MINISTRY OF PUBLIC WORKS AND TRANSPORT (MPWT)
THE ROYAL GOVERNMENT OF THE KINGDOM OF CAMBODIA

PREPARATORY SURVEY
FOR
PHNOM PENH – BAVET EXPRESSWAY DEVELOPMENT PROJECT
IN THE KINGDOM OF CAMBODIA

FINAL REPORT
EXECUTIVE SUMMARY

AUGUST 2017

JAPAN INTERNATIONAL COOPERATION AGENCY

KATAHIRA & ENGINEERS INTERNATIONAL
CENTRAL NIPPON EXPRESSWAY CO. LTD.
METROPOLITAN EXPRESSWAY CO. LTD.
ORIENTAL CONSULTANTS GLOBAL

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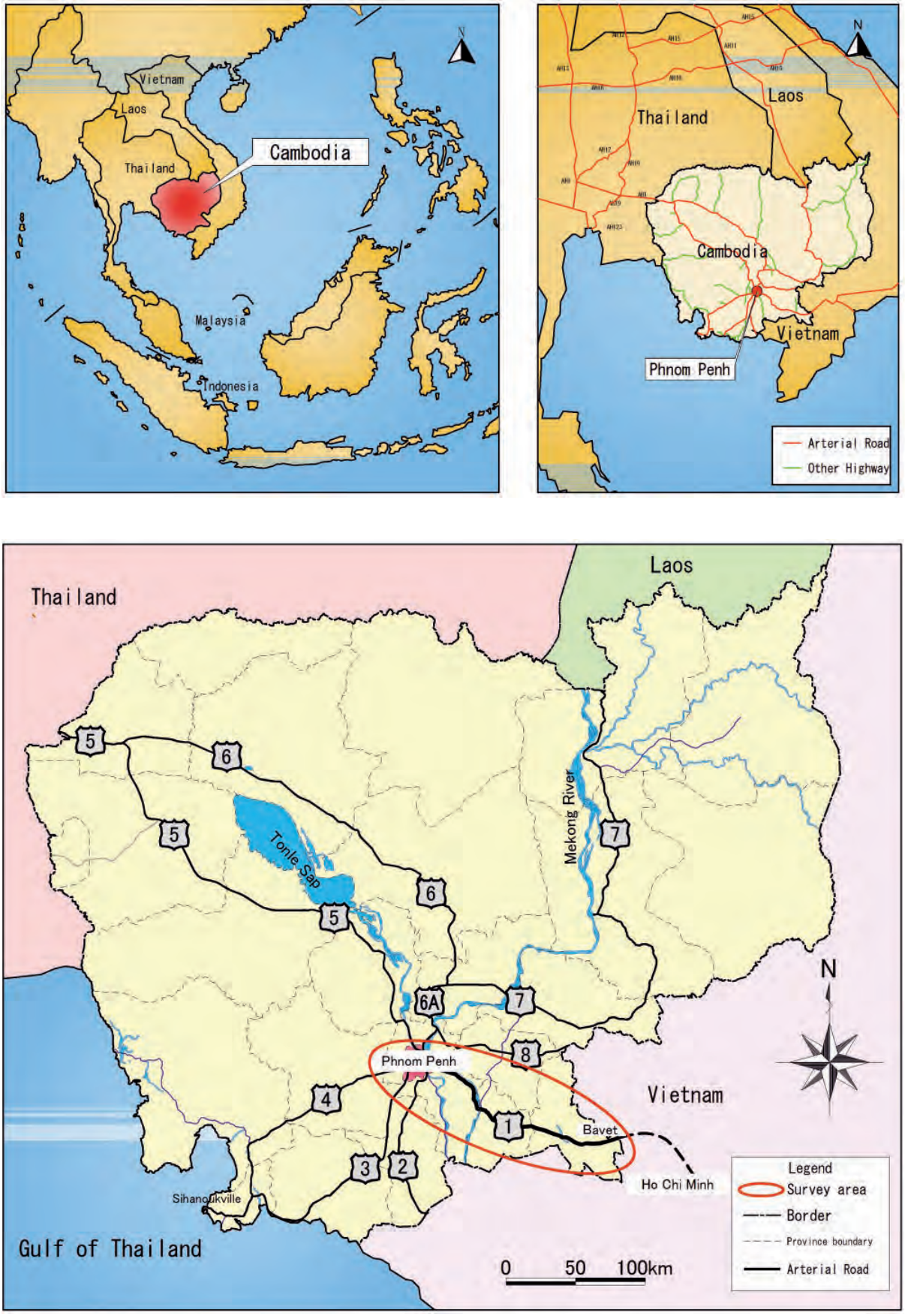

LOCATION MAP

Bird’s Eye View of Embankment Section with Over-Pass Bridge, Under Pass Culvert and Frontage Road

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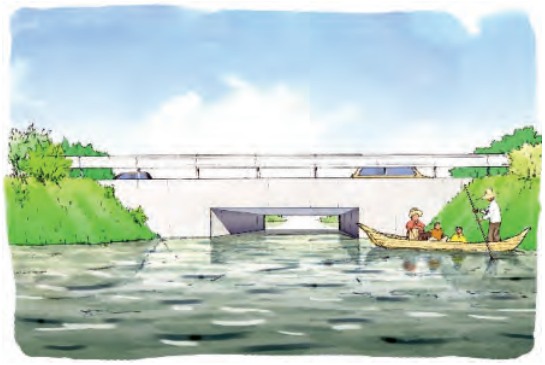

Passage of Boat under Expressway during Flood Season

Extra-Dosed Bridge for Crossing Mekong River (Ring Road No. 3)

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LIST OF ABBREVIATIONS (1/3)

AADT	: Annual Average Daily Traffic
AASHTO	: American Association of State Highway and Transportation Officials
AC	: Asphalt Concrete
ADB	: Asia Development Bank
AH1	: Asian Highway No. 1
AIDS	: Acquired Immune Deficiency Syndrome
ASEAN	: Association of South East Asian Nations
Bc	: Box Culvert
BCR	: Benefit Cost Ratio
BOT	: Built Operate Transfer
Br	: Bridge
CBR	: California Bearing Ratio
CDC	: Council for the Development of Cambodia
CO_2	: Carbon Dioxide
DBST	: Double Bituminous Surface Treatment
DMS	: Detailed Measurement Survey
EDC	: Electricite Du Cambodge
EIA	: Environmental Impact Assessment
EIRR	: Economic Internal Rate of Return
ESAL	: Equivalent Single Axle Load
EXMID	:Department of Expressway, Mega Bridge, and Investment
FC	:Foreign Currency
FEF	: Front-End Fee
FEIA	: Full Environmental Impact Assessment
FIIDIC	:International Federation of Consulting Engineers
FIRR	:Financial Internal Rate of Return
GDCE	: General Department of Customs and Excise
GDR	: General Department of Resettlement
GFS	: Government Financial Support
GL	: Ground Level
GMS	: Grater Mekong Sub region
GOC	: Government of Cambodia
HIV	: Human Immunodeficiency Virus
HV	: Heavy Vehicle
IC	:Interchange
ICB	: International Competitive Bidding
ICD	: International Cooperation Department (of MPWT)

LIST OF ABBREVIATIONS (2/3)

ICT	: Information and Communication Technology
IDC	: Interest During Construction
IEIA	: Initial Environmental Impact Assessment
IMF	: International Monetary Fund
IOL	: Inventory of Loss
IRC	: Inter-Ministerial Resettlement Committee
IRC-WG	: IRC-Working Group
IRP	: Income Restoration Program
IRR	: Internal Rate of Return
JICA	: Japan International Cooperation Agency
JV	: Joint Venture
LC	: Leam Chabang Port
LV	: Light Vehicle
MC	: Motorcycle
MEF	: Ministry of Economic and Finance
MLMUPC	: Ministry of Land Management, Urban Planning and Construction
MOT	: Ministry of Transport of Vietnamese Government
MPWT	: Ministry of Public Works and Transport
NEXCO	: Nippon Expressway Company
NO_2	: Nitrogen Dioxide
NPV	: Net Present Value
NR	: National Road No.
OD	: Origin Destination
ODA	: Official Development Assistance
PA	: Parking Area
PAPs	: Project Affected Person(s)
PC	: Pre-stressed Concrete
PCE	: Passenger Car Equivalents
PCU	: Passenger Car Unit
PMU	: Project Management Unit
PPP	: Public Private Partnership
PRSC	: Provincial Resettlement Sub Committee
PRSC-WG	: PRSC Working Group
PV	: Provincial Road
RAP	: Resettlement Action Plan
RCS	: Reinforced Concrete Flat Slab, also Replacement Cost Survey
RGC	: Royal Government of Cambodia
ROW	: Right of Way

LIST OF ABBREVIATIONS (3/3)

SA	: Service Area
SHM	: Stakeholder Meeting
SN	: Structure Number
SO_2	: Sulfur dioxide
SPC	: Special Purpose Company
SPT	: Standard Penetration Test
SPV	: Special Purpose Vehicle
STA	: Station
STRADA	: System for Traffic Demand Analysis
TTC	: Travel Time Cost
TTS	: Telegraphic Transfer Selling rate
USD	: United States Dollar
UXO	: Unexploded Ordnance
VAT	: Value Added Tax
VCR	: Traffic Volume per Capacity Ratio
VOC	: Vehicle Operating Cost
WTP	: Willingness-to-Pay

CHAPTER 1 INTRODUCTION

1.1 Background

- The national road network of Cambodia deteriorated severely during the civil war. Many road rehabilitation projects were implemented during the 1990s to early 2000s, and the main focus of road network development is now shifting to strengthening the functions of the existing road network.
- One of the key issues for strengthening the function of the road network is the construction of a national expressway network.
- As a result of the above circumstances, The Japan International Cooperation Agency (JICA) implemented a "Preliminary Data Collection Survey for Expressway Development in the Kingdom of Cambodia" (hereinafter referred to as "the Preliminary Survey") from June to August 2013. The result of this survey, a national expressway network with a total length of 2,200km was proposed.

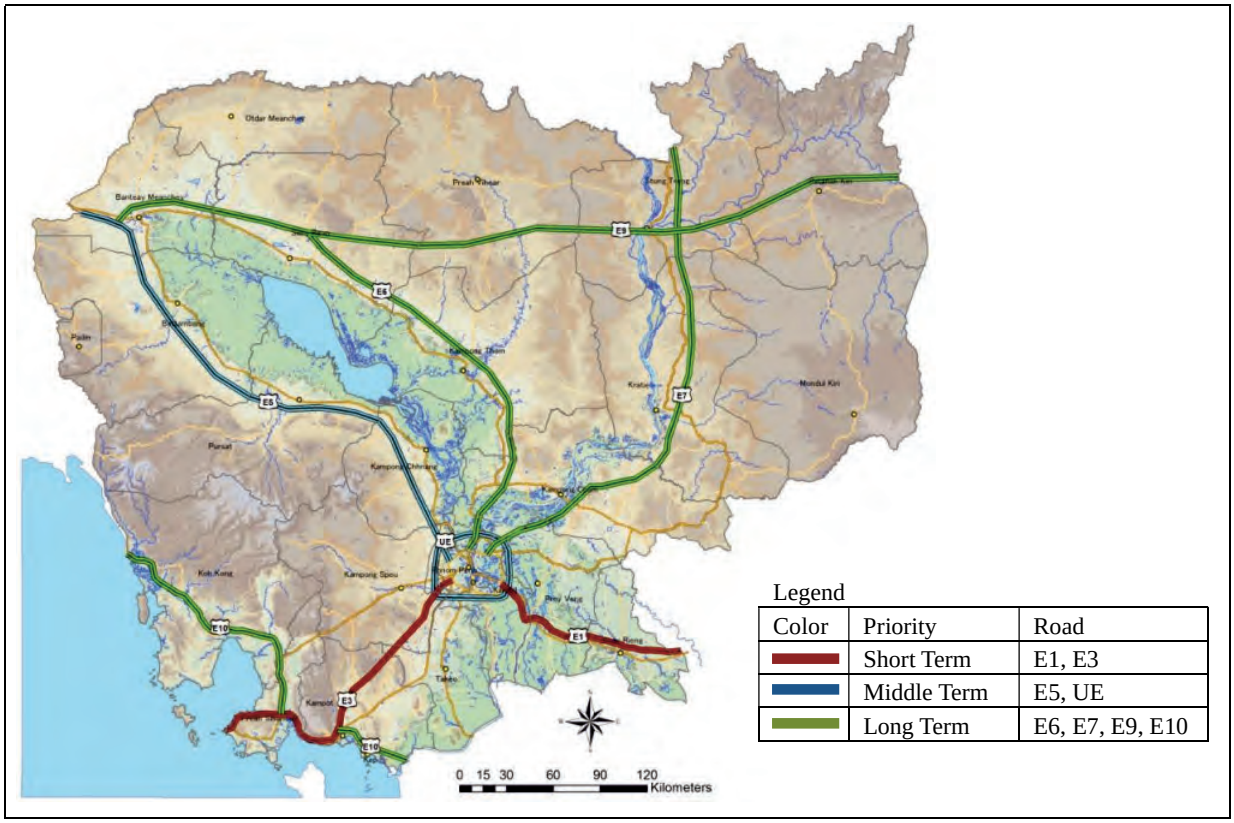


Figure 1-1 National Expressway Network Proposed by the Preliminary Survey

- Following the above survey, JICA conducted the "Data Collection Survey on Phnom Penh – Ho Chi Minh City Expressway Development Plan in the Kingdom of Cambodia" (hereinafter referred to as "the Data Collection Survey") from January to May 2014. This survey showed the possibility and the importance of the development of this expressway. This survey also proposed two candidate routes for the expressway.
- After the completion of the Data Collection Survey, MPWT and JICA consulted and agreed to carry out a feasibility study on Phnom Penh – Bavet Expressway.

1.2 Necessity of Phnom Penh – Bavet Expressway

- The route connecting Bangkok, Thailand to Phnom Penh and Ho Chi Minh City, Vietnam is an important international transport route. It is designated as Route No. 1 in the ASEAN Highway Network and the Asian Highway Network. It is also designated as the "Southern Corridor of GMS" by ADB.
- In the territory of the Kingdom of Cambodia, National Roads No. 1 (NR1) and No. 5 (NR5) constitute this route.

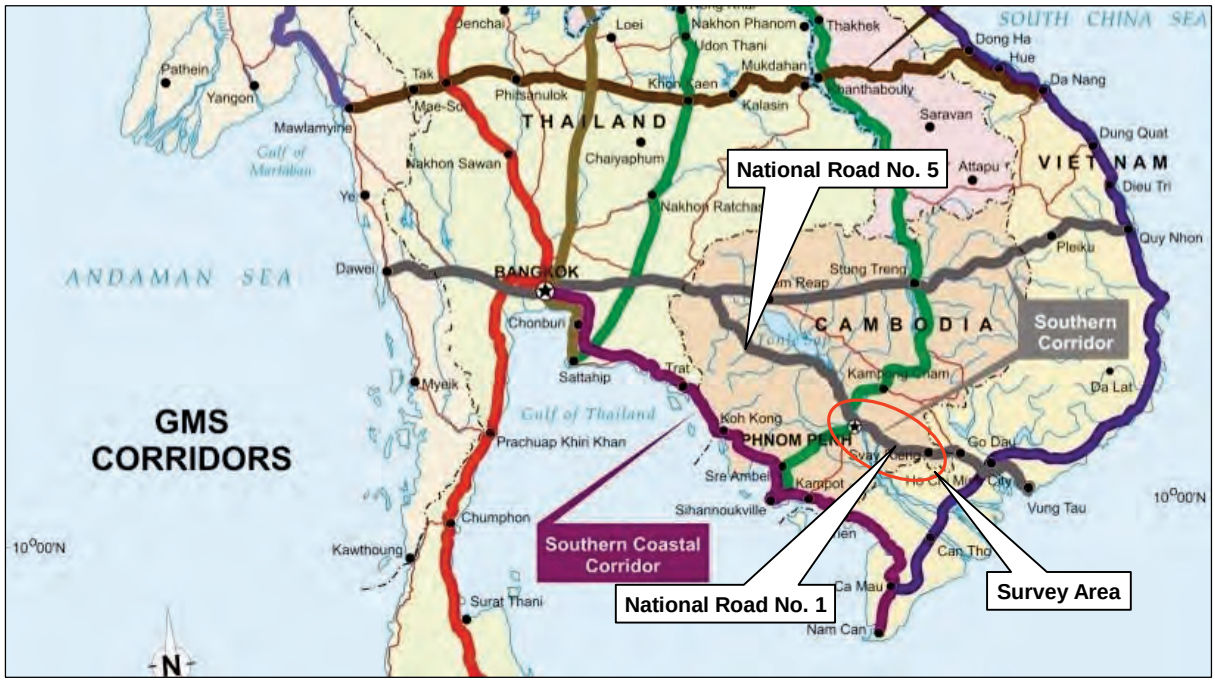


Figure 1-2 Southern Corridor of GMS

- While NR5 is being widened to cope with the increase in traffic demand, widening of NR1 is difficult due to the following reasons:
  - There are many towns and cities along NR1 which make land acquisition difficult.
  - NR1 crosses the Mekong River by the Tsubasa Bridge. Since this bridge is of cable-stayed type, it is very difficult to widen this bridge. (The width of this bridge is 10m: 2-lane + motorcycle lanes). Thus, this bridge will constitute a bottleneck even if the other parts of NR1 are widened.
- A high standard highway or expressway has much higher traffic function (high travel speed, high stability of traffic flow, large traffic capacity and high traffic safety) and is indispensable for modernization of industrial structure of Cambodia.
- High standard highway is expected to bring about the following benefits:
  - Promotion of growth of national economy: Sn expressway improves the efficiency of transport and contributes to a reduction in production costs. This, in turn, improves the environment for foreign investment resulting in economic growth of the nation.
  - Promotion of regional development: New factories are expected to be constructed, and new job opportunities are created and the region is developed economically.
  - Expansion of market for agricultural products: Due to the shortened transport time and the reduction in damage during transport, agricultural products can be transported longer distances

and can be sold in the market in large cities, such as Phnom Penh.

- Easier access to public services Citizens living far away from a big city can come to the big city and receive better public services, such as medical service and education, after completion of the expressway.

・ The Phnom Penh – Bavet Expressway, in particular, is expected to promote regional cooperation between Vietnam and Cambodia.

1.3 Objective of the Survey

・ There is a possibility that the Phnom Penh – Bavet Expressway Project might receive financial assistance (an ODA loan) from the Japanese Government. Thus, the objective of this survey is to obtain data and information required for the appraisal of a loan project funded by Japanese ODA. This will include such items as the objectives, outline, project cost, implementation schedule, implementation organization, maintenance system and natural and social impacts.

1.4 Scope of the Survey

・ The survey is divided into two phases: Phase 1 focuses on the selection of the route location, and Phase 2 focuses on the preliminary design, cost estimate, implementation plan and other information needed for the appraisal of the Project as a Japanese ODA loan project. The main scope of the Survey for Phase 1 and Phase 2 are as summarized below:

1.5 Survey Area

・ The survey area is the area along the proposed routes of Phnom Penh – Bavet Expressway and Ring Road 3 (Phnom Penh City, Kandal Province, Prey Veng Province and Svay Rieng Province).

CHAPTER 2 ROUTE SELECTION

2.1 Candidate Routes

- Figure 2-1 shows the three candidate routes for the expressway route selection.

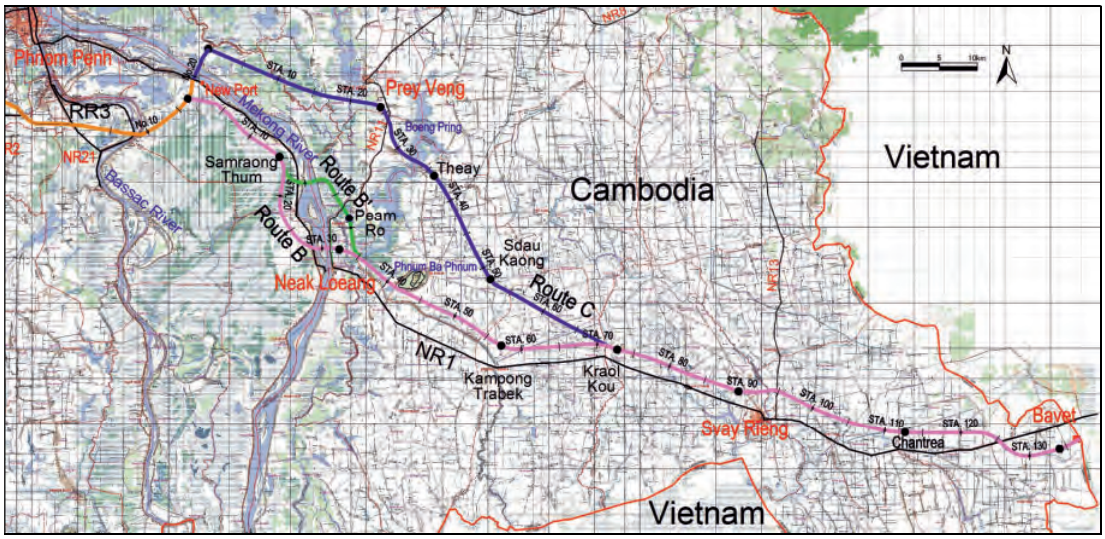


Figure 2-1 Three Candidate Routes

2.2 Comparative Evaluation of Candidate Routes and Selection of Optimum Route Location

- The evaluation criteria for the Phnom Penh – Bavet Expressway are selected to assess the candidate routes from two viewpoints; the degree of conformity with the objectives of the expressway development and technical feasibility.
- Data and information used in the evaluation were approximate ones available at the time of evaluation which was conducted in the early stage of this Survey.
- Table 2-1 summarizes the results of the evaluation. The Survey Team recommended Route C.

2.3 Consultation among the Stakeholders and Adoption of the Recommended Route by the Government of Cambodia

(1) Process of Route Selection by the Government of Cambodia

- A meeting attended by the Minister and other senior management of MPWT was held on 12 August 2015, and it was decided that Route C be adopted as the preferred route of MPWT.
- A meeting attended by the undersecretaries of the relevant ministries and the deputy governors of the relevant provinces was held on Thursday, 20 August. The meeting supported Route C.
- With the result of the meeting described above, MPWT sent the Prime Minister's Office a letter dated 7 September 2015 seeking approval on the selection of Route C. The approval on the route selection was issued by the Council of Ministers on 6 October 2015.
- With the above approval by the Council of Ministers, the route was adopted by the Cambodian Government.

Table 2-1 Summary of Comparative Evaluation of Candidate Routes

Criteria		Evaluation Indicator	Route B		Route B'		Route C	
Conformity with Objective of Expressway Construction	1. Integration into the Region (ASEAN, GMS) and the World	Travel Time: Phnom Penh – Bavet (2033)	127 min	○	127 min	○	129 min	○
		Avg. Travel Speed (2033)	73 km/h	○	73 km/h	○	72 km/h	○
	2. Balanced Development of National Land	Travel Time: Phnom Penh – Prey Veng (2033)	143 min	△	109 min	○	70 min	◎
		Travel Time: Prey Veng – Bavet (2033)	138 min	△	108 min	○	70 min	◎
		Potential of Regional Development	Low	△	Medium	○	High	◎
	3. Improvement of Traffic Condition	Average VCR of NR1: Phnom Penh – Bavet (2033)	0.65	○	0.65	○	0.69	○
	Conformity with Objective of Expressway Construction		**Low**	**△**	**Medium**	**○**	**High**	**◎**
Technical Feasibility	4. Environmental and Social Impact	No. of Protected area / Forest zone	None	○	None	○	None	○
		No. of Affected Building (Approx.)	710	△	710	△	850	△
	5. Engineering Feasibility	Project Cost (USD million)	2,562 (+76)	○	2,527 (+41)	○	2,486 (0)	○
	6. Timeliness of Project Completion	Construction Period of RR3 and RR3 - Bavet	13 years	○	13 years	○	13 years	○
	7. Economic Efficiency	Benefit (of 30 years, present value, discount rate=12%, USD million)	771	○	855	○	889	○
		EIRR	11.2%	○	12.0%	○	12.3%	○
	Technical Feasibility		**Feasible**	**○**	**Feasible**	**○**	**Feasible**	**○**
Overall Evaluation							**Recommended**	

(2) Explanation to Local Communities

- MPWT held a series of meetings to explain the outline of the project to the local communities (Districts and Communes) during the period from 2 (Monday) to 6 (Friday) November 2015.
- All the participants expressed their support to the Project. The major comments or questions raised are request for minimizing social impact (resettlement) and questions on compensation for land acquisition and resettlement.

(3) Consultation with the Vietnamese Government

- A delegate of MPWT headed by HE Tauch Chankosal, Secretary of State visited the Ministry of Transport (MOT) of Vietnam on Friday, 10 June 2016 and had discussion on the route of expressway near the border.
- However, MOT of Vietnam declined to comment on the route saying that the study on Ho Chi Minh City – Moc Bai Expressway had not been started yet.
- In late November 2016, MOT, Vietnam visited Phnom Penh to discuss the route of expressway near the border.
- MPWT, Cambodia and MOT, Vietnam agreed that the route of expressway be approximately 2km north of NR 1.

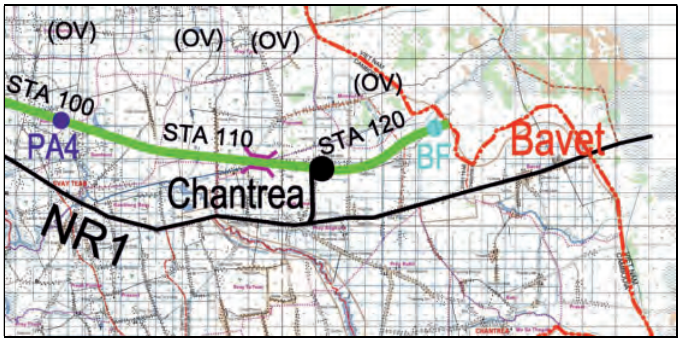


Figure 2-2 Route of Expressway near Border as Agreed by MPWT and MOT

CHAPTER 3 TRAFFIC DEMAND FORECAST

3.1 Traffic Demand Forecast

(1) Procedure for Forecasting Traffic Demand

- To estimate the traffic volumes on the planned expressway network, traffic count and WTP surveys were conducted. Traffic count data are used to analyze the present traffic characteristics, most up-to date road link conditions and to establish present OD tables by vehicle category. WTP survey data are used to conclude the diversion parameters of traffic assignment model on the expressways. Then, the forecasted Vehicle OD matrices of Phase I are recalculated based on the results of traffic surveys and information on the economic growth of Cambodia for the target years of 2024, 2027, 2030, 2040 and 2050 on a vehicle categories basis.
- Traffic volumes are assigned on the existing and future road networks without the proposed expressway network, which is "Without Project" case. Next, volume of traffic which will be handled on the expressway network in the future are determined, which is "With Project" case.

(2) Assumptions

- For the traffic demand forecasting which require consideration of network data, OD table, and several parameters. Toll fee and diversion rate also consider in the assumptions for expressway project. The major assumptions are shown in below.

(a) Traffic Analysist Zone

- There are 211 traffic zones which consists of 198 internal traffic zones in Cambodia, and 13 external zones such as Thailand, Vietnam, and Laos.

(b) The OD tables

- The vehicle trips in the present OD table, which is recalculated based on the OD table of the Phase I survey and the traffic survey results of this survey, is assigned to the road network. Computed results and actual observed traffic volume (converted into PCU) were compared to check the accuracy of the model.

(c) Passenger Car Equivalents (PCE)

- Traffic volume is expressed in the form of both Passenger Car Unit (PCU) and the number of vehicles. The PCU equivalents used in this survey are shown in Table 3-1.

Table 3-1 Passenger Car Equivalents (PCE)

Categories	Motor Cycle	Light Vehicle	Heavy Vehicle
PCE	0.30	1.25	3.00

Source: JICA Study Team

(d) Diversion Rate Model

- Based on the Willingness-to-Pay Survey, the traffic volume of the expressway is estimated by using diversion rate model.
- Table 3-2 shows the parameters for the diversion rate model.

$$P = \frac{1}{1+\alpha(X/S)^{\beta}/T^{\gamma}}$$

Where,

P : diversion rate
X : toll/time difference
T : time difference (difference of the travel time between the expressway and alternative route)
S : shift rate (growth rate of GDP per capita)
α, β, γ : parameters (see Table 3-2)

Table 3-2 Parameters for Diversion Rate Model

Parameter	Light Vehicle	Heavy Vehicle
α	0.165	0.038
β	2.50	1.70
γ	0.50	0.30

Source: JICA Study Team

(e) Toll Level

- The toll level of the expressway used for traffic demand forecast in this study is assumed to be the followings.
  - Light Vehicle : USD 0.05 / km
  - Heavy Vehicle: USD 0.15 / km

(f) Possibility of Shift of Cargo from Inland Water and Marine Transport to Expressway

- An interview survey was conducted to understand the possibility of shift of cargo by land transportation to Ho Chi Minh when the expressway is opened in future, using logistic and transportation company and manufactures of inland water on the Mekong river or marine transport via Sihanoukville Port.
- Base on the survey result, it is assumed that the cargo traffic which is currently transported by ship and that would shift to the expressway in the future is small in view of the following facts:
  - The majority of goods currently transported by ship is mainly with low time-value.
  - The quantity of high-time-value products which will be produced in Cambodia in the future will be relatively small.
- Therefore, the diversion of goods from ship to the expressway is not taken into account in the traffic demand forecast.

(3) Future Traffic Demand

- Traffic demand on the expressway is computed by multiplying the traffic demand which can use the expressway by the diversion rate. It is assumed in the estimation that motorcycles are not allowed to use expressway since motorcycles are prohibited on expressways in many countries. Location of traffic demand by interchange is shown in Figure 3-1.

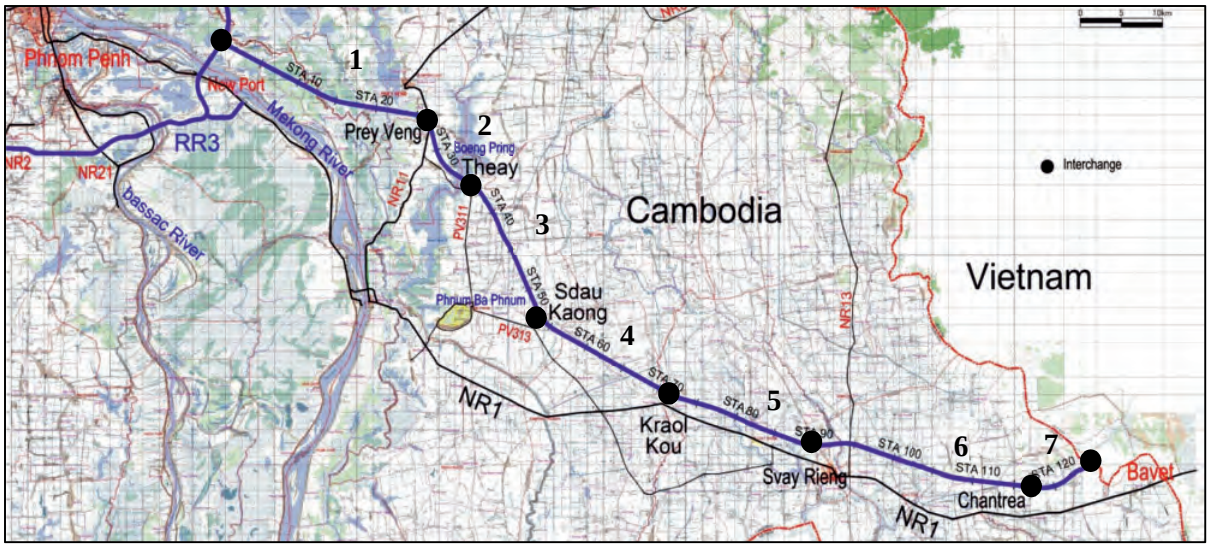


Figure 3-1 Location of Traffic Demand by Inter Change

- Future traffic demand is forecasted for the "Without Expressway" case and "With Expressway" case in each target year: 2024, 2027, 2030, 2040, and 2050. Figures 3-2 and 3-3 illustrate the assigned traffic demand forecasted for the "With Expressway" in 2030 and 2050 year.
- The traffic demand result (PCU/day) by interchange sections shows in Table 3-3. The entire expressway will be operated in year 2030.

Table 3-3 Traffic Volume on Expressway (PCU/day)

Year	Vehicle type	1 Ring Road - Prey Veng	2 Prey Veng - Theay	3 Theay - Sdau Kaong	4 Sdau Kaong - Kraol Kou	5 Kraol Kou - Svay Rieng	6 Svay Rieng - Chantrea	7 Chantrea - Bavet
2024	LV	4,336	-	-	-	-	-	-
	HV	4,404	-	-	-	-	-	-
	Total	8,740	-	-	-	-	-	-
2027	LV	8,304	3,924	3,418	3,354	-	-	-
	HV	8,332	5,444	5,158	5,084	-	-	-
	Total	16,636	9,368	8,576	8,438	-	-	-
2030	LV	13,492	5,804	5,180	5,084	4,442	2,004	252
	HV	12,452	7,864	7,556	7,504	6,532	4,630	1,724
	Total	25,944	13,668	12,736	12,588	10,974	6,634	1,976
2040	LV	32,454	16,606	16,086	15,074	13,038	5,256	486
	HV	25,438	16,860	33,616	16,464	14,426	9,422	3,262
	Total	57,892	33,466	49,702	31,538	27,464	14,678	3,748
2050	LV	41,066	24,534	24,978	25,152	20,904	9,010	762
	HV	32,572	23,570	25,572	26,272	22,826	14,968	4,954
	Total	73,638	48,104	50,550	51,424	43,730	23,978	5,716

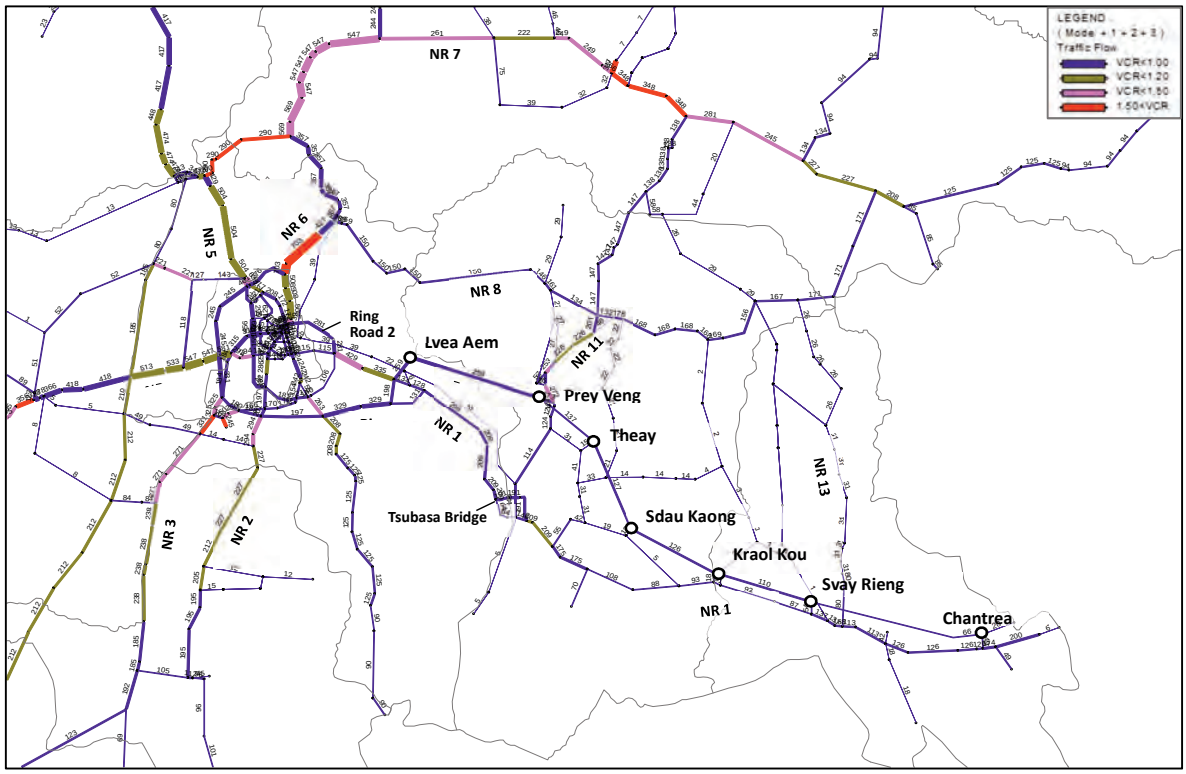


Figure 3-2 Traffic Volume with Expressway in Year 2030 (PCU/day)

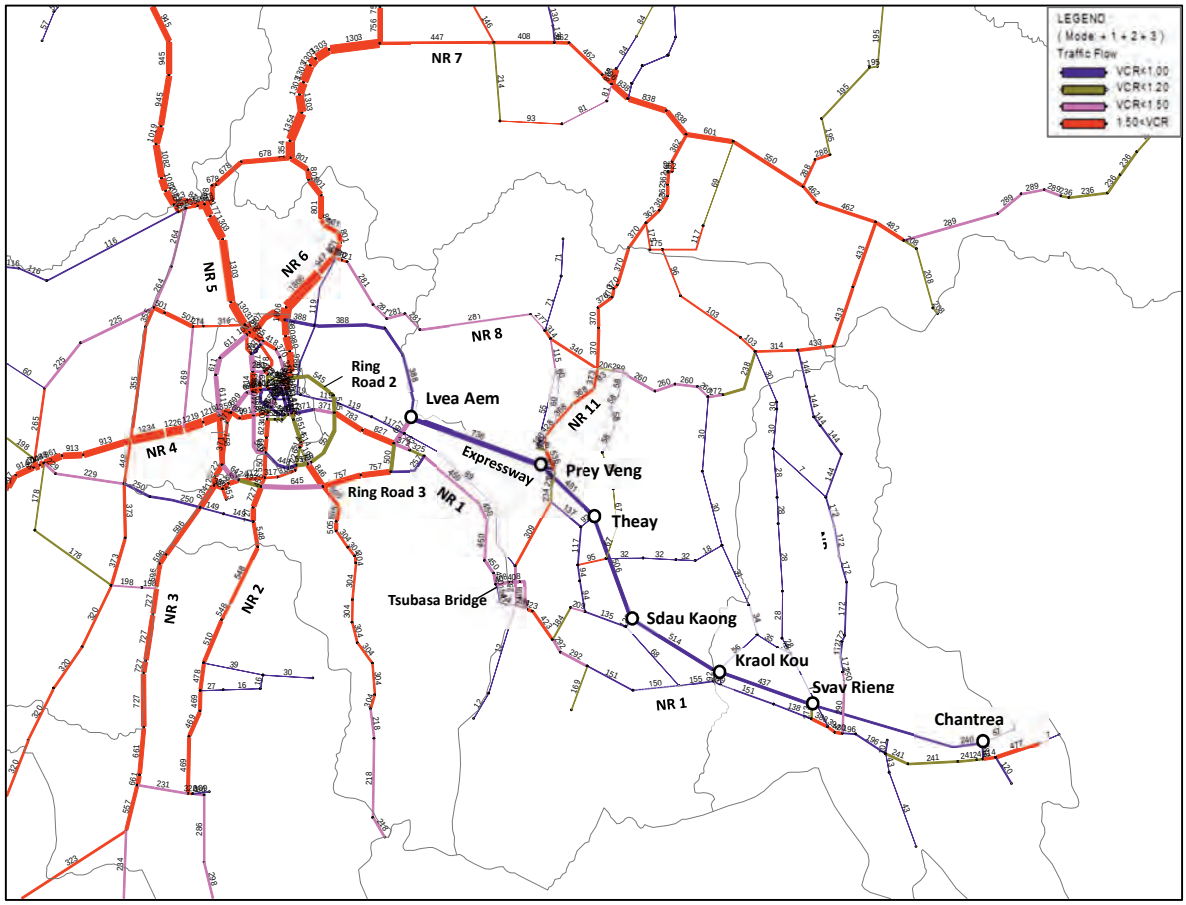


Figure 3-3 Traffic Volume with Expressway in Year 2050 (PCU/day)

3.2 Validation of Expressway's Connecting with Ring Road 2

・ As mentioned in the preceding section, even after the construction of the expressway there will be traffic congestion on NR1 inside Ring Road 3 (RR 3) due to excess traffic demand. Connection of the expressway and the Ring Road 2 (RR 2) is expected to disperse incoming and outgoing traffic to/from Phnom Penh and alleviate this congestion. In this section, a justification for the expressway's connecting with Ring Road 2 is validated. The development of RR 2 project was not advanced enough to be included in the expressway project at the time when the Survey started, and the beginning point of the expressway was set on RR3 (Lvea Aem).

(1) Traffic Demand Forecast

・ Traffic demands in 2033 are forecasted for the following cases:

- Without connection between the expressway and RR 2
- With connection between the expressway and RR 2

Note: the connecting road is assumed to be completed 3 years after the full section of the expressway will be opened in 2030.

(2) Effect of the Connection of the Expressway with RR 2

(a) Dispersion of Traffic

・ While VCRs of some radial roads such as NR1 and PV 21 exceeds 1.50 without the connection (Figure 3-4), they are expected to be less than 1.50 after the expressway and RR2 are connected (Figure 3-5).

(b) Economic Benefit

・ The economic Internal Rate of Return (EIRR) and Benefit - Cost ratio (B/C ratio) as calculated for the construction of the connecting road are shown below. Construction of the connecting road is considered to be economically feasible.

- EIRR : 21.5%
- B/C ratio : 2.06

Note: Assumption of estimation is as follows: Construction period is from 2031 to 2033. Refer to Section 6.14 for the construction cost. Benefit is accumulated for 30 years after construction completed. Social discount rate for B/C calculation is 12.0 %.

(3) Justification of Expressway's Connection with RR 2

・ Through the above analysis, it is found that connecting the expressway with RR 2 is expected to alleviate congestion on some radial roads inside RR 3 and is economically feasible as well. Therefore, construction of the connecting road between the expressway and RR 2 is justified.

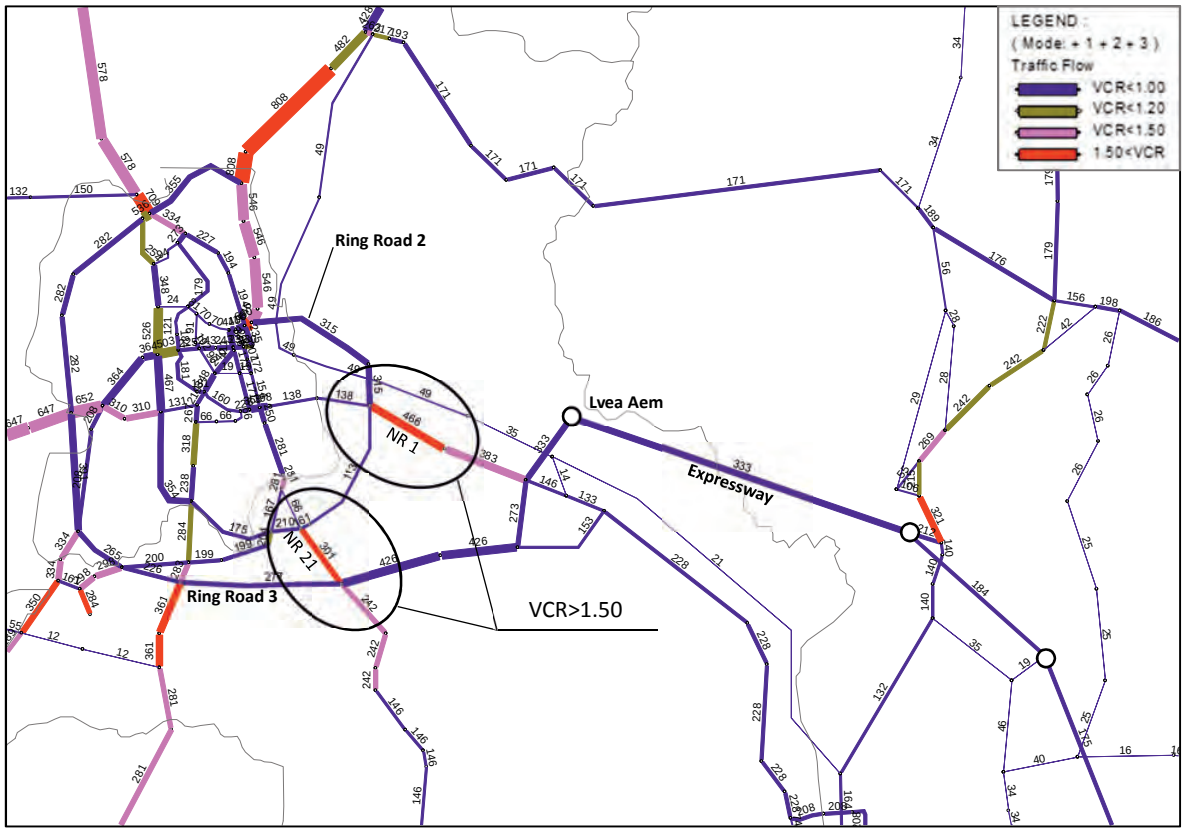


Figure 3-4 Traffic Demand without Connecting Road in 2033 (PCU/day)

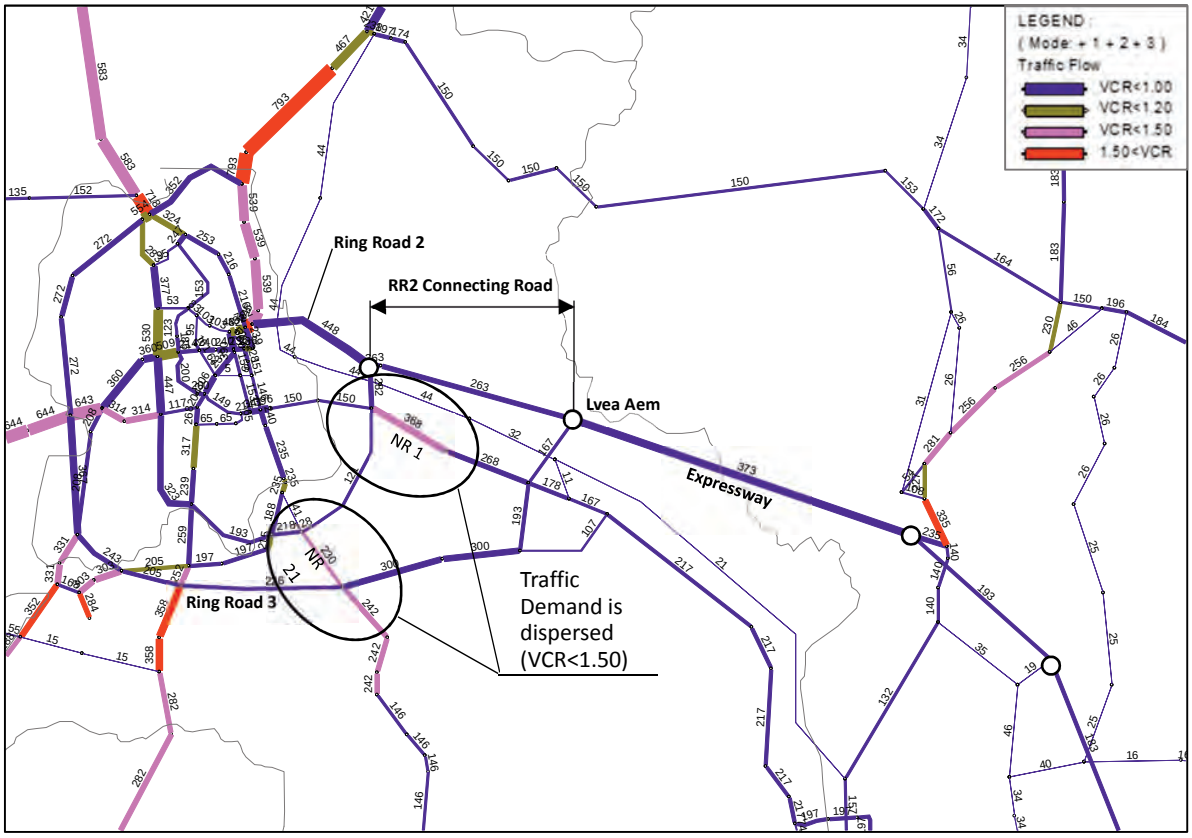


Figure 3-5 Traffic Demand with Connecting Road in 2033 (PCU/day)

CHAPTER 4 EXPECTED PROJECT EFFECT

- An expressway brings about various positive effects on socio-economic activities.
- The positive effects, or benefits, are usually categorized into two types; the direct and indirect.
- "Direct effects" refers to the benefit enjoyed by the road user, while "indirect effects" refers to the development of related socio-economic activities brought about by shortening of travel time and reduction in transport cost.

4.1 Direct Effect

(1) Shortening of Travel Time

- The travel time between Phnom Penh and Bavet via the expressway is shortened from 4 hours of via NR1 to approximately 2 hours in 2030.
- The travel time between the cities/towns along the expressway, other than Phnom Penh and Bavet, is also shortened by using the expressway.

(2) Monetary Value of Travel Time Saving

- The value of the travel time saving accruing from use of the Phnom Penh – Bavet Expressway is estimated at approximately USD 24,000 million per year.

(3) Reduction in Transport Cost

- Owing to a smooth road surface and non-stop travel, the operating cost of vehicles using the expressway is substantially reduced compared to that of using ordinary an highway.
- The total amount of vehicle operating cost (VOC) saving by using the Phnom Penh – Bavet Expressway is estimated at USD 8,900 million per year.

(4) Mitigation of Traffic Congestion

- Traffic demand in Cambodia is increasing rapidly due to economic growth and severe traffic congestion is anticipated on many roads around Phnom Penh.
- The volume/capacity ratio (VCR) on NR 1 is anticipated to be 1.46 in the year 2030, indicating substantial traffic congestion.
- VCR on NR 1 in the same year is estimated to be reduced to 0.96 if the expressway is opened to traffic.

(5) Improvement of Traffic Safety

- As a result of careful design for high speed traffic, an expressway is much safer than ordinary roads. According to the statistics measured in Japan, the accident rate of expressway is approximately one twelfth (1/12) of all other roads.

(6) Reduction in Vehicle Emissions

- In general, the construction of an expressway, eases traffic congestion, and as a result, reduces vehicle emissions. Expressways also contribute to a reduction in vehicle emissions through smooth running traffic. Tables 4-1 shows the reduction in CO_2 emission brought about by the construction of the Phnom Penh – Bavet Expressway.

Table 4-1 Estimated Reduction of CO_2 Emission

Year	Opened Section of Expressway	Emission of CO_2		
		Without Project	With Project	Reduction
2030	NR1	357	231	127
	Expressway	–	83	▲83
	Total	357	313	44

(7) Economic Evaluation of Direct Effect

- Economic internal rate of return (EIRR) is often used as a measure in the justification of road projects.
- The EIRR of Phnom Penh – Bavet Expressway is calculated to be 12.04%.
- This value is usually considered to be sufficient for justifying a road project.

4.2 Indirect Effect

- As a result of the direct effects discussed in Section 4.1, socio-economic activities are also promoted. Such effects are called 'indirect effects'.

(1) Effect on Growth of the National Economy

- Speedy and stable road transport, together with a stable and sufficient power supply, is one of the fundamental infrastructures required to attract foreign investment.
- Speedy and stable transport is indispensable for reducing transport cost and transportation time which leads to an increase in competitiveness of the export products.

(2) Effect on Promotion of Tourism

- Phnom Penh is a growing tourism destination in Cambodia after Siem Reap. Many foreign tourists come to Phnom Penh from Ho Chi Minh City in Vietnam or vice versa.
- It currently takes 5 hours or more between Phnom Penh and Ho Chi Minh City, including 4 hours between Phnom Penh and Bavet. This will be shortened by 2 hours to become 3 hours when the expressway between Phnom Penh and Bavet is completed. This will lead to an increase in tourists between these two cities.

(3) Effect on Agriculture

- Reduction in transportation time, together with reduction in vibration due to smooth pavement surface, will allow an improvement in freshness of products as well as a reduction of damage and loss during haulage.
- All these combined will result in an increase of value of agricultural products at the market. Thus

the sales of the agricultural products produced in the areas far from the market (big city) can grow and the income of farmers is improved.

(4) Effect on the Improvement of Social Welfare

- Due to the speed and comfortable nature of travel on the expressway, the patients who are living in the remote areas and need high-level medical care can access a large hospitals in large cities such as Phnom Penh.

(5) Promotion of Regional Cooperation among ASEAN and GMS Countries

- ASEAN countries including Cambodia established the ASEAN Community (A/C) in order to accelerate the regional cooperation and economic growth among the member countries.
- The strengthening of the ASEAN Highway Network is listed among the components of the A/C Protocol.
- The Bangkok – Phnom Penh – Ho Chi Minh City route is one of the most important routes in the ASEAN Highway Network. It is designated as Route No.1 of the ASEAN Highway Network (AH1) and also designated as the Southern Corridor of GMS.
- Construction of the expressways between t Phnom Penh and Bavet is expected to contribute to the enhancement of connectivity between Bangkok, Phnom Penh and Ho Chi Minh City.

4.3 Operation and Effect Monitoring Plan

- In view of a very large amount of the investment required for the Project, it is necessary to monitor and validate that the Project objective is achieved.
- The monitoring is conducted from two viewpoints; (i) if the facility is operated and is performing as expected/planned and (ii) if the Project is yielding the expected effects.

(1) Operation Indicator

(a) Annual Average Daily Traffic (AADT)

- Gross traffic volume on an expressway over a year indicates how many people are using the expressway. Gross annual traffic volume is usually converted to annual average daily traffic (AADT). Thus, AADT is proposed as an indicator of operation.

(b) Availability Factor

- Performance of an expressway can be expressed in terms of the percentage of days (or hours) when the normal traffic conditions are maintained against the total number of hours of a year.

(c) Annual Toll Revenue

- The amount of toll revenue can be the indicator for the “financial performance” of the Project since the toll revenue is used as the primary fund source for amortize the loan used for the Project.

(2) Effect Indicator

(a) Annual Average Daily Traffic (AADT)

・ The traffic volumes on the expressway and NR 1 reflect the direct effect and indirect effects such as growth of economic activities. The AADT of heavy vehicles (heavy trucks and large buses) is considered to more clearly reflects the growth of the economic activities.

(b) Travel Time Saving

・ Saving in travel time is a direct effect and results in the growth of socio-economic activities in various ways. Thus, travel time saving is proposed as the effect indicator.

(3) Summary

・ Table 4-2 summarizes the proposed monitoring indicators and their data source or method for data collection:

Table 4-2 Summary of Monitoring Indicators and Data Source/Data Collection Method

Indicator	Evaluation Section / Unit of Measurement		Base Line Data (2016)	Target Value (2030)	Method of Data Collection / Data Source
AADT (vehicles/day)	NR1:Section 1*		14,100	30,500	Traffic count survey *Refer to Table 3.6-9 on the Section No.
	NR1:Section 2*		11,700	25,300	
	NR1:Section 3*		6,100	11,100	
	NR1:Section 4*		6,200	10,400	
	NR1:Section 5*		7,700	16,600	
	NR1:Section 6*		8,200	20,500	
	Exp: Lvea Ayem - Prey Veng	All	－	14,900	
		HV	－	4,200	
	Exp: Prey Veng - Theay	All	－	7,300	
		HV	－	2,600	
	Exp: Theay - Sdau Kaong	All	－	6,700	
		HV	－	2,500	
	Exp: Sdau Kaong - Kraol Kou	All	－	6,600	
		HV	－	2,500	
	Exp: Kraol Kou - Svay Rieng	All	－	5,700	
		HV	－	2,200	
	Exp: Svay Rieng - Chantrea	All	－	3,100	
		HV	－	1,500	
	Exp: Chantrea - Bavet	All	－	800	
		HV	－	600	
Availability Factor	Ratio of hours the expressway was open to traffic against the total hours for 1 year (length of section x hour)		－	100%	Maintenance record of the Expressway operator (Excluding the road closure due to traffic accident)
Annual Toll Revenue	All sections		－	USD 58 million	Internal report of the Exp. operator
Travel Time	Phnom Penh - Bavet		3.4 h	2.1 h	Travel Speed Survey ・2016：via NR 1 ・2030：via Exp.
	Phnom Penh - Prey Veng		1.9 h	0.9 h	
	Prey Veng - Bavet		2.6 h	1.0 h	

4.4 Economic Evaluation

- The economic analysis of the project is principally made in comparison between benefits and costs which is derived from with and without the project.

(1) Estimation of Economic Benefit

- The quantified economic benefits, which would be realized from the implementation of the project, are defined as saving in road user cost such as saving in travel time cost (TTC) and vehicle operating cost (VOC).
- TTC used in "the Preparatory Survey for National Road No. 5 Rehabilitation Project (Middle Section: Thlea Ma'am – Battambang) in the Kingdom of Cambodia", JICA, 2014 is adopted after inflated to fit to the conditions of 2016. Table 4-3 shows the TTC unit by vehicle type.

Table 4-3 Adopted Travel Time Cost by Vehicle Type

(Unit: USD/ hour)

Year	Motorcycle	Light Vehicle	Heavy Vehicle
2016	1.03	10.55	30.75

- Table 4-4 shows the VOC unit by vehicle type.

Table 4-4 Vehicle Operating Cost by Vehicle Type

(Unit USD/km)

Travel Speed (km/h)	MC	LV	HV
10	0.048	0.224	0.476
20	0.044	0.190	0.418
30	0.042	0.177	0.384
40	0.041	0.172	0.367
50	0.041	0.172	0.365
60	0.041	0.172	0.363
70	0.041	0.172	0.367
80	0.042	0.177	0.384
90	0.043	0.183	0.402
100	0.044	0.190	0.418

(2) Initial Cost

- Initial costs are calculated for four cases which correspond to the phases as explained in Chapter 10. Table 4-5 shows the economic and financial costs of the Projects.

Table 4-5 Project Costs

Case 1		Case 2		Case 3		Case 4	
RR3 + Whole Expressway		RR3 + Phase-1		RR3 + Phase-2		RR3 + Phase-3	
Financial Cost	Economic Cost	Financial Cost	Economic Cost	Financial Cost	Economic Cost	Financial Cost	Economic Cost
2694.56	2664.86	1334.66	1323.24	658.12	649.66	665.78	656.67

- Financial costs are the Project as explained in Chapter 8. They are used in the financial analysis as explained in Section 4.5 below.
- Economic costs are calculated based on the financial costs and adjusted considering the import and export duties as explained in Chapter 8.

(3) Discount Rate

- A discount rate of 12% is adopted.

(4) Economic Indicators

- The following economic indicators are used in the Study:
  - Economic Internal Rate of Return (EIRR)
  - Net Present Value (NPV)
  - Benefit Cost Ratio (BCR)

(5) Result of Analysis

- The economic indicators of the project obtained as the results of analysis are shown in Table 4-6.
- EIRR exceeds 12% only in Case 1.

Table 4-6 Results of Economic Analysis

Indicators	Case 1	Case 2	Case 3	Case 4
	RR 3+ Whole Expressway	RR 3 + Phase-1	RR3 + Phase-2	RR3 + Phase-3
EIRR (%)	12.04 %	10.50 %	4.13 %	6.76 %
BCR	1.01	0.79	0.26	0.42
NPV (USD million)	7.06	-161.84	-306.44	-242.75
Discounted Benefit (USD million)	1,189.35	592.88	105.75	174.43
Discounted Cost (USD million)	1,182.28	754.72	412.19	417.18

(6) Sensitivity Analysis

- The sensitivity analysis is made on the cases with +10% and -10% in the cost and benefit respectively.
- The results of the sensitivity analysis for Case1 is shown in Tables 4-7 as an example.

Table 4-7 Sensitivity Analysis

		Economic Indicator	Benefit		
			-10 %	Base Case	+10 %
Cost	-10%	NPV (USD million)	6.36	125.29	244.22
		BCR	1.01	1.12	1.23
		EIRR	12.04%	12.72%	13.35%
	Base Case	NPV (USD million)	-111.87	7.06	126.00
		BCR	0.91	1.01	1.11
		EIRR	11.38%	12.04%	12.65%
	+10%	NPV (USD million)	-230.10	-111.17	7.77
		BCR	0.82	0.91	1.01
		EIRR	10.80%	11.44%	12.04%

4.5 Financial Analysis

- As described in Chapter 9, the financial viability of the project is one of the few decisive factors for selecting the optimum project scheme. In this section, financial viability of the alternative project schemes is discussed.

(1) Financial Analysis Case

- This section describes the quantitative analysis of the following basic four (4) alternatives selected in "9.2 Project Scheme."
  - Alternative 1: Expressway Authority Scheme
  - Alternative 2: PPP (BOT) Scheme
  - Alternative 3: PPP (Lease) Scheme
  - Alternative 4: Direct Construction and Operation by MPWT Scheme

(2) Focal Indices of Financial Analysis

- It is important that the institution that is in charge of road construction and operation (hereinafter referred to as "the Road Operator") maintain the financial soundness throughout the project. However, he estimated project cost is too large for a single Road Operator to manage without financial support by the Government.
- On the other hand, it is expected that a surplus in revenue is generated in the later stage of the operation of the project road which can be used as the fund for further development of the expressway network. The amount of this revenue surplus needs to be evaluated.
- Therefore, this quantitative analysis mainly focuses on the following three indices as evaluation criteria:
  - Financial Internal Rate of Return (IRR) for the Road Operator
  - Government Financial Support (GFS), required to satisfy the financial soundness and sustainability of the project
  - Pooled Amount for New Construction

(3) Assumptions and Conditions of Financial Analysis

- Please refer Table 4.6-1 in Volume 1: Main Text of the Final Report.

(4) Results of Financial Analysis

- The FIRR, Government Financial Support and Amount of Pooled Revenue Surplus are summarized in Tables 4-8 and 4-9.
- It is noted that "Expressway Authority Scheme" and "Direct Construction and Operation by MPWT Scheme" yield larger pooled amount.
- "BOT Scheme" and "Lease Scheme" require large amount of government expenditure as financial support.

Table 4-8 IRR for Road Operator by Project Scheme

(USD million)

Scheme		Costs					Revenue	Balance	IRR
		Capital	O&M	Lease Fee	Corporate Tax	Total	Toll Revenue		
0	Project	2,552	494	-	-	3,046	4,127	1,081	1.16 %
1	Expressway Authority	2,180	494	-	-	2,674	4,127	1,453	1.70 %
2	BOT	2,474	494	-	358	3,326	4,127	802	0.94 %
3	Lease	72	494	2,474	215	3,256	4,127	872	9.07 %
4	Direct	2,191	494	-	-	2,685	4,127	1,442	1.68 %

Table 4-9 Government Expenditure and Pooled Amount for New Construction

(USD million, current price)

Scheme		Government Expenditure	Income	Pooled Amount for New Construction	Remarks
1	Expressway Authority	86	1,186	1,100	
2	BOT	2,345	654	-1,691	GFS is assumed to be given to achieve 12% of FIRR
3	Lease	2,237	2,702	465	
4	Direct	75	1,174	1,100	

(5) Sensitivity Analysis

・ The sensitivity of IRR for the expressway operator (Expressway Authority, SPV and MPWT) is analyzed for variation of the revenue (-10%) and project cost (+10%). The results of the analyses are shown in Table 4-10.

Table 4-10 Results of IRR Sensitivity Analysis for Revenue and Project Cost (IRR for Road Operator)

Sensitivity Factor			Scheme			
Case	Cost	Revenue	1. Expressway Authority	2. BOT	3. Lease	4. Direct Construction & Operation
Base	0%	0%	1.70 %	0.94 %	9.07 %	1.68 %
I	+10%	0%	1.32 %	0.60 %	6.93 %	1.31 %
II	0%	-10%	1.28 %	0.56 %	6.68 %	1.27 %
III	+10%	-10%	0.91 %	0.22 %	4.01 %	0.89 %

CHAPTER 5 NATURAL CONDITION SURVEY

- The components of the natural condition survey are topographic survey, air photo survey and geotechnical survey.

5.1 Topographic Survey

- The topographical survey consisted a road centerline survey, longitudinal profile survey, a cross section survey and survey of intersecting roads, the setting out of stakes showing the right of way, a toll barrier, interchanges, service areas and parking areas, as well as bathymetry survey.
- Table 5-1 shows the length of the expressway and RR3 where the topographic survey was conducted. Table 5-2 shows the items of the survey.

Table 5-1 Length of Surveyed Section

Section	Station	Distance
Ring Road No.3	No. -2 + 00～No. 7+ 00	9km
Expressway	STA. 0- 445.784～STA. 125 + 744.979	126km
Total		135km

- Forty-seven bench marks were established to be used as the reference points.
- The profiles along the centerlines of the expressway and RR 3 are shown in Figures 5-2 and 5-3.
- In addition, cross-section of approximately 120 locations were drawn.

5.2 Aerial Photo Survey

- Aerial photos to be used for the highway design were taken from a paraglider with an engine. The distortion of the photos caused by the inclination of the camera was corrected to obtain orthographic photos. Table 5-2 shows the specifications of the aero photo survey. Figure 5-1 shows the framing of the aero photos and an example of the photo taken.

Table 5-2 Specification of Aero Photo Survey

Item	Description
Aerial Ortho-Photo	Length of alignment: Ring Road No.3 (7km); Expressway (126km); Total 135km
	Forward overlap 60%, Lateral overlap 30%
	Resolution of 0.2m relevant to scale:1/500
Ground Control Point	47 points
Digital Mapping	A3 size, Scale: 1/5000

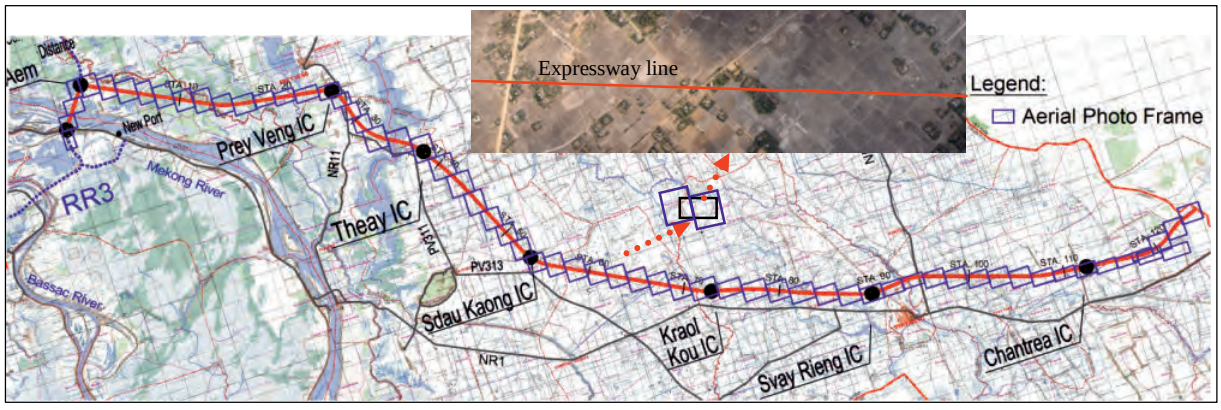


Figure 5-1 Frames of Aerial Photo Survey along Expressway Centerline

5.3 Geotechnical Survey

- Boring was conducted at 32 locations as shown in Figure 5-2.
- At each bore hole, standard penetration tests (SPTs) were conducted at an interval of 1m.
- Samples were taken also at an interval of 1m, and soil property tests (specific gravity, water content, particle size and Atterberg limits) and physical tests (consolidation and unconfined test) were conducted.
- Figures 5-2 and 5-3 show the soil profiles and the line of the assumed bearing layer (N>50).

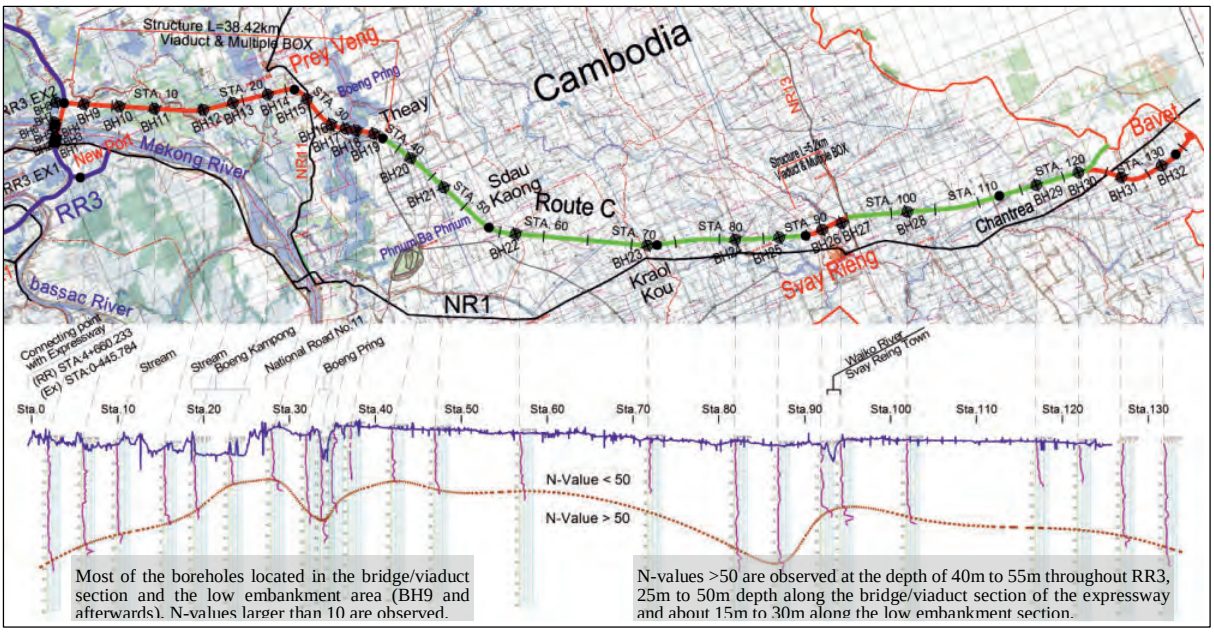


Figure 5-2 Soil Profile along Expressway

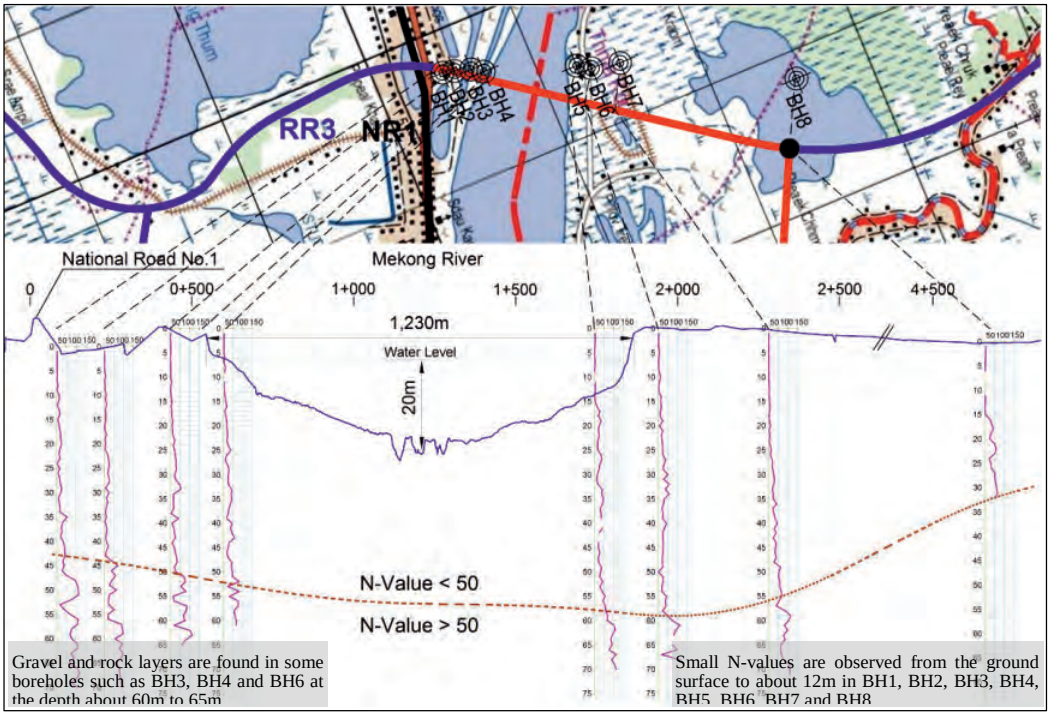


Figure 5-3 Soil Profile along Ring Road 3

CHAPTER 6 EXPRESSWAY DESIGN

6.1 Design Standard

(1) Expressway

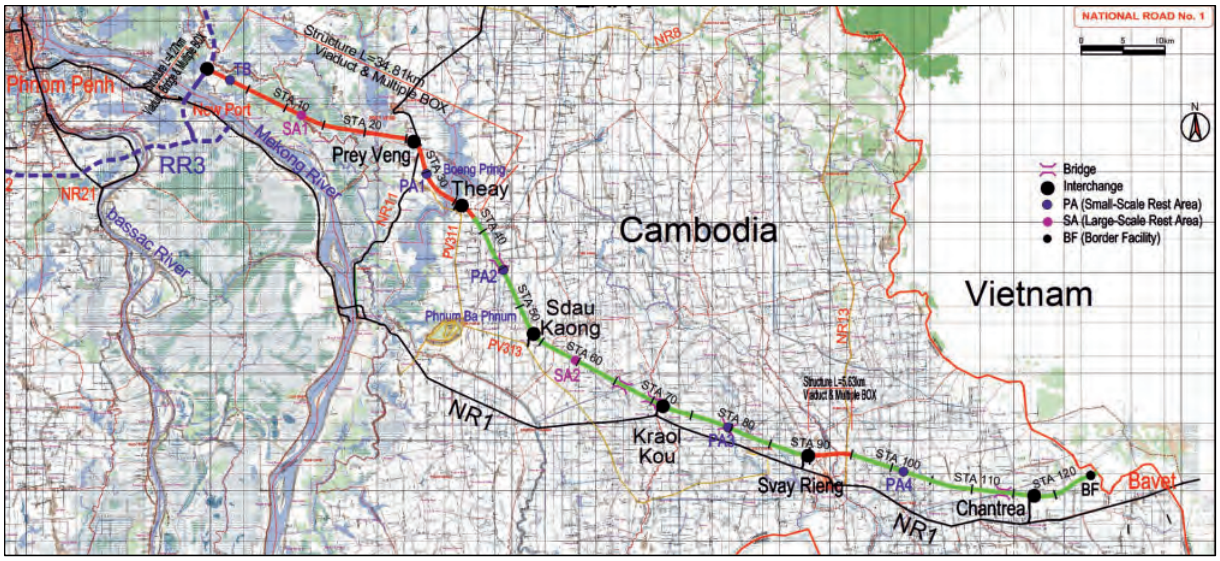


Figure 6-1 Planned Route of Expressway

- The design standards for the Phnom Penh – Bavet Expressway were selected based on the Cambodian Road Design Standard, referring the relevant standards of the international highway network, such as Asian Highway and ASEAN Highway, as well as those of Thailand and Vietnam.

Table 6-1 Design Standard of the Expressway

Items	Cambodia	Asian Highway	ASEAN Highway	Vietnam	Thailand	Japan	Proposed
Road Class	R6 (Rural)	Primary	Primary	Class A	Motorway	Type 1	
Terrain	Flat	Flat	Flat	Flat	Flat	Flat	Flat
Design Speed (km/h)	120	120	120	120	120	120	120
Lane Width (m)	3.5	3.5	3.75	3.75	3.6	3.5	3.75
Shoulder Width (m)	3.0	3.0	3.0	3.0	3.0	2.5	3.0
Median Width (m)	6.0~18.0	4.0	–	2.5~4.5	3.6~6.3	4.5	4.5
Cross Slope	2.5, 3.0%	2.0%	–	2.0%	2.0%	2.5%	2.5%
Vertical Clearance (m)	5.5	4.5	4.5 (5.0)	5.0	5.25	4.5	5.5

(2) Ring Road No. 3 (RR 3)

- Ring Road No.3 (RR3) is categorized as the high-standard urban trunk road (U5) in the Cambodian standard. Thus, the standard for this road is adopted. Table 6-2 shows the proposed standard of RR 3.

Table 6-2 Design Standard of RR 3

Item	Design Value
Road Class	U5 (Urban)
Terrain	Flat
Design Speed	80 km/h
Lane Width	3.5 m
Shoulder Width	3.0 m
Median Width	3.0 m
Cross Slope	2.5%, 3.0%
Vertical Clearance	5.5 m

6.2 Lane Width

(1) Expressway

- The lane width of 3.75m is proposed considering that the lane widths of ASEAN Highway and Vietnam which are 3,75m.

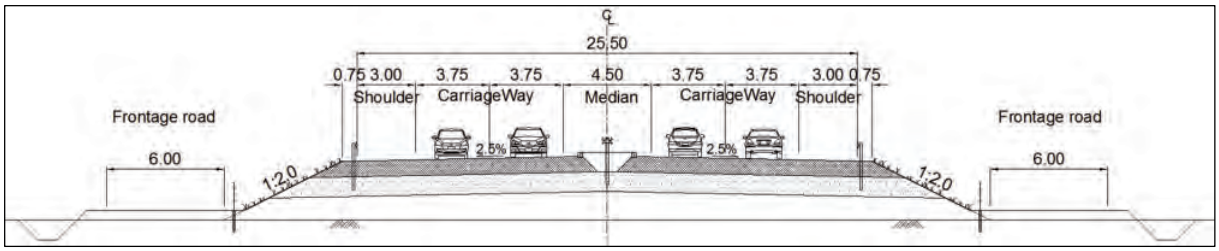


Figure 6-2 Proposed Cross-Sectional Composition of Expressway

(2) RR 3

- The cross section of RR 3 is planned in accordance with the standards for U5 roads.
- The shoulder width for U5 road is 3.0m. However, the 2.25m wide motorcycle lane and 1.50m wide sidewalk are provided in place of 3m-wide shoulder, to be in conformity with the cross section adopted in the China-assisted section.

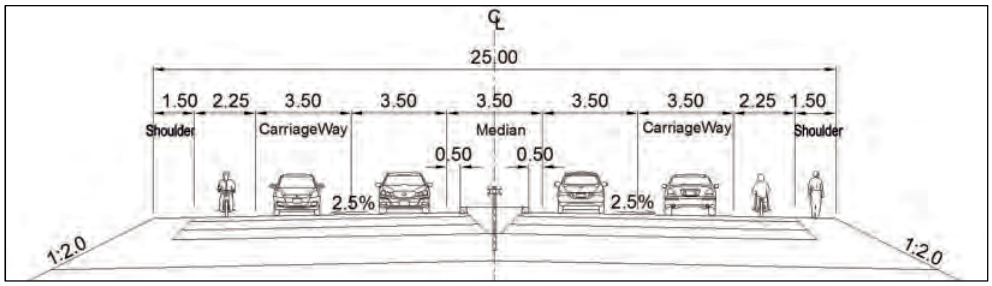


Figure 6-3 Typical Cross Section of RR 3 Propose by the Chinese Consultant

6.3 Alignment

(1) Expressway

- The term "control point" refers to topographical features, such as a hill or lake, and objects such as historic heritage and religious facilities, which need to be avoided. Table 6-3 shows the type of control points considered in selecting the alignment

Table 6-3 Type of Control Point

Type of Control Point	Example	Remarks
Topography	Narrow section of river and lake	
Residence of People	Villages and towns	
Religious Facility	Temple (Wat and Pagoda), graveyard	No Moslem mosque or Christian church was found along the route
Public Service Facility	School and hospital	
Large-Scale Building	Large factory, market	
Large-Scale Public Utility	Tower of high-voltage power line	

(2) RR 3

- The alignment of RR 3 was planned on the extension of the section of RR 3 which is to be constructed with the assistance of China.

・ There is a settlement of Vietnamese people on the northeastern bank of Mekong River. The alignment was planned avoiding this settlement.

Figure 6-4 Alignment of RR 3

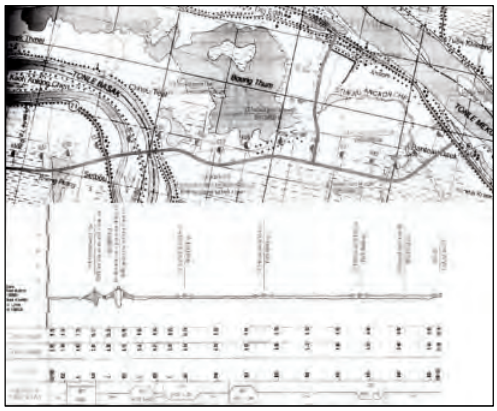


Figure 6-5 Route Map of China-Assisted Section of RR 3

6.4 Profile and Structure Type

(1) Profile

(a) Expressway

・ The elevation of the road surface is determined by taking into consideration such factors as flood area of the Mekong river, level of flood water and clearance of crossing roads.

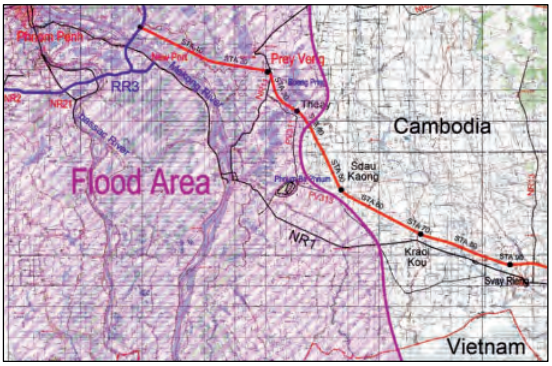


Figure 6-6 Lower Mekong Basin (Flood Prone Area)

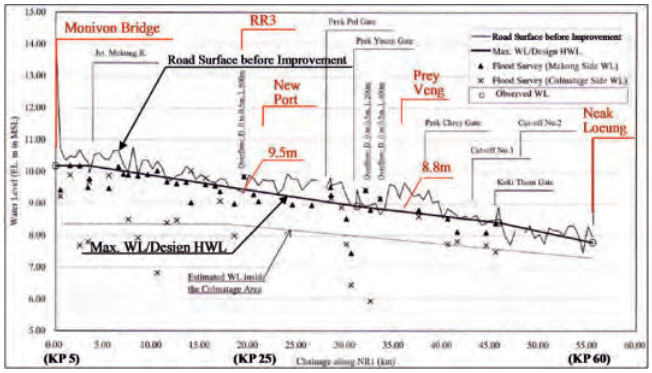


Figure 6-7 Flood Water Level

• The height of road surface of the expressway was determined taking into account the importance of the expressway and consequent larger safety margin against flood as well as the clearance for crossing roads and passage of boats during flood season.

Table 6-4 Factors Taken into Consideration in Studying Profile (Height of Road Surface)

Roadside Area	Section	Structure*	Minimum Elevation
Flood-Prone Area	RR3, Lvea Aem IC - STA 38 (L=38.0 km)	Viaduct	H.W.L + Clearance for small boat 1.5 m + girder height 2.0 m (or top slab thickness 1.0m, in case of multiple box culvert structure)
		Embankment	H.W.L + Subgrade 1.0 m + Pavement 1.0 m
Non Flood-Prone Area	STA 38 - STA. 90, STA 95+500 - Border (L=52+30.1 =82.1km)	Embankment	GL+ WL 1.0 m + Subgrade 1.0 m + Pavement 1.0 m
Vicinity of Urbanized Area	STA 90 - STA 95+500 (L=5.5km)	Viaduct	GL+ Clearance 5.5m + Girder height 2.0 m (or Top Slab Thickness 1.0m)

・ Figure 6-8 shows the profile of the expressway.

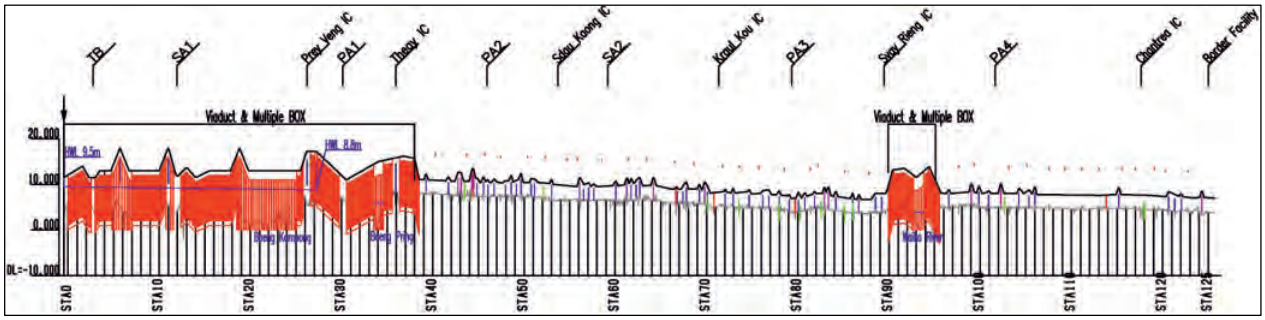


Figure 6-8 Profile of Expressway

(2) RR 3

・ The elevation of RR3 is designed taking into account the clearance of the bridge above the high water level of the Mekong River and the flood water level.

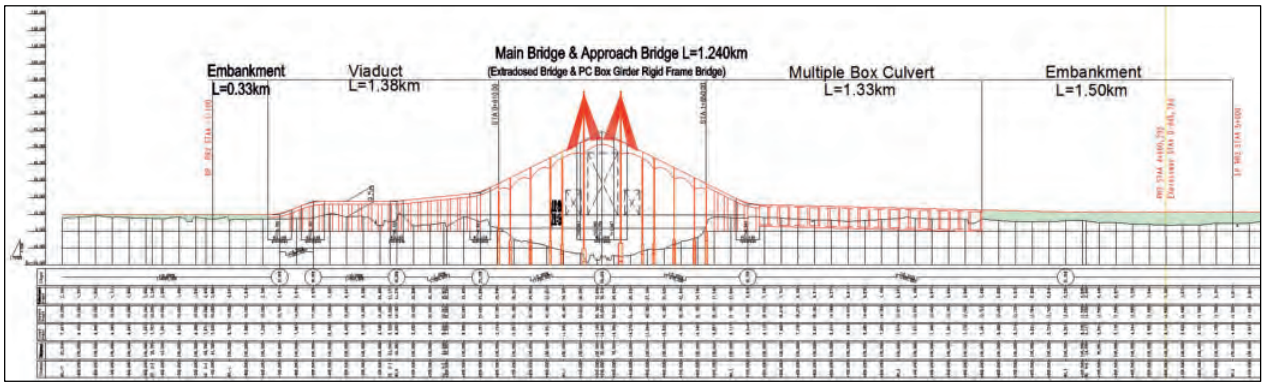


Figure 6-9 Profile of RR3 between NR1 and Lvea Aem IC

(3) Road Structure

・ Three types road structures are adopted for the expressway; viaduct, low embankment and high embankment.

・ A viaduct is adopted for the section traversing the flood-prone area, the section for crossing rivers and lakes.

・ A viaduct is adopted for the section in order to avoid hampering the future expansion of an urbanized area in the vicinity of the city of Svay Rieng.

・ For the sections where viaduct is not required, low embankment is adopted in order to minimize the volume of the required volume of embankment material.

Table 6-5 Summary of Road Structure

Structure Type		Length (km)
Viaduct	Viaduct	12.0
	Multiple Box Culvert	28.4
Embankment		85.8
Total		126.2

6.5 Crossing Road

- The expressway crosses 144 roads. All the intersections are planned as grade-separated intersections so that vehicles, pedestrians and animals do not cross the carriageway of expressway.
- The structure of the expressway at the locations where two national roads (NR 11 and NR 13) cross the expressway is viaduct. Thus, these national roads can underpass the expressway.
- Over-pass bridges are constructed for crossing of all the provincial roads. If under-pass is selected, the inner height of the culvert need to be 4.5m which leads to increase in the embankment height and embankment volume.
- For district roads and commune roads, under-pass culverts are constructed. Width of a culvert shall be decided based on the width of the crossing road.

Table 6-6 Road Class and Method of Crossing

Road Class	Vertical Clearance	Method of Crossing
National Road (NR 11 and NR 13)	5.5m	Under-pass the viaduct
Provincial Road	4.5m	Over-pass with bridge
Local Road	3.3m, 2.5m (2.0m)	・ Over-pass with bridge (23 selected local roads) ・ Under-pass with box culvert

- The inner height of the culverts shall be 2.5m, in principle, to allow passage of motorcycle, small agricultural tractors and tuktuks. Where the width of the existing crossing road is 3.5m or more, the inner height of the culvert shall be 3.3m to allow travel of larger agricultural tractors and vehicles carrying agricultural products.

Table 6-7 Types of Under-Pass Culverts

Size (Wm x Hm)	Criteria for Provision	No. of Unit	Remarks
2.0 x 2.0	3 units per 1km of expressway section with embankment structure, regardless of width of existing road	258	Pedestrian, bicycle, animal, motorcycle (tuk-tuk and small agricultural tractor)
4.0 x 2.5	Existing road W<2.0m	32	
6.0 x 2.5	Existing road W>2.0m	16	
6.0 x 3.3	Existing road W>3.5m	15	

- Over-pass bridges are also planned at an interval of 5km in order to accommodate the traffic of large vehicles which is expected to increase in the future due to development of roadside areas.

6.6 Embankment Design

(1) Embankment Height

- The minimum height of the road surface in the embankment section is planned to be 3m in order to prevent seepage of water into top part of embankment or subgrade during the flood season.
- Assuming that the flood water level is 1m above the ground surface and 1m thickness of pavement (plus 1m-thick subgrade above flood water level), the minimum height of the road surface is calculated to be 3 m.

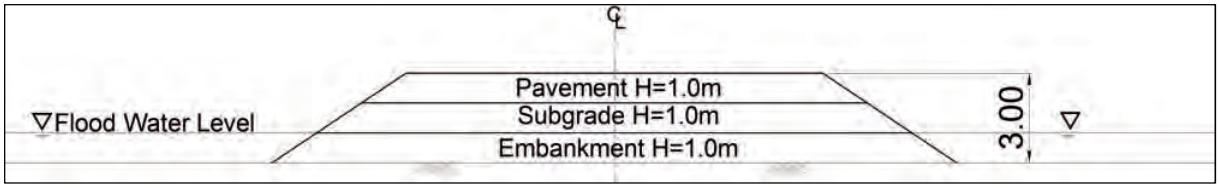


Figure 6-10 Height of Embankment with Respect to Flood Water Level

(2) Study on Reduction of Earthwork Volume

- Phnom Penh – Bavet Expressway traverses flat land and it is not easy to find borrow pits. Thus, the volume of earthworks needs to be as small as possible.
- Attention was paid to a reduction of earthwork volume throughout the planning of the profile of the expressway or embankment height. Basic measures for reducing the earthwork volume or lowering the embankment height are as summarized in Table 6-8.

Table 6-8 Steps of Embankment Height Planning in Effort to Reduce Earthwork Volume

Step	Attention Paid to	Main Change from Previous Plan	Earthwork Volume
1	Reduction of construction cost	Shorten length of viaduct section near Svay Rieng from 10 km to 5 km	9.2 million m^3
2	Reduction of earthwork volume	・ Lower road surface of expressway at IC ・ Replace 14 units of under-pass culverts (6.0 m ×4.0 m) with over-pass bridge ・ Maximum inner height of 2.5m was adopted for all under-pass culverts where vehicles travel.	6.1 million m^3
3	Increase of inner height of culverts for allowing passage of fully loaded agricultural vehicles	Increased the inner height of 15 culverts from 2.5 m to 3.3m	6.3 million m^3

(3) Analysis of Stability and Settlement of Embankment on Soft Ground

- The heights of the embankments for the toll barrier and the service area in the east of Prey Veng IC is 7m or higher. These embankments are constructed on the soft ground of flood area of the Mekong River. Thus, stability and settlement of embankment were analyzed.
- The factor of safety for failure of embankment was calculated to be 1.27. This value is within the allowable range so that no special treatment for stability is required.
- The amount of ultimate settlement is calculated to be 87.8cm. Residual settlement at 1,000 days after construction is estimated at 22cm. The residual settlement can be reduced to 8.8cm by applying surcharge of 3m additional embankment.

6.7 Pavement Design

- The pavement structure is designed in accordance with the AASHTO's Pavement Design Manual, which is one of the most widely used text books on pavement design.
- The design period is set at 15 years in consideration of such factors as the importance of the expressway, minimizing the initial investment and maintenance of pavement.
- The value of "cumulative 18-Kip Equivalent Single Axle Load (ESAL)" used in this pavement design was calculated using the axle load data recorded at the weighing stations placed on NR 1.
- The required values of Structural Number (SN) were calculated using the ESAL and CBR of the subgrade obtained through the soil tests.

Table 6-9 Pavement Design Condition

Section	RR3 – Prey Veng	Prey Veng – Kraol Kou	Kraoul Kou - Border
Period	2025-2039	2028-2042	2031-2045
ESAL	4.46×10^7	3.77×10^7	3.75×10^7
CBR of Subgrade	6%	6%	6%
Required SN	5.81	5.68	5.68

・ Pavement structure was selected so that the required SN is secured with economically reasonable combination of thicknesses of layers as shown in Table 6-10.

Table 6-10 Pavement Composition using Asphalt Concrete

	Thickness	SN
Asphalt Concrete	15 cm	2.30
Base Course (CBR80%)	30 cm	1.59
Sub-Base Course (CBR30%)	45 cm	1.91
Total	90 cm	5.81

6.8 Drainage

・ The hydrological and hydraulic study conducted in the Phase 1 survey identified that four (4) units of pipe culverts need to be installed for every 1 km of embankment section of expressway in order to prevent the expressway from blocking the smooth flow of flood/inundation water. The diameter of the pipe culverts is planned to be 1.5 m.

6.9 Interchange and Access Road

・ There are seven (7) interchanges (ICs) along the expressway, as listed in Table 6-11 and shown in Figure 6-11.

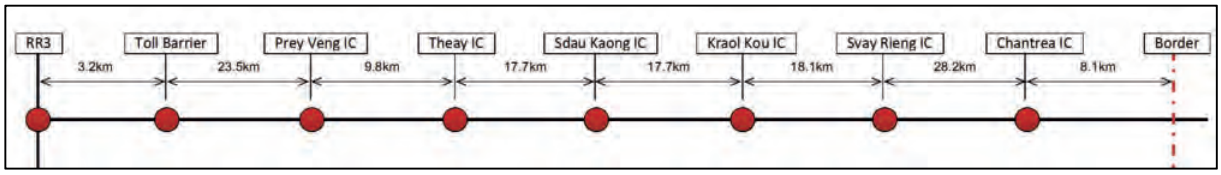


Figure 6-11 Distance between ICs and Rest Areas

Table 6-11 Location of ICs and Access Roads

Name of Interchange	STA	Name of Access Road	Distance to	Access Road		Remarks
				Width (m)	Pavement	
Beginning Point (Lvea Aem)	0-446	RR3	NR1: 3.5km	24.0	AC	To be constructed together with the expressway
Prey Veng	26+200	NR11	NR1: 24.3km	7	DBST	
Theay	35+960	PV311	NR11: 9.0km	6.5	DBST	
Sdau Kaong	53+700	New Road	PV313: 1.5km NR1 (West): 16.8km NR1 (East): 13.9km	10.0	(AC)	New road: L=1.9km
Kraol Kou	71+350	New Road	NR1: 1.1km	10.0	(AC)	New road: L=1.3km
Svay Rieng	89+460	Widening Existing Local Road	NR1: 1.2km	10.0	(AC)	Widening existing local road: L=1.7km
Chantrea	117+650	New Road	NR1: 3.0km	10.0	(AC)	New road: L=3.6km

・ Trumpet type interchange, which is most commonly adopted in toll expressway, is assumed for

the purpose of cost estimation. Numbers of lanes on rampways and toll booth are calculated based on the estimated volume of traffic entering and exiting the said IC. Figure 6-12 to 6-14 show an example of configuration of an interchange.

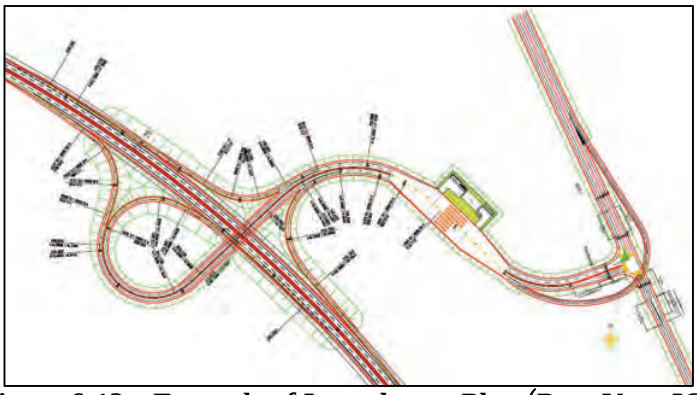


Figure 6-12 Example of Interchange Plan（Prey Veng IC）

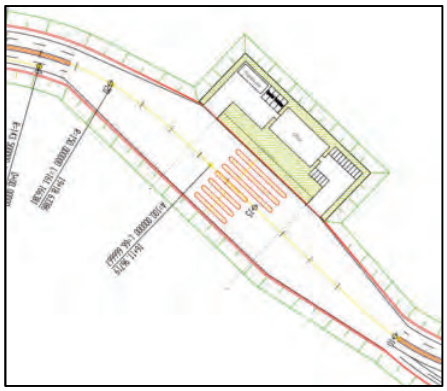


Figure 6-13 Example of Toll Gate

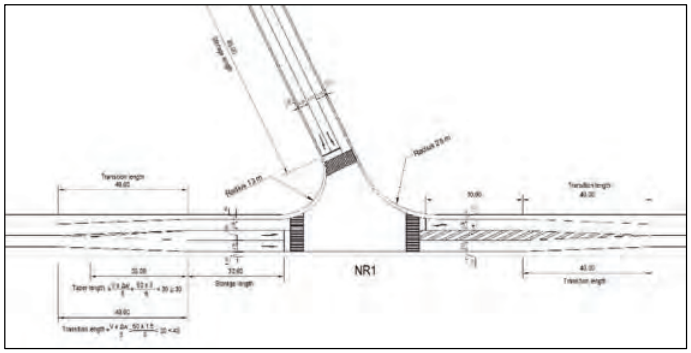


Figure 6-14 Example of Intersection

6.10 Rest Area

- Rest areas are provided along the expressway at appropriate intervals so that drivers and passengers can take a rest without getting off the expressway.
- The rest areas are classified into two categories depending on their functions (services). In this project, a large-scale rest area whose main purpose is to provide services such as restaurant and gas station is called a service area (SA), while a small-scale rest area whose main purpose is parking and rest is called a parking area (PA).
- PAs are provided at an interval of 15 – 25km while SAs are provided at an interval of 50 – 100km. These intervals are based on the criteria used in Japan.

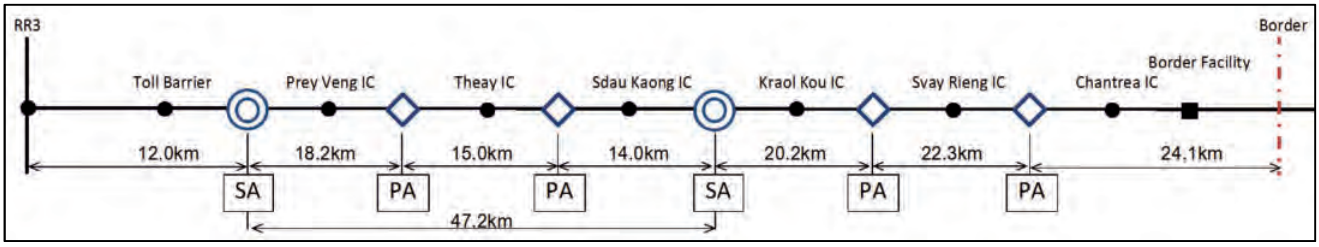


Figure 6-15 Locations of Rest Areas

- The number of necessary parking places and the scale of the service areas and parking areas are calculated based on the indices of characteristics of the traffic, such Directional Rate, Percentage

of Use, Peak Hour Ratio and Parkin Duration.

- Figures 6-16 and 6-17 show examples of layout large-scale rest area.

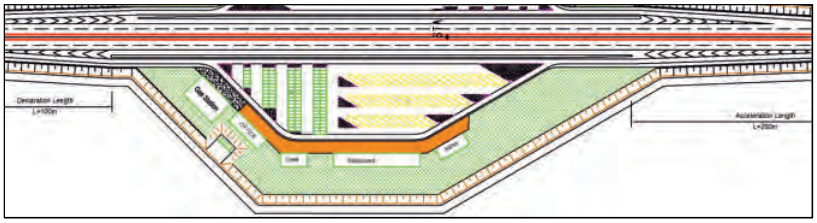


Figure 6-16 Typical Layout of Service Area

Figure 6-17 Example of Facilities of Service Area

6.11 Border Control Facility

- The town of Bavet is located at the border between Cambodia and Vietnam and there is a border control facility for NR 1. Thus, a new border control facility is proposed on the expressway.
- The layout of the proposed border facility was based on the design documents provided by MPWT for the proposed Cambodian-Thai border facility at Stung Bot.
- The number of booths was calculated using queuing theory, where the server utilization rate (ρ) is set to less than 1.
- $\rho = \frac{\lambda}{c\mu} < 1$
- Where λ=demand per hour, c=number of servers, μ=service rate per server

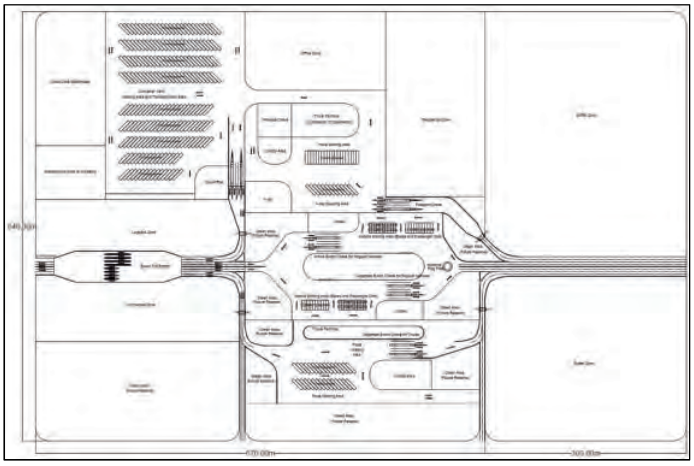


Figure 6-18 Proposed Layout of the Bavet Border Control Facility

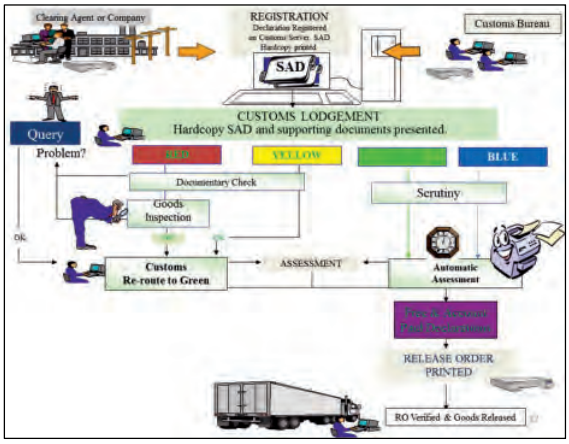


Figure 6-19 Customs Declaration Procedure for Inbound Trucks

Table 6-12 Summary of Proposed Border Facility Requirements

	Average Truck Demand (λ)	Service Rate per Server (μ)	Required Number of Servers (c)	Calculated Number of Parking Spaces (Peak Hour)	Proposed Number of Parking Spaces (Design)	Average Waiting Time (in minutes)
Truck Departure Area	2040: 34 heavy vehicles/hour 2050: 52 heavy vehicles/hour	15 trucks/hour	4 booths	2040: 15 parking spaces 2050: 32 parking spaces	35 parking spaces	2 minutes*
Truck Arrival Area (Passport	2040: 34 heavy vehicles/hour	20 trucks/hour	4 booths	N/A (queuing on the road)	N/A (queuing on the road)	2 minutes*

	Average Truck Demand (λ)	Service Rate per Server (μ)	Required Number of Servers (c)	Calculated Number of Parking Spaces (Peak Hour)	Proposed Number of Parking Spaces (Design)	Average Waiting Time (in minutes)
Check)	2050: 52 heavy vehicles/hour					
Truck Arrival Area (Exit from Facility)	2040: 34 heavy vehicles/hour 2050: 52 heavy vehicles/hour	15 heavy vehicles/hour	4 booths	2040: 15 parking spaces 2050: 32 parking spaces	20 parking spaces (truck terminal); 199 parking spaces (container yard)	4 hours and 31 minutes**
X-ray Scanner (Truck Arrival Area)	20% of truck arrival demand (2040: 7 heavy vehicles/hour; 2050: 11 heavy vehicles/hour)	10 heavy vehicles/hour	2040: 1 X-ray scanner 2050: 2 X-ray scanners Recommended number: 3 X-ray scanners	2040: 10 parking spaces 2050: 13 parking spaces	15 parking spaces	13 minutes*

6.12 Traffic Safety & Traffic Control Facilities and Devices

(1) Traffic Signs

- There are mainly two types of traffic signs; regulatory signs and guide signs.
- The term “regulatory sing” refers to such traffic signs as “speed limit sign”. In this survey, it is assumed, for the purpose of estimation of construction cost, that these signs are installed at a frequency of 4 units per kilometer in average.
- The term “guide sign” refers to such traffic signs as “notifying that the driver is approaching an exit of expressway”. Figure 6-20 shows a typical layout of guide signs for one interchange.

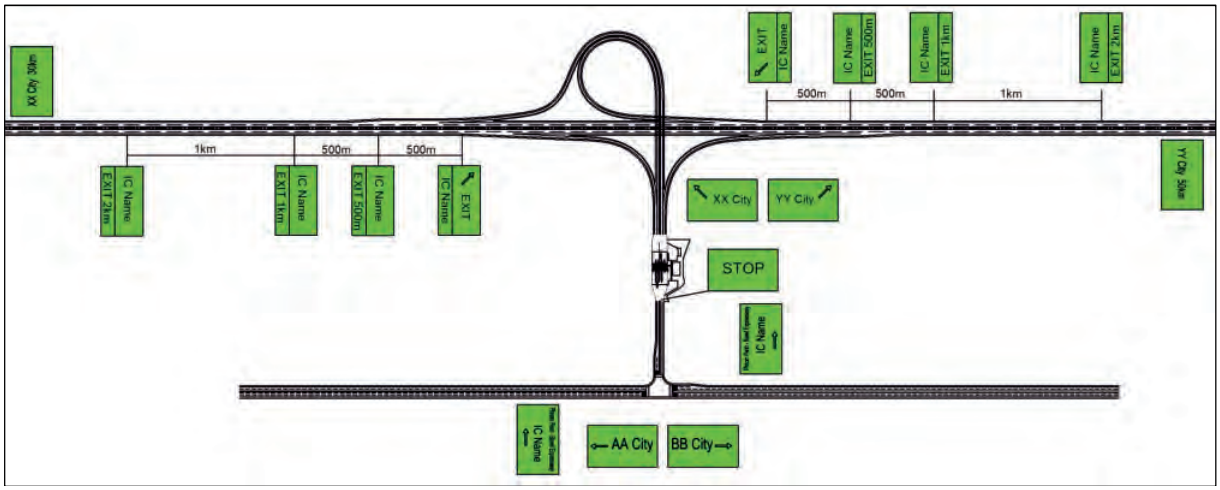


Figure 6-20 Typical Layout of Guide Signs in the Vicinity of an Interchange

(2) Traffic Safety Device

- Traffic safety devices include guard rails, delineator, road makings and traffic sings. Figure 6-21 shows an example of a light-reflection type delineator.

(3) Traffic Control Facilities and Devices

- Traffic control facilities and devices include traffic surveillance TV cameras and display (screen), emergency telephone, variable message board and weather observation system.
- Figures 6-22 and 6-23 show examples of these traffic control facilities and devices.

Figure 6-21 Delineator Attached on Guard Rail

Figure 6-22 Traffic Control Center

Figure 6-23 Example of Variable Message Board

6.13 Office for Operation and Maintenance

- Offices are needed for operation and maintenance. Table 6-13 lists the types of offices for operation and maintenance.

Table 6-13 Functions of Offices

Type of Office	Function	Proposed Location	Area of Office
Administration Headquarter	Overall administration of Phnom Penh – Bavet Expressway	In the premises of toll barrier near Phnom Penh	6,000m^3
Administration Office of Interchange	Administration/supervision of toll collection at each interchange	Besides the toll gate of each interchange	2,000m^3
Maintenance Depot	・ Depot of crew, vehicle, equipment and material engaged/used in accident clearance, emergent repair works etc. ・ Expressway police squad may be accommodated.	・ 50 – 70km interval ・ In same building with administration office	

6.14 Connection of Expressway and Ring Road 2

- The large portion of the traffic entering/exiting the expressway via RR 3 is assumed to use the section of NR 1 between NR 3 and Phnom Penh, causing traffic congestion on NR 1.
- It will improve the traffic conditions greatly if the expressway is connected to Ring Road 2 (RR 2).
- Two alternative routes are assumed and compared. Alternative-1 is a newly constructed road which runs parallel to the northeastern bank of the Mekong River with a distance of 1.5 to 3 km. Alternative 2 is the widening and improvement of the existing road (PV 380) which runs along the bank of the Mekong River.
- Alternative-1 is recommended because of fewer relocation of house/people and shorter length of connecting the expressway and RR 2.

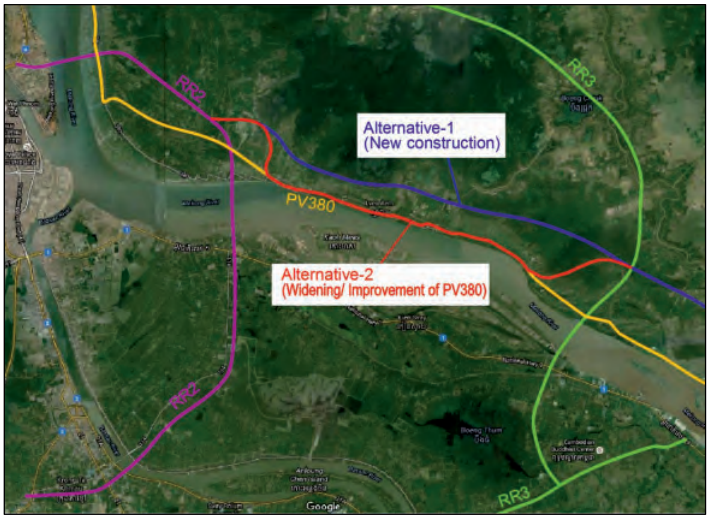


Figure 6-24 Proposed Connecting Road between RR2 and RR3

Table 6-14 Features of Alternative Routes of the Road Connecting Expressway and RR 2

Route	Alternative-1	Alternative-2
Type of Road	Newly constructed	Widening and improvement of existing road
Roadside Land Use	Rice field and marsh	Agriculture and residential
Length	15 km	17 km
Degree of Difficulty of Land Acquisition	Not very difficult because the roadside area is mainly rice field and marsh.	Considerable number of resettlement is required.

Table 6-15 Connecting Road between RR2 and RR3

Road Class	U5
Road Length	L=15 km
Typical Cross Section	Same as RR3
Height of Embankment	6 m
Construction Cost	USD 105 million (USD 7 million/km)

CHAPTER 7 BRIDGE PLAN

7.1 Long-Span Bridge Over the Mekong River

(1) Summary

- This section contains description of the long-span bridge planned at the point where RR3 crosses the Mekong River. It is comprises the selection of a bridge type, the outcome of outline designs and an execution plan. In planning the bridge, and especially in the selection of the bridge type, past experiences and methods of construction have been considered. The optimum bridge type has thus been assessed based on the following:
  - Economic efficiency: Initial construction cost and the maintenance cost based on availability of construction materials
  - Traffic function, seismicity and climate condition: Drivability, seismic resistance, effects of wind forces and fluctuation of temperature, etc.
  - Ease of construction: Ease of construction under local conditions and procurement of equipment, experiences, in addition to the construction period and influences on the navigation channel
  - Ease of maintenance: Maintenance frequency and difficulty of inspection and maintenance when considering the site conditions
  - Landscape: Harmonization and balance with the surrounding environment
- After comparing alternative bridge types based on the above criteria, a combination of an Extradosed Bridge (over the navigation channel) and a Prestressed Concrete Continuous Box Girder Bridge is proposed as the most practicable. Regarding a foundation type, a steel pipe sheet pile foundation is planned considering the workability, construction quality and cost performance.

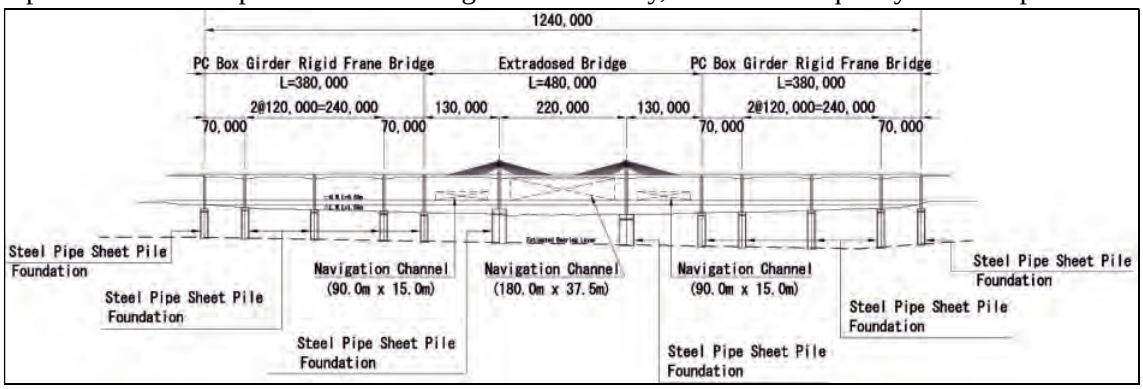


Figure 7-1 Bridge Type for Over the Mekong River

(2) Preliminary Design for the Long Span Bridge

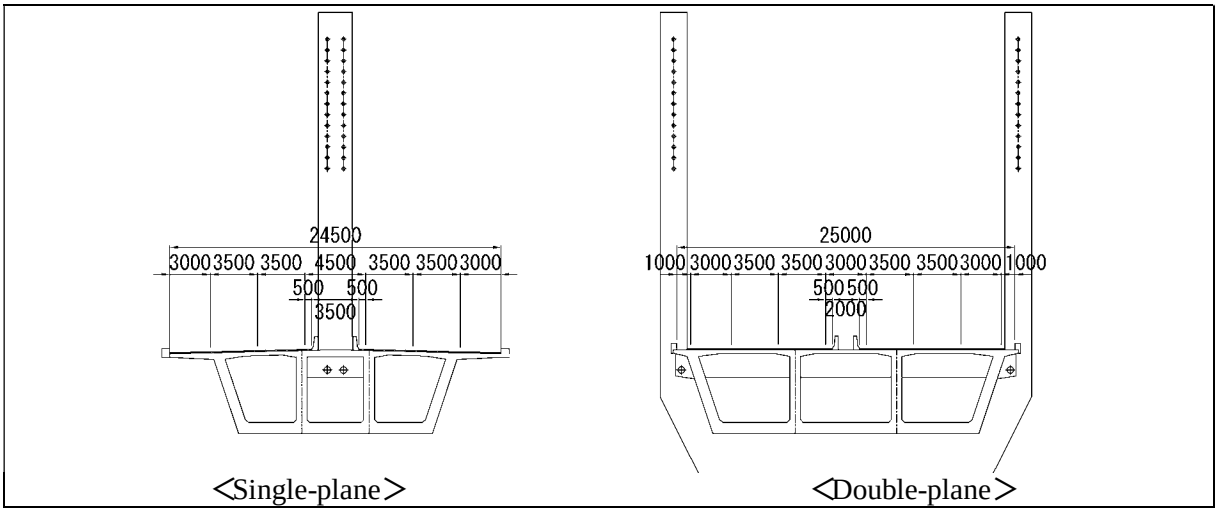
(i) Study of Extradosed Bridge

(a) Arrangement of Stay Cables

- The typical stay cables arrangements of Extradosed Bridge can be classified roughly into two types: single-plane and double-plane arrangements.
- The double-plane arrangement needs an effective width of 25.0m in order to set the stay cables and the pylon outside the clearance limit. In addition, the girder width needs to be widened because it is difficult to set the large capacity stay cables at the edge of the overhanging slab. Moreover, it is difficult to cope with the 6-lane development in the future.
- Although median strip of the single-plane arrangement needs a width of 4.5m to install the pylon,

the effective width can be reduced to 24.5m by placing the stay cables in the median. In addition, a compact box girder can be formed with the overhanging slab by setting the stay cables beside the web formed inside the girder. And this contributes to the reduction of the cost of substructures and basements through self-weight reduction.

- For the above reasons, single-plane type is adopted as the rational arrangement of stay cables.



Source: JICA Study Team

Figure 7-2 Arrangement of Stay Cables and Cross Section

(b) Girder Height and Pylon Height

- The girder height and pylon height are determined by the structural study based on the previous track records (refer Appendix 7-1).

(c) Segmentation Plan of Cantilever Erection

- The cantilever erection of this bridge is planned by assuming a "Wagen" with maximum capacity of 11,000kN.m, maximum block length of 5.0m, and the total equipment weight of 300t (refer to the Appendix).

(ii) Study on the PC Box Girder Bridge

- As well as the extradosed bridge, the girder height of the PC box girder bridge is determined by the structural study based on the previous track records (refer to the Appendix).

7.2 Viaduct

(1) Outline

- This chapter compares the candidate bridge types in terms of economic efficiency and structural properties for the selection of a viaduct type to be employed. Also considered are the local conditions planned construction methods. The viaducts are used in the sections that are flood prone between RR 3 and Pery Veng (38km) and some section of Svay Rieng where there is a need to avoid community splitting (5km). The results are presented as the conceptual design of the viaduct. Furthermore, the selected bridge type in this chapter is applied to the overpassing of lakes and rivers where, because of their depth or scale, it is not necessary to design separate bridges.

(2) Preliminary Design of Viaduct

- The following presents the preliminary design of the viaducts with selected structure types. In consideration of the depth of bearing ground (between 30m to 50m below ground level), three cases with different pile length: 30m, 40m and 50m are examined.
- To summarize these examination results, a general view of the viaduct structure to be employed in this project is shown in Figure 7-3. Taking into account the driving comfort and maintainability, the continuous girder structure is proposed. The number of span to be continuous is proposed to be 5, considering the past instance of approach bridge in the Tsubasa Bridge, which is similar in type and scale.

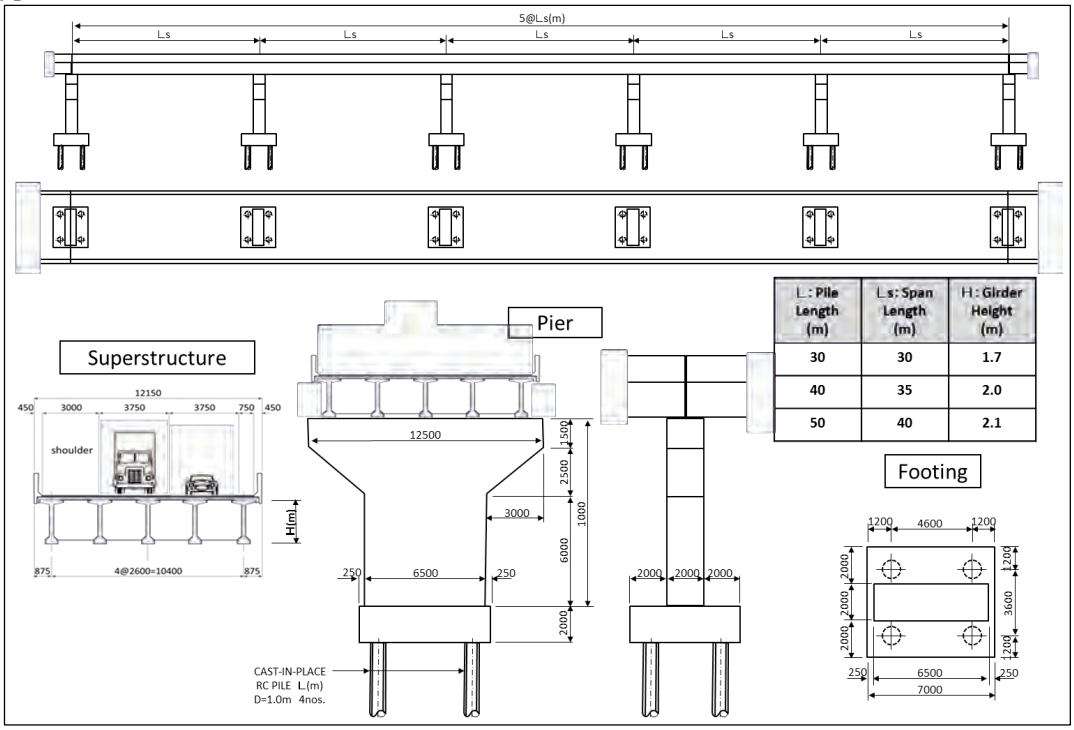


Figure 7-3 General View of the Viaduct

(3) Study of the Continuous Box Culvert Type Viaduct

- The suitability of the *continuous box culvert type* for the viaduct structure was studied. This type has been employed frequently in expressways of Japan and is proposed because the results of soil survey indicates bearing stratum exists at a deep level (between GL-30 to GL-50m) and the construction of foundation piles of 30 to 50m depth throughout the viaduct sections will require considerable construction works.
- The main reason for selecting a viaduct design of the continuous box culvert type is the cost saving in construction at the points where it would require many deep foundation piles due to the depth of the soft ground.
- Previous cases constructed on soft ground, which used a preloading method and replacement of materials where necessary, have not experienced serious ground subsidence. The load of the continuous box culvert type viaduct on the subgrade is 40 to 60kN/m^2 which is equivalent to the load of an embankment with a height of 2.2 to 3.3m. This embankment height is approximately same as that of the low embankment structure adopted in this project. Therefore, necessity of preloading for reducing the post-construction settlement of box culvert type should be carefully studied together with the study of post-construction settlement of low embankment structure.
- Even though prior cases indicate that a cost reduction of 20 to 40% can be expected compared to

the other viaduct bridge types, the decision to use continuous box culvert type requires careful considerations of the following conditions in order to select the appropriate construction type.

- In the sections where flood water level reaches over ＋2.5m above actual ground surface, this should not be employed because it can prevent the crossing roads from securing clearance limit (Inner space of culvert: 9.25m ＜ clearance above crossing road: 5.5m + water level: 2.5m + allowance: 1.0m).
- To secure 1m of earth covering on bottom slab, the sections where can be scoured by possible flood require caution for the employment.
- As the continuous spread foundations in its structure can limit possible installation of underground facilities, the box culverts should not be constructed over long continuous sections.

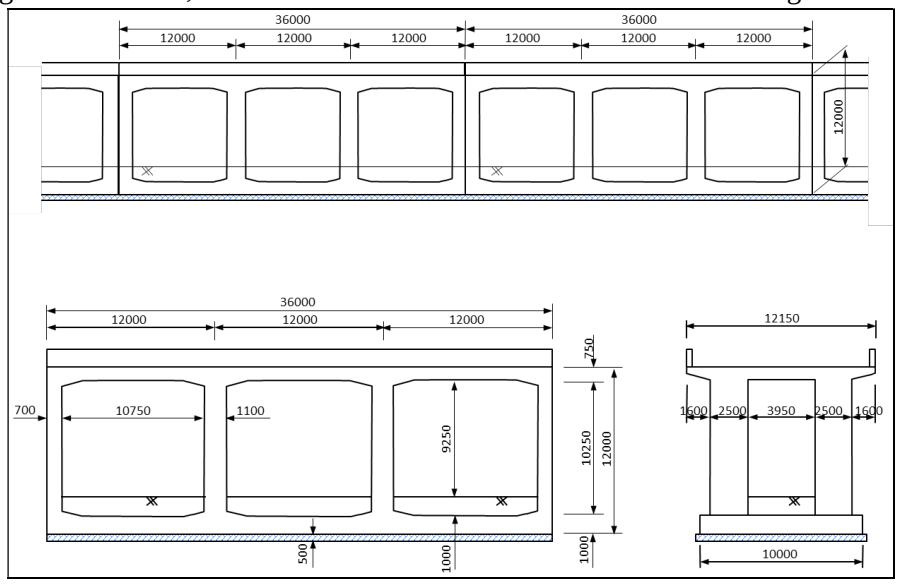
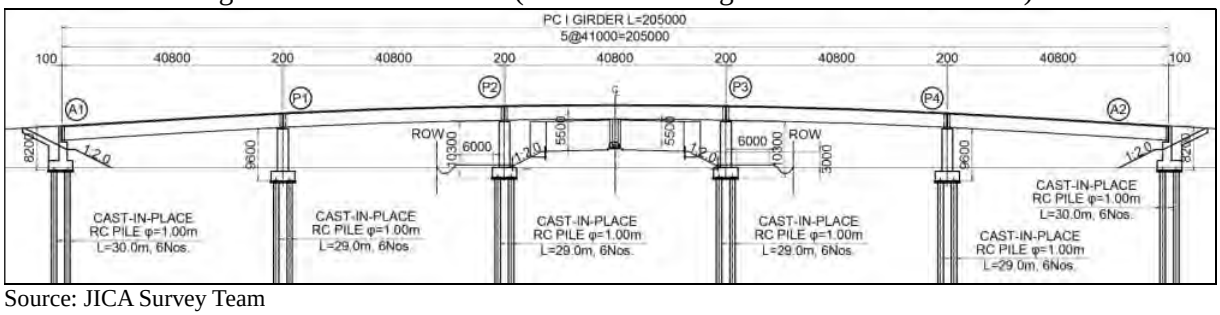


Figure 7-4 Viaduct of Box Culvert Type

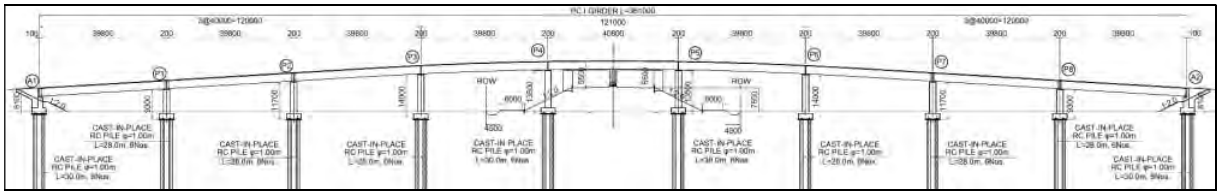
7.3 Plan of Over-Pass Bridge

- Since the overpass bridge locations are undecided, a general view of two possible cases of these bridges are provided:
  - Case-1: Standard Section (embankment height is assumed to be 3.0m)
  - Case-2: High Embankment Section (embankment height is assumed to be 7.5m)



Source: JICA Survey Team

Figure 7-5 Span Arrangement of Overpass Bridge Case-1



Source: JICA Survey Team

Figure 7-6 Span Arrangement of Overpass Bridge of Case-2

CHAPTER 8 COST ESTIMATE

8.1 Volume of Works

・ The construction volumes of the Ring Road 3 and the Expressway are as summarized in Tables 8-1 and 8-2, respectively.

Table 8-1 Construction Volume of the Ring Road 3

Items			unit	Quantity
Total Length			km	6.1
Road & Bridge	Embankment Road	RR3 Embankment Road	km	1.830
	Main Bridge	PC Extra-dosed bridge, W=25.39m	km	0.480
	Approach Bridge	PC cantilever bridge W=25.39m	km	0.760
	Viaduct	Multiple box culvert	km	1.330
		PCI composite girder viaduct	km	1.700
Exit 1	Embankment Ramp Road		km	1.28
	Ramp Bridge	PCI composite girder ramp bridge	km	1.160
Exit 2	Embankment Ramp Road		km	0.080
	Ramp Bridge	PCI composite girder ramp bridge	km	0.320
Auxiliary Facilities	Pipe Culvert	Pipe culvert φ1500mm L=30m	nos	8
	Box Culvert	Box culvert 2m x 2.5m L=27m	nos	6
	Guide Sign		nos	12
	Traffic Signal		nos	2

Table 8-2 Construction Volume of the Expressway

Items			unit	Quantity
Total Length			km	126.190
Road & Bridges	Embankment Road	Low embankment, h=3m, b=27m	km	85.34
	Bridge & Viaduct	Multiple box culvert viaduct	km	28.380
		PCI composite girder viaduct	km	12.470
Expressway Facilities	Toll Barrier Facilities	Toll Barrier	nos	1
		Expressway administration office	m^2	6,000
	Interchange	Interchange	nos	6
		Interchange ramp bridge	nos	4
	Service Area		nos	2
	Parking Area		nos	4
Auxiliary Facilities	Border Control Facility		nos	1
	Frontage Road	Gravel road b=6m	km	186.245
	Over-Crossing Bridge	PCI composite girder bridge L=205m, b=11m	nos	34
	Waterway Channel	10m x 2~3m	m	556
		15m x 2m	m	275
		25~30m x 4m	m	580
	Waterway Box Culvert	5m x 2m	m	436
		10m x 3~4m, 3 cells	m	308
	Pipe Culvert	Pipe culvert φ1500mm L=30m	nos	347
	Box Culvert	2m x 2.5m L=27m	nos	260
		4m x 3m L=27m	nos	32
		6m x 3.0~3.8m L=27m	nos	31
	Traffic Information Facilities	Guide sign	nos	127
		Digital Information board	nos	21
		Optical fiber line	m	126,190
Toll Facilities	Toll System	Centralized control system	L.S.	1
		Local control system	L.S.	7
		Toll booth	nos	39
	Data Communication	Optical fiber line	m	126,190
	Building	Toll booth building	nos	39
		Local management office	m^2	5,500

8.2 Project Cost

(1) Estimate Conditions

・ The conditions of cost estimate are summarized in Table 8-3.

Table 8-3 Estimate Conditions

Items	Conditions
Point of time for the estimation	August 2016
Local currency and exchange rate	US Dollar, 1USD=107.13Yen (Tokyo-Mitsubishi UFJ's TTS rate)
Foreign currency	Japanese Yen
Loan interest rate	0.7%
Front-End Fee	0.2%
Price contingency	For local currency: 3.03% (IMF's 2018 estimation of Cambodia) For foreign currency: 0.98% (IMF's 2018 estimation of Japan)
Physical contingency	For construction: 10% of its base cost & price contingency For consulting service: 5% of its base cost & price contingency For non-eligible construction: 10% of its base cost & price contingency
Administration cost	2% of the construction, the consulting service & contingencies
VAT and Import tax	VAT: 10%, Import tax: 7%

(2) Main Items and Their Unit Price

・ Main items for cost estimate and their unit prices are summarized in Table 8-4.

Table 8-4 Main Items and Their Unit Prices of Cost Estimation

Item	Unit	Unit Price (USD)	Remark
Expressway			
Embankment Road	km	3,968,000 ~ 5,017,000	
Viaduct (Multiple box culvert, b=24.3m)	km	22,655,000	
Viaduct (PC composite girder, b=24.3m)	km	36,286,000 ~ 49,404,000	
Interchange	Location	3,984,000 ~ 7,836,000	
Service Area	Location	11,836,000 ~ 19,164,000	
Parking Area	Location	2,864,000 ~ 3,187,000	
Toll Barrier	Location	10,524,000	
Border Facility	Location	36,757,000	
Over-Pass Bridge (11m x 205m)	Unit	3,004,0000	
Frontage Road (b=6m, gravel road)	km	162,000	
Box Culverts (2.0m x 2.5m x 27m)	Unit	41,000	
Box Culverts (4.0m x 3m x 27m)	Unit	68,000	
Box Culverts (6.0m x 3m x 27m)	Unit	111,000	
Box Culverts (6.0m x 3.8m x 27m)	Unit	126,000	
Pipe Culvert (φ1500 x 30m)	Unit	16,000	
Waterway Box Culvert (5m x 2m)	km	3,000,000	
Waterway Box Culvert (10m x 3m)	km	5,000,000	
Waterway Box Culvert (10m x 4m)		6,000,000	
Toll Facilities	Location	364,000,000 ~ 4,034,500,000	
Ring Road 3			
Extra-dosed Bridge (b=25.39m)	km	209,230,000	Main
PC Cantilever Bridge (b=25.39m)	km	159,704,000 ~ 168,324,000	Approach
Viaduct (PC composite girder, b=9.55m ~ 12.15m)	km	15,753,000 ~ 17,509,000	Exit Ramp
Embankment Road	km	3,521,000 ~ 5,583,000	
Embankment Ramp Road	km	1,062,000 ~ 1,826,000	

(3) Summary of Project Cost

・ The estimated project cost is summarized in Table 8-5. Main items which are eligible for Japanese ODA loan are the construction cost and cost of consultant services, while those to be borne by RGC are costs for land acquisition and resettlement, utility relocation, mines and UXO relocation and administration.

Table 8-5 Summary of Project Cost

Items		FC (YEN million)	LC (USD million)	Total (YEN million)
A. ELIGIBLE PORTION				
I)	**Procurement / Construction**	**127,318**	**1,846.14**	**325,095**
	Base cost for JICA financing	**107,309**	**1,272.70**	**243,653**
	Ring Road 3	28,532	87.10	37,863
	Expressway Phase 1	40,967	412.90	85,201
	Expressway Phase 2	20,375	370.70	60,088
	Expressway Phase 3	17,435	402.00	60,501
	Price contingency	**8,434**	**405.61**	**51,887**
	Physical contingency	**11,574**	**167.83**	**29,554**
II)	**Consulting services**	**8,945**	**37.83**	**12,998**
	Base cost	**7,921**	**28.65**	**10,990**
	Price contingency	**602**	**7.40**	**1,395**
	Physical contingency	**426**	**1.80**	**619**
Total (I + II)		**136,263**	**1,883.97**	**338,092**
B. NON ELIGIBLE PORTION				
a	**Procurement / Construction**	**0**	**4.24**	**454**
	Base cost	**0**	**3.41**	**365**
	Utilities Relocation	0	1.21	129
	Mines and UXOs Removal	0	2.20	236
	Price contingency	**0**	**0.45**	**48**
	Physical contingency	**0**	**0.39**	**41**
b	**Land acquisition**	**0**	**28.35**	**3,038**
	Base cost	0	28.35	3,038
c	**Administration cost**	**0**	**63.77**	**6,832**
d	**VAT and Import Tax**	**0**	**399.21**	**42,767**
Total (a + b + c + d)		**0**	**495.62**	**53,096**
TOTAL (A + B)		**136,263**	**2,379.59**	**391,188**
		18,064	**0.00**	**18,064**
	Interest during Construction (Const.)	18,052	0.00	18,052
	Interest during Construction (Consul.)	12	0.00	12
D. Front-End Fee (FEF)		**712**	**0.00**	**712**
GRAND TOTAL (A + B + C + D)		**155,038**	**2,379.59**	**409,964**
JICA finance portion incl. IDC and FEF (A + C + D)		**155,038**	**1,883.97**	**356,868**

(4) Construction Cost by Section

・ Table 8-6 shows the construction cost by sections calculated based on the conditions as described above.

Table 8-6 Construction Cost by Section

Road	Phase	Section No.	Section	Construction Cost (USD Million)
RR3	I	1	NR 1 – Lvea Aem IC	353.5
Expressway		2	Lvea Aem IC – Prey Veng IC	795.4
	II	3	Prey Veng IC – Theay IC	225.6
		4	Theay IC – Sdau Kaong IC	180.8
		5	Sdau Kaong – Kraol Kou IC	154.5
	III	6	Kraol Kou IC – Svay Rieng IC	153.2
		7	Svay Rieng IC – Chantrea IC	317.3
		8	Chantrea IC – Vitenam Border	94.2
Total				2,174.5

8.3 Procurement of Materials

(1) Embankment Soil Requirement

- The volume of the embankment soil required for the Expressway is 6.3 million cubic meters.

Table 8-7 Embankment Materials of Expressway

Facilities	Embankment Soil (million m^3)	Sub-grade (million m^3)
Expressway	4.63	2.75
Toll Barrier	0.29	0.04
Interchange	0.37	0.24
Service Area	0.40	0.04
Parking Area	0.17	0.03
Border control	0.31	0.15
Frontage road	0.00	0.65
Over-Cross Bridge	0.09	0.15
Total	6.26	4.05

(2) Borrow Pit Survey

- The survey was carried out by interviewing land owners located within 3km both sides from the Expressway center.
- Table 8-8 shows the results of the survey. Potential borrowed volume exceeds 11 million cubic meters.

Table 8-8 Borrow Pits Survey Result

Province	No. of Land Owner	Type of Providing Soil			Borrow Pit Total Area (m^2)	Assumed Excavation Depth (m)	Potential Borrow Volume (million m^3)
		Sell Land (m^2)	Sell Soil Only (m^2)	Give Soil Free (m^2)			
Prey Veng	531	2,914,000	1,105,000	1,855,000	5,874,000	3	17.62
Svay Rieng	440	4,078,000	870,000	417,000	5,365,000		16.10
Total	971	6,992,000	1,975,000	2,272,000	11,239,000		33.72

(3) Candidates of Large-Scale Borrow Pits

- There are 8 candidates for large-scale borrow pits (>10ha = 10,000m^2) as shown in Table 8-9. The total potential volume of embankment soil from them will be 8.4 million cubic meters. Moreover, the estimated volume obtained from 4 candidate locations of "free of charge" is approximately 4.6 million cubic meters.
- Thus, procurement of embankment material is considered to be possible by expanding the area of borrow pit survey to a reasonable range.

Table 8-9 Candidate of Large-Scale Borrow Pit

Province	Type of Providing Soil						Total
	Sell Land		Sell Soil Only		Give Soil Free		
	Owner	Area (m^2)	Owner	Area (m^2)	Owner	Area (m^2)	
Prey Veng	3	900,000	0	0	3	1,240,000	2,140,000 m^2
Svay Rieng	1	360,000	0	0	1	300,000	660,000 m^2
Total	4	1,260,000	0	0	4	1,540,000	2,800,000 m^2
Soil Volume*	3,780,000 m^3		0		4,620,000m^3		8,400,000 m^3

Notes: The depth of excavation is assumed as 3 meters.

(4) Soil from Commune Projects

- There are 15 cases where communes are planning to construct irrigation channels or fish farms and want their lands excavated, providing soil free.
- If these borrow pits can be actually used, Phnom Penh – Bavet Expressway Project can benefit also these local commune projects.

CHAPTER 9 PROJECT SCHEME

- The Phnom Penh – Bavet Expressway Development project needs preparation in various areas that are not usually required in standard road improvement projects.
  - Setting of the toll level which enables amortization of the loan for the construction, and, at the same time, is socially acceptable.
  - A diligent analysis of financial viability of the expressway is essential to ensure that the very large loan can be repaid by toll revenue alone.
  - Careful planning on the institutional set up and legal framework is also required to implement the project smoothly and achieve the best results after it is completed.

9.1 Toll Road System

(1) Purposes of the Toll Road System and Applicability to the Project

- The basic concept of a "toll road system" is to develop an expressway network in a targeted time framework using borrowed funds when the amount of construction expenditure is larger than the available budget.
- If an increase in traffic volume continues to be more than 6% per year, the traffic volume on NR1 will double within the next 10 years.
- The annual national budget allocated to MPWT in 2014 was only USD 76.6 million. This amount is evidently insufficient for developing the expressway to cope with the rapid growth of traffic demand.

(2) Basic Policy for Toll Level

- The following factors needs to be taken into consideration in determining the toll level:

(a) Redemption Principle
  - The basic concept of this principle is that the full cost of the expressway is recovered by toll revenue.

(b) Fair and Just Principle
  - This principle is that the toll amount should be set so that is socially equitable and acceptable.

(c) Benefit Principle
  - The principle is the concept that the toll amount must not exceed the benefit which users can get by using the toll road.

- In addition to the above principles, the following considerations are also made:

(d) Cross Subsidies (Toll Revenue Pooling System)
  - The toll revenue pooling system, in which the revenues and expenditures of a group of routes are combined together, is an effective way to assure fairness in the cost burden on users by making the toll levels and collection periods uniform and consistent, while ensuring smooth repayment of loans.
  - In order to secure the fund for the development of expressways network at the national level in

the future, introduction of the toll revenue pooling system is strongly recommended.

(e) Toll Rate System

- There are two types of toll rate system commonly adopted in the world; flat rate system (or open system) and distance-dependent system (or closed system).
- Flat rate system is often used in urban toll roads where trip lengths are short while distance-dependent system is used mainly in inter-city toll roads where trip lengths are generally long and there is wide variety in trip lengths.
- Distance-dependent system is recommended for Phnom Penh – Bavet Expressway because of it length and variety of trip lengths.

(3) Proposed Level of Toll Rate on Phnom Penh – Bavet Expressway

(a) Toll Rate of Passenger Car

・ Considering the toll levels in the neighboring countries and past cases in Cambodia, the toll level of expressway in Cambodia is proposed to be in the rage of USD 0.04 - 0.10/km for passenger car.

・ In this Survey, the toll level of the expressway for passenger car is proposed to be USD 0.05/km taking into account the results of WTP, EIRR, and financial analysis.

(b) Ratio of Toll among Vehicle Types

・ The vehicle classification and their toll ratio for the Phnom Penh - Bavet Expressway is proposed as shown in Table 9-1 and takes into consideration the following aspects:

Table 9-1 Proposed Vehicle Classification and Toll Ratio

Classification	Class 1			Class 2		Class 3	Class 4	Class 5	
	Light Vehicle			Midium Vehicle		Large Vehicle	Trailer I	Trailer II	
Toll Ratio by Class	1.0			2.0		3.0	4.0	5.0	
Deffinition	Passenger car, Jeep/4WD, and Taxi	Mini Bus (8-16 seats)	Light Truck (<4 tons), Pick up truck (for goods)	Medium and Large Body Bus	Medium Truck (2 Axle) (>4 tons)	Truck (3 axles)	Truck / Trailer (4 axles)	Truck/ Trailer (5 axles)	Truck / Trailer (6axles more)
									

(c) Proposed Tariff by Vehicle Class

- Considering the proposed toll rate of a passenger car (USD 0.05/km), the vehicle classification and their toll ratio, the proposed tariff by vehicle class on the Phnom Penh - Bavet Expressway is as shown in Table 9-2.

Table 9-2 Proposed Tariff by Vehicle Class on Phnom Penh – Bavet Expressway

Taffic and Distance Table (Class 1)

Phase	IC		1	2	3	4	5	6	7	8	
1	1	RR 3		*26.6*	*36.4*	*54.1*	*71.8*	*89.9*	*118.1*	*126.2*	Distance (km)
	2	Prey Veng IC	1.25		*9.8*	*27.5*	*45.2*	*63.3*	*91.5*	*99.6*	
2	3	Theay IC	1.75	0.50		*17.7*	*35.4*	*53.5*	*81.7*	*89.8*	
	4	Sdau Kaong IC	2.75	1.50	1.00		*17.7*	*35.8*	*64.0*	*72.1*	
	5	Kraol Kou IC	3.50	2.25	1.75	1.00		*18.1*	*46.3*	*54.4*	
3	6	Svay Rieng IC	4.50	3.25	2.75	1.75	1.00		*28.2*	*36.3*	
	7	Chantrea IC	6.00	4.50	4.00	3.25	2.25	1.50		*8.1*	
	8	Bavet	6.25	5.00	4.50	3.50	2.75	1.75	0.50		
			Tarrif (USD)								

Taffic and Distance Table (Class 2)

Phase	IC		1	2	3	4	5	6	7	8	
1	1	RR 3		*26.6*	*36.4*	*54.1*	*71.8*	*89.9*	*118.1*	*126.2*	Distance (km)
	2	Prey Veng IC	2.50		*9.8*	*27.5*	*45.2*	*63.3*	*91.5*	*99.6*	
2	3	Theay IC	3.50	1.00		*17.7*	*35.4*	*53.5*	*81.7*	*89.8*	
	4	Sdau Kaong IC	5.50	3.00	2.00		*17.7*	*35.8*	*64.0*	*72.1*	
	5	Kraol Kou IC	7.00	4.50	3.50	2.00		*18.1*	*46.3*	*54.4*	
3	6	Svay Rieng IC	9.00	6.50	5.50	3.50	2.00		*28.2*	*36.3*	
	7	Chantrea IC	12.00	9.00	8.00	6.50	4.50	3.00		*8.1*	
	8	Bavet	12.50	10.00	9.00	7.00	5.50	3.50	1.00		
			Tarrif (USD)								

Taffic and Distance Table (Class 3)

Phase	IC		1	2	3	4	5	6	7	8	
1	1	RR 3		*26.6*	*36.4*	*54.1*	*71.8*	*89.9*	*118.1*	*126.2*	Distance (km)
	2	Prey Veng IC	3.75		*9.8*	*27.5*	*45.2*	*63.3*	*91.5*	*99.6*	
2	3	Theay IC	5.25	1.50		*17.7*	*35.4*	*53.5*	*81.7*	*89.8*	
	4	Sdau Kaong IC	8.25	4.50	3.00		*17.7*	*35.8*	*64.0*	*72.1*	
	5	Kraol Kou IC	10.50	6.75	5.25	3.00		*18.1*	*46.3*	*54.4*	
3	6	Svay Rieng IC	13.50	9.75	8.25	5.25	3.00		*28.2*	*36.3*	
	7	Chantrea IC	18.00	13.50	12.00	9.75	6.75	4.50		*8.1*	
	8	Bavet	18.75	15.00	13.50	10.50	8.25	5.25	1.50		
			Tarrif (USD)								

Taffic and Distance Table (Class 4)

Phase	IC		1	2	3	4	5	6	7	8	
1	1	RR 3		*26.6*	*36.4*	*54.1*	*71.8*	*89.9*	*118.1*	*126.2*	Distance (km)
	2	Prey Veng IC	5.00		*9.8*	*27.5*	*45.2*	*63.3*	*91.5*	*99.6*	
2	3	Theay IC	7.00	2.00		*17.7*	*35.4*	*53.5*	*81.7*	*89.8*	
	4	Sdau Kaong IC	11.00	6.00	4.00		*17.7*	*35.8*	*64.0*	*72.1*	
	5	Kraol Kou IC	14.00	9.00	7.00	4.00		*18.1*	*46.3*	*54.4*	
3	6	Svay Rieng IC	18.00	13.00	11.00	7.00	4.00		*28.2*	*36.3*	
	7	Chantrea IC	24.00	18.00	16.00	13.00	9.00	6.00		*8.1*	
	8	Bavet	25.00	20.00	18.00	14.00	11.00	7.00	2.00		
			Tarrif (USD)								

Taffic and Distance Table (Class 5)

Phase	IC		1	2	3	4	5	6	7	8	
1	1	RR 3		*26.6*	*36.4*	*54.1*	*71.8*	*89.9*	*118.1*	*126.2*	Distance (km)
	2	Prey Veng IC	6.25		*9.8*	*27.5*	*45.2*	*63.3*	*91.5*	*99.6*	
2	3	Theay IC	8.75	2.50		*17.7*	*35.4*	*53.5*	*81.7*	*89.8*	
	4	Sdau Kaong IC	13.75	7.50	5.00		*17.7*	*35.8*	*64.0*	*72.1*	
	5	Kraol Kou IC	17.50	11.25	8.75	5.00		*18.1*	*46.3*	*54.4*	
3	6	Svay Rieng IC	22.50	16.25	13.75	8.75	5.00		*28.2*	*36.3*	
	7	Chantrea IC	30.00	22.50	20.00	16.25	11.25	7.50		*8.1*	
	8	Bavet	31.25	25.00	22.50	17.50	13.75	8.75	2.50		
			Tarrif (USD)								

9.2 Project Scheme

(1) Options of Implementing Agency

・ In order to consider options for the project scheme, the following table basically defines who the implementing agency is likely to be.

Table 9-3 Options of Implementing Agency

Option	Implementing Agency
A	Public (Expressway Authority)
B	Public (MPWT)
C	Private (PPP)

(2) Project Scheme Alternatives

・ Based on the options of the implementing agency as mentioned above, four alternatives of the project scheme are assumed as presented below:

(a) Alternative 1: Expressway Authority Scheme

- The government establishes the state-owned enterprise, called “the Expressway Authority” and this executing agency finances, constructs, and operates the whole section of expressway.

(b) Alternative 2: PPP [Public-Private-Partnership: BOT (Build-Operate-Transfer) scheme]

- A private company finances, constructs, and operates the whole section of expressway. It collects the toll during the contracting term. BOT scheme may be the most common form of PPP in case of construction and operation of a new toll road.

(c) Alternative 3: PPP (Lease Scheme)

- In this scheme, the government constructs the infrastructure with their fund so that the private company can reduce their financial requirement. Then the government leases the asset to a private company for operation and management (O & M). The company collects the toll, and pays the lease fee to the government during the concession period.

(d) Alternative 4: Direct Construction and Operation by MPWT

- MPWT, as the executing agency, finances, constructs, and operates the whole section of expressway and MPWT collects the toll.

Table 9-4 Stakeholders and Their Roles in Alternatives of the Project Scheme

Alternatives		Finance	Construction (Civil Works)	Construction (O & M facility)	Operation & Maintenance	Toll Revenue	Assets Holder
1	Expressway Authority	Public	Public	Public	Public	Public	Public
2	PPP (BOT)	Private	Private	Private	Private	Private	Public
3	PPP (Lease)	Public	Public	Private	Private	Private	Public
4	Direct Construction & Operation by MPWT	Public	Public	Public	Public	Public	Public

9.3 Evaluations of Alternatives

(1) Evaluation Criteria

・ The alternatives detailed above are evaluated against the following criteria.

Qualitative Evaluation Criteria

(a) Balanced development of Provincial Area

(b) Uniformity of O & M level

(c) Certainty of Implementation

(d) Early Completion of the Phnom Penh – Bavet Expressway Project

(e) Legislative and Institutional Issue

Quantitative Evaluation Criteria

(f) FIRR for Operator

(g) Government Financing Support

(h) Pooled Amount for New Construction

(2) Optimum Project Scheme

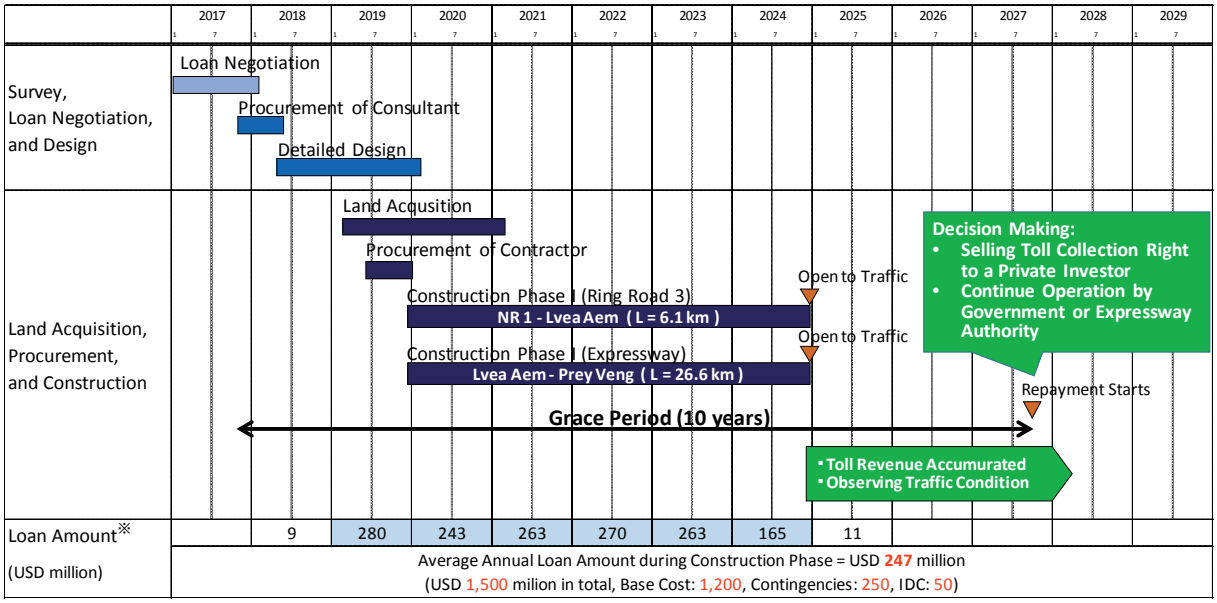
- Based on the results of the above evaluation, Expressway Authority Scheme is recommended as the best alternative. The following advantages are assumed:
  - Less profitable expressway can be constructed with toll revenue pool system to achieve balanced development of provincial area.
  - O & M over every expressway with unified standard is possible.
  - Timely response to urgent repair etc. is possible owing to autonomous decision mechanism and cash revenue.
  - Know-how of constructing and operating expressways is accumulated in the Expressway Authority and MPWT.
  - Financial soundness and reliability of Expressway Authority is high.
  - Results of financial analysis are best (fair FIRR, smaller GFS, and larger accumulated surplus of revenue).
  - The accumulated surplus of the toll revenue is estimated to amount to USD 1,100 million by 40 years after the completion. (In case of PPP, such profits are absorbed by the investor.)
- Table 9-5 gives a detailed evaluation summary of alternatives.

9.4 Additional Alternative Project Scheme for Reducing the Debt of the Cambodian Government

- Although the Expressway Authority scheme is highly recommended through the above evaluation, the large amount of the foreign debt is focused on by the Cambodian Government since the annual amount of foreign debt is strictly regulated.
- Thus, additional project scheme is proposed as shown in Figure 9-1. This scheme intends to make the loan repayment practically unnecessary or, at least, very small.
- In this scheme, RR3 and Phase 1 of the expressway (Lvea Aem – Prey Veng) are constructed in 2019 – 2024 with the ODA loan as the fund source.
- Three years after the completion of Lvea Aem – Prey Veng section of the expressway (before the repayment of the ODA loan starts), the Government sells to a private investor the right of the toll

collection for a long period, such as 30 years, and obtains a certain amount of income.

- The Government can use the toll revenue of 3 years and the income of selling the toll collection right for amortizing loan, or use as the fund for constructing other expressways.

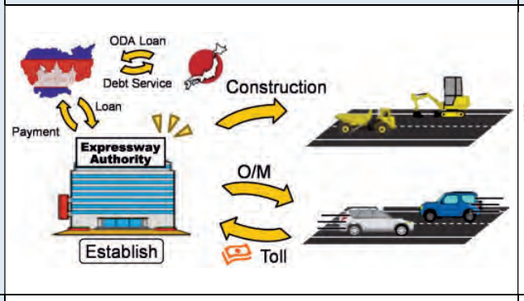
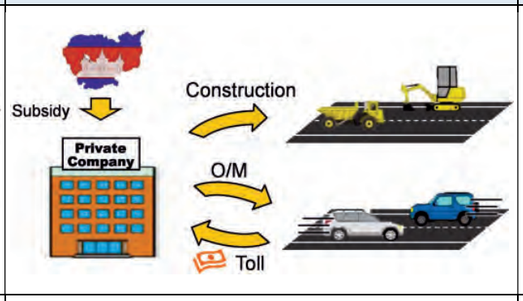
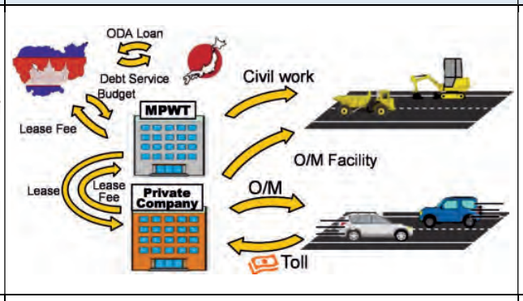
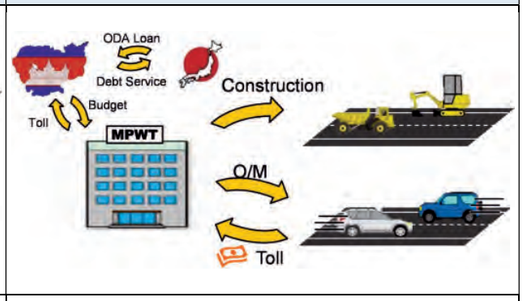


※Loan amount including RR 3. Followings are excluded: costs of land acquisition, utilities relocation, mines/UXO removal, administration cost, VAT, import duty and Front-End fee.

Figure 9-1 Additional Alternative Scheme: Brownfield PPP

- This scheme has the following advantages:
  - The project can be started with the initial loan amount of USD 1,500 million, compared to USD 3,350 million for Scenario 1 (see Section 10.1).
  - Repayment of the ODA loan is not required up to 3 years after the completion of the expressway (during the grace period). This means that the amortization of the ODA loan can be completed before the grace period starts and the debt becomes zero (or nearly zero).
  - The decision of selling the toll collection right can be made after the completion of the expressway. Thus, this decision can be made taken into account the actual traffic volume on the expressway and the toll revenue. [Brownfield PPP]
  - Before deciding to sell the toll collection right to the private investor, the Government can reconsider and opt to let the Expressway Authority operate the expressway and collect the toll, considering the toll revenue and other conditions at that time.
  - Sale of toll collection right will be easier after completion of the expressway because the private investors can estimate the income.

Table 9-5 Detailed Evaluation Summary of Alternatives

Items		Alternatives			
		Expressway Authority Scheme	BOT Scheme	Lease Scheme	Direct Construction & Operation by MPWT Scheme
					
Balanced Development of National Land		◎Suitable Less profitable expressway can be constructed with toll revenue pool system	△Difficult Less profitable expressway is left unconstructed	△Difficult Less profitable expressway is left unconstructed	◎Suitable Less profitable expressway can be constructed with toll revenue pool system
Uniformity of O&M level		◎Suitable O&M over every expressway with unified standard Timely response to urgent repair etc. possible owing to autonomous decision mechanism and cash revenue	△Difficult O&M level of each expressway varies by concessionaire	△Difficult O&M level of each expressway varies by concessionaire	○Possible O&M over every expressway with unified standard Slower and less flexible operation
Certainty of Implementation	Financial Soundness:	◎High	△Low	○Middle	△Low
	Reliability of Project Owner:	◎High	△Low	○Middle	◎High
	Capacity for Project Implementation:	◎High with capacity building (the know-how is accumulated in the Authority)	○Possible	○Possible	◎High with capacity building (the know-how is accumulated in MPWT)
Early Completion of the Phnom Penh – Bavet Expressway Project		◎Suitable if the ceiling for loan not considered	◎Suitable Only if profitable	◎Suitable if the ceiling for loan not considered	◎Suitable if the ceiling for loan not considered
Legislative and Institutional Issue		・Establishing toll road system and Expressway Authority. ・Capacity building is urgently needed.	・Existing related laws (Low on Concessions and Low on Investment) are completely reviewed. ・Capability to monitor the performance of SPV is required.	Same as left	・Establishing toll road system ・Capacity building is urgently needed. ・Formulating legislation to specify purpose of toll revenue exclusively for expressway development.
Project IRR		1.16 %			
FIRR for Operator		1.70 %	0.94 %	9.07 %	1.68 %
Government Financing Support (GFS)		None	USD 2,270 million (Supplement to achieve the Hurdle Rate 12%)	USD 34 million (Supplement to Achieve the Hurdle Rate 12%)	None
Capital Investment by Government		USD 86 million (Cost for Non-Eligible Portion except for Taxes)	USD 75 million (Cost for Non-Eligible Portion except for Taxes)	USD 2,203 million (Total Capital Cost except for Toll Facility and Taxes)	USD 2,652 million (Total Capital Cost except for Taxes)
Pooled Amount for New Construction		USD 1,100 million (Toll Revenue – Capital Cost – OM Cost - Interest)	None (Profits are absorbed by investors)	USD 465 million ([Lease Fee + Taxes] – [Capital Cost + GFS])	USD 1,100 million (Toll Revenue – Capital Cost – OM Cost - Interest)
Evaluation		**A: Highly Recommended**	**C: Not Recommended from the Long-Term Viewpoint**	**C: Not Recommended from the Long-Term Viewpoint**	**B: Recommended**

Note: A: Good, B: Medium, C: Poor

CHAPTER 10 IMPLEMENTATION PLAN

10.1 Time Schedule

(1) Time Schedule Scenario

- Four scenarios of time schedule are proposed:
  - Scenario 1: Complete the whole section by the year 2024
  - Scenario 2: Complete whole section between Lvea Aem and border, together with RR3, by year 2030
  - Scenario 3: Complete whole section by the year 2027
  - Scenario 4: Complete the section of expressway between Lvea Aem IC and Kraol Kou IC, together with RR3, by the year 2027 and leave the time of construction of Kraol Kou IC – border section undecided for the time being

(a) Scenario 1: Shortest Construction Period Plan

- This is the scenario where the whole section between Phnom Penh and Bavet is constructed in as short period as technically possible.
- The maximum amount of annual expenditure is around USD 640 million which may exceed the limit that the Government of Cambodia is allowed to inject into a single project.
- Excess concentration of public investment in short period may very possibly cause “overheating” of national economy and severe price escalation.

(b) Scenario 2: Plan Considering the Ceiling for Amount of Annual Expenditure

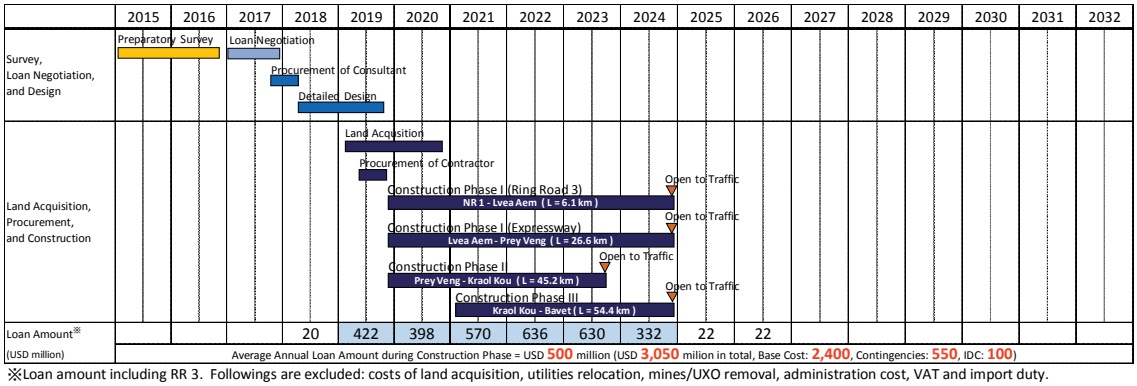
- This scenario intends to reduce the annual expenditure. By extending the construction period and distributing the total construction cost of USD 2,300 million over time period of 11 years, the maximum annual expenditure is reduced to around USD 200 million.
- The maximum annual expenditure of USD 200 million is proposed considering the loan amount of NR 5 Improvement Project which is approximately USD 150 to 200 million.
- The year of completion of the whole section is set at the year 2030 which is the target year for Cambodia to become a middle-level income country.
- The estimated traffic demand between Svay Rieng and Bavet reach 20,000 pcu/day in year 2030. Thus, the opening of the whole section of the expressway is planned to in the year 2030 in order to alleviate the traffic congestion on the existing NR 1.

(c) Scenario 3: Intermediate Plan

- This scenario intends to reduce the annual expenditure to the amount at the middle of those of Scenario 1 and Scenario 2 and thus, avoid excess stimulation to the macro economy of Cambodia, by setting the year of completion at the year 2027.
- The annual expenditure exceeds USD 300 million in the years 2023 – 2025, it is USD 200 million or less in the other years.
- The whole section will be opened to traffic by 2027 and traffic congestion on NR 1 will not occur.

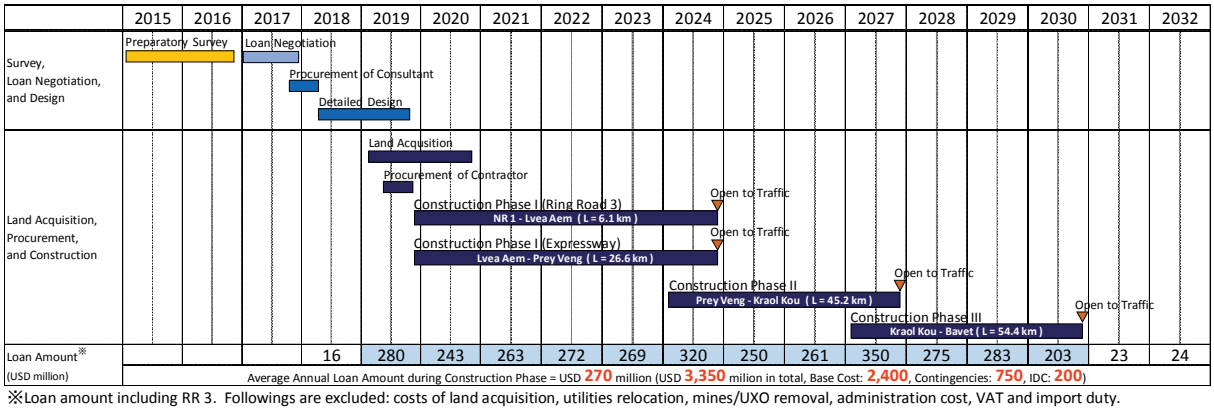
(d) Scenario 4: Plan for Minimum Expenditure

- The amounts of annual expenditures become same as in Scenario 1 (USD 200 million or less) by constructing only RR 3 and the expressway section between Lvea Aem and Kraol Kou for time being.
- The traffic demand between Phnom Penh and Bavet can be accommodated with sufficient smoothness because the traffic demand will be high mainly on the Phnom Penh – Kraol Kou section.
- Figures 10-1 to 10-4 show the time schedule of the four scenarios.



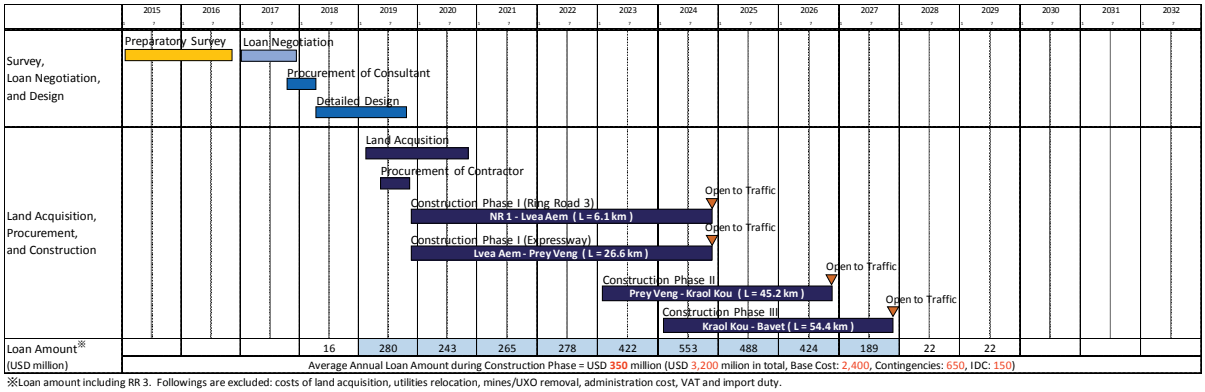
※Loan amount including RR 3. Followings are excluded: costs of land acquisition, utilities relocation, mines/UXO removal, administration cost, VAT and import duty.

Figure 10-1 Time Schedule of Scenario 1



※Loan amount including RR 3. Followings are excluded: costs of land acquisition, utilities relocation, mines/UXO removal, administration cost, VAT and import duty.

Figure 10-2 Time Schedule of Scenario 2



※Loan amount including RR 3. Followings are excluded: costs of land acquisition, utilities relocation, mines/UXO removal, administration cost, VAT and import duty.

Figure 10-3 Time Schedule of Scenario 3

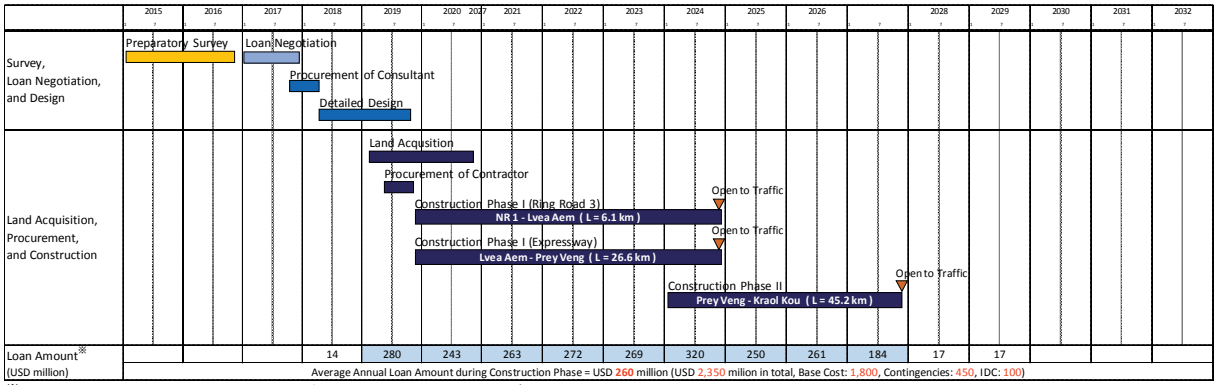


Figure 10-4 Time Schedule of Scenario 4

(2) Detailed Schedule up to Start of Construction

・ Figure 10-5 shows the detailed schedule up to the start of construction.

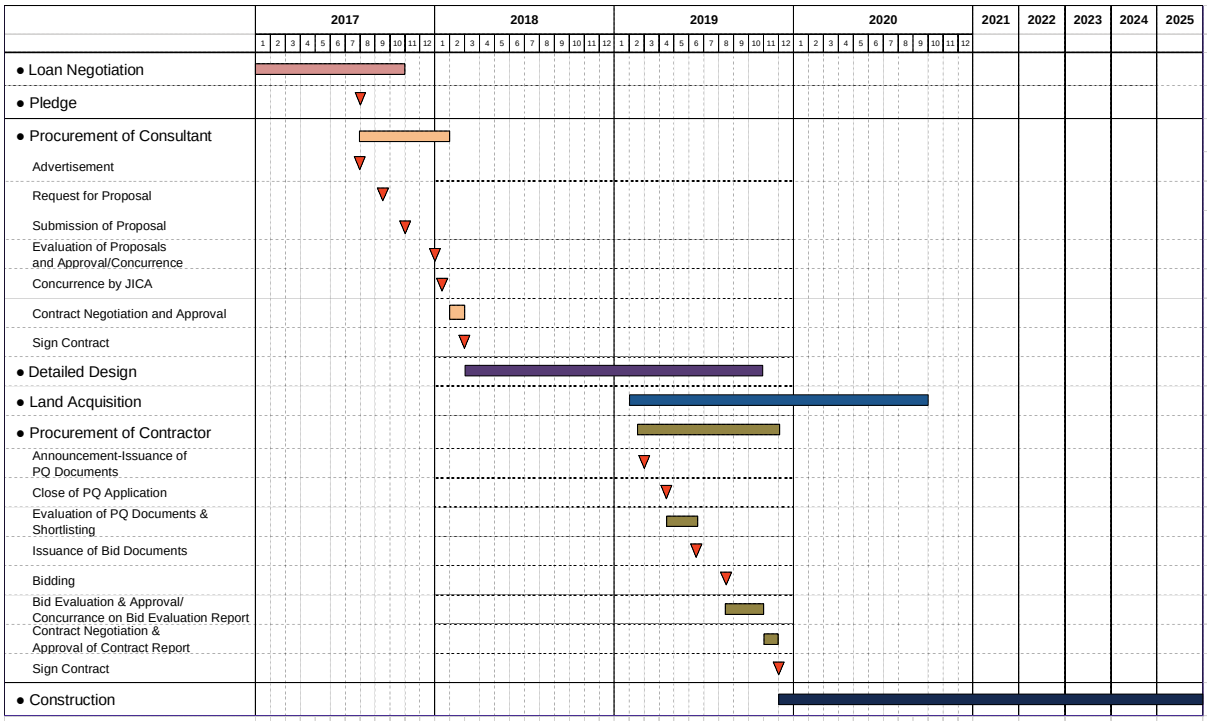


Figure 10-5 Detailed Schedule up to Start of Construction

10.2 Procurement of Consultant Services and Construction Works

(1) General Situation of Procurement for Large-Scale Road Projects in Cambodia

・ A majority of the large-scale public works projects in Cambodia are made with financial assistance from multi-lateral and bi-lateral donors, and contracts based on “Conditions of Contract for Construction” published by the FIIDIC are usually adopted.

・ In most of the past large-scale road projects, joint ventures (JVs) of international and local consultant firms were awarded the contracts of consultant services for detailed design and construction supervision

・ Local contractors participated in large-scale public works projects as subcontractors of international contractors.

(2) Basic Policy for Procurement for This Project

- Since this project is expected to receive a Japanese ODA loan, it is appropriate that the procurement process is based on "Guidelines for Procurement Under Japanese ODA Loans".
- International Competitive Bidding (ICB) with a single-stage two-envelope bidding procedure which was successfully adopted for the National Road No. 5 (North Section) Improvement Project is recommended for this Project.

(3) Procurement of Consultant Services

- The extra-dosed type bridge is proposed for the crossing of the Mekong River. The consultant is required to possess experiences in design and construction supervision of extra-dosed bridges.
- A long section of embankment is to be newly constructed. Good quality control of embankment construction is indispensable in order to achieve smooth road surface which last for long period. The consultant is required to have sufficient experience in design and construction supervision of highway embankment, as well as experience in design and construction of expressways.

(4) Procurement of Contractor

- The chances of contractors with larger execution and financial capacities participating in the bidding increases as the contract amount becomes larger. Thus, large contract packaging is preferable.
- The number of contract becomes small and contract management becomes easier as sizes of contract packages become large.
- Table 10-1 shows the proposed contract packages.

Table 10-1 Proposed Contract Package

Road	Phase	Section No.	Section	Construction Cost (USD Mil.)	No. of Package	Contract Amount (USD Million)
RR3	I	1	NR 1 – Lvea Aem IC	353.5	3	Western Bank of the Mekong River**: 83.8 Main Bridge**: 225.1 Eastern Bank of the Mekong River**: 44.7
Express-way		2	Lvea Aem IC – Prey Veng IC	795.4	6	Average 132.6
	II	3	Prey Veng IC – Theay IC	225.6	2	Average 112.8
		4	Theay IC – Sdau Kaong IC	180.8	1 (2)*	180.8 (90.4)*
		5	Sdau Kaong – Kraol Kou IC	154.5	1	154.5
	III	6	Kraol Kou IC – Svay Rieng IC	153.2	2	153.2
		7	Svay Rieng IC – Chantrea IC	317.3	3 (2)*	Ave. 105.8 (158.7)
		8	Chantrea IC – Vitenam Border	94.2	1	94.2

*To be selected at the stage of tender preparation considering the cost estimate.

**Western Bank of the Mekong River: NR 1 – STA 0+610, Main Bridge: STA 0+61 – STA 1+850, Eastern Bank of the Mekong River: STA 1+850 – Lvea Aem IC

10.3 Notes on Project Implementation

(1) Further Study and Adjustment of the Route

- The route of the expressway should be adjusted in the early stage of detailed design in order to minimize negative impacts on the social and the natural environment as well as to reduce construction cost, taking into account the information obtained through the site survey, topographical survey and other surveys conducted in the early stage of the detailed design.

(2) Consultation with Local Communities on the Details of Design

- The Phnom Penh – Bavet Expressway is to be constructed across many agricultural land plots and will split some of them. Many under-pass culverts, over-pass bridges and frontage roads connecting them will need to be constructed. The location of such facilities needs to be decided after consensus with the stakeholders, or the users, is obtained.

(3) Selection of Borrow Pit

- More than 6 million cubic meters of soil is required. The preliminary survey on the borrow pits showed that there are several projects of a public nature, such as constructing irrigation channels and the construction of irrigation reservoir cum fish-culturing pond planned by the local communes which can be used as the borrow pits.

(4) Coordination with Other Public Works Projects

- Using the sites of irrigation channel and fish-culturing ponds as the borrow pits of the expressway construction will give benefits to both these projects and the expressway project. Thus, such arrangements should be positively considered.
- High-voltage power lines are being constructed in the vicinity of the planned expressway route. It is necessary to consult with Electricite Du Cambodge (EDC) so that the tow public projects do not interfere with each other.
- Close consultation and coordination with other public projects often bring about benefits to both the expressway and relevant public projects.

(5) Application of Japanese Technology

- Japan possesses rich experience in construction and maintenance of expressways and extra-dozed bridge. Such technologies of Japan can improve the cost efficiency and/or life-cycle cost if adopted in the Phnom Penh – Bavet Expressway or Ring Road 3.

CHAPTER 11 INSTITUTIONAL PLAN

11.1 Institutional Setup

- A dedicated department for expressways in MPWT; Department of Expressway, Mega Bridge, and Investment (EXMID) was officially established on February 19th, 2016.

11.2 Function/Role of Relevant Institutions

- At any stages, the tasks for the development of expressways can be divided into two types. One is the tasks which should be the government's responsibility. That is, related directly to the governmental policy and measures. The other is the tasks related to the implementation of projects including construction, operation, and maintenance of expressway which will comply with the governmental policy.
- The concept of the institutional and organizational framework for expressway development is shown below.

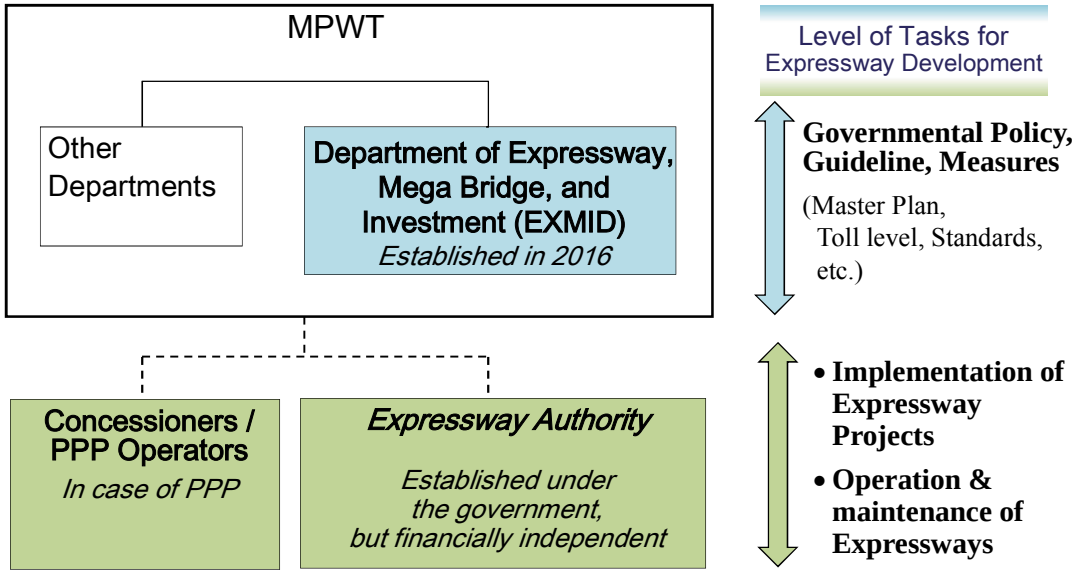


Figure 11-1 Concept of Institutional and Organizational Framework for Expressway Development

11.3 Tasks of Planning, Construction, Operation and Maintenance of Expressway

- The below table shows the tasks required at the planning and construction phase. In addition, proposed implementation body for each task is described in the extreme right column of the table.

Table 11-1 Tasks at Planning and Constructing Phase

Category of Task	Sub-Category of Task	Task	Proposed Implementation Body
Planning	Establishment of Plans	・ Establishment of the "Expressway Master Plan"	MPWT
		・ Formation of "Implementation Plan" of each project	Public or Private Corporation
	Toll System	・ Deciding the guideline of "Toll System"	MPWT
		・ Setting the specific toll on each project	Public or Private Corporation
	Procedure	・ Legislation of procedures related to expressway projects	MPWT
Engineering (Feasibility Study & Design)	Technical Standards & Guidelines	・ Preparation of design standards, rules of tendering system, etc.	MPWT
	Technical Survey	・ Topographical survey, geological survey, traffic survey, etc.	Public or Private Corporation
	Basic Design / Detail Design	・ Designing roads, bridges, facilities, etc.	Public or Private Corporation
	Coordination / Consultation	・ Coordination and consultation with stakeholders regarding the expressway design	MPWT/Public or Private Corporation
	Procurement of Contractor	・ Preparation of tender document, evaluation of contractors	MPWT
Constructing	Resettlement (Land Acquisition)	・ Preparation of compensation standard	MEF
		・ Implementation of Resettlement	
	Construction Supervision	・ Quality control	MPWT/Public or Private Corporation
		・ Safety management	
		・ Inspection for completion of construction	
	Coordination / Consultation	・ Coordination and consultation with stakeholders regarding the construction works	MPWT/Public or Private Corporation
Financing and fund-raising		・ Issuing bonds, etc.	Public or Private Corporation (In case of ODA→ MEF, MPWT)

11.4 Capacity Development for Each Step

・ The proposed steps to develop the institution for Phnom Penh – Bavet expressway is shown in the chart below.

STEP-1: Establishment of the Department (EXMID) in MPWT

STEP-2: Establishment of "*Expressway Authority*"

STEP-3: Development of "*Expressway Authority*" to be suitable for the construction of "Phnom Penh - Bavet Expressway" Project

STEP-4: Development of "*Expressway Authority*" to be suitable for operation of "Phnom Penh - Bavet Expressway"

STEP-5: Development of "*Expressway Authority*" to be suitable for construction & operation of whole national expressway network

・ In STEP-1 and STEP-2, capacity development on the expressway master plan is necessary from the earliest stage. It can be considered to construct "Phnom Penh - Bavet Expressway" by Expressway Authority directly as a "case studies" of capacity development program.

・ Capacity development for the know-how of operation/maintenance is needed to be done by experienced experts. In view of this, it is assumed that the capacity development for operation and maintenance of expressway can be the most effectively achieved through institution-to-institution technical cooperation between expressway authorities, or similar organizations.

CHAPTER 12 LEGISLATIVE FRAMEWORK

12.1 Current Status of Legislation Relevant to Expressway

- MPWT is given authority to develop the national road network including expressways in Law on Roads (2015). The authority shall develop a road master plan which is needed to be permitted by the government. At present, MPWT has no master plan for the expressway network, including related prakas and sub-decree to show the specific procedure.
- According to the Law on Roads, the government aims to promote and encourage participation from private sector and the authorities of the roads may implement road development projects or may delegate to the private sector.
- As the sources of funds for road development and maintenance, "National budget", "International development fund (grant, loan)" and "Funds from private sectors" are designated in the Law on Roads.
- There is no definition of an expressway in the Law on Road Traffic. Accordingly, there are no rules on the traffic on expressway.
- The EXMID has been established with a ministerial decree. The main functions of EXMID are stipulated in the decree.
- For the purpose of the promotion and facilitating implementation of privately financed projects, Law on Investment and Law on Concessions are prepared. Then, it is stipulated that the Council for Development of Cambodia (CDC) is the one stop service entity for obtaining authorizations required to implement an investment project.
- The detailed legislative regulations which state specific rules concerning PPP expressway projects have not been developed yet.

12.2 Legislative Frame Work for Expressway

- The legislations necessary for development of national expressway is shown in the below table.

Table 12-1 Legislations Necessary for Development of National Expressway Network

Classification Symbol	Legislation	Objective and Main Provisions	Note
A	- National Expressway Law	· This law sets forth the Government's policy for the development of the expressway network. · Master Plan of the expressway network, Responsibilities and powers the Government, Overall procedure of planning and project implementation	- Equivalent to "National Development Arterial Expressway Construction Law" in Japan - Necessary urgently
B	- Toll Road Law	· This law sets forth the basic policy, rules for administration of toll roads. · Toll level, period of toll collection, conditions for allowing toll collection and procedures for approval of toll road, etc. are stipulated.	- Necessary urgently
C	- Law for Establishment of the Expressway Authority - Law for PPP	· This law sets forth the details for the establishment of the Expressway Authority as an organization to perform construction, reconstruction and the management and operation of the expressway. · The assignment of the roles of government and Expressway Authority are also stipulated.	
D	- Law on Road Traffic	· Traffic rules on expressway such as minimum speed, overtaking lane, types of available vehicles.	

12.3 Legislations Relevant to Expressway in Neighboring Countries

- In Vietnam, the Expressway Master Plan was prepared by the Ministry of Transport (MOT) and approved by the Prime Minister. This Master Plan defines the total length of expressway network in Vietnam and the total amount of construction project cost. There is also a regulation which stipulates the policy on setting toll level for national highways. However, the regulation refers only to road improvement, and the toll level for newly constructed road is not included.
- In Thailand, there are Highway Act (basic concepts and rules for development and maintenance of highway), Motor Vehicle Use on Highway and Bridge Fee Specification Act (basic idea and maximum rate of toll fee), and Concession Highway Act (basic rules of the concession highway).

12.4 Schedule for Legislative Framework

・ The proposed schedule for developing the legislative framework is shown in the below figure.

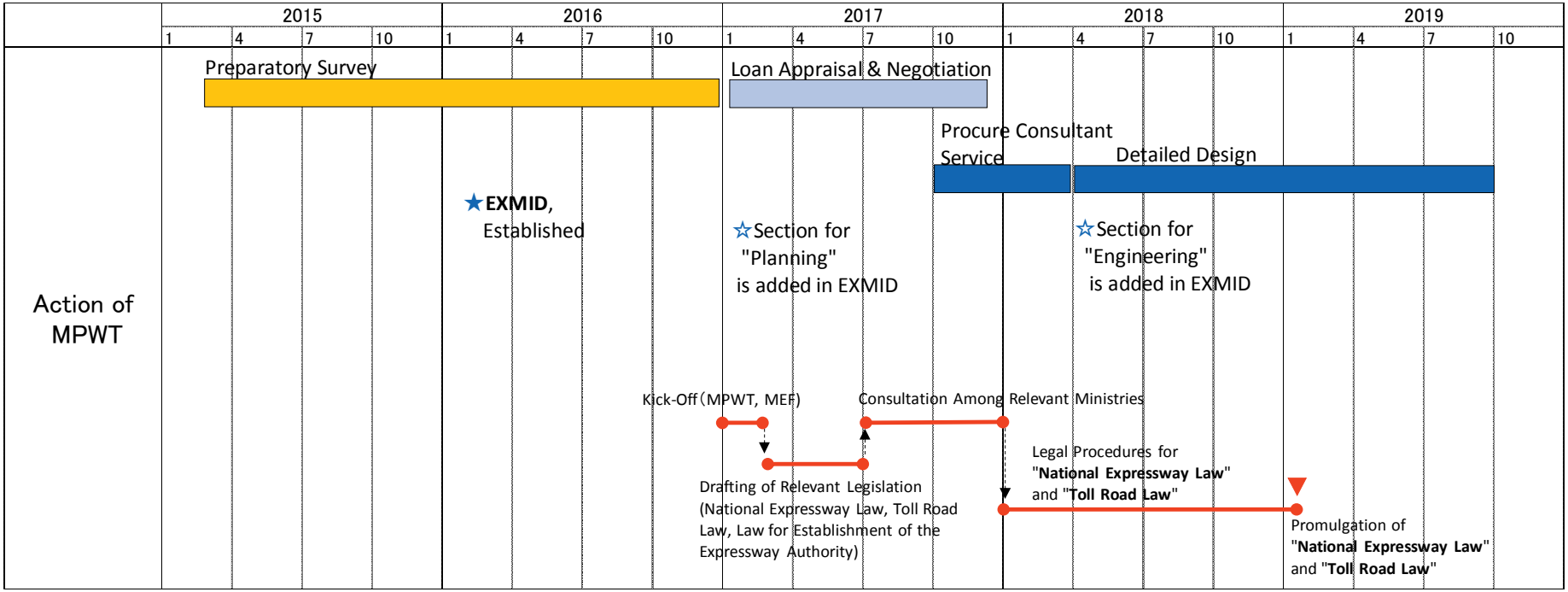


Figure 12-1 Schedule for Legislative Framework

CHAPTER 13 ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

13.1 EIA System in Cambodia

- A project owner defined in "Sub-decree on Environmental Impact Assessment Process" must conduct an EIA study on the basis of "General Guideline for Conducting Initial and full Environmental Impact Assessment Reports" and obtain the approval from the Ministry of Environment. In road sector, national road construction projects with more than 100 km long and bridge construction projects with more than 30 ton weight need the EIA study.
- A project owner conducts Initial Environmental Impact Assessment (IEIA) for projects with substantial environmental impacts or Full Environmental Impact Assessment (FEIA) for projects with significant environmental impacts.

13.2 Local Conditions of Project Area

- The land use around the project area is mostly agricultural land such as rice field. The other areas are urban, built-up or village garden areas. The project areas around Mekong River are inundated in rainy season.
- Because the area along the proposed road alignment has been well developed, there are no protected areas or forest zones in and around the area.
- There are many kinds of aquatic file including box turtle, cobra and fish as endangered species in flooded grassland areas that do not use for agriculture.
- Because there are no major air pollution sources except for vehicle emission gas in the project area, the NO_2 and SO_2 levels in the air are low.

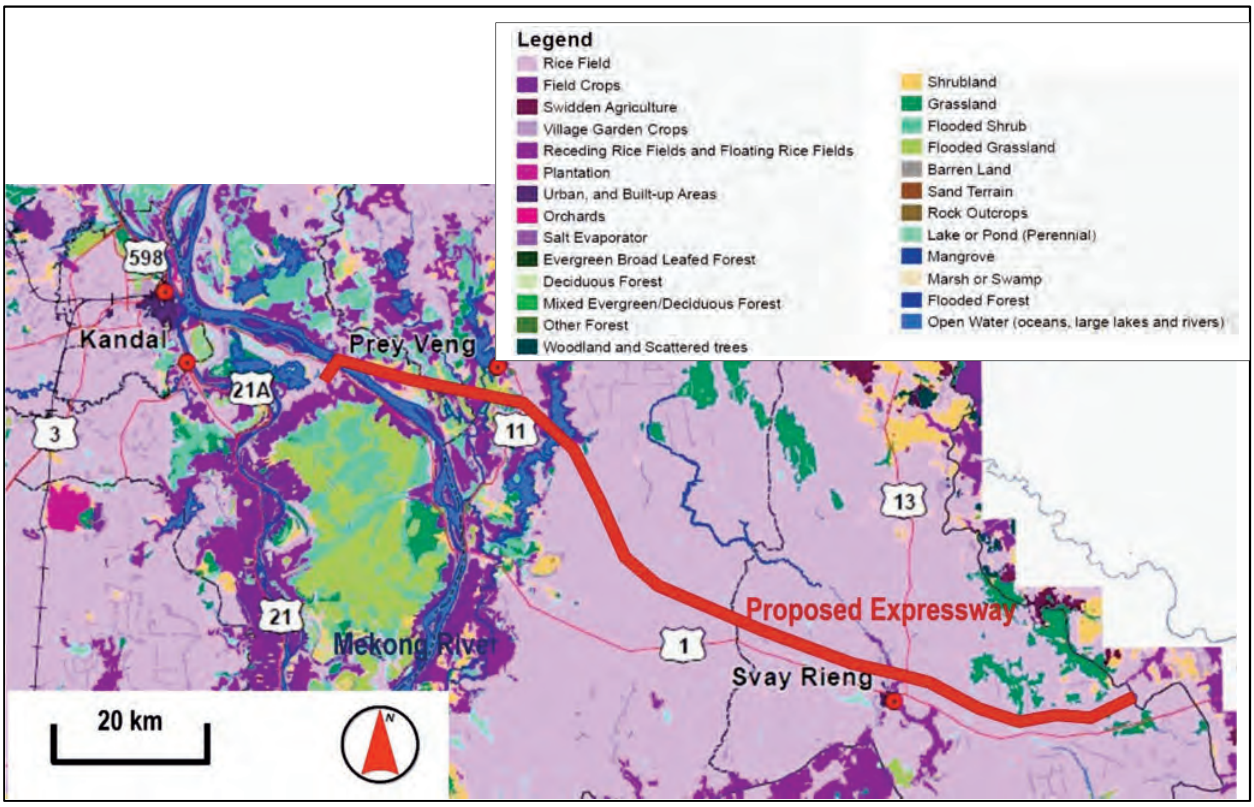


Figure 13-1 Land Use around Project Area

13.3 Potential Environmental and Social Impact

・ Potential environmental and social impact of the Project is shown in the following Table 13-1.

Table 13-1 Potential Environmental and Social Impact

Impact Item	Assessment Phase		Reason / Remarks
	Pre-Construction/ Construction	Operation	
Pollution			
Air pollution	B-	B±	**Construction Phase:** ・Construction works and operation of construction equipment will generate dust and emission gas. ・Traffic congestion in construction site will cause increase in exhaust gas from vehicles. ・Dust will occur in borrow pit and quarry site. **Operation Phase:** ・In the future, total amount of air pollutant caused by vehicle exhaust gas will increase. ・Because of improved traffic efficiency, the amount may be reduced compared to without project.
Water Pollution	B-	B-	**Construction Phase:** ・Turbid water caused by construction works is likely to affect existing surface water resources. ・Bridge construction works will cause surface water contamination. ・In case of accidental massive leaking of fuel or oil, water pollution including ground water may occur. ・Turbid water from borrow pit and quarry site by rainfall may cause surface water contamination. **Operation Phase:** ・Considerable water pollution is unlikely to occur However, filling sections may be eroded by rainwater and cause surface water contamination. ・Turbid water from borrow pit and quarry site by rainfall may cause surface water contamination until the recovery of vegetation. ・If toilets and eating places are installed in rest areas, wastewater from these facilities may cause surface water contamination.
Waste	B-	B-	**Construction Phase:** ・Construction waste caused by construction works and general waste from construction office will be generated. **Operation Phase:** ・Solid waste from road users will generate in rest areas.
Noise and Vibration	B-	B-	**Construction Phase:** ・Construction works will cause noise and vibration. ・Noise and vibration will occur in borrow pit and quarry site. **Operation Phase:** ・Vehicle driving will cause noise and vibration.
Ground Subsidence	B-	B-	**Construction Phase:** ・Subsidence near the road due to added soil weight may occur. **Operation Phase:** ・Pressure of loading on road will be too low to cause subsidence. However, because some portions of the new road run through flooded area, subsidence may occur.
Ecosystem	B-	B-	**Construction Phase:** ・Vegetation will be lost due to construction works. However, tree clearing of protected or community forest will not be required. ・ Agricultural ecosystem will be lost or disturbed by construction works. ・Turbid water caused by bridge construction is likely to affect aquatic life. **Operation Phase:** ・Because the target road mostly passes through well-developed area such as agricultural land and residential areas, impact on biodiversity is unlikely to occur. ・If filling sections of the new road choke off existing surface water flow, impact on surrounding and remote aquatic ecosystem may occur.
Hydrology	B-	B-	**Construction Phase:** ・Water flow in the river or stream may be altered during construction works. But the impact will be temporary and in limited area. **Operation Phase:** ・Because some portions of the new road run through flooded areas, impact caused by newly constructed filling sections on surface water flow may occur.
Geographical Features	B--	D	**Construction Phase:** ・Because a large quantity of filling soil and aggregate will be required, topography will be changed in borrow pit and quarry site. **Operation Phase:** ・Impact on geographical features is unlikely to occur.

Impact Item	Assessment		Reason / Remarks
	Phase		
	Pre-Construction/ Construction	Operation	
Resettlement/ Land Acquisition	A-	D	**Pre-Construction Phase:** ・Large scale land acquisition and resettlement will be required. **Construction Phase:** ・Temporary lease of land and additional small-scale resettlement will be required. **Operation Phase:** ・Additional physical resettlement and land acquisition will not be required. ・Depending on conditions of relocated site, the livelihood restoration program is likely to be unworkable.
Local Economies, such as Employment, Livelihood, etc.	B±	B±	**Pre-Construction Phase:** ・Land acquisition and resettlement may cause livelihood degradation of Project Affected Persons (PAPs). ・Because borrow pit development will require excavation of lands in the vicinity of the alignment of the Project, agricultural lands will be lost partially. **Construction Phase:** ・Construction will create job opportunities to local people. ・Bridge construction works are likely to have impacts on fishery and water transportation. Commercial fishery using floating fish cages is operated in approximately 500 m downstream side of the proposed Mekong bridge. Water contamination including turbid water caused by construction works may have impacts on the fishery. **Operation Phase:** ・Reduction of travel time will contribute to local economies and promote tourism. On the other hand, rapid changes of local economic conditions may widen gap in local economy. ・The ponds created from borrow pits will have a positive impact on local fisheries.
Existing Social Infrastructures and Services	B-	B±	**Pre-Construction Phase:** ・Relocation or protection of existing utilities, such as electric poll, water pipe and optical fiber cable will be required. **Construction Phase:** ・Temporary traffic congestion in construction site, NR1 and other rural roads will occur. **Operation Phase:** ・Wide area network to social services will be improved. On the other hand spilt of local communities or widening disparity may occur along the new road.
Cultural Heritage	B-	B-	**Construction Phase:** ・The construction works will have impacts on cultural properties in and around the ROW. There are three ancestral spirit sites and a pagoda within the ROW of the proposed alignment. **Operation Phase:** ・Considerable direct impact on cultural heritage along the expressway is unlikely to occur. ・Impacts of exhaust gas and noise on the pagoda and hushed ambience are likely to occur.
Landscape	B-	B-	**Construction Phase:** ・Vegetation in the ROW will be lost by construction works, and landscape along the roadside will be changed. **Operation Phase:** ・There are no protected scenic view areas. However, because a huge artificial structure will appear in pastoral land, impact on landscape is likely to occur.
Gender	B±	D	**Construction Phase:** ・Construction will create job opportunities to women who lost their agricultural lands. ・Woman's construction workers are likely to perform back-breaking work. **Operation Phase:** ・Considerable impact only on gender is unlikely to occur.
Infectious Diseases such as HIV/AIDS	B-	D	**Construction Phase:** ・Infection risks of HIV/AIDS may be increased among construction workers and local business offering food and entertainment. **Operation Phase:** ・Because of project in developed areas, considerable impact on infectious diseases is unlikely to occur.
Working Conditions (including occupational safety)	B-	D	**Construction Phase:** ・Dust and emission gas caused by construction works may affect workers health. ・Sanitary conditions around construction site may get worse due to waste from workers and toilet. **Operation Phase:** ・Considerable impact on working conditions is unlikely to occur.

Impact Item	Assessment		Reason / Remarks
	Phase		
	Pre-Construction/ Construction	Operation	
Accidents	B-	B±	**Construction Phase:** ・Construction works will carry risk of work related accident. **Operation Phase:** ・Traffic safety including pedestrians will be improved due to decrease in heavy and high-speed vehicles in existing NR1. ・The new road will carry risk of many traffic accidents till drivers adjust to high-speed driving.
Trans-boundary Impacts or Climate Change	B-	B±	**Construction Phase:** ・Operation of construction equipment will generate CO_2. **Operation Phase:** ・In the future, total amount of CO_2 emission from vehicles will increase. ・Because of improved traffic efficiency, the amount may be reduced compared to without project.

A+/-: Significant positive/negative impact is expected.
B+/-: Positive/negative impact is expected to some extent.
C+/-: Extent of positive/negative impact is unknown. (A further examination is needed, and the impact could be clarified as the study progresses)
D: No impact is expected

13.4 Main Mitigation Measures

- Resettlement: The authorities concerned shall prepare and strictly implement a proper Resettlement Action Plan (RAP). The authorities shall monitor the resettlement progress. If troubles of some sort occur, the authorities should consider and implement the countermeasures.
- Environmental pollution caused by construction works: The contractor shall prepare and strictly implement the mitigation measures. The supervision consultant shall monitor the environmental qualities and complaint from the local people. If issues of some sort occur, the supervision consultant and contractors should consider and implement the countermeasures.
- Noise from vehicle driving: The detail design consultant shall reconsider the alignment to avoid quiet areas such as school zone. The proper countermeasures to reduce noise such as soundproof wall should be installed in residential areas.
- Ecosystem, Hydrology and Water usage: To maintain existing surface flow conditions, newly constructed bridges and culverts should be constructed on the existing surface flows and have sufficient flow capacity.
- Impact on Fishery: The supervision consultant and contractor shall monitor water quality by potable water quality meters and production of the local fishery. If a decrease in the production caused by water contamination due to the construction works is identified, the supervision consultant and contractors should reconsider the construction technique and method, and the proper compensation shall be provided to the affected fisher persons by organizations concerned.
- Cultural heritage: The detail design consultant should consider the alignment to avoid cultural properties at first. The project owner should discuss with the authorities concerned to consider the relocation and conservation. If the removals are required, the removal works should respect and follow Khmer tradition and culture.
- Impact on local society and ecosystem in operation phase: It is difficult to assess long term impacts on local society and ecosystem including flooded areas of Mekong River at this time. The authorities concerned such as Expressway Authority shall monitor the environmental and social conditions. If issues of some sort occur, the authorities should consider and implement the countermeasures.

CHAPTER 14 LAND ACQUISITION AND RESETTLEMENT

・ The project will cause land acquisition and resettlement mainly in private land area. Each survey related to land acquisition and resettlement have been implemented based on Cambodian domestic legal framework and JICA's Guidelines for Environmental and Social Considerations, and the results were reflected to the resettlement action plan (RAP). This chapter shows outline of the RAP focusing on land acquisition and resettlement by the project.

14.1 Resettlement Policy

(1) Legal Framework

・ Policies on land acquisition and resettlement in Cambodia are covered by the legal framework with the Constitution (1993), Land Law (2001, modified in 2011 due to Civil Code), and Expropriation Law. Under the legal framework, Sub-Decrees, Prakas/Declaretaions, and Sarachors/Circulras have been developed for implementation of the laws. Ministry of Economy and Finance (MEF) and Ministry of Land Management, Urban Planning and Construction (MLMUPC） are mainly responsible for the legal framework.

・ Government of Cambodia (GOC) also prepared RAP for each specific project to fulfil gaps between domestic legal framework and development partner's safeguard policies.

(2) Institutional Framework

・ Institutional framework on resettlement in Cambodia consists of the planning stage and the implementation stage. Project owner takes responsibilities during the planning stage and Inter-Ministerial Resettlement Committee (IRC) takes over that function in the implementation stage.

・ In Ministry of Public Works and Transport (MPWT), International Cooperation Department (ICD) takes responsibilities on environmental and social considerations as a Project Management Unit (PMU).

・ General Department of Resettlement (GDR) in MEF leads IRC to implement land acquisition and resettlement based on RAP, including comment and approval of RAP, budget management, instruction for IRC-Working Group, etc.

14.2 Procedures for Land Acquisition and Resettlement

・ Table 14-1 shows working steps of land acquisition and resettlement after project decision with Japanese ODA Loan.

Table 14-1 Working Steps of Land Acquisition and Resettlement in Cambodia

Implementation Stage	Outline
1. Project Decision	After project decision by Exchange of Notes (E/N), MEF organize IRC with its working group (IRC-WG) and request to local government to establish Provincial Resettlement Sub Committee (PRSC) with its working group (PRSC-WG).
2. Detailed Measurement Survey	Based on RAP and other related documents, Detailed Measurement Survey (DMS) and Replacement Cost Survey (RCS) are implemented to identify eligible affected persons and determine compensation amount.
3. RAP Updating	Based on the results of DMS and RCS, database is modified and RAP is updated. Updated RAP is submitted to development partners.

Implementation Stage	Outline
4. Preparation Works	IRC and relevant authorities prepare works described as below; - Budget disbursement for compensation payment - Selection of relocation site and preparation before land clearance - Procurement for external monitoring and income restoration program
5. Compensation Payment / Land Acquisition	Before land clearance, local government make payment for compensation. Affected persons are informed that they must be relocated within 1-2 months after obtaining the compensation money.

14.3 Impact caused by land acquisition and resettlement

・ Based on the results of field surveys, such as Census, Socio-Economic Survey, Inventory of Loss, etc.), implemented in a period from March to August in 2016, Table 14-2 shows estimated degree of impact caused by the project. Among total number of affected households of 4,317, 413 households, around 10% of the total number, may be affected their main structures.

Table 14-2 Degree of Land Acquisition and Resettlement

Number of Project Affected Households	Area of Land Acquisition	Note
Total 4,317 Households ・ Households affected their land: 4,249* ・ Households affected their main structures: 413 ・ Households affected their secondary structures only: 48	Total 8,788,876.56 m² ・ Agricultural land: 85.88% ・ Residential land: 8.54% ・ Flood plain: 5.59%	Affected land is basically private owned land. Limited cross sections with existing road have right of way as state property.

* One single household can possess several types of land, therefore, the number is less than total number of households

・ Affected land area is set based on ROW policy in Cambodia. The area is 30m from planned road centreline in both sides (total 60m width). Table 14-3 shows affected land areas.

Table 14-3 Affected Land Areas

Province	District/Town	Residential Land		Agricultural Land		Flood Plain		Total Households
		Households	m^2	Households	m^2	Households	m^2	
KANDAL	Kien Svay	17	12,665.37	15	19,253.49	0	0.00	25
	Lvea Aem	16	25,625.49	296	579,026.62	33	458,755.04	345
PREY VENG	Ba Phnum	214	226,850.42	945	1,292,327.33	0	0.00	1,114
	Kampong Trabaek	85	99,326.23	422	649,791.52	0	0.00	475
	Peam Ro	29	13,682.63	210	359,819.31	0	0.00	239
	Prey Veng	1	11,205.11	113	554,324.53	1	9,323.39	115
	Pur Rieng	9	5,766.54	127	425,072.44	7	22,843.27	142
SVAY RIENG	Svay Chrum	119	129,105.61	584	831,812.12	0	0.00	672
	Svay Rieng	97	91,702.90	389	642,253.39	0	0.00	477
	Svay Teab	65	85,933.29	337	923,129.60	0	0.00	387
	Bavet	25	48,399.13	241	1,270,881.78	0	0.00	258
Total		677	750,262.72	3,679	7,547,692.14	41	490,921.70	4,249

・ Most affected structures are residential house and some houses are used as small shops and other business. Besides that, secondary structures, such as movable kiosk, shelter, gate, fence are affected. Table 14-4 shows affected properties.

Table 14-4 Affected Structures and Other Properties

Province	District/Town	Affected Structures					
		House	House/Shop	Shop/Restaurant	Shelter	Other Structures	Total
KANDAL	Kien Svay	8	0	0	0	11	19
	Lvea Aem	9	1	0	0	12	22

Province	District/Town	Affected Structures					
		House	House/Shop	Shop/Restaurant	Shelter	Other Structures	Total
PREY VENG	Ba Phnum	142	1	0	40	236	419
	Kampong Trabaek	65	0	0	8	135	208
	Peam Ro	8	0	0	1	10	19
	Prey Veng	1	0	0	0	0	1
	Pur Rieng	10	0	0	0	9	19
SVAY RIENG	Svay Chrum	74	1	0	17	130	222
	Svay Rieng	70	0	0	14	130	214
	Svay Teab	36	0	1	15	71	123
	Bavet	11	0	0	2	25	38
Total		434	3	1	97	769	1,304

14.4 Compensation Policy / Entitlement Matrix

- Eligibility and contents of compensation of project affected persons (PAPs) are determined in the entitlement matrix of RAP.
- Target properties of compensation are mainly classified in two, land and other properties on the land. Private land is compensated but state land, such as ROW, is not compensated. In case that people lost their land for living, they are recognised as land less PAPs and relocation site or other assistance are provided.
- Affected structures are classified into physical relocation, setback, partial slice, based on their degree of impact. Structures have four different categories based on materials and finally classified into 41 groups based on roof, wall, floor, and etc. Unite price for each category are determined by average of replacement cost survey. Other properties except structure are also determined by replacement cost based on market price.
- In addition to compensation payment, social vulnerable people, such as women-headed household, handicap-headed household, physically relocated household, etc., are assisted by cash.
- There have not been observed landless PAPs based on socio-economic survey, relocation site is not prepared in this project and "cash for land" compensation policy is applied in principle.

14.5 Public Participation and Stakeholder Meeting (SHM)

- Stakeholder meetings (SHMs) were organized during RAP preparation process. Prior to the SHMs, MPWT informed to local authorities to encourage women's participation and share information to NGO Forum in Cambodia to enhance wide and fair information disclosure and opinion exchange with civil society. Participants did not oppose the project but requested conditions on compensation policy and ask uncertain points.

(1) Draft Scoping Stage

- SHMs were organized commune by commune along the planned road alignment. People living along the area and related authorities participated in the SHMs. MPWT made explanation of project outline as well as survey schedule of census, inventory of lass (IOL), and socio-economic survey. People made question on project schedule and entitlement for compensation. In addition, cut-off-date was declared at the date of census survey.

(2) Draft Final Report Stage

- MPWT made explanation on possible impact by the project and compensation policy based on the results of Census, IOL, and Socio-Economic Survey and future schedule for land acquisition. Participants raised questions on time of project commencement, compensation entitlement, and etc.

14.6 Grievance Redress

- PAPs have been informed their right for grievance redress at the SHMs with oral explanation and broacher.
- Once grievance redress is made by PAPs, meditation in different steps, such as commune level, district level, and provincial level is prepared. Regional court is the last resort for solving grievance.

14.7 Income Restoration Program

- After implementation of Detailed Measurement Survey (DMS), Income Restoration Program (IRP) is prepared and local consultant contracted by MEF will take responsibility for implementation.
- IRP target wide range of affected people including social vulnerable people, physically relocated people, and etc. Means of livelihood restoration shall be well discussed based on actual needs of target groups and their living standard before project implementation.

14.8 Monitoring and Evaluation

- PMU in MPWT coordinated with IRC implement internal monitoring for resettlement
- Items for monitoring including, implementation status of RAP, number of final affected households, negotiation and compensation status, assistance for PAPs, reporting, etc.
- Monitoring report shall be submitted to JICA quarter basis.
- External monitoring is introduced in order to investigate and report status of livelihood restoration
- IRC makes contract with local consultant to implement external monitoring and post evaluation

14.9 Following Schedule

- MPWT and MEF establish IRC and IRC-WG. MEF request local government to establish PRSC and PRSC-WG.
- Based on IOL, IRC implement DMS at the same time of RCS. By using the survey results, compensation amount is determined complying with entitlement matrix.
- IRC update RAP and submit it to JICA for approval. After that MEF starts procedure for budget disbursement.
- Based on fixed compensation amount, individual negotiation and compensation payment are implemented after stakeholder meetings. Following the payment, land is cleared for the project site.
- Income restoration program and monitoring are commenced.

CHAPTER 15 CONCLUSION AND RECOMMENDATION

15.1 Conclusion

(1) Necessity for the Project

- The traffic demand on NR 1 is estimated to grow three times greater than the present one by the year 2030.
- Widening of NR 1 is difficult because there are many urbanized areas along NR 1 and land acquisition for widening is difficult.
- Also, widening of Tsubasa Bridge is very difficult due to its structure.
- Thus, construction of a new road traversing the relatively undeveloped areas is the practical measure to cope with the future traffic growth.
- If a new road is to be constructed, it should be an expressway which is the most important transport infrastructure indispensable for the modern industry and economy.

(2) Justification of the Project

- The Phnom Penh – Bavet Expressway Development Project is justified by the following facts:
  - Alleviation of traffic congestion on National Road No. 1.
  - Various benefits: Decrease in traffic accidents, reduction in vehicle emission, promotion of growth of national economy and regional development, enhancement of regional cooperation in GMS, expansion of market for agricultural products, improvement of access to public services.
  - Economic viability: EIRR of the Project is calculated to be 12% that equals the minimum threshold required for economically justifying a road project.
  - Financial viability: The debt for the expressway construction cost of can be successfully amortized if an ODA loan is the source of funds. Moreover, the accumulated surplus of toll revenue is expected to amount USD 1,200 million by year 2060. This surplus of toll revenue can be used as the fund for constructing expressways in the remoter regions whose toll revenue is not sufficient to cover the construction cost.

(3) Funding Scheme

- ODA Loan as the Fund Source: If ODA loan is introduced as the fund source, the debt of the loan can be amortized with the toll revenue. The Project is financially viable only when funded with an ODA loan with low interest rate and long grace period, such as Japanese ODA loan.
- Risk of PPP: The largest drawback of PPP is that there is a high risk that the Project may not be completed or greatly delayed if the financial conditions of the investor become difficult. If the Project is stopped, it is very difficult for the Government to complete it within the scheduled time.
- Necessity of a Toll Road System: Development of expressways is an urgent need for Cambodia. However, the Cambodian Government does not have funds for expressway construction, and introduction of a toll road system is necessary.

(4) Toll Level

- A toll level of USD 0.05/km for small vehicles and USD 0.15/km for heavy vehicles is proposed.
- This level of toll is estimated to allow full recovery of construction cost or amortization of the loan, (if ODA loan of Japan is introduced as the fund source).
- This toll level is believed to be socially acceptable in view of the results of the willingness-to-pay survey.

(5) Accumulated Surplus of Toll Revenue as the Fund Source for Constructing Expressways in the Remote Regions

- In the case of "Expressway Authority Scheme" with Japanese ODA as the fund source, more than USD 1,000 million is expected to be accumulated as the surplus of toll revenue after the ODA loan is amortized. This surplus of toll revenue can be used as the fund source for constructing the expressways in the remote regions.

15.2 Recommendation

(1) Project Scheme

- In view of its urgency, the Project should be started as early as possible.
- The scheme where the Expressway Authority is established under MPWT and implement the Project is recommended because of its various advantages.
- In order to use the surplus of toll revenue for constructing the expressways in the remote regions, introduction of "toll revenue pooling system" is recommended. Expressway Authority scheme is suitable for effective use of the toll revenue pooling system where the surplus of toll revenue needs to be smoothly transferred to construction of new expressways.
- It is recommended that the Project be implemented with a financial assistance of Japanese ODA loan.
- In view of the large amount of the required fund and the complexity of funding, the Government of Cambodia is recommended to consult JICA for funding scheme and detail conditions of the ODA loan for the Project.

(2) Project Implementation

- This report was prepared based on the various surveys and studies as well as discussions between the various stakeholders, including MPWT and the relevant institutions of Cambodia, JICA, JICA's Advisory Committee on Environmental and Social Considerations, and the Survey Team. It contains the subjects which needs due attention during the detailed design, tendering and construction stages. These subjects need to be properly incorporated in the detailed design and construction supervision.
- Resettlement of affected people and structures and land acquisition should be conducted as proposed in Chapter 14 of this report. Likewise, environmental mitigation and environmental monitoring should be implemented as proposed in this report.
- New legislation is necessary in order to effectively implement and operate the Phnom Penh – Bavet Expressway. Such legislation includes Law for toll road, National Expressway Law, Law for establishment of Expressway Authority, Road Traffic Law (Revision).
- It is recommended to establish an Expressway Authority under MPWT which shall be exclusively responsible for construction and operation of the expressway network in Cambodia.

(3) Capacity Building

- In view of the difficulty and complexity associated with the implementation of the Phnom Penh-Bavet Expressway Project, considerable effort is necessary for the Government of Cambodia to build the institutional capacity for construction and operation of the said expressway.
- Japan has a rich experience in all phases of expressway network development such as planning, funding, designing, constructing, operating and maintaining the expressway. Japan also has a long history of extending technical cooperation for expressway development to Asian countries. It is therefore recommended that MPWT request technical cooperation from the Japanese Government (JICA) to develop its capacity.