.

5.1.1 Yard Layout of Existing Container Terminal of Sihanoukville Port

The layout of Sihanoukville Port is shown in Figure 5.1-1. Currently, a Multi-purpose Terminal is under construction.

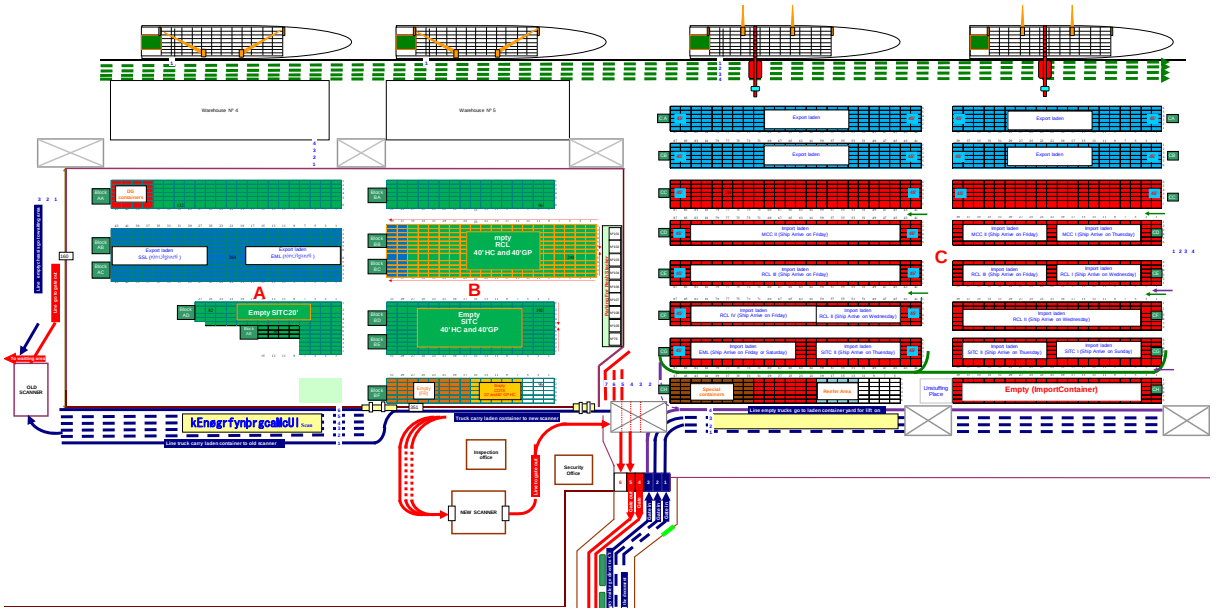


Source: PAS

Figure 5.1-1 Layout of Sihanoukville Port

The yard layout of the existing container terminal is shown in Figure 5.1-2. Currently, the cargo handling operation of Yard C is carried out by the rubber tyred gantry crane (RTG), while that of Yard A and B are carried out by Reach Stacker.

12 Container ships per week will call at Sihanoukville Port, container handling volume at the quay in 2016 is about 244,000 Boxes (about 390,000 TEUs). Approximately 67% of the weekly container handling volume is handled from Friday to Saturday.



Source: PAS, Operation Department

Figure 5.1-2 Yard Layout of Existing Container Terminal of Sihanoukville Port

5.1.2 Maintenance Situation of the Cargo Handling Equipment at the Existing Container Terminal

The cargo handling equipment used in the existing container terminal of Sihanoukville Port is grouped by type and use in Table 5.1-1. The utilization status of the cargo handling equipment is shown in Table 5.1-2.

Table 5.1-1 Cargo Handling Equipment at the Existing Container Terminal

Name of CHE	Moniker	Quantity (unit)	Use
Quayside Container Crane	QC	2	Berth handling of container from Ship to Shore
Rubber Tyred Gantry Crane	RTG	7	Lift on/off of container at RTG Stacking Tard (in “C” zone)
Reach Stacker	RS	9	Lift-on/off of container at RS Stacking Yard (Mainly, in the “A & B” zone)
Fork lift	FL	1	Handling for Laden and Empty containers
Yard Chassis	YC	22	Transfer container in the container yard

Source: PAS, Technical Materials-Construction Department

The 3rd and 4th (Quayside Container Crane) QC were already ordered. The 3rd QC will be delivered at the end of 2016 and the 4th QC will be delivered at the beginning of 2017. The total of QC installed on the quay will be 4 units. In addition, the 5th QC is scheduled to be ordered around the middle of 2017. Maintenance of cargo handling equipment is being carried out as scheduled. Although the power supply for 3rd QC from the ground side has been secured, the power supply for the 4th & 5th QC has not yet been determined. The present maintenance situation of cargo handling equipment in the existing container terminal is shown in Table 5.1-2. In order to meet sharply increasing cargo demand, PAS plans to introduce additional cargo handling equipment as shown in Table 5.1-3.

Table 5.1-2 Maintenance Situation of the Cargo Handling Equipment in the Existing Container Terminal of Sihanoukville Port

	No. of CHE	Appellative	Fabricator	Rated Load for Container (Hatch-cover)	Start of Operation (Year)	Status of Utilization
QC	No. 1	QC401	MES	30.5Ton (35.5Ton)	2008	In-service
	No. 2	QC402	MES	30.5Ton (35.5Ton)	2008	In-service
RTG	No. 1	201	HYUNDAI	40LT	1999	In-service
	No. 2	202	HYUNDAI	40LT	1999	In-service
	No. 3	203	MES	35LT	2009	In-service
	No. 4	204	MES	(Ditto)	2009	In-service
	No. 5	205	MES	(Ditto)	2009	In-service
	No. 6	206	MES	(Ditto)	2009	In-service
	No. 7	207	MES	35LT	2009	In-service
Reach Stacker	No. 1	101	PPM	45	1994	In-service
	No. 2	102	PPM	45	1994	In-service
	No. 3	103	TREX	45	1997	In-service
	No. 4	104	TFC	45	1997	In-service
	No. 5	105	(Removal)	-	--	-
	No. 6	106	Kalmar	45	2003	In-service
	No. 7	107	Kalmar	45	2003	In-service
	No. 8	108	Kalmar	7.5	2004	In-service
	No. 9	109	Kalmar	45	2007	In-service
	No. 10	110	Kalmar	45	2007	In-service
Fork-Lift	FL	76	KOMATSU	25	1969	In-service
Yard Chassis Total: 22 units	10 units	4106 to 4108, 4110, 4112 to 4116	MITSUBISHI	30	1997	In-service
	4 units	1653,1675, 1684,1686	KAMAZ	30	2001	In-service
	8 units	27 to 34	NISSAN	35	2008	In-service

Source: PAS, Technical Materials-Construction Department

Table 5.1-3 Cargo Handling Equipment to be Introduced in Future

	No. of CHE	Appellative	Fabricator	Rated Load for Container (Hatch-cover)	Estimated Arrival Time
QC	No. 3	3rd QC	MES	30.5Ton (35.5Ton)	Jan. 2017
	No. 4	4th QC	ZPMC	30.5Ton (35.5Ton)	Dec. 2016
	No. 5	5th QC	(Unknown)	(Unknown)	Procurement: Beginning of 2019
RTG	4 sets of RTG	No. 5 to No. 7	ZPMC	40LT	Dec. 2016
	5 sets of RTG	No. 8 to No. 13	MES	40LT	Jan. 2017

Source: PAS, Technical Materials-Construction Department

Table 5.1-4 shows the main particulars of the existing QC No. 401 & 402.

The main particulars from No.203 to No.207 of the existing RTG are shown in Table 5.1-5, and ones of No. 201 & 202 are shown in Table 5.1-6.

Table 5.1-4 Main Particulars of Existing Quayside Container Crane (QC) No. 401 & 402

Item	Unit	Value	Remarks
Rated Load	ton	30.5	(for container)
		35.5	(for Hatch Cover)
		38.0	(for Cargo)
Lifting Height Under Spreader	m	25.0	(above Seaside rail top))
		10.0	(below Seaside rail top)
		35.5	Total Lifting Height
Span	m	20.035	
Out Reach		36.0	
Back Reach		11.0	
Main Hoist Speed	m/min	50	with rated load
		120	without load
Boom Hoist Speed	min/one way	4.5	
Trolley Traverse Speed	m/min	150	
Gantry Travel Speed	m/min	45	
Supply Power	A.C. 6.6kV, 50Hz, 3 Phase		

Source: Instruction Manual and Operation Manual for Quayside Container Crane

Table 5.1-5 Main Particulars of Existing Rubber Tyred Gantry Crane (RTG) No. 203 to 207

Item	Unit	Value/Remarks
Rated Load	LT	40
Type of Spreader	m	Single lift (20/40FT) Telescopic Spreader
Span	m	23.47
Container Arrangement	row	6 (1 + 6) Arrangement
No. of Tier	tier	4 (1 over 4)
No. of Tyres	wheel	8
Wheel-distance	m	2.5
Power Source		Diesel-Engine Generator Sets

Source: Instruction Manual and Operation Manual for Rubber Tyred Gantry Crane

Table 5.1-6 Main Particulars of Rubber Tyred Gantry Crane (RTG) No. 201 & 202

Main Particulars	Unit	Value/Remarks
Rated Load	LT	40
Type of Spreader	m	Single lift (20/40FT Telescopic Spreader
Span	m	23.47
Container Arrangement	row	6 (1 + 6) Arrangement
No. of Tier	tier	4 (1 over 4)
No. of Tyres	wheel	8
Wheel-distance	m	2.5
Power Source		Diesel-Engine Generator Sets

Source: Instruction Manual and Operation Manual for Rubber Tyred Gantry Crane

Based on information from the Technical Materials-Construction Department, the Breakdown rate and Availability rate in 2015 are shown in Table 5.1-7.

Table 5.1-7 Breakdown Rate and Availability of RC. RTG and Reach Stacker in 2015

	QC	RTG	Reach Stacker
Quantity (unit)	2	7	9
The Breakdown rate	1.47&	5.92%	Not studied.
Availability rate	96.4%	84.9%	Not studied.

Source: PAS, Technical Materials-Construction Department

Figure 5.1-3 shows the location and appearance of the Truck-Scale Inspection Facility.

Source: JICA Survey Team

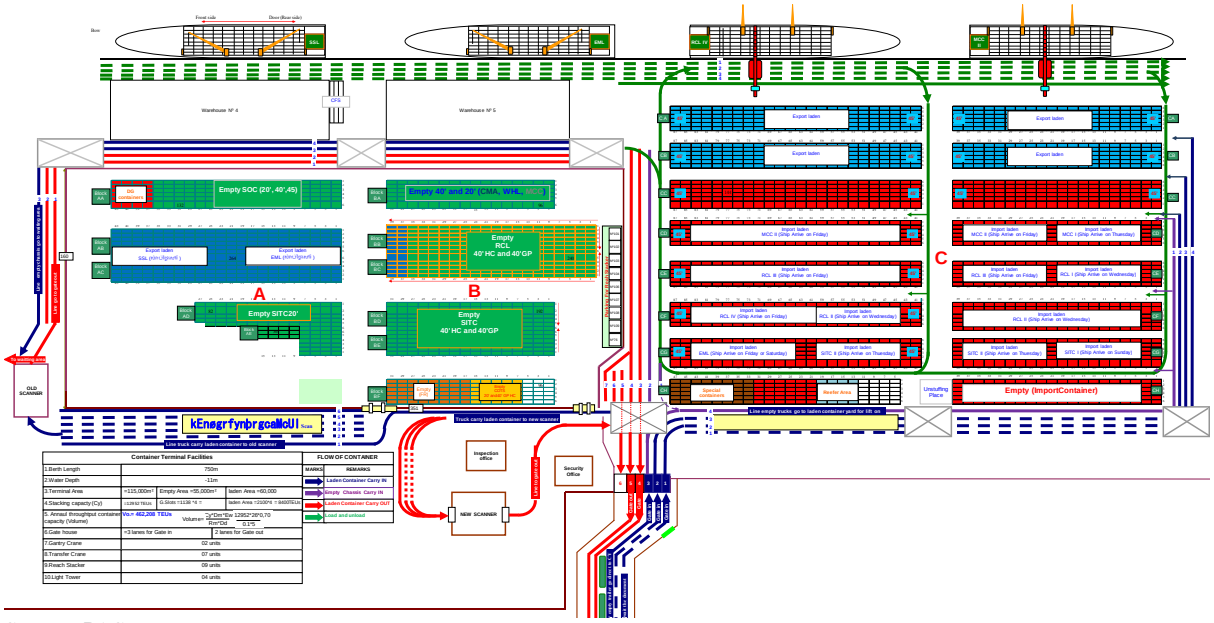
Figure 5.1-3 Location and Outline of Track-Scale Facility

5.2. Evaluation of Cargo Handling Capacity of the Existing Container Terminal

5.2.1 Present state of Cargo Handling of the Existing Container Terminal

(1) Yard Layout of Existing Container Terminal

Figure 5.2-1 shows the Yard Layout of the existing container terminal.

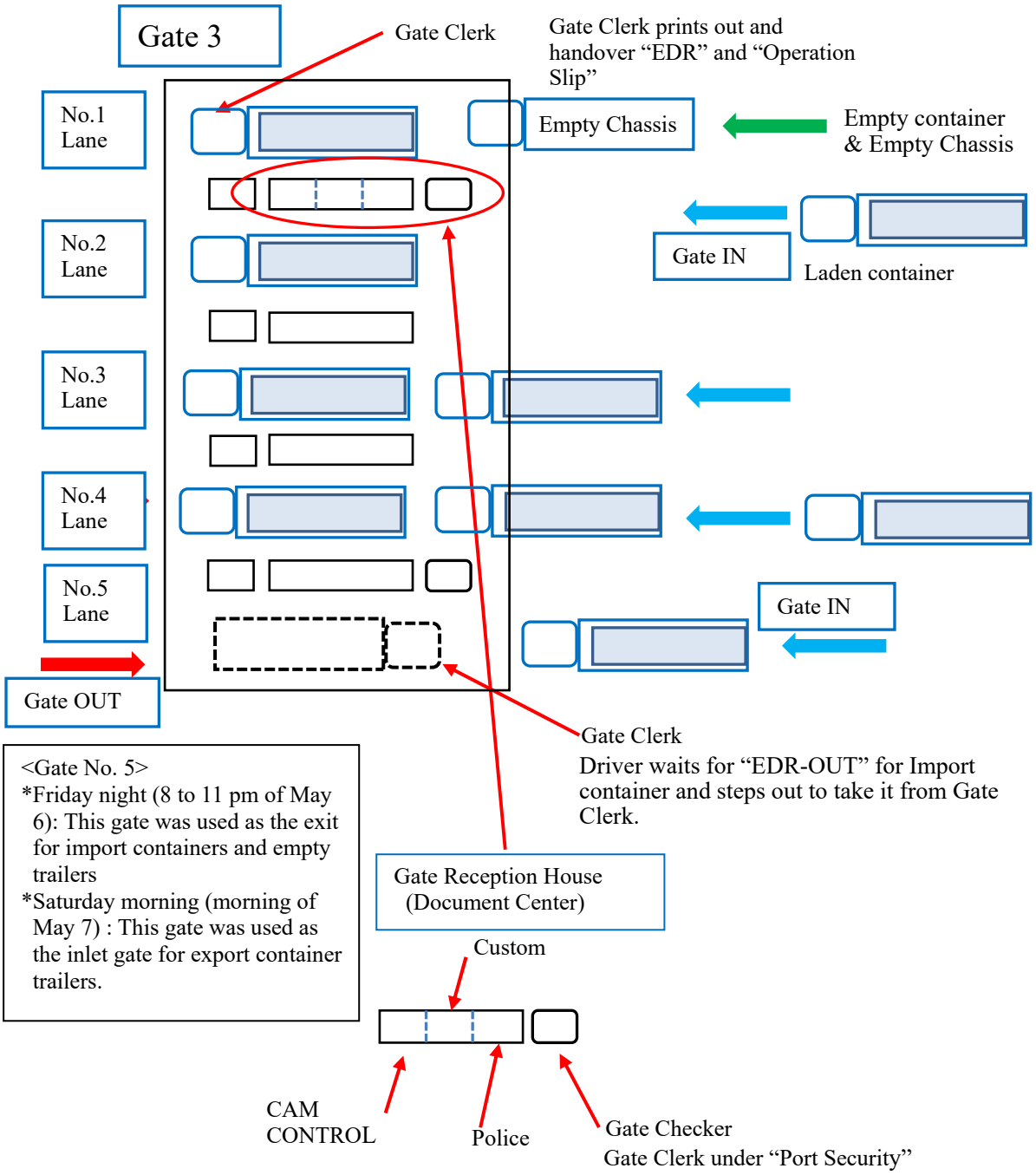


Source: PAS

Figure 5.2-1 Container Layout of Existing Container Terminal

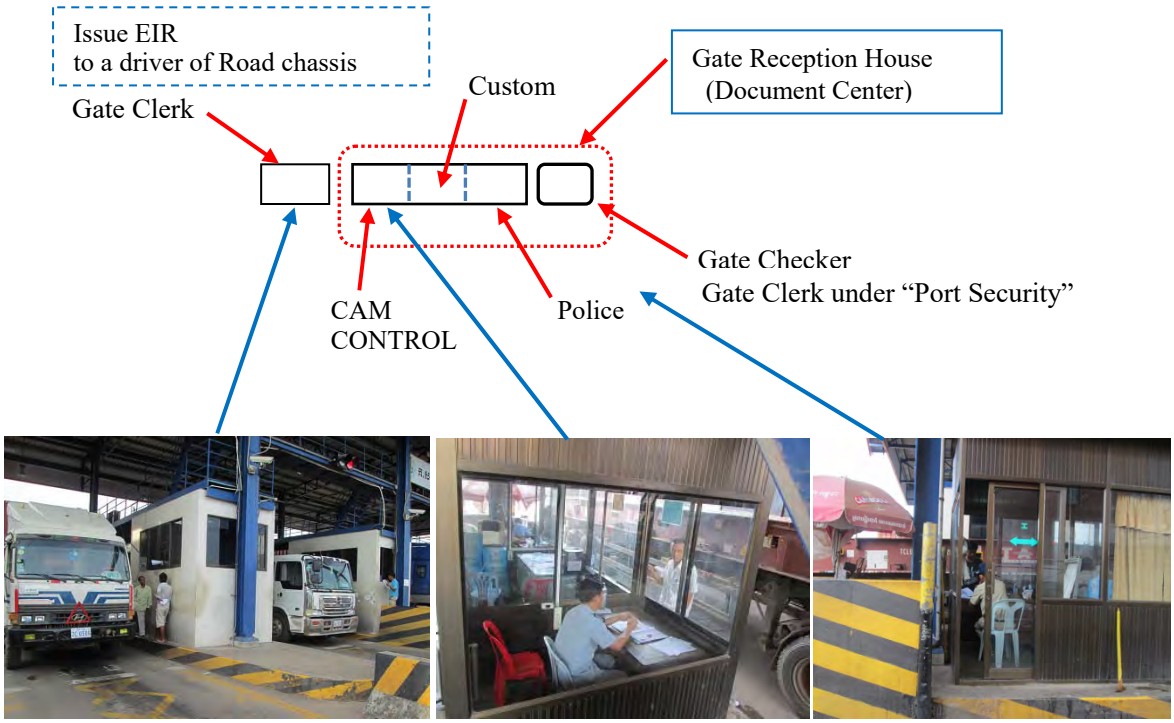
(2) Waiting time of Trailers at the Gate

Figure 5.2-2 shows "Arrangement of related parties and Waiting state of trailers at Gate 3 in the existing container terminal. Gate clerks have been allocated by the relevant agencies at Gate 3 as shown in Figure5.2-3 below.



Source: JICA Survey Team

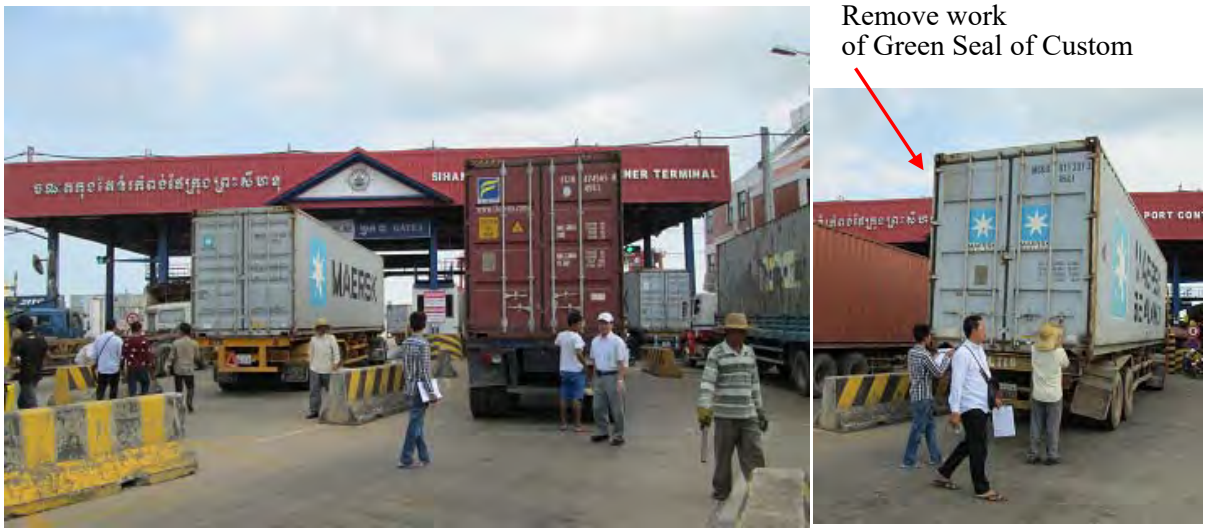
Figure 5.2-2 Arrangement of Related Parties and Waiting State of Trailers at Gate 3



Source: JICA Survey Team

Figure 5.2-3 Document Procedure for Export and Import Container at Gate 3

Figure 5.2-4 shows the present state in front of Gate 3 of Existing Container Terminal.



Source: JICA Survey Team

Figure 5.2-4 Present State in front of Gate 3 of Existing Container Terminal

The number of waiting trailers and waiting time at the IN-GATE are shown in Table 5.2-1. Waiting times of trailers were surveyed from 8 pm to midnight on Friday, May 6 and also from 6 am to 10 am on Saturday, May 7 as the number of trailers carrying export containers tends to increase at those times.

Table 5.2-1 Number of Waiting Trailers and Waiting Time at Gate 3 around 6:20 am on May 7

Item	Quantity or Waiting Time (minute)	Waiting Length from Gate 3
Number of Waiting Trailers	About 61 Chassis	About 600m
Shortest Waiting Period	3 – 5 minutes	Sometimes 2 minutes
Average Waiting Time	5 to 7 minutes	
Long Waiting Time	7 to 13 minutes	Sometimes 15 minutes

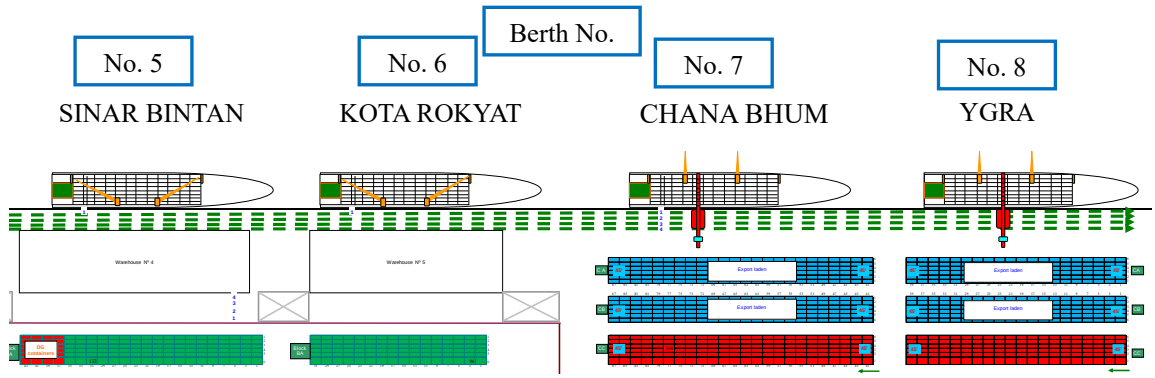
Source: JICA Survey Team
Remarks: Waiting time of each trailer will vary depending upon the processing time of customs documents.

(3) Cargo Handling Situation at Berth No. 5, 6, 7 and 8

The cargo handling situation of Berth 5, 6, 7 and 8 in the existing container terminal is shown in Figure 5.2-5.

Handling of containers of Stacking Yard C where 2 units of QC have been installed is carried out by RTGs, while cargo handling of Stacking Yard A & B behind the two warehouse is carried out by Reach Stackers. Berth No.5 and 6 are usually used as a wharf for general cargo such as tapioca and coal but the loading and unloading operations of containers are conducted here when many container ships call on the weekend. From Friday until Saturday afternoon, loading/unloading operations of 4 ships is simultaneously carried out at Berth No. 5, 6, 7 and 8 (see Figure 5.2-5).

Figure 5.2-7 shows container loading and unloading operation by quayside container cranes while Figure 5.2-8 shows container loading and unloading operation by means of ship gears.



Source: JICA Survey Team

Figure 5.2-5 Ship Simultaneous Cargo Handling Situation (4 ship all, 2 Derrick equipped container ship)

Loading and unloading works using 2 units of QC and 4 units of RTG at Berth No.7 and 8 in front of Stacking Yard C are shown in Figure 5.2-7.

Source: JICA Survey Team
*Back side: Berth No. 8, Container vessel: "YGRA" Loading of Export containers by 1 unit of QC,
*Front side: Berth No. 7, Container vessel: "CHANA BHUM", Loading of Export containers by 1 unit of QC
*Yard-Transportation of Export containers by Yard-chassis and Lift-off of container by 4 units of RTG in the Yard "C" (RTG Yard)
* Using 2 units of QC and 4 units of RTG)
* Pictured on May 7, 2016 (Saturday, around AM4:30)

Figure 5.2-6 Loading of Export Containers at Berth No. 7 & 8

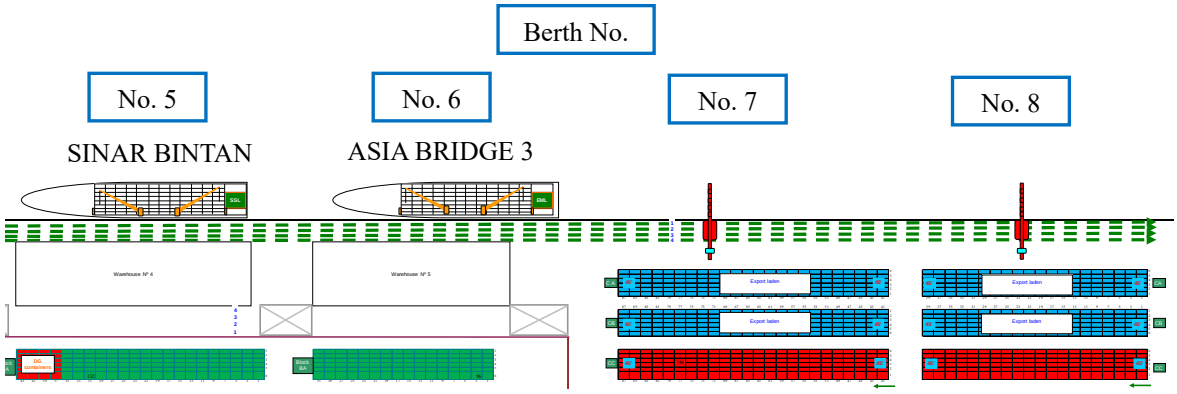
The loading work of Export containers in Berth No.5 and 6 in front of two warehouses is carried out by 2 Derricks, and it is shown in Figure 5.2-7. A Reach Stacker is loading import container onto Yard Chassis at the wharf of Berth No. 5.

Source: JICA Survey Team
*Back side: Berth No. 5, Container vessel: "SINAR BINTAN"(SAMDERA)
Unloading of containers by 2-Derricks & Lift-on of container onto Yard chassis using Reach Stacker
*Front side: Berth No. 6, Container vessel: "ROTA YAKYAT", Unloading by 2-Derricks
* Pictured on May 7, 2016 (Saturday, around AM4:30)

Figure 5.2-7 Loading of Export Containers Using by Two (2) Derricks installed on Vessel

In addition, the coal unloading work of the carrier "LATOUR" which was berthed at Berth No. 5 in front of warehouse on May 10th is shown in Figure5.2-9. Also the loading work of tapioca of Bulk Carrier "ASIA BRIDGE 3" which was berthing to the Berth No. 6 is shown in Figure 5.2-9.

Berth No.5 and 6 is usually used for loading and unloading of general cargo such as Tapioca, coal and used cars. However, container handling by means of ship gear (derrick) of a container ship is carried out here on the weekend when many container ships call the port.



Source: JICA Survey Team
* Pictured on May 10, 2016 (Wednesday, around PM4:00)

Figure 5.2-8 Tapioca and Coal Handling Status

Unloading of Wood-Tip (Back-Haw & Dump Truck)
(Vessel Name: "LATOUR")

Loading of Tapioca using two derrick
(Vessel Name: "ASIA BRIDGE 3")

Source: JICA Survey Team
* Pictured on May 10, 2016 (Wednesday, around PM4:00)

Figure 5.2-9 Photos of Tapioca and Coal Handling Status

Annual container handling volume in 2015 was 390,000 TEUs, of which about 15% (or 60,000 TEUs) was loaded and unloaded at the wharf in front of two warehouses and about 85% (or 330,000 TEUs) was loaded and unloaded at the No. 7 and No. 8 wharves.

On average, 12 container ships are berthing at Sihanoukville Port per week which has necessitates that loading and unloading operations of two ships be carried out at Berth No. 5 & 6. At these berths, reach stacker and derrick of ship or Harbor cranes are employed for handling works. On the weekend, 4 container ships are berthed at Berth No. 5, 6, 7 and 8 where loading and unloading works are carried out simultaneously.

According to a manager of the Operation department, a container ship that is docked in front of the warehouse may be requested to change berths (from Berth No. 5 or 6 to Berth No. 7 or 8). The purpose is to reduce the number of berthing days for the convenience of the shipping company.

The actual handling productivities by QC and by derricks in front of the warehouses are shown in Table 5.2-2.

The reason why the gantry crane was not used at the beginning of the opening of the existing container terminal is thought to be that the usage fee was high and that small ships with cargo gears (i.e., capable of loading and unloading using own cargo gear) were in service.

At present, large-sized container ships without cargo gear are in service, and the gantry cranes are in full operation on weekends for loading/unloading container vessels.

Table 5.2-2 Actual Handling Productivity by Derrick and QC

	Handling Quantity / Hour by Derrick at Berth No. 5 and 6 (in front of two (2) warehouses)	Handling Quantity / Hour by QC at Berth NO. 7 & 8 (RTG Yard: C)
Productivity of Wharf	Average 6 boxes /Hour/Derrick	Average 25 boxes /Hour/QC

Source: PAS, Technical Materials-Construction Department

The monthly volumes are shown in Figure 5.2-10 and 5.2-11. Regarding the breakdown of Loading and Unloading containers in 2015, the ratio of 20 ft and 40 ft containers of total handling volume is 40% and 60% respectively.

The total number of 20 ft containers handled = 244,000 TEUs x 40% = 97,600 Boxes, Total handling volume of 40 ft containers = 244,000 TEUs x 60% = 146,400 TEUs, therefore, Total TEUs = 97,600 TEUs + 146,400 TEUs x 2 = 390,400 TEUs

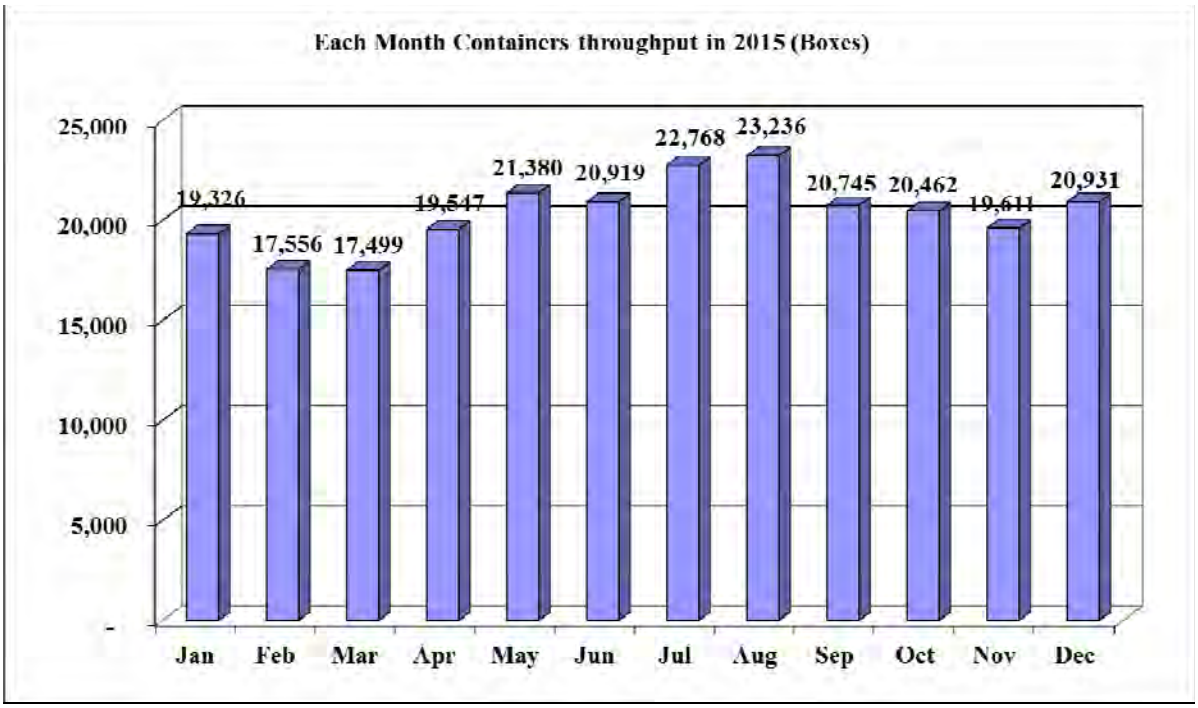
Volumes decrease in February and March but increase significantly in July and August.

Regarding the weight of containers, rice is exported using 20 ft containers which weigh 20 tons, while garments exported using by 40 ft containers which weigh 10 tons on average.

Table 5.2-3 Anneal Handling Volume in 2015（Boxes and TEUs）

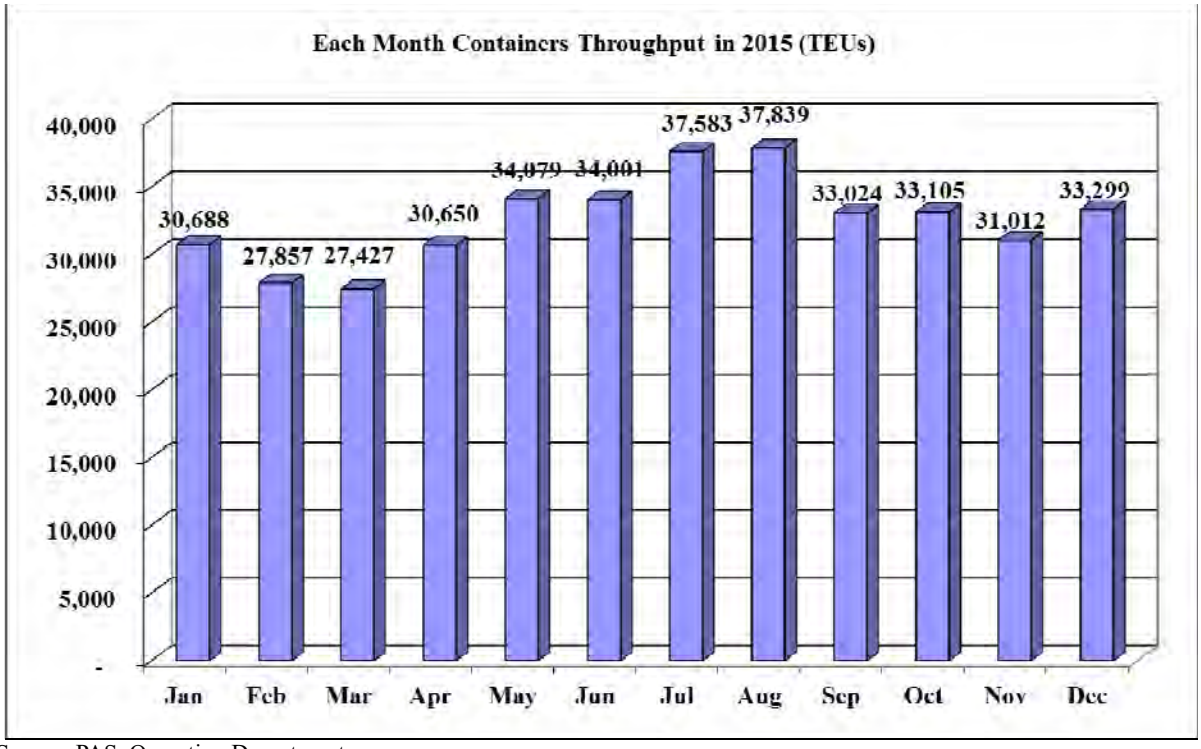
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Boxes	19,326	17,556	17,499	19,547	21,380	20,919	22,768	23,236	20,745	20,462	19,611	20,931	243,980
TEUs	30,688	27,857	27,427	30,650	34,079	34,001	37,583	37,839	33,024	33,105	31,012	33,299	390,564

Source: PAS, Operation Department



Source: PAS, Operation Department

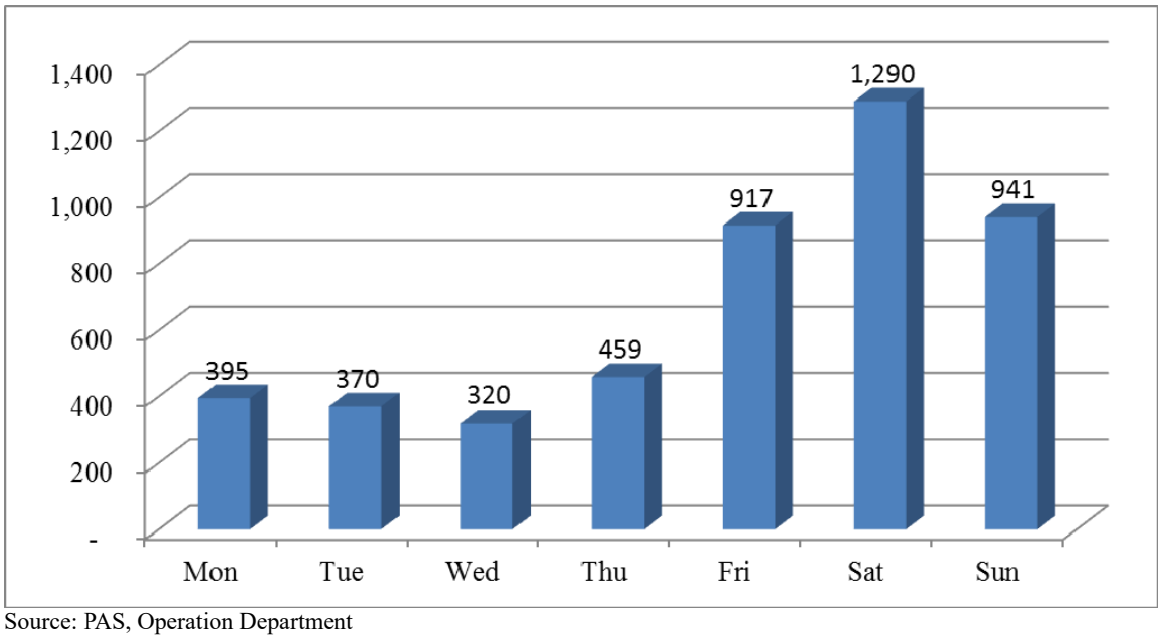
Figure 5.2-10 Annual Container Handling Volume in 2015 (Boxes)



Source: PAS, Operation Department

Figure 5.2-11 Annual Container Handling Volume in 2015 (TEUs)

The trend of the average container handling volume for each day of the week over a 12 month period is shown in Figure 5.2-12. Of the total container handling volume of 4,692 TEUs, it can be seen that the majority of containers (67% of the total) are handled on Friday (917 TEUs), Saturday (1,290 TEUs) and Sunday (941 TEUs).



Source: PAS, Operation Department

Figure 5.2-12 Changes in Average Container Handling Amount for Each Day of the Week of Existing Container Terminal in 2015

The average dwell time (days) of containers in 2015 and the 4-month period from January to April in 2016 is shown in Table 5.2-4.

In the calculating the annual handling capacity of the container terminal, the Average Dwell Time will be assumed as 5 days.

Table 5.2-4 Average Dwell Time of Container in 2015 and 2016 (January to April)

	2015	2016 (Jan. to Apr.)
Export Container	3.5 days	4 days
Import Container	4.15 days	5 days

Source: PAS, Technical Materials-Construction Department

(4) Implementation Status of X-ray and γ-ray Inspection

X-ray or γ-ray inspection is carried out for all import containers. Regarding export containers, the inspection of the factory shipment is not necessary in the container terminal because they will be inspected in the factory. Agricultural products such as rice, however, are subject to inspection; about 20% of export containers of agricultural products undergo an X-ray inspection. Non-destructive testing is applied to all imported containers.

The X-ray Inspection Facility is shown in Figure 5.2-13 and the Gamma-ray Inspection Facility is shown in Figure 5.2-14. These test facilities, which are located in the container terminal, are managed Customs.

During the survey period, not many trailers were observed waiting in front of the inspection facilities from Monday to Wednesday.

Source: JICA Survey Team

Figure 5.2-13 X-ray Inspection Facility

Source: JICA Survey Team

Figure 5.2-14 Gamma-ray Inspection Facility

5.2.2 Evaluation of Cargo Handling Capacity of the Existing Container Terminal

The theoretical container handling capacity of the existing container terminal is calculated below.

The layout of the existing container terminal is shown in Figure 5.2.1. For the purpose of the calculation, Effective utilization ratio, Dwell Time (in general, the number of days) and Peak ratio of container yard are assumed as a follows.

- Effective utilization ratio of Yard : 0.75
- Peak ratio of annual or monthly handling amount: 1.4
- Average Dwell time of a container : 5 days (See Table 5.2-5.)

The number of Ground Slot and container storage capacity are shown below.

- Ground Slot of Yard A & B : 1,138 TEUs
- Ground Slot of Yard C : 2,100 TEUs
- Total Ground Slot of Existing CT : 3,238 TEUs
- Yard A & B : Handled by Reach Stackers

Here, CT: Container Terminal, CY: Container Yard

Table 5.2-5 Number of Ground Slot and Container Storage Capacity

Item	Unit	Value
Total Ground Slot of Existing CT	TEU	3,238
Dead Maximum CY Capacity/time	TEU	12,952
Effective utilization ratio of Yard		0.75
Peak ratio (of annual or monthly handling amount)		1.4
Average Dwell time of a container	Day	5
Workable Maximum CY Capacity/time	TEU	9,714
Sustainable Maximum CY Capacity/time	TEU	6,938
Sustainable CY Capacity/Year	TEU/year	506.474

Source: JICA Survey Team

5.3. Evaluation of Cargo Handling Capacity of Existing Container Terminal after Installation of New Equipment

Annual container handling capacity of the existing container terminal is evaluated in below on the assumption that new cargo handling equipment, namely two (2) sets of QC and nine (9) sets of RTG are installed, besides reach stacker system currently adopted at Yard A & B is converted to an RTG system.

5.3.1 Calculating Condition of Annual Handling Capacity

The prerequisites used in calculating the annual container handling capacity are as follows.

Yard A and Yard B which currently employs a reach stacker system will be modified to become a RTG yard.

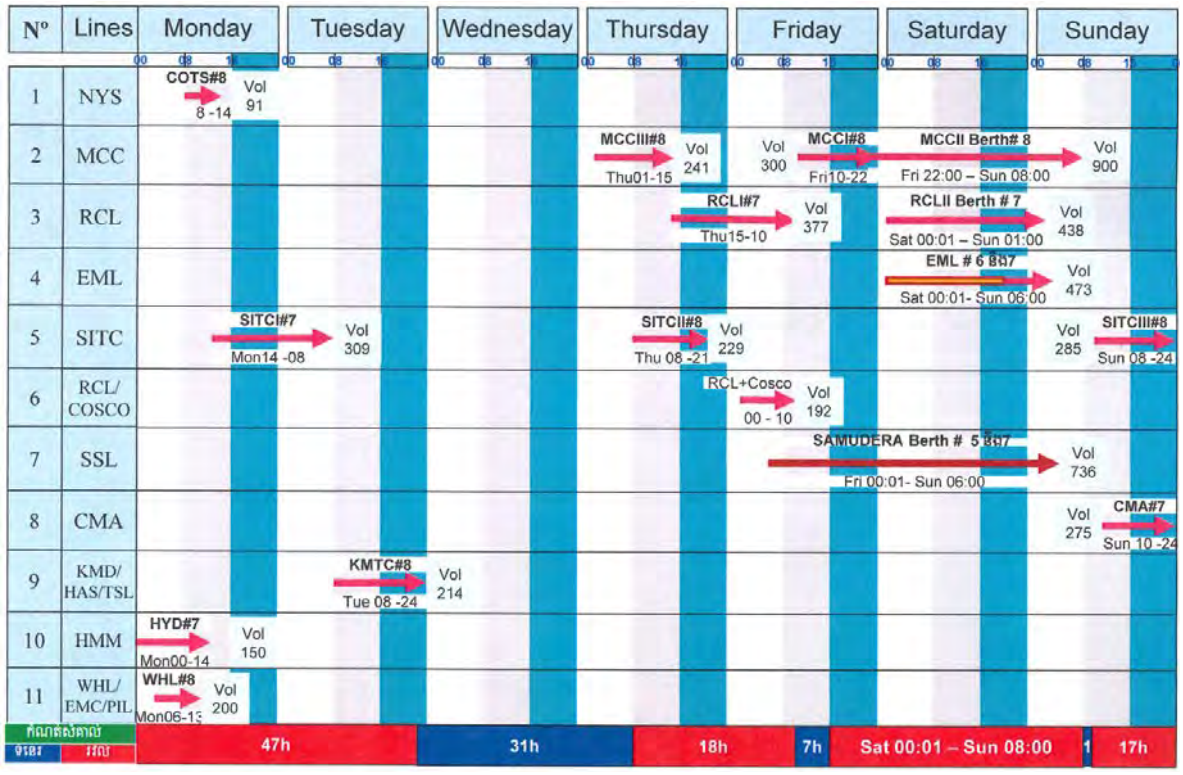
The number of QC installed in Berth No. 7 & 8 is 4 or 5 units.

The number of RTG will be increased in accordance with the increase of QC mentioned above. (According to the current plan, the total number of RTG will be 16 units until around middle of 2017.

Off-Dock Container Yard (Dry Terminal) is assumed to be allocated outside of the existing container terminal.

The total number of loading & unloading containers per ship is assumed around 500 Boxes.

According to Figure 5.3-1 "Schedule of Vessels calling and Departure per Week in 2016", container handling quantity per ship is around 350 Boxes/ship and sometimes 700 Boxes/ship or more.



Source: PAS, Operation Department
* Container Handling Volume a Vessel per Week (Average) for 3 months in 2016)

Figure 5.3-1 Schedule of Calling and Departing Vessels per Week in 2016

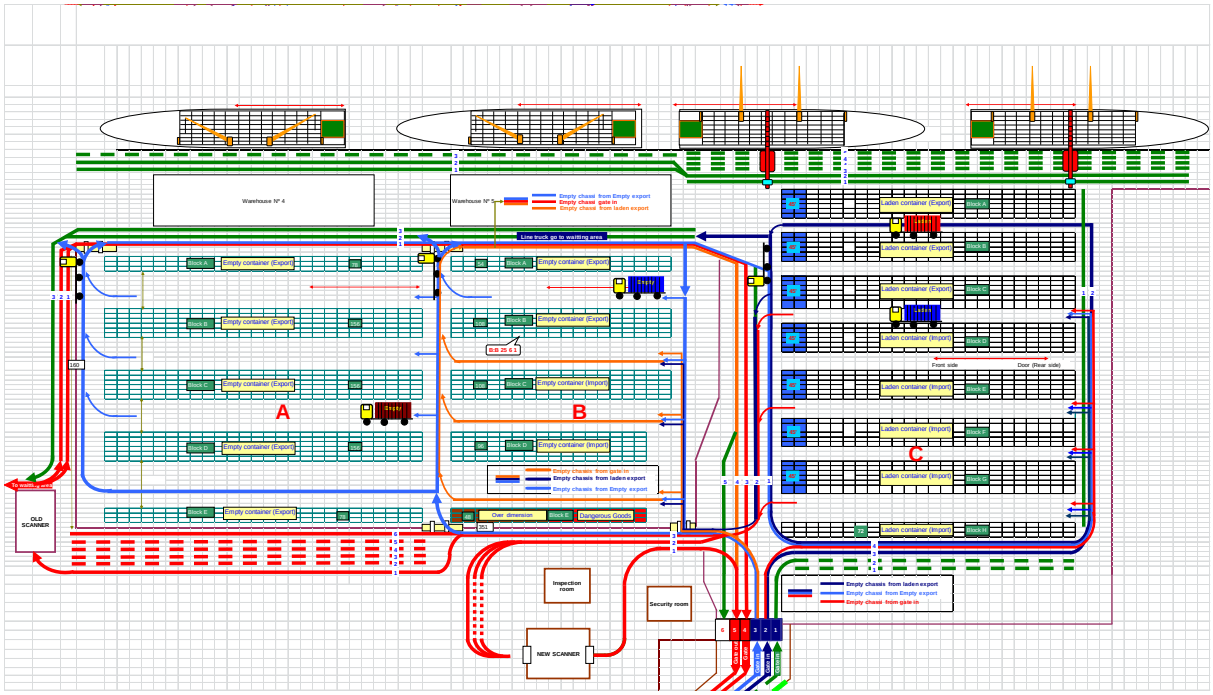
5.3.2 Cargo Handling Capacity after Installation of New Equipment

The layout of the existing container terminal after an RTG system is introduced is shown in Figure 5.3-2.

According to this layout, cargo handling in the quay side in front of two warehouses and the land side of Yard A & B is still carried out by Reach Stackers.

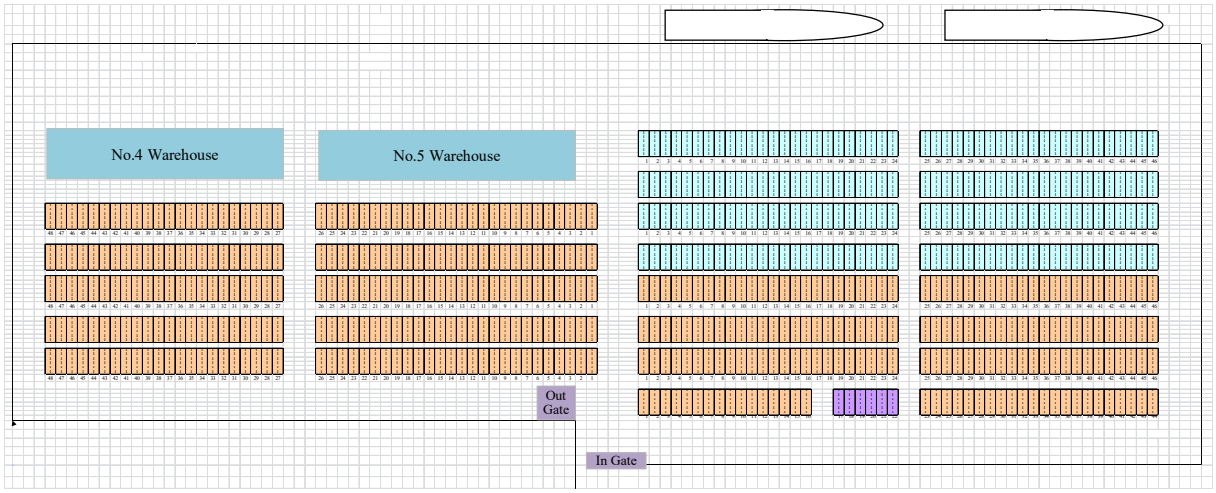
The operation of Container Terminal is not fully carried out by RTG. To make this a fully RTG-operated container terminal, 5 lanes of the present RTG Lanes of Yard C must be extended and the RTG operation system must be adapted to the whole container terminal. PAS is planning the layout of Yard A and B to change to RTG lanes.

The layout of Full RTG-operated container terminal is shown in Figure 5.3-3.



Source: PAS, Operation Department

Figure 5.3-2 Layout of Existing Container Terminal after Modification to RTG Operation Yard (PAS Plan)



Source: JICA Survey Team

Figure 5.3-3 Layout of Existing Container Terminal after Modification to RTG Operation Yard (JICA Survey Team's Plan)

Effective utilization ratio, Dwell Time (in general, the number of days) and Peak ratio of container yard are assumed as follows.

- Effective utilization ratio of Yard: 0.75
- Peak ratio of annual or monthly handling amount: 1.5
- Average Dwell time of a container: 5 days (See Table 5.2-4)

The number of ground slots and container storage capacity are given below.

- Ground Slots of Yard A & B : 1,440 TEUs
- Ground Slot of Yard C : 2,196 TEUs
- Total Ground Slot of Existing CT : 3,636 TEUs

Here, CT: Container Terminal, CY: Container Yard

When the existing container terminal is fully converted to an RTG-operation system, the number of RTG with 1 over 5 and 1 over 4 will be 9 units and 7 units respectively. As 7 units of 1 over 5-RTG are introduced in the 7 Lanes of the seaside of Yard C, it will be possible to stack average 4.356 tiers. And also, it would be possible to stack average 3.3 tiers in the 8th Lane of Yard C. When the number of stacking container of Yard A & B of the existing container terminal is assumed to be 3.5-stacks, the cargo handling capacity of the existing container terminal is about 540,000 TEUs.

In order to increase the cargo handling capacity moreover, Off-Dock CY outside the present port area is required, in addition to newly introduced cargo handling equipment as shown in Table 5.1-3. In case that 9 ha of Off-Dock CY is introduced, though it is not acquired at present, total the cargo handling capacity of the existing container terminal will be about 700,000 TEUs. Breakdown of each Container Yard is shown Table 5.3-1.

Table 5.3-1 Cargo Handling Capacity of Each Container Yard

Stacking Yard	Unit	CY Yard "C"	CY Yard "A" & "B"	Off-dock CY 9 ha
Number of Stacking Tier	tier	4.356	3.5	4
Total Ground Slot of Existing CT	TEU	2,196	1,440	1,200
Dead Maximum CY Capacity/time	TEU	9,565	5,040	4,800
Effective utilization ratio of Yard		0.75	0.75	0.75
Peak ratio (of annual or monthly handling amount)		1.5	1.5	1.5
Average Dwell time of a container	Day	5	5	5
Workable Maximum CY Capacity/time	TEU	7,174	3,780	3,600
Sustainable Maximum CY Capacity/time	TEU	4,783	2,520	2,400
Sustainable CY Capacity/Year	TEU/year	349,150	183,960	175,200
Total Sustainable (Yard C + Yard A & B) Capacity/Year	TEU/year	533,410		-
Total Sustainable (CY + Off-dock CY) Capacity/Year		708,610		

Source: JICA Survey Team

5.3.3 Confirmation of Cargo Handling Capacity from the Viewpoint of the Efficiency of Equipment

The theoretical calculation of annual container handling volume based on the efficiency of QC is carried out under the following conditions.

1) Theoretical handling capacity of a QC: 30 Boxes / Hour
2) The wharf cargo handling capacity is calculated based on average two units of QC, which are engaged in the loading and unloading of the container of a ship. Further, in the case of cargo handling by three units of QC, the wharf cargo handling capacity is calculated in consideration of work ratio of each QC.
3) Target vessel: Panamax container ship

Annual Container Handling Volume of Berth of Existing Container Terminal is shown in the following Table.

Table 5.3-2 Annual Container Handling Volume of Berth of Existing Container Terminal

Item	Unit	Value		
Berth Length	m	450		
QC No.		No. 1 & 2	3rd & 4th	5th
Annual Working Hours	Hour	8,760	8,760	8,760
Theoretical Handling Capacity of QC	Box/Hour	30	30	30
Operation Availability of QC		0.833	0.833	0.833
Handling Capacity of QC		25	25	25
Gross Working Hours		15	15	15
Operation Availability of Berth		0.625 (15/24)	0.625 (15/24)	0.625 (15/24)
Work-share Ratio of QC		1.0	0.8	0.5
Annual Handling Quantity / QC		136,875	109,500	27,375
Conversion Rate from Box to TEU	TEU/Box	1.6	1.6	1.6
Annual Handling Volume (TEU)/QC	TEU	219,000	175,200	68,437
Number of QC	Unit	2	2	1
Annual Container Handling Volume per Berth	TEU	788,400		68,437

Source: JICA Survey Team

According to the previous section 5.3-1, the annual container handling capacity of New Terminal No. 1 with Off-dock CY becomes about 700,000 TEUs, and the required number of QC to be installed in the Berth No. 7 & 8 is 4 units in order to achieve a cargo handling capacity of the new container terminal. Cargo handling capacity of these berths by 4 units of QC will be about 790,000 TEUs.

In the case mentioned above, the actual cargo handling capacity of QC is assumed based on 25Boxes/Hour. If however, productivity is only 20 boxes/hour, the annual handling capacity would be reduced to 630,000 TEUs, that is, it would be less than the cargo handling capacity of the container terminal. For this reason, 3 units of QC should be installed in the existing container terminal to ensure that operations proceed smoothly.

It should be noted that the theoretical cargo handling capacity mentioned above does not consider cases in which ships call the port with relatively small loads. Specifically, when a Panamax type ship berths with a load of only 300 boxes, the capacity mentioned above cannot be achieved.

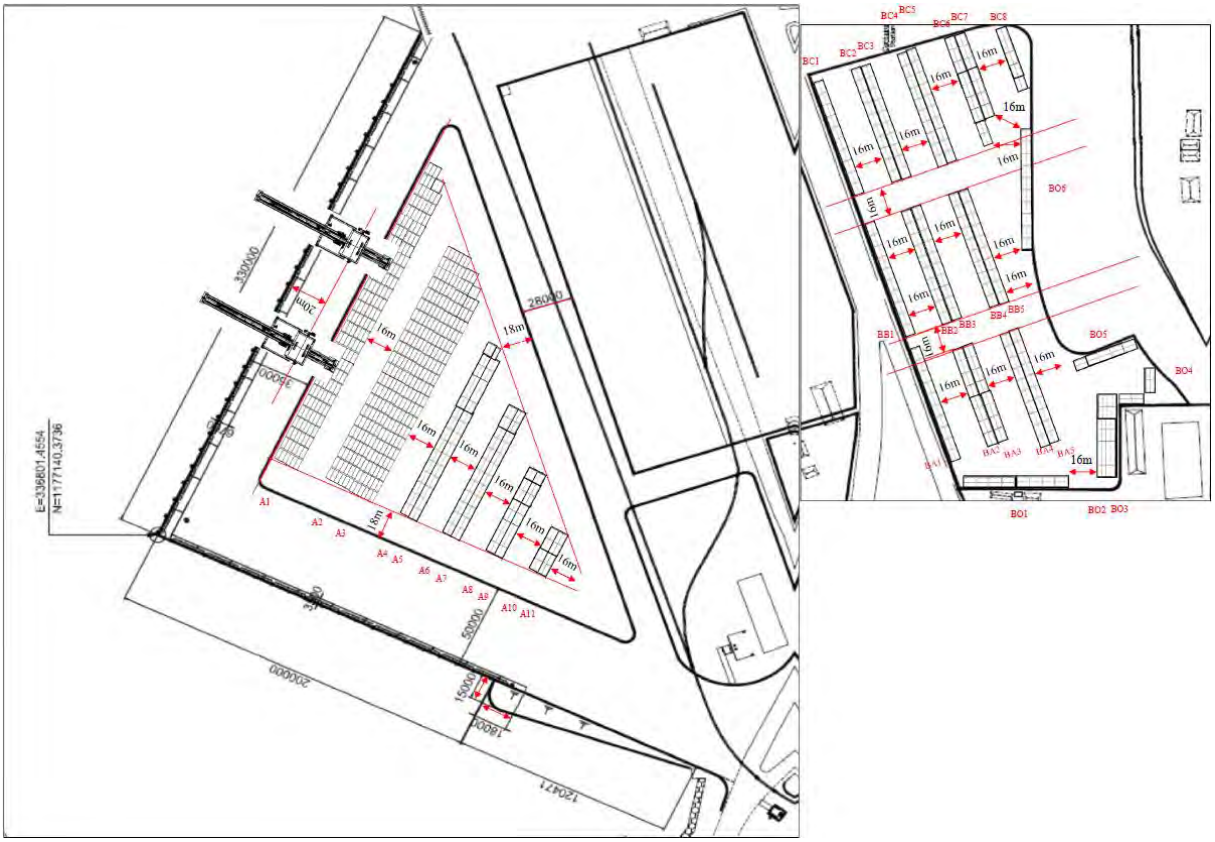
For example, when the "Operation Availability of Berth" is approximately 0.45 (average three days full operation per week), cargo handling amount by handled 4 Quayside Container Cranes will be about 560,000 TEUs (i.e. 788,0008 TEUs x 0.45 / 0.626 = 567,000 TEUs).

The wharf cargo handling capacity in the above table merely means achievable cargo handling capacity. It will be difficult to achieve 700,000 TEUs even with 4 or 5 units of QC unless quay occupancy rates and productivity is improved.

5.4. Examination of Container Handling Capacity of Multi-Purpose Terminal

5.4.1 In Case of Handling by Rail-Mounted Gantry Cranes

If the new container terminal cannot be realized, or a significant delay occurs, it is conceivable that the multi-purpose terminal could be used as a temporary container terminal. The cargo handling efficiency in case of using the multi-purpose terminal as a container terminal is examined below. The layout of the Multi-purpose Terminal is shown in Figure 5.4-1.



Source: JICA Survey Team

Figure 5.4-1 Layout of Multi-Purpose Terminal

If a "6 row-stacking storage" operation is performed by Reach Stacker at the Multi-purpose Terminal, it is necessary to note the following points.

1) Export containers are to be marshaled to each destination.
2) Empty containers are to be sorted by type and by shipping company.
3) As random pick-up will be applied for stored import containers, the following conditions need to be borne in mind.

a) About 50 percent of yard storage capacity is not sorted to 6-rows (like export containers) but to 2-rows stacking (for import containers).
b) In order to compensate for the reduction in container storage capacity, the width of passage and work area of the Reach Stacker yards is to be 15-16 m.
c) 45 ft containers are to be stocked in each end of Lanes, and containers stocked at the bays of the center area of each Lane should be 20 ft or 40 ft.

Therefore, even if the Reach Stacker performs shift operation in the yard while lifting a container (this frequently occurs), Clearance between 20 ft containers is to be set to 40 Cm in consideration of the safe operation and periodic inventory check.

The annual container Handling capacity of the existing container terminal, in case of assuming cargo handling by two Rail-Mounted Gantry Cranes for multi-purpose use installed on the wharf, will be 140,000 TEUs as described in Table 5.4-1

Table 5.4-1 Cargo Handling Capacity by Rail-Mounted Gantry Cranes

Item	Unit	Value	Remarks
Dead Max. CY Capacity/time	TEU	3,397	Refer to the volume mentioned above
Dead Max. CY Capacity/time	TEU	0.75	
Peak ratio (of annual or monthly handling amount)		1.3	
Average Dwell time of a container (days)	day	5	
Workable Max. CY Capacity/time	TEU	2,548	(Dead Max. Capacity/time x 0.75)
Sustainable Mac. CY Capacity/time	TEU	1,960	CY Peak Factor as 1.3
Sustainable CY Capacity/Year	TEU	143,066	5 days as average CY-dwelling time of the containers

Source: JICA Survey Team

Therefore, it is possible to conduct cargo handling using 2 multi-purpose gantry cranes. However, container handling is not expected to be performed at the multi-purpose terminal after operations commence at the new container terminal.

5.4.2 In Case of Handling by Ship Derricks

Annual container handling capacity calculated below, assuming that cargo handling equipment is not installed on the quay and that cargo handling at the berth is performed by derricks mounted on a container ship.

As shown in Table 5.4-2, container handling capacity in the case of two derricks mounted on a container ship is about 100,000 TEUs.

Table 5.4-2 Cargo Handling Capacity by Ship Derricks

Item	Unit	Value	Remarks
Cargo Handling Capacity/Derrick	Box/Hour	6	
Number of Derrick/Ship		2	
Cargo Handling Capacity of 2 units of Ship Gear	Box/Hour	12	
Cargo Handling Time/Day	Hour/Day	18	3 Shifts/Day: 6 Hours/Shift x 3 Shifts = 18 Hours/Day
Number of Cargo Handling Container/Day	Box/Day	216	
Container Handling Number/Ship	Box/Ship	350	Track record of PAS in 2016 (Average number of loading and unloading containers per vessels for total 15-16 ships calling at berth a week)
Required Container Handling day/Ship	Day/Ship	1.71	
Annual Days	Day	365	
Wharf Annual Availability/Ship		0.75	Number of days of Container ship berthing: 273 days of 365 days/Year
Number of Ship Call to Berth/Year	Ship/Year	160	
Annual Container Handling Capacity	Box	59,130	
Ratio to 20 ft Container		1.6	Actual Conversion Ratio to 20 ft of container in 2016
Annual Container Handling Capacity	TEU	94,608	

Source: JICA Survey Team

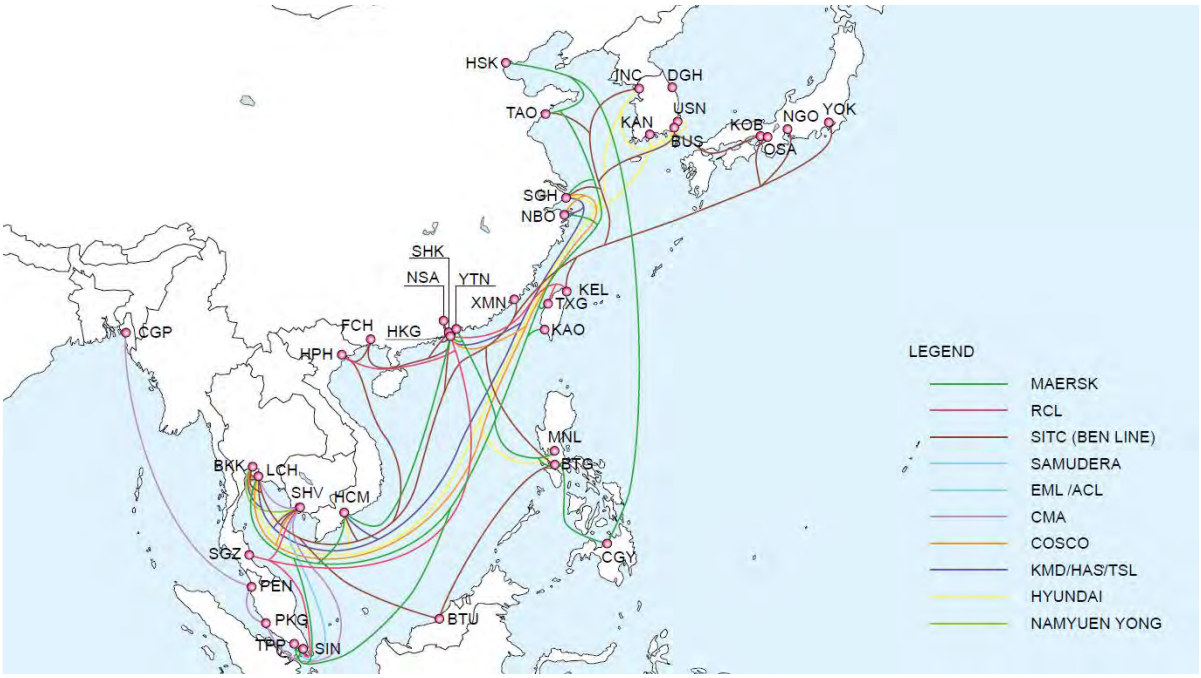
6. DEMAND FORECAST

6.1. Present Situation and Circumstances of Container Cargoes

6.1.1 Shipping Trend

(1) Shipping Route

International liner services are calling at the Sihanoukville Port, and the directly linked ports are: Singapore, Tanjung Pelapas, Hong Kong, Ho Chi Minh, Laem Chabang, Chittagong, Manila, Songkhla, Kuantan, Kobe, Osaka, Nagoya, Yokohama, Shanghai, Busan, Ningbo, Yantian, and so on. Most of the cargoes to/from Europe and North America are transited to the mother vessel at Singapore Port. Liner shipping loops from/to Sihanoukville Port are shown in Figure 6.1-1 and their details are shown in Table 6.1-1.



Source: PAS

Figure 6.1-1 Liner Service Loops from Sihanoukville Port

Table 6.1-1 Liner Shipping Services from Sihanoukville Port (2016)

Shipping lines	Calling Schedules	Frequency	Port Calling Rotation
MAERSK (MCC)	1. Thu 01:00 Thu 15:00 2. Fri 10:00 Fri 22:00 3. Fri 22:00 Sun 08:00	1 call / week 1 call / week 1 call / week	1. YTN-SHV-LCH-SGH-NBO-KAO-MNL-YTN-HKG-BTG-CGY-HSK-TAO-TXG-HKG-YTN 2. YTN-SHV-LCH-SGH-NBO-KAO-MNL-YTN-HKG-BTG-CGY-HSK-TAO-TXG-HKG-YTN 3. HCM-SHV-TPP-SIN-BTG-KAO-YTN-HKG-HCM
RCL	1. Thu 15 : 00 - Fri 10 : 00 2. Sat 00 : 01 - Sun 01 : 00	1 call / week 1 call / week	1. HKG-SHV-SGZ-HKG-HPH-HKG-KEL-TXG-HKG 2. SIN-SHV-SGZ-SIN
SITC (BEN LINE)	1. Sun 08 : 00 - Sun 24 : 00 2. Mon 14 : 00 - Tue 08 : 00 3. Thu 08 : 00 - Thu 21 : 00	1 call / week 1 call / week 1 call / week	1. HCM-SHV-BKK-LCH-HCM-NSA-SGH-OSA-KOB-BUS-SGH-HKG-HCM 2. HCM-SHV-BKK-LCH-HPH-FCH-SHK-XMN-INC-TAO-SGH-NGO-YOK-HKG-HCM 3. HKG-SHV-LCH-BTU-BTG-SGH-KEL-SHK-HKG
SAMUDERA (SSL)	Fri 00 : 01 - Sun 06 : 00	1 call / week	SIN-SHV-SIN
EML / ACL	Sat 00 : 01 - Sun 06 : 00	1 call / week	SIN-SHV-SIN
CMA	Sun 10 : 00 - Sun 24 : 00	1 call / week	PKG-SHV-LCH-PKG-CGP-PEN-PKG
COSCO	Fri 00 : 00 - Fri 10 : 00	1 call / week	SHK-SHV-BKK-LCH-NBO-SGH-SHK
KMD/HAS/TSL	Tue 08 : 00 - Tue 24 : 00	1 call / week	HCM-SHV-BKK-LCH-SGH-NBO-SHK-HCM
HYUNDAI (HMM)	Mon 00 : 01 - Mon 14 : 00	1 call / week	LCH-SHV-MNL-BUS(T)-BUS(H)-INC-TXG-BUS(H)-USN-BUS(T)-KAN-SGH-HCM-LCH
NAMYUEN YONG (NYS)	Mon 08 : 00 - Mon 14 : 00	3 call / month	BKK-LCH-SHV-BKK

BKK	Bang Kok, Thailand	HPH	Hai Phong, Vietnam	NGO	Nagoya, Japan	TPP	Tanjung Pelepas, Malaysia
BTG	Bantagas, Philippines	HSK	Xingang, China	NSA	Nansha, China	TAO	Qingdao, China
BTU	Bintulu, Malaysia	INC	Inchon, South Korea	OSA	Osaka, Japan	TXG	Taichung, Taiwan
BUS	Busan, South Korea	KAN	Kwang Yang, South Korea	PEN	Penang, Malaysia	USN	Ulsan, South Korea
CGP	Chittagong, Bangladesh	KAO	Kaohsiung, Taiwan	PKG	Port Klang, Malaysia	XMN	Xiamen, China
CGY	Cagayan De Oro, Philippine	KEL	Keelung, Taiwan	SGH	Shanghai, China	YOK	Yokohama, Japan
DGH	Donghae, South Korea	KOB	Kobe, Japan	SGZ	Songkhla, Thailand	YTN	Yantian, China
FCH	Fangcheng, China	LCH	Laem Chabang, Thailand	SHK	Shekou, China		
HCM	Ho Chi Minh, Vietnam	MNL	Manila, Philippines	SHV	Sihanoukville Port, Cambodai		
HKG	Hong Kong, China	NBO	Ningbo, China	SIN	Singapore, Singapore		

Source: PAS

(2) Ship Size

Currently, there are 15-16 container ships calling at the Sihanoukville Port per week, and the loading capacity ranges from 600 TEUs to 1,000 TEUs.

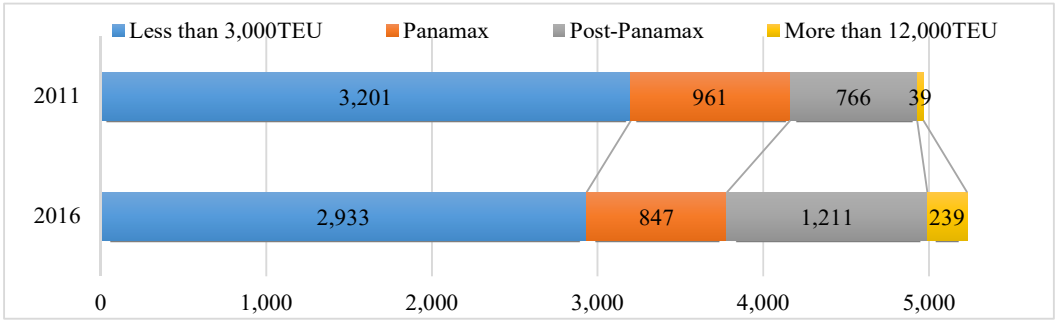
In recent years, the trend of increase in maximum ship size is seen in order to improve the transport efficiency on the background of globalization and increasing volume of the seaborne cargo. In particular, increase in the size of the container ship is remarkably progressing.

Figure 6.1-2 shows the number of container ships by size in 2011 and 2016. In the past five years, the number of vessels in Post-Panamax[1] and more than 12,000 TEUs category has increased, and contrastingly the number of vessels in Panamax[2] and less than 3,000 TEUs category has declined. Moreover, the opening of New Panama Canal on 26 June 2016 underpinned the prospect of worldwide ship size increase trend.

Besides, it has been estimated by the latest report of OECD that both maximum and average size of container ships will grow over the coming years based on the ship orders that are currently under construction. The abstract of this report is shown in Appendix-6.1.

[1] The definition of Panamax is the maximum ship size that can pass the Panama Canal before the completion of the expansion work in June 2016. A typical ship specifications are shown below:
LOA: 294.1 m, Beam: 32.3 m, Draft: 12.0 m, Capacity (maximum): about 5,000 TEUs

[2] The definition of Post-Panamax is the maximum ship size that can pass the Panama Canal after the completion of the expansion work in June 2016. A typical ship specifications are shown below:
LOA: 365.8 m, Beam: 48.8 m, Draft: 15.2 m, Capacity (maximum): about 12,000 TEUs



Source: Japan Maritime Center

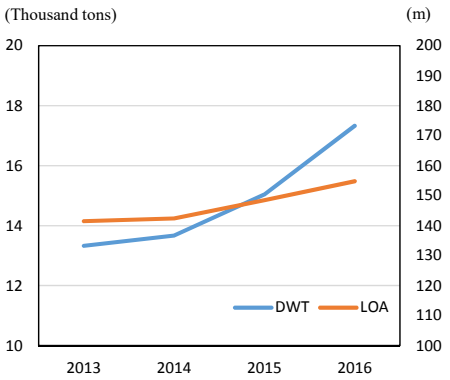
Figure 6.1-2 Worldwide Trend in Number of Container Ship by Size in 2011 and 2016

In Sihanoukville Port, the increase in the size of container ship is progressing, even in recent years. Figure 6.1-3 shows the average specifications of container ships from 2013 to 2016, such as DWT, LOA, draft and so on. It can be said that even large-sized container ships will be able to berth by the completion of this development project.

The specifications shown in Figure 6.1-3 are the average of overall calling ships. As of September 2016, the size of the largest container ship in Sihanoukville Port is shown below:

- DWT: 30,646 tons
- LOA: 188.03 m
- Capacity (maximum): 2,100-2,500 TEUs

	2013	2014	2015	2016
DWT (tons)	13,330	13,667	15,037	17,331
GT (tons)	10,080	10,296	11,597	13,760
NT (tons)	5,060	5,219	5,479	6,061
Maximum TEU	700-1,200	700-1,200	800-1,400	900-1,600
LOA (m)	141.5	142.4	148.5	154.8
Fore Draft (m)	6.2	6.4	6.2	6.6
Aft Draft (m)	6.9	7.1	7.1	7.2



Source: PAS

Figure 6.1-3 Trend of Average of Specification of Container Ship from 2013 to 2016

In addition to worldwide trend, there is a regional trend or so-called the Cascade Effect. The middle-scale ship in North American and European line might be shifted to Intra-Asia routes. The shift will result in the container ship size increase in the Intra-Asia routes.

Table 6.1-2 shows the statistics regarding the container ship size that classified service route in East Asia. The container ships operated in East Asia are feeder ships which are connecting the main hub port and the neighboring countries, and the type of ships was mainly from 500 to 2,000 containers loading size. Along with the increase of cargo volume in the feeder ports, 4,000 containers loading (50,000-60,000 DWT) ship has been increasing. On the other hand, 4,000 containers loading ship has been decreasing in European and North American line, along with the increasing in the size of container ship. Based on these trends, it is thought that 4,000 containers loading ship is increasing in East Asia routes as a feeder ship, and the Cascade Effect is in progress. Therefore, it is necessary to forestall the problem such as insufficient water depth of port facilities in Sihanoukville Port.

Table 6.1-2 Container Ship Size Classified Service Route in East Asia

Unit: Vessel Numbers

Year	Ship Capacity (TEUs)	500	1,000	1,500	2,000	3,000	4,000	6,000	8,000	10,000	12,000
2012	Route Europe-East Asia	0	0	0	0	10	56	97	162	37	104
	Route North America -East Asia	0	2	8	14	21	291	91	70	4	1
	Route in East Asia Region	**214**	**235**	**154**	**95**	**18**	**33**	**0**	**0**	**0**	**0**
2013	Route Europe-East Asia	0	0	0	0	9	60	76	132	33	133
	Route North America -East Asia	0	3	7	8	16	274	92	102	8	2
	Route in East Asia Region	**210**	**244**	**254**	**106**	**20**	**45**	**0**	**0**	**0**	**0**
2014	Route Europe-East Asia	0	0	0	0	7	33	69	114	39	162
	Route North America -East Asia	0	2	7	8	6	233	98	111	34	5
	Route in East Asia Region	**195**	**259**	**153**	**106**	**24**	**66**	**0**	**0**	**0**	**0**

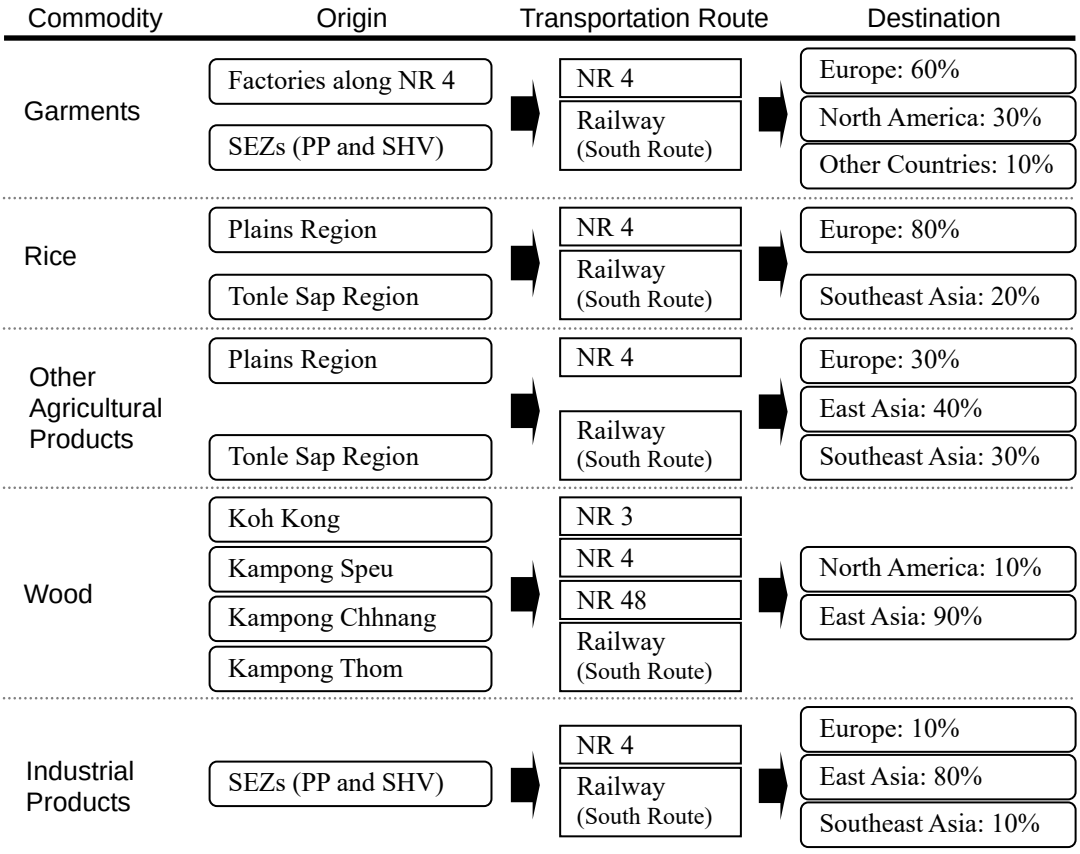
Source: National Institute for Land Infrastructure Management (ISSN 1346-7328)

In consideration of the increasing cargo demand of Sihanoukville Port, worldwide container ship size trend and the Port Authority of Sihanoukville (PAS) intense request, target ship size for design is regarded to be 60,000 DWT (4,000–4,600 TEUs) on the safe side. Detailed specifications are mentioned in Chapter 8 (8.1 Basic Concept).

6.1.2 Origin/Destination of Cargoes

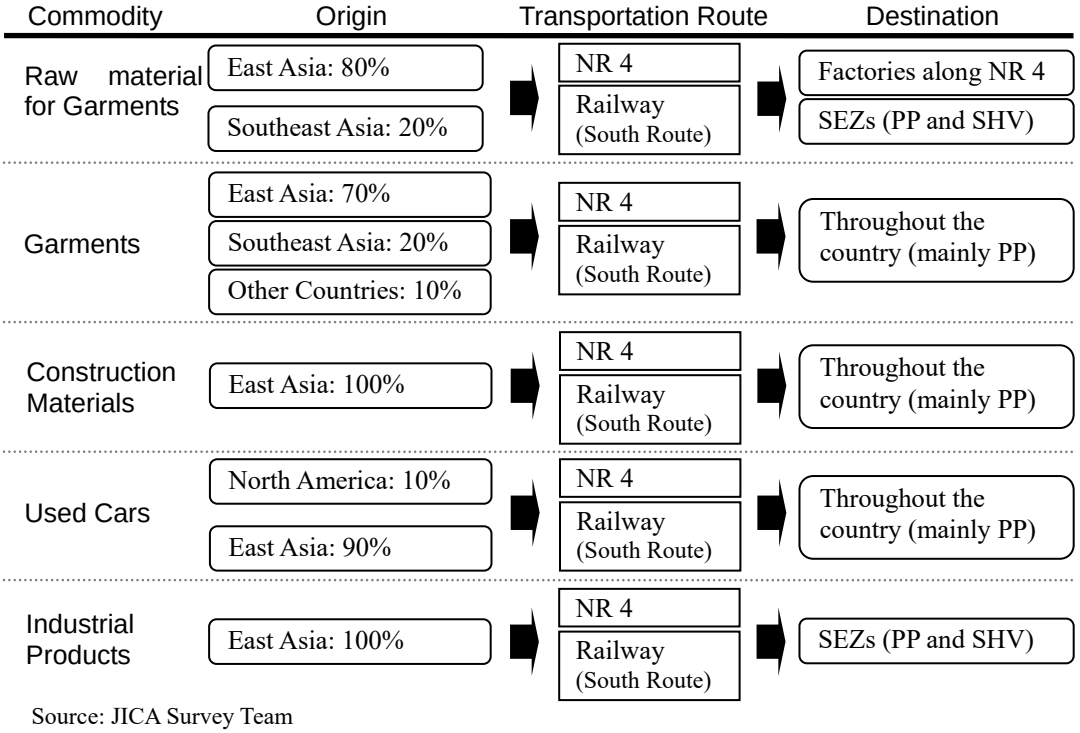
At present, most of the sea-born cargoes are transported through NR 4. While NR 48 and NR 33 functions as a border trade route to Thailand and Vietnam, respectively. On the other hand, the cargo volume transported by railway has been increased in accordance with the progress of the railway

rehabilitation project. The future commodity-wise transportation routes and main origin/destination of Sihanoukville Port are summarized in Figures 6.1-4 and 6.1-5.



Source: JICA Survey Team

Figure 6.1-4 Future Commodity-Wise Transportation Mode and Origin/Destination (Export)



Source: JICA Survey Team

Figure 6.1-5 Future Commodity-Wise Transportation Mode and Origin/Destination (Import)

6.2. Methodology of Demand Forecast of Container Cargo

(1) Outline of Methodology

Two methods, a macro forecast and a micro forecast, are generally used to forecast the future cargo volume. The macro forecast is based on the assumption that the cargo volume handled by the port reflects the economic activities in the port's hinterland, while the total cargo volume is forecasted using a statistical correlation between the cargo volume and economic indices.

On the other hand, micro forecast estimates the cargo volume of each commodity individually based on the national industrial development policy, individual industrial development plan, trend of containerization, logistic conditions including trade agreement, economic conditions of origin/destination countries, and various trade circumstances.

In this survey, the macro method was applied to obtain the cargo forecast. And then the result of macro forecast was verified by micro method, which forecasted the volume of each item of import and export by commodity individually. In the macro forecast, three growth scenarios, i.e., high, middle, and low were considered.

(2) Future Framework of Gross Domestic Product (GDP) and Population

The GDP and population were adopted as indices for the demand forecast of container cargo, bulk cargo, and general cargo. These indices were obtained from the latest figures of the International Monetary Fund (IMF) and the United Nations.

The growth rate of GDP and population for the cargo demand forecast are set as below.

Table 6.2-1 Real GDP Growth Projections (in percent)

Year	2015	2016	2017	2018	2019	2020	2021
Real GDP Growth	7.0%	7.0%	6.9%	6.8%	6.8%	6.5%	6.5%

Source: IMF[3]

Table 6.2-2 Population Growth Projections (in percent)

Year	2016-2020	2021-2025	2026-2030	2031-2035	2036-2040
Population Growth	1.52%	1.31%	1.13%	1.03%	0.93%

Source: United Nations[4]

[3] World Economic Outlook Database (October 2016)
[4] World Population Prospects (2015 Revision)

6.3. Macro Forecast of Container Cargo

(1) Setting of Three Growth Scenarios

For the setting of the three growth scenarios (high, middle, and low), the growth projections with the target year of 2030 from SDRI (Cambodia's Leading Independent Development Policy Research Institute) were adopted.[5]

Table 6.3-1 SDRI's Three Growth Scenarios (2030)

	Low Case	Middle Case	High Case
Growth Projections	5.0%	7.0%	9.0%

Source: SDRI

For the setting of middle case, the IMF's projections of the abovementioned (Table 6.2-1) were adopted, which expected in more detail.

The growth projections of each scenario adopted in this survey are set as below. The figures inside the parentheses show the complementing for the year without the predictive value. Regarding the after 2035 of the middle case, the IMF's projection in 2015 were adopted assuming that the Cambodia will be put on the track of new economic growth[6].

Table 6.3-2 Growth Projections of Each Scenario

Year	2015	2020	2025	2030	2035	2040
Low Case	(5.0%)	(5.0%)	(5.0%)	5.0%	(5.0%)	(5.0%)
Middle Case	7.0%	6.5%	(6.5%)	(6.5%)	(6.9%)	(6.9%)
High Case	(9.0%)	(9.0%)	(9.0%)	9.0%	(9.0%)	(9.0%)

Source: IMF and SDRI

(2) Container Cargo Throughput at the Sihanoukville Port

Container cargo throughput of Sihanoukville Port from 2000 to 2015 is shown in Table 6.3-3. It is observed that cargo throughput has increased steadily except for 2009. In 2009, cargo throughput was suddenly decreased due to the influence of the worldwide economic downturn triggered by the Lehman Brothers bankruptcy; however, it has recovered and steadily increased since then. Currently, cargo throughput has sharply increased, and its annual growth rates for 2014 and 2015 were 16.6% and 17.3%, respectively.

Although there are statistical data recorded by PAS since 1993, the situation such as the contents of handling cargo have been changed compared with the initial period, where import and export by container started. Therefore, the container cargo throughput since 2000 was adopted for the demand forecast in order to focus on the recent trend.

Table 6.3-3 Container Cargo Throughput at the Sihanoukville Port

Year	2000	2001	2002	2003	2004	2005	2006	2007
Cargo Throughput (TEU)	130,435	145,292	166,638	181,286	213,916	211,141	231,036	253,271

Year	2008	2009	2010	2011	2012	2013	2014	2015
Cargo Throughput (TEU)	258,775	207,861	222,928	237,941	255,378	286,450	333,904	391,819

Source: PAS

[5] ASEAN 2030: Growing Together for Economic Prosperity – the Challenges (January 2014)
[6] IMF Country Report No. 15/307 Cambodia (November 2015)

(3) Consideration of GDP Elasticity

For the macro forecast with long-term target, the GDP elasticity should be considered according to the stage of industry development. In an economically backward country as well as the present situation in Cambodia, the GDP elasticity should be higher. Actually in Sihanoukville Port, the GDP elasticity of 2014 and 2015 showed very high result at "2.4". On the other hand, it is expected that GDP elasticity is less than one (1.0) during the future stage of tertiary industry development such as service sector, which has less relevance to cargo volume.

The GDP elasticity was set in each of the three stages (high growth period, stable growth period, and low growth period) as shown in Table 6.3-4. However, it should not be changed drastically but gradually when the stage is shifted to the next.

Table 6.3-4 GDP Elasticity of Each Period

Stage of Development	GDP Elasticity	Applicable Year	Remarks
High Growth Period	2.0	2016 to 2020	The actual statistics 2011 to 2015 were applied *mutatis mutandis*.
Stable Growth Period	1.0	2021 to 2030	The actual statistics 2000 to 2015 were applied *mutatis mutandis*.
Low Growth Period	0.6	2031 to 2040	The actual statistics 2000 to 2011 were applied *mutatis mutandis*.

Source: JICA Survey Team

(4) Result of Macro Forecast

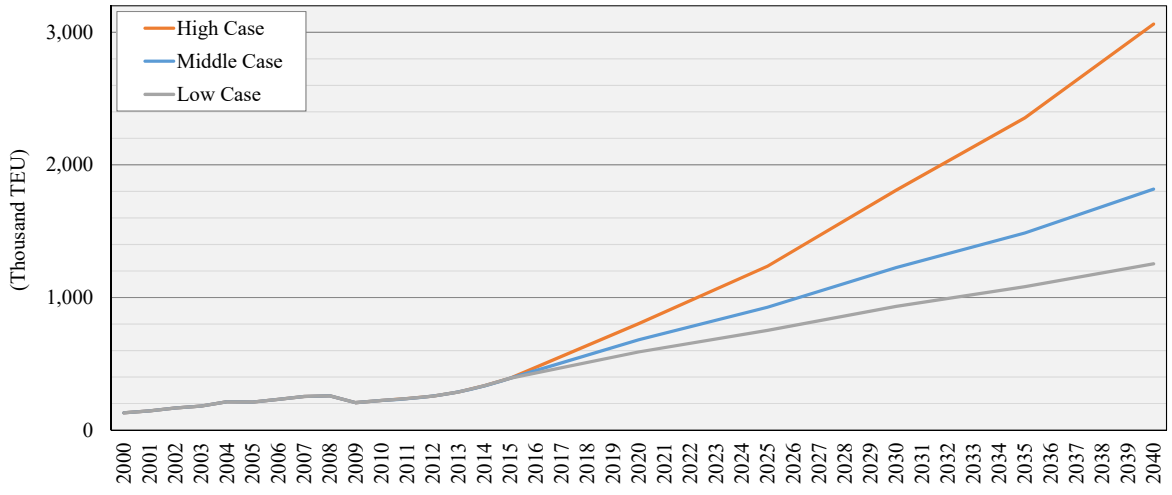
The results of the demand forecast by macro method are summarized in Table 6.3-5 and illustrated in Figure 6.3-1.

Table 6.3-5 Forecast Result of Container Cargo Throughput by Macro Method

Unit: Thousand TEUs

Year	2015	2020	2025	2030	2035	2040
Low Case	391.8	589.4	752.3	932.9	1,081.5	1,253.8
Middle Case	**391.8**	**681.9**	**927.3**	**1,225.6**	**1,486.9**	**1,817.7**
High Case	391.8	803.7	1,236.6	1,809.9	2,354.2	3,062.3

Source: JICA Survey Team



Source: JICA Survey Team

Figure 6.3-1 Container Cargo Throughput Forecast Trend by Macro Method

6.4. Micro Forecast of Container Cargo

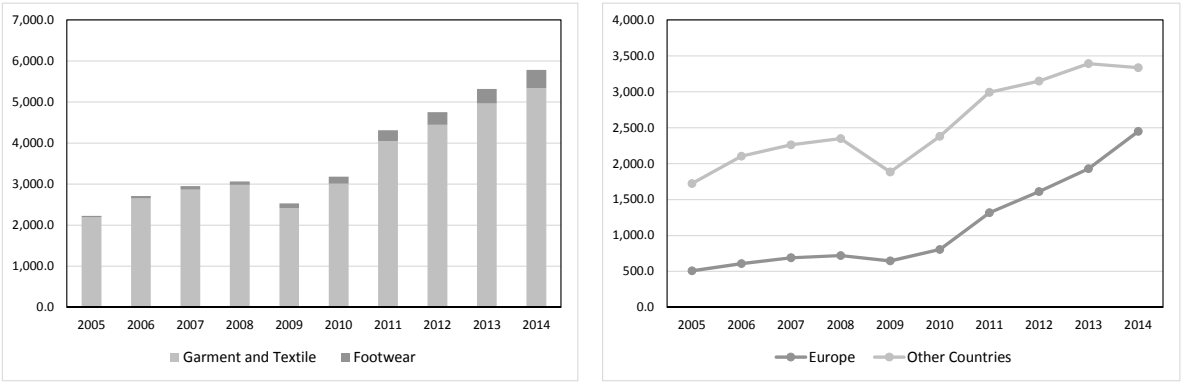
6.4.1 Container Cargo of Export

The latest port statistics by commodity and destination were used for the micro forecast. The detailed port statistics are shown in Appendix-6.2.

(1) Garments

1) Overview of the Garment Industry

The garment industry in Cambodia has been a key industry due to the general preferential duties and most-favored nation treatment given by Europe and America since 1996. Especially for Europe, the growth rate of export achieved an annual average rate of 20% (from 2005 to 2014) as shown in Figure 6.4-1. In Sihanoukville Port also, the garments are the main export cargoes and the ratio is more than 70%, as of 2015.



Source: GMAC

Figure 6.4-1 Cambodian Garment Exports (Left: by Items, Right: by Destination)

Table 6.4-1 Amount and Growth Rate of Garment Exports in Cambodia

(Unit: Million USD)

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Average Growth Rate		
											2005-2014	2010-2014	2012-2014
Garment and Textile	2,190.3	2,651.5	2,866.3	2,981.3	2,418.6	3,008.2	4,047.1	4,445.7	4,966.5	5,343.2	3,491.9	4,362.1	4,918.5
Growth Rate	*10.5%*	*21.1%*	*8.1%*	*4.0%*	*-18.9%*	*24.4%*	*34.5%*	*9.8%*	*11.7%*	*7.6%*	*16.0%*	*19.4%*	*10.1%*
Footwear	38.4	59.7	84.3	88.3	110.4	177.2	264.0	311.2	353.6	441.4	192.9	309.5	368.8
Growth Rate	*-12.3%*	*55.4%*	*41.2%*	*4.7%*	*25.0%*	*60.5%*	*49.0%*	*17.9%*	*13.6%*	*24.8%*	*28.0%*	*33.2%*	*18.8%*
Total	2,228.8	2,711.2	2,950.7	3,069.6	2,529.0	3,185.3	4,311.1	4,756.9	5,320.1	5,784.7	3,684.7	4,671.6	5,287.2
Growth Rate	*10.0%*	*21.6%*	*8.8%*	*4.0%*	*-17.6%*	*26.0%*	*35.3%*	*10.3%*	*11.8%*	*8.7%*	*17.7%*	*20.4%*	***10.8%***

Source: GMAC

However, it is thought the garments will be under severe business environment caused by intensification of price competition by Vietnam's participation in Trans-Pacific Partnership (TPP) and the possibility of increase in minimum wage. On the other hand, new foreign investment has increased for manufacturing other industrial products for export such as mechanical products, electric and electronics products, agro-products, and so on. Therefore, it is expected that the volume of garments will continue to increase also in the future, but the ratio of garments to the entire export will decrease gradually.

2) Setting of Growth Rate

The trend of garments for export in Cambodia was grasped by the statistics of the Garment Manufacturers Association in Cambodia (GMAC) from 2005 to 2014. Based on this trend and the interview to GMAC, the growth rate from 2016 to 2025 was set to the average rate in the recent three years, and the growth rate after 2026 was set to be about half of the average rate. In addition, in consideration of the severe business condition surrounding the garment industry, the upper limit was set to five times of the current export volume.

Table 6.4-2 Growth Rate of Garments

Year	2016-2020	2021-2025	2026-2030	2031-2035	2036-2040
Garments	10%	10%	5%	5%	5%

Source: JICA Survey Team

3) Result of the Forecast of Garments

Table 6.4-3 shows the result of the forecast of garments.

Table 6.4-3 Result of the Forecast of Garments

Unit: Thousand TEUs

	2015	2020	2025	2030	2035	2040
Garments	88.1	141.8	228.4	291.5	372.1	448.7
Europe	51.5	82.9	133.5	170.3	217.4	277.5
North America	23.0	37.0	59.6	76.0	97.0	100.0
East Asia	5.4	8.7	14.1	17.9	22.9	29.2
Southeast Asia	2.1	3.4	5.5	7.1	9.0	11.0
Other Countries	6.1	9.8	15.8	20.2	25.8	31.0

Source: JICA Survey Team

(2) Rice

1) Overview of the Rice Industry

Cambodia has been ranked 11th producing country in the whole world in terms of paddy production according to the situation of major rice producing countries. In terms of growth rate of paddy production volume in the past five years, Cambodia's growth rate is more than 30%, which is extremely high.

Table 6.4-4 Paddy Production and Growth Rate (2011)

Country	Paddy production (thousand tons)	Ratio of Total Production	Growth Rate of past 5 years
1 China	202,667	28.0%	8.1%
2 India	157,900	21.8%	9.2%
3 Indonesia	65,757	9.1%	15.0%
4 Bangladesh	50,627	7.0%	17.2%
5 Viet Nam	42,398	5.9%	18.0%
6 Thailand	36,128	5.0%	12.6%
7 Myanmar	29,010	4.0%	-7.8%
8 Philippines	16,684	2.3%	2.7%
9 Brazil	13,477	1.9%	21.8%
10 Pakistan	9,194	1.3%	10.2%
11 Cambodia	8,779	1.2%	30.5%
12 Japan	8,566	1.2%	-1.7%

Source: FAOSTAT, 2015

In Cambodia, about 8 million tons of rice, which is more than double of the domestic consumption, was produced in 2015. On the other hand, the surplus paddy amounting to 4 million tons are not milled in the country but delivered to Thailand and Vietnam informally. These paddy are exported to other countries after the rice milling as Thai or Vietnamese products.

Under the motto, “Rice - White Gold,” the government’s new rice policy, adopted in 2010, is a five-year plan that focuses on expanding the production and export of rice. The policy aims to transform Cambodia into a rice basket and key milled rice exporting country in the global market. In this connection, the Royal Government has set the year 2015 as the target year to achieve milled rice

export of at least 1 million tons. The policy looks at all the aspects of value-chain and has the following key objectives:

a) Facilitating Trade

Through reducing informal fees, eliminating illegal checkpoints, boosting warehousing and rice milling capacity, creating a one-stop service for export processing, and creating an independent body to certify the products according to the standards of importing countries.

b) Raising Productivity

Paddy rice yield in Cambodia is still low, only 2.9 tons per hectare compared with 4.9 tons per hectare in Vietnam. Most Cambodian farmers cultivate once a year in the rainy season, compared with 3.5 times a year in low land Mekong plain in Viet Nam. In the near term, using higher yield seeds, expanding irrigation systems, and facilitating quicker customs clearance for imports of inputs will help improve productivity. In the longer term, the policy aims at modernizing farming techniques.

c) Addressing Land Issues

Only about 10% of farmers have land titles. The policy plans to use zoning to clearly demarcate land for agriculture while improving land titling to enable farmers to use land as collateral for loans to finance critical investments and working capital.

d) Improving Infrastructure including Reducing Energy Costs

Energy costs account for about 25% of the total production costs. Energy prices in Cambodia are generally double than those in neighboring countries, primarily because of the heavy reliance on petroleum for electricity generation. Plans to build new hydropower plants with donor support over the medium term and the use of alternative sources of energy will help reduce the costs.

It has confirmed that target volume (1 million tons) can be reached within four to five years certainly through the interview with the Cambodian Rice Federation (CRF), although the export volume of 2015 was less than the target volume (540,000 tons). And it is expected that paddy production volume will be increased by raising the productivity and addressing issues as abovementioned.

2) Setting of Growth Rate

The trend of rice for export in Cambodia was grasped by the statistics of CRF from 2013.

Table 6.4-5 Cambodian Rice Exports by Month

Unit: Metric Tons

	2013	2014	2015	2016	Grouwth Rate (2013-2015)
January	25,728	21,536	35,921	44,033	20%
February	24,089	27,037	37,676	51,912	28%
March	45,413	35,757	75,867	-	34%
April	23,276	35,961	51,719	-	61%
May	28,350	27,971	41,842	-	24%
June	29,105	29,666	40,800	-	20%
July	31,411	26,060	28,492	-	-5%
August	29,358	29,871	29,819	-	1%
September	29,395	35,511	26,969	-	-4%
October	28,031	35,418	39,064	-	20%
November	37,855	31,137	48,748	-	14%
December	46,847	51,136	81,479	-	37%
Yearly Export	**378,858**	**387,061**	**538,396**	**-**	**21%**

Source: JICA Survey Team

In consideration of the recent strong growth and the interview to CRF, the growth rate from 2016 to 2020 shall be set to 20% as the same level as the average rate in the recent three years. Since there are limits to the land of rice field and also the improvement of technologies, the growth rate after 2021 is set as shown in Table 6.4-6.

Table 6.4-6 Growth Rate of Rice

Year	2016-2020	2021-2025	2026-2030	2031-2035	2036-2040
Rice	20%	10%	10%	10%	10%

Source: JICA Survey Team

3) Setting of Ratio of Shifting to Bulk Cargo

In the current situation, transportation of rice is through a container to secure the quality at a higher level and designation from the destination countries such as China. However, it is expected that shifting to bulk cargo from container will occur gradually in consideration of the transport efficiency. This ratio is set as shown in Table 6.4-7.

Table 6.4-7 Ratio of Shifting to Bulk Cargo

Year	2015	2020	2025	2030	2025	2035
Ratio of Shifting to Bulk Cargo	0%	10%	20%	30%	40%	50%

Source: JICA Survey Team

4) Result of the Forecast of Rice

Table 6.4-8 shows the result of the forecast of rice.

Table 6.4-8 Result of the Forecast of Rice

Unit: Thousand TEUs

	2015	2020	2025	2030	2035	2040
Rice	15.8	35.3	50.6	71.3	98.4	132.0
Europe	12.1	27.0	38.7	54.5	75.2	100.9
North America	0.1	0.3	0.5	0.6	0.9	1.2
East Asia	0.5	1.2	1.7	2.4	3.3	4.5
Southeast Asia	2.7	6.0	8.6	12.1	16.7	22.5
Other Countries	0.4	0.8	1.1	1.6	2.2	3.0

Source: JICA Survey Team

(3) Other Agricultural Products

In Cambodia, although about half of the population is engaged in agriculture, most of the production is single crop and it remains in the level of self-sufficient. Currently, the limited surplus of domestic consumption are purchased by the merchants from Thailand and Vietnam and they tend to bring down the price to a level that is so cheap.

The Cambodian government has promoted to introduce cash crops same as rice industry in order to solve these issues. Cassava, corn, soy bean, and forest products (rubber, palm, etc.,) are recognized as cash crops that contribute to increase in income. In the future, it is thought that production will be expanded dramatically by promoting the combination of multiple cropping of rice and cash crops using a vast of unused land. Also, this industry has much potential for agro-products using local agricultural materials such as dry fruits, various juices, livestock products, product made of rice, and so on. The growth ratio is set as shown in Table 6.4-9.

Table 6.4-9 Growth Rate of Other Agricultural Products

Year	2016-2020	2021-2025	2026-2030	2031-2035	2036-2040
Other Agricultural Products	10%	10%	10%	5%	5%

Source: JICA Survey Team

Table 6.4-10 shows the result of the forecast of other agricultural products.

Table 6.4-10 Result of the Other Agricultural Products

Unit: Thousand TEUs

	2015	2020	2025	2030	2035	2040
Other Agricultural Products	0.8	1.3	2.1	3.4	4.4	5.6
Europe	0.2	0.4	0.6	1.0	1.3	1.6
East Asia	0.3	0.5	0.8	1.3	1.7	2.2
Southeast Asia	0.2	0.4	0.6	1.0	1.2	1.6
Other Countries	0.0	0.0	0.1	0.1	0.1	0.2

Source: JICA Survey Team

(4) Wood

There are still vast forest resources in Cambodia and the robust timber industry has still been maintained although deforestation is in progress by the influence of the civil war, and there were issues caused by inappropriate management of logging rights and timber production license in order to realize the sustainable use of wood until several years ago. However, the Cambodian government has been making efforts for sustainable management of forest resources as the following cases illustrate:

- Forest Law was promulgated in 2002, and a new forestry administration was established in 2003
- National Forest Programme (2010-2029) was published in 2010

In view of these relations, the growth ratio of the wood is set to 5% as shown in Table 6.4-11 below.

Table 6.4-11 Growth Rate of Wood

Year	2016-2020	2021-2025	2026-2030	2031-2035	2036-2040
Wood	5%	5%	5%	5%	5%

Source: JICA Survey Team

Table 6.4-12 shows the result of forecast of wood.

Table 6.4-12 Result of the Wood

Unit: Thousand TEUs

	2015	2020	2025	2030	2035	2040
Wood	1.6	2.1	2.7	3.4	4.3	5.5
Europe	0.0	0.0	0.0	0.0	0.0	0.1
North America	0.2	0.2	0.3	0.4	0.5	0.7
East Asia	1.4	1.8	2.3	2.9	3.7	4.8
Southeast Asia	0.0	0.0	0.0	0.0	0.0	0.1

Source: JICA Survey Team

(5) Industrial Product

1) Target SEZ

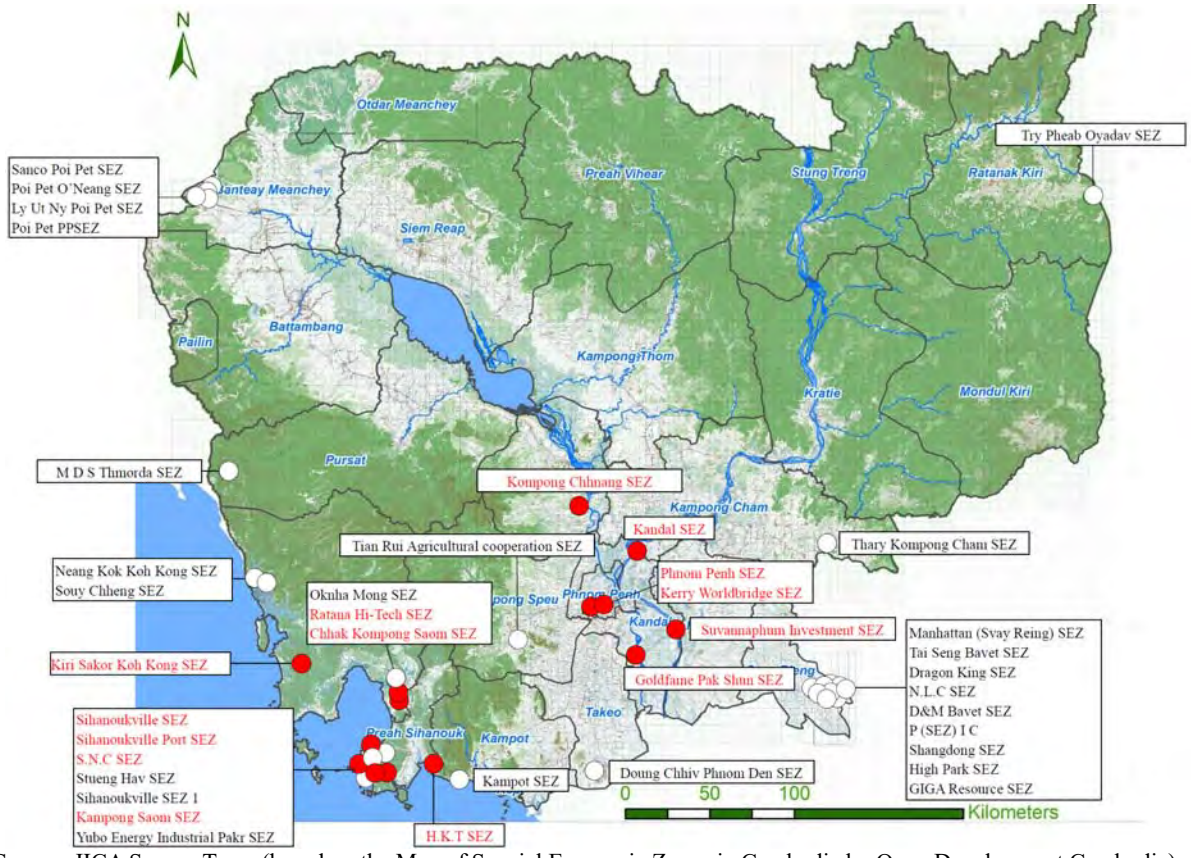
The following 14 SEZs were targeted as the present or prospective users of Sihanoukville Port out of the 39 SEZs shown in Table 2.5-1. These SEZs are shown in Table 6.4-13 and highlighted in red in Figure 6.4-2. The number of approved SEZ has increased in recent years (e.g., 2014: 24, 2015: 34, 2016: 39) and also it is expected that the number of SEZ will be increased in the future. The target year of demand forecast is until 2040, however, it is difficult to predict the industrial situation in the distant future such as 2040. Therefore, the present number of approved SEZ were used in order to prevent the overestimation.

Although SEZs that are located near the border cities of Bavet, Poipet, and Koh Kong attract many manufacturers, they will not be constant users of Sihanoukville Port due to the proximity of the ports in neighboring countries. Also, there are development plans of SEZs in Steung Hav and Oknha Mong; however, these SEZs are not target zones because the feasibility of the development plans is uncertain and there are also development plans of the exclusive port. In addition, the SEZs that do not generate industrial products are not targets such as the energy industry (No. 15 Kampot SEZ, No. 16 Sihanoukville SEZ 1, and No. 37 Yubo Energy Industrial Park SEZ).

Table 6.4-13 Targeted SEZs (Excerpt from Table 2.5-1)

3	Phnom Penh SEZ	21	Kiri Sakor Koh Kong SEZ	31	Suvannaphum Investment SEZ
5	Sihanoukville SEZ	22	Kampong Saom SEZ	32	Ratana Hi-Tech SEZ
6	Sihanoukville Port SEZ	25	Kandal SEZ	34	Chhak kampong Soam SEZ
10	S.N.C SEZ	26	H.K.T SEZ	35	Kerry Worldbridge SEZ
18	Goldfame Pak Shun SEZ	27	Kompong Chhnang SEZ		

Source: JICA Survey Team



Source: JICA Survey Team (based on the Map of Special Economic Zones in Cambodia by Open Development Cambodia)

Figure 6.4-2 Targeted SEZs (Aforementioned)

2) Method of Forecast

a) Classification of Industrial Products

The classification of industrial products is performed based on the occupancy status of the companies in the SEZs, which are operating at 50% or more, as of now. The ratio of each industry is calculated from the number of tenant companies.

- Phnom Penh SEZ: Machinery and Parts (39%), Garment (32%), Food and Beverage (10%), Paper Products (13%), and Other Products (6%)
- Sihanoukville SEZ: Machinery and Parts (34%), Garment (50%), Food and Beverage (1%), Paper Products (3%), and Other Products (12%)

For the other SEZs that are operating at less than 50% or not operating, the ratio of Phnom Penh SEZ was applied to SEZs close to Phnom Penh and the ratio of Sihanoukville SEZ was applied to SEZs close to Preah Sihanouk.

b) Exclusion of the Garment Industry

The garment factories, which require less power consumption as compared with other industrial products, tend to be located outside of SEZ. Therefore, the cargo demand of the garment industry, including shoes and bags, was estimated by commodity; and the cargo volume originated from the SEZ was excluded.

3) Setting of Various Factors for Estimation

I. Land Area: The land area of each SEZ was set in consideration of the future expansion plan.

II. Building Coverage Ratio: In order to apply the basic unit of cargo, the factory area must be extracted from the entire development area of each industrial zone, as industrial zones typically include public facilities such as ICDs, roads, water supply facilities, sewage plants, drainage, administration offices, etc., that are not considered to be part of the actual factory area. For major coastal industrial estates, the factory area ratio (to overall development area) is typically 70%-80%. Based on the above, a building coverage ratio of 75% was assumed in this survey.

III. Ratio of Export and Domestic: The industrial products are distributed for exports but also domestic consumption such as products of food, beverage, and paper. The ratio of export and domestic was set as below based on the current situation of Phnom Penh SEZ and Sihanoukville SEZ.

- Machinery and Parts (60%), Food and Beverage (50%), Paper Products (30%), and Other Products (10%)

IV. Basic Unit: In order to establish the basic unit cargo volume, the previous survey[7] prepared by the Ministry of Land, Infrastructure, Transport, and Tourism (MLIT) of Japan, was used as a reference.
The basic unit of the outbound cargo throughput in tonnage per square meter has been set as shown below. These data are not recent figures. However, it is thought that 1964, which was the industrial development stage of Japan, is equivalent as the current development stage in Cambodia. Therefore, it is determined that these data can be applied *mutatis mutandis*.

[7] Baseline Survey on Land Use and Cargo Throughput of Coastal Industrial Estates in Japan, Ministry of Land, Infrastructure, Transport and Tourism, Japan (1964)

- The basic unit of the outbound cargo throughput

Machinery and Parts		Paper Products	
Automotive component	0.08 t/m^2	Paper	0.33 t/m^2
Steel building material	0.17 t/m^2	Cardboard boxes	0.47 t/m^2
Average	**0.13 t/m^2**	**Average**	**0.40 t/m^2**

Food and Beverage		Other Products	
Canned food	0.15 t/m^2	Wood product	0.01 t/m^2
Boiled fish paste	0.79 t/m^2	Wood construction material	0.79 t/m^2
Average	**0.47 t/m^2**	**Average**	**0.40 t/m^2**

V. Ratio of Transport Mode: The ratio of seaborne transport was set as below in terms of mode of transportation for export.
   - Phnom Penh SEZ (including SEZs close to Phnom Penh): 70%
   - Sihanoukville SEZ (including SEZs close to Preah Sihanouk): 90%

VI. Utilization Ratio of Sihanoukville Port: For the seaborne shipment, the utilization ratio of Sihanoukville Port was set as below.
   - Phnom Penh SEZ (including SEZs close to Phnom Penh): 30%
   - Sihanoukville SEZ (including SEZs close to Preah Sihanouk): 90%

VII. Ratio of Container Cargo: The ratio of transportation by a container. Basically, the outbound cargo from SEZ are transported by container except for the other products including fertilizer.
   - Machinery and Parts (100%), Food and Beverage (100%), Paper Products (100%), and Other Products (90%)

VIII. Tonnage per TEU: The average weight per TEU at Sihanoukville Port in 2015 was 8.0 tons for export. The average weight for export is rather light compared with that in many ports in the world, since the present Cambodian export cargoes are dominated by garment products. However, it is expected that heavier cargoes such as milled rice will increase. Accordingly, the standard unit weight of 10 tons/TEU for converting the weight to the number of containers was adopted in order to avoid overestimation.

Based on the above various factors, the maximum production volume was calculated in case the occupancy rates achieve 100% in consideration of the expansion plans in the future. The calculation formula is shown below and the detailed maximum production volume is shown in Appendix-6.4.

Maximum Production Volume (TEUs)
I: Land Area x II: Building Coverage Ratio x III: Ratio of Export x IV: Basic Unit x V: Ratio of Transport Mode x VI: Utilization Ratio x VII: Ratio of Container Cargo / VIII: Tonnage per TEU

4) Setting of the Occupancy Rate

The cargo volume of each year shall be obtained by multiplying the occupancy rate and the maximum production volume that is calculated above.

About the four SEZs that are already operating, interviews were conducted in order to confirm the current situation and future prospects. The occupancy rate of these SEZs, shown in Table 6.4-14, were below based on the interviews. It was further verified whether the result of interviews were accurate or not, regarding the Phnom Penh SEZ and Sihanoukville SEZ, where the present occupancy rates exceed 50% (refer to Appendix-6.5).

Phnom Penh SEZ: The ratio of the area which was already purchased or booked, and the total area including Phases III and IV were estimated. It was confirmed that the calculated ratio and the information from the interview were almost the same.

Sihanoukville SEZ: It is confirmed that set rate is not overestimated based on the comparison between the actual trend and estimation using this occupancy rate.

Table 6.4-14 Occupancy Rate of the Operating SEZs

	2015	2020	2025	2030	2035	2040	Remarks
Phnom Penh SEZ	80%	100%	100%	100%	100%	100%	Considering the expansion plan
Sihanoukville SEZ	50%	100%	100%	100%	100%	100%	
Sihanoukville Port SEZ	10%	40%	90%	100%	100%	100%	
Goldfame Pak Shun SEZ	10%	40%	70%	90%	100%	100%	

Source: JICA Survey Team

After the approval of the development plan by CDC and the issuance of sub-decrees by the Cambodian government, the SEZ in Cambodia can be authorized officially.

The following SEZs were already approved by CDC; however, only three SEZs were able to obtain the sub-decrees by the Cambodian government, as of March 2016. An SEZ, which has not obtained the sub-decree may consider uncertainty on the implementation of its plan. Based on this, the occupancy rates are set as shown in Table 6.4-15.

Table 6.4-15 Occupancy Rate of the Non-operating SEZs

	2015	2020	2025	2030	2035	2040	Sub-decree
S.N.C SEZ	0%	10%	20%	30%	40%	50%	Not yet
Kiri Sakor Koh Kong SEZ	0%	10%	20%	30%	40%	50%	Not yet
Kampong Saom SEZ	0%	10%	20%	30%	40%	50%	Not yet
Kandal SEZ	0%	10%	20%	30%	40%	50%	Not yet
H.K.T SEZ	0%	20%	40%	60%	80%	100%	No. 189 (25 Oct. 2012)
Kampong Chhang SEZ	0%	10%	20%	30%	40%	50%	Not yet
Suvannaphum Investment SEZ	0%	20%	40%	60%	80%	100%	No.60 (11 Feb. 2014)
Ratana Hi-Tech SEZ	0%	10%	20%	30%	40%	50%	Not yet
Chhak Kampong Soam SEZ	0%	10%	20%	30%	40%	50%	Not yet
Kerry Worldbridge SEZ	0%	20%	40%	60%	80%	100%	No.87 (8 Jul. 2015)

Source: CDC

5) Result of the Forecast of Industrial Products

Table 6.4-16 shows the result of the forecast of industrial products.

Table 6.4-16 Result of the Industrial Products

Unit: Thousand TEUs

	2015	2020	2025	2030	2035	2040
Industrial Product	1.3	39.4	49.5	59.0	68.2	77.4
Phnom Penh SEZ		5.1	5.1	5.1	5.1	5.1
Sihanoukville SEZ		24.2	24.2	24.2	24.2	24.2
Sihanoukville Port SEZ		0.6	1.4	1.5	1.5	1.5
S.N.C SEZ		0.3	0.7	1.0	1.3	1.6
Goldfame Pak Shun SEZ		0.4	0.6	0.8	0.9	0.9
Kiri Sakor Koh Kong SEZ		3.8	7.6	11.4	15.2	19.0
Kampong Saom SEZ		0.6	1.1	1.7	2.2	2.8
Kandal S.E.Z		0.1	0.2	0.3	0.5	0.6
H.K.T SEZ		1.5	3.0	4.5	6.0	7.5
Kampong Chhang SEZ		0.5	1.0	1.6	2.1	2.6
Suvannaphum Investment SEZ		0.4	0.9	1.3	1.8	2.2
Ratana Hi-Tech SEZ		1.3	2.7	4.0	5.4	6.7
Chhak Kampong Soam SEZ		0.4	0.8	1.2	1.6	2.0
Kerry Worldbridge SEZ		0.1	0.3	0.4	0.6	0.7

Note: The figures of 2015 shows the actual statistics.
Source: JICA Survey Team

(6) Other Cargo

The breakdown of other cargo in 2015 is shown in Table 6.4-17. The major item is the general cargo such as miscellaneous and consumable goods, where it is difficult to grasp the details. A certain amount of export can be expected along with industrial development of the entire Cambodia although a significant growth is not expected. The growth ratio is set below.

Table 6.4-17 Breakdown of Other Cargo (2015)

GENERAL CARGOES	94.55%	MEDICINE	0.14%
CIGARETTES	3.43%	FLUE CURED STRIPS	0.13%
TOBACCO	0.84%	FROZEN SEAFOOD	0.06%
PERSONAL EFFECT	0.56%	BEER	0.03%
FILTER CIGARETTES	0.27%		

Source: PAS

Table 6.4-18 Growth Rate of Other Cargo

Year	2016-2020	2021-2025	2026-2030	2031-2035	2036-2040
Other Cargo	5%	5%	5%	5%	5%

Source: JICA Survey Team

Table 6.4-19 shows the result of the forecast of other cargo.

Table 6.4-19 Result of Other Cargo

Unit: Thousand TEUs

	2015	2020	2025	2030	2035	2040
Other Cargo	13.8	17.7	22.5	28.8	36.7	46.8

Source: JICA Survey Team

6.4.2 Container Cargo of Import

The latest port statistics by commodity and origin are used for the micro forecast. The detailed port statistics are shown in Appendix-6.3.

(1) Raw Materials for Garments

The raw materials for the domestic production of garments are imported from East Asia mainly. It is thought that the import volume of the raw materials will increase along with the growth of garment industry. Thus, the growth rate was set same as the garments for export shown in Table 6.4-20.

Table 6.4-20 Growth Rate of Raw Materials for Garments

Year	2016-2020	2021-2025	2026-2030	2031-2035	2036-2040
Raw material (garments)	10%	10%	5%	5%	5%

Source: JICA Survey Team

Table 6.4-21 shows the result of raw materials for garments.

Table 6.4-21 Result of Raw Materials for Garments

Unit: Thousand TEUs

	2015	2020	2025	2030	2035	2040
Raw materilal (garments)	1.1	1.7	2.7	3.5	4.4	5.7
East Asia	0.9	1.4	2.2	2.8	3.6	4.6
Southeast Asia	0.2	0.3	0.4	0.6	0.7	0.9
Other Countries	0.0	0.0	0.1	0.1	0.1	0.1

Source: JICA Survey Team

(2) Garments

Aside from the import of raw material, there is the import of garments. The major origin is East Asia. In the future, a certain amount of import can be expected along with the economic growth. The growth rate was adopted as GDP growth.

Table 6.4-22 Growth Rate of Garments

Year	2016	2017	2018-2019	2020	2021-2024	2025-2034	2035-
GDP Growth	7.0%	6.9%	6.8%	6.5%	6.3%	6.5%	6.9%

Source: IMF

Table 6.4-23 shows the result of the forecast of garments.

Table 6.4-23 Result of the Forecast of Garments

Unit: Thousand TEUs

	2015	2020	2025	2030	2035	2040
Garments	0.8	1.2	1.6	2.2	3.0	4.2
North America	0.0	0.0	0.0	0.0	0.0	0.1
East Asia	0.6	0.8	1.1	1.5	2.1	2.9
Southeast Asia	0.2	0.3	0.4	0.5	0.7	1.0
Other Countries	0.0	0.1	0.1	0.1	0.2	0.2

Source: JICA Survey Team

(3) Construction Materials

The construction materials are imported from East Asia mainly. In the future, the demand of construction materials will increase inevitably along with industrial development in the entire country. The growth rate was set same as GDP growth.

Table 6.4-24 Growth Rate of Construction Materials

Year	2016	2017	2018-2019	2020	2021-2024	2025-2034	2035-
GDP Growth	7.0%	6.9%	6.8%	6.5%	6.3%	6.5%	6.9%

Source: IMF

Table 6.4-25 shows the result of the forecast of construction materials.

Table 6.4-25 Result of the Forecast of Construction Materials

Unit: Thousand TEUs

	2015	2020	2025	2030	2035	2040
Construction Materials	0.5	0.7	0.9	1.3	1.7	2.4
East Asia	0.5	0.7	0.9	1.2	1.7	2.3
Other Countries	0.0	0.0	0.0	0.0	0.1	0.1

Source: JICA Survey Team

(4) Used Cars

The used cars except for heavy vehicles such as buses and trucks are imported from East Asia mainly (especially China). This is because the transport cost by container is more economical. In the future, it is thought that the demand for used cars will increase along with economic growth. The growth rate was set same as GDP growth.

Table 6.4-26 Growth Rate of Used Cars

Year	2016	2017	2018-2019	2020	2021-2024	2025-2034	2035-
GDP Growth	7.0%	6.9%	6.8%	6.5%	6.3%	6.5%	6.9%

Source: IMF

Table 6.4-27 shows the result of the forecast of used cars.

Table 6.4-27 Result of the Forecast of Used Cars

Unit: Thousand TEUs

	2015	2020	2025	2030	2035	2040
Used Cars	11.5	16.0	21.8	29.9	41.1	57.3
North America	0.9	1.2	1.6	2.2	3.1	4.3
East Asia	10.6	14.7	20.0	27.4	37.7	52.7
Southeast Asia	0.0	0.0	0.1	0.1	0.1	0.2
Other Countries	0.0	0.1	0.1	0.1	0.1	0.2

Source: JICA Survey Team

(5) Industrial Product

1) Setting of Various Factors for Estimation

I. Land Area: The land area was set same as the export industrial products. Refer to 6.4.1 (5) 3) I.

II. Building Coverage Ratio: This ratio was also set same as export industrial products. Refer to 6.4.1 (5) 3) II.

III. Ratio of Import and Domestic: The materials for industrial products such as food, beverage, and other products are procured domestically not only from import. The ratios of import and domestic are set as below based on the current situation of Phnom Penh SEZ and Sihanoukville SEZ.

- Machinery and Parts (100%), Food and Beverage (50%), Paper Products (100%), and Other Products (50%)

IV. Basic Unit: The basic unit of the inbound cargo throughput was set in reference to the previous survey in Japan same as export forecast.

- The basic unit of the inbound cargo throughput

Machinery and Parts		Paper Products	
Automotive component	0.16 t/m^2	Paper	1.17 t/m^2
Steel building material	0.89 t/m^2	Cardboard boxes	0.97 t/m^2
Average	**0.53 t/m^2**	**Average**	**1.07 t/m^2**

Food and Beverage		Other Products	
Canned food	0.61 t/m^2	Wood product	0.05 t/m^2
Boiled fish paste	1.49 t/m^2	Wood construction material	1.18 t/m^2
Average	**1.05 t/m^2**	**Average**	**0.62 t/m^2**

V. Ratio of Transport Mode: The ratio of seaborne transport is set as below in terms of mode of transportation for import.

- Phnom Penh SEZ (including SEZs close to Phnom Penh): 70%
- Sihanoukville SEZ (including SEZs close to Preah Sihanouk): 90%

VI. Utilization Ratio of Sihanoukville Port: For the seaborne shipment, the utilization ratio of Sihanoukville Port is set as below.

- Phnom Penh SEZ (including SEZs close to Phnom Penh): 30%
- Sihanoukville SEZ (including SEZs close to Preah Sihanouk): 90%

VII. Ratio of Container Cargo: This ratio is also set same as export industrial products. Refer to 6.4.1 (5) 3) VII.

- Machinery and Parts (100%), Food and Beverage (100%), Paper Products (100%), and Other Products (90%)

VIII. Tonnage per TEU: The average weight per TEU at Sihanoukville Port in 2015 was 8.4 tons for import. However, the standard unit weight of 10 tons/TEU for converting the weight to the number of containers was adopted same as an export container.

Based on the above various factors, the maximum production volume was calculated in case that occupancy rates achieve 100% in consideration of the expansion plans in the future. The calculation formula is shown below and the detailed maximum production volumes are shown in Appendix-6.6.

Maximum Production Volume (TEUs)
I: Land Area x II: Building Coverage Ratio x III: Ratio of Import x IV: Basic Unit x V: Ratio of Transport Mode x VI: Utilization Ratio x VII: Ratio of Container Cargo / VIII: Tonnage per TEU

2) Setting of the Occupancy Rate

The occupancy rate is set same as export industrial products. Refer to 6.4.1 (5) 4).

3) Result of the Forecast of Industrial Products

Table 6.4-28 shows the result of the forecast of industrial products.

Table 6.4-28 Result of the Industrial Products

Unit: Thousand TEUs

	2015	2020	2025	2030	2035	2040
Industrial Product	151.8	266.8	335.9	400.3	463.2	525.5
Phnom Penh SEZ		29.7	29.7	29.7	29.7	29.7
Sihanoukville SEZ		168.4	168.4	168.4	168.4	168.4
Sihanoukville Port SEZ		4.2	9.5	10.6	10.6	10.6
S.N.C SEZ		2.3	4.5	6.8	9.1	11.3
Goldfame Pak Shun SEZ		2.1	3.6	4.7	5.2	5.2
Kiri Sakor Koh Kong SEZ		26.5	53.0	79.4	105.9	132.4
Kampong Saom SEZ		3.9	7.7	11.6	15.4	19.3
Kandal S.E.Z		0.7	1.4	2.0	2.7	3.4
H.K.T SEZ		10.4	20.9	31.3	41.8	52.2
Kampong Chhang SEZ		3.1	6.1	9.2	12.2	15.3
Suvannaphum Investment SEZ		2.6	5.2	7.8	10.4	13.0
Ratana Hi-Tech SEZ		9.3	18.6	27.9	37.3	46.6
Chhak Kampong Soam SEZ		2.8	5.6	8.4	11.2	14.0
Kerry Worldbridge SEZ		0.8	1.6	2.4	3.2	4.0

Note: The figures of 2015 shows the actual statistics.
Source: JICA Survey Team

(6) Other Cargo

The major item is a general cargo such as miscellaneous and consumable as well as exports and it is difficult to grasp the details. A certain amount of import can be expected along with economic growth although a significant growth will not be expected. The growth rate is set same as GDP growth.

Table 6.4-29 Growth Rate of Other Cargo

Year	2016	2017	2018-2019	2020	2021-2024	2025-2034	2035-
GDP Growth	7.0%	6.9%	6.8%	6.5%	6.3%	6.5%	6.9%

Source: IMF

Table 6.4-30 shows the result of the forecast of other cargo.

Table 6.4-30 Result of Other Cargo

Unit: Thousand TEUs

	2015	2020	2025	2030	2035	2040
Other Cargo	1.4	2.0	2.7	3.6	5.0	7.0

Source: JICA Survey Team

6.4.3 Result of Micro Forecast

1) Result of Micro Forecast

The cargo demand was obtained by multiplying the cargo volume calculated in Sections 6.4.1 and 6.4.2 and ratio of empty container. The ratio of empty container was set to the average ratio in the most recent three-year period. Table 6.4-31 shows the result of micro forecast.

Table 6.4-31 Result of the Micro Forecast

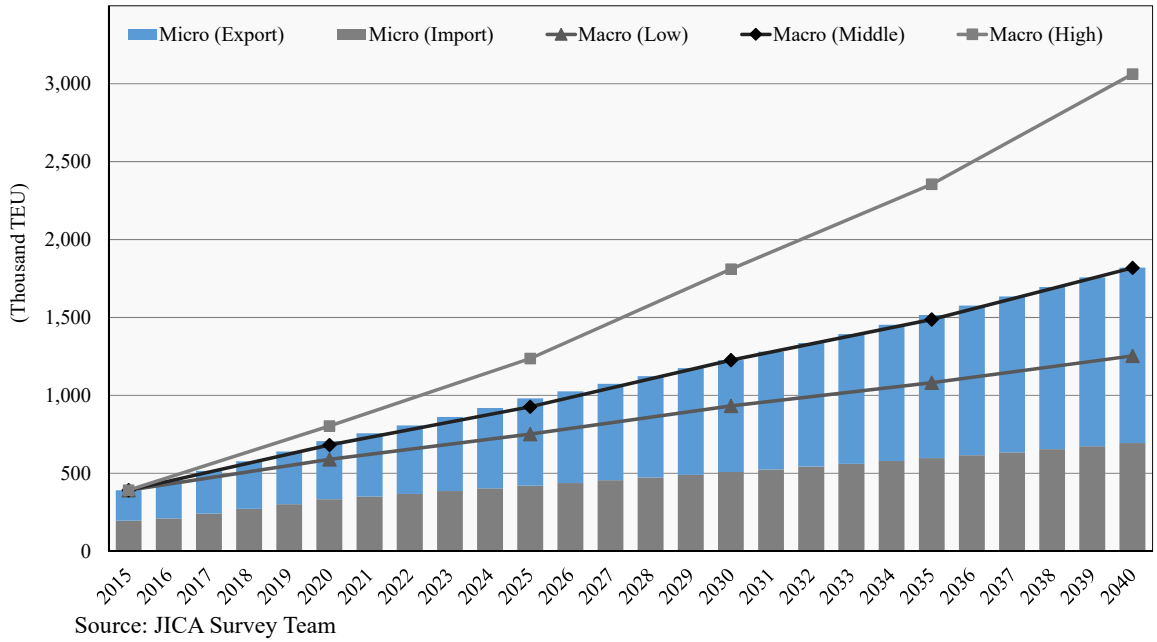
Unit: Thousand TEUs

		2015 (base year)	2020	2025	2030	2035	2040
Export	Laden	121.5	237.6	355.9	457.4	584.1	716.1
	Empty	74.5	135.8	203.4	261.5	333.9	409.3
	Sub total	196.0	373.4	559.3	718.9	918.1	1,125.4
Import	Laden	167.1	288.3	365.6	440.8	518.4	602.1
	Empty	28.7	43.8	55.6	67.0	78.8	91.6
	Sub total	195.9	332.1	421.2	507.8	597.3	693.6
Total		**391.8**	**705.5**	**980.5**	**1,226.7**	**1,515.3**	**1,819.0**

Source: JICA Survey Team

2) Comparison of Macro Forecast and Micro Forecast

The comparison of the macro forecast and micro forecast is shown in Figure 6.4-3. The middle case of macro forecast is estimated based on the assumption that current condition of economic growth (GDP growth rate: about 7%) will continue in the future and its result is considered as the most realistic estimation. In addition, this result was compared and verified by micro forecast that estimated each commodity. Based on this, the JICA Survey Team adopted the middle case of macro forecast.



Source: JICA Survey Team

Figure 6.4-3 Comparison of Macro Forecast and Micro Forecast

The port development with overestimation of cargo demand might face financial burden. On the other hand, the lack of port capacity due to underestimation of cargo demand might be detrimental to the national economy. Based on this, it is important to monitor the fluctuations of demand continuously in the future and review the demand estimation as necessary.

6.5. Review of Demand Forecast of General Cargo and Bulk Cargo

In the multipurpose terminal currently under construction, PAS initially envisaged handling the bulk and general cargo. However, since there is the surplus handling capacity, PAS plans to handle the container cargo also. Therefore, in addition to container cargo, the demand forecast for the bulk and general cargo was reviewed and statistical data were updated based on the previous studies.

(1) Results of Demand Forecast of the Previous Studies

The results of demand forecast of general cargo and bulk cargo conducted in previous studies are shown below. It was found that the trend of results is almost the same although the estimation figures are different because targeted year is different.

Table 6.5-1 Result of Demand Forecast in Multipurpose Terminal Development Project

Unit: Thousand Tons

	Commodity		Demand Forecast 2020
Export	Woodchips		1,000
	Agriculture Products	Rice	500
		Subtotal	**1,500**
Import	Steam Coal		240
	Material and Equipment for Oil Development		120
	Agriculture Products	Wheat	148
		Sugar	9
	General Cargo	Cement	100
		Machinery	57
		Others	60
		Steel	142
		Subtotal	**876**
		Total	**2,376**

Source: Sihanoukville Port Multipurpose Terminal Development Project (April 2012)

Table 6.5-2 Result of Demand Forecast in the Study on Strengthening Competitiveness

Unit: Thousand Tons

	Commodity		Demand Forecast 2010 (base year)	Demand Forecast 2030
Export	Dry Bulk	Wood Chip	71	1,921
	Break Bulk	Milled Rice	0	933
		Subtotal	**71**	**2,854**
Import	Dry Bulk	Wheat	0	255
		Steam Coal	123	240
	Break Bulk	Cement	46	0
		Vehicle	17	194
		Sugar	0	10
		Others	58	571
		Subtotal	**244**	**1,270**
		Total	**315**	**4,124**

Source: The Project for the Study on Strengthening Competitiveness and Development of Sihanoukville Port (July 2012)

(2) Methodology of Demand Forecast of General Cargo and Bulk Cargo

Basically, the cargo demand of each commodity was estimated by multiplying the recent handling statistics and growth rate of GDP or population, same method as the previous studies.

The base cargo volume was set to an average in the most recent three-year period. The throughput of general cargo and bulk cargo from 2006 to 2015 is shown in Appendix-6.7.

The growth rate of GDP and population was set, same as shown in Section 4.2. The ratio, which is set relative to the base year of 2015, is shown in Table 6.5-3 as the social and economic future framework.

Table 6.5-3 Social and Economic Future Framework

	2015 (base year)	2020	2025	2030	2035	2040
Population	1.00	1.08	1.15	1.22	1.28	1.34
GDP	1.00	1.39	1.89	2.59	3.56	4.97

Source: JICA Survey Team based on data from IMF and United Nations

(3) General Cargo and Bulk Cargo of Export

Concerning commodities of export, it is expected that demand of tapioca chip, machinery, and general cargo will increase in consideration of the handling situation of general cargo and bulk cargo in recent years and future prospects. Also, rice will be the one of target items in view of the shifting from container cargo to bulk cargo as mentioned in Section 4.4. In addition, it is thought that cement has a large potential to be an exported item based on the interview with the cement factories in Kampot.

It is assumed that the growth of tapioca chip is proportional to the population growth and the growth in volumes of machinery and general cargo are proportional to the GDP growth. For the growth of rice and ratio of shifting to bulk cargo, refer to Section 6.4 (2) 2) and 3). For the growth rate of cement, it was referred to in the future business plan of 10,000 tons per month after 2018.

On the other hand, wood chip and sugar are out of the scope of consideration according to the information obtained by interviews. Wood chip had been exported from 2010 to 2013; however, the wood chip project is discontinued at present because the plants used as material do not grow properly in Cambodia.

According to the procedure mentioned above, the export commodities are forecasted as below.

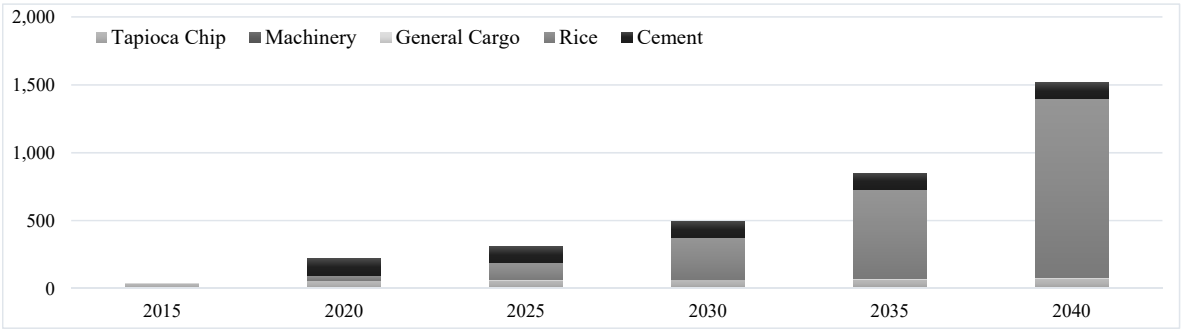
Table 6.5-4 General Cargo and Bulk Cargo of Export

Unit: Thousand Tons

		2015 (base year)	2020	2025	2030	2035	2040
1	Tapioca Chip	38.9	57.6	61.3	65.0	68.2	71.4
2	Machinery	0.3	1.0	1.3	1.8	2.5	3.5
3	General Cargo	0.2	0.8	1.1	1.6	2.2	3.0
4	Rice	0.0	39.3	126.4	305.4	655.9	1,320.4
5	Cement	0.0	120.0	120.0	120.0	120.0	120.0
Total		**39.4**	**218.6**	**310.2**	**493.8**	**848.7**	**1,518.3**

Source: JICA Survey Team

Unit: Thousand Tons



Source: JICA Survey Team

Figure 6.5-1 General Cargo and Bulk Cargo of Export

(4) General Cargo and Bulk Cargo of Import

Concerning commodities of import, it is expected that consumption of machinery, steel, steam coal, and general cargo will increase in consideration of the handling situation of general cargo and bulk cargo in recent years and future prospects.

It is assumed that the growth of machinery and general cargo are proportional to the population growth and the growth in volumes of steel is proportional to the GDP growth. For the growth rate of cement, it was referred to the future business plan of the cement factories.

On the other hand, other commodities are out of the scope of consideration according to the information obtained by interviews. Cement was imported before 2013; however, the demand has been decreased because cement factories in Kampot are promoting a plan to increase the production capacity to about twice. In fact, the import volume of cement in Oknha Mong Port also has decreased between 2014 and 2015 and it is expected that the volume will decrease in the future.

According to the procedure mentioned above, the import commodities are forecasted as below.

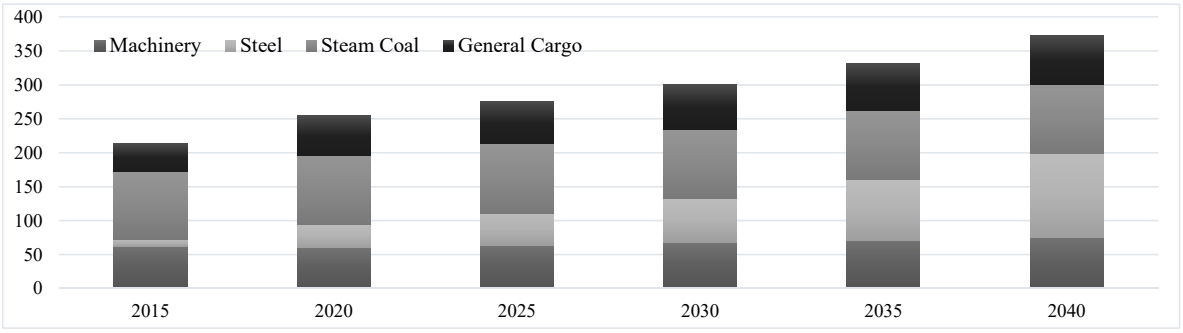
Table 6.5-5 General Cargo and Bulk Cargo of Import

Unit: Thousand Tons

		2015 (base year)	2020	2025	2030	2035	2040
1	Machinery	62.2	59.8	63.7	67.5	70.9	74.2
2	Steel	10.4	34.8	47.3	64.8	89.1	124.5
3	Steam Coal	99.7	102.1	102.1	102.1	102.1	102.1
4	General Cargo	40.7	58.2	62.0	65.7	69.0	72.2
Total		**213.0**	**254.9**	**275.1**	**300.2**	**331.1**	**373.0**

Source: JICA Survey Team

Unit: Thousand Tons



Source: JICA Survey Team

Figure 6.5-2 General Cargo and Bulk Cargo of Import

(5) Result of Demand Forecast of General Cargo and Bulk Cargo

The result of demand forecast of general cargo and bulk cargo is summarized below.

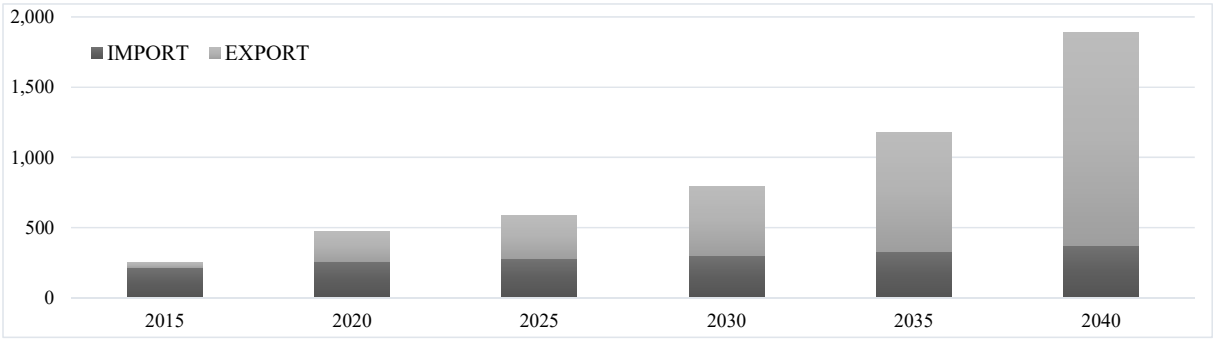
Table 6.5-6 Result of Demand Forecast of General Cargo and Bulk Cargo

Unit: Thousand Tons

	2015 (base year)	2020	2025	2030	2035	2040
Export	39.4	218.6	310.2	493.8	848.7	1,518.3
Import	213.0	254.9	275.1	300.2	331.1	373.0
Total	**252.4**	**473.5**	**585.3**	**794.0**	**1,179.8**	**1,891.3**

Source: JICA Survey Team

Unit: Thousand Tons



Source: JICA Survey Team

Figure 6.5-3 Result of Demand Forecast of General Cargo and Bulk Cargo

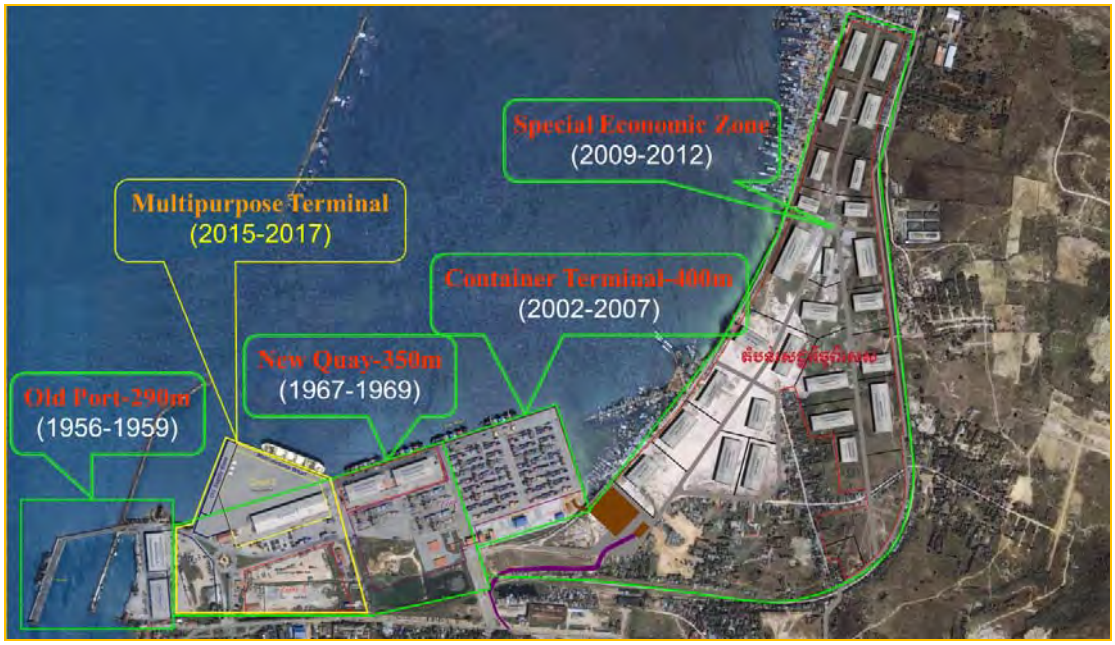
7. PORT DEVELOPMENT PLAN

7.1. Scenario of Port Development Plan

7.1.1 Concept of Port Development Plan

(1) Current Situation

The old port, new quay, and container terminal areas have been developed in the past at the Sihanoukville Port, and the multipurpose terminal area is under construction. In addition, the special economic zone (SEZ) along the seaside and the inland depot to transship containers to railways behind the new quay area were developed.



Source: PAS

Figure 7.1-1 Current Situation of the Sihanoukville Port

(2) Target Year of Port Development Plan

The target year of the development plan of Sihanoukville Port is proposed as listed below. Here, the construction period is not included in the development plan. For example, the new container terminal Phase I is scheduled to start its operation in 2023; thus, it is mentioned in the medium-term plan (-2030).

Short-term Plan (-2023):	Installation of new handling equipment and development of the multipurpose terminal
Medium-term Plan (-2030):	Development of new container terminal (Phase I)
Long-term Plan (-2040):	Development of new container terminal (Phases II and III)
Extra Long-term Plan (2040-):	Stage I: Development of remaining inner area of the existing breakwater
	Stage II: Expansion to outer area of the existing breakwater

Note: The development of the new container terminal is divided into three phases: Phase I is conducted in the medium-term plan, and Phases II and III are planned in the long-term plan.

(3) General Concept of Port Development Plan

1) Short-term Plan

The objective of the short-term plan is to install a handling equipment for the existing container terminal, and to develop the multipurpose terminal and off dock yard. The target year of the short-term plan is 2023.

The targeted annual handling capacity of containers is estimated to be around 800,000 TEUs.

2) Medium-term Plan and Long-term Plan

In the medium-term and long-term plans, new container terminal is developed in three phases to cope with the estimated increment demand of containers. The yard and berth of Phase I is constructed by 2023 as the medium-term plan. The target capacity of container is approximately 1.15 million TEUs, which enables the port to meet the estimated demand in around 2030. The remaining two yards and berths will be constructed consecutively in the long-term plan in order to cope with further increasing demand.

In this study, the medium-term plan is mainly studied in anticipation of the long-term plan.

3) Extra Long-term Plan and Future Plan

The main concept of the extra long-term plan is to ensure a port-related area and to arrange the inhabitant area for fisherfolks by planning a reclamation of the inner area of the existing breakwater. Thus, congestion between large-sized vessels and small-sized fishing boats is reduced and port safety is improved.

In the future plan, the Sihanoukville Port aims to enhance the marine logistics base as main port of Cambodia. The outer area of the existing breakwater is developed to cope with the growing vessel size.

7.1.2 Study of Port Development in the Medium-term and Long-term Plans

The port development in the medium-term and long-term plans is studied in this clause since the short-term plan is under construction.

(1) Long-term Port Development Plan

Three container yards are to be developed in the long-term plan. The container yards can accept 60,000 DWT sized container vessels. The total length of the berths is 950 m.

1) Condition of Port Layout

The points listed below are considered as conditions for the layout of the long-term plan.

- To utilize the existing calmness area inside the existing breakwater.
- To minimize the impact on the fisherfolk in the port.
- To plan considering future development in the super long-term plan and future plan.
- To install a continuous berth with 950 m length for ease of use.
- To ensure a container yard area with 400 m width behind berth line.
- To ensure the road area and others with 100 m width behind the container yard.
- To set a 400 m of distance between the east edge of existing container berth and the east edge of new container berth connection area considering berth length, which is able to accept 60,000 DWT sized container vessels in the future.
- To install an access road from land area to the new container yard at location where the existing central road of SEZ running east-west direction meets up with the coastal road considering traffic line and future plan.

- To ensure over 300 m length of the access road to the new container yard based on clearance of bridge considering fisher boat and required critical slope for container truck.
- To ensure 600 m of turning basin diameter and DL-13.5 m of water depth in order to accept 60,000 DWT vessels and tug boat.
- To consider berth pocket with 50 m (1.5 B) width and DL-14.5 m (maximum draft) depth.

2) Direction of the New Container Berth Line

The berth line of the new container berth was determined by considering three cases of angle between the berth line and the existing breakwater line as follows:

a) Case 1: Case of Acute Angle (less than 90 degree)

- The water area between the breakwater and the berth is narrow. Therefore, it is difficult to control vessels and utilize some water area.
- In the case that total length between the east edges of the existing container berth and new container berth is the same, dredging volume will be large since turning basin is located at the center of the berth.

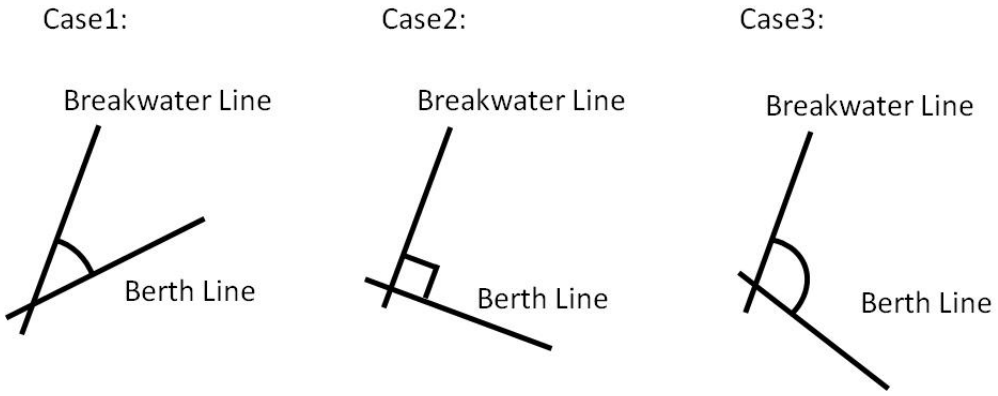
b) Case 2: Case of Right Angle (90 degree)

- There is no limitation of water area at the breakwater side and connection side

c) Case3: Case of Obtuse Angle (more than 90 degree)

- The water area of the connection area and the berth is narrow. Therefore, it is difficult to utilize some water area.
- In the case that total length of the connection area is short; the berth line will be confined since turning basin is limited.

As a result, the berth line with right angle between the break water line and the berth line was employed.



Source: JICA Survey Team

Figure 7.1-2 Image of Berth Line

3) Layout Plan

Three layouts of the long-term plan were studied considering different distance between the east edges of the existing container berth and the west edge of the new container berth (Phase I).

Plan A: The distance is 400 m (50 m + 300 m + 50 m).
Plan B: The distance is 210 m consistent with the PAS's future plan.
Plan C: The distance is 700 m considering the development of future two berths.

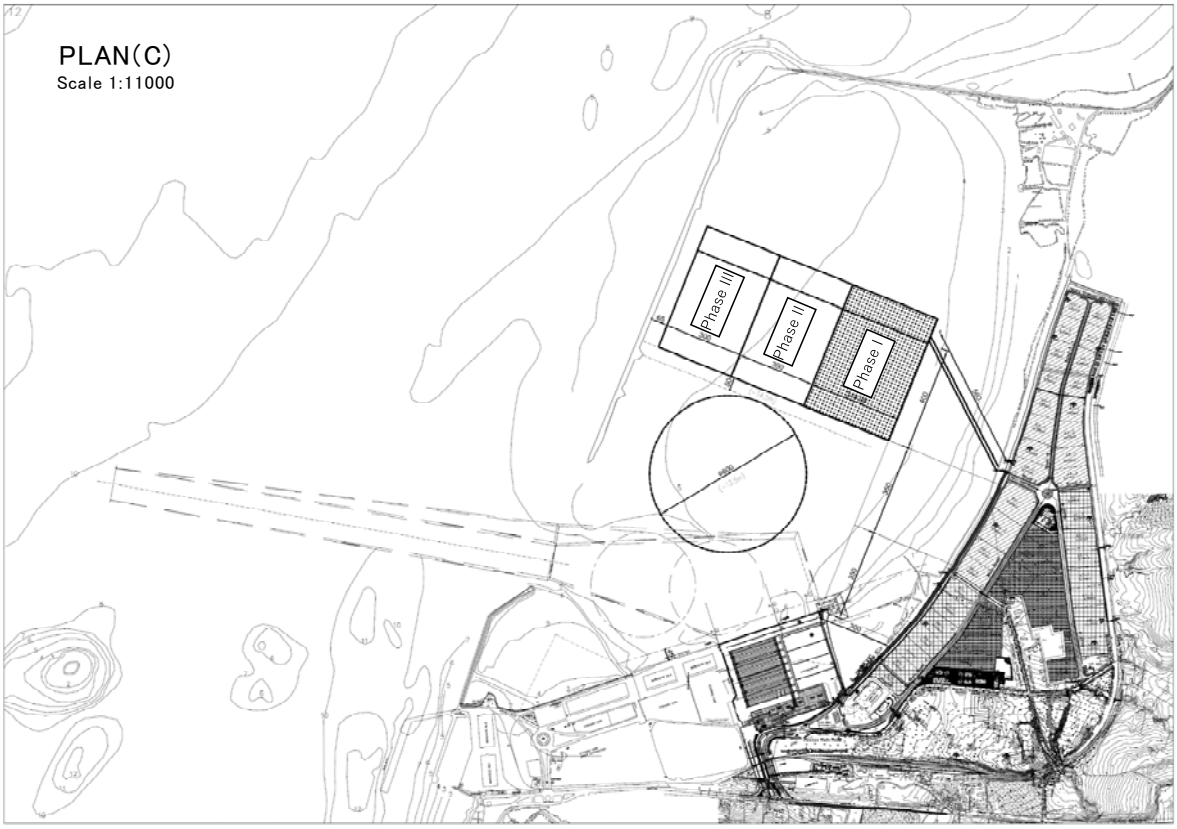
The layout of each plan is as follows:

Source: JICA Survey Team

Figure 7.1-3 Layout of Plan A

Source: JICA Survey Team

Figure 7.1-4 Layout of Plan B



Source: JICA Survey Team

Figure 7.1-5 Layout of Plan C

4) Comparative Study and Result

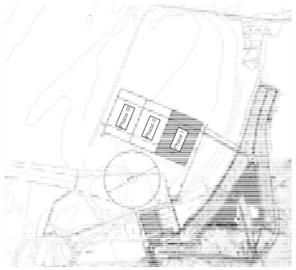
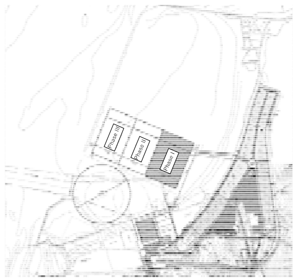
The comparative study is shown in Table 7.1-1. As a result, Plan A was employed.

Basic policy of the new container yard layout

- 950 m (350 m + 300 m + 300 m) of length for the three berths is ensured considering the super long-term plan.
- The impact on the inhabitant area of fisherfolk is minimized in the yard layout plan.

The berth line of the new container berth is orthogonal to the existing breakwater. The berth line of the connection area is parallel to the existing breakwater.

Table 7.1-1 Comparison Table of Layout Plan

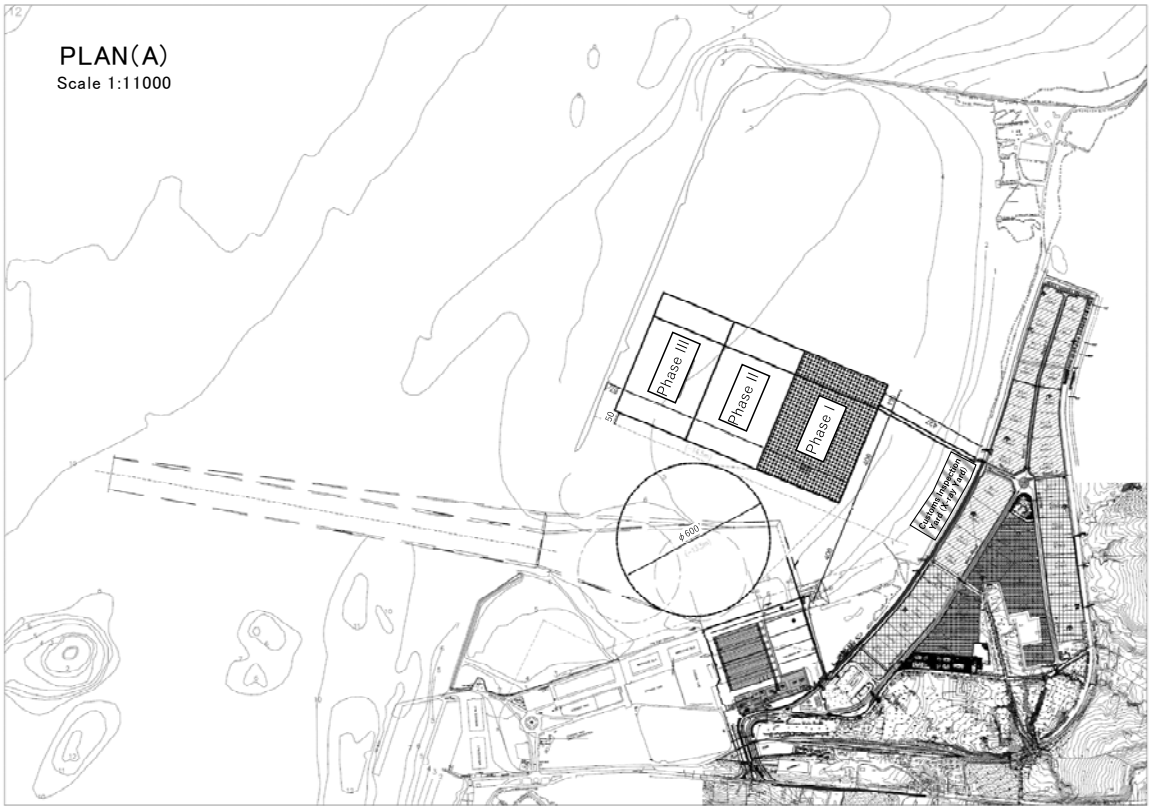
Plan	Layout	Dredging Volume	Berth Layout	Calmness of Berth	Connection Area	Water Area of Berth Front	Location of Turning Basin	Alignment and Length of Access Road	Future Plan	Evaluation Result
A		Small	Three berths are continuous and they are easy to use.	Calmness is maintained because of the existing breakwater.	The length of connection area between the new container berth and the existed container berth is 400 m, which can be developed as a container berth in the future.	The berth front water area has enough space.	Turning basin is located in front of the new container berth.	It is installed by almost a straight line from the installation point at the land area. The length is about 430 m.	In case that future berth is extended beyond the inner harbor in the future plan of PAS, the removal quantity of the breakwater will be huge.	**Excellent**
B		Small	Three berths are continuous and they are easy to use.	Calmness is not maintained due to outside of calm area by the existing breakwater.	The length of the connection area is 210 m. It will be difficult to use a container berth in the future.	The berth front water area is not enough. Shipping is overcrowded.	Turning basin is arranged near the port entrance. It is a little far from Phase I container berth.	It is installed with a little angle from the installation point at the land side. The length is about 440 m.	It is consistent with the future plan of PAS. In case that future berth is extended beyond the inner harbor, the removal quantity of the breakwater will be minimal.	**Good**
C		Very large	Three berths are continuous and they are easy to use.	The berth area is extremely calm because the berth is located deep in the existing breakwater.	The length of connection area is 700 m. It is available for two container berths in the future.	The berth front water area is wide. Shipping is safe.	Turning basin is located in front of the new container berth.	It is installed with large angle from installation point at the land side. The length is about 560 m.	In case that future berth is extended beyond the inner harbor in the future plan of PAS, the removal quantity of the breakwater will be extremely huge.	**Poor**

Source: JICA Survey Team

(2) Medium-term Port Development Plan

One of the three berths is to be developed by 2030 as the medium-term plan.

The land side berth was selected as Phase I among the three phases, considering its accessibility to the land area, workability, and availability of fishers. The berth length is 350 m under the assumption that the berth edge of the land side becomes the corner of the future berth.



Source: JICA Survey Team

Figure 7.1-6 Layout Plan of the Medium-term Plan

7.1.3 Study of Port Development of the Extra Long-term Plan

(1) Basic Policy of the Extra Long-term Plan

Port development of the extra long-term plan is considered based on the basic policy of PAS.

The extra long-term plan that is formulated by PAS includes the following five policies:

1) The area surrounded by the existing breakwaters will be reclaimed and used as a harbor site. As the available land side area is limited, it is important for the development of the port to make use of the area.

2) For exclusive entrance of small vessels, a new port entrance will be constructed at the existing north-side breakwater. Together, large vessels and small vessels are congested because there is only one port entrance at present. Considering the increase of entry into the port of large vessels in the future, port safety will be improved as the channel will be divided for large and small vessels.

3) For access from land to the plan site, the access from north-side, which makes use of the existing north-side breakwater is considered. The way of access by train is also considered. Considering the expansion of access route to offshore area in the future, several access routes to the offshore area and access method not only by road but also by train are considered.

4) The access route from port to NR 4 is considered by using the detour route from the gentle road gradient at the north-side. It is not adequate for mass traffic of large vehicles on the existing access road at Route 4 because of the steep road gradient in the vicinity of Sihanoukville.

5) The breakwater on the offshore side and north-side is considered as a port development area in the future. The expansion at the north-side breakwater will be reclaimed based on the future development plan by PAS.

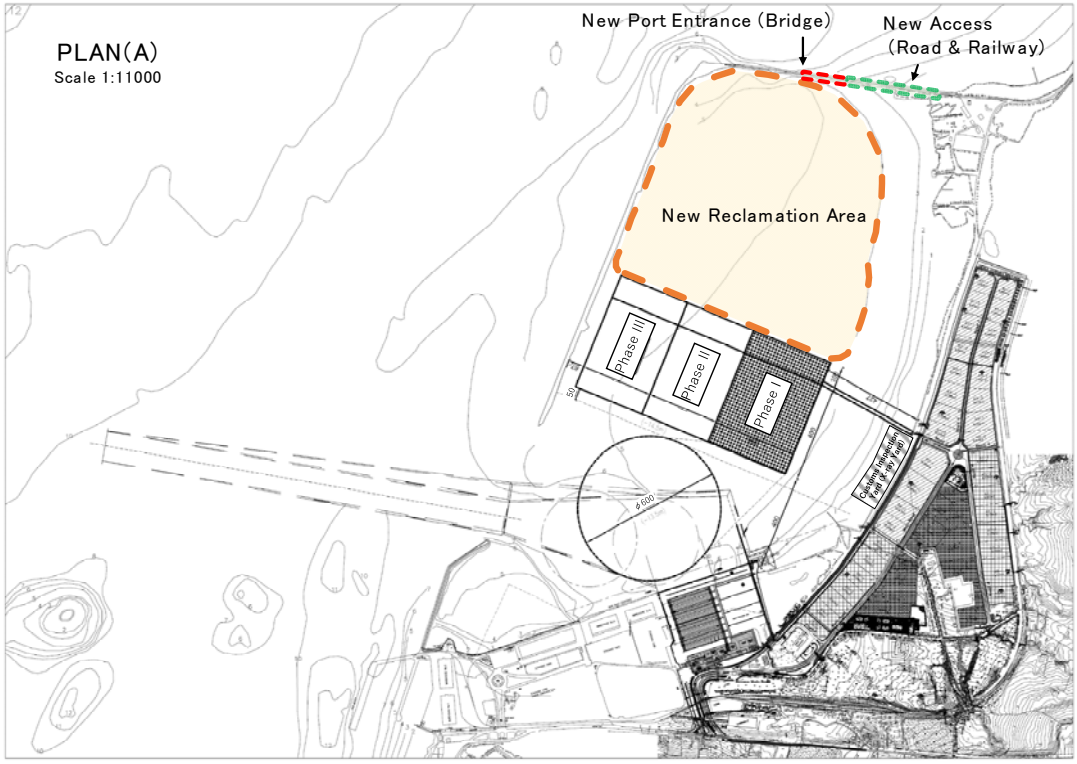
(2) Stage I (Inner Area of the Breakwater)

The target area planned in the extra long-term plan stage I is shown in Figure 7.1-7. In the extra long-term plan stage I, the prospect in the future is not clear, including the transfer of the inhabitants and fishery facilities. Therefore, an image, which is based on basic policy of PAS, is shown in this study.

1) The backyard of the new container yard (phases I to III) surrounded by the existing breakwater is utilized as a reclaimed harbor site. The new container yard is expected to be operated effectively because this reclaimed area can be directly accessed to the new container yard by the proposed access bridge.

2) The new port entrance, i.e., the exclusive entrance for small boat at the existing north-side breakwater should be constructed. In case there is an influence on the calmness of harbor, another new breakwater will be constructed at the outside of the existing breakwater.

3) For the access from land to the plan site, the access by road and train is considered by using the access from north-side, which makes use of the existing north-side breakwater. In this access, the road congestion to the new container yard is improved. The way of access for passing through the new harbor entrance at the north-side breakwater by a bridge is considered. In general, the maximum gradient of a freight train is 1.0%. Adequate clearance for small boat passing under the bridge will be maintained, in case the maximum gradient from the end of breakwater will be adopted.



Source: JICA Survey Team

Figure 7.1-7 Layout Plan of the Extra Long-term Plan (Stage I)

(3) Stage II (Outer Area of the Breakwater)

The port development plan for the far future should be drew up based on the prospect of economic development and industrial structure in Cambodia, and at present, several unforeseeable aspects are included. In this study, the future development concept outside of the breakwater planned by PAS is delineated from the technical viewpoints as listed below.

- It is required to consider an installation of outer breakwater since it is difficult to ensure calmness in the area for new berths constructed outside of the existing breakwater.
- The planned berths are only for containers. It is necessary to consider the use of not only containers but also bulk cargo.
- It is planned to develop large railways area at the center of the landfill area. It is required to confirm future cooperation between marine and railways transportation.
- Access channel from central turning basin to the existing main channel shall be considered.
- Several access routes to the inland area shall be considered.

Source: PAS

Figure 7.1-8 Future Concept by PAS

7.1.4 Zoning

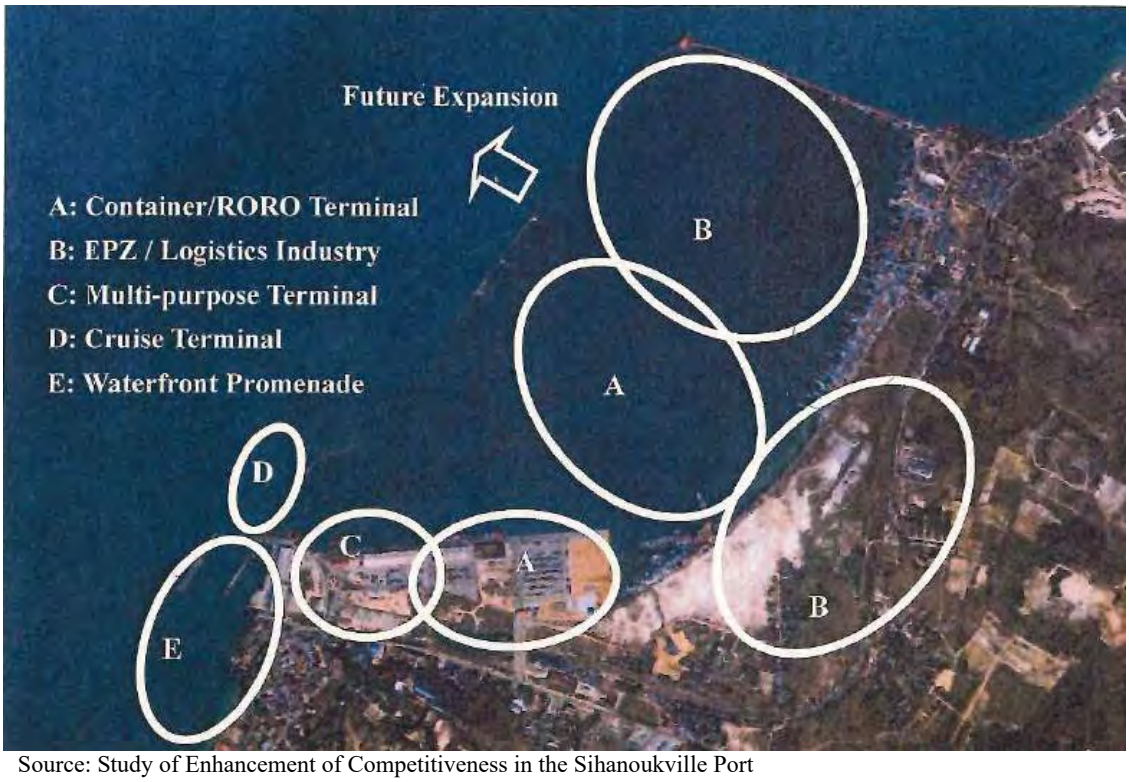
The usage of the port facility is zoned in the study of enhancement of competitiveness according to Figure 7.1-9.

If the handling freight constitution of the current Sihanoukville Port will not be greatly changed in the future, the Sihanoukville Port is divided as follows:

1. Zone for Cruise Terminal
2. Zone for Multi-purpose Terminal
3. Zone for Container Terminal, and
4. Zone for EPZ and Port Industry
5. Waterfront Promenade

It is planned that the container cargoes are handled temporarily in the berth for multi-purpose terminal until the start of operation of the new container terminal. However, the multi-purpose terminal will be used for its original purpose after the medium-term plan.

On the other hand, PAS plans to use the inner sea area surrounded by the existing breakwater as fishermen activity and inhabitant area in the far future as mentioned in Figure 7.1-9. Therefore, although the zoning in this study is not so different from the zoning set in the study of enhancement of competitiveness, the part of zone B will be available for fishermen activity and inhabitant area for a while.



Source: Study of Enhancement of Competitiveness in the Sihanoukville Port

Figure 7.1-9 Zoning of the Sihanoukville Port

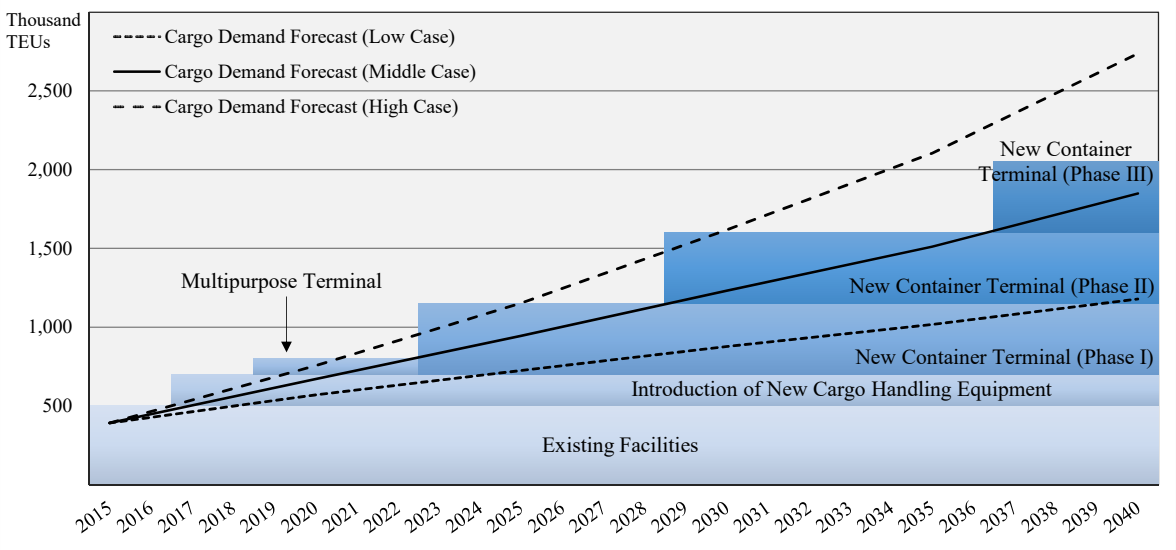
7.2. Necessity of New Container Terminal

Cargo handling capacity of existing container yard with present handling equipment is estimated to be around 500,000 TEUs as mentioned in Chapter 5. In accordance with sharp increase in container cargoes in recent years, PAS plans and implements to increase the container handling capacity by installing new handling equipment and improving handling efficiency, Thereby, the cargo handling capacity of the existing container terminal will increase to around 700,000 TEUs, provided that 9 ha of additional off-dock yard is prepared, three (3) gantry cranes, and nine (9) RTGs are newly installed.

Furthermore, PAS has planned to handle container cargoes tentatively at the multipurpose terminal, which is under construction, until the start of operation of new container terminal. Its cargo handling capacity is estimated to be around 100,000 TEUs on condition that derricks mounted on a container ship load and unload the container boxes.

Taking into account of the said cargo handling capacity of the existing container terminal and under-construction multipurpose terminal, 800,000 TEUs of container cargoes will be handled in the present port area.

Along with steady increase in container cargo in the future as mentioned in Chapter 6, it is expected that container cargo throughput will exceed the cargo handling capacity of the present port area (800,000 TEUs) in 2023 as mentioned in Figure 7.2-1. It is assumed that container cargo will not be handled at the multipurpose terminal after the opening of new container terminal. Under such circumstances, the new container terminal development plans should be promptly formulated to meet the increasing container cargo demand.



Source: JICA Survey Team

Figure 7.2-1 Stepwise Development Plan in Accordance with Container Cargo Demand