PREPARATORY SURVEY FOR NATIONAL ROAD NO. 5 REHABILITATION PROJECT IN THE KINGDOM OF CAMBODIA

FINAL REPORT

OCTOBER 2012

JAPAN INTERNATIONAL COOPERATION AGENCY

KATAHIRA & ENGINEERS INTERNATIONAL

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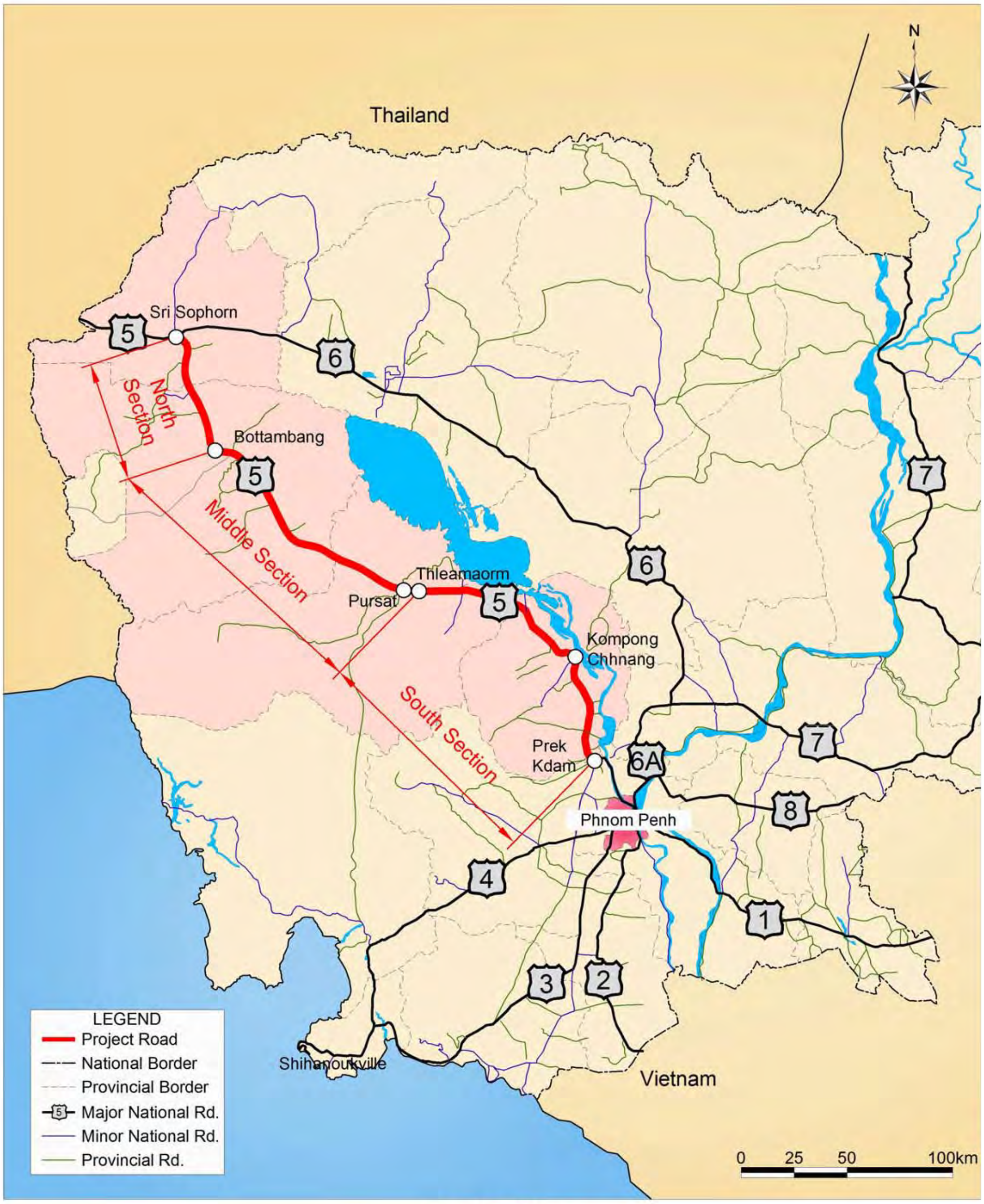


Location Map

** The name of the city of 'Sisophon' was officially changed to 'Serei Saophoan' after this Survey had started, and finally to 'Sri Soporn' during the loan processing. In preparing the Final Report, the Survey Team corrected from 'Sisophon' to 'Sri Sophorn' as much as possible. However, there may still remain the word 'Sisophon' and 'Serei Saophoan'. The readers are kindly requested to interpret that 'Sisphon', 'Serei Saophoan' and 'Sri Sophorn' refer the same city.*

SUMMARY

1. Outline of the Project

- The Project consists of three components:
  - (i) Widening Battambang – Sri Sophorn Section (47.0km) of National Road No. 5 (NR 5) into 4 lanes
  - (ii) Construction of Battambang Bypass (23.1km) and Sri Sophorn Bypass (13.4km) as 2-lane roads.

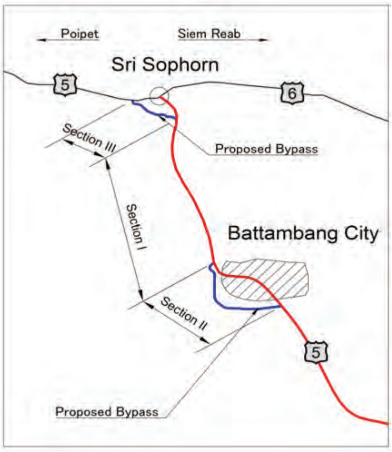


Figure 1 Project Road

2. Objective of the Preparatory Survey

- Objectives of the Preparatory Survey are twofold:
  - (i) Evaluate the current conditions of the North, South and Middle Section (see the Location Map) and evaluate the priorities for improvement.
  - (ii) Prepare the data and information required for appraisal of loan project.

Figure 2 Location Map

3. Importance of National Road No. 5

- NR 5 plays important role in Cambodia and ASEAN:
  - NR 5, together with NR 1, constitutes a part of ASEAN Highway No. 1 connecting Bangkok – Phnom Penh – Ho Chi Minh City.
  - This corridor is called ‘Southern Economic Corridor of GMS (Greater Mekong Sub-region).
  - Improvement of NR 5 is expected to contribute to development of cooperation in GMS as well as development of socio-economic activities in Cambodia.

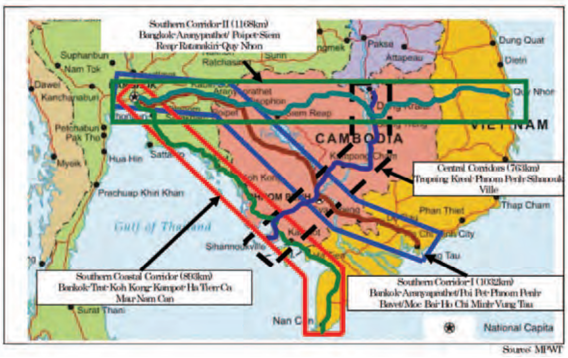


Figure 3 GMS Economic Corridor

4. Existing Conditions of NR 5 and Its Problems

- The existing NR 5 is 2-lane road which imposes hazardous traffic condition.
- Pavement is DBST which is vulnerable to heavy traffic and cannot support growing economic activities.
- Fragile pavement is also imposing the Government of Cambodia heavy financial burden of maintenance.
- Inundation frequently occurs and hampers smooth and stable transport.

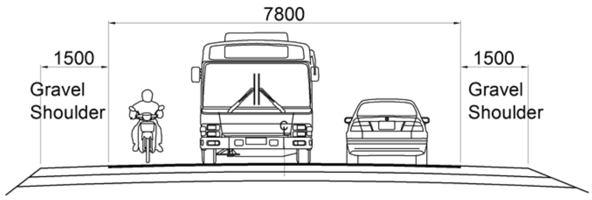


Figure 4 Typical Cross Section of North Section

Figure 5 Hazardous Traffic Condition

Figure 6 Damaged Pavement

5. Future Traffic Demand

- Future traffic demand on NR 5 was forecasted based on the results of surveys on current traffic characteristics and future economic growth.
- Vehicle registration is estimated to reach around 6.5 million in Year 2030 owing to rapid economic growth of Cambodia.
- Traffic volume on the North, Middle and South Sections are estimated as shown in Table 1.
- Traffic volume in Year 2030 exceeds traffic capacity on the North Section and approaches to the capacity on the South Section.

Table 1 Estimated Traffic Volume

(Unit: pcu)

Section	Year			
	2011	2016	2021	2030
North	8,453	12,356	17,812	25,540
Middle	6,071	8,232	11,368	15,899
South	8,644	11,519	15,735	21,164

6. Priority of North, Middle and South Sections for Improvement

- Road widths of North Section and South Section are similar with each other while the road width of Middle Section is slightly wider than those of North and South Sections.
- Urgent repair of the South Section is on-going under financial assistance of ADB (RAMP).
- Considering mainly the urgent repair of RAMP, the priority of the North Section is evaluated to be higher than that of the South Section, although the both sections needs to be urgently improved.

7. Priority of Bypass

- Battambang Bypass and Sri Sophorn Bypass are evaluated to have higher priority than Kampong Chhnang Bypass since from viewpoint of continuity of traffic flow and the project implementation/ supervision.

8. Study of Bypass Route

(1) Battambang Bypass

- Six alternative routes were studied for Battambang Bypass.
- Alternative routes were evaluated mainly from viewpoints of number of houses/household to be relocated, impact to natural environment of especially Tonle Sap Lake and Tonle Sap River, and future urban development, as well as traffic flow.
- After consultation among MPWT, Provincial Government of Battambang, affected people and JICA Study Team, Alternative JICA-1 was selected as the most preferable route.
- After further study and consultation the route as shown in Figure 8 was finally selected.

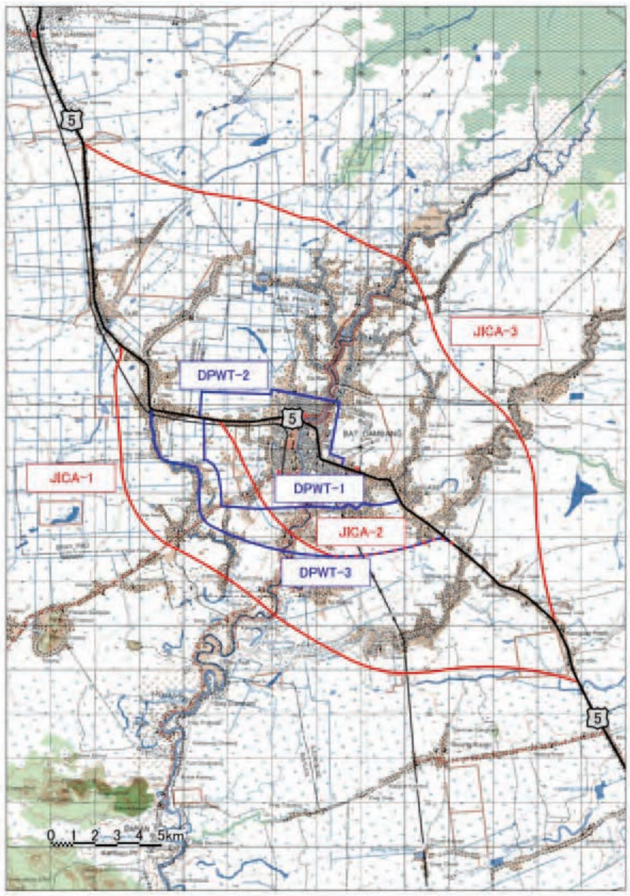


Figure 7 Alternative Routes of Battambang Bypass

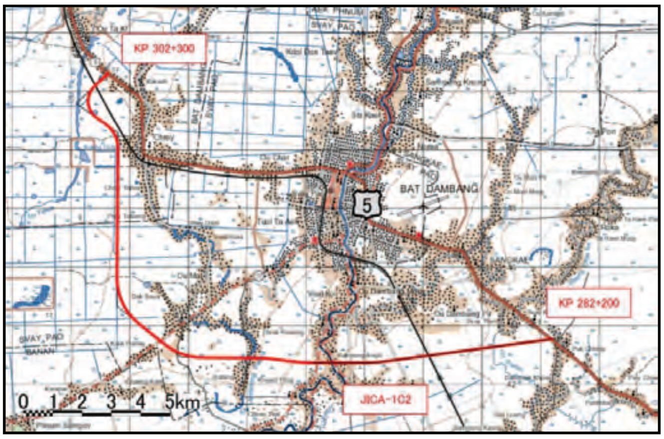


Figure 8 Finally Selected Route of Battambang Bypass

(2) Sri Sophorn Bypass

- Sri Sophorn Bypass was planned to avoid resettlement of people in the city of Sri Sophorn.
- Alternative routes as shown in Figure 9 were evaluated.
- With consultation among MPWT, Provincial Government of Banteay Meanchey, and JICA Team, Alternative JICA-3 was adopted.

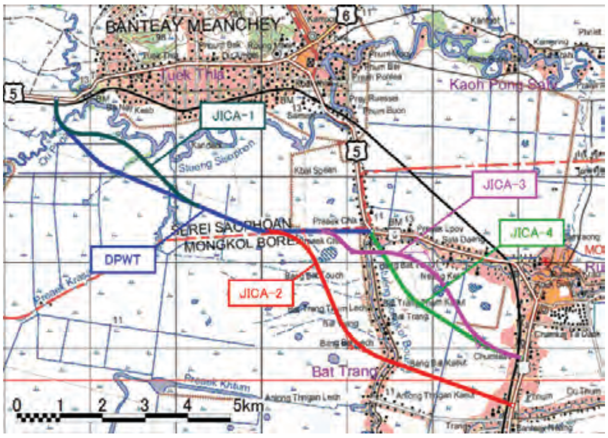


Figure 9 Alternative Routes of Sri Sophorn Bypass

9. Design of Widening of North Section and Bypasses

(1) Design of Widening of North Section

- Three alternatives of cross section were studied
  - (i) Full 4-lane with 3m-wide median division and 3m-wide paved shoulder,
  - (ii) 4-lane with 0.5m-wide median and 3m-wide gravel shoulder
  - (iii) Opposed 2-lane plus slow vehicle lanes of 2.5m wide on the both sides
- In the all alternatives, 2.5m-wide parking space was planned in urbanized sections.
- The above alternatives were compared from viewpoints on the following aspects:
  - (i) Standard of ASEAN Highway and Cambodian Road Design Standards
  - (ii) Traffic Capacity
  - (iii) Traffic Safety
  - (iv) Resettlement and other social impacts
  - (v) Project Cost
- After many discussions between MPWT, MEF, JICA and JICA Survey Team, Alternative (ii) was selected. Figures 10 and 11 shows typical cross section for rural and urbanized section, respectively.
- Figure 12 shows perspective view of the widened NR 5.

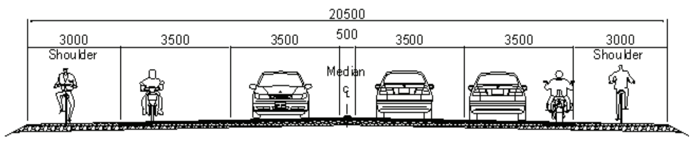


Figure 10 Adopted Typical Cross Section of Rural Section

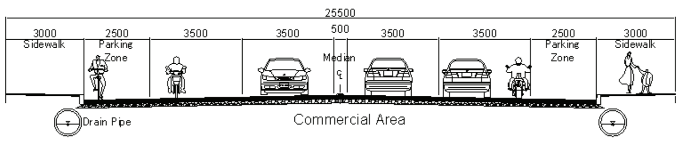


Figure 11 Adopted Typical Cross Section of Urban Section

Figure 12 Perspective View of Widened NR 5

(2) Design of Bypass

- Considering the estimated traffic which will divert to the bypasses, opposed 2-lane cross section was proposed by the JICA Survey Team and was agreed among MPWT, MEF and JICA.
- Same cross section is to be used in both Battambang and Sri Sophorn Bypasses considering the estimated traffic volumes.
- Figure 13 shows the adopted typical cross section of bypasses.

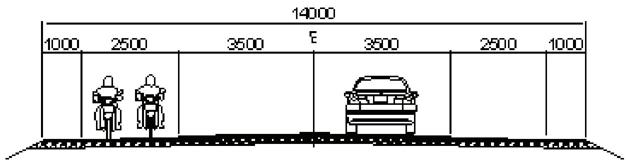


Figure 13 Typical Cross Section of Bypasses

10. Project Cost

- Project cost is estimated as shown in Table 2.

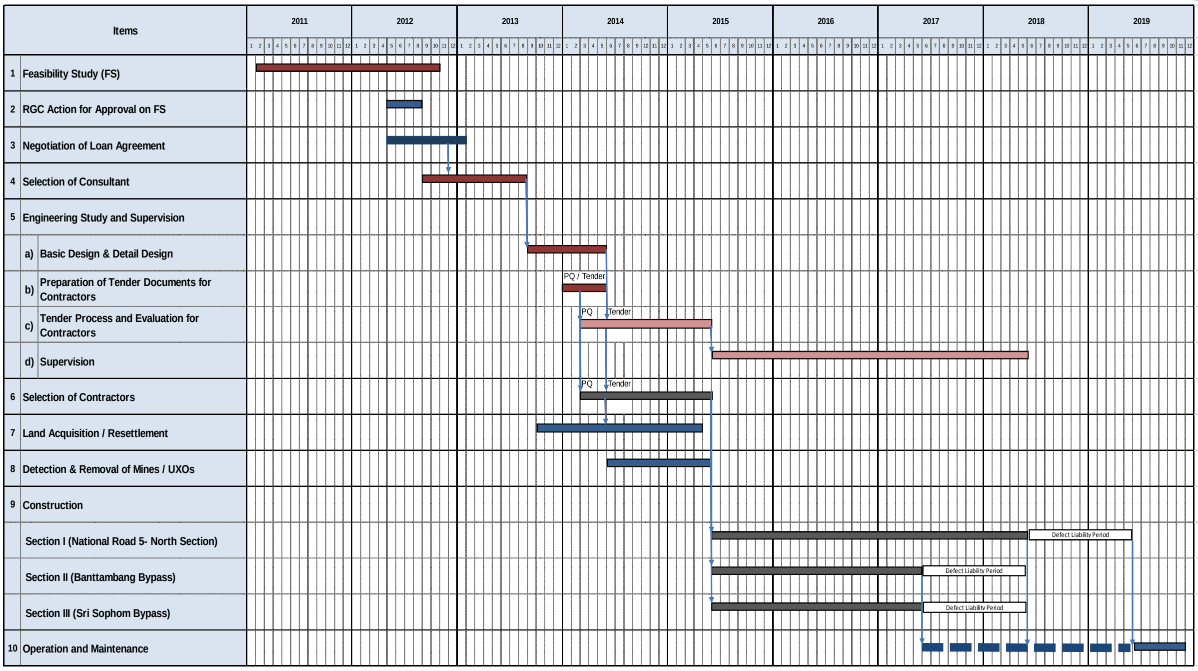
Table 2 Estimated Project Cost

Items		Amount (USD million)	Items		Amount (USD million)
JICA Portion			**RGC Portion**		
1-1	Construction cost		2-1	Land Acquisition and Resettlement Cost	6.3
	Section I (North Section of NR 5)	42.3	2-2	Utilities Relocation / Removal / Protection Cost	4.1
	Section II (Battambang Bypass)	23.8	2-3	Detection and Removal Cost of Mines and UXOs	0.3
	Section III (Sri Sophorn Bypass)	15.1	2-4	Price Escalation	0.7
	Total of Construction Cost	81.2	2-5	Contingency	0.5
1-2	Consulting Services	8.1	2-6	Employer's Administration Cost	2.0
1-3	Price Escalation for above	13.1	2-7	Taxes	11.8
1-4	Contingency	9.7			
	Total of Project Cost (JICA Portion)	**112.1**		**Total of Project Cost (RGC Portion)**	**25.7**
Grand Total			**137.8**		

11. Implementation Schedule

- Table 3 shows the Implementation Schedule. The Project is expected to be completed in Year 2018, if the procedures of procurement consultant for detailed design and construction supervision will be started in September 2012.

Table 3 Implementation Schedule



12. Project Evaluation

- Based on the improvement of traffic condition and estimated traffic cost, economic internal rate of return (EIRR) and other economic indicators were calculated as shown in Table 4.
- Sensitivity analysis shows that even in the most unfavorable scenario with 10% increase in the Project cost and 10% decrease in the benefit, EIRR is calculated to be 20.2%.
- With EIRR larger than 20%, the project is evaluated to be economically viable.

Table 4 Economic Parameters

Indicator	Result
EIRR (%)	22.4
B/C	3.08
NPV （USD Million）	147.86

Table 5 Sensitivity Analysis

Case	EIRR
Base Case	22.4
Investment Cost +10%	21.3
Benefit -10%	21.2
Investment Cost +10%, Benefit -10%	20.2

13. Environmental and Social Consideration

- According to the Cambodian legislations on EIA, EIA is not required for the Project since the total length of Project road is less than 100km.
- However, the project is anticipated to require large number of resettlement of families and preparation of EIA report and Resettlement Action Plan (RAP) are required according to the JICA's Guidelines for Environmental and Social Consideration'.
- EIA report and RAP were prepared by MPWT with assistance of JICA Survey Team and were submitted to JICA.
- Preliminary survey on Affected Households (AHs) showed that 2,265 households are affected.
- In the stakeholder meetings, there were very few opinion of oppositions to resettlement for the Project.

Table 6 Affected Households

Province	No. of AHs by Section			Total (AHs)
	National Road 5	BTB Bypass	BMCH Bypass	
Banteay Meanchey Province	**644**	**0**	**150**	**794**
Mongkol Borei District	644	0	108	752
Krong Sri Sophorn	0	0	42	42
Battambang (BTB) Province	**964**	**507**	**0**	**1,471**
Thma Koul District	964	107	0	1071
Krong Bat Dambang	0	235	0	235
Sangkae District	0	165	0	165
Total (the Project)	**1,608**	**507**	**150**	**2,265**

14. Conclusion and Recommendation

(1) Conclusion

- Improvement of Battambang – Sri Sophorn Section of Natinal road No. 5 and construction of Battambang Bypass and Sri Sophorn Bypass are justified considering the following aspects:
  - There is no strong opposition to the Project among the stakeholders, including the people who are anticipated to be relocated.
  - The Project is expected to yield economic benefit such as EIRR of 22%
  - No significant adverse impact on natural and living environment of the Project Area is anticipated.

(2) Recommendation

- Improvement of Battambang – Sri Sophorn Section of NR 5 and construction of Battambang Bypass and Sri Sophorn Bypass is recommended to be implemented.
- MPWT is recommended to employ competent consultants for the consultat services of detailed design/assistance for procurement of civil works/construction supervision to minimize risks possible to occur during construction.
- MPWT is recommended to request to JICA for technical assistance for implementation of Yen loan project.
- Survey on improvement of Prek Kdam – Thlea Ma'am Section and construction of Kampong Chhnang Bypass need to be urgently studied.

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LIST OF ABBREVIATIONS (1/2)

AC	: Asphalt Concrete
ADB	: Asia Development Bank
AP	: Affected People
ASEAN	: Association of South East Asian Nations
BC	: Beginning Curve
Br	: Bridge
CBR	: California Bearing Ratio
COM	: Council of Ministers
CRIP	: Cambodia Road Improvement Project
CS	: Construction Stage
DBST	: Double Bituminous Surface Treatment
DE	: Department of Environment
DEIA	: Department of Environmental Impact Assessment
DPWT	: Department of Public Works and Transport
EC	: End Curve
EFRP	: Emergency Flood Rehabilitation Project
EIA	: Environmental Impact Assessment
GDP	: Gross Domestic Product
GMS	: Grater Mekong Subregion
HV	: Heavy Vehicle
IEIA	: Initial Environmental Impact Assessment
IG	: Welded Steel Plate I Girder
IP	: Intersection Point
IRC	: Inter-Ministerial Resettlement Committee
Jct.	: Junction
JICA	: Japan International Cooperation Agency
kN	: kilo Newton
KP	: Kilometer Post
LV	: Light Vehicle
MAFF	: Ministry of Agriculture, Forestry and Fisheries
MC	: Motor Cycle
MEF	: Ministry of Economic and Finance
MLMUPC	: Ministry of Land Management, Urban Planning and Construction
MOC	: Ministry of Commerce

LIST OF ABBREVIATIONS (2/2)

MOE	: Ministry of Environment
M/P	: Master Plan
MPWT	: Ministry of Public Works and Transport
MRC	: Mekong River Commission
N.A.	: Not Applicable
NGO	: None Governmental Organization
NR	: National Road No.
OD	: Origin Destination
ODA	: Official Development Assistance
PAP(s)	: Project Affected Person(s)
PC	: Pre-stressed Concrete
PCDG	: Pre-tensioned Precast Concrete Deck Girder
PCS	: Pre-tensioned Precast Concrete Plank hollow Slab
PCU	: Passenger Car Unit
PMO	: Prime Minister's Office
PRC	: People's Republic of China
PRRP	: Primary Roads Restoration Project
PS	: Planning Stage
RAMP	: Road Assets Management Project
RAP	: Resettlement Action Plan
RC	: Reinforced Concrete
RCA	: Reinforced Concrete Arched Rib
RCDG	: Reinforced Concrete Deck Girder
RCS	: Reinforced Concrete Flat Slab
RGC	: Royal Government of Cambodia
ROW	: Right of Way
SBST	: Single Bituminous Surface Treatment
SHMs	: Stakeholder Meetings
SPT	: Standard Penetration Test
SS	: Service Stage
STRADA	: System for Traffic Demand Analysis
USDA	: United States Department of Agriculture
VCR	: Traffic Volume per Capacity Ratio

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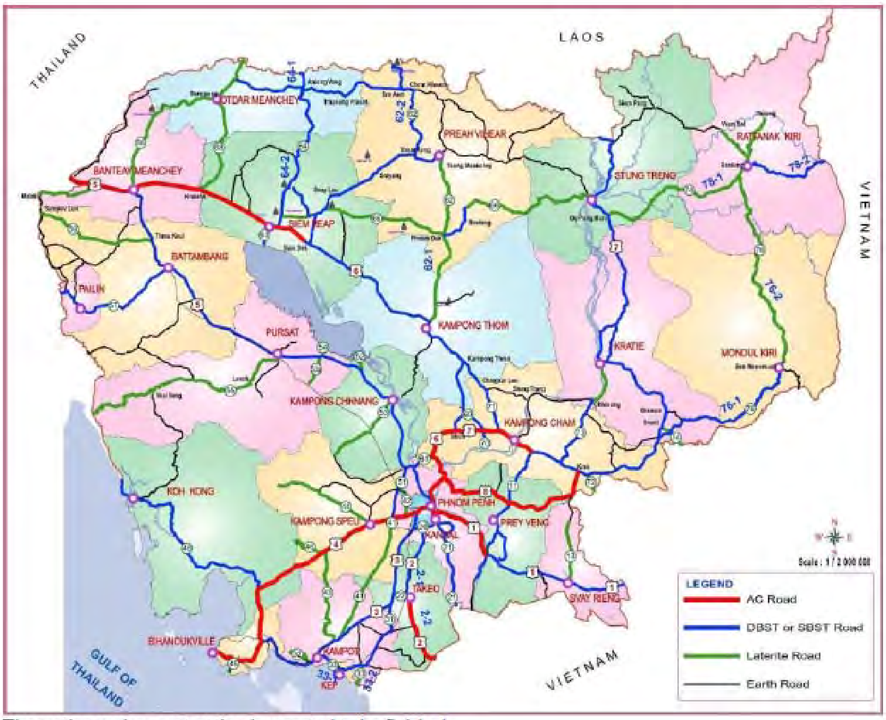
CHAPTER 1 INTRODUCTION

1.1 Background

In the Kingdom of Cambodia ("Cambodia"), the road transport accounts for around 65% of the passenger transport, for 70% of the freight transport, and plays the most important role in the domestic transport. However the most of the roads were severely deteriorated during the civil war in the 70's to 80's. Since the early 90's Royal Government of Cambodia (RGC) has been exerting strenuous effort on rehabilitation of the road network with the assistance of Japan, the United States, Australia, Asian Development Bank ("ADB") and Word Bank.

National Road No. 5 (NR 5) is the trunk road reaching Bangkok through the border between Cambodia and Thailand. It is also designated as Asian Highway A-1 or Southern Economic Corridor of GMS. The Survey Roads was damaged by the flood in 2000, and the section between Prek Kdam and Thlea ma'Am and the section between Battambang and Sri Sophorn have been temporarily repaired.

The repairs mentioned above mostly adopted DBST and the surface condition is being deteriorated, and the traffic flow has been hampered. Improvement of Southern Economic Corridor is in urgent need as known from the fact that it was designated as one of the prior projects in the 'Study on the Road Network Development in the Kingdom of Cambodia' (Master Plan Study), implemented by JICA in 2006.



Note: The section under construction is assumed to be finished

Source: MPWT

Figure 1.1-1 Surface Condition of National Roads in Cambodia (As of 2010)

Under such condition, JICA dispatched a survey team to Cambodia in November, 2010, held a series of discussions and reached agreement about a scope of the Preparatory Survey.

This Preparatory Survey (the Survey) is implemented, in view of the background as sited above, to obtain data and information required for appraisal of loan project of Japanese ODA, such as preliminary design, project cost, implementation plan, and natural and social impacts.

1.2 Objectives of the Survey

(1) The objective of the Project: The objectives of National Road No. 5 Rehabilitation Project (the Project) are as follows.

- To ensure safe and smooth means of transport
- To promote economic activity in the area along the Project Road.

(2) Objective of the Survey: The objectives of the Survey are as follows.

- To confirm the justification of the Project
- To obtain data and information required for appraisal of a loan project.

1.3 Survey Area

The Survey is to cover the section of National Road No. 5 between Prek Kdam and Sri Sophorn* (length: approximately 337 km). This road section traverses the provinces of; Kandal, Kampong Speu, Kampong Chhnang, Pursat, Battambang, and Bantey Meanchey,

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1.4 Scope of Work

The original Scope of Work of the Survey as follows:

(1) Confirmation of the Scope of the Work

(2) Investigation and Evaluation of Existing Facilities

(3) Traffic Survey and Future Traffic Demand Forecast

(4) Aerial Photo Survey and Digital Mapping

(5) Geotechnical Investigation

(6) Environmental and Social Considerations Study, including support to MPWT in preparing EIA report and RAP and holding stakeholders meetings

(7) Evaluation of Priority Section

(8) Comparative Study of Bypass Route (around the cities of Kampong Chhnang and Battambang)

(9) Topographic Survey

(10) Preliminary Design of Roads and Bridges

(11) Project Cost Estimation and Economic Evaluation

(12) Project Implementation Plan

In the 2nd Steering Committee held on 30 August 2011, study on Sri Sophorn Bypass was requested by the Cambodian side and JICA accepted this. Thus, the study on Sri Sophorn Bypass was added to the scope.

1.5 General Works Schedule

Due to the addition of Sri Sophorn Bypass to the scope, as sited above, the schedule of the Survey was revised. Table 1.5-1 shows the general schedule of the Survey after the revision:

Table 1.5-1 General Schedule of the Survey

TASK / WORK ACTIVITY	2012											2012									
	February	March	April	May	June	July	August	September	October	November	December	January	February	March	April	May	June	July	August	September	October
1. Analysis in Japan I																					
2. Study in Cambodia I																					
Explanation and Discussion of Inception Report																					
Confirmation of Scope of the Project																					
Review of Needs of the Project																					
Site Survey																					
Transport Demand Forecasting																					
Natural Condition Survey																					
Aerial photo survey																					
Geotechnical Investigation					(Digital Mapping)																
Analysis of the pavement condition																					
Traffic Survey																					
Environmental and Social Consideration Survey																					
Study of the Project Road																					
Preparation, Explanation and Discussion of Interim Report																					
3. Analysis in Japan II																					
Justification of the Project																					
The Environmental and Social Consideration Advisory Committee																					
Planning of the Second Study in Cambodia																					
4. Study in Cambodia II																					
Explanation of the Second Survey in Cambodia																					
Topographical Survey (Bypass Section)																					
Study of Road Alignments																					
Study of Bypass Plan																					
Study of Bridge Location and Structure																					
Environmental and Social Consideration Survey																					
Preparation and Explanation of Progress Report																					
Preliminary Design of Road and Bridge																					
Preparation of Road Safety Plan																					
Preparation of Implementation System, Operation and Maintenance																					
Review of Execution Scheme																					
Cost Estimation and Object Loan Project Cost																					
Monitoring Plan of Project Effect																					
Project Implementation Plan																					
Preparation of Preliminary Draft Report																					
5. Analysis in Japan III																					
Study of Serei Saophoane Bypass																					
Planning of the Third Study in Cambodia																					
6. Field Survey III (Serei Saophoane Bypass)																					
Explanation of the Second Survey in Cambodia																					
Study of Bypass Plan																					
Topographical Survey (Bypass Section)																					
Traffic Survey																					
Transport Demand Forecasting																					
Geotechnical Investigation																					
Environmental and Social Consideration Survey																					
Preliminary Design of Road and Bridge																					
Cost Estimation and Object Loan Project Cost																					
Monitoring Plan of Project Effect																					
Project Implementation Plan																					
7. Analysis in Japan IV																					
Preparation and Submission Draft Final Report																					
The Second Environmental and Social Consideration Advisory Committee																					
8. Field Survey IV																					
Explanation and Discussion of Draft Final Report																					
9. Analysis in Japan V																					
Discussion and Preparation of Final Report																					

Remark : Cambodia Japan Discussion and Exposition of Report

1.6 Organization of the Survey

The organization of the Survey is shown in Figure 1.6-1.

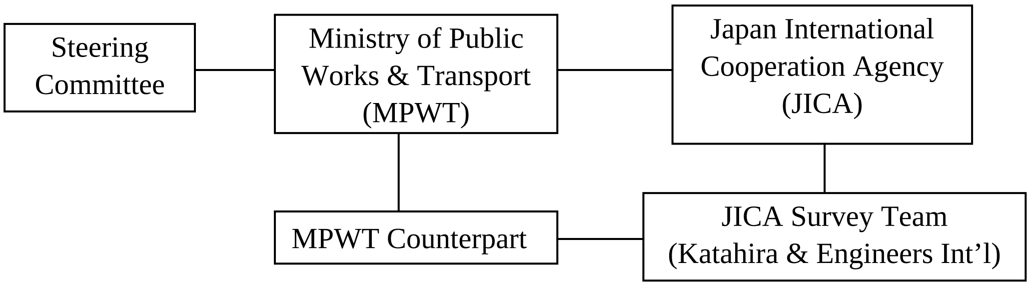


Figure 1.6-1 Organization of Survey

Members of the Steering Committee are the representatives of relevant organization of Cambodia, JICA and the Survey Team. Table 1.6-1 shows the member of the Steering Committee.

Table 1.6-1 List of Steering Committee Member

Organization	Steering Committee Member	Remarks
Ministry of Public Works & Transport (MPWT)	Secretary of State (HE Tauch Chankosal)	Chair Person
	Director General of Public Works (HE Kem Borei)	
	Director of International Cooperation (Mr. Chhim Phalla)	
	Deputy Director of Intnt'l Coop. (Mr. Kong Sophal)	
Ministry of Economy & Finance (MEF)	Representative of Department of Resettlement Department	
Ministry of Environment (MOE)	Representative of	
Banteay Meahchey Province	Director of DPWT (or his representative)	
Battambang Province	Ditto	
Pursat Province	Ditto	1st S/C only
Kampong Chhnang Province	Ditto	Ditto
Kandal Province	Ditto	Ditto
JICA	Sr. Representative, Cambodia Office (Mr. HIRATA Hitoshi)	
	Representative, Cambodia Office (Mr. MORIHATA Shigo: Up to May 2011) (Mr. EGAMI Masahiko: From June 2011)	

At the headquarter of JICA in Tokyo, Mr. KIMURA Hiroshi (up to May 2011) and Mr MIYAKE Shigeaki (from June 2011), Directors of Transport & ICT Division 2, Economic Infrastructure Department, Mr. OSHIRO Nodoka (up to June 2011) and Mr. FUKUI Takanori (from July 2011), Deputy Directors of Transport & ICT Division 2, Economic Infrastructure Department were in charge of administration of the Survey.

The members of JICA Survey Team are as listed in Table 1.6-2.

Table 1.6-2 Team Member List

No.	Name	Job Title	Firm
1	SAKURAI Tatsuyuki	Team Leader/Road Traffic Plan	Katahira & Engineers International
2	MURAKAMI Keiichi	Deputy Team Leader/Road Design	Katahira & Engineers International
3	ANTHONY GOURLEY	Road Structure Plan	Katahira & Engineers International
4	YASHIRO Shuichi	Traffic Survey/Demand Forecast / Economic Analysis	Katahira & Engineers International
5	TAKEUCHI Ryouji	Natural Condition Survey / Environnement Consideration	Katahira & Engineers International
6	SAITO Kumi	Social Consideration	Katahira & Engineers International (Seconded from Nippon Koei)
7	YAMAUCHI Masafumi	Construction Plan/Cost Estimation	Katahira & Engineers International
8	TOCHINAKA Masateru	Project Coordination/Road Designing Assistant	Katahira & Engineers International

CHAPTER 2 PROFILE OF THE SURVEY AREA

2.1 Physical Profile

(1) Geography

NR 5 starts from Phnom Penh and traverses the southwest side of Tonle Sap River and Tonle Sap Lake up to Battambang. Between Battambang and Sri Sophorn, it passes through the upstream area of Tonle Sap Lake and finally reaches the border with Thailand. The distance between the city of Sri Sophorn (the north end of the Survey Section) and Poipet (the border point with Thailand) is approximately 50km and distance between Poipet and Bangkok in Thailand is approximately 250km. Thus, NR 5 becomes the main transport route between Phnom Penh and Bankgkok.

Figure 2.1-1 Location of NR 5

(2) Topography

The ground height along the NR is, in general, around 10m above sea level or less except at some sections passing low hills as shown in Figure 2.1-2 [Also see Figures 7.1-2 (1) – (3)].

Thus, the terrain along NR 5 is generally flat.

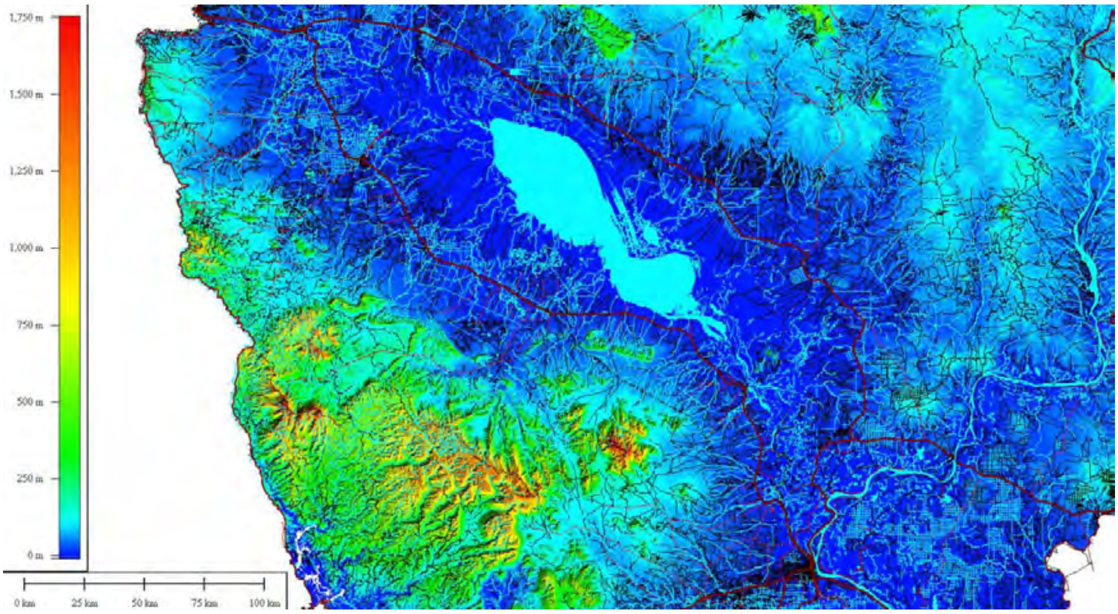


Figure 2.1-2 Topography of Survey Area

(3) Meteorology

Climate of Cambodia is influenced by the Asian Monsoon and the climate can be described as 'hot and humid' in general. Figure 2.1-2 shows annual rainfall in Cambodia. It shows that the annual rainfall of the Survey Area is in the range of 1,200 – 1,600mm/yr.

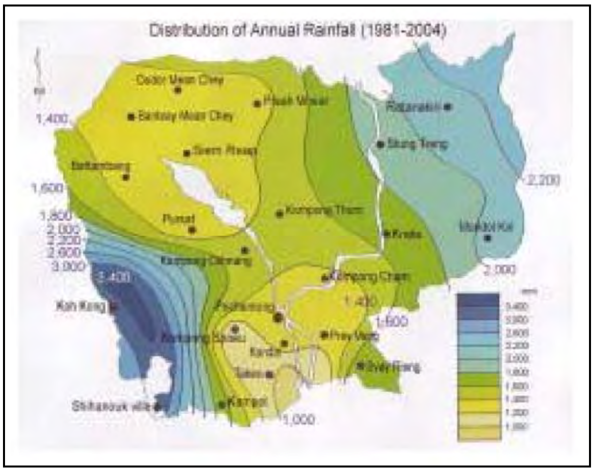


Figure 2.1-3 Annual Rainfall

(Quoted from the final report of 'the Study on the Road Network Development in the Kingdom of Cambodia, October 2006, JICA)

Figure 2.1-3 shows the monthly average rainfall and temperature measured at Pochetong, Phnom Penh. It shows that the rainy season is from May to September and dry season is from November to April. It also shows that the monthly average temperature ranges between 25 and 34 degree Celsius.

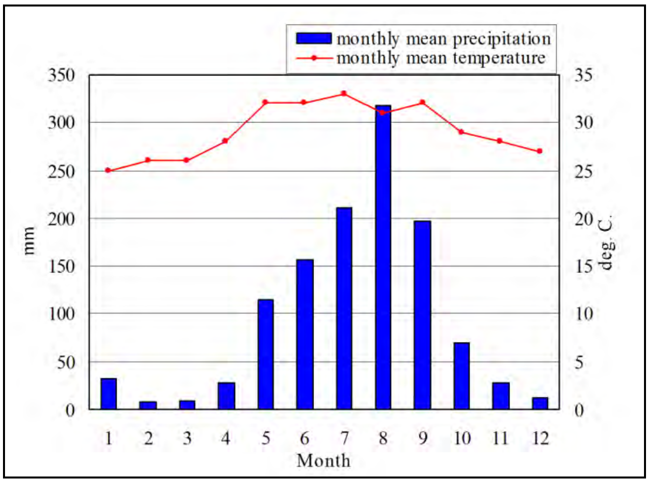


Figure 2.1-4 Average Monthly Rainfall and Temperature
(Quoted from the final report of 'the Study on the Road Network Development in the Kingdom of Cambodia, October 2006, JICA)

Table 2.1-1 shows record of monthly rainfall in Battambang Province in years 2010 and 2011, as an example. June to October are rainy months and December to February are dry months.

Table 2.1-1 Monthly Rainfall in Batttambang Province

(mm)

Year	Month												Total
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
2010	8.3	12.0	25.2	69.9	77.3	121.2	241.9	216.6	193.3	325.2	40.5	8.3	1339.7
2011	0.0	50.8	35.1	152.7	151.5	108.0	186.8	253.2					-

Source: Department of Water Resources and Metrology, BB Province

The condition water of the area is also greatly influenced by the flood of Mekong River and Tonle Sap. The flood of Mekong River and Tonle Sap is discussed in Chapter 6.

Table 2.1-2 shows the temperature of Battambnag Province in years 2010 and 2011. March to May are hot months and October to December are cool months.

Table 2.1-2 Maximum and Minimum Temperaturein Battambang Province in 2010 and 2011

(o C)

	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Max	2010	33.2	35.3	36.1	37.1	36.6	34.6	33.4	32.3	32.1	30.5	30.6	31.1
	2011	30.8	33.6	32.5	33.8	34.0	33.4	33.5					
Min	2010	22.4	24.9	25.2	26.0	27.2	26.3	25.6	25.4	25.5	24.5	23.7	21.7
	2011	20.1	23.2	23.3	25.3	25.8	26.0	25.6					

Source: Department of Water Resources and Meteorology, BB Province *Station: Veal Bek Chan*

2.2 Socio-Economic Profile

Table 2.2-1 summarizes the socio-economic data of the Survey Area, focusing the 4 provinces substantially influenced by the Project.

Table 2.2-1 Socio-Economic Data of Survey Area (4 provinces only)

	Kampong Chhnang	Pursat	Battambang	Banteay Meanchey	Whole Country	Proportion to Whole Country (%)
Population	472,000	397,000	1,025,000	678,000	13,389,000	28.3
Land Area (ha)	552,100	1,269,200	1,170,200	6,67,900	18,103,500	20.2
Rice Field Area (ha)	127,700	95,300	234,100	210,800	2,566,800	17.8
Proportion of Rice Field Area (%)	23.1	7.5	20.0	31.6	14.2	N.A.
Rice Production (ton)	311,500	239,700	567,200	447,200	6,727,100	23.3

Source: Statistical Yearbook of Cambodia 2008

It is noted that the percentage of total population of the 4 provinces against that of the whole country is approximately 28% while the percentage of land area is only 20%. This means that the population density of the Survey area is higher than the national average, implying that the Survey Area is the developed area in Cambodia.

As can be seen in the above table, one of the most important industries in the Survey Area is rice production. Figure 2.2-1 shows the status of rice production of the provinces. In this figure, the provinces which supply rice other provinces are indicated in blue and light blue. In Figure 2.2-1, it is seen that the provinces in the Survey Area are major areas of rice production. This leads to traffic demand for transportation of rice via NR 5.

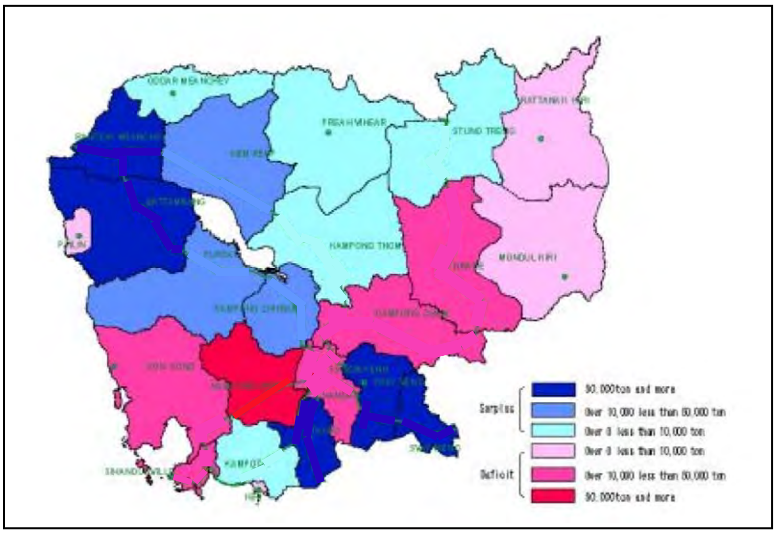


Figure 2.2-1 Rice Production by Province

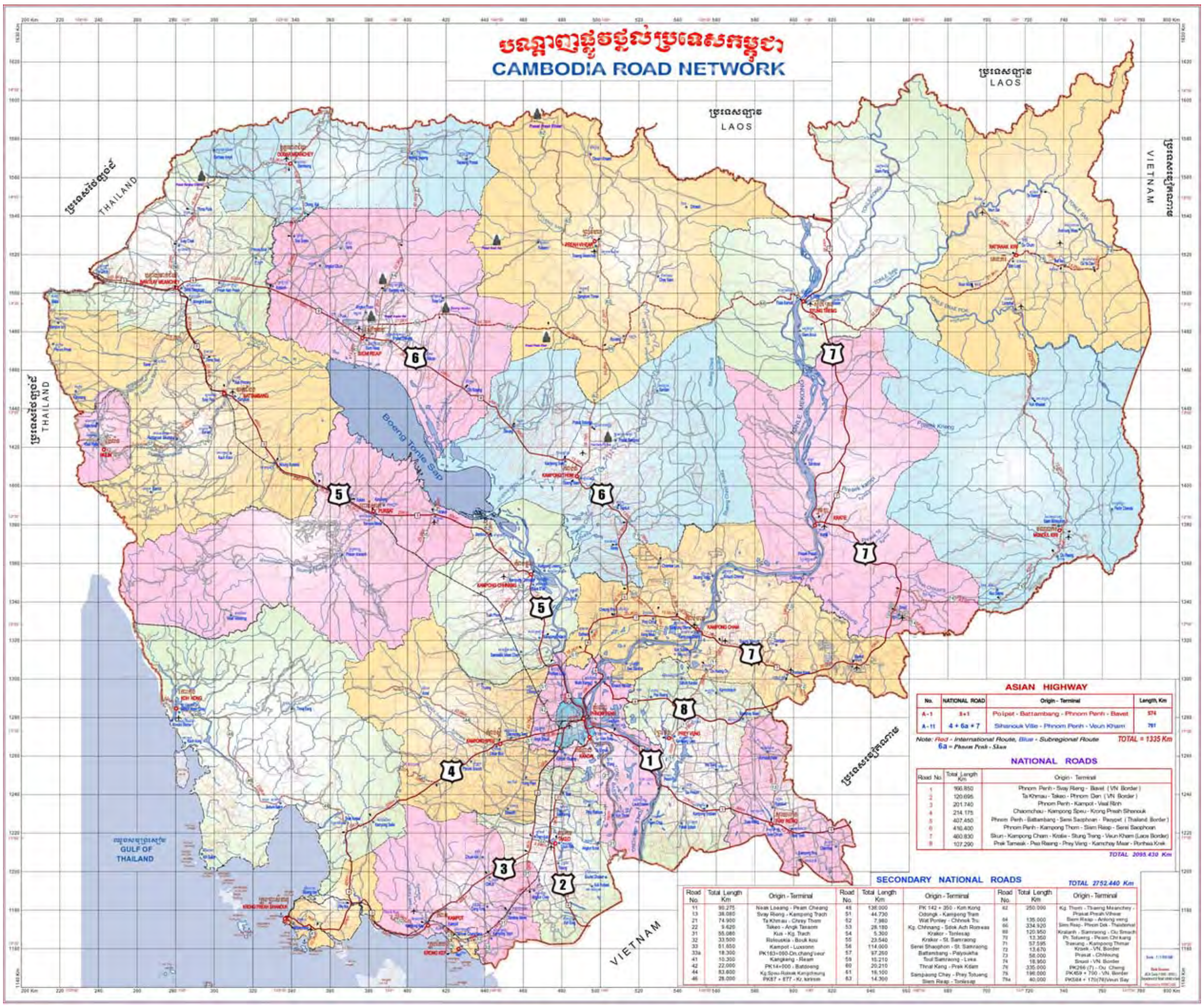
(Quoted from the final report of ‘the Study on the Road Network Development in the Kingdom of Cambodia, October 2006, JICA)

CHAPTER 3 NATIONAL ROAD NETWORK OF CAMBODIA AND ROLE OF NATIONAL ROAD NO. 5

3.1 National Road Network of Cambodia

3.1.1 National Road Network of Cambodia

National Road Network of Cambodia consists of arterial national roads with single digit numbers (1 to 8) with a total length of 2,096km and minor arterial roads with double digit numbers with a total length of 4,848km (as of end of year 2008). Figure 3.1-1 show the map of National Road Network of Cambodia. As can be seen in the figure, most of the arterial national roads of Cambodia is extend in radial directions centered at Phnom Penh and reach to the border points with neighboring countries of Vietnam and Thailand. They are numbered, in principle, in crock-wise direction starting from No. 1.



Source: MPWT

Figure 3.1-1 National Road Network of Cambodia

Table 3.1-1 shows the lengths and routes of arterial (single-digit) national roads.

Table 3.1-1 Length and route of Arterial National Road (As of 2008)

Road No.	Length (km)	Route
1	166.9	Phnom Penh – Bavet (Vietnam border)
2	120.7	Ta Kmau – Takeo – Phnom Den (Vietnam border)
3	201.7	Phnom Penh – Kampot – Veal Rinh
4	214.2	Chaom Chau – Kampong Speu – Krong Prea Sihanouk
5	407.5	Phnom Penh – Battambang – Sri Sophorn – Poipet (Thailand border)
6	416.4	Phnom Penh – Kampong Thom – Siem Reap – Sri Sophorn
7	460.8	Skun – Kamopong Cham – Kratie – Steung Treng – Veum Kham (Vietnam border)
8	107.3	Prek Kdam – Pea Reang – Prey Veng – Kamchay Mear – Ponhhea Krek

3.1.2 Surface Condition of National Road Network

Road network of Cambodia had deteriorated during the period of the civil war which ended in 1992 with signing of peace accord. Many bridges were collapsed and pavements were severely damaged. In 1990s, there were many impassable sections even on arterial national roads. Thus, road rehabilitation in 1990s and early 2000s mainly focused on urgent rehabilitation of arterial roads.

By late 2000s, most of urgent rehabilitation of the arterial roads had been completed. Most arterial national roads were passable and road surfaces were paved with mostly DBST. Further, some sections of arterial roads were paved with asphalt concrete as shown in Figure 1.1-1. By late 2000s, the focus for improving pavement condition had shifted from arterial national roads (single-digit roads) to minor arterial roads (double-digit roads).

However, the pavements of most sections of arterial roads are DBST which does not have sufficient bearing capacity to cater for heavy vehicles. The volume of heavy traffic is rapidly increasing on many roads due to rapid economic growth of Cambodia. This increase in heavy traffic is accelerating deterioration of DBST pavements and imposing heavy financial burden of maintenance to the Government of Cambodia.

Another problem of the existing national road network is insufficient road width or number of lanes. Road widths of most section are 2 lanes. Widths of some sections are even not sufficient for 2 lanes. This situation is resulting in deterioration in traffic safety condition and possible traffic congestions in the near future when traffic volume will increase.

3.1.3 Development Plan

National Strategic Development Plan (NSDP) 2006 – 2010 adopted ‘Rectangular Strategy’ as the very basic strategy/policy for national development. ‘Further Rehabilitation of Physical Infrastructure’ was designated as one of the four components of ‘Rectangular Strategy’. The NSDP was updated in 2008 and issued as ‘NSDP Update 2009 – 2013’, which is currently valid. NSDP Update 2009 – 2013 prescribes ‘Further Rehabilitation and Construction of Transport Infrastructure’ as one of the four sub-components of ‘Further Rehabilitation of Physical Infrastructure’. Then, NSDP Update 2009 – 2013 states ‘Continuing to seek funding for ……(omitted)… the widening of NR 1, NR 4, **NR 5** and NR 6’.

Road network development in Cambodia is planned and implemented basically based on the master plan proposed by ‘the Study on the Road Network Development in the Kingdom of Cambodia’ conducted in 2006 by JICA (M/P Study). In this M/P Study, NR 5 was proposed to be improved to support ‘Multi Growth Pole Development’ and ‘Development of International Corridor’. However, M/P Study proposed widening of NR 5 to 4 lanes between Phnom Penh and Kampong Chhnang and remaining sections were proposed to be 2 lanes.

The M/P Study was updated in 2009 in view of rapid economic growth and increase in vehicle registration in Cambodia, as well as several road improvement project implemented up to date. This update study reiterated the importance of NR 5 but no major change in widening to 4 lanes was proposed.

3.2 Role of National Road No. 5

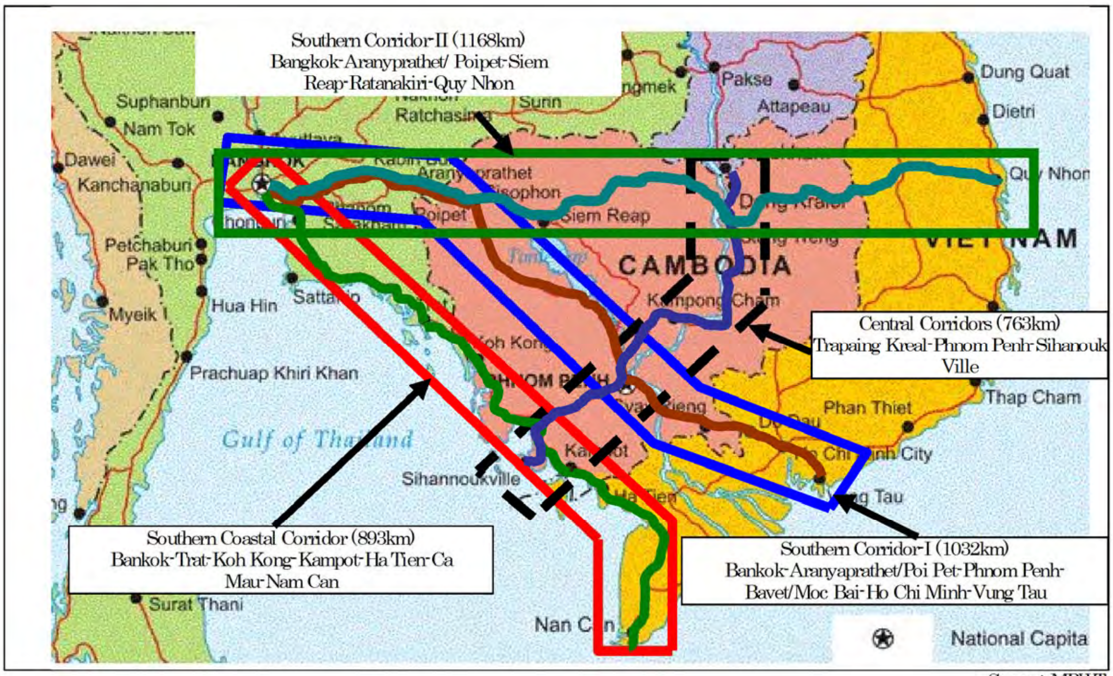
NR 5 is an arterial national road connecting Phnom Penh and Poipet, the border point with Thailand. It traverses provinces of Banteay Meanchey and Battambang whose populations are 3rd and 4th largest in the country. Thus, NR 5 accommodates the traffic needed for the day-to-day activities of the citizens, including access to the public services such as hospital and school, along the highway.

NR 5 also accommodates the traffic transporting goods and passengers between the major cities along the highway, such as Sri Sophorn, Battambang, Pursat, Kampong Chhinang and Phnom Penh. Further it is connected, via Phnom Penh, to National Road No. 1 (NR 1) which reaches to Ho Chi Min City in Vietnam and National Road No. 3 (NR 3) and National Road No. 4 (NR 4) which reach to Sihanoukville, the largest international seaport of Cambodia.

NR 5 is an important highway not only for domestic transport in Cambodia but also for international transport in ASEAN and the Greater Mekong Subregion (GMS). NR 5, together with National Road No. 1 (NR 1), forms a route connecting Bangkok, Phnom Penh and Ho Chi Minh City. Thus, NR 5 has been designated as ASEAN Highway No. 1 and Asian Highway No. 1. With rapid growth in the regional cooperation in GMS in the recent years, the importance of NR 5 is also rapidly growing.

Source: ASEAN Economic Community

Figure 3.2-1 ASEAN Highway



Source: MPWT

Source: Overview on Transport Infrastructure Sectors in the Kingdom of Cambodia, Infrastructure and Regional Integration Technical Working Group, 2010

Figure 3.2-2 Economic Corridors of GMS

Importance of NR 5 as an international transport corridor has been recently increasing due to the development of regional cooperation in GMS, as seen in the signing and ratification of Cross-Border Transport Agreement (CBTA) in 2008:

<u>Cross-Border Transport Agreement</u>

Cross-Border Transport Agreement (CBTA) is a compact and comprehensive multilateral instrument that covers all the relevant aspects of cross-border facilitation including the followings:

- *Facilitation of border crossing formalities (single-window and single-stop custom inspection, coordinating of hours of operation, and exchange of advanced information and clearance)*
- *Facilitate cross-border movement of people (multi-entry visa, recognition of driver license)*
- *Facilitate cross-border movement of goods (regional transit regime)*
- *Exchange of commercial traffic rights*
- *Requirements for admittance of road vehicles*
- *Institutional arrangements*
- *Setting-up custom transits (guaranteeing system)*
- *Coordination on bridge design standards, road signs and signals*

The CBTA is expected to accelerate the regional cooperation in GMS and further increase the importance of NR 5.

CHAPTER 4 PRESENT CONDITION OF NATIONAL ROAD NO. 5

4.1 Physical Condition of National Road No. 5

4.1.1 Overall Conditions

Figure 4.1-1 (a) through (c) show the overall physical conditions of NR 5 in the form of ‘straight line diagram’. This diagram has been prepared based on the information obtained through the site survey conducted from late February to late March 2011.

MPWT is currently installing kilometer posts (KP) along NR 5. The straight line diagram shown in Figure 4.1-1 basically uses this KP. In this diagram, the whole Survey Section of NR 5 is divided into 3 sections; South Section (KP 32 – KP 171), Middle Section (KP 171 – KP 301) and North Section (KP 301 – KP 361).

The criteria for classification of the conditions shown in the diagram are as described below:

Table 4.1-1 Description of Classification for Straight Line Diagram

Item	Classification	Description
Inundation	Overflow Near by None	Overflow on the road surface Water level rose to near but lower than road surface No report of inundation
Drainage	Bad Poor Fine	Water logs remain on the road after rain Water logs are seen at roadside after rain No remaining water on the road or roadside after rain
Pavement	Bad Poor Fair	Function of pavement substantially lost due to occurrence of several types of defects Function of pavement lost to light degree due to occurrence of a few types of defects No major defects observed
Project Affected Persons (PAPs)	Many Few None	Buildings densely located along the roadside Buildings sparsely located along the roadside No building nearby the road
Resettlement	Many Few None	Roadside heavily populated Houses sparsely located close to the road No houses nearby the road

The following subsections describe the conditions of each item.

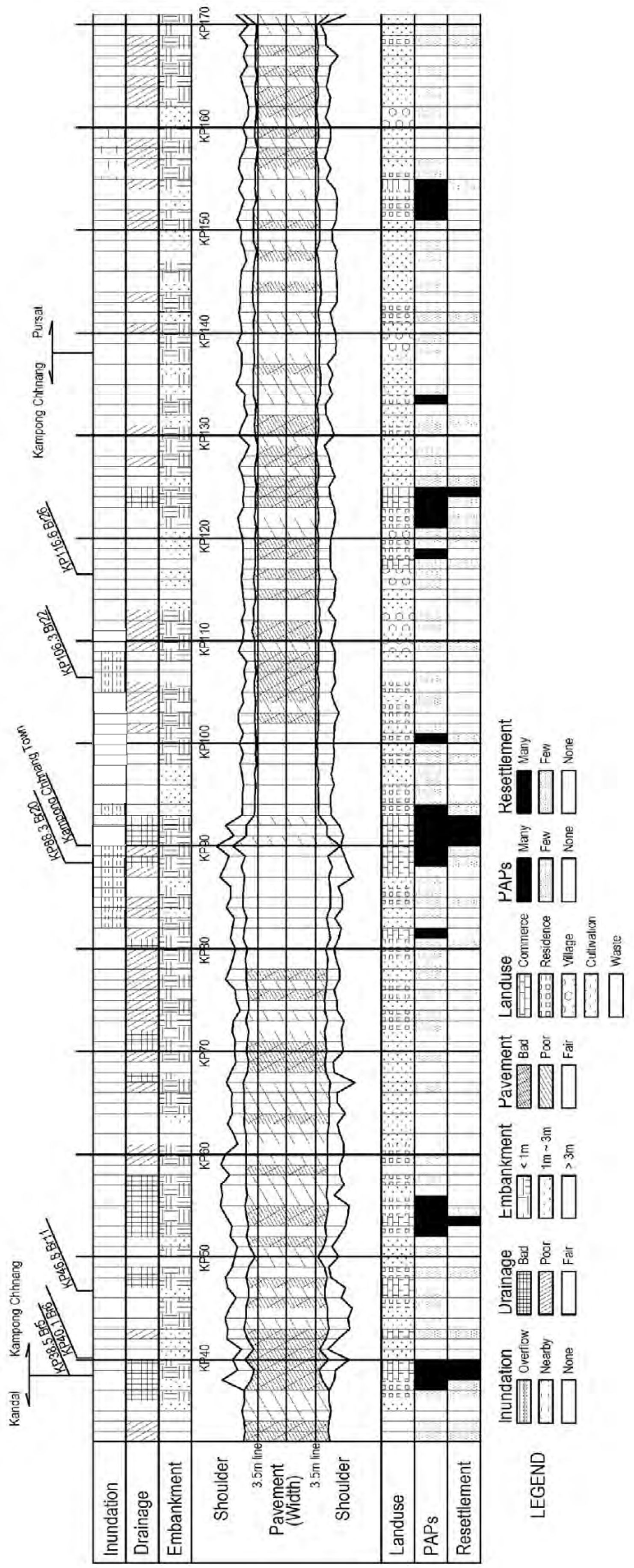


Figure 4.1-1 (a) Straight Line Diagram : South Section (KP 32~KP 171)

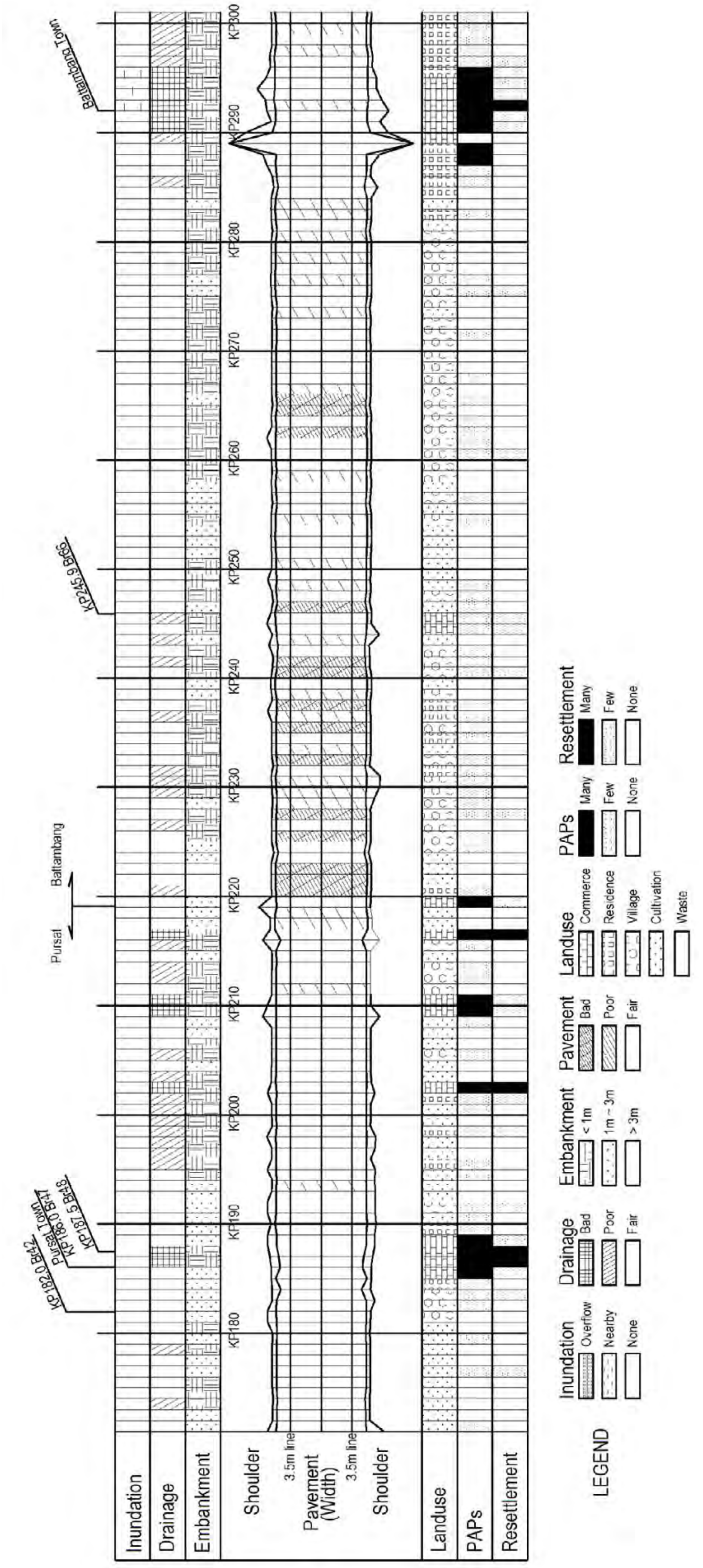


Figure 4.1-1 (b) Straight Line Diagram : Middle Section (KP 171~KP 301)

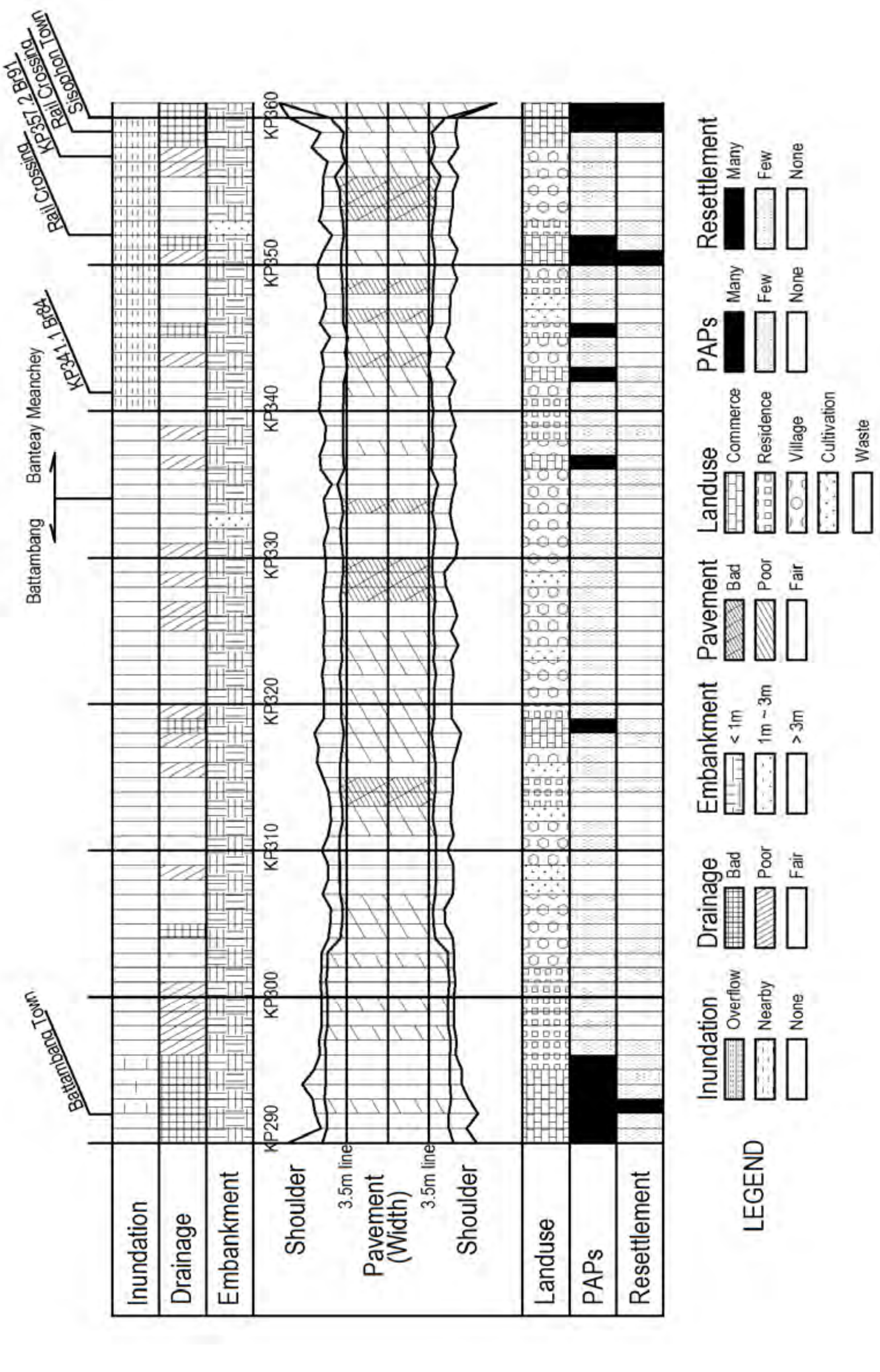


Figure 4.1-1 (c) Straight Line Diagram : North Section (KP 301~KP 361)

4.1.2 Geometric Structure

(1) Horizontal Alignment

Horizontal alignment of NR 5 is generally generous. Where there is a curve, the radius is usually large enough to satisfy the criteria of geometric design of Cambodia. Some sharp curves are found near the major cities such as Oudong, Kamopong Chhnang, Battambang and Sri Sophorn. Improvement of these sharp curves are discussed in Subsection 10.2.3: Horizontal Alignment of Chapter 10.

(2) Vertical Alignment

As NR 5 generally traverses flat terrain, its vertical alignment is also generally flat. Some sections with steep grade are found particularly near the bridges. Whether or not these steep-grade sections satisfy the design criteria will be discussed also in the 2nd Stage of the Survey.

The height of road embankment is another important subject in view of the flood. The table below shows the summary of embankment height. The problem of flood is discussed in Chapter 7.

Table 4.1-2 Embankment Height

Section	Embankment Height	Inundation
South Section	-0.3 ~ 5.0m	Some sections in 2002&04
Middle Section	-0.3 ~ 2.5m	Inside town by heavy rain
North Section	0.0 ~ 2.5m	Few sections in 2010

* Minus (-) embankment height indicates that the height of the road surface is lower than the ground surface adjacent to the road.

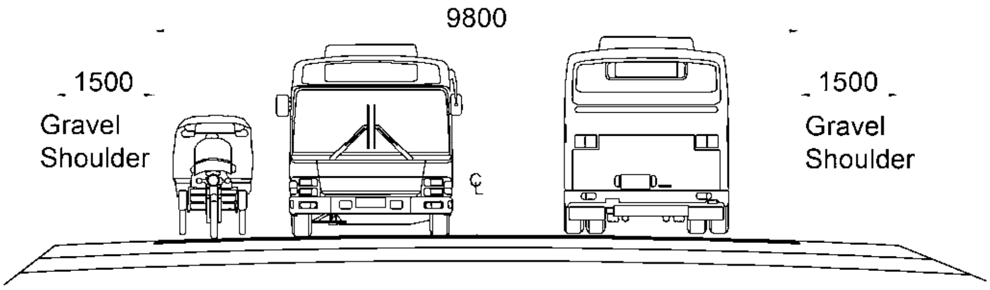
(3) Cross-Sectional Composition

Cross section of NR 5 is composed of 2-lane carriageway and shoulders except few hundreds meter long stretches in Battambang and Sri Sophorn. The improved section between Sri Sophorn and Poipet, the border point with Thailand, also has the same cross-sectional composition. The photo shown at right was taken between Prek Kdam Br. ~ Kampong Chhnang.

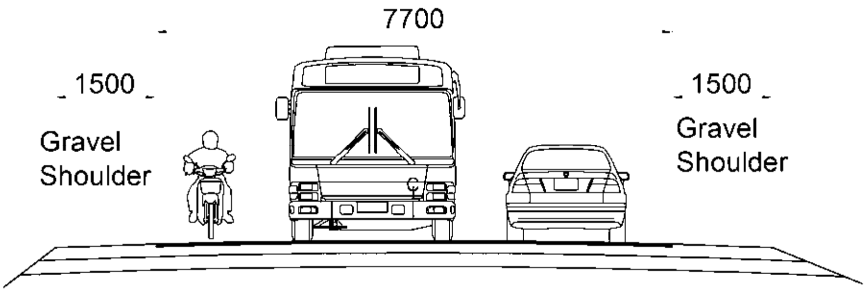
Photo 4.1-1 Edge Line and Paved Shoulder

<u>South Section</u>

There are two types of typical cross section on the South Section. The average width of pavement is 9.8m between Prek Kdam Bridge and Kampong Chhnang, and is 7.7m between Kampong Chhnang and Thlea Ma'Am. The wider section has enough space to separate motorcycles and carts from 4-wheel vehicles, while the narrow section does not have any separate space for motorcycles. The typical cross sections of the South Section are shown in Figure 4.1-2.



Prek Kdam Br ~ Kampong Chhnang

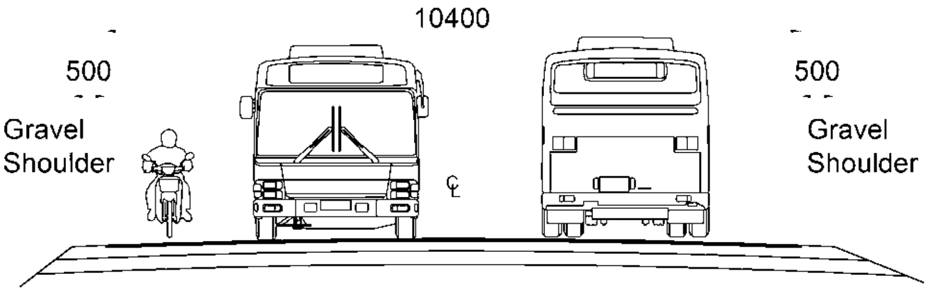


Kampong Chhnang ~ Thlea ma'Am

Figure 4.1-2 Typical Cross Section of South Section

Middle Section

The average width of pavement on middle section is the widest in NR 5 except for few hundreds meter portions of 4-lane near Battembang city. The shoulder is paved by SBST and it provides enough space for motorcycles and carts. The additional shoulders with gravel have been constructed for the protection of edge damage. The typical cross section of the Middle Section is shown in Figure 4.1-3.

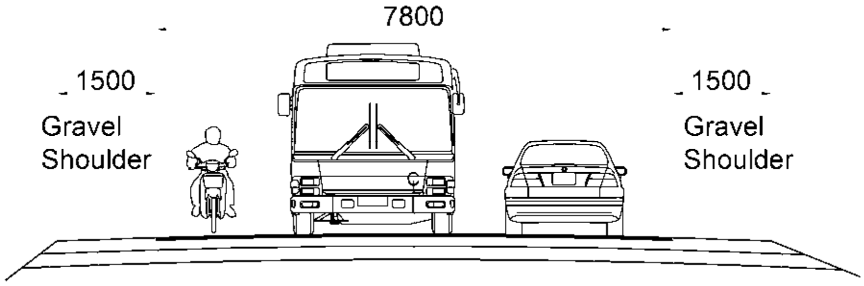


Thlea ma'Am ~ Battambang

Figure 4.1-3 Typical Cross Section of Middle Section

<u>North Section</u>

The average width of pavement on north section is 7.8m. The cross-sectional composition is similar with the section between Kampong Chhnang and Thlea Ma'Am. The vehicles overtaking slow traffic use the opposite lane due to insufficient space in the traveling lane. The typical cross section of north section is shown in Figure 4.1-4.



Battambang ~ Sri Sophorn

Figure 4.1-4 Typical Cross Section of North Section

<u>Sri Sophorn-Poipet Section</u>

The cross section beyond Sri Sophorn is similar with that of the Middle Section, but the pavement type is asphalt concrete. This section is directly connecting to the border with Thailand and has recently been improved. Therefore, this cross section composition can be a good reference case for this project. The general cross section of the section between Sri Sophorn and Poipet is shown in Figure 4.1-5.

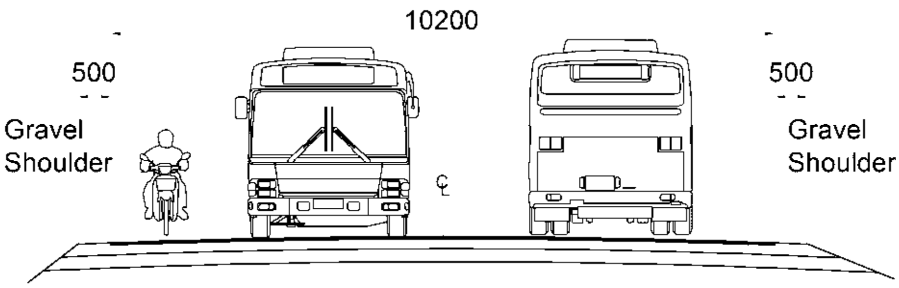


Figure 4.1-5 General Cross Section of Sri Sophorn-Poipet Section

(4) Summary of Problems

The major problems of geometric structure known at this stage are the following two:

- The narrow pavement width
- The insufficient height of embankment

4.1.3 Pavement Condition

The condition of existing pavement was closely observed at the points of failure and every 1km interval where fixed kilometer post exists.

The maintenance of the pavement has been carried out well in general. Completed repair works such as patching, overlay and seal coat are observed. The maintenance works under RAMP also have been carried out in the section from KP 3.9 to KP 171 of NR 5. Several kinds of failure have been thoroughly repaired in RAMP.

The typical failures of the pavement observed on NR 5 are as described below:

- Crack: There are two types of crack; longitudinal line crack on the shoulder and mesh crack on the depressed area. The longitudinal line cracks are supposed to be caused by the settlement of embanked ground
- Pothole: Most of the large potholes have been repaired, but there are some small holes not reaching base course layer without being addressed. These small halls usually further develop during rainy season.
- Depression: Usually observed in the right wheel tracks of vehicles due to insufficient strength of the pavement and/or penetration of water into the pavement structure.
- Flush (Bleeding): Seeping out of bituminous material to the pavement surface. Cased by excess use of bitumen.
- Rutting: Observed on the wheel tracks of vehicles; caused by insufficient strength of the pavement compared to the traffic load.
- Aggregate loss: Breakaway of surface aggregate is observed on the old surface due to the poor adhesion of deteriorated bitumen or insufficient binder.
- Edge Damage: Wear of shoulder caused by action of water and/or vehicle entering to the road.
- Shoving: Usually it is observed near the edge of the pavement due to the ingress of water reducing the bearing capacity of the pavement and/or subgrade.

The locations where these defects are observed are summarized below:

<u>South Section (KP 32~KP 171)</u>

Failure	Location
Crack	KP 32 ~ KP 54, KP 136 ~ KP 167
Depression	KP 32 ~ KP 77, KP 102 ~ KP 170
Aggregate Loss	KP 93 ~ KP 98
Edge Damage	KP 92 ~ KP 131

<u>Middle Section (KP 171~KP 301)</u>

Failure	Location
Crack	KP 232 ~ KP 248, KP 259 ~ KP 284
Depression	KP 217 ~ KP 243, KP 262 ~ KP 266
Rutting	KP 187 ~ KP 268
Edge Damage	KP 216 ~ KP 220

[Note] The surface condition is comparatively fair in the Middle Section and the original surface course constructed under PRRP is still being used without major repair in general. It seems that the bearing capacity of the pavement is stronger than the other two sections.

<u>North Section</u>

Failure	Location
Crack	KP 311 ~ KP 322, KP 338 ~ KP 357
Depression	KP 302 ~ KP 306, KP 311 ~ KP 324, KP 341 ~ KP 348, KP 353 ~ KP 360
Rutting	KP 325 ~ KP 335, KP 347 ~ KP 355
Aggregate Loss	KP 350 ~ KP 351, KP 360 ~ KP 361

[Note] Percentage of commercial and residential usage of roadside land along this section is higher than the other two sections. The elevation of road surface is sometimes lower than the roadside land. This makes weakening of the pavement due to the penetration of rain water into the roadbed.

Photo 4.1-2 Roadside Higher than Road Surface without Drainage

4.1.4 Bridge Condition

The number of bridges located on the Survey Section is 87 in total. Some of the bridges are constructed by the fund of Australia in the middle of 1990s and their structures with steel plate girders are still stable. Most of the bridges are constructed under PRRP and EFRP after the extensive flood in 2000. The superstructure of those bridges is prestressed concrete (PC) hollow slab and its condition is quite good. The other bridges are also still in fair condition for supporting the present traffic load. Only one bridge located in Kampong Chhnang City (bridge code Br 20 at KP 88) is seriously damaged. The bottom of reinforced concrete (RC) slab is exfoliated and rusted steel bars are exposed. Thus this bridge needs to be replaced urgently to provide the safe road service.

Even though the present condition is still fair, the reconstruction of old bridges and culverts will be required when the road will be widened. Also safety of old bridges against the increased traffic load is not certain. Therefore the basic policy of bridge works should be replacement of old bridges. The old bridges to be replaced are listed up in Table 4.1-3.

Photo 4.1-3 Damage of Br20

Table 4.1-3 Bridges Considered to be Replaced

KP	Code	Length	Carriageway Width	Bridge Type
South Section				
38.5	Br 5	9.15 m	10.75 m	2 span Rigid Frame RC Girder
40.1	Br 6	24.0 m	8.1 m	2 span Simple Steel Plate Girder
46.8	Br 11	16.7 m	10.4 m	4 span Rigid Frame RC Slab
88.3	Br 20	6.0 m	13.6 m	1 span RC Slab
106.3	Br 22	91.0 m	7.3 m	4 span Simple Steel Plate Girder
116.6	Br 26	71.0 m	7.25m	3 span Simple Steel Plate Girder
Middle Section				
182.0	Br 42	19.4 m	9.7 m	4 span Simple RC Girder
186.0	Br 47	120.0 m	7.3 m	6 span Simple PC Girder
187.5	Br 48	38.9 m	8.8 m	2 span Simple RC Girder
245.9	Br 66	9.7 m	9.3 m	2 span Simple RC Girder
North Section				
341.1	Br 84	4.9 m	10.2 m	2 span Rigid Frame RC Arch
357.2	Br 91	14.4 m	8.6 m	3 span Simple RC Girder

Regarding two bridges in the South Section (bridge code Br 22 at KP 106.3 and Br 26 at KP 116.6) the pier is constructed on pile-bent type, and some of the foundation piles are battered piles. This implies that the construction of additional piles for expansion bridge seat is difficult. Thus, replacement is needed if these bridges are to be widened.

Photo 4.1-4 Battered Piles of Br 26

4.1.5 Roadside Land Use

The cities, towns and villages are developed along the road. Many factories, shops, stalls, vendors, benches and houses are observed just beside the road. The basic form of land use outside of urbanized area is agriculture, especially rice paddy. There are many rice mill factories and warehouses along the road functioning as the base station of transportations for rice.

<u>Negligence of Drainage</u>

The roadside of existing route has been developed rapidly such as new factories, commercial activities and residential buildings. Land fill for such development after pay very little attention to the necessity of drain channel at road shoulder. Some houses and shops bury the existing drainage channel of their front for their convenience of access. As a result, rain water stays on the road surface or penetrates through the road bed and subgrade soil causing damage to the pavement.

<u>Occupancy of ROW by Roadside Shops and Utilities</u>

In town areas, private shops occupy the existing road shoulder and sidewalk to display their merchandise, and their buildings are placed within Right of Way. On the other land, most of the houses are built outside of Right of Way and some houses are moving to their backyard by their intention. It may be the effect of the notice board installed by ADB project to announcing the width of Right of Way of 30 m from the center of existing road. The boards are installed on roadside at many locations on the whole stretch of NR 5.

Announcement about National Corridor

Decree about the corridor management along national roads and rail of the Kingdom of Cambodia No. 197 issued on the 23rd of November 2009 article No. 8 states that the corridor is limited for development process on the infrastructure as below:

National Road Level 1: Represent as 1 digit number, the corridor has 30 meter width from the center of the road axe so all the constructions must follow to this decree by keep the space at lease 30 meter from the center of road axe. Moreover, for the public service equipment such as Electric poles, Telephone line Poles, Optical Cables etc… must be placed at lease 28 meter from the central road axe. (as shown in figure below)

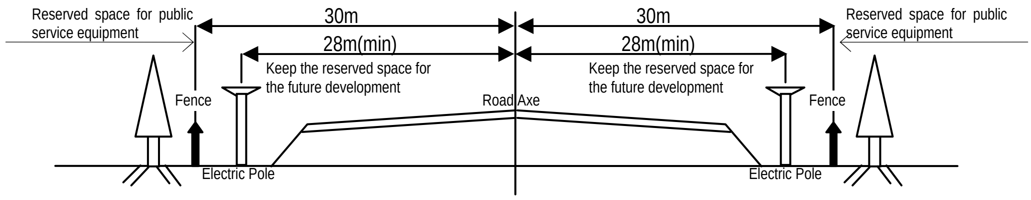


Figure 4.1-6 Notice Board of Right of Way (Unofficial Translation)

Although, it is instructed on the board that electric poles should be installed 28 m away from the road center, actual installation work of new electric poles is ongoing approximately 17 m away from the road center. This will bring confusion among the residents. It is strongly recommend that MPWT shall issue the warning to SKL Group, who has been installing electric poles within the road reserves.

4.2 Planned, Ongoing and Past Project for Rehabilitation/Improvement of NR 5

This subsection summarized the past projects which contributed to the current condition of NR 5, as well as the on-going and planned project which are expected to improve the current condition of NR 5.

(a) ADB: Primary Roads Restoration Project (PRRP)

The whole stretch of NR 5 had been originally scheduled to be improved in the ADB funded “Primary Roads Restoration Project (PRRP). Due to the severe flood occurred on 2000, some parts of NR 5 covered by the contract packages of PRRP were damaged, and extensive rebuilding and improvements became necessary (e.g., repair of eroded embankments, raising of embankment heights, construction of additional culverts, bridge rehabilitation etc.). As a result, 130 km of the Middle Section was improved under contract packages of PRRP.

(b) ADB: Emergency Flood Rehabilitation Project (EFRP)

Two cancelled package of PRRP were transferred to the subprojects of "Emergency Flood Rehabilitation Project (EFRP) funded by ADB. This project was aimed to restore damaged facilities to their pre-flood conditions to permit early restoration of economic and social activities. Given the Project's urgent nature, the detailed design was left for implementation and the rehabilitation works were commenced immediately with ensuring dry season. The design process depends heavily on national ministries and provincial agencies for information on the extent of damage. Therefore 139 km of the South Section and 60 km of the North Section except bridge works, reconstruction of bridges covered by PRRP Package 5E, were restored under contract packages of EFRP.

(c) ADB: Cambodia Road Improvement Project (CRIP)

The contract package 5F or PRRP, the section between Sri Sophorn and Poipet, was implemented under Cambodia Road Improvement Project (CRIP) funded by ADB. The road was paved with AC and the cross section composition is 2-lane road with motorcycle lane. Total width of the pavement is 10.2 m.

(d) Project Funded by Phnom Penh Municipality and Chinese Government

Regarding the section between Phnom Penh and Prek Kdam Bridge which is outside of scope of this Survey, a short stretch of approximately 8 km was overlaid with asphalt concrete (AC) recently by the fund of Phnom Penh Municipality, and there is a plan to upgrade into 4-lane with AC pavement over the whole section by Chinese fund on the period from 2012 to 2015. If this plan will come to reality, the section from Phnom Penh to the South Section will be greatly improved in the near future.

(e) ADB: Road Asset Management Project (RAMP)

Road Asset Management Project (RAMP) funded by ADB implements the maintenance work between Phnom Penh (KP 3.9) and Thlea Ma'Am (KP 170.9) in 2010 and 2011. The contents of the work are the installation of road signs, guide posts, lane marking and kilometer posts and the repair of cracks, potholes, depression, rutting, shoving, corrugation, base course failure, edge break damage and full depth reconstruction of failure. Any improvement or upgrading works are not carried out in this project.

The recent projects on NR 5 are listed in Table 4.2-1. The locations of repair/rehabilitation works executed under these projects are schematically illustrated in Figure 4.2-1.

Table 4.2-1 Project List on National Road No. 5

Section	Project	Year
Phnom Penh ~ Prek Kdam Br.	Restored by Army RAMP funded by ADB 4-lane widening by China fund	2000 - 2002 2010 - 2011 2012 -
Prek Kdam Br. ~ Kampong Chhnang (South Section)	Restored by Army RAMP funded by ADB	2000 - 2002 2010 - 2011
Kampong Chhnang ~ Thlea Ma'Am (South Section)	EFRP funded by ADB RAMP funded by ADB	2000 - 2004 2011 - 2012
Thlea Ma'Am ~ Battambang (Middle Section)	PRRP funded by ADB	2000 - 2005
Battambang ~ Sri Sophorn (North Section)	EFRP funded by ADB	2000 - 2004
Sri Sophorn ~ Poipet	CRIP funded by ADB	2004 - 2007

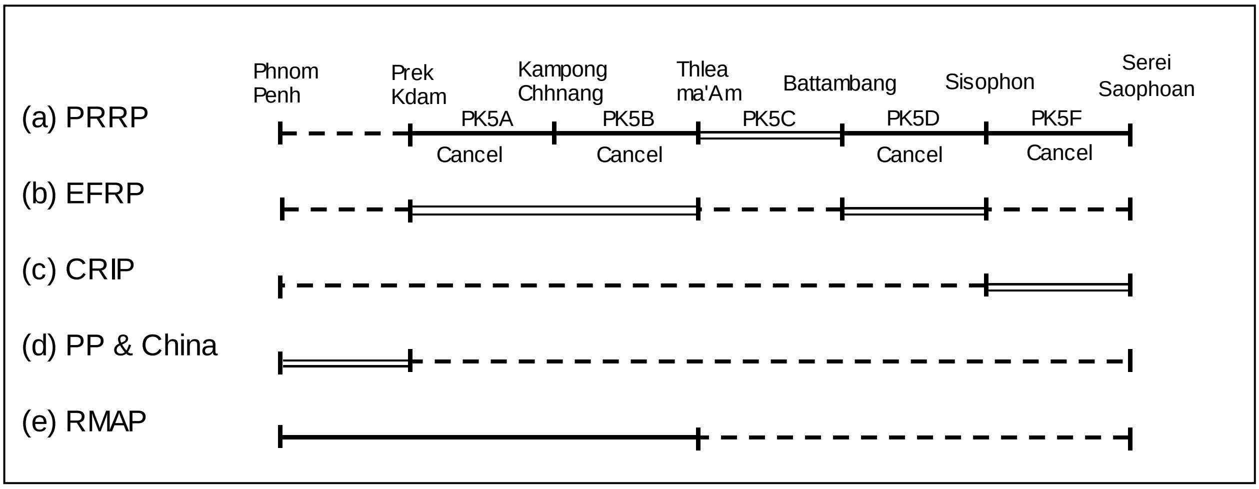


Figure 4.2-1 Schematic Illustration of Location of Works Executed under Projects Cited Above

CHAPTER 5 TRAFFIC SURVEYS

Traffic surveys were carried out on the National Road No. 5. The objectives of the surveys were to have better understanding on the characteristic of the Survey Area, as well as the present traffic pattern. The data obtained through the traffic surveys are also used in forecasting future traffic demand, which, in turn, is used in evaluation of priority of the South, Middle and North Sections and planning of cross sections.

The following three (3) types of the survey were conducted, namely; traffic count survey (12hr and 24hr), origin destination (OD) interview survey and travel speed survey. The outline, method and result of the survey are explained in each section below.

5.1 Traffic Count Survey

5.1.1 Outline

The traffic counts were conducted at eight (8) stations with three (3) vehicle groups and eight (8) vehicle classifications. 24 hours counts were carried out at two (3) stations from 6:00 a.m. to 6:00 a.m. next day and 12 hours counts at six (6) stations from 6:00 a.m. to 6:00 p.m. These traffic counts were carried out on weekdays, excluding Saturday, Sunday and national holidays. The groups and classifications of vehicle were classified as follows.

Table 5.1-1 Vehicle Classification for the Traffic Count Survey

Group		Classification	
I	Motor Cycle (MC)	1	Motorcycle and Motor Tricycle
		2	Motorbike Trailer
II	Light Vehicle (LV)	3	Sedan, Wagon, Light Van and Pick-up(for passenger)
		4	Pick-up(for commodity), Jeep and Light Truck (>3.5t)
		5	Mini Bus (Van type and Pick-up Type)
III	Heavy Vehicle (HV)	6	Short and Long Body Bus
		7	Short and Long Body Truck (<3.5t)
		8	Semi and Full Trailer Truck

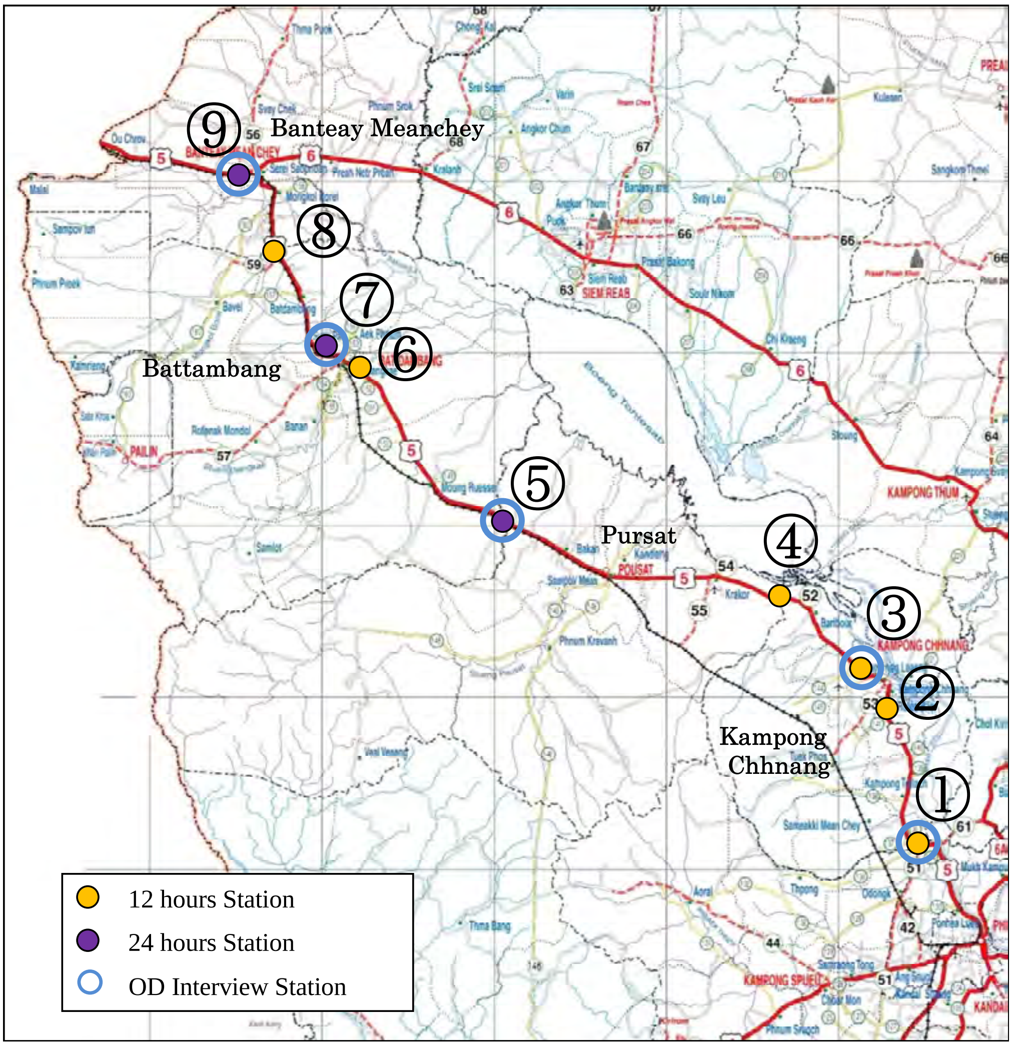
5.1.2 Location of Traffic Count Survey

The survey locations were selected at the provincial boundary and city boundary (Kompong Chhnang City and Battambang City) and they are shown in Table 5.1-2 and Figure 5.1-1, respectively.

Table 5.1-2 Location of Traffic Count Survey

No	Location	Time	Year 2011 and Date
1	Provincial Boundary (between Kadal and Kampong Chhnang)	12 hrs	22 March (Tue)
2	Kampong Chhnang City (Southern)	12 hrs	22 March (Tue)
3	Kampong Chhnang City (Northern)	12 hrs	22 March (Tue)
4	Provincial Boundary (between Kampong Chhnang and Pursat)	12 hrs	22 March (Tue)
5	Provincial Boundary (between Prusat and Battambang)	24 hrs	22-23 March (Tue and Wed)
6	Battambang City (Southern)	12 hrs	22 March (Tue)
7	Battambang City (Northern)	24 hrs	22-23 March (Tue and Wed)
8	Provincial Boundary (between Battambang and Banteay Meanchey)	12 hrs	22 March (Tue)
9	Sri Sophorn Suburb(Western)	24 hrs	23-24 November(Wed and Thrs)
Note: 24 hrs: from 06:00 in the morning to 06:00 in the following morning 12 hrs: from 06:00 in the morning to 18:00 in the evening			

Figure 5.1-1 Location of Traffic Count Survey



5.1.3 Survey Result

The results of the traffic count survey are as described below.

(1) 12-hour traffic volume and vehicle composition

Table 5.1-3 shows 12 hours traffic volume by vehicle group and classification. The traffic volume at station 6 and 7 (boundary of Battambang City) were over 10,000 vehicles.

Table 5.1-3 Traffic Volume for 12 Hours

Unit: Vehicle

Station No.	Motorcycle (MC)			Light Vehicle (LV)				Heavy Vehicle (HV)			Grand Total
	Motorcycle and Tricycle	Motorbike Trailer	Total	Sedan, Wagon and Light Van	Pick-up, Jeep and Light Truck	Mini Bus	Total	Short & Long Body Bus	Short & Long Body Truck	Total	
1	4,148	318	4,466	1,562	534	796	2,892	184	484	72	740
2	4,748	101	4,849	1,596	555	509	2,660	190	294	19	503
3	3,505	51	3,556	1,207	365	503	2,075	181	297	35	513
4	670	38	708	809	264	356	1,429	177	247	23	447
5	1,475	48	1,523	756	282	349	1,387	176	315	32	523
6	11,339	423	11,762	1,541	621	487	2,649	171	646	31	848
7	7,107	412	7,519	1,768	526	433	2,727	131	246	72	449
8	3,615	201	3,816	1,297	311	280	1,888	98	555	50	703
9	3,128	81	3,209	2,221	431	272	2,924	90	306	119	515

Figure 5.1-2 shows the vehicle composition at each survey station. Ratio of Motorcycle (MC) to total vehicle is more than 50% at most stations. The volume of MC is less than that of Light Vehicle (LV) at station No. 4 and No. 5. This may be attributed to the fact that there is no housing and facilities nearby.

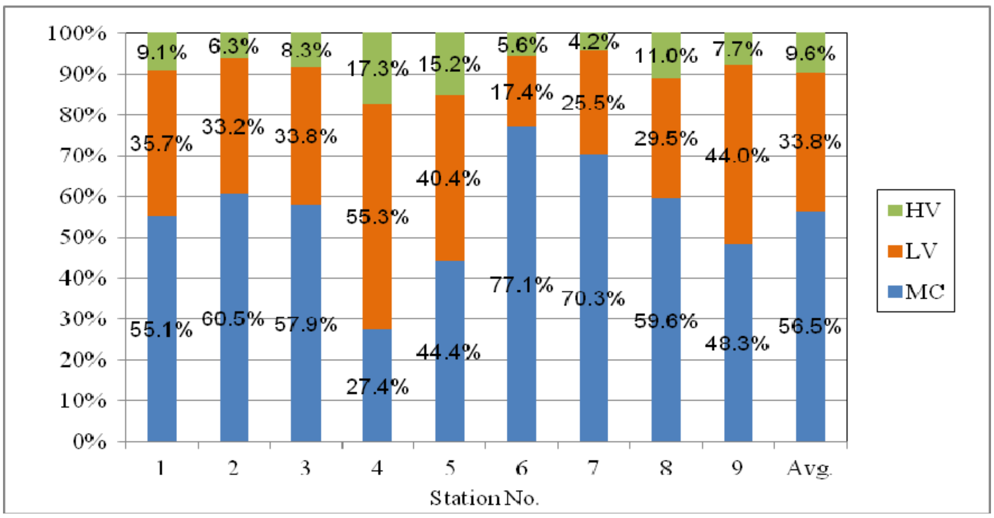


Figure 5.1-2 Vehicle Composition by Survey Station

(2) Peak hour traffic volume

Table 5.1-4 shows the peak hour traffic volume for all vehicles and for Heavy Vehicle (HV) in the two directions of "to Poipet" and "to Phnom Penh". There was no particular time zone of peak traffic common to all counting stations.

Table 5.1-4 Peak Hour Traffic Volume by Direction

Unit: Vehicle

Station No.	Traffic count hour	Direction			
		Phnom Penh ⇒ PoiPet		PoiPet ⇒ Phnom Penh	
		Maximum hourly traffic volume	Time zone	Maximum hourly traffic volume	Time zone
1	12	483	7:00-8:00	379	16:00-17:00
2	12	517	7:00-8:00	441	17:00-18:00
3	12	331	11:00-12:00	395	7:00-8:00
4	12	151	9:00-10:00	126	11:00-12:00
5	24	166	10:00-11:00	201	21:00-22:00
6	12	887	8:00-9:00	809	17:00-18:00
7	24	553	17:00-18:00	575	8:00-9:00
8	12	301	8:00-9:00	344	9:00-10:00
9	24	365	9:00-10:00	324	17:00-18:00

(3) 24 hour/12 hour ratio

The 24 hour traffic count was carried out at three (3) stations (No. 5, No. 7 and No. 9) in order to confirm the trend of the traffic volume in rural area and at boundary of the city on the National Road No. 5. The rations of 24 hour/12 hour by vehicle classification are shown in Table 5.1-5 and Table 5.1-6, respectively. The 24 hour/12 hour ratio of Semi & Full Trailer Truck is the highest among those of various vehicle types, and is more than two (2) times of others. This means the semi & full trailer trucks move actively during night rather than daytime. It is assumed that they intend to avoid traffic congestion at those places.

Table 5.1-5 24 Hours/12 Hours Ratio at Station 5 (Rural Area)

Unit: Vehicle

Area	Station No.	Motorcycle (MC)		Light Vehicle (LV)			Heavy Vehicle (HV)			Grand Total
		Motorcycle and Tricycle	Motorcycle Trailer	Sedan, Wagon and Light Van	Pick-up Jeep and Light Truck	Mini Bus	Short & Long Body Bus	Short & Long Body Truck	Semi & Full Trailer Truck	
Rural	12 hour	1475	48	756	282	349	176	315	32	3433
	24 hour	1674	50	970	357	391	195	567	194	4398
	24/12 ratio	113	1.04	1.28	1.27	1.12	1.11	1.80	6.06	1.28

Table 5.1-6 24 Hours/12 Hours Ratio at Station 7 (Boundary of City)

Unit: Vehicle

Area	Station No.	Motorcycle (MC)		Light Vehicle (LV)		Heavy Vehicle (HV)				Grand Total
		Motorcycle and Tricycle	Motorcycle Trailer	Sedan, Wagon and Light Van	Pick-up Jeep and Light Truck	Mini Bus	Short & Long Body Bus	Short & Long Body Truck	Semi & Full Trailer Truck	
Near the Enter City	12 hour	7107	412	1768	526	433	131	246	72	10695
	24 hour	8238	484	2205	651	516	157	382	193	12826
	24/12 ratio	1.16	1.17	1.25	1.24	1.19	1.20	1.55	2.68	1.20

(4) Conversion to 24 hours (daily) traffic volume

The 24 hours (daily) traffic volumes were calculated using the conversion factor of 24 hours/12 hours ratio of rural area and city boundary. The conversion factor for rural area is applied to traffic volume at station No.1, 4 and 8 and that for city boundary is applied to those at station No. 2 and 6 respectively. The results of 24 hours traffic volume are shown in Table 5.1-7.

Table 5.1-7 Daily (24 Hour) Traffic Volume

Unit: Vehicle

Station No.	Motorcycle			Light Vehicle				Heavy Vehicle			Grand Total
	Motorcycle and Tricycle	Motorcycle Trailer	Total	Sedan, Wagon and Light Van	Pick-up, Jeep and Light Truck	Mini Bus	Total	Short & Long Body Bus	Short & Long Body Truck	Total	
1	4708	331	5039	2004	676	892	3572	204	437	1512	10122
2	5504	119	5622	1990	687	607	3284	228	51	735	9641
3	4063	60	4123	1505	452	599	2556	217	94	772	7451
4	760	40	800	1038	334	399	1771	196	139	780	3351
5	1674	50	1724	970	357	391	1718	195	194	956	4398
6	13143	497	13640	1922	769	580	3271	205	83	1291	18202
7	8238	484	8722	2205	651	516	3372	157	193	732	12826
8	4103	209	4312	1664	394	314	2372	109	303	1411	8094
9	3476	92	3568	2816	545	312	3673	113	314	812	8053

5.2 Origin Destination (OD) Survey

5.2.1 Outline

Origin Destination (OD) survey was carried out to establish travel patterns (where people are moving to/from). ODs of vehicles were surveyed through roadside interviewed to the drivers. This method is most commonly practiced. Interviews to vehicle drivers were carried out in 12 hours from 6:00 a.m. to 18:00 pm on Tuesday 22nd of March and 23rd of November (Station 9) during the same time with the traffic count survey was conducted (See Table 5.1-2 and Figure

5.1-1). The target sample rate was set at 10 %. The vehicles were stopped on random sampling basis, and drivers were interviewed.

The following information was collect in the driver's interview

- Trip purpose (to home, to work, to school, at work/business, or private)
- Origin and destination
- Number of passengers (including driver)
- Estimated travel time
- Major cargo/loading factor (for truck)

5.2.2 Survey Result

(1) Number of samples and sampling rate

Number of sampling and rate at each station are shown in Table 5.2-1. Sampling rates exceeded the target of 10% at all the stations.

Table 5.2-1 Number of Sampling and Rate

Station No.	Traffic Volume (12 hrs)	No. of Sample	Sampling Rate
1	8,098	886	10.9%
3	6,144	938	15.3%
5	3,433	616	17.9%
7	10,695	1,681	15.7%
9	6,648	1,191	17.9%

(2) Average passenger occupancy

The average passenger occupancy by vehicle classification is shown in Table 5.2-2.

Table 5.2-2 Average Passenger Occupancy

Motorcycle (MC)		Light Vehicle (LV)			Heavy Vehicle (HV)		
Motorcycle and Tricycle	Motorcycle Trailer	Sedan, Wagon and Light Van	Pick-up, Jeep and Light Truck	Mini Bus	Short & Long Body Bus	Short & Long Body Truck	Semi & Full Trailer Truck
1.7	4.9	3.8	4.3	8.94	35.0	2.3	2.0

(3) Major cargo and load factor

Table 5.2-3 shows the major cargo carried by trucks and trailer trucks. The cargo type was classified into ten (10) categories. Cargos in "Agriculture" and "Construction" category count for approximately 50% of whole cargos except "Others category".

Table 5.2-3 Major Cargo

Cargo	Share	
	Including Others	Excluding 'Others'
Agriculture (rice, vegetable, fruits etc.,)	23.1%	29.3%
Forest (log, timber)	1.8%	2.3%
Marine (fish seafood, fish sauce etc.,)	4.9%	6.2%
Mineral (coal, cooper etc.,)	2.9%	3.6%
Metal & Machine (steel, car , motorbike, equipment, etc.,)	5.8%	7.4%
Chemical (petroleum, etc.,)	12.0%	15.2%
Light Industry (machine parts, electronics, etc.,)	4.9%	6.2%
Miscellaneous Industry (garment shoes, etc.,)	7.9%	10.0%
Construction (sand, gravel, concrete, brick etc.,)	15.5%	19.7%
Others (water bottle, cosmetic, recycle materials(can paper, steel), animal etc.,)	21.2%	
Total	100.0%	100.0%

Figure 5.2-1 shows loading factor (percentage of actually loaded cargo against the capacity of vehicle). Approximately 40% of truck-type vehicles are fully loaded.

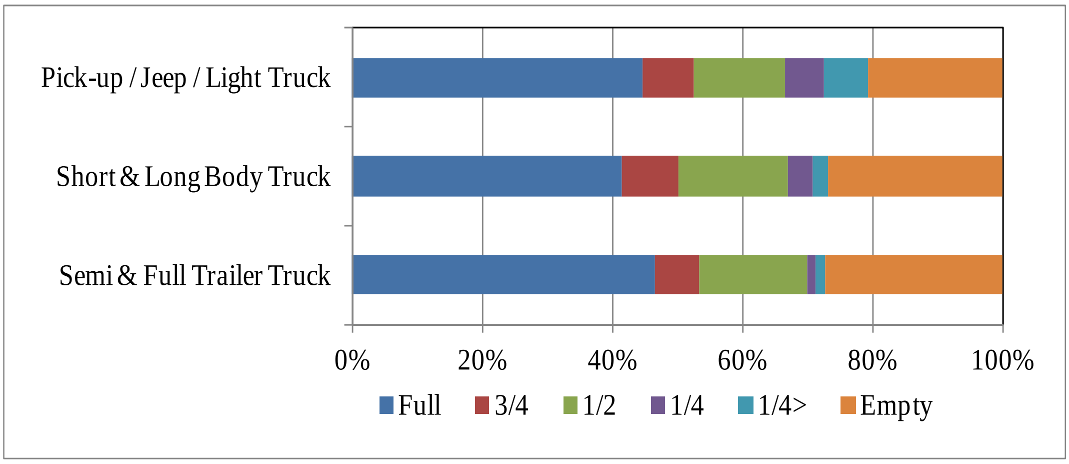


Figure 5.2-1 Loading Factor with Vehicle Classification

(4) Trip purpose

Figure 5.2-2 shows trip purpose by vehicle classification. Except Motorcycle and Tricycle, the trip purpose with the largest share is 'At Work / Business'.

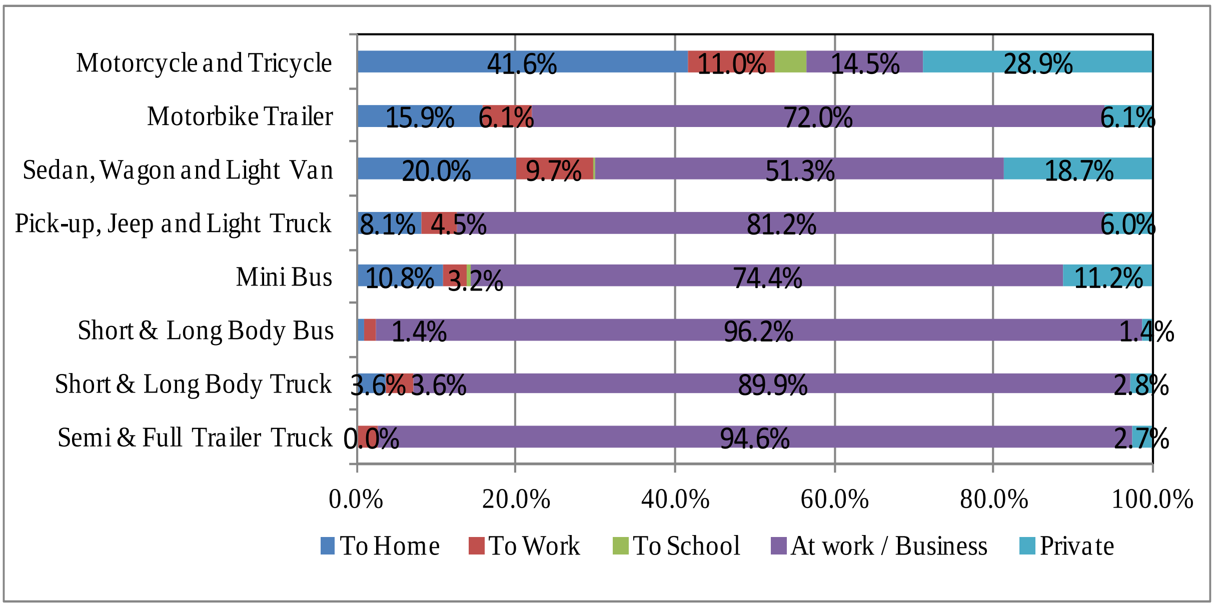


Figure 5.2-2 Trip Purpose with Vehicle Classification

(5) Travel time

Figure 5.2-3 shows the estimated average travel time by vehicle classification. The travel time from origin to destination was calculated based on estimation of driver's sense. Travel time for "Semi & full trailer truck was more than 400 minute (7 hours). However those seem to be one (1) hour shorter than actual travel time, as "short & long body bus" includes a break and truck includes loading and unloading time for category.

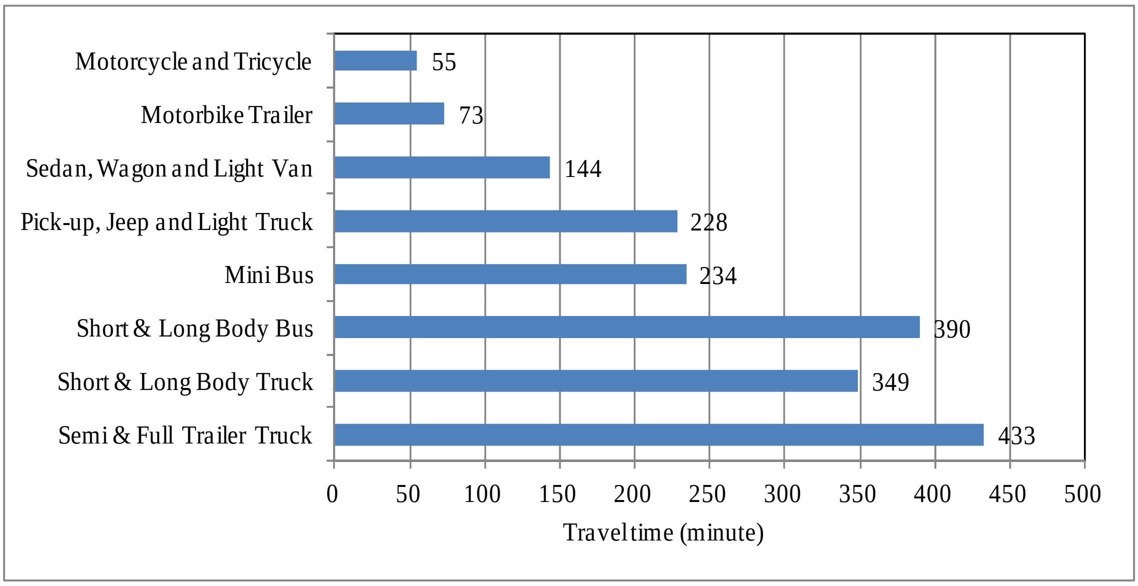


Figure 5.2-3 Estimated Average Travel Time

(6) OD trip pattern

Figure 5.2-4 shows the OD trip pattern by vehicle group in the form of desire line. Motorcycle has usually the characteristic of the short-range trip. One of the OD survey points was located at the boundary of Kampong Chhnang and Kampong Speu. There are many towns and markets in this neighborhood, and many motorcycles travel between Kampong Chhanang and Kampong Speu. In case of light vehicle, medium range trips such as between Banteay Meanchey and Battambang, and between Kampong Chhnang and Phnom Penh, as well as long-distance trips between Phnom Penh and Battmabang are prominent. As for heavy vehicles, long-distance trips such as Banteay Menchey - Phnom Penh and Battambang - Phnom Penh are eminent.

Unit: Vehicle

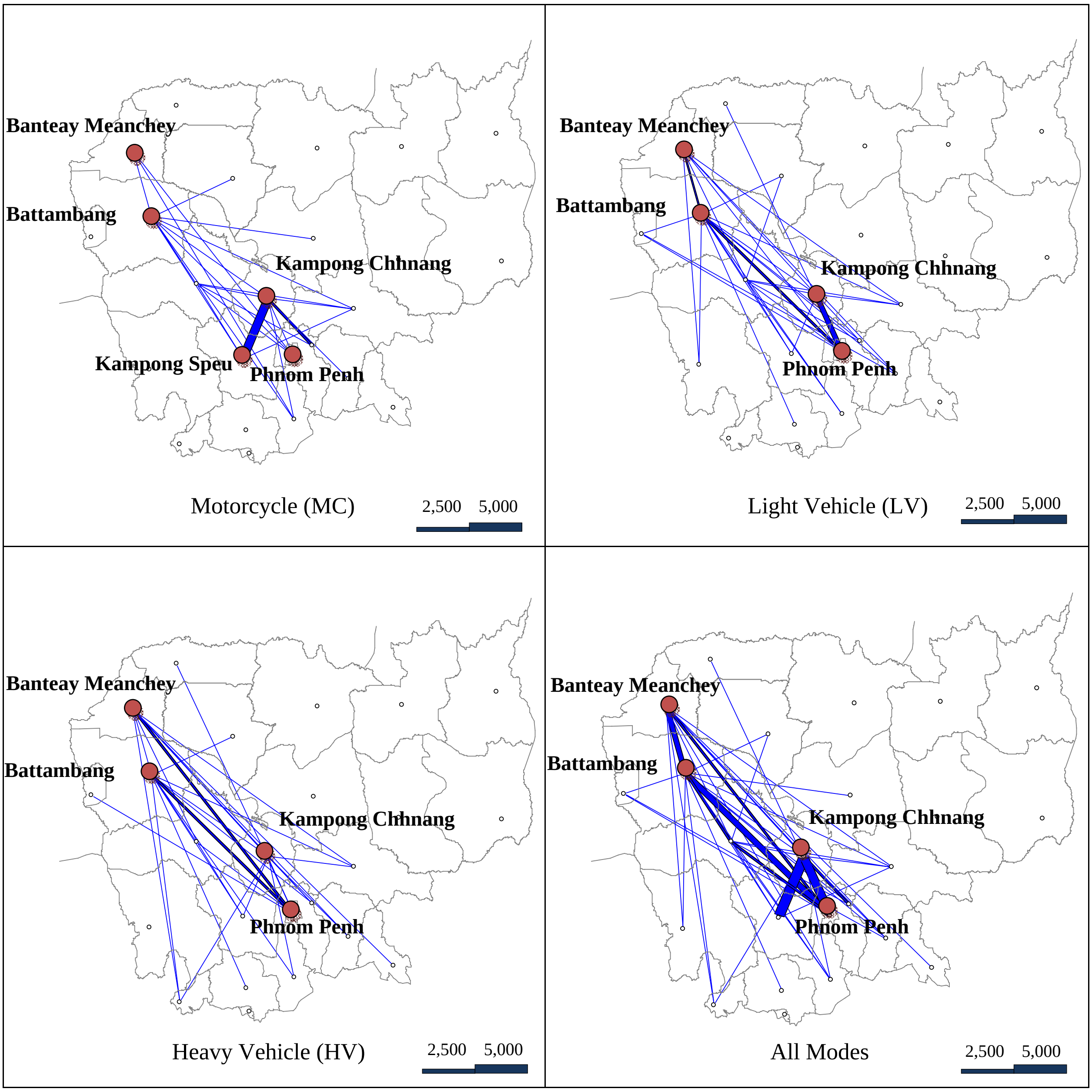


Figure 5.2-4 OD Trip Pattern

5.3 Travel Speed Survey

5.3.1 Outline

The travel speed survey was conducted from Prek Kdam Bridge to Sri Sophorn and vice versa at 7:00am on Thursday 24th of March. The whole stretch was divided into nine (9) sections and the survey was conducted by sedan car traveling at the average speed of traffic flow. In addition, the survey was conducted in Kampong Chhnang City and Battambang City in order to figure out travel speed in the urbanized area.

5.3.2 Route and Sections of Travel Speed Survey

The route and section of travel speed survey are shown in Figure 5.3-1.

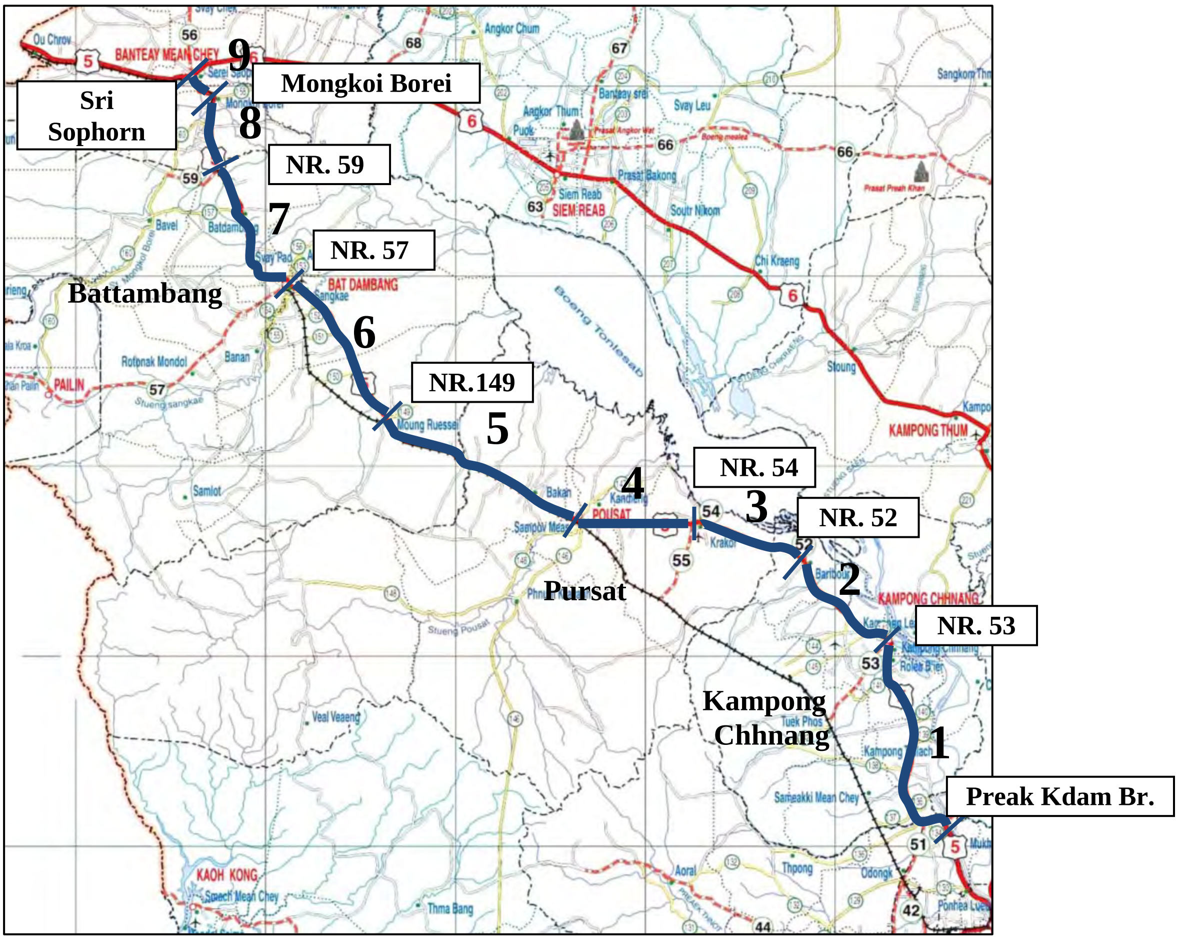


Figure 5.3-1 Travel Speed Survey Route and Section

5.3.3 Survey Result

The obtained average speed is shown in Table 5.3-1. Average travel speed between Prek Kdam and Sri Sophorn was 64.6 km/h. This speed is lower than that surveyed in the JICA Study 2005. Small reduction in the travel speed may reflect (i) deterioration of pavement and (ii) increase in traffic volume or congestion.

Table 5.3-1 Long-Distance Average Travel Speed

Section	From	To	Distance (km)	Average Speed (km/h)
1	Prek Kdam Bridge	NR 53 Jct. (Kampong Chhnang)	59.9	61.3
2	NR 53 Jct. (Kampong Chhnang)	NR 52 Jct.	32.3	62.2
3	NR 52 Jct.	NR 54 Jct.	30.0	76.7
4	NR 54.Jct	NR 148 Jct. (Prusat)	31.8	76.2
5	NR 148 Jct. (Prusat)	NR 149 (Moung Russey)	59.0	63.8
6	NR 149 (Moung Russey)	NR 57 Jct. (Battambang)	43.2	68.3
7	NR 57 Jct. (Battambang)	NR 59 Jct.	29.8	53.9
8	NR 59 Jct.	Mongkol Borei	32.3	62.8
9	Mongkol Borei	Sri Sophorn	8.5	44.3
Whole	Prek Kdam Bridge	Sri Sophorn	326.8	64.7

Travel speed survey was also conducted during the morning peak hour (8:00-8:30) in the Kampong Chhnang City and Batanmbang City. Average speeds in these cities were 49.3km and 32.4km, respectively. In the city centers, the travel speed drops to less than 30km/h and recovers to more than 40km/h when passenger car passing the city center.

Table 5.3-2 Travel Speed in Kampong Chhnang City

Section	From	To	Distance (km)	Average Speed (km/h)
1	South City Gate	Rotary (Monument)	3.60	67.7
2	Rotary (Monument)	Jct. NR 53 (City Center)	0.80	29.2
3	Jct. NR 53 (City Center)	North City Gate	2.20	41.7
Whole	South City Gate	North City Gate	6.60	49.3

Table 5.3-3 Travel Speed in Batanmbang City

Section	From	To	Distance (km)	Average Speed (km/h)
1	East City Gate	Small Rotary	0.78	34.5
2	Small Rotary	Roundabout	2.10	44.1
3	Roundabout	Bridge	2.10	40.6
4	Bridge	Rotary (City Center)	0.90	23.0
5	Rotary (City Center)	West City Gate	1.20	21.0
Whole	East City Gate	West City Gate	7.08	32.4

CHAPTER 6 FUTURE TRAFFIC DEMAND FORECAST

Forecast of the future traffic demand is the basis of highway planning and economic analysis. This chapter describes the methodology and data used in the traffic demand forecast, as well as the result of the forecast.

In the estimation of future traffic demand, target years are set at 2016, 2021 and 2030. Years 2016 and 2021 correspond to 5 and 10 years from now, and year 2030 is chosen since it will be 10 years after the long-term target year of the JICA M/P Study, 2006.

6.1 Methodology

Figure 6.1-1 shows the flow of future traffic forecast.

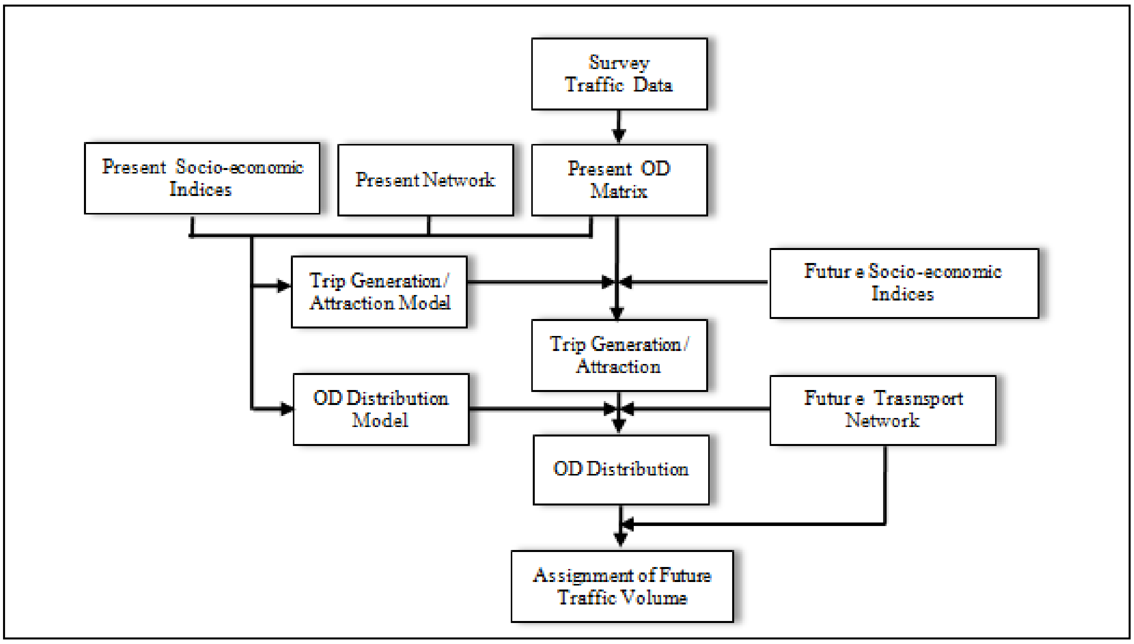


Figure 6.1-1 Flow of Traffic Demand Forecast

First, the future OD table is prepared based on the present OD table and reflecting future socio-economic indices, such as population and vehicle registration forecast. Future OD tables are forecasted through use of trip generation and attraction, and OD distribution. The future traffic demand is forecasted by assigning the future OD table onto the future network on the JICA STRADA program.

6.2 Socio-Economic Framework

Since transportation supports the social activities of the citizens and the economic activities of the industries and commerce, traffic demand is governed by socio-economic factors such as GDP, population and vehicle registration. This section describes the present conditions and future forecast of such socio-economic factors.

6.2.1 Population Projection

"General Population Census of Cambodia 2008" published in January 2011 by the National Institute of Statistics, Ministry of Planning is the latest population projection of Cambodia. The population projection by province up to 2030 is shown in Table 6.2-1. Growth rate of whole Cambodia (country) between 2008 and 2030 is 1.33. It is noted that the growth rates of provinces in the Survey Area (Banteay Meanchey, Battambang and Pursat) are higher than that of whole country.

Table 6.2-1 Population by Province

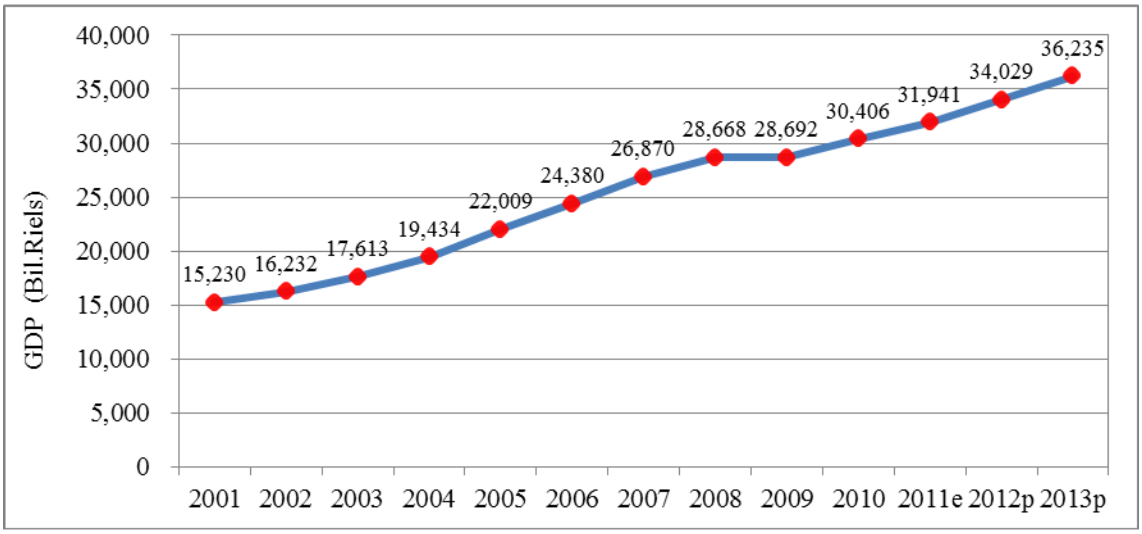
Unit: Person

Provinces	2008	2011	2016	2021	2026	2030	2030/2008
Banteay Meanchey	701,786	745,618	822,187	899,389	968,181	1,017,936	1.45
Battambang	1,061,336	1,126,345	1,238,103	1,349,178	1,449,411	1,519,185	1.43
Kampong Cham	1,739,254	1,745,054	1,739,002	1,721,623	1,689,252	1,648,438	0.95
Kampong Chhnang	488,999	512,667	549,913	583,716	611,551	628,577	1.29
Kampong Speu	742,235	767,827	804,796	837,783	865,696	882,184	1.19
Kampong Thom	653,684	668,876	688,305	705,001	718,447	724,456	1.11
Kampot	606,516	613,305	629,383	654,515	687,197	716,987	1.18
Kandal	1,309,915	1,364,065	1,463,411	1,563,607	1,653,018	1,716,290	1.31
Koh Kong	121,624	133,047	153,846	176,552	199,995	218,811	1.80
Kratie	330,480	350,566	383,382	414,756	444,084	465,960	1.41
Mondul Kiri	63,263	70,587	83,410	97,607	113,303	126,725	2.00
Phnom Penh	1,374,451	1,570,791	1,898,407	2,175,636	2,364,203	2,450,717	1.78
Preah Vihear	177,176	185,509	199,547	214,576	230,617	243,681	1.38
Prey Veng	980,790	980,667	985,036	1,006,084	1,046,198	1,089,316	1.11
Pursat	411,171	425,704	453,467	486,491	522,505	553,067	1.35
Ratanak Kiri	155,773	166,339	182,759	200,145	218,482	233,141	1.50
Siem Reap	928,065	999,703	1,120,313	1,235,423	1,339,563	1,414,727	1.52
Preah Sihanouk	229,205	247,355	279,419	311,363	340,266	360,684	1.57
Stung Treng	115,610	122,756	135,778	151,803	170,639	187,442	1.62
Svay Rieng	499,820	500,275	504,905	517,511	538,082	559,726	1.12
Takeo	874,711	877,839	889,420	916,727	957,279	997,025	1.14
Otdar Meanchey	192,375	218,786	261,201	301,968	339,134	365,010	1.90
Kep	37,016	40,142	47,945	59,427	74,433	88,797	2.40
Pailin	72,971	87,453	112,509	137,997	162,734	181,801	2.49
Cambodia	13,868,227	14,521,275	15,626,444	16,717,422	17,704,090	18,390,683	1.33

Source: National Institute of Statistics, Ministry of Planning, January 2011

6.2.2 Economic Growth of Cambodia

Figure 6.2-1 shows the historical trend of GDP of Cambodia in real term from 2001 to 2010 and estimated/predicted GDP from 2011 to 2013. The data show that Cambodian's economic growth rate was continuously increasing from year 2001 to 2008 with an average annual growth rate of 9.5%. Slight increase in growth rate was experienced in year 2008 to 2009 probably due to the influence of the economic trend of the world (so-called 'Lehman Shock'). It is predicted that the average annual growth rate will recover to 6.0% from year 2010 to 2013.

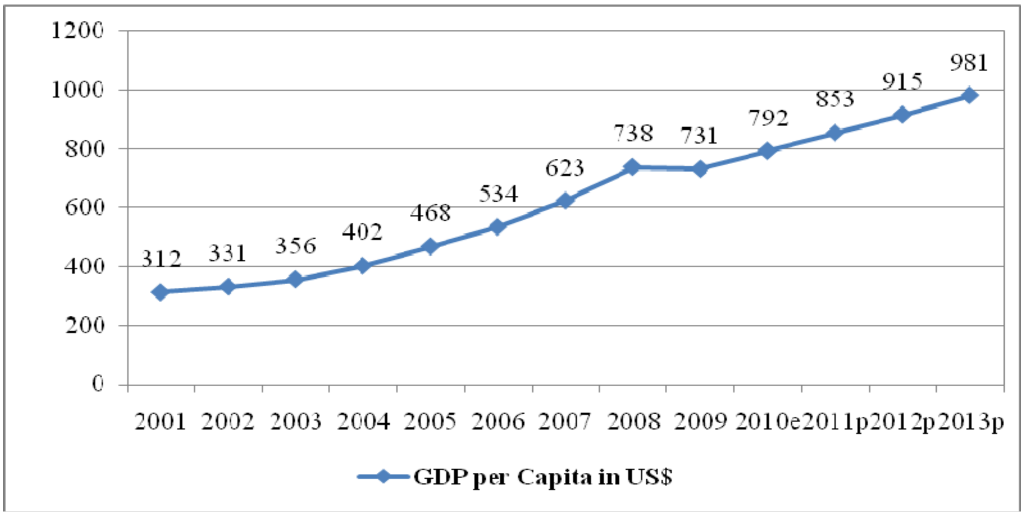


Note: p = predicted, e = estimated

Source: Cambodia Macroeconomic Framework 2010-2011 of Ministry of Economic and Finance, March 2010 and Mid-Term Review 2011 on National Strategic Development Plan Update 2009-2013, Ministry of Planning

Figure 6.2-1 Historical Trend of GDP Growth (2001 -2013)

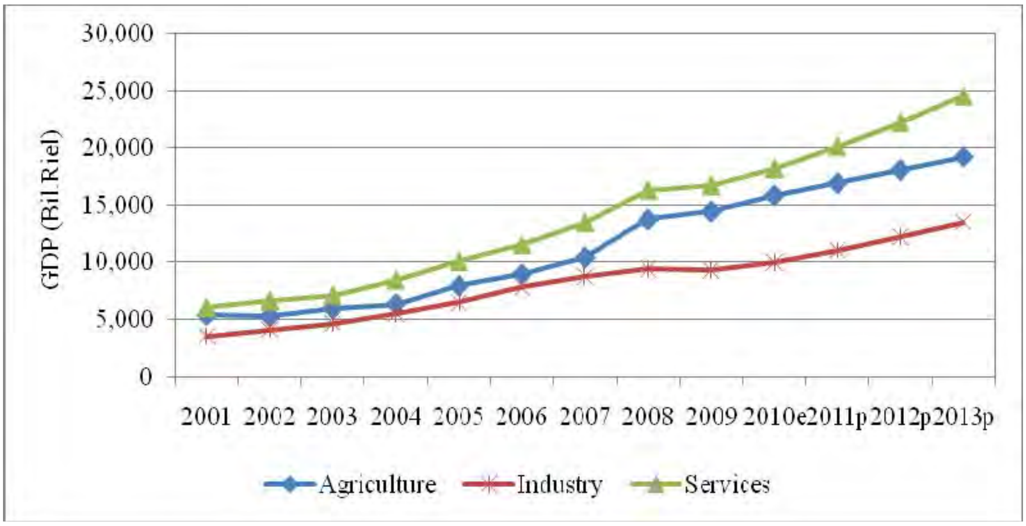
Figure 6.2-2 shows the growth of GDP per Capita. GDP per Capita increased from US$312 in 2001 to US$738 in 2008 with an average annual growth rate of 13.0%. After 2009, it is projected to increase to US$981 in year 2013.



Source: Cambodia Macroeconomic Framework 2010-2011 of Ministry of Economic and Finance

Figure 6.2-2 GDP per Capita in US$ (2001-2013)

Figure 6.2-3 shows the GDP growth rate by industry during the same periods with that of GDP Per Capita. The Cambodia's economic activities such as agriculture, industry and services keep steady increase.



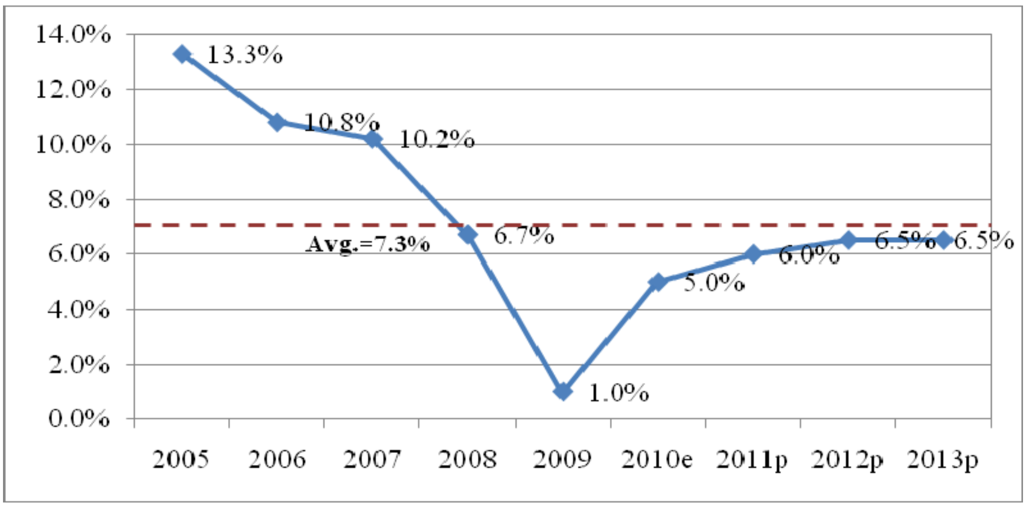
Source: Cambodia Macroeconomic Framework 2010-2011 of Ministry of Economic and Finance

Figure 6.2-3 GDP Growth by Industry (2001-2013)

6.2.3 Future GDP Prediction

(1) Past Trend

The influence of the global economic slowdown is seen in the GDP of Cambodia in 2009. However, the Cambodian economy was expected start recovering from year 2010 and an average growth rate of 6.3% is predicted for the period of 2011-2013, according to the Ministry of Economics and Finance.



Source: Cambodia Macroeconomic Framework 2010-2011 of Ministry of Economic and Finance (MEF)

Figure 6.2-4 GDP Growth 2005-2013

(2) Prediction by US Department of Agriculture

The long term (by 2030) GDP and GDP per Capita of Cambodia at constant price has been predicted by United States Department of Agriculture (USDA). According to this prediction, the annual growth rate of GDP and GDP per Capita will gradually decrease from 2013 to 2030.

Table 6.2-2 Annual Growth Rate of GDP and GDP Per Capita

Unit: %

Year	2008	2009	2010	2011	2012	2013	2016	2021	2030
GDP	6.2	-1.1	3.8	6.1	6.6	7.0	6.6	6.1	5.2
GDP per Capita	4.4	-2.83	2.0	4.3	4.8	5.2	5.0	4.6	4.1

Source: Economic Research Service, United states Department of Agriculture (USDA).

(3) Prediction Used in JICA Master Plan Study

In the report of ‘the Study on the Road Network Development in the Kingdom of Cambodia’, October 2006, JICA (JICA M/P Study), the GDP growth rates shown below were adopted:

Table 6.2-3 GDP Growth Rate Adopted in JICA M/P Study

Period	2006 - 2010	2011 - 2015	2016 - 2020
Growth Rate (%/Yr.)	6.0	6.9	7.8

By comparing this table with Figure 6.2-4 above, it is known that the actual growth rates for 2006 – 2008 were much higher than those predicted in the JICA M/P Study.

(4) GDP Growth Experienced in Neighboring Countries

Two neighboring countries, People’s Republic of China (PRC) and Vietnam, have recently experienced, and is experiencing, rapid economic growth. These countries well may be the model of Cambodia in economic growth.

Table 6.2-4 GDP Growth Rate of PRC and Vietnam

Unit: %/Yr

Country	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
PRC	8.4	8.3	9.1	10.0	10.1	11.3	14.2	9.6	9.2	10.3
Vietnam	6.9	7.1	7.3	7.8	8.4	8.2	8.5	6.3	5.3	6.8

Source: PRC – National Statistic Bureau of China, Vietnam – IMF

(5) Scenario of Future GDP Growth

Considering the above-stated predictions, as well as the economic growth actually happened in Cambodia in the past, three scenarios of GDP growth are assumed.

Table 6.2-5 Scenario of Future GDP Growth

Unit: %/Yr

Scenario	2011 - 2016	2017 - 2021	2022 - 2030
High Growth	8.0	7.0	6.0
Medium Growth	6.5	6.1	5.2
Low Growth	5.5	5.0	5.2

These scenarios are used in the prediction of growth of vehicle registration described below.

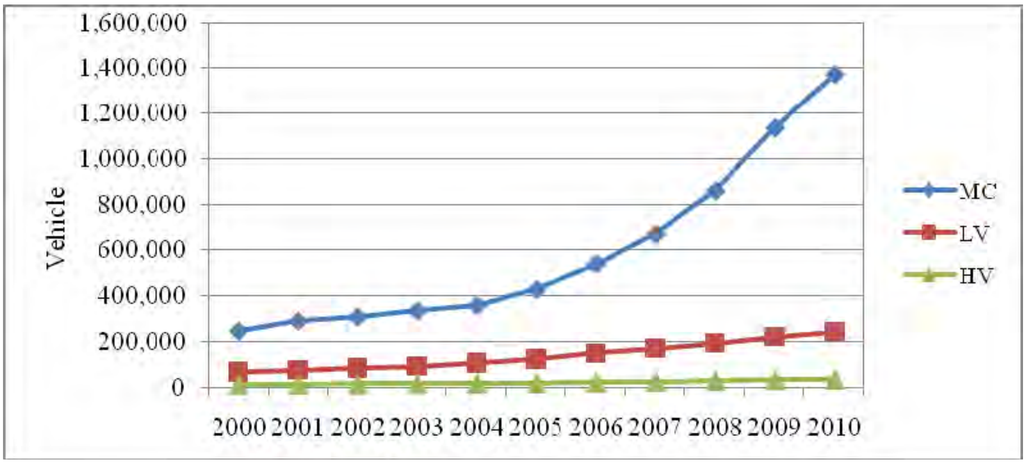
6.2.4 Vehicle Registration

(1) Trend of Vehicle Registration

Figure 6.2-5 shows trend of vehicle registration in Cambodia since 2000. Table 6.2-6 shows the recorded composition of vehicle ownership by vehicle group in 2010. Table 6.2-6 shows the number of registered vehicles as of year 2010.

The salient feature of vehicle registration in Cambodia is that the share of motorcycles (MC) is predominantly larger than those of the other vehicles. In 2010, the total number of vehicles in Cambodia accounts for 1.65 million, of which 1.37 million are MC and the remaining 0.28 million are Light vehicle (LV) and Heavy Vehicle (HV).

Average growth rates of MC, LV and HV over the period from 2000 to 2010, obtained by discarding the maximum and minimum annual growth rates, are 33%, 18% and 10%, respectively. Vehicle ownership of MC and LV per 1000 population is 96.0 and 17.0, or 1 vehicle per 10 people for MC and 1 vehicle per 59 people for LV, respectively.



Source: Ministry of Public Works and Transport

Figure 6.2-5 Trend of Vehicle Registration in Cambodia

Table 6.2-6 Vehicle Ownership in year 2010

Group	Number of vehicle	Percentage (%)
MC	1,372,252	83.0%
LV	244,267	14.8%
HV	36,015	2.2%
Total	1,652,534	100%

Source: Vehicle registration in year 2010 of Ministry of Public Work and Transport

(2) Future Vehicle Registration

Future growth rates of vehicle registration in Cambodia for the 'Medium Growth Scenario' are estimated as shown in Table 6.2-7 were estimated considering and/or assuming the following:

- Although the growth rate of motorcycles in Cambodia was very high (more than 33%, 18% and 10 % for MC, LV and HV, respectively) in the past few years, probably owing to very high rate (more than 10%) of economic growth recorded in years 2005 – 2007, it should become smaller as the growth rate of economy becomes stable at around 6%.

- It is assumed that people tend to shift from MC to LV as GDP per capita increases, or income level goes up. Thus, the decrease of the growth rate of MC in the future will be larger than that of LV.

- Demand for HV will increase as the economy grows because transportation by HV is necessary for the economic activity. Thus, the growth rates of vehicle registration by vehicle type are estimated as shown in Table 6.2-7.

Table 6.2-7 Growth Rate of Vehicle Registration

Year	Growth Rate of Vehicle Registration (%/yr)		
	MC	LV	HV
2000 – 2010 (Trimmed Average)	33	18	10
2010	21	10	7
2011	17	15	10
2012	14	12	10
2013	12	10	10
2014	10	8	8
2015	9	7	7
2016 – 2020	8-4	6	6
2021 – 2026	3-2	5	5
2027 – 2030	1	4	4

Figure 6.2-6 shows the future growth of vehicle registration, as well as growth of past 10 years.

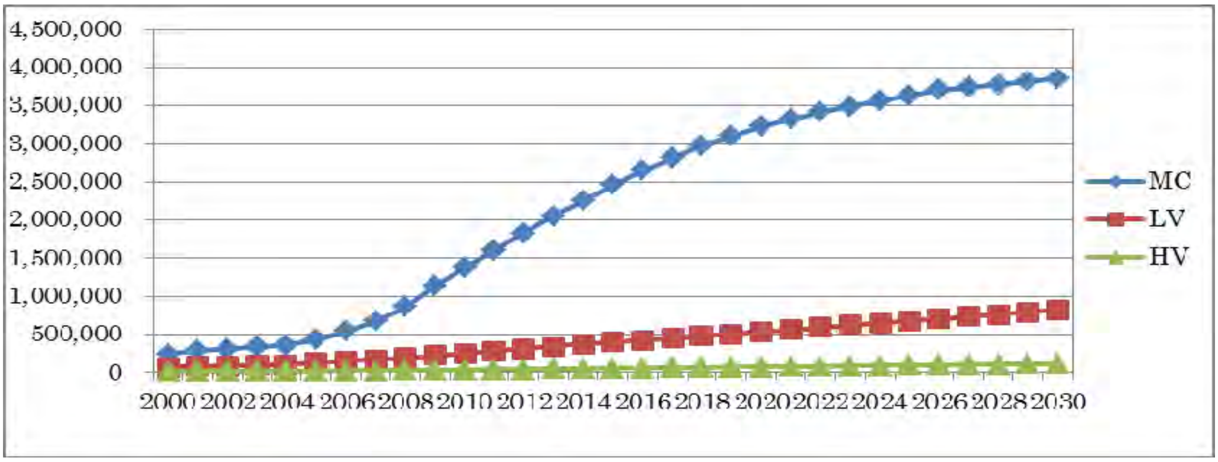


Figure 6.2-6 Projection of Number of Vehicles

Table 6.2-8 shows the projected number of vehicle registration in years 2011, 2016, 2021 and 2030.

Table 6.2-8 Projection of Number of Vehicle

Group	2011	2016	2021	2030
MC	1,605,535	2,654,517	3,322,777	3,855,002
LV	280,907	423,923	561,952	823,128
HV	39,617	58,718	77,837	114,013
Total	1,926,058	3,137,158	3,962,567	4,792,143

If this estimation becomes reality, ratio of number of people per one vehicle, including MC, is to become 3.8 persons/vehicle, or 1.25 vehicle/household, in year 2030. For reference, this ratio is approximately 1.8 persons/vehicle in Japan now. In case of Japan percentage of MC is much smaller (4.5%, excluding those with engine smaller than 50 cc) than that in Cambodia.

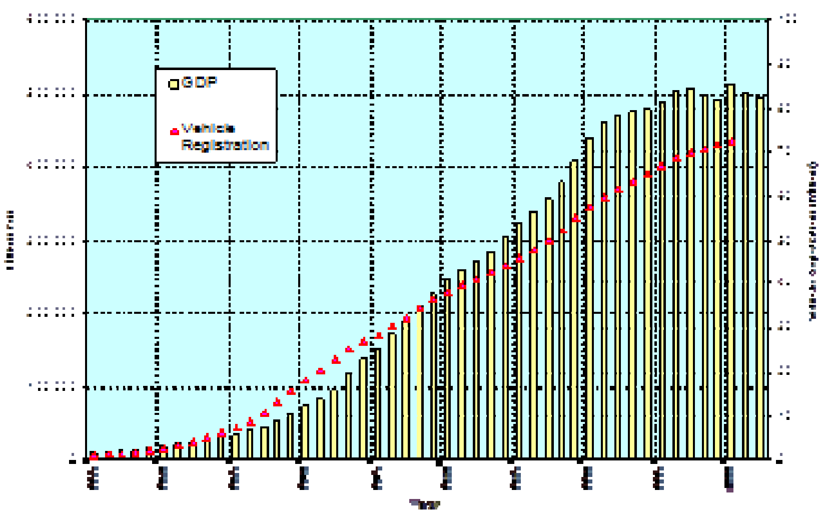


Figure 6.2-7 Increase of Vehicle Registration in Japan in the Past

In case of Vietnam, the total number of MC reached 19 million or 4.5 person/veh in 2006. This is comparable to 4.7 person/veh of MC in Cambodia projected in 2030.

Figure 6.2-8 shows the projected growth of vehicle registration for the three scenarios of GDP growth as in Subsection 6.2.3 above. In case of the ‘High Growth Scenario’, the total number of registered vehicle is projected to reach 6,547,000, or 2.8 person/veh, in 2030. Compared to the figures of Vietnam and Japan, this figure is considered to be too large. Thus, the figure of the ‘Medium Growth Scenario’ is adopted.

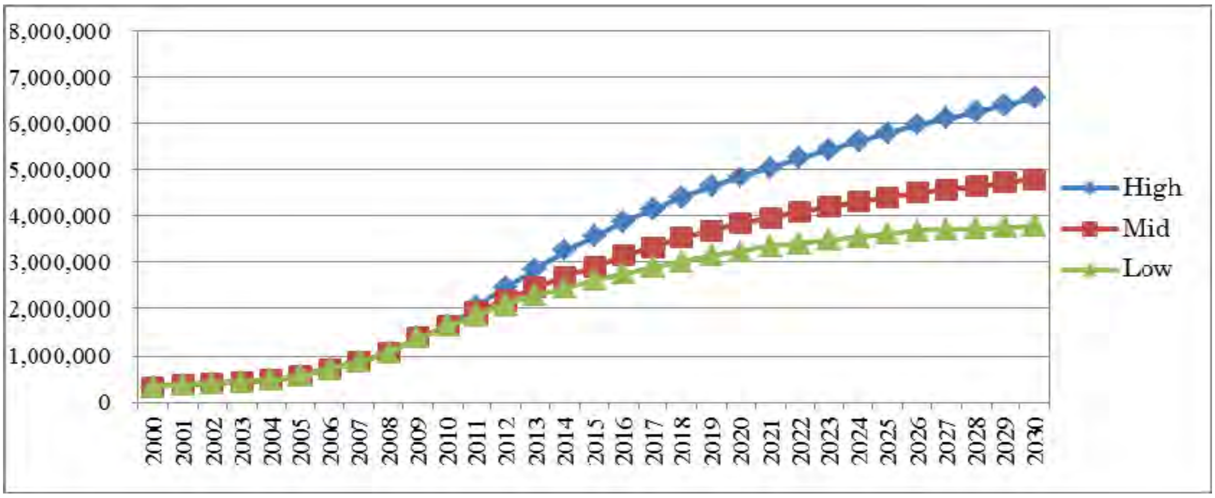


Figure 6.2-8 Projection of Number of Vehicles for Three Scenarios of GDP Growth

6.3 Future OD Table

6.3.1 Zoning System

The OD zoning system used the JICA M/P Study is also used in this Survey. The total number of zones is 197 (185 zones within Cambodia and 12 zones outside of Cambodia). Table 6.3-1 shows the list of OD zones.

Table 6.3-1 Zoning Code

Province	Zone No	District	Traffic Zone
Banteay Meanchey	1	Mongkol Barei	1
		Phnum Srok	2
		Preah Netr Preah	3
		Ou Chrov	4
		Serei Saophoan	5
		Thma Puok	6
		Svay Chek	7
		Malai	8
Battambang	2	Banan	9
		Thma Koul	10
		Bat Dambang	11
		Bavel	12
		Aek Phnum	13
		Moung Ruessei	14
		Rotanak Mondol	15
		Sangkae	16
		Samlout	17
		Sampov Lun	18
		Phnum Proek	19
		Kamrieng	20
		Koas Krala	21
Kampong Cham	3	Batheay	22
		Chamkar Leu	23
		Cheung Prey	24
		Dambae	25
		Kampong Cham	26
		Kampong Siem	27
		Kang Meas	28
		Kaoh Soutin	29
		Krouch Chhmar	30
		Memot	31
		Ou Reang Ov	32
		Ponhea Kraek	33
		Prey Chhor	34
		Srei Santhor	35
		Stueng Trang	36
		Tboung Khmum	37
Kampong Chhnang	4	Baribour	38
		Chol Kiri	39
		Kampong Chhnang	40
		Kampong Leaeng	41
		Kampong Tralach	42
		Rolea B'ier	43
		Sameakki Mean Chey	44
		Tuek Phos	45
Kampong Speu	5	Basedth	46
		Chbar Mon	47
		Kong Pisei	48
		Aoral	49
		Odongk	50
		Phnum Sruoch	51
		Samraong Tong	52
		Thpong	53
Kampong Thom	6	Baray	54
		Kampong Svay	55
		Stueng Saen	56
		Prasat Balangk	57
		Prasat Sambour	58
		Sandan	59
		Santuk	60
		Stoung	61
Kampot	7	Angkor Chey	62
		Banteay Meas	63
		Chhuk	64
		Chum Kiri	65
		Dang Tong	66
		Kampong Trach	67
		Kampot	68
		Kampong Bay	69
Kandal	8	Kandal Stueng	70
		Kien Svay	71
		Khsach Kandal	72
		Kaoh Thum	73
		Leuk Daek	74
		Lvea Aem	75
		Mukh Kampul	76
		Angk Snuol	77
		Ponhea Lueu	78
		S'ang	79
		Ta Khmau	80
Koh Kong	9	Botum Sakor	81
		Kiri Sakor	82
		Kaoh Kong	83
		Smach Mean Chey	84
		Mondol Seima	85
		Srae Ambel	86
		Thma Bang	87
		Kampong Seila	88
Kratie	10	Chhloung	89
		Kracheh	90
		Preaek Prasab	91
		Sambour	92
		Snoul	93
Mondul Kiri	11	Kaev Seima	94
		Kaoh Nheaek	95
		Ou Reang	96
		Pechr Chenda	97
		Saen Monourom	98
Phnom Penh	12	Chamkar Mon	99
		Doun Penh	100
		Prampir Meakkara	101
		Tuol Kouk	102
		Dangkao	103
		Mean Chey	104
		Ruessei Kaev	105
Preah Vihear	13	Chey Saen	106
		Chhaeb	107
		Choam Khsant	108
		Kuleaen	109
		Rovieng	110
		Sangkom Thmei	111
		Tbaeng Mean Chey	112
Prey Veng	14	Ba Phnum	113
		Kamchay Mear	114
		Kampong Trabaek	115
		Kanhchriech	116
		Me Sang	117
		Peam Chor	118
		Peam Ro	119
		Pea Reang	120
		Preah Sdach	121
		Prey Veaeng	122
		Kampong Leav	123
		Sithor Kandal	124
Pursat	15	Bakan	125
		Kandieng	126
		Krakor	127
		Phnum Kravanh	128
		Sampov Meas	129
		Veal Veaeng	130
Ratanak Kiri	16	Andoung Meas	131
		Ban Lung	132
		Bar Kaev	133
		Koun Mom	134
		Lumphat	135
		Ou Chum	136
		Ou Ya Dav	137
		Ta Veaeng	138
		Veun Sai	139
Siemreap	17	Angkor Chum	140
		Angkor Thum	141
		Banteay Srei	142
		Chi Kraeng	143
		Kralanh	144
		Puok	145
		Prasat Bakong	146
		Siem Reab	147
		Soutr Nikom	148
		Srei Snam	149
		Svay Leu	150
		Varin	151
Sihanoukville	18	Mittakpheap	152
		Prey Nob	153
		Stueng Hav	154
Stung Treng	19	Sesan	155
		Siem Bouk	156
		Siem Pang	157
		Stueng Traeng	158
		Thala Barivat	159
Svay Rieng	20	Chantrea	160
		Kampong Rou	161
		Rumduol	162
		Romeas Haek	163
		Svay Chrum	164
		Svay Rieng	165
		Svay Teab	166
Takeo	21	Angkor Borei	167
		Bati	168
		Bourei Cholsar	169
		Kiri Vong	170
		Kaoh Andaet	171
		Prey Kabbas	172
		Samraong	173
		Doun Kaev	174
		Tram Kak	175
		Treang	176
Oddar Meanchey	22	Anlong Veaeng	177
		Banteay Ampil	178
		Chong Kal	179
		Samraong	180
		Trapeang Prasat	181
Kep	23	Damnak Chang'aeur	182
		Kaeb	183
Pailin	24	Pailin	184
		Sala Krau	185
Laos	25	NR7	186
Thailand	26	NR5	187
	27	NR48	188
	28	NR57	189
	29	NR67	190
	30	NR68	191
Vietnam	31	NR1	192
	32	NR2	193
	33	NR21	194
	34	NR33	195
	35	NR72	196
	36	NR76	197

6.3.2 Preparation of Present OD table

OD table of year 2010 used in the JICA M/P Study 2006 was adopted as the basis of the present OD table of this Survey. It was adjusted based on the results of OD survey conducted in this Survey, focusing the traffic along NR 5.

6.3.3 Trip Generation and Attraction

Future OD matrices were estimated by the Frator method using the present OD matrix and the estimated trip generation and attraction. Future trip generation/attraction was estimated by incorporating the future growth of population and vehicle registration as described in Section 6.2 above. Present and future trip generation and attraction by vehicle type for the years 2011, 2016, 2021 and 2030 are shown in Table 6.3-2 (1) to Table 6.3-2 (4).

Table 6.3-2 (1) Trip Generation and Attraction by Vehicle Type Group in 2011

Unit: Vehicle/day

Zone No.	Province	Trip Generation in 2011			Trip Attraction in 2011		
		MC	LV	HV	MC	LV	HV
1	Banteay Meanchey	6,446	2,929	1,147	6,303	3,247	1,040
2	Battambang	23,505	3,448	1,341	23,701	3,743	1,591
4	Kampong Chhnang	9,299	2,482	339	8,578	2,752	411
12	Phnom Penh	50,588	22,848	5,191	50,920	21,821	5,164
15	Pursat	1,521	398	236	1,534	498	273

Table 6.3-2 (2) Trip Generation and Attraction by Vehicle Type Group in 2016

Unit: Vehicle/day

Zone No.	Province	Trip Generation in 2016			Trip Attraction in 2016		
		MC	LV	HV	MC	LV	HV
1	Banteay Meanchey	10,816	4,024	1,557	10,573	4,482	1,412
2	Battambang	39,936	4,724	1,808	40,252	5,153	2,145
4	Kampong Chhnang	14,063	3,264	441	12,974	3,642	534
12	Phnom Penh	90,844	39,560	8,144	91,330	37,917	8,109
15	Pursat	2,418	521	314	2,439	656	363

Table 6.3-2 (3) Trip Generation and Attraction by Vehicle Type Group in 2021

Unit: Vehicle/day

Zone No.	Province	Trip Generation in 2021			Trip Attraction in2021		
		MC	LV	HV	MC	LV	HV
1	Banteay Meanchey	17,649	5,537	2,082	17,249	6,189	1,888
2	Battambang	65,398	6,480	2,406	65,903	7,092	2,854
4	Kampong Chhnang	21,943	4,312	568	20,247	4,830	689
12	Phnom Penh	151,570	62,586	11,853	152,303	60,158	11,811
15	Pursat	3,868	697	416	3,902	880	481

Table 6.3-2 (4) Trip Generation and Attraction by Vehicle Type Group in 2030

Unit: Vehicle/day

Zone No.	Province	Trip Generation in 2030			Trip Attraction in 2030		
		MC	LV	HV	MC	LV	HV
1	Banteay Meanchey	27,567	7,145	2,659	26,938	8,020	2,411
2	Battambang	102,090	8,329	3,052	102,860	9,153	3,621
4	Kampong Chhnang	33,362	5,210	690	30,787	5,867	837
12	Phnom Penh	237,020	96,186	16,624	238,120	92,788	16,581
15	Pursat	6,042	886	534	6,094	1,126	617

Figure 6.3-1 (1) to Figure 6.3-1 (4) (in the following pages) show the total trip production (total of generation and attraction) by zone in 2011, 2016, 2021 and 2030.

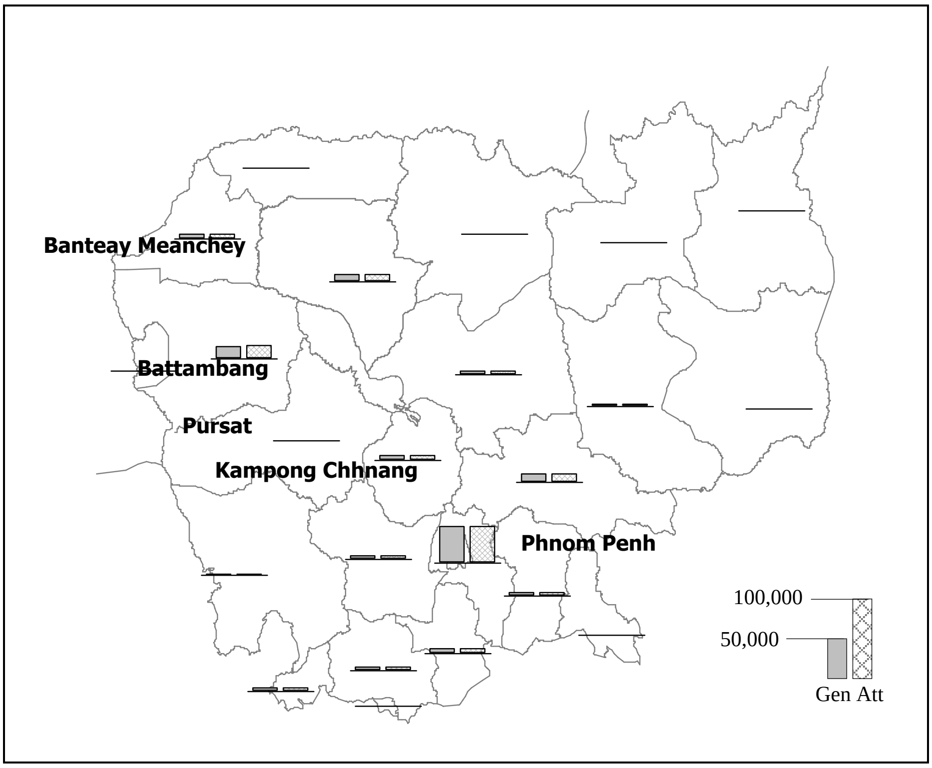


Figure 6.3-1 (1) Total Trip Production in 2011 (Total Vehicle)

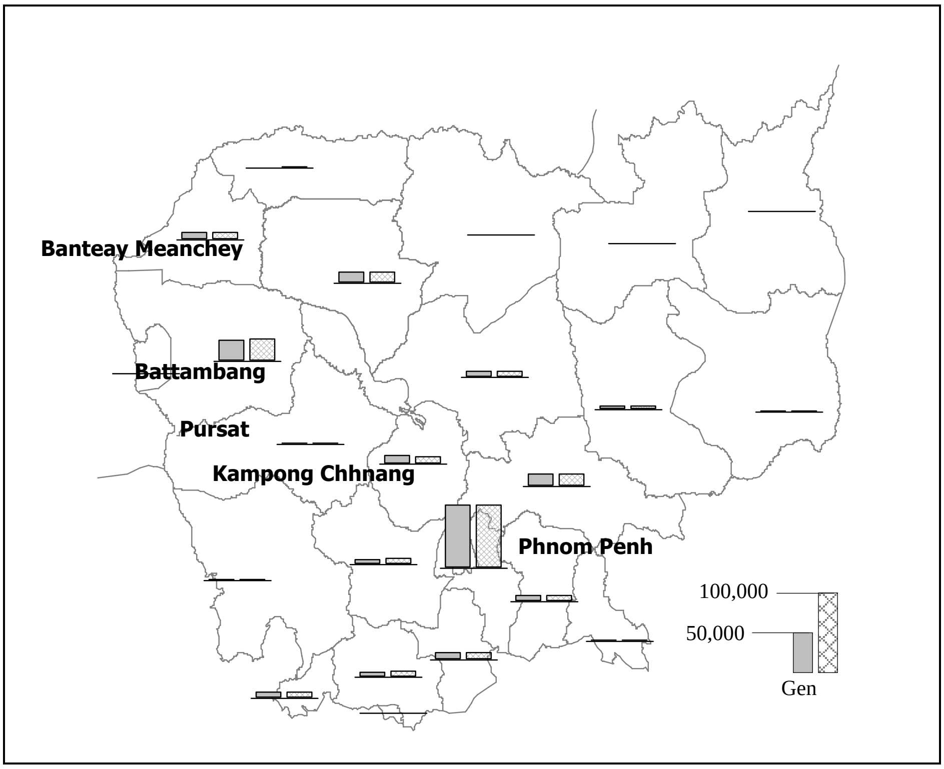


Figure 6.3-1 (2) Total Trip Production in 2016 (Total Vehicle)

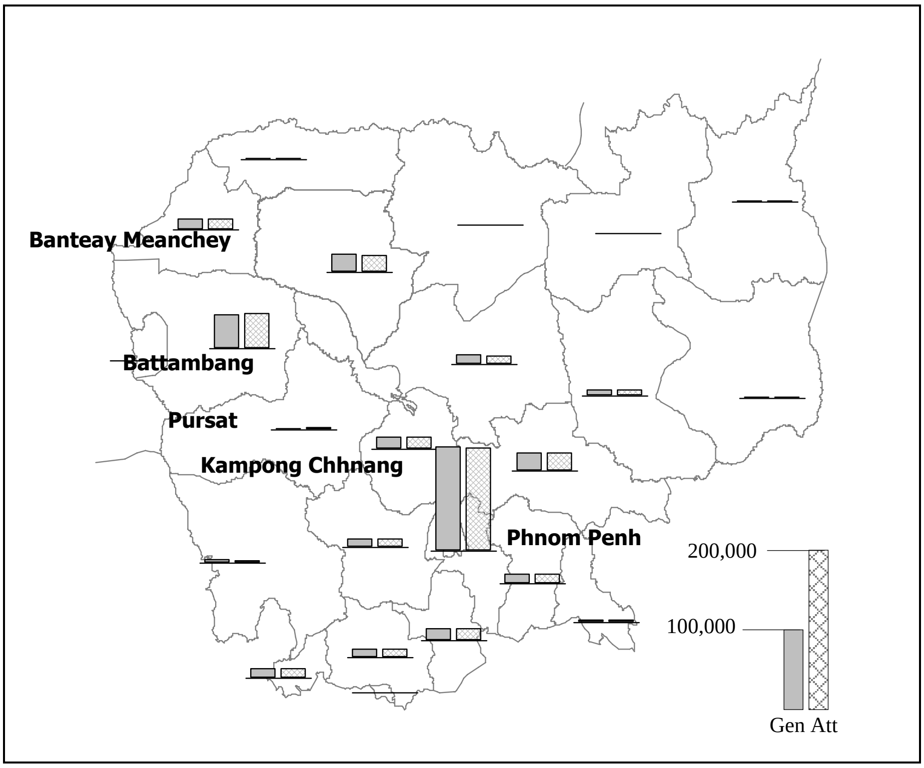


Figure 6.3-1 (3)　Total Trip Production in 2021 (Total Vehicle)

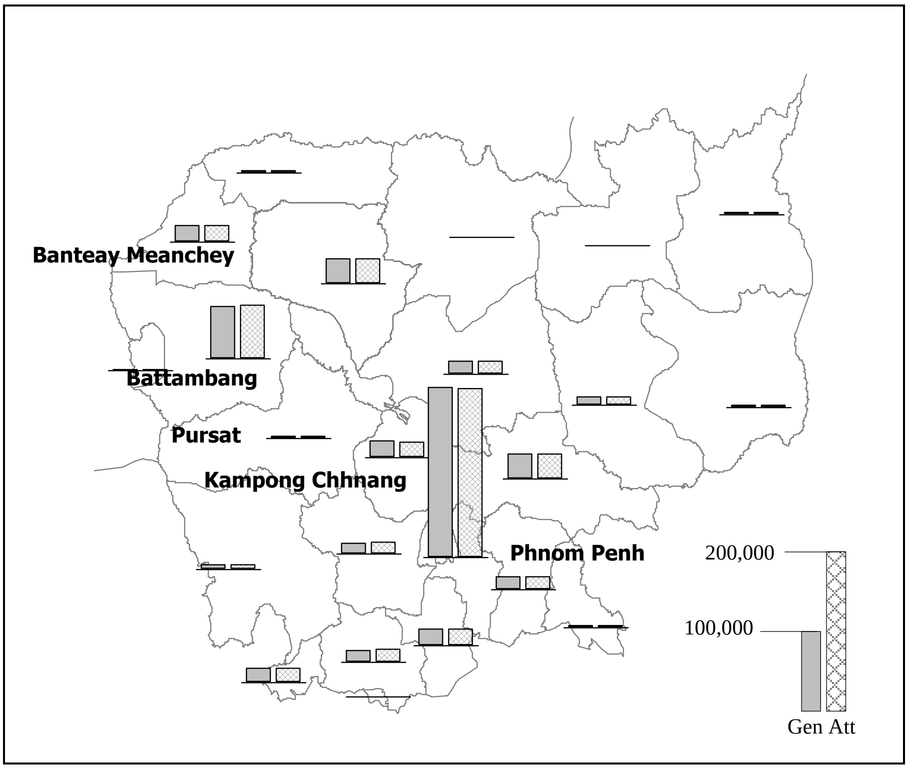


Figure 6.3-1 (4)　Total Trip Production in 2030 (Total Vehicle)

6.3.4 Modal Split

(1) Railroad

A railroad line (North Line) between Poipet and Phnom Penh, is running in parallel to NR 5. This railroad is currently being rehabilitated with a financial assistance of ADB. In this rehabilitation plan, 5 times a day of train operation is assumed in the future. However, type and volume of cargo to be transported by the railroad is not known at present. Therefore, diversion of cargo nor passenger from automobile to railroad is not taken into account in this traffic forecast, but considered in overall examination of forecasted traffic volume presented in Item (3) of Subsection 6.4.1 below.

(2) Bus Service

Many long-distance bus services are available on NR 5. It is not conceivable that the share of transport by such long-distance buses greatly increase in the future as the income level of the people will be upgraded. Therefore, diversion to long-distance bus service is not taken into account in this future traffic demand forecast.

(3) Inland Water Transport

An agreement to promote inland water transport was signed between the RGC and the government of Vietnam in December 2009. This will encourage the inland water transport along Mekong River, Tonle Sap River, Tonle Sap Lake and Bassac River. However the diversion of cargo or passenger from NR 5 to such inland water transport is considered to be limited. Thus, such diversion is not considered in this traffic forecast.

6.4 Traffic Demand Forecast

6.4.1 Traffic Assignment

(1) Methodology and Result

Traffic volume by road section in the future was estimated by traffic assignment program of JICA STRADA. JICA STRADA adopts ‘the minimum paths method’ in which the vehicles are assumed to take the path with the minimum cost (sum of travel time cost and vehicle operation cost) among the road links of the network connecting the pair of OD zones. Figure 6.4-1 (1) to Figure 6.4-1 (4) show the result of the traffic assignment for year 2016 and 2030.

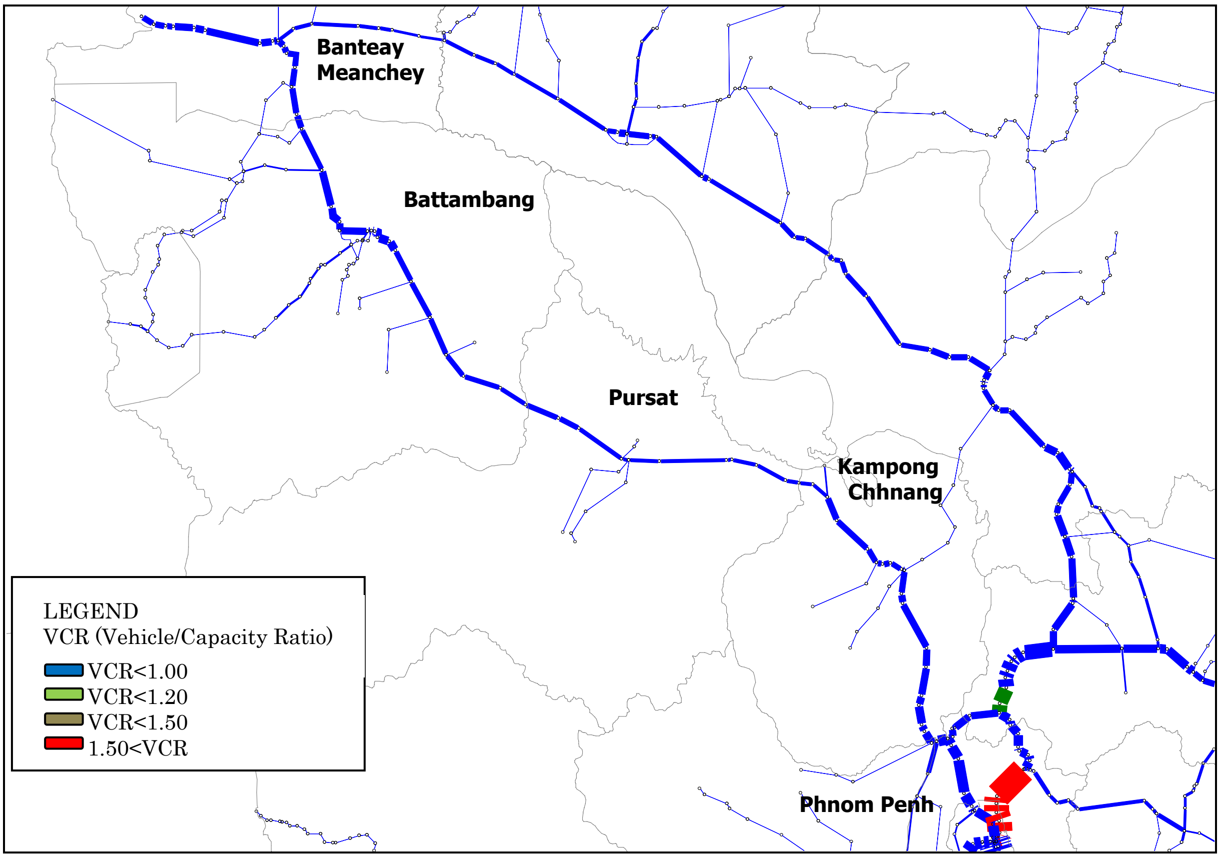


Figure 6.4-1 (1) Result of Traffic Assignment for Year 2011

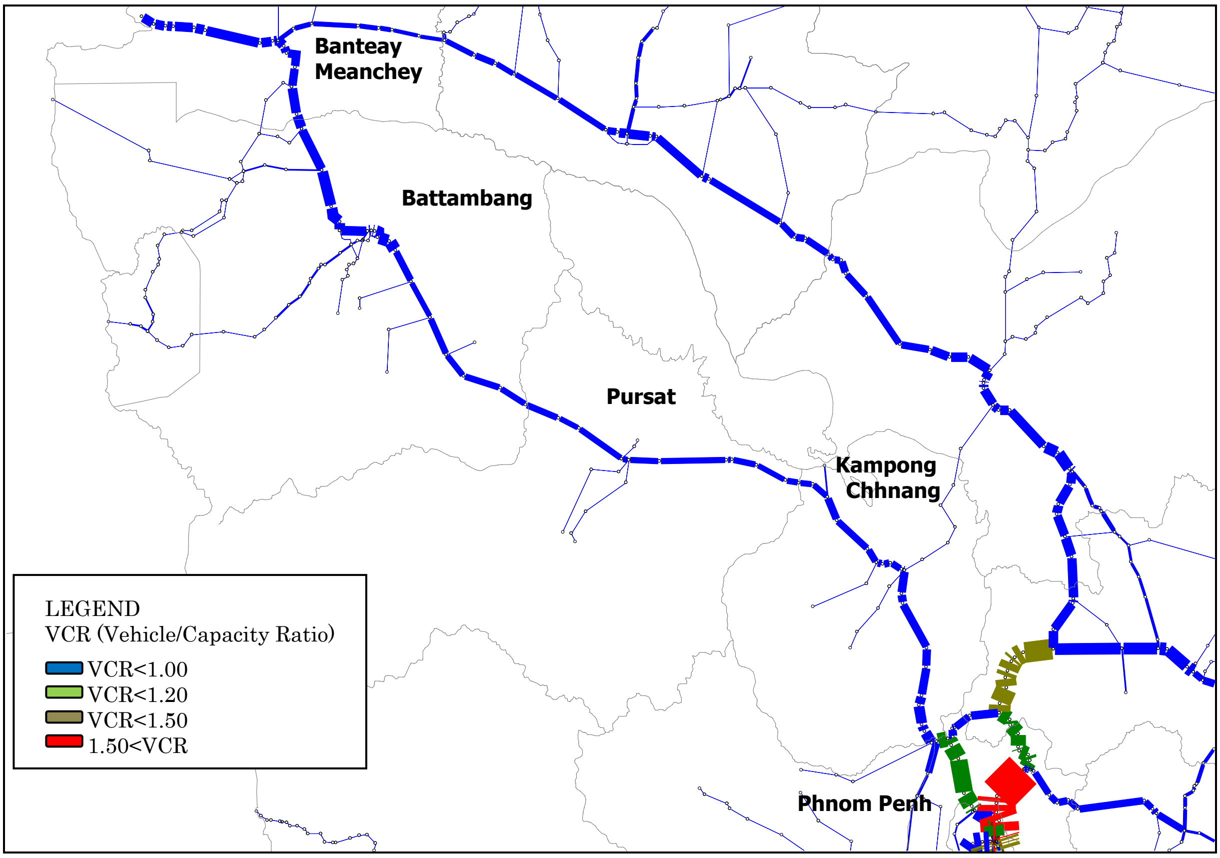


Figure 6.4-1 (2) Result of Traffic Assignment for Year 2016

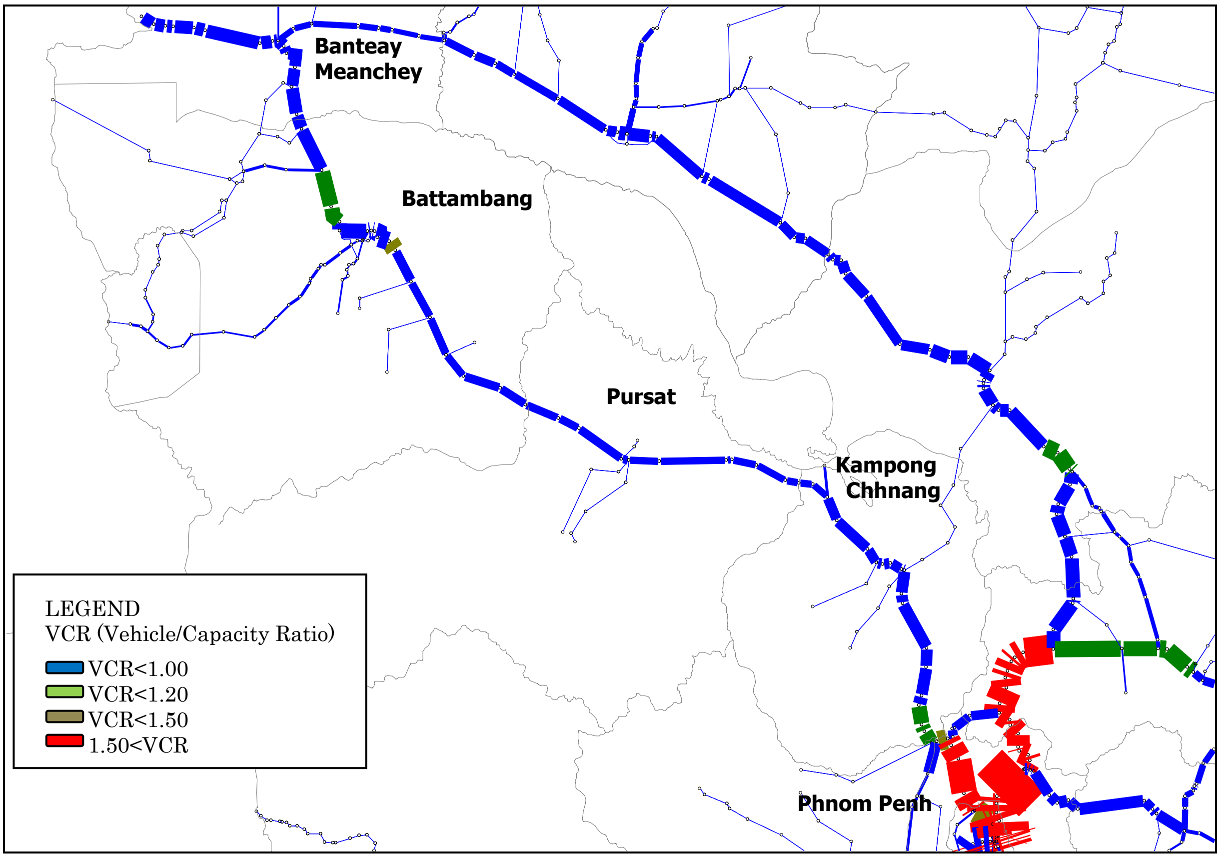


Figure 6.4-1 (3) Result of Traffic Assignment for Year 2021

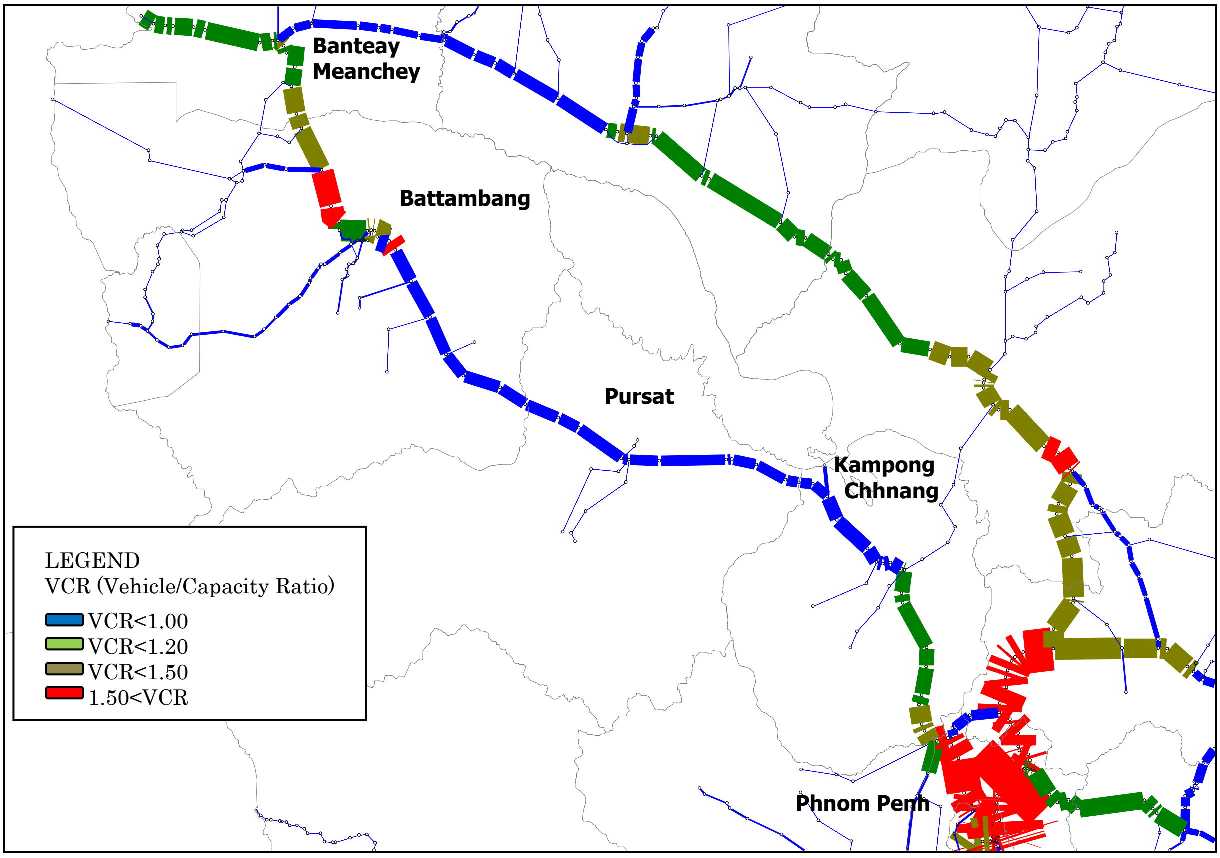


Figure 6.4-1 (4) Result of Traffic Assignment for Year 2030

Passenger Car Unit

In the traffic assignment, traffic volume is expressed in the form 'Passenger Car Unit' (PCU). The PCU equivalents used in this study are shown below.

Categories	MC	LV	HV
PCU Equivalents	0.30	1.25	3.00

Usually, PCU of sedan and pick-up truck is set at 1.0. In this Survey, PCU of Light Vehicle (LV) is set at 1.25 considering that this category includes light truck and pick-up truck whose speed are slower than passenger cars because of cargo and contribution to traffic congestion is larger than ordinary passenger car.

Table 6.4-1 lists the forecasted traffic volumes for years 2011, 2016, 2021 and 2030 at the traffic counting stations stated in Chapter 5. Traffic volumes by vehicle type for each target year are shown in Table 6.4-2.

Table 6.4-1 Result of Traffic Assignment

Unit: PCU

Section	Station No.	Year			
		2011	2016	2021	2030
South	1	10,612	14,720	20,641	28,637
	2	8,644	11,519	15,735	21,164
	3	7,426	10,001	13,775	18,947
	4	5,616	7,453	10,092	13,888
Middle (Boundary)	5	6,071	8,232	11,368	15,899
	6	12,052	17,556	25,625	36,834
North	7	9,065	13,545	20,090	29,464
	8	8,453	12,356	17,812	25,540
	9	8,983	12,734	17,794	23,861

Table 6.4-2 Traffic Volume by Vehicle Type

Unit: Veh.

Section	Station No.	2011					2016				
		MC	LV	HV	Total (Veh.)	PCU	MC	LV	HV	Total (Veh.)	PCU
South	1	5,797	3,520	1,491	10,808	10,612	8,907	4,706	2,055	15,668	14,720
	2	3,677	3,347	1,119	8,143	8,644	5,643	4,146	1,556	11,346	11,544
	3	3,890	2,298	1,129	7,317	7,426	5,977	2,770	1,587	10,334	10,017
	4	690	1,781	1,061	3,532	5,616	1,137	2,104	1,494	4,735	7,453
Middle (Boundary)	5	1,380	2,308	924	4,612	6,071	2,327	2,830	1,332	6,489	8,232
	6	12,523	3,250	1,411	17,184	12,052	21,263	4,168	1,989	27,420	17,556
North	7	8,807	3,297	734	12,837	8,965	15,030	4,646	1,096	20,772	13,605
	8	4,617	2,374	1,367	8,357	8,453	7,803	3,356	1,940	13,099	12,356
	9	3,903	3,636	1,089	8,628	8,983	6,403	5,542	1,505	13,451	13,364

Section	Station No.	2021					2030				
		MC	LV	HV	Total (Veh.)	PCU	MC	LV	HV	Total (Veh.)	PCU
South	1	13,880	6,464	2,799	23,143	20,641	21,003	9,027	3,684	33,715	28,637
	2	8,763	5,337	2,145	16,245	15,735	13,220	6,863	2,873	22,956	21,164
	3	9,297	3,530	2,191	15,018	13,775	14,033	4,729	2,942	21,704	18,947
	4	1,737	2,672	2,077	6,486	10,092	2,537	3,772	2,804	9,113	13,888
Middle (Boundary)	5	3,693	3,672	1,890	9,255	11,368	5,623	5,106	2,610	13,339	15,899
	6	34,713	5,554	2,756	43,024	25,625	54,063	7,612	3,700	65,375	36,834
North	7	24,647	6,492	1,527	32,666	20,090	38,560	9,253	2,110	49,923	29,464
	8	12,700	4,827	2,656	20,183	17,812	19,807	7,242	3,514	30,562	25,536
	9	10,220	6,970	2,005	19,195	17,794	15,700	9,162	2,566	27,428	23,861

(2) Verification of Result of Traffic Forecast

In order to verify the accuracy of the traffic volumes estimated by the above-described method, the estimated traffic volumes of 2011 at traffic counting stations, as shown in Table 6.4-1 above, are compared with the actually observed traffic volumes. Figure 6.4-2 shows the result of comparison. The figure indicates overall agreement between the estimated values and actually observed values, with a tendency that the estimated values are slightly smaller than observed values.

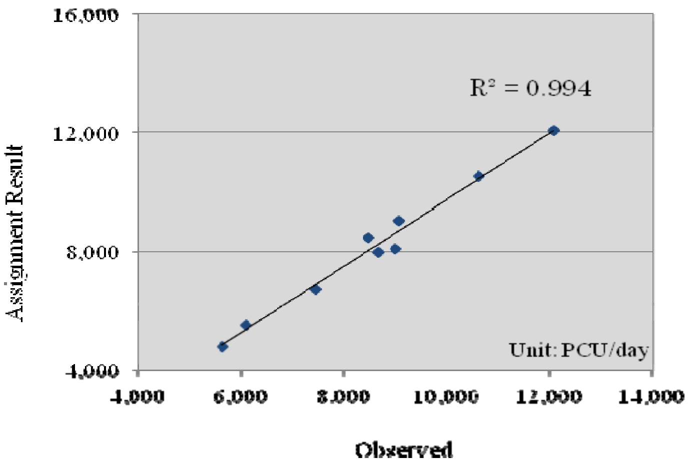


Figure 6.4-2 Verification Between Assignment Result and Actual Traffic Count

(3) Overall Examination of Forecasted Traffic Volume

As stated before, rehabilitation of the North Line of railroad is being implemented. Also, the plan of constructing a new road between Battambang and Siem Reap has recently been discussed. Ii is difficult to estimate the influences of these projects on the traffic demand of NR 5 since operation plan of railroad and route of the new road are not fixed yet. However, the influences of these projects are examined to see if there is any need of adjustment in overall plan of improvement of NR 5.

(i) Influence of Railroad

Based on the experiences of Japan, USA and European countries, as well as considering the routes and other conditions of rail transport and NR 5, the followings are assumed for estimation of diversion from road to railroad:

- ✓ Traffic of heavy vehicles with trip length longer than 100 km is considered to be possibly subject to diversion to rail transport.
- ✓ Considering modal shares of road and rail transports Japan etc, 10% of the above heavy vehicle traffic is assumed to divert to rail.

The result of calculation is shown in Table 6.4-3. Also, cases of 20% and 30% diversion are shown in the table as reference.

Table 6.4-3 Traffic Volume Diverted to Rail

Heavy Vehicle Traffic with Trip Length > 100 km (Year 2030)	Traffic Volume Diverted to Rail		
	Div. Rate: 10%	Div. Rate: 20%	Div. Rate: 30%
5,598 pcu	560 pcu	1,120 pcu	1,679

It should be noted that traffic volumes of ‘semi trailers’ and ‘full trailers’ actually observed at Station No. 5 and No. 7 are 194 vehicles/24 hr and 193 vehicles/24 hr, respectively (see Tables 5.1-5 and 5.1-6 in Chapter 5). With pcu factor of 3.0, these observed traffic volumes are converted to be around 580 pcu. Thus, 560 pcu, as calculated in Table 6.4-3, above is almost equivalent to the total traffic volume of semi trailers and full trailers observed in year 2011. Thus, the above calculation represents the situation where almost all the bulk and heavy cargo currently transported by semi trailers and full trailers divert to rail transport.

(ii) Influence of planned new road between Battambang and Siem Reap

The number of trips between the OD zones of Battambnag and southwards and Siem Reap and northwards is 2,187 pcu in year 2030. These trips can be assumed to divert to the new road.

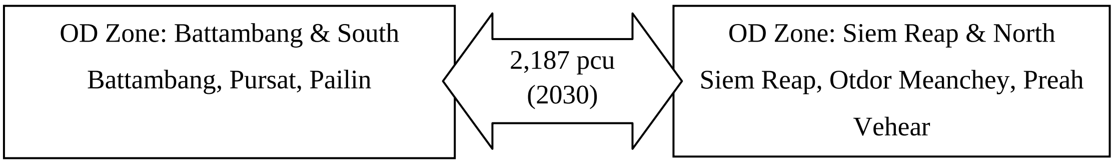


Figure 6.4-3 Trips Which can Divert to Planned Battambang – Siem Reap Raod

(iii) Total diversion traffic volume

From the above, the total of possible diversion traffic is calculated to be;

560 + 2,187 = 2,747 pcu.

The traffic volume on the North Section (Battambang – Sri Sophorn) in year 2030 is estimated at 25,540 pcu (see Table 6.4-1). Thus, the total diversion traffic volume is a little more than 10% of the traffic volume estimated in year 2030. Therefore, influence of the diversion to rail and new road does not give substantial influence to the overall plan of improvement of NR 5.

6.4.2 Peak Hour Traffic Volume and Congestion

Table 6.4-4 shows the traffic volumes in peak hour at the traffic counting stations. The degree of congestion expressed in the form of the ratio of traffic volume against traffic capacity of the road (v/c ratio or VCR). VCR of 0.85 is usually considered to be the allowable limit of congestion in road planning.

VCR in peak hour at Station No. 6 is anticipated to become 1.0 in year 2021. The location of station No.6 is within the urbanized area of Battambang City. Therefore, the traffic volume at station No.6 is considered to include the short trips within the city or around the city.

By year 2030, at all the counting stations except No. 2, No. 4, No. 5 and No. 9, VCRs exceed

1.0. Thus both the South Section and North Section need widening by that time.

Table 6.4-4 Peak Hour Traffic Volume and Congestion Degree

Sation No.	Peak Hour Volume (PCU)				Congestion Degree VCR				Lnk Capacity(hour)	No. of Lane
	2011	2016	2021	2030	2011	2016	2021	2030		
1	1103	1531	2146	2978	0.41	0.57	0.79	1.10	2700	1.5x2
2	948	1264	1726	2322	0.35	0.47	0.64	0.86	2700	1.5x2
3	781	1052	1448	1992	0.39	0.53	0.72	1.00	2000	2
4	565	750	1015	1397	0.28	0.37	0.51	0.70	2000	2
5	507	687	949	1327	0.19	0.25	0.35	0.49	2700	1.5x2
6	1276	1858	2712	3898	0.47	0.69	1.00	1.44	2700	1.5x2
7	772	1153	1710	2509	0.39	0.58	0.86	1.25	2000	2
8	821	1200	1729	2479	0.41	0.60	0.86	1.24	2000	2
9	711	1007	1408	1887	0.36	0.50	0.70	0.94	2000	2

It should be noted that **daily traffic volumes** at Stations No. 7 and 8 exceed, or approach, 20,000 PCU by year 2021 (see Table 6.4-1). 20,000 PCU is generally considered to be, or close to be, the capacity of an opposed 2-lane road. Thus, the traffic at these locations is anticipated to be congested. By year 2030, the daily traffic volume at stations No. 1, 6, 7 and 8 exceed, 25,000 PCU and widening of the North Section and the South Section will becomes absolutely necessary.

6.4.3 Traffic Volume on Bypass

One of the tasks included in the Scope of this Survey is to study the possibility of construction of bypasses around Kampong Chhnang, Battambang and Sri Sophorn. Table 6.4-5 shows the forecasted traffic volume on these bypasses.

Table 6.4-5 Future Traffic Volume on Bypass

Area	Section	2011	2016	2021	2030
Kampong Chhnang	Bypass	6,437	8,499	11,432	15,395
	Inner city	1,752	2,456	3,533	4,859
Battambang	Bypass	3,831	5,450	7,840	11,799
	Inner city	6,886	10,161	15,495	22,136
Sri Sophorn	Bypass	3,940	5,563	7,632	10,281
	Inner city	4,505	6,546	9,482	13,284

While the traffic volume on the bypass is almost three times of what goes into the city in Kampong Chhnang, the traffic volume going into the city of Battambang is much larger than that on the bypass. The larger traffic volume going into the city of Battambang may well be attributed to the fact that Battambang City is the core city of the region and attracts/generates traffic.

CHAPTER 7 NATURAL CONDITION SURVEY

7.1 Hydrological Condition and Record of Flood

Information on hydrology and flood was collected and analyzed to know the general condition of flood/inundation of NR 5. This is necessary mainly to compare the urgency for improvement of North, Middle and South Sections. Thus, the information presented here is based on preliminary survey and analysis.

7.1.1 Flood Condition Information obtained from Provincial DPWTs

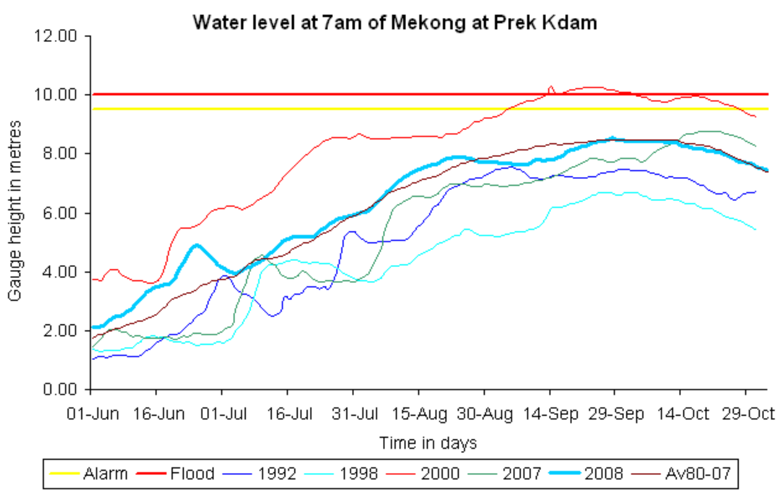
Flood condition and maintenance records were provided by four Provincial DPWTs of Kampong Chhnang, Pursat, Battambang and Banteay Meanchey. Table 7.1-1 shows the summary of flood prone areas obtained from respective DPWT.

Table 7.1-1 Flood Information Provided by Provincial DPWT

Province	Kampong Chhnang	Pursat	Battambang	Banteay Meanchey
Flood Prone Area KP (km)	83.0, 90.0 ~ 92.0 105.0 ~ 109.0	155.0 ~ 160.0	No	340.0 ~ 359.0

7.1.2 Water Level of Mekong River

Water level of Tonle Sap River at Prek Kdam, provided by Mekong River Commission (MRC), is shown in Figure 7.1-1. Figure 7.1-1 indicates that the highest water level has reached almost 10 m above the sea level in Year 2000. Based on this information, a 10 m contour line is drawn on Figures 7.1.2 (1) to (3). At some parts along NR 5, the 10 m contour line passes NR 5 into the mountain side (left side toward north) from Tonle Sap Lake. Generally the areas where the 10 m contour line passes are considered to be flood prone.



Source: Mekong River Commission

Figure 7.1-1 Water Level of Mekong at Prek Kdam

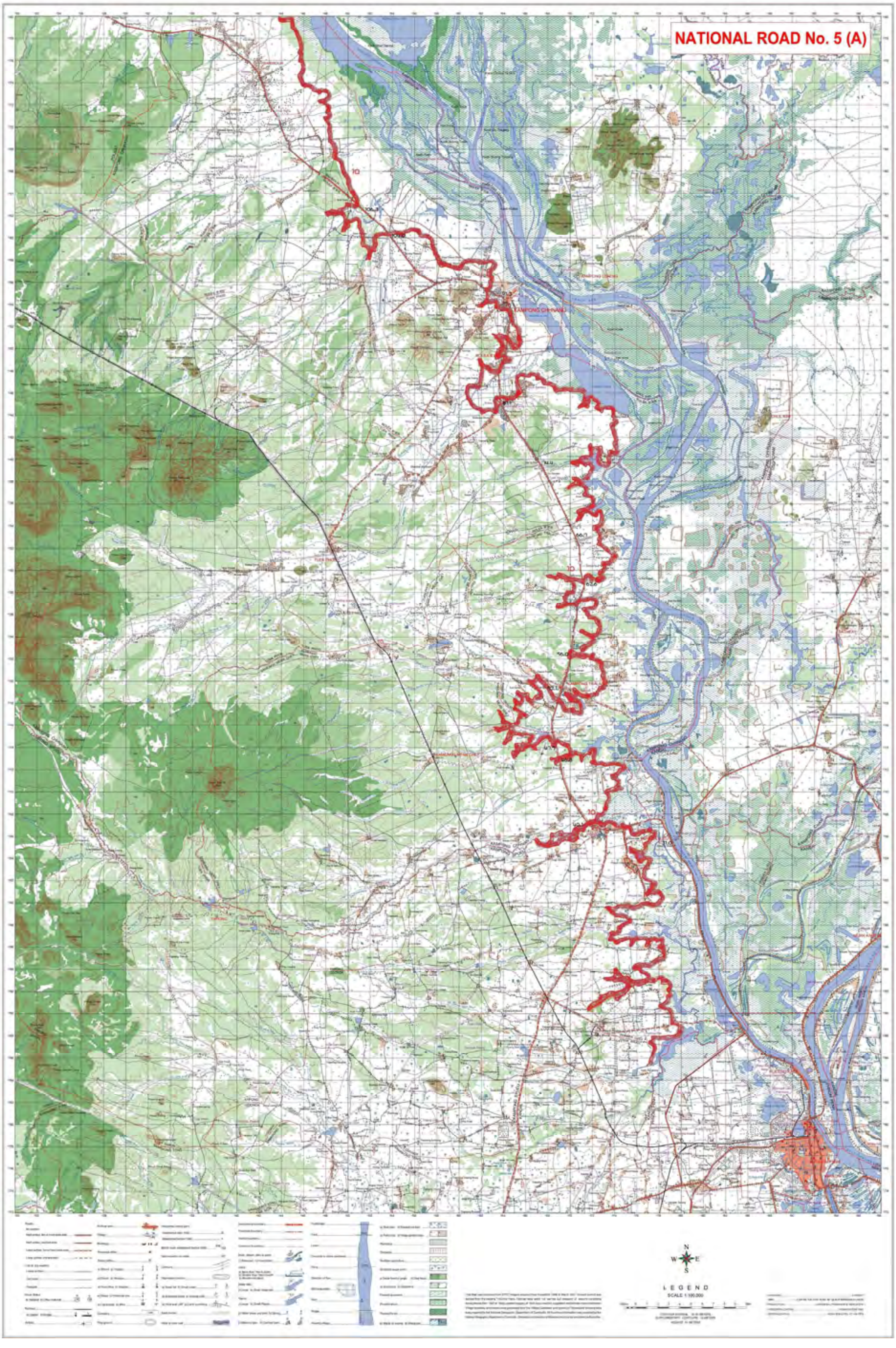


Figure 7.1-2 (1)   Flood Prone Area (1) Prek Kdam to Kampong Chhnang

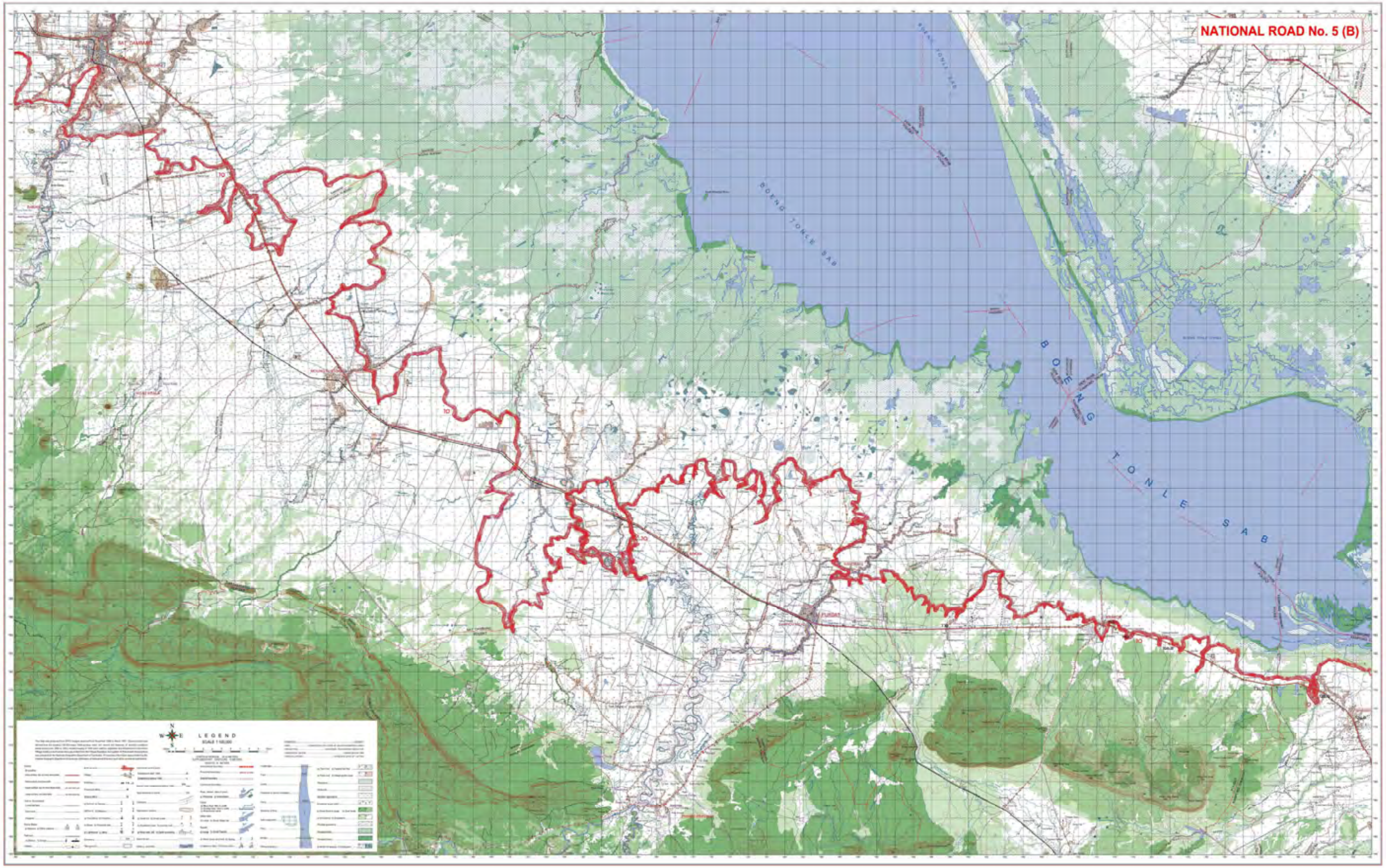


Figure 7.1-2 (2)   Flood Prone Area (2) Pursat

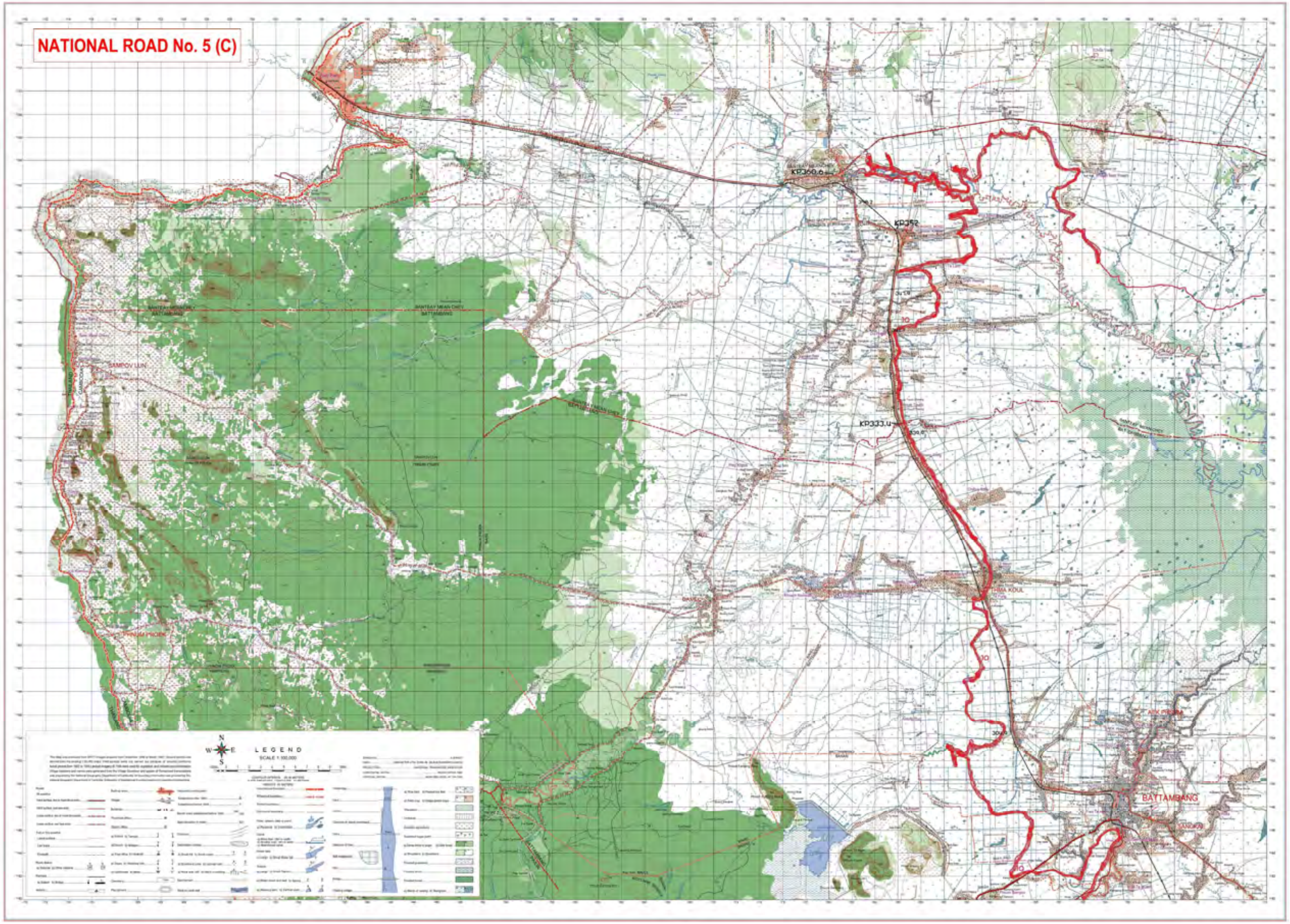


Figure 7.1-2 (3) Flood Prone Area (3) Battambang to Sri Sophorn

7.1.3 Hearing on Flood Condition from Residences along the Road

Flood prone areas were identified based on the information provided by Provincial DPWTs and Mekong River Commission. Then, the experiences of the local residents living in the identified flood prone areas were surveyed through the interviews to the local residents. Table 7.1-2 summarizes the information on flood provided by Provincial DPWTs and Mekong River Commission, and those obtained through the hearing from the residents. The information thus obtained is attached in Appendix 7-1. This information on the flood prone areas is to be taken into consideration in the preliminary design of road.

Table 7.1-2 and Table 7.1-3 show the sections where countermeasures for flood need to be taken into consideration in the design stage. Figure 7.1-3 shows the diagram of the information on flood.

Table 7.1-2 Flood Prone Area in South Section

Area	KP 40.1 to KP 62.2 (21.1 km)	KP 90 (0.2 km)	KP 155 to KP 160 (5 km)
DPWT Information	Not mentioned in the report	Yes.	Yes.
Ground Level 10 m below	Partly yes.	Yes.	No
Hearing at Site	Flood occurred at several locations.	Flood occurred.	Flood occurred.
General view	Generally low embankment		Generally low embankment

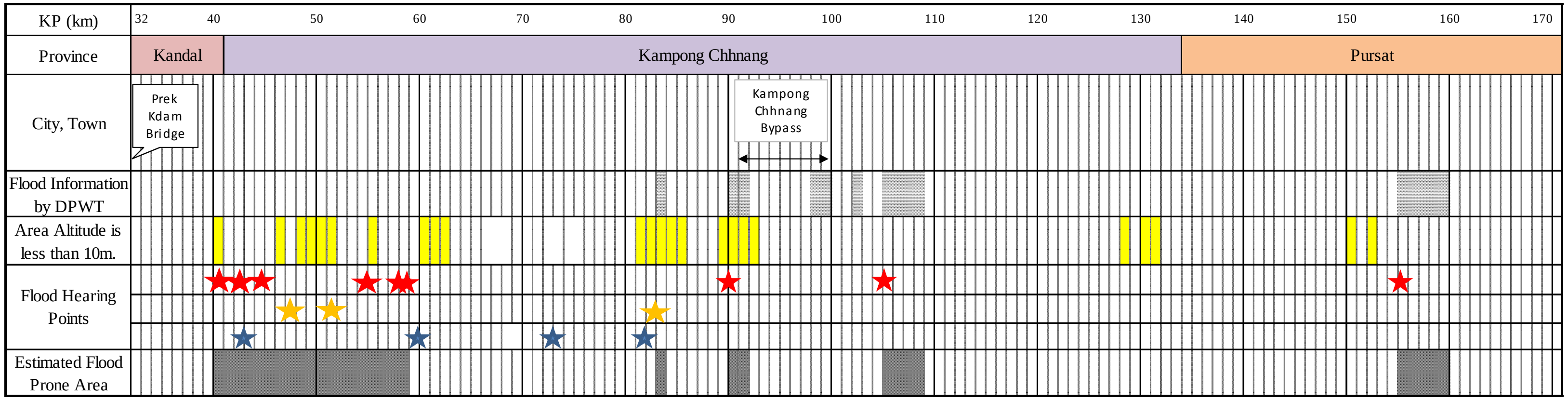
Table 7.1-3 Flood Prone Area in North Section

Area	KP 340 to KP 359 (19 km)
DPWT Information	Yes
Ground Level 10 m below	No
Hearing at Site	Flood occurred at several places
General view	River overflowed

Remarkable point to be address during detailed design shall be the place where the road was not passable for 1 month due to overflowed and stagnant water. Two (2) locations KP 351.5 and KP 356.1 both near the river were identified such umpassable location during flood hearing.

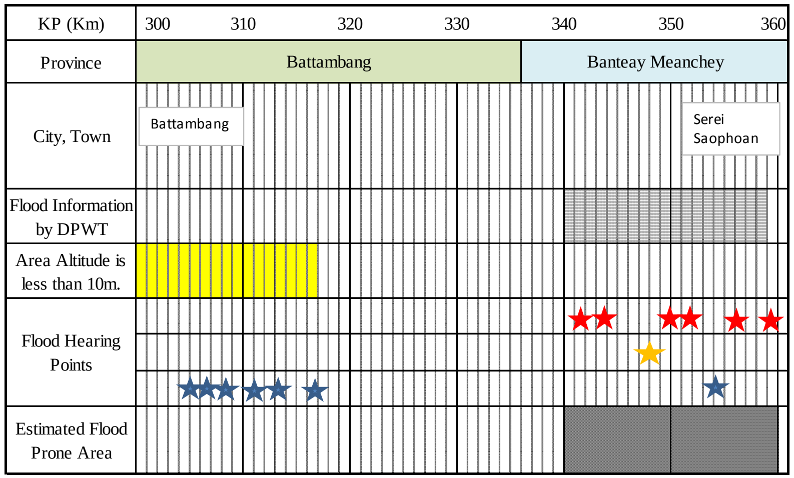
PREPARATORY SURVEY FOR NATIONAL ROAD No.5 REHABILITATION PROJECT

FLOOD SITUATION DIAGRAM SOUTH SECTION (PREK KDAM TO PURSAT)



★ : Water Level above Road Surface ★ : Water Level almost Same as Road Shoulder ★ : No Flood

FLOOD SITUATION DIAGRAM NORTH SECTION (BATTAMBONG TO SISOPHON)



★ : Water Level above Road Surface ★ : Water Level almost Same as Road Shoulder
★ : No Flood

DESCRIPTION OF FLOOD

SOUTH SECTION

★ Water Level above Road Level

KP(km)	Description of Flood
40.6	Rain water flow on the road, depth is 20-30cm. 1/Year, Every Year
42.7	Depth 10cm. 1/Year, Every Year. Flood Duration 2 weeks.
45.4	Depth 30cm. 1/Year. Duration 1 month. Before Development, no flood.
55	Depth 20cm. 1/Year. Every Year. Deration 1-2 days.
57.6	Depth 30cm. 1/Year. Duration 1 day.
58.8	Depth 1-2cm. 1/Year. Every Year. Duration 1-2 days.
90	Depth 1-2cm. 1/Year. 2010 only.
106.1	Depth 1-2cm. Intermittent sections.
155	Depth 5cm. 1/Year. Every Year. Duration 3 days.

NORTH SECTION

★ Water Level above Road Level

KP(km)	Description of Flood
341.7	River Overflow. Depth 30cm. Year 2010 only. Duration 15 days.
350	Depth 20cm. Year 2010 only. Flood Duration 2 weeks.
351.5	River Overflow. Depth 30cm. Year 2010 only. Duration 1 month.
356.1	River Overflow. Depth 30cm. Year 2010 only. Duration 1 month.
360	Depth 30cm. Year 2010 only. Duration 2-3 days.

Figure 7.1-3 Flood Situation Diagram

7.1.4 Estimated Flood Volume

Besides the water of Tonle Sap, substantial portion of flood on the southwestern side of NR 5 is supposed to be caused by run-off of the rain water falling on the area on the southeastern side of NR 5 which flows towards Tonle Sap across NR 5. If the cross-sectional area of the openings of NR 5 (bridges and culverts) is not sufficient, flow of the run-off water of rain may dammed up and cause flooding. Thus, relation between the volume of run-off and cross-sectional area of opening of NR 5 needs to be studied.

Volume of run-off of water is usually calculated by so-called 'Rational Formula', as shown below:

$Q = (C \cdot I \cdot A)/3.6$

Q: Water Volume (m^3/sec)
C: Coefficient of water flow
I: Intensity of precipitation (mm/hr)
A: Catchment area (km^2)

Rainfall data obtained from Mekong River Commission indicates highest daily precipitation of 173.5 mm for 10years (2000 to 2010), which is recorded in Year 2010. Based on this figure, it is presumed that the intensity of precipitation be 60mm/hr for return period 10 years. Coefficient of water flow of 0.7 is adopted for rice field area. Table 7.1-4 shows calculated water volume for specific area.

Table 7.1-4 Volume of Rain Water Run-Off

Area(km^2)	Intensity of Rainfall (mm/hr)	Coefficient of water flow	Water Volume (m^3/sec)
0.5	60	0.7	5.8
1	60	0.7	11.7
1.5	60	0.7	17.5
2	60	0.7	23.3
2.5	60	0.7	29.2
5	60	0.7	58.3

The above figures, after reviewing each factor used in the calculation, will be incorporated in the design of drainage in the detail design stage.

7.2 Geotechnical Investigation

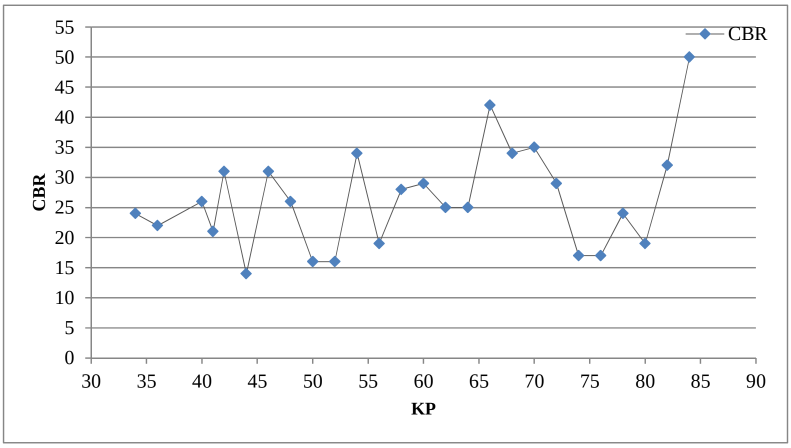
Geotechnical Investigation was conducted to obtain the data/information needed for the design of bridges. Thus, the geotechnical investigation was conducted for the North Section of NR 5, Battambang Bypass and Sri Sophorn Bypass after the priorities of these section/bypasses had been agreed between the Cambodian side and the JICA Survey Team on 12 May 2011.

7.2.1 CBR Test and Associated Soil Tests

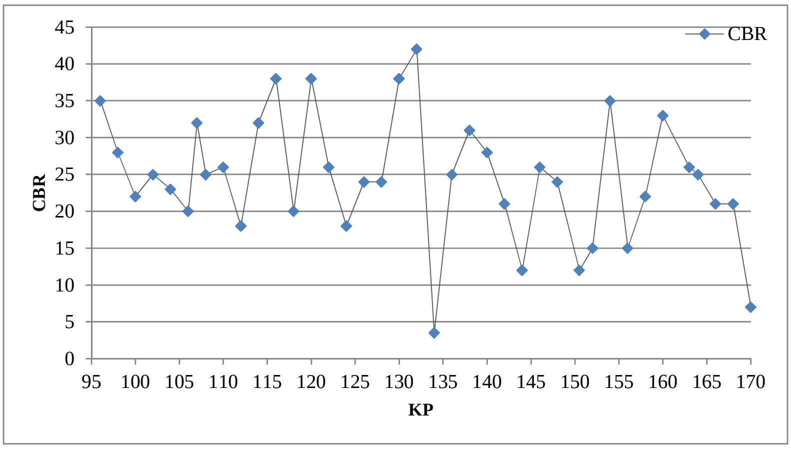
Test pitting and soil sampling were conducted at an interval of 2km along the NR 5 in South Section (Prek Kdam to Thlea ma'Am) and North Section (Battambang to Sri Sophorn) to know the characteristics of the subgrade soils. Thicknesses of bituminous material, base course and sub-base course were also measured at the sites and photos were taken as a reference.

Laboratory test including CBR, specific gravity, soil classification, Atterberg Limits and water content on the collected soil samples have been carried out. The results of these tests are summarized in Appendix 7-2.

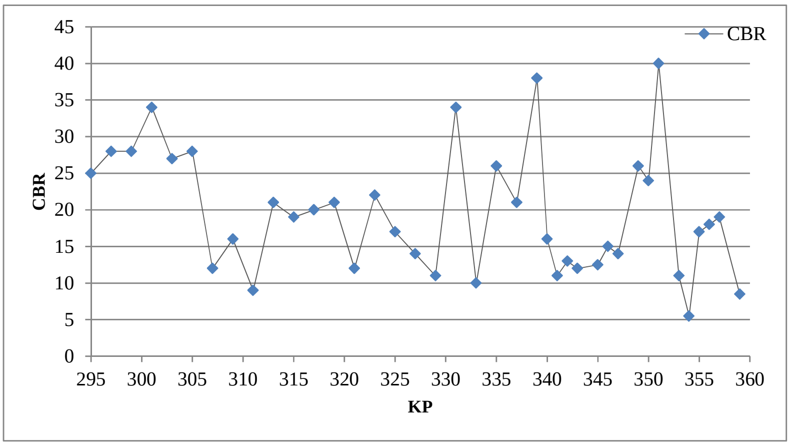
Figure 7.2-1 shows the CBR values of the subgrade soils along the road. The CBR values fluctuate in a wide range of less than 5 to more than 40.



Prek Kdam - Kampong Chhnang



Kamopong Chhnang - Pursat



Battambang – Sri Sophorn

Figure 7.2-1 CBR of Subgrade Soils

Variation of CBR values included No. of data, minimum, maximum and average values of CBRs are summarized in Table 7.2-1.

Table 7.2-1 Variation of CBR

Section	No. of Data	Minimum CBR(%)	Maximum CBR(%)	Average CBR(%)
South (Prek Kdam to K. Chhnang)	26	14	50	26.4
South (K.Chhnang to Pursat)	39	3.5	42	24.5
North (Battambang to Sri Sophorn)	39	5.5	40	19.0

Histogram of each section is shown in Figure 7.2-2.

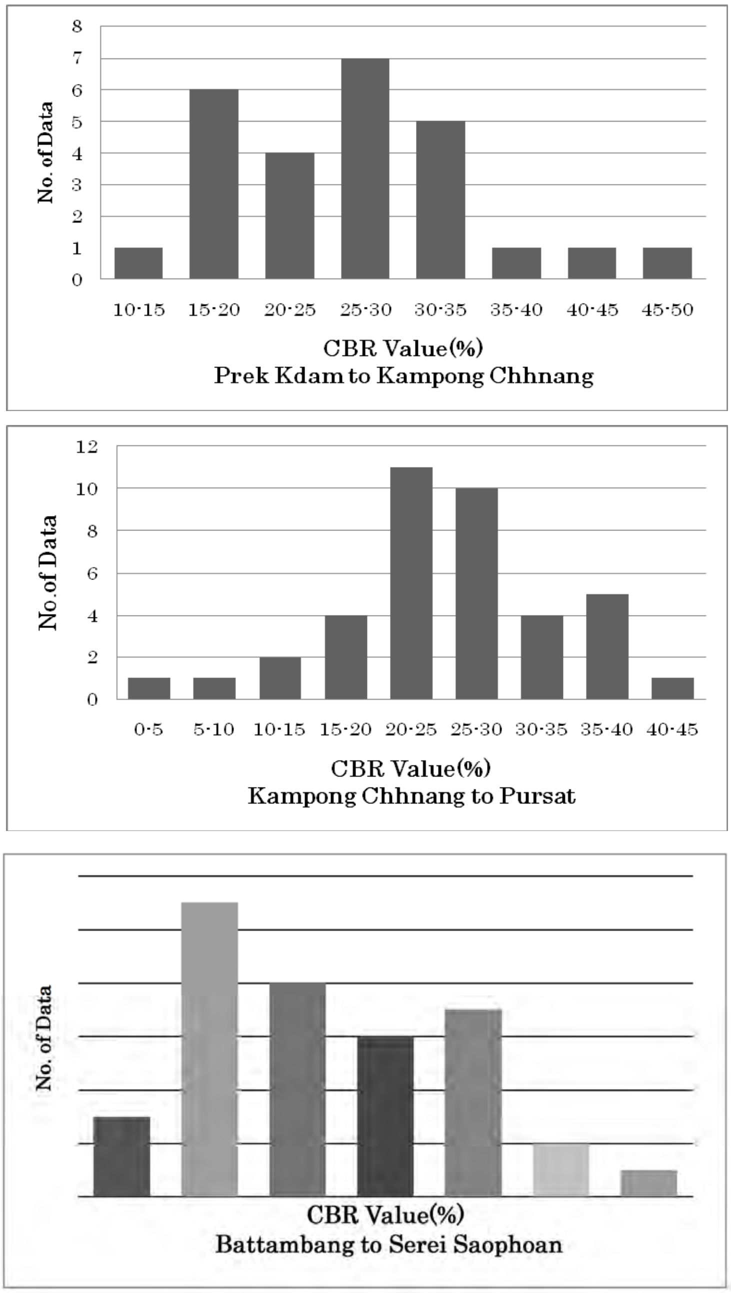


Figure 7.2-2 Histogram of CBR

CBR value of sub-grade both South and North Section show technically sound soil condition in term of road construction. However, particular small section shows weak soil layer which need to be addressed during Detailed Design.

7.2.2 Geotechnical Investigation for Bridges

Exploration borings were conducted at the proposed Battambang Bypass Bridge, 2 bridges on Sri Sophorn Bypass and seven (7) bridges along the National Road No. 5 from Battambang to Sri Sophorn. These borings were conducted to obtain the data needed for bridge planning after the North Section and two bypasses (Battambang and Sri Sophorn) were selected as priority sections. Table 7.2-2 shows the location of boring.

Table 7.2-2 Borehole Location

Province	Bridge/River	KP (km)	No of Boreholes	Location
Battambang	Br.79	303.4	1	LHS
	Br.80	304.8	1	LHS
	Br.82	311.9	1	RHS
Banteay Meanchey	Br.84	341.1	1	LHS
	Br.89	351.4	1	RHS
	Br.91	357.2	1	LHS
	Br.92/Sri Sophorn River	358.4	2	Each Bank LHS
Battambang Bypass	Sankae River	7.6	2	Each Bank
Sri Sophorn Bypass	Steung Tauch River	4.63	2	Each Bank
	Mongkol Borei River	12.71	2	
Total No of Bore Holes			14	
Total Length of Borings			350 m	

The main points of the obtained data are as summarized below:

(1) There are no hard layer within 25 m from the surface. Hard layer means N-value on SPT is more than 50.
(2) Characteristic of soil is generally clayey-silt and sandy-silt.
(3) N-value varies from 2 to 15 in 10 m from surface, and from 10 to 30 from 10 m to 25 m
(4) Friction pile foundation can be considered in new bridge design based on the laboratory test result.

Each SPT and Laboratory test results are shown in Appendix 7-3.

7.3 Topographical Survey

7.3.1 Topographical Survey of National Road No. 5

Topographical Survey of existing National Road No. 5 was carried out by Aerial Photo Survey. Aerial Photo Survey was conducted to prepare digital map to be used in the road design as described in Chapter 10. In this survey a propeller equipped paraglider was used, in place of airplane. Use of paraglider makes the entire schedule of the survey flexible since the flight schedule of a paraglider does not need the approval of the authority for aviation and can be adjusted to weather and other conditions more flexibly than an ordinary airplane.

Table 7.3-1 summarizes the outline of the activities of aerial photo survey.

Table 7.3-1 Description of Activities of Aero Photo Survey

Aerial Photo	Length of Road: 210 Km
	Scale: 1/5000 (Overlap 60%, Side lap 30%)
	No of Photos: 1200 pcs
Ground Survey Control Point	50 points
Digital Mapping	Scale: 1/2000
	Mapping Area 21,000,000 m2 (210,000 m x 100 m)

7.3.2 Topographical Survey of Battambang Bypass and Sri Sophorn Bypass

Topographical survey on the selected routes of Battambang Bypass Route and Sri Sophorn Bypass was conducted for preliminary road design and cost estimation.

Details and output of the topographical survey are shown in Tables 7.3-2 and 7.3-3 for road section, Tables 7.3-4 and 7.3-5 for the bridge survey.

Table 7.3-2 Survey Item and Output for Road Section

Survey Item	Description
Control Point Setting	Setting Control Points approximately 2 km interval. Coordination and Elevation should be provided.
Road Center Line Survey	Setting Center line 50 m interval, IP, BC, EC shall be set out.
Longitudinal Survey	Longitudinal survey along center line, 50 m interval and changing points shall be surveyed.
Cross Section Survey	Cross section survey interval 50 m, changing points within 30 m both side of road shall be surveyed
Mapping	Survey houses, culverts, trees, objects and terrain within 30 m both side of road

Table 7.3-3 Output of the Survey

Item	Description
Road Plan	Scale: 1/1000. Contour Line 1m each. Road elements and coordinates shall be indicated.
Longitudinal Section	Scale: Horizontal 1/1000, Vertical 1/100. Water level of river/canal shall be indicated.
Cross Section	Scale: 1/200. Fence, house, canal etc shall be drawn.

Table 7.3-4 Survey Item for Bridge

Survey Item	Description
Longitudinal Survey	Longitudinal survey along center line, 10 m interval and changing points shall be surveyed. Within 50 m from center of bridge both side to be surveyed
Cross Section Survey	Cross section survey interval 10 m within 50 m both side from center of bridge along the road, changing points within 50m both side of centerline shall be surveyed
Mapping	Survey houses, culverts, trees, objects and terrain within 50 m both side of road. Elevation of bore hole for soil investigation shall be surveyed.

Table 7.3-5 Output of the Survey

Item	Description
Road Plan	Scale: 1/250. Contour Line 1m each.
Longitudinal Section	Scale: 1/250. High Water level shall be indicated.
Cross Section	Scale: 1/200. Fence, house, canal etc shall be drawn.

CHAPTER 8 EVALUATION OF EXISTING ROAD CONDITION AND PRELIMINARY SELECTION OF SECTION TO BE REHABLITATED

Considering the limit of amount of the possible loan and other constraints, the three sections need to be prioritized for implementation. Selection of the section of NR 5 to be rehabilitated and the bypass to be constructed is to be made through the consultation between RGC and JICA during the project appraisal process by JICA. The task assigned to the Survey Team is to evaluate the present condition of NR 5 and show priorities of the South, Middle and North Sections for rehabilitation, as well as priorities of Battambang and Kampong Chhnang Bypasses for construction. Thus, the term ‘preliminary selection’ is used in this report.

This chapter discusses evaluation of the existing condition of NR 5 in order to consider the necessity and urgency of rehabilitation or improvement and construction of bypass based on the information available at the time of preparation of the Interim Report in early May 2011.

8.1 Criteria for Prioritization of Three Sections of Existing NR 5

Criteria for prioritization of the three sections (South, Middle and North) of existing NR 5 are proposed as described in Table 8.1-1.

Table 8.1-1 Criteria for Prioritization

Criteria	Description	Reason
Traffic Demand/ Traffic Congestion	Existing or anticipated traffic congestion	Smooth traffic is the most important reason for road improvement.
Existing Road Condition	· Existing conditions of geometric structure, pavement and other road facilities · Condition inundation/flood	Bad condition of existing road hampers smooth and safe transportation.
Difficulty/Easiness of Implementation	· Land acquisition/relocation (acceptance by stakeholders) · Difficult technical/ engineering problem	Negative factors need to be taken into consideration.
Relation with Other Project	· Improvement by other project · Modification in timing of implementation etc. to cope with other relevant projects, if any	Existing road conditions and/or other criteria are influenced.

Table 8.1-1 briefly explains the reason for proposing each criterion. These reasons are further explained below:

(i) Traffic Condition

One of the main objectives of rehabilitation/improvement of NR 5 is to avoid traffic congestion, especially congestion in the near future, and secure smooth and safe traffic, which in turn, contribute to socio-economic development of region and whole nation.

(ii) Existing Road Condition

Existing road condition is taken into consideration to identify problems which is hampering, or is anticipated to hamper in the future, smooth and safe traffic.

(iii) Relation with Other Project

As described in Chapter 4, several repair/maintenance works are being, or have been, implemented on the South Section. Improvement of pavement executed shortly after completion of these repair/maintenance works is considered as 'double investment' and should be avoided. Also, execution some other projects may interfere execution of this Project.

8.2 Evaluation of Existing Road Condition

The situation of NR 5 is evaluated considering the criteria for prioritization as sited above. Followings are evaluation of existing NR 5.

8.2.1 Traffic Condition

The results of the future traffic forecast as described in Chapter 6, the traffic congestion is anticipated in the future at the locations listed below:

Table 8.2-1 Summary of Anticipated Traffic Congestion

Year	Location	Station No.	Description of Congestion
By 2021	South Section (Prek Kdam)	1	・VCR in peak hour approaches 0.8 and congestion is anticipated in peak hour. ・Daily traffic volume exceeds 20,000 PCU and congestion is anticipated substantial periods of day time.
	Middle Section (South end of Battambang City)	6	・Daily traffic volume exceeds 25,000 PCU and congestion is anticipated substantial periods of day time.
	North Section	7, 8	・VCR in peak hour exceeds 0.85 and congestion is anticipated in peak hour.
By 2030	South Section	1	・Daily traffic volume exceeds 28,000 PCU and severe congestion is anticipated substantial periods of day time.
		2	・Daily traffic volume exceeds 21,000 PCU and congestion is anticipated substantial periods of day time.
	Middle Section (South end of Battambang City)	6	・Daily traffic volume exceeds 36,000 PCU and traffic is paralyzed.
	North Section	7, 8	・Daily traffic volume approaches 25,000 PCU and congestion is anticipated substantial periods of day time.

It should be noted that the location of No. 6 is in the southern suburbs of Battambang City and thus, it coincides with the boundary between the Middle Section and North Section. It should also be noted that Counting Station No.6 is located in the southern suburbs of Battambang City, and thus, the traffic volume at this location includes short-trip traffic as substantial portion.

8.2.2 Existing Road Condition

(1) Geometric Structure/Road Width

The horizontal and vertical alignments of existing NR 5 are generous in general, although there are some sections with substandard sharp curves. This situation is common to the three sections (North, Middle and South Sections).

On the other hand, the widths of the North Section (Battambang – Sri Sophorn) and Kampong Chhnang – Thlea Ma'Am Section of the South Section are 7.7 to 7.8 meters and considered to be insufficient for 4-wheel vehicles to overtake motorcycles. (Please see Subsection 3.1.2.)

In view of increasing traffic volume, both in 4-wheel vehicles and motorcycles, separation of sow vehicles (motorcycles) and fast-going vehicles (4-wheel vehicles) is essential for enabling smooth and safe traffic.

From this viewpoint, widening of the North Section and South Section is more urgent than that of Middle Section considering that the road width of Middle Section is 10.4m. However this does not mean the width of Middle Section is sufficient. Rather, widening of the Middle Section is also necessary especially for traffic safety.

(2) Pavement Condition

Pavement conditions are generally acceptable, although many defects such as depression and cracks are actually observed. However this does not necessarily mean that the strength of the existing pavement is sufficient. Rather, the strength of existing pavement, in general, is not sufficient to support the increasing traffic volume, especially that of heavy vehicles. Also, frequent inundation and subsequent reduction in bearing capacities of the pavement/subgrade is accelerating the deterioration of the pavement.

Although the pavement is maintained in a acceptable condition owing to the strenuous effort of MPWT and Provincial DPWTs, such maintenance will become heavy burden in the near future in many ways such as budget requirements, workload of contacting and supervision of maintenance works and traffic management during the implementation of maintenance works.

This situation is more or less same among the North, Middle and South Sections.

(3) Bridge Condition

As discussed in Chapter 3, twelve bridges need to be replaced for various reasons. Table 8.2-2 shows the number of bridges which need to be replaced. Replacement of bridges requires relatively large cost and thus, the number of bridges which need replacement is taken in to consideration in evaluation of priority.

Table 8.2-2 Number of Bridge Which Need to be Replaced

Section	South	Middle	North
No. of Bridges to be Replaced	6	4	2

(4) Inundation

The results of the survey on inundation are summarized in Table 8.2-3.

Table 8.2-3 Summary of Survey Result of Inundation

Section	South			Middle	North
Location (KP)	40.6, 42.7, 57.6	45.7	55, 58.8, 90, 106.1	155	341.7 - 360
Water Depth	10 – 30cm	30cm	1 -5 cm	5cm	20 – 30cm
Frequency	1/ Every Yr.	1/ Every Yr.	1/ Every Yr.	1/ Every Yr.	2010 only
Duration	1 day – 2 weeks	1 month	1 – 2 days	3 days	2 days – 1 month

The severest inundation is that of KP 45.7. According to the local residents, the inundation started after a training center had been constructed nearby NR 5. Malfunction of side ditch is suspected as the cause of the inundation. If this is the case, the inundation may be mitigated by recovering the function of the side ditch.

Inundation of the North Section happened only once in year 2010. Some special cause is suspected.

8.2.3 Summary of Evaluation

The evaluations described above are summarized in the table below:

Table 8.2-4 Summary of Evaluation

	North Section	Middle Section	South Section
Geometric Structure	Narrow width	Narrow width in Pursat – Thlea Ma'Am	Width is generally OK
Pavement	Insufficient strength with weakening due to inundation on several sections		
No. of Bridges to be Replaced	2	4	6
Traffic Congestion	･Congestion by 2021 (in the south end of Battambang City) ･Congestion by 2021 for whole North Section	Congestion is not anticipated before 2030, except near the boundary with North Section (in the southern suburbs of Battambang City)	Congestion in peak hour anticipated near Prek Kdam by 2021
Inundation	･Only in year 2010	Only light inundation at limited location	Severe inundation is occurring at KP 45.7, but may be mitigated by improvement of side ditch

8.3 Preliminary Selection of Section to be Rehabilitated

8.3.1 Comparative Evaluation of Priority

(1) Prioritization of South, Middle and North Sections of Existing NR 5

Table 8.3-1 shows the application of the priority criteria stated in Subsection 8.1 above. It should be noted that the number of houses or families and area of land acquisition was not known at the time of this evaluation was made (August 2011), and thus, cannot be evaluated.

As indicated in Table 8.3-1, **the North Section is evaluated to have the highest priority** for rehabilitation.

Table 8.3-1 Priority of Three Sections of Existing NR 5

Criteria	Evaluation and Reason		
	North Section	Middle Section	South Section
Traffic Demand/ Traffic Congestion	◎ ・ Congestion by 2021	△ ・ Some congestion is anticipated by 2030	○ ・ Congestion on the south end (Prek Kdam) by 2021
Existing Road Condition	○ ・ Narrow width ・ Insufficient pavement strength ・ Some sharp curves ・ Inundation	△ ・ Insufficient pavement strength	○ ・ Narrow width on Pursat – Thlea Ma'Am section ・ Insufficient pavement strength ・ Inundation
Influence of Other Project	○ Nothing particular	○ Nothing particular	× ・ Existing serious pavement defects are to be repaired in RAMP: Large-scale rehabilitation in the next few years becomes 'double investment'. ・ There is a possibility that Chinese government improves/ widens the section near Prek Kdam.
Overall Evaluation of Urgency	Very High	Medium	Very High: Considering that various repair/maintenance works are being implemented, the priority is evaluated next to North Section.

8.4 Further Discussion on the Selection of Section to be Improved

Initial selection of priority section was made by the time of preparation of Interim Report in May 2011. In September – October 2011, severe flood/inundation occurred in many places in Cambodia and several sections of the South Section were damaged, giving rise to discussion on the priority. This section is added to further discuss the issue of priority, focusing on the priorities of the North Section and South Section.

Although the discussion here focuses on the improvement of the North and South Sections, it is implicitly assumed in the following discussions that improvement of the Middle Section be implemented in the future, considering that the entire length of NR 5 needs to be improved because of the importance of NR 5 as an international and national arterial road.

8.4.1 Strategy for Improvement

There are a few strategies which are commonly considered in planning of road network development:

(1) Continuity with already-improved section

Experience in Japan shows that road improvement give larger impact to traffic if the improved section is continuous, rather than fragmented, and connected to a large city. From this viewpoint, two scenarios for improvement of NR 5 are possible:

(i) Start from Phnom Penh: This is the most straightforward policy in view of the above.

(ii) Start from Sri Sophorn: In view of increasing international traffic between Cambodia and Thailand, as well as the fact that Sri Sophorn – Poipet Section has been already improved, this scenario is also justifiable. Especially, if seen from the viewpoint of Thai drivers, improvement of the North Section will give an impression of ‘continuity’.

Further, it is recommended that improvement of the Middle Section be implemented without time lag from improvement of the North Section and South Section to maintain ‘continuity’ over the whole section of NR 5.

(2) Traffic demand versus development effect

When multiple number of road projects are planned and priority of implementation is discussed, there are two main opinions:

(i) Economic effect: Road improvement projects, like any other type development project, give large impact to the local/regional economy. In many countries, public works are used as a tool to stimulate regional economy and national economy. From this viewpoint, a road project implemented in less developed region is given higher priority than those implemented in developed region such as Phnom Penh and its surroundings.

(ii) Traffic demand: On the other hand, there is an opinion that road improvement needs to be implemented to cope with the traffic demand and thus, should be started from the section with high traffic demand. From this viewpoint, the South Section should be given higher priority than the North Section.

The above two opinions are considering completely different effect of road projects and it is difficult to decide which is more important. However, one thing may be said in case of NR 5:

Most congested section of NR 5 is Phnom Penh – Prek Kdam. Severe traffic congestions are occurring every day on this section, especially near Phnom Penh. Basic solution to this congestion is widening of Prek Kdam – Phnom Penh Section and development of alternative routes such as NR 51 – NR 42 route and Kop Slov Dike Road. Without such improvements, simple widening of the South Section will amplify the congestion on Prek Kdam – Phnom Penh Section.

Actually it is very difficult to show the difference of priority between the North Section and South Section in a strictly quantitative manner. The JICA Team compared several factors and evaluated that the priority of North Section is higher than that of South Section as explained in the previous section. But this is relative comparison between North Section and South Section. It should be noted that the necessity for improvement is also very high in both of South and North Sections.

8.4.2 Timing of Implementation of Improvement

Timing of implementation of In usual road planning, capacity of the road is planned so that the planned traffic volume is around 65% of the capacity or less to ensure smooth traffic flow. Usually 20,000 pcu is considered to be the capacity of opposed 2-lane road. Thus, opposed 2-lane roads need to be widened before traffic volume reach to around 13,000 pcu to ensure smooth traffic.

As explained in Chapter 13, completion of improvement works are estimated in year 2017, if the civil works are to be started in year 2015 (see Table 13.3-1). Traffic volume on the North Section (Station No. 8) is estimated to reach 13,000 pcu around year 2017, coinciding with the expected completion year of the Project.

Table 8.4-1 Traffic Volume on the North Section

Year	2011	2016	2017 (Interpolated)	2021	2030
Traffic Volume (pcu)	8,453	12,356	13,447	17,812	25,540

Thus, it is justified to start the civil works for improvement of the North Section in year 2015, and a loan is extended to the Project of improvement of the North Section.

8.5 Necessity and Prioritization of Bypasses

8.5.1 Necessity and Priorities of Battambang Bypasses and Kampong Chhnang Bypass

(1) Necessity of Bypass in General

The main reasons for constructing a bypass are as described below:

- Common textbooks on road network planning state that through traffic should be guided, as much as possible, to detour the urbanized area. This is necessary to avoid traffic congestion, traffic accidents and deterioration of living environment (noise and air quality).
- Even without serious traffic congestion in urbanized area, travel speed of vehicles becomes slower in urbanized area due to traffic lights and other causes. This situation will cause considerable time loss of long trip and cause unnecessary transport cost.
- Also, a street would become excessively wide if it is to cater both intra-urban traffic and through traffic. An excessively wide street would separate the communities on the both sides of the street and hamper sound social and economic activities.
- Quite often, bypass becomes the outer boundary of the city in the long future. Properly planned bypass can help desirable form of urban development.

(2) Necessity of Battambang Bypass

Construction of bypass around the city of Battambang is considered to be necessary for the following reasons:

- Traffic volume in the city of Battambang is very large and is expected to further increase in the near future. Actually, DPWT Battambang is implementing widening of streets in the city area. However, widening of streets cannot be regarded as a good measure for mitigating traffic congestion in the city, considering the reasons for the necessity of bypass as sited above.
- Traffic volumes on NR 5 in the outskirts of the urbanized area of Battambang City are forecasted to exceed the capacity of a 2-lane road by year 2021. To secure smooth traffic flow (V/C <0.65), Battambang Bypass becomes necessary before 2016.

Table 8.5-1 Future Traffic Volume in the Outskirt of Battambang City

Location	Traffic Volume	2016	2021	2030
Southern Outskirt (Sta. 6)	Traffic Volume	17,556	25,625	36,834
	V/C*	0.878	1.28	1.84
Northern Outskirt (Sta. 7)	Traffic Volume	13,545	20,090	29,464
	V/C*	0.68	1.00	1.47

*Ratio of traffic volume to capacity of road section: Full capacity of 2-lane road (20,000 pcu/day) is assumed. V/C larger than 0.65 is not desirable from viewpoint of smooth traffic.

(3) Necessity of Kampong Chhnang Bypass

Reasons explaining necessity of a bypass as described in (1) above can be applied also to Kamong Chhnang Bypass. Thus, Kampong Chhnang Bypass is necessary. However, the forecasted traffic volume around Kampong Chhnang City is smaller than that around Battambang and estimated to exceed the capacity of a 2-lane road around year 2030. To secure smooth traffic flow, Kampong Chhnang Bypass becomes necessary around year 2020.

Table 8.5-2 Future Traffic Volume in the Outskirt of Kamopong Chhnang City

Location	Traffic Volume	2016	2021	2030
Southern Outskirt (Sta. 2)	Traffic Volume	11,519	15,735	21,164
	V/C*	0.58	0.79	1.058
Northern Outskirt (Sta. 3)	Traffic Volume	10,001	13,775	18,947
	V/C*	0.50	0.69	0.95

*Ratio of traffic volume to capacity of road section: Full capacity of 2-lane road (20,000 pcu/day) is assumed. V/C larger than 0.7 is not desirable from viewpoint of smooth traffic.

(4) Comparison of Priority Between Battambang Bypass and Kampong Chhnang Bypass

The priorities between Battambang Bypass and Kampong Chinanng Bypass are compared as described below:

- Traffic volume around Battambang City is larger than that around Kampong Chhnang City.
- Especially the traffic volume in the southern suburbs of Battambang City is the largest among those forecasted at eight locations, and is anticipated to greatly exceed the capacity of the road by 2021.
- If the North Section is to be rehabilitated, supervision of construction of Battambang Bypass is easier than that of Kampong Chhnang Bypass because it is adjacent to the North Section.

Based on the above consideration, **Battambang Bypass is evaluated to have higher priority.**

The final decision of the section to be rehabilitated, as well as the bypass to be constructed, is to be made during the process of appraisal of the Project where RGC and JICA Appraisal Mission will consult.

The above opinion of the Survey Team on the priorities was explained in the 1st Steering Committee held on 12 May 2011 and accepted by the Committee. Upon return to Tokyo after the 1st Steering Committee, the Survey Team explained to JICA the above priorities and JICA accepted the Team's explanation. With these consent of RGC and JICA, the Survey Team focused on the North Section and Battambang Bypass.

(5) Necessity of Sri Sophorn Bypass

Sri Sophorn Bypass was initially proposed by Province of Banteay Meanchey. The main reason of this proposal was to avoid relocation of large number of houses and people which would become necessary if the North Section would be widened to 4-lane up to the intersection with NR 6.

DPWT of Banteay Meahchey also explains that the number of heavy truck coming from Thai border and pass through the city of Sri Sophorn has been increasing especially during night. This is causing noise and vibration during night, as well as hazardous situation for traffic accident.

These are typical reasons necessitating construction of bypass, rather than widening of existing streets in the city, as explained before.

Further, the traffic volume on Sri Sophorn Bypass is estimated to be considerably large and is comparable to that on Battambang Bypass.

Table 8.5-3 Traffic Volume on Sri Sophorn Bypass and Battambang Bypass

City	Section	2011	2016	2021	2030
Sri Sophorn	Bypass	3,940	5,563	7,632	10,281
	Inner city	4,505	6,546	9,482	13,284
Battambang	Bypass	3,831	5,450	7,840	11,799
	Inner city	6,886	10,161	15,495	22,136

Thus, construction of Sri Sophorn Bypass is judged to be justified.

CHAPTER 9 PLANNING OF BYPASS ROUTE

9.1 Planning of Battambang Bypass

Based on the agreement for this Survey between RGC and JICA, the priorities of Kampong Chhnang Bypass and Battambang Bypass were studied in the 1st Stage Survey. According to the results of traffic demand forecasts and other data, it was concluded that Battambang Bypass has a higher priority than Kampong Chhnang Bypass and it was accepted by the Steering Committee that this Survey focuses on Battambang Bypass. Also, necessity of Battambang Bypass was explained in Subsection 8.5.1.

9.2 Alternatives

(1) Alternative Routes Proposed by DPWT Battambang

Prior to the commencement of this Survey, DPWT Battambang already proposals for the bypass route as shown in Figure 9.1-1 by the blue lines. These proposed routes are planned along the existing roads. The main features of the alternative routes proposed by DPWT Battambang are as follows:

(i) Bypass is constructed by widening the existing road/streets.
(ii) Thus, the residents along the bypass benefit.
(iii) Legally, the land used for the existing roads need not to be acquired. Thus, acquisition is needed only for the land taken for widening.
(iv) The subgrade of the existing roads/streets has been compacted during the long period that these roads/streets have been used. Thus, compaction is not required.

(2) Alternative Routes Proposed by JICA Team

The JICA Team proposed three other alternative routes as shown by the red lines in Figure 9.2-1. The alternative routes proposed by the JICA Team are to traverse mainly agricultural land and minimize the number of houses or other buildings to be relocated. The main features of the alternative routes proposed by the JICA Team are follows:

(i) Minimize relocation of houses and other buildings.
(ii) To fully achieve the function of bypass which is to allow the through traffic detour the urbanized area and sustain this function as long as possible.
(iii) The bypass practically defines the boundary of future urbanized area. Thus the route is selected so that sufficient space be provided for future development of Battambang City

Advantages and disadvantages of these alternatives are compared in Table 9.2-1.

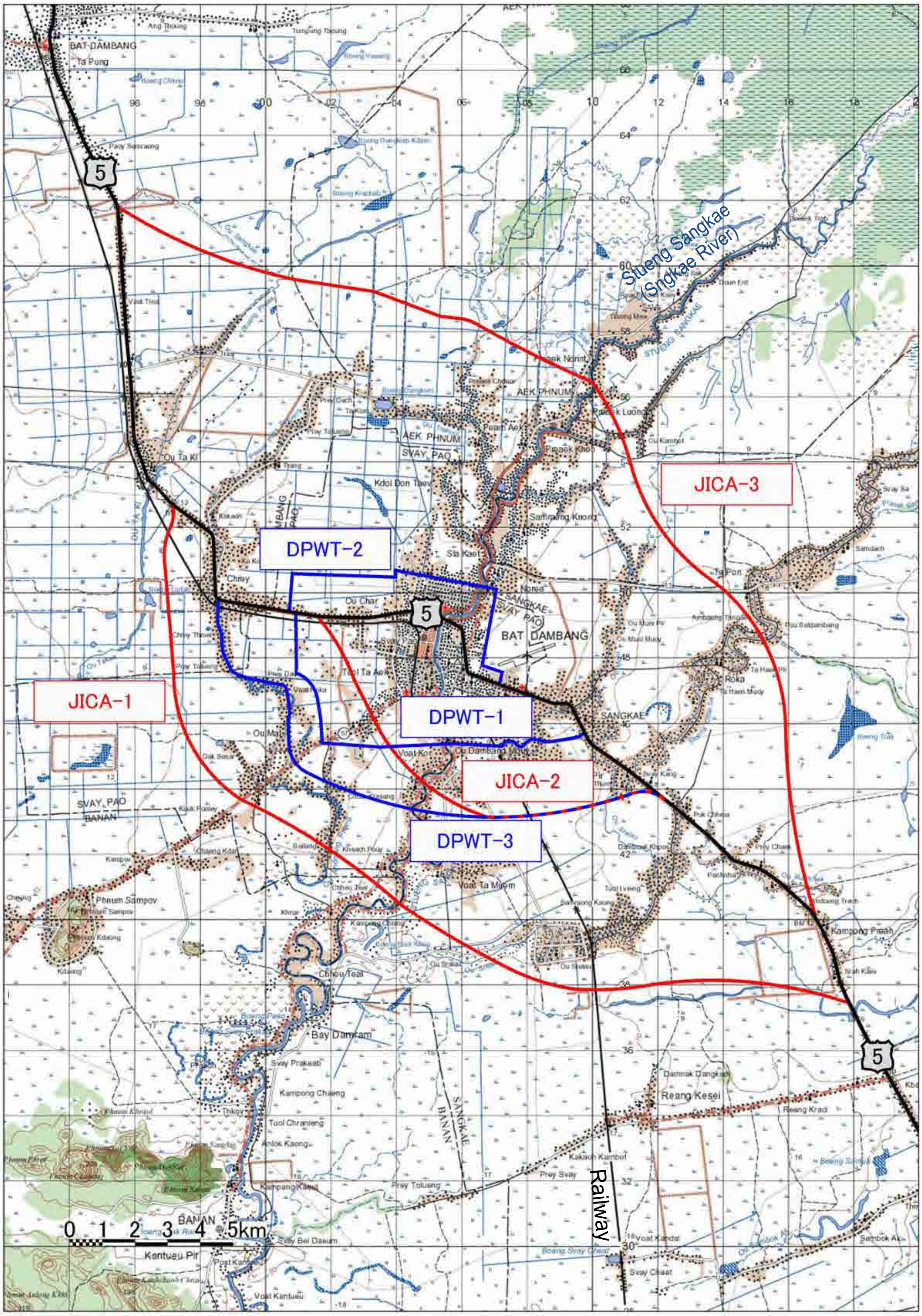


Figure 9.2-1 Alternative Routes of Battambang Bypass

Table 9.2-1 Comparison of Alternatives of Battambang Bypass Routes

Alternative	Length (km)	Estimated No. of Relocated House/Bldg.*	Advantage	Disadvantage
DPWT-1	13	180	✓ Owners of properties (houses and/or land) want the road in front of their properties be improved. Thus, this alternative is welcomed by these people.	✓ Large number of houses/buildings need to be relocated. ✓ Through traffic still passes through urbanized areas resulting in increase of traffic congestion and traffic accidents. ✓ Horizontal alignment is not smooth and prospects of traffic congestion and traffic accidents are considered to be more than those in JICA-1 to JICA-3.
DPWT-2	11	400	✓ Same as above	✓ Same as above
DPWT-3	18	360	✓ Same as above	✓ Large number of houses/buildings need to be relocated. ✓ Through traffic enters urbanized area resulting in increase of traffic congestion and traffic accident.
JICA-1	30	80	✓ The basic function of bypass road which is to allow through traffic to bypass the urbanized area is well achieved. ✓ The route is remote from the urbanized area and the above function of bypass will be maintained in future.	✓ Route is longer than JICA-2 resulting in larger project cost. ✓ Considerable area of agricultural land is lost.
JICA-2	14	70	✓ The basic function of bypass road which is to let through traffic bypass the urbanized area is well achieved.	✓ As the urbanized area will expand in future, the 'function as bypass' will be lost or reduced. ✓ Considerable area of agricultural land is lost, although

			✓ Shortest among the alternatives proposed by JICA Team resulting in the minimum project cost.	smaller than that in JICA-1,
JICA-3	34	50	✓ The basic function of bypass road which is to let through traffic bypass the urbanized area is well achieved. ✓ Estimated number of houses/buildings to be demolished is the least among the alternatives.	✓ Traverses the vicinity of the conservation area of Tonle Sap Lake. Thus, some impact on the natural environment may occur. ✓ There is a possibility that the highway embankment will disturb the hydrological environment of Tonle Sap Lake and/or its vicinity. ✓ Length traversing soft ground area and the total route is the longest among the alternative routes resulting in the largest project cost.

*The number of demolished house/building is based on the preliminary survey conducted in the early stage of this Survey when required ROW is not fixed. Thus, the numbers shown here are subject to change in the future depending on the detailed design of the road and detailed survey on the houses/building which need to be demolished.

9.3 Preliminary Selection of Optimum Route

A stakeholder meeting was held on 19 May 2011, with the participation of 14 people including three representatives from MPWT and chaired by H.E. Vice Governor of Battambang Province. Route of the bypass was one of the main subjects for discussion at the meeting. The comment of H.E. Governor of Battambang Province made at the meeting was that Alternative JICA-3 is the most preferable from the viewpoint of future development of Battambang City. However, the MPWT staff and their consultant explained that Alternative JICA-3 traverses the designated conservation area of Tonle Sap Lake and its vicinity and there is a possibility of adverse impact on the natural environment. The MPWT staff and their consultant also explained that Alternative JICA-3 passes through a soft ground area and the construction cost may be higher than the other alternatives proposed by JICA Team.

After discussion among the participants, as well as upon communication to H.E. Governor through the Chairperson (H.E Vice Governor), the following order of preference was concluded:

- 1st preference: JICA-1
- 2nd preference: JICA-2

9.4 Adjustment of Alignment

(1) Fine adjustment of JICA-1 alignment

Prior to the departure from Japan for the 2nd Stage Survey, the JICA Team undertook a fine adjustment of the JICA-1 alignment to reduce the numbers of houses/buildings to be demolished. This adjustment was done with the use of 1:2000 scale satellite images. The adjusted routes are shown in Figure 9.4-1.

JICA-1A1:
Shift the alignment at Point-A to make the crossing angle with the existing road and residential area on the both sides of the road as close to a right angle as possible to shorten the length of the section traversing the residential area and reduce the number of houses/buildings to be demolished.

JICA-1A2:

Shift the section between Steung Sangkae and the railroad to the southwest direction to cross the residential area along the existing local road at a point away from urbanized area where the houses/buildings are assumed to be sparsely distributed. The JICA Team visited the site of Battambang Bypass on 23 and 24 June 2011 to observe the actual situation of houses/building located along the proposed route of bypass. The JICA Team also met the Director of DPWT

Battambang, on 23 June 2011, to confirm that JICA-1 is the 1st choice of Battambang Province and this was confirmed.

After the meeting with the Director of DPWT Battambang, the JICA Team visited the sites of the above two alternatives, and concluded that JICA-A2 is more preferable than JICA-1A1 because of the smoothness of horizontal alignment and smce there is very little difference in number of houses/buildings to be demolished.

(2) Comment by H.E. Governor of Battambang Province

While the JICA Team was visiting the site, a further comment from H.E. Governor was transmitted to the JICA team indicating that the governe prefers the bypass route to be located not too far from the urbanized area was transmitted to the JICA Team.

(3) New alignments

Upon receipt of the above comment by the Governor, the JICA Team reexamined the alignment of JICA-1 and found two possible new alignments as shown in Figure 9.4-1 as JICA-1B and JICA-1C.

Among these two new alignments, JICA-1B is evaluated to be less advantageous than JICA-1A and JICA-1C for the following reason:

- The location of the intersection with the existing NR 5 to the south of Battambang City is the same as that of JICA-1C.The refore the effect on traffic flow is the same as JICA-1C (less than that of JICA-1A), while the route is longer than JICA-1C resulting in higher construction cost than JICA-1C.

Thus, JICA-1B is discarded at this stage and JICA-1A and JICA-1C are compared. Advantages and disadvantages of these two alternatives are summarized in Table 9.4-1.

(4) Selection of JICA-1C

As a whole, JICA-1A is preferable from the view point traffic flow bypassing the urbanized area of Battambang while JICA-1C is preferable from the view point of the traffic starting from or arriving in the urbanized area of Battambang. These features can be said only when the two alternatives are compared with each other and neither of them has a serious disadvantage as a bypass in view of the flow of traffic or future development of Battambang City.

Finally, the JICA Team recommended the JICA-1C route as the best choice to mto consideration the opinion of HE Governor of Battambang. MPWT consulted DPWT of Battambang on the selection of the bypass route and concluded that JICA-1C is also the most preferable.

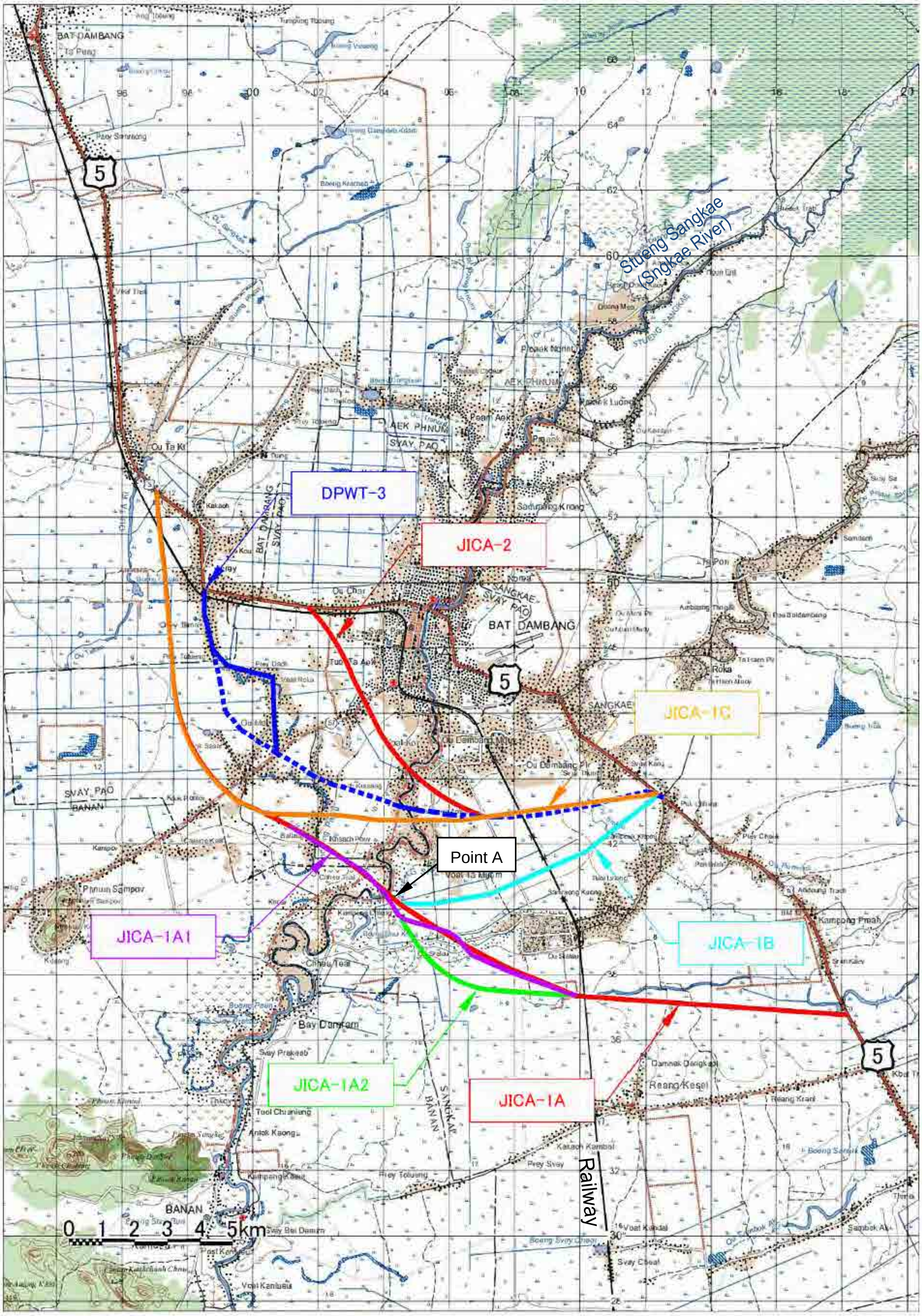


Figure 9.4-1 Adjustment of Alignment

Table 9.4-1 Comparison of JICA-1A and JICA-1C

Alternative	Length	Advantage	Disadvantage
JICA-1A	30 km	✓ Widening of Battambang City – Ou Sanda (KP 273) is not necessary. ✓ Travel distance between Sri Sophorn and Phnom Penh is shorter than that of JICA-1C. ✓ The function of bypass (smooth traffic) will be maintained in the long term. ✓ There is sufficient space for expansion of Battambang City in the long term.	✓ South connection point with existing NR 5 is far from existing urbanized area of Battambang City. ✓ Thus, this may have less desirable influence on the expansion of Battambang City in the short term or medium term. ✓ Higher construction cost
JICA-1C	23 km	✓ South connection point with existing NR 5 is near to the existing urbanized area of Battambang City ✓ Thus, this will contribute to expansion of Battambang City in short term or medium term. ✓ Lower construction cost	✓ Widening of Puk Chhma (KP 280) – Ou Sanda (KP 273) will be necessary in future. ✓ Travel distance between Sri Sophorn and Phnom Penh becomes longer than that of JICA-1A. ✓ The long term., urbanized area of Battambang will expand and the function of bypass (smooth traffic) will be reduced. ✓ The long term, expansion of Battambang City will be limited to the bypass.

- JICA-1A is preferable from viewpoint of long distance traffic and city development in the long term.
- JICA-1C is preferable from viewpoint of traffic around Battambang City and medium-term city development.
- Differences of advantages and disadvantages between the two alternatives are not large.
- Thus, both alternatives are technically feasible plans.

9.5 Planning of Sri Sophorn Bypass

During the Second Steering Committee held on 30 August 2011, the Cambodian side requested JICA to add study on the construction of Sri Sophorn Bypass to the scope of the Project. Construction of Sri Sophorn Bypass can reduce the traffic in the urbanized area of Sri Sophorn City and widening of the existing NR 5 can be minimal. Decrease in the required ROW for widening is expected to substantially decrease the number of houses and households that will be affected. After several discussions among RGC and JICA, JICA agreed to the proposal and added study of Sri Sophorn Bypass to the scope of work of the JICA Team. Necessity of Sri Sophorn Bypass is also explained in Subsection 8.5.1.

9.5.1 Alternatives

(1) Routes Proposed by DPWT Banteay Meanchey

The plan of DPWT Banteay Meanchey was to construct the bypass connecting western suburbs of Sri Sophorn City with the existing NR 5 south of Sri Sophorn city at the location where the existing NR 5 turns to the North coming from the town of Mongkol Borei. (See Figure 9.5-1.)

(2) Alternative Routes Proposed by the JICA Team

While the route proposed by DPWT Banteay Meanchey is reasonable, the JICA Team considered it preferable to extend the bypass to the south of the town of Mongkol Borei. This proposal was made to minimize the necessity of widening of existing NR 5 in the town of Mongkol Borei.

Based on the above consideration, the JICA Team proposed 4 alternatives as shown in Figure 9.5-1. Advantage and disadvantage of these 4 alternatives, as well as the alternative proposed by DPWT Banteay Meanchey are compared in Table 9.5-1. After consultation among MPWT, DPWT Banteay Meanchey and the JICA Team, it was agreed that JICA-3 be adopted.

9.6 Regulation on Disorderly Development of Lands Along Bypasses

Battambang Bypass and Sri Sophorn Bypass are to be constructed to let the trough traffic detour the urbanized areas of the two cities and shorten the travel time of vehicles. To maintain the function of bypass, disorderly development of the land along the bypass needs to be regulated. This is particularly necessary in Cambodia where many factories and other industrial facilities are newly built along an road shortly after it is improved.

Also, conservation of agricultural land is important issue in view of the fact that the Project Area is one of the main production area of rice in Cambodia.

Table 0-1 Comparison of Alternatives of Sri Sophorn Bypass

Alternative	Length (km)	No. of Relocated Houses/Bldg.	Advantage	Disadvantage
DPWT	8.6	Less than 20	Short route and minimum construction cost	Traffic needs to pass through city of Mongkol Borei (Ruessei Kraok)
JICA-1	8.7	No substantial difference with the case of Alternative of 'DPWT'	Same as DPWT. Avoids irrigation channel and does not need a bridge to cross the channel.	Same as above.
JICA-2	13.7		Through traffic can bypass both Sri Sophorn and Mongkol Borei.	Bypass can connect to NR 5 only at the both ends of the bypass.
JICA-3	13.4		Same as above Can connect to NR 5 at a location midway between Sri Sophorn and Mongkol Borei through the existing local road.	Alignment is winding
JICA-4	13.3		If the fund is not sufficient, the section to bypass Mongkol Borei can be constructed later.	There will be an intersection at a location midway between Sri Sophorn and Mongkol Borei which reduces the travel speed.

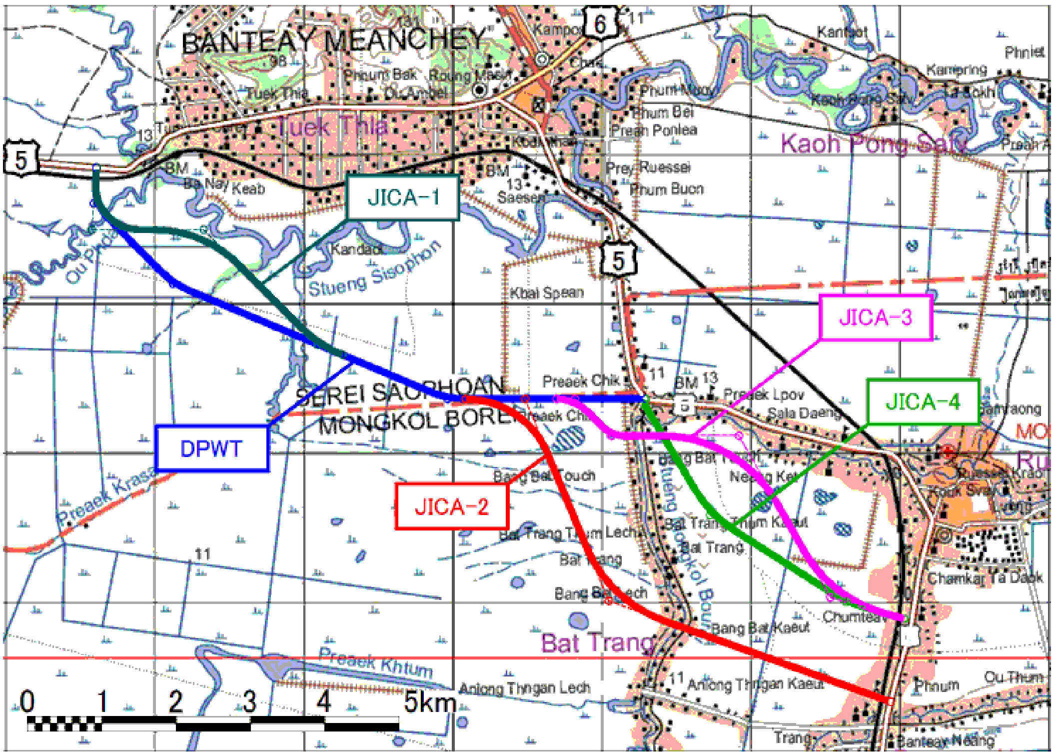


Figure 0-1 Alternatives of Route of Sri Sophorn Bypass

CHAPTER 10 HIGHWAY DESIGN

Improvement of the North Section of existing NR 5 and construction of Battambang Bypass and Sri Sophorn Bypass were selected as the components of the Project in Chapter 8. This chapter describes the preliminary design of these improvement/construction.

10.1 Basic Design Policy

Before actual preliminary design is conducted, basic policy for design and existing conditions corresponding to the said design item are discussed.

10.1.1 Horizontal Alignment

The horizontal alignment of North Section of NR 5 is composed of long straights and some curved sections. These curved sections may need improvement if the existing alignment does not satisfy the requirements of the design criteria.

(1) Applicable Design Criteria

NR 5 is designated as Class I road of Asian Highway Network. Thus, it is desirable to satisfy the design criteria of Asian Highway Class I road. At the same time, NR 5 is an arterial national road of Cambodia and it needs to satisfy the Road Design Standard of Cambodia. Table 10.1-1 compares the design criteria of Asian Highway Class I and Road Design Standard of Cambodia. The table also shows the criteria recommended for the Project. These recommended criteria have been discussed in outline between MPWT and JICA Team.

Table 10.1-1 Comparison of Design Speed and Criteria

Standard	Asian Highway	Cambodian Standard		Recommended	
Road Class	Class I	R5 (Rural)	U5 (Urban)	Rural	Urban
Design Speed	100 km/h (Flat)	100 km/h (flat)	50 km/h (type3)	100 km/h	50 km/h
Min. Curve Radius (Superelevation)	350 m (10%)	415 m (6%)	90 m (6%)	350 m (10%)	80 m (10%)

(2) Existing Conditions of Horizontal Alignment of North Section

Table 10.1-2 shows the existing curved sections of the North Section. There are 39 curved sections along the North Section, from KP 301 in Battambang City to the roundabout intersection (KP 360+620) with NR 6 in Sri Sophorn City. Twenty (20) curved sections are located after KP 350. In particular, there are many curves in the city area of Sri Sophorn. Straight line is widely adopted in other parts of the North Section.

At present, the speed limit on NR 5 is 60 km/h in the ordinary (rural) sections and 40 km/h in the town areas. There are road signs giving speed limits installed at the entrance and exit points of the town areas in Battambang Province as listed below:

- Battambang City (KP 285+720 ~ KP 296+030)
- Chreg Commune (KP 298+370 ~ KP 299+410)
- Otaki Commune (KP 306+030 ~ KP 306+410)
- Taporg Commune (KP 316+900 ~ KP 318+910)

However, there are no road signs giving speed limits for town areas in Banteay Meanchey Province. Therefore, 3 sections are provisionally assumed to be town areas in Banteay Meanchey Province, based on the observation of the site condition by the JICA Team:

- Brosat Commune (KP 339+380 ~ KP 339+800)
- Russey Krork Commune (KP 350+400 ~ KP 351+000)
- Ambel Commune (KP 357+610 ~ 360+620)

As for the curves on the rural sections, the curve radii are generally small and some of them do not satisfy the requirements of the design criteria of the Project, and improvement of horizontal alignment will be required to satisfy design criteria.

Table 10.1-2 Curved Sections on North Section

No.	KP of IP	Curve Radias	Land**	Criteria	No.	KP of IP	Curve Radias	Land	Criteria
1	301+003	150	R	small	21	351+455	170	R	small
2	302+656	760	R	OK	22	351+525	200	R	small
3	303+333	1040	R	OK	23	351+797	250	R	small
4	303+592	250	R	small	24	352+481	1100	R	OK
5	304+582	470	R	OK	25	353+721	1010	R	OK
6	304+897	430	R	OK	26	354+392	250	R	small
7	311+910	690	R	OK	27	355+485	110	R	small
8	312+135	270	R	small	28	355+767	210	R	small
9	316+535	1050	R	OK	29	357+228	950	R	OK
10	317+801	230	T	OK	30	357+685	170	T	OK
11	318+228	230	T	OK	31	358+139	220	T	OK
12	318+786	290	R	small	32	358+139	180	T	OK
13	319+372	250	R	small	33	358+416	200	T	OK
14	334+996	310	R	small	34	358+547	230	T	OK
15	339+108	290	R	small	35	359+041	140	T	OK
16	339+108	330	T	OK	36	359+742	100	T	OK
17	339+935	200	R	small	37	359+795	60	T	small
18	340+590	500	R	small	38	359+850	230	T	OK
19	342+531	700	R	OK	39	360+016	70	T	small
20	350+732	160	T	OK					

*intersecting point (of the extensions the straight lines tangent to the said curve) **Land T: Town, R:Rurul

10.1.2 Vertical Alignment and Height of Road Surface

(1) Basic Design Policy

Maximum grade of 4.0% is adopted for the vertical alignment, considering the design criteria of Asian Highway and Cambodian Standard. The North Section traverses generally flat plain, and slope sections exist only in the approach sections of the bridges. Where the bridges will be improved and the surface of bridge will be raised as discussed in Chapter 11, the approach sections will also be improved together with the construction of structures. Figure 10.1-1 shows schematic illustration of an approach section of bridge.

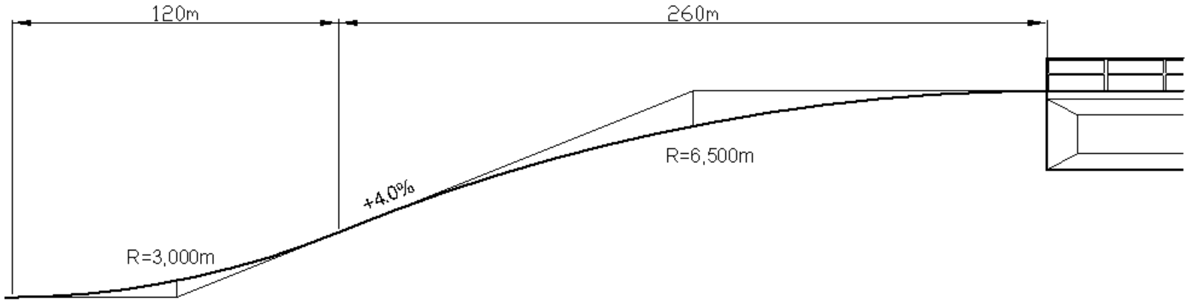


Figure 10.1-1 Vertical Curve at Bridge Approach

Where the surface of the bridge will remain as the existing condition, the existing vertical alignment shall be examined based on the above-mentioned criteria, and improved as necessary.

The height of road surface needs to be raised so that the pavement structure will not be submerged. In general, the bottom of pavement structure shall be 50 cm higher than flood water level to protect the pavement. Also height of road surface needs to be raised to prevent the inundation and/or overflow during flood.

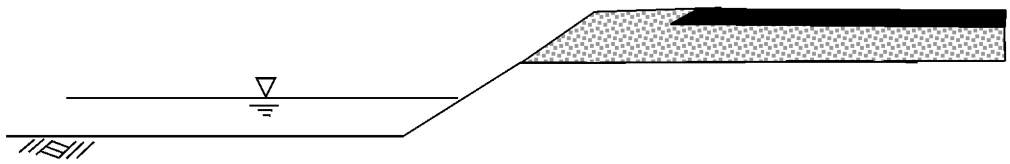


Figure 10.1-2 Schematic Illustration of Minimum Height of Pavement Structure

The Battambang Bypass and Sri Sophorn Bypass are to traverse paddy fields which are submerged during flood season. The height of road surface shall be sufficiently higher than the water level in flood season. It is also necessary to install cross drainage structures over a few hundred meters intervals and the height of embankment shall be designed so that sufficient depth of cover is provided to the culverts.

(2) Existing Condition

The vertical alignment on the North Section is generally flat, except in the approach sections of bridges. At some of the approach sections of bridges, the vertical curves are substandard, resulting in insufficient sight distance. It is necessary to improve the approach section properly in accordance with the adopted design speed.

According to the results of interviews at flood sections as described in Chapter 6, the section between KP 351 and KP 360 has been inundated only in October 2010. The depth of inundation varied between 15 cm and 30 cm, and the road became impassable during this flood. There is information that this inundation may be attributed to the collapse of a dam in Thailand.

The local residents near KP 344 say that overflow occurs every year at several locations. The depth of water is 1 ~ 2 centimeters only and duration is usually less than 1 day. Raising of road surface and installation of additional culvert for equalizing the water level on both sides of the road may be necessary. This will be a subject for in the detailed design stage.

10.1.3 Cross Section

(1) Basic Design Policy

Table 10.1-3 shows the road cross section design criteria to be applied.

Table 10.1-3 Comparison of Design Criteria

Items	Asian Highway	Cambodian Standard		Recommend
Road Class	Class I	R5 (Rural)	U5 (Urban)	
Lane Width	3.50 m	3.50 m		3.50 m
Shoulder Width	3.00 m (Flat)	3.00 m (Flat)	2.50 m (Type3)	3.00 m
Median Strip	3.00 m (Flat)	4.0~12.0 m (Flat)	2.0~4.0 m (Type3)	0.5~3.0 m
Cross Slope	2.0% (AC)	2.5~3.0% (AC)		2.0%
Shoulder Slope	3.0~6.0%	3~4% (sealed)	3%	
Vertical Clearance	4.5 m			4.5 m

The lane widths and shoulder widths of Asian Highway and Cambodian Standard are the same. The shoulder is proposed to be covered with DBST to provide the space for the bicycles and pedestrians. Low speed traffic also can use the shoulder if pedestrians or non-motorized traffic is not using it.

Regarding the median strip, MPWT’s preference is not to install the mount-up type divider because the traffic is forced to stay in lanes in one direction and access to/from the facilities located on the other road side is hindered. The wider median will be installed only in the rural areas, while narrow median will be adopted in the urbanized areas. Chatter bars will be installed at the center of narrow median to clear the centerline and to prevent traffic running accidentally the opposite lane.

(2) Existing Condition

The present cross section of the North Section is composed of undivided 2-lane carriageway and shoulders except for a few hundreds meter-long stretch in Battambang and Sri Sophorn, where divided 4-lane carriageway was constructed. The average width of pavement is 7.8 meter. The width of lane is not sufficient for 4-wheeled vehicles to overtake slow traffic, and these vehicles are frequently forced to enter the lane in the opposite direction. The typical cross section of existing road is shown in Figure 10.1-3.

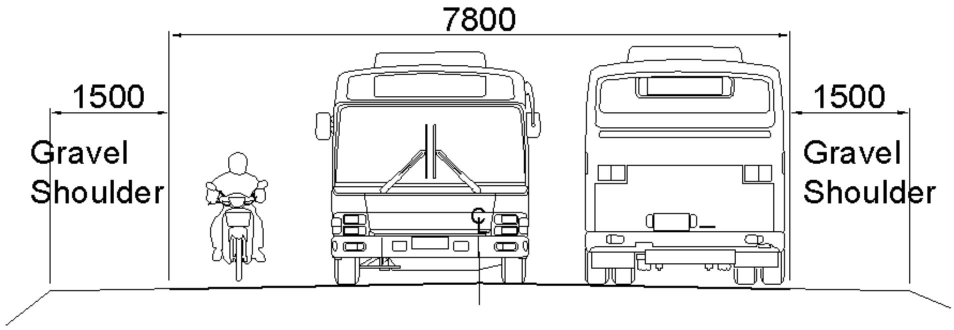


Figure 10.1-3 Typical Cross Section of North Section

10.2 Preliminary Design of North Section

10.2.1 Roadside Land Use

Road structure, such as typical cross section, is adjusted considering roadside condition. The land use of roadside of NR 5 is classified into three categories; urbanized, suburban and rural. Table 10.2-1 and Figure 10.2-1 summarizes the roadside land use of NR 5.

Table 10.2-1 Classification of Roadside Land Use

Rural Area W = 23 m			Suburban Area W = 20.5 m		
Start	End	Length (m)	Start	End	Length (m)
301+200	303+400	2,200	300+000	301+200	1,200
306+300	308+400	2,100	303+400	306+100	2,700
320+800	324+000	3,200	308+400	317+200	8,800
327+700	328+600	900	318+300	320+800	2,500
331+800	332+700	900	324+000	327+700	3,700
342+900	343+800	900	328+600	331+800	3,200
345+500	347+300	1,800	332+700	335+300	2,600
356+100	357+200	1,100	335+600	339+400	3,800
Urbanized Area W = 25.5 m			339+700	342+100	2,400
Start	End	Length (m)	342+300	342+900	600
306+100	306+300	200	343+800	345+500	1,700
317+200	318+300	1,100	347+400	347+600	200
335+300	335+600	300	347+700	350+400	2,700
339+400	339+700	300	350+800	356+100	5,300
342+100	342+300	200	357+200	358+400	1,200
347+300	347+400	100			
347+600	347+700	100			
350+400	350+800	400			
358+400	360+000	1,600			

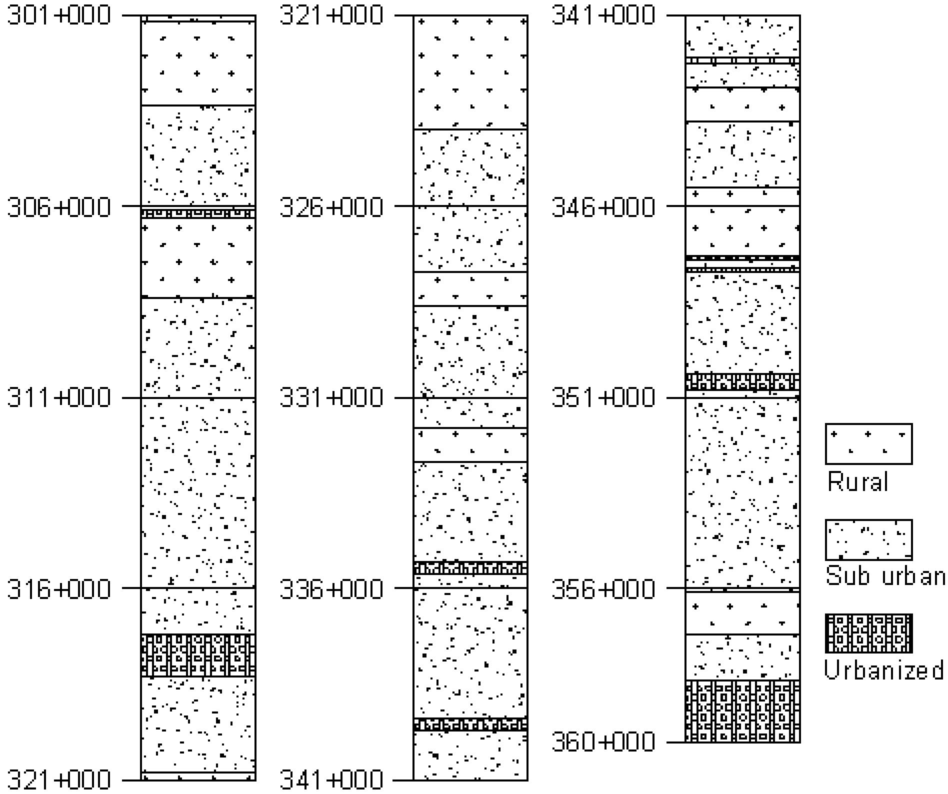


Figure 10.2-1 Straight Diagram of Roadside Land Use

10.2.2 Typical Cross Section

(1) Basic Consideration

In studying the typical cross section most suitable to the condition of the North Section and bypasses around Batttambang and Sri Sophorn, the following aspects are taken into consideration.

(i) Estimated Traffic Volume

Table 10.2-2 shows the estimated future traffic volume on the North Section. The number of lanes shall to be selected to provide sufficient capacity to cater to the estimated traffic volume.

Table 10.2-2 Estimated Traffic Volume

Counting Station No.	Location of Counting Station	Traffic Volume (pcu)	
		Year 2021	Year 2030
8	Provincial boundary between Battambang and Steung Meanchey Provinces (Between KP 332 and 333)	17,812	25,540

In addition to the data at Counting Station No. 8, traffic volume at Counting Station No. 7 has been estimates as explained in Section 6.4. However, Counting Station No. 7 is located in the northwestern suburbs of Battambang City. Thus, traffic volume passing this location is considered to contain a considerable portion of short trips with journeys in and around Battambang City area. On the other hand, Counting Station No. 8 is located far from Battambang City or Sri Sophorn City, and thus, the traffic volume at this location is considered to represent the traffic condition of the entire North Section. Therefore, the estimated traffic volumes at Counting Station No. 8 are used in the following discussion.

(ii) Capacity of 4-Lane Road

The Road Structure Ordinance of Japan stipulates that National Roads with expected traffic volume equal to, or larger than, 20,000 veh (pcu)/day be planned as 4-lane roads. 4-lane rural roads are considered to accommodate traffic volumes up to 30,000 pcu/day with reasonable smoothness. Thus, 4-lane is preferable from the traffic viewpoint.

(iii) Possibility of Opposed 2-Lane with Motorcycle Lanes from View Point of Traffic Capacity

Although it is not internationally common, a cross section of “opposed 2-lane with motorcycle lanes” is often adopted in Cambodia. Typical examples of this cross section are seen in Phnom Penh – Neak Loueng Section of NR 1 (Japanese Grant Aid Project) and NR 5 and NR 6 between Siem Riap and Poipet (ADB loan project). In these cases, paved shoulder can accommodate motorcycle traffic. In case of Phnom Penh – Neak Loueng Section of R 1, the width of motorcycle lane is 2.5 meter.

Estimation of traffic capacity for such cross section is difficult because there are no measured data for such cross sections, especially for the traffic condition with high percentage of motorcycle. By adopting conservative assumptions, the “allowable traffic volume” for this cross section can be estimated as follows:

Opposed 2-lane:	9,000 pcu/day/2-lane (based on Road Structure Ordinance of Japan)
Motorcycle lane:	11,000 pcu/day/lane x 0.7 = 7,700 pcu/day/lane
	For both direction: 7,700 x 2 = 15,400 pcu/day/lane
Total:	24, 400 pcu/day/2-direction

Thus, this cross section (opposed 2-lane + MC lanes) can accommodate the estimated traffic volume of year 2021 (17,812 pcu/day), but may not be sufficient for the traffic volume of year 2030 (25,540 pcu/day). Therefore, if the cross section of “opposed 2-lane + MC lane” will adopted, further widening will become necessary before year 2030.

(iv) Role of NR 5

As discussed in Section 3.2, NR 5 is given a very important role in the road network of both Cambodia and GMS. To fulfill this important role, the whole section of NR 5 needs to be widened to 4-lane. In addition NR 1 and NR 4 need also to be widened to 4-lane considering that these highways are vital infrastructure components if Cambodia is to be modernized.

In that sense, the section between Poipet and Sri Sophorn needs to be widened to 4-lane in the near future, or high-standard trunk road needs to be constructed, as proposed in JICA M/P Study.

(v) Traffic Safety

Traffic safety is another aspect that needs to be considered in planning of arterial highways. Accident rate of NR 5 is the highest among the single-digit national highways.

Table 10.2-3 Traffic Accident of Single-Digit National Highways

Road No.		1	2	3	4	5	6	7
Length	(km)	184	144	202	229	431	412	463
2009	No.	277	218	130	260	741	455	284
	/km	1.505	1.513	0.644	1.135	1.719	1.104	0.613
2010	No.	222	207	139	235	750	435	318
	/km	1.206	1.438	0.688	1.026	1.740	1.056	0.689
Total	No.	499	425	269	495	1,491	890	602
Average	/km	1.356	1.476	0.666	1.081	1.730	1.080	0.650

Source: Road Accident Data by National Police Commission Department, Ministry of Interior

Nation-wide data show a high percentage of accidents involving motorcycles as shown in Table below:

Table 10.2-4 Vehicle Types Involved in Traffic Accidents

		All Accident	MC Involved	MC vs MC	MC vs Small Car
2009	No.	8,560	7,318	3,085	2,063
	%	100	85.5	36.0	24.1
2010	No.	8,232	7,226	2,823,	2,084
	%	100	87.8	34.3	25.3
Total	No.	16,792	14,544	5,908	4,147
Average	%	100	31.3	35.2	24.7

Source: Road Accident Data by National Police Commission Department, Ministry of Interior

Although there is no detailed data on the cause or mode of traffic accidents which enable further analysis, there is a possibility that mixture of slow traffic and high-speed traffic is one of the main causes of high accident rate on NR 5. If this is the case, clear separation of slow traffic and high-speed traffic by providing 4 lanes can reduce the risk of traffic accidents.

(vi) Technical Discussion between MPWT and JICA Team

The team undertook technical discussions with MPWT officials on the recommended road cross section. Basically it was agreed to adopt a 4-lane road design. The summary of the discussion is shown below.

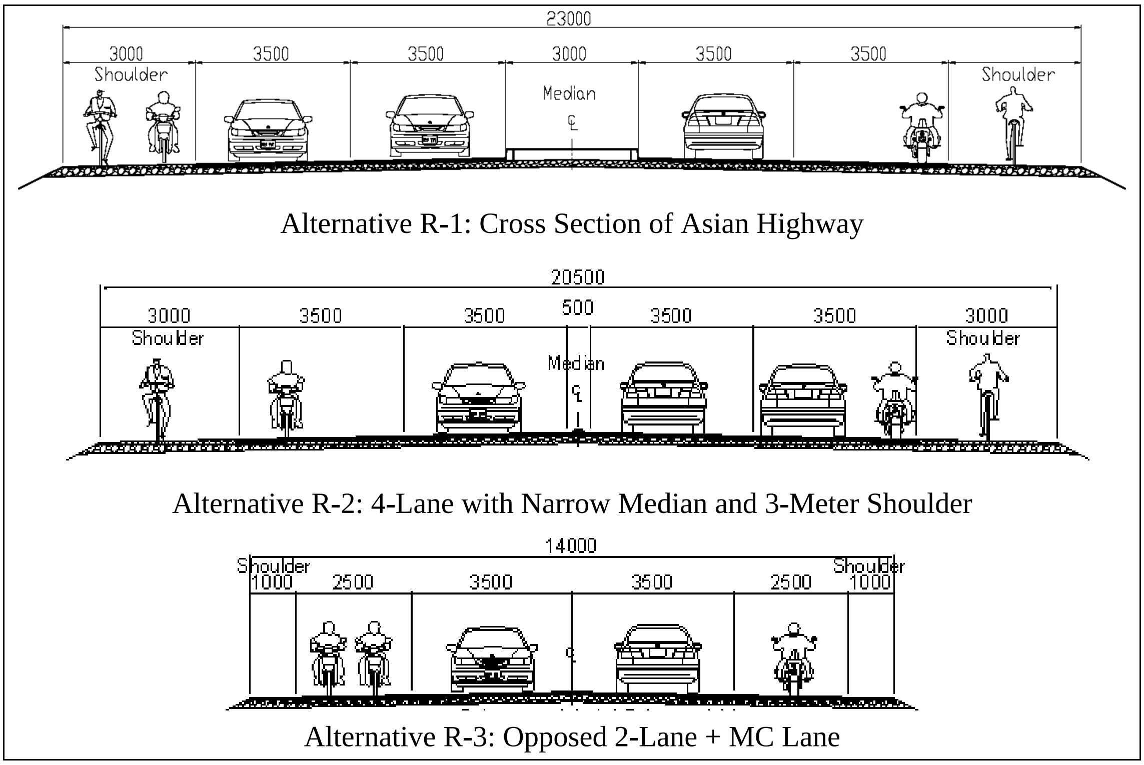
- NR 5 is Asian Highway No.1 and it shall satisfy international standards.
- In the alternatives, only the 4-lane option conforms to Asian Highway Standard.
- Initially, MPWT favored 4-lane +MC lane. However, this option may be too costly.
- 2-lane +MC lane option is not preferable from viewpoint of separation of 4-wheel vehicles and MCs.
- Thus, 4-lane option is the most favored option.
- MC may occupy the outside lane and mix with high speed traffic
- Space for exclusive use of MC should be provided.
- The pavement shall be extended to the shoulder to provide the space for MCs.
- The width of pariment extension shall be 1.5 m (same as Sri Sophorn ~ Thai border section)
- 2-lane+MC (A) option shall be also studied as the reserve option.

(2) Cross Section Alternatives

Considering the aspects as explained above, three cross section alternatives for rural area and suburban area are proposed. As reference, cross section of Asian Highway is also shown.

(i) Cross Section for Rural Area

Three alternatives of cross section for rural area as shown in Figure 10.2-2 are assumed and compared.



Alternative R-1: Cross Section of Asian Highway

Alternative R-2: 4-Lane with Narrow Median and 3-Meter Shoulder

Alternative R-3: Opposed 2-Lane + MC Lane

Figure 10.2-2 Alternatives of Cross Section for Rural and Suburban Areas

The merits and demerits of these alternatives are summarized in the Table 10.2-5.

Table 10.2-5 Merits and Demerits of Cross Section Alternatives for Rural/Suburban Area

Alternative	R-1	R-2	R-3
Asian Highway Standard	Satisfied	Partially Satisfied	Not Satisfied
Design Criteria	Satisfied	Satisfied	2.5 m width of MC lane is substandard
Traffic Capacity	Sufficient for Long Term	Sufficient up to 2030	Insufficient before Year 2030
Overtaking by 4-Wheeled Vehicles	Safe for all types of traffic	Safe overtaking by 4-wheeled vehicle is possible	Overtaking by 4-wheeled vehicle needs to be carefully negotiated
Safety of MC & Slow Traffic (ST)	MC & ST can use outside lane and can be safely overtaken by high speed traffic	Same to R-1	Better than current situation but to less extent than in R-1 and R-2
Reguired Additional Right of Way	Large	Medium	Small
Separation of Community	Large	Medium	Small
Project Cost	High	Medium	Low

As can be seen in the above table, Alternative R-1 is most preferable from the viewpoint of safe and smooth traffic. Thus, this alternative is most recommendable. However, Alternative R-2 may be adopted if there is a constraint in available fond for construction. Alternative R-3 is least preferable and should be adopted only in the case when adoption of R-1 or R-2 is not possible.

In conclusion, Alternative R-2 is recommended considering cost and traffic capacity. It should be noted that widening into R-1 cross section should be retained as the ultimate plan to enable development of the Asian Highway Network as essential infrastructure for strengthening regional cooperation in the GMS.

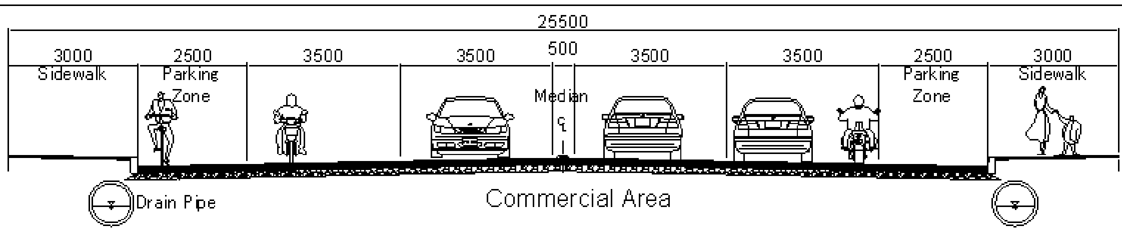
Figure 10.2-3 Perspective Drawing of NR 5 with R-2 Cross Section

(ii) Cross section for urbanized or commercial area

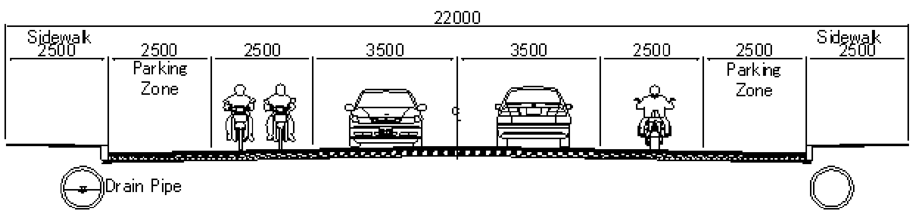
In case of the cross section for urbanized area, different considerations from those for rural/suburban areas are needed:

- Low speed regulation is imposed. Thus, travel speed of vehicles become lower.
- Less attention is needed for overtaking and separation of community. Also, design standards of Asian Highway cannot be applied.
- Traffic volume of motorcycles, moto-rumok and other slow-speed vehicles may be larger than those in rural areas because this slow-speed traffic tends to have origin or destination of trips in urbanized areas.
- There are commercial activities on the both sides of the road and vehicles often turn to the left to go to the shops etc. located on the other side of the road. Thus, median division should not be of raised structure type.
- Space for road side parking should be provided to prevent parked vehicles blocking the traffic.

Considering these facts, two cross section alternatives are proposed.



Alternative U-1: 4-Lane with Parking Space and Sidewalk



Alternative U-2: 2-Lane + MC with Parking Space and Sidewalk on Both Sides

Figure 10.2-4 Alternatives of Cross Section for Urbanized Area

The merits and demerits of these alternatives are summarized in the Table 10.2-6.

Table 10.2-6 Feature of Cross Section Alternatives for Urbanized Area

Alternative	U-1	U-2
Traffic Capacity	Sufficient	Insufficient before Year 2030
Roadside Parking Space	Provided	Provided
Land Acquisition	Large	Medium
Project Cost	High	Medium
Asian Highway Standard	Partially Satisfied	Not Satisfied
Design Criteria	Satisfied	2.5 m width of MC lane is substandard
Traffic Capacity	Sufficient up to 2030	Insufficient before Year 2030
Overtaking by 4- Wheeled Vehicles	Overtaking in urbanized section is not taken into consideration	Overtaking in urbanized section is not taken into consideration
Safety of MC & Slow Traffic (ST)	MC & ST can use outside lane and can be safely overtaken by high speed traffic	Better than current situation but to less extent than in U-1
Reguired Additional Right of Way	Large	Medium
Separation of Community	Large	Medium
Project Cost	Large	Medium

For urbanized areas, Alternative U-1 is preferable and recommended.

As shown in the above, the technically preferable cross section requires larger cost, not with standing the problem of social impact of land acquisition and resettlement. Thus, final decision for adoption of the cross section type needs to be made after diligent discussion on the available fund.

10.2.3 Horizontal Alignment

The design speed of 100 km/h is adopted for general sections and that of 50 km/h is adopted for urban sections. There are some sharp curve sections, the where the existing curve radii are less than the required minimum value. In accordance with design criteria, substandard curve sections shall be improved to ensure a safe traffic environment.

Table 10.2-7 shows the elements of curve sections with substandard curve radii and distances of centerline shift for the improvement of curve radii. Schemes of major improvements of curve sections are shown in Figures 10.2-5 to 10.2-7.

Table 10.2-7 Element of Curves to Be Improved

IP	KP of IP	Land	Radii of Curve		Center Shift
			Existing	Proposed	
1	301+003*	Rural	150	350	23.3
4	303+592	Rural	250	350	1.8
8	312+135	Rural	270	350	0.8
13	319+372	Rural	250	350	1
14	334+996	Rural	310	350	1.2
15	339+108	Rural	290	350	0.9
17	339+935	Rural	200	350	3
21	351+455	Rural	170	350	0.6
22	351+525	Rural	200	350	1.2
23	351+797	Rural	250	350	11.6
26	354+392	Rural	250	350	1.8
27	355+485*	Rural	110	350	19.8
28	355+767	Rural	210	350	2.5
37	359+795	Town	60	80	0.6
39	360+016	Town	70	80	0.5

* These curve sections may not be included in the Project (see Section 10.3 & 10.4).

Figure 10.2-5   New Alignment at IP1

Figure 10.2-6   New Alignment at IP23 (KP 351 + 797)

Figure 10.2-7 New Alignment at IP27 (KP 355 + 485)

10.2.4 Vertical Alignment and Profile

The longitudinal profile of the existing road centerline was examined based on the digital map prepared for this Survey. As a result, the elevation of road surface at sections near KP 320 and KP 345 was found to be lower than 11.0 m. During flood condition interviews, the frequent inundation at KP 344 was also informed by the residents.

The actual condition of water level was confirmed through field observation during the flood season in September 2011. The water level on the paddy along those sections was observed at near the top of the subgrade course.

Considering this site condition, the road surface of the sections between KP 320~324, KP 327~328, KP 342~343 and KP 345~347 is proposed to be raised approximately 1 m from the present road surface level.

The approach of bridges shall be properly designed with appropriate vertical curve. The minimum radius of vertical curve is 6,500 m for crest curve and 3,000 m for sag curve and the minimum length of vertical curve is 85 m at design speed 100 km/h (see Figure 10.1-1).

10.2.5 Intersection

There are two major intersections on the North Section at NR 59 and NR 6. The geometric design of the both intersections is acceptable and only minor adjustments are required for the widening of NR 5. However, the connections with planned Battambang Bypass and Sri Sophorn Bypass necessitates construction of new intersections. Considering the prevailing practices in Cambodia and familiarity of the motorists, round-about intersections are proposed at there locations. Figure 10.2-8 shows the basic design of round-about intersection with intersection of NR 5 and bypass. A different configuration may be adopted in the detailed design stage.

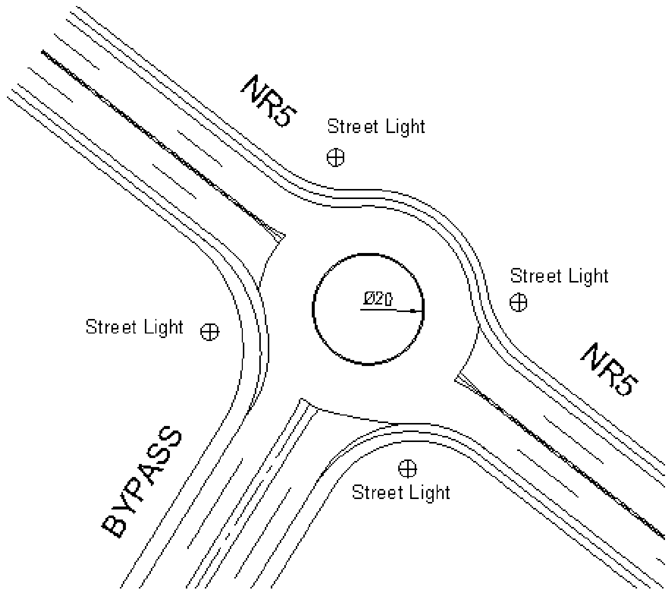


Figure 10.2-8 Intersection of NR 5 and Bypass

10.2.6 Pavement Design

Pavement structure is usually designed based on forecasted traffic load and CBR. AASHOTO's Pavement Design Manual is one of the most widely used standards of pavement design. In the design method presented in this Manual, estimated traffic volume is converted to cumulative 18-KIP equivalent single axle load (ESAL). However there are no effective data for this conversion in Cambodia.

On the other hand, the design procedure presented in the Pavement Design Guideline of Japan classifies the types of traffic depending on the share of heavy vehicles in the total traffic volume and does not require conversion to ESAL. Thus, this design method is used in this stage. The design condition as written below are used and results of design obtained are shown in Table 10.2-8:

- Design Period: 10 years
- Number of HV: 1,408 units/day direction
- Reliability: 90%
- Design CBR: 8~20
- Minimum Thickness of AC Layer: 15 cm

Table 10.2-8 Designed Pavement Structure

Section	Design CBR	Existing Layer		Additional Layer		Remarks
		Subbase	Base	Base	AC	
KP 301 ~ 306	20	20 cm	15 cm	0~10 cm	15 cm	Base for leveling
KP 306 ~ 330	8	20 cm	15 cm	0~10 cm	15 cm	Base for leveling
KP 330 ~ 340	12	20 cm	15 cm	0~10 cm	16 cm	Base for leveling
KP 340 ~ 360	8	15 cm	15 cm	10 cm	15 cm	

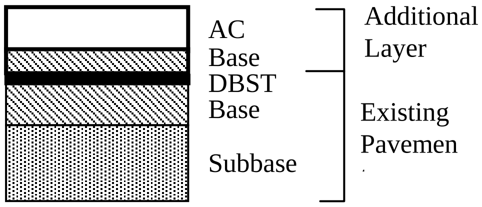


Figure 10.2-9 Pavement Structure

Existing pavement shall be utilized as a part of the pavement structure. Such an approach can reduce the construction cost and mitigate the traffic disturbance. During constructions also it can reduce industrial waste.

<u>Alternative Pavement Design</u>

In the process of appraisal of loan, alternative pavement design was discussed. The main points of discussion were;

- to change the thickness of AC layer to 10 cm so that it coincides with the thickness of AC layer in the past projects in Cambodia, and
- to save cost of pavement.

As a conclusion a pavement structure as shown in Figure 10.2-10 was adopted for the purpose of cost estimation to be used in the loan appraisal.

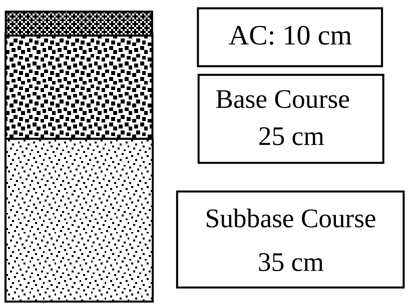


Figure 10.2-10 Alternative Pavement Structure Adopted in Loan Appraisal

This pavement structure consists of excessively thick base course and subbase course compared to the ordinary pavement. Thus, the structure of base course and subbase course needs to be reviewed and revised as necessary in the detailed design stage when more concrete data, such as axle load, will become available.

10.2.7 Drainage

Basically NR 5 is an embanked road traversing flat flood plain. However, the existing road level on some sections is lower than the roadside and rain water often remains on the shoulder and seeps into the base course and subgrade, causing reduction in bearing capacity. To solve this situation, lined ditches are proposed to be installed to drain the rain water. The schedule of lined ditch is listed in Table 10.2-9.

Table 10.2-9 Location of Lined Ditch

Lift Side			Right Side		
Start	End	Length (m)	Start	End	Length (m)
303+900	304+400	500	303+900	304+400	500
			315+100	315+400	300
316+600	317+200	600			
318+300	319+000	700	318+300	319+000	700
335+600		400	335+600	336+000	400
			343+700	344+000	300
345+000	345+300	300	345+000	345+300	300
350+800	351+400	600	350+800	351+400	600
			352+100	352+200	100
356+400	356+800	400			
357+700	357+800	100			

In urbanized areas, mounted up sidewalks are to be constructed and new drainage facilities shall be provided to drain the road surface. As shown in Figure 10.2-4, catch basins and drainpipe are to be installed under the sidewalk.

The cross drainage facilities (culverts) of NR 5 were improved by the PRRP and EFRP. No overflow caused by lack of capacity is reported for the existing facilities except for the particular flood in year 2010. In this project, all culverts are proposed to be extended to fit the widened road width and inlets and outlets. The widening of bridges is discussed in Chapter 11.

10.2.8 Appurtenance

(1) Street Lighting

The purpose of street lighting is to illuminate danger points to improve visibility at night.

- The bridges, especially where there is one bridge for each direction.
- The major intersections
- The railway crossings

(2) Railroad Crossings

A railroad line runs between Phnom Penh and Poipet generally in parallel to NR 5. There are two railroad crossings (KP 352 and KP 359) on the North Section. Currently, the railroad is not in operation. MPWT has a plan to rehabilitate the railroad and operate trains 2 times a day in the future. This proposed train operation is not considered to cause serious traffic congestion. Thus, these railroad crossing are planned as at-grade crossings. Figure 10.2-11 shows a schematic plan of the railroad crossing.

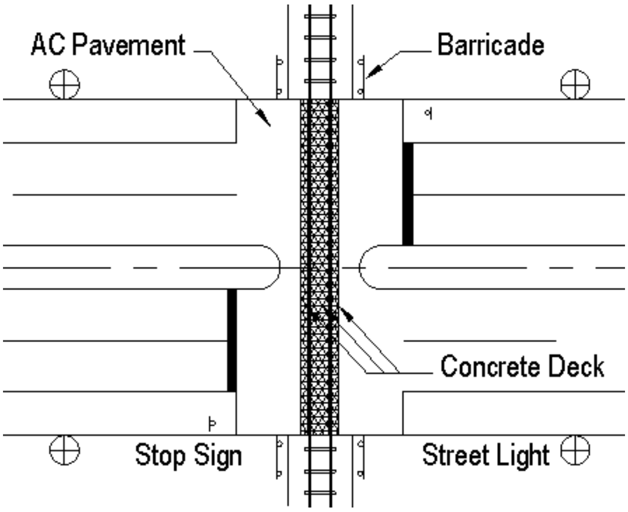


Figure 10.2-11 At Grade Railway Crossing

(3) Road Sign

Road signs are proposed to be installed as follows;

- Regulatory Signs: Stop, Speed limit, No entry, No overtaking, No U-turn, No parking etc.
- Warning Signs: Curve, Hump, Junction, Rotary, Zebra crossing zone, Railway, School, Narrow etc.
- Information Signs: Parking, Road No., Town name, Destination direction & distance etc.

10.3 Preliminary Design of Battambang Bypass

10.3.1 Typical Cross Section

After Battambang Bypass will have been constructed, the function of Asian Highway No.1 will divert to the bypass from the existing NR 5 passing through the Battambang town route. In view of the function as the international corridor, the cross section composition of ASEAN Highway No.1 should be adopted.

However, according to the traffic forecast carried out in this Survey, a 2-lane road has the capacity to accommodate the estimated traffic volume until year 2030. In view of the estimated traffic volume, staged construction will be one of the options to consider in reducing the initial investment. Figure 10.3-1 shows the proposed cross section.

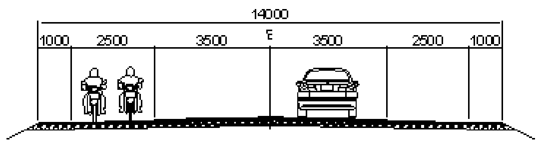


Figure 10.3-1 Cross Section of Battambang Bypass

10.3.2 Horizontal Alignment

As a result of the Study, JICA-1C route was selected as the most favorable bypass route and topographical survey was carried out along this route. During the alignment analysis, obstacles and problems were found at canal crossings, railway crossings, high voltage power towers and a rice mill factory. To avoid such obstacles, the route has been modified. The new alignment of bypass route is shown in Table 10.3-1 and Figure 10.3-2. The design speed of 100 km/h was adapted in selecting the alignment.

Table 10.3-1 IP & Element of Curves

KP	Radius (m)	Curve Length (m)	Tangent (m)
6+062	5000	675.089	338.058
8+578	5000	627.610	314.218
9+834	5000	580.138	290.395
12+697	2000	1328.221	689.646
15+453	2000	1794.383	971.467
21+228	1000	965.042	521.235
22+890	700	1245.929	864.130

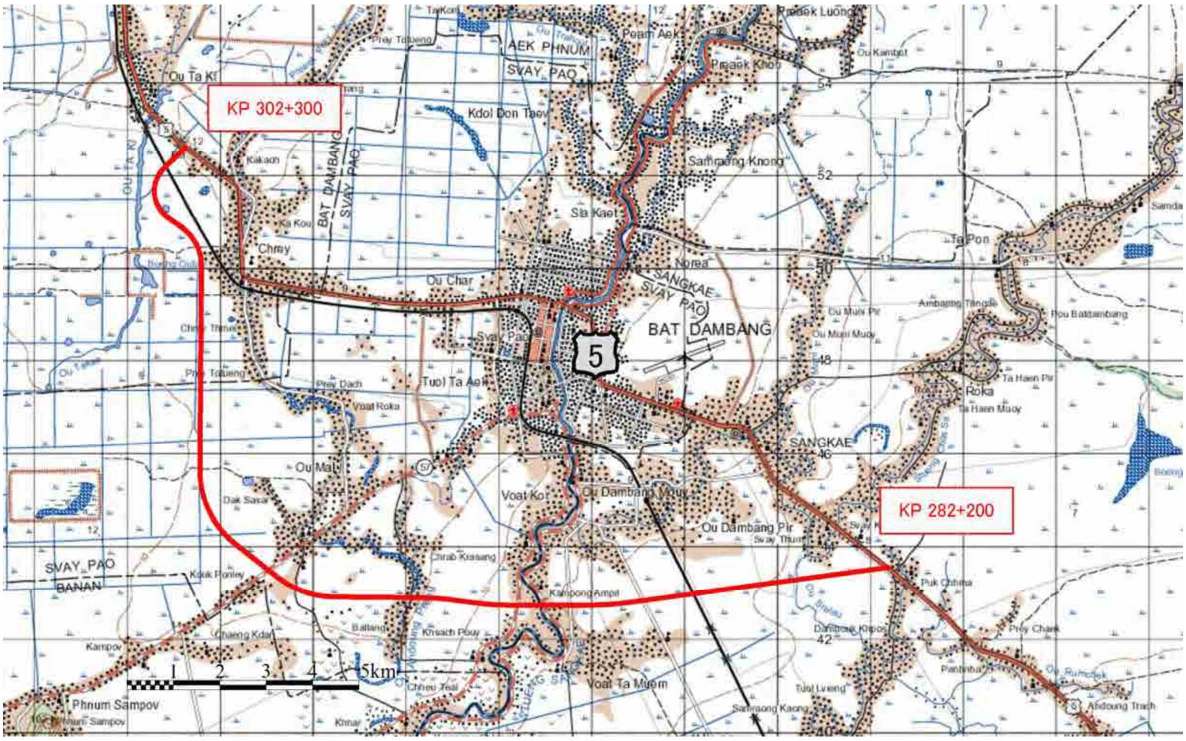


Figure 10.3-2 Alignment of Bypass Route

10.3.3 Vertical Alignment

The proposed route traverses mostly paddy areas and the land is often covered by water for cultivation of rice and/or by accumulated rain water. The embankment of the roadbed shall be sufficiently higher than usual water level of paddy and subgrade layer should be kept above the water to maintain the pavement strength.

According to the result of topographical survey, ground elevations along the route are approximately 10 ~ 12 m above sea level. While the surface levels of existing NR 5 at the starting point and end point of the bypass are 11.5 m and 11.4 m, respectively. According to DPWT officials, no flood or overflow has not been reported at these locations.

Higher embankment height is desirable from the viewpoint of flood/overflow. However, higher embankment height results in higher construction cost of embankment and grease land acquisition. Considering these, the elevation of water level is assumed at 11.5 m and embankment height is planned to be 1.5 m on average. Sufficient embankment height is also necessary to provide adequate cave for pipe culverts providing cross drainage.

10.3.4 Pavement Design

The pavement design method for the bypass is the same as that of the North Section. The design condition and the results of design are as follows:

<u>Design Condition</u>

- Design Period: 10 years
- Number of HV: 461 units/day direction
- Reliability: 90%
- Design CBR: 6
- Minimum Thickness of AC Layer: 10 cm

<u>Pavement Structure</u>

Subbase Course: 25 cm

Base Course: 15 cm

Surface Course: 10 cm

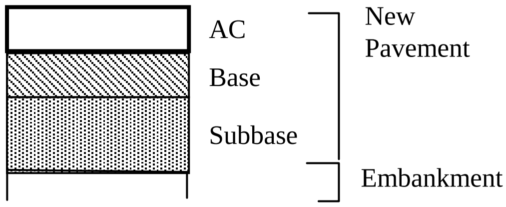


Figure 10.3-3 Pavement Structure

10.3.5 Drainage

The embankment of the bypass will behave as a dike during the flood season and block water flow. Thus, it will be necessary to install sufficient cross drainage to provide adequate cross-sectional area for discharge of flood water.

There are many channels crossing the proposed bypass route. The direction of flow is basically west to east (towards Tonle Sap Lake). Based on the result of topographical survey, cross drainage facilities are scheduled as required. For larger streams such as Sangkae River (km7+550) and the channel at (km2+020), bridges are to be constructed.

Table 10.3-2 Box Culvert Schedule

km	No. of Cell	Width	Length
00+025	3	10.2	20.5
00+270	1	3.4	20.5
03+710	2	6.6	20.5
05+335	1	3.4	20.5
06+925	2	6.6	20.5
06+935	1	3.4	20.5
09+570	1	3.4	20.5
11+440	2	6.6	20.5
11+465	2	6.6	20.5
13+470	2	6.6	20.5
14+400	3	10.2	20.5
16+620	2	6.6	20.5
17+730	1	3.4	20.5
18+245	2	6.6	20.5
19+770	3	10.2	20.5
19+795	3	10.2	20.5
21+325	2	6.6	20.5
22+960	1	3.4	20.5

(1) Box culverts are installed at comparatively wider channels. The box culvert schedule is shown in Table 10.3-2.

(2) Pipe culverts are installed at small streams and also every 250 m interval. The purpose of this is to minimize the difference of the water level on the both sides of the bypass. An in-depth study shall be undertaken at the Detailed Design stage.

10.4 Preliminary Design of Sri Sophorn Bypass

10.4.1 Typical Cross Section

Following the construction of Sri Sophorn Bypass, the function of Asian Highway No.1 will transfer to the bypass from the existing NR 5 passing through the Sri Sophorn town route. In view of the function as an international corridor, the cross section composition of ASEAN Highway No.1 should be adopted.

However, according to the traffic forecast carried out in this Survey, 2-lane road has the capacity to accommodate the estimated traffic volume until year 2030. In view of the estimated traffic volume, staged construction will be one of the options to consider to reduce the initial investment. Thus, the same cross section with Battambang Bypass is adopted. Figure 10.4-1 shows the proposed cross section proposed for the initial stage.

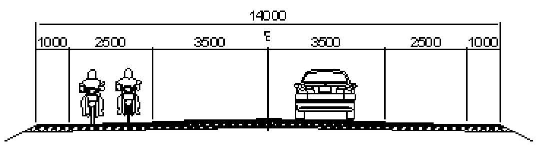


Figure 10.4-1 Cross Section of Sri Sophorn Bypass

10.4.2 Horizontal Alignment

As the result of the Study, the JICA-3 route was selected as the most favorable bypass route and topographical survey was carried out along this route. The alignment of the bypass route is shown in Table 10.4-1 and Figure 10.4-2. Design speed of 100 km/h is adapted in selecting the alignment.

Table 10.4-1 IP & Element of Curves

KP	Radius (m)	Curve Length (m)	Tangent (m)
1+034	1800	1392.751	715.181
3+458	1800	1900.375	500.000
4+975	400	314.159	284.368
5+656	600	471.238	1222.553
7+343	1200	476.384	1300.394
9+227	1800	702.800	1153.985
11+399	1600	1259.889	194.314
12+836	600	987.674	188.728

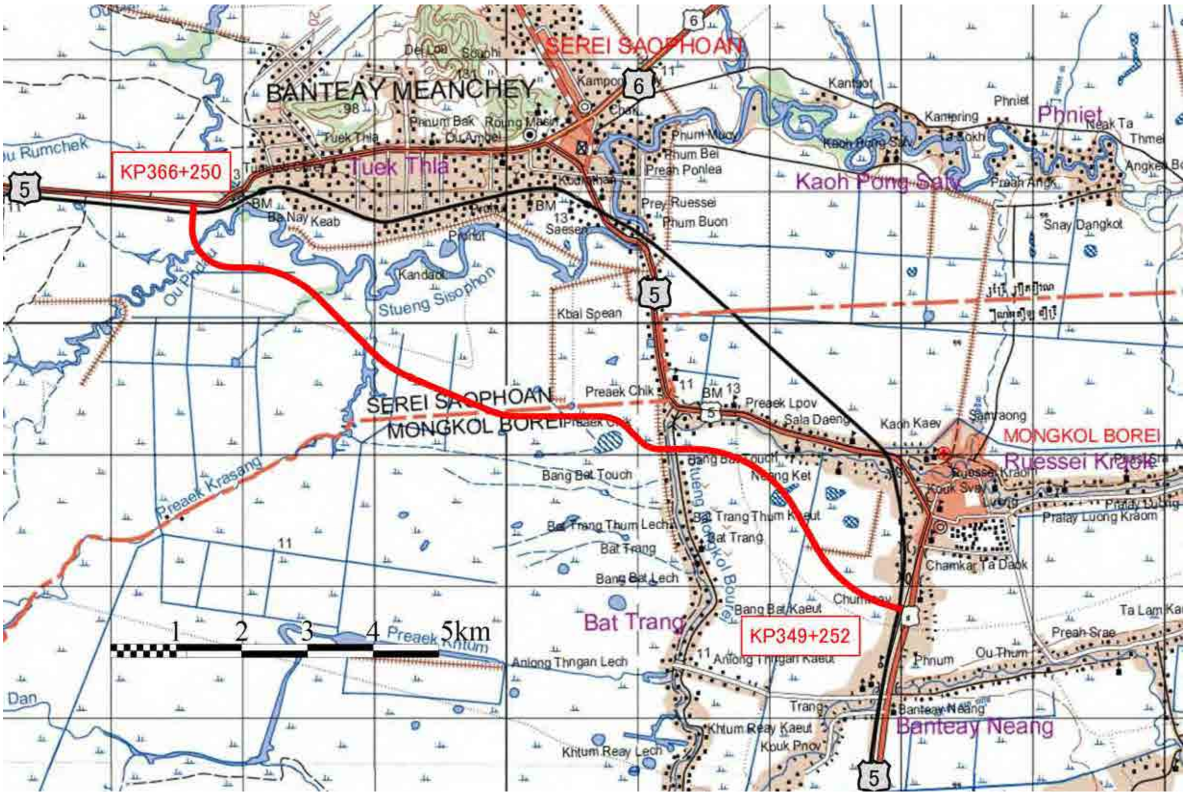


Figure 10.4-2 Alignment of Bypass Route

10.4.3 Vertical Alignment

The proposed route traverses mostly paddy areas and the land is often covered by water for cultivation of rice and/or by accumulated rain water. The embankment of the roadbed shall be sufficiently higher than usual water level of paddy and subgrade layer should be kept above the water to maintain the pavement strength.

According to the result of topographical survey, ground elevations along the route are approximately 8 ~ 9 m above sea level. While the surface levels of existing NR 5 at the starting point and end point of the bypass are 11.2 m and 12.2 m, respectively.

Higher embankment height is desirable from the viewpoint of flood/overflow. However, higher embankment height results in higher construction cost of embankment and greater land acquisition. Considering these, the elevation of water level is assumed at 11.2 m and embankment height is planned to be 2.0 m on average.

10.4.4 Pavement Design

The permit design method for the bypass is the same as that of the North Section. The design condition and the results of design are as follows:

Design Condition

- Design Period: 10 years
- Number of HV: 391 units/day direction
- Reliability: 90%
- Design CBR: 6
- Minimum Thickness of AC Layer: 10cm

Pavement Structure

Subbase Course: 25 cm
Base Course: 15 cm
Surface Course: 10 cm

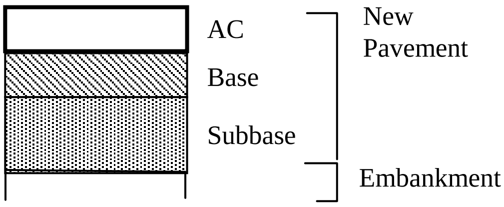


Figure 10.4-3 Pavement Structure

10.4.5 Drainage

The embankment of bypass acts as the dike during flood season and block the water flow in the roadside area. Thus, it is necessary to install sufficient cross drainage to secure the sufficient cross-sectional area for water to flow as smooth as possible.

There are many cannels crossing the proposed bypass route. The direction of flow is basically west to east (towards Tonle Sap Lake). Based on the result of topographical survey, the necessary cross drainage facilities are scheduled. For bigger streams such as the cannel (km4+620 and km12+700), bridges are to be constructed.

(1) Box culverts are installed at comparatively wider cannels. The schedule of box culvert is shown in Table 10.4-2.
(2) The pipe culverts are installed at small stream and also every 250 m interval. The purpose of this is to minimize the difference of the water level on the both sides of the bypass. The detail study shall be done at Detailed Design stage.

Table 10.4-2 Box Culvert Schedule

km	No. of Cell	Width	Length
00+015	3	10.2	14
00+135	1	3.4	14
01+530	3	10.2	14
01+970	5	17	14
02+580	5	17	14
04+370	3	10.2	14
04+780	2	6.6	14
06+220	1	3.4	14
08+170	2	6.6	14
09+360	4	13.6	14
09+500	5	17	14
09+700	2	6.6	14
10+440	2	6.6	14
10+640	5	17	14
10+680	5	17	14
11+170	2	6.6	14
11+920	1	3.4	14
13+340	1	3.4	14

10.5 Traffic Safety Measures

When a road is improved and travel speed of the vehicles increases, often traffic accidents increase. The usual types and causes of increase in traffic accidents due to road improvement are as summarized below:

Table 10.5-1 Types, Causes and Measures of Traffic Accident due to Road Improvement

Type	Cause	Measure
Vehicles collide with pedestrians or bicycles	Driver error	✓ Speed regulation ✓ Provision of rumble strip ✓ Lighting at hazardous location
	Pedestrians' misjudgment on increased vehicle speed when crossing the road	✓ Traffic safety campaign to roadside residents ✓ Provision of rumble strip near the entrance to town/ residential areas ✓ Provision of warning signs at strategic locations, such as near town, school and roadside market
Vehicles collide with other vehicle (side-to-side)	Over-speeding and driver error	✓ Speed regulation
Head-on collision	Travel on the opposite lane by mistake	✓ Provision of chatter bar on the center line
Vehicle collides with roadside obstacles	Over-speeding and driver error	✓ Install road signs & other obstacles sufficiently distant from carriageway ✓ Provision of guardrail around hazardous obstacles

Main measures are briefly explained below:

(1) Chatter bar on the center line

Raised median is preferable from the pure viewpoint of traffic safety. However, raised median has several drawbacks such as complete prohibition of overtaking on the opposed 2-lane road. Cambodian drivers usually go beyond the centerline when over taking, even on a 4-lane road since the outside lane is often occupied by motorcycles and other slow vehicles. Thus, overtaking by using the opposite lane with sufficient care needs to be accepted. Chatter bars are often installed along the road centerline to give warning to drivers when crossing the centerline, as well as to discourage drivers to cross the centerline. If the cross section of opposed 2-lane or 4-lane with narrow median is to be adopted, installation of chatter bar or road stud is proposed.

(2) Rumble strip

Rumble strip is special pavement with rough surface which cause noise when vehicle passes it. It is placed in multiple strips across the carriageway to give drivers warning. Rumble strips shall be planned at the entrance to town areas, near schools and markets, and at other strategic locations.

(3) Shoulder

Shoulder with sufficient width is expected to have the following functions:

(i) If paved, can serve as the lane for motorcycles and other slow traffic and can aid in separating this traffic from high-speed traffic.
(ii) Provide sufficient distance between the vehicles and roadside obstacles, and contribute to decrease the possibility that the vehicles will collide with obstacles.
(iii) Provide sufficient sight distance.

As discussed in Section 10.2, 3 m-wide shoulder is proposed for existing NR 5. As for the bypasses, 1.0 m-wide shoulder is proposed. The reasons for proposing 1.0 m-wide shoulder are as follows:

(i) Traffic volumes on the bypasses are smaller than that on the existing NR 5. Thus, 2.5 m-wide left lane can safely accommodate slow traffic such as motorcycles and agricultural tractors.
(iv) The bypasses traverse the areas away from the urbanized areas. Thus, traffic of slow traffic and pedestrians who needs to evacuate to shoulder is limited.

(4) Guard rail

Guard rail is proposed to be installed at the locations of hazardous roadside obstacles. Typically, guard rails shall be installed at bridge approaches.

(5) Lighting

Lighting is planned at the following locations:

- Major intersections
- Long bridges
- Railroad crossing

10.6 Summary of Proposed Design

The main points of the design of improvement of existing NR 5 and construction of the two bypasses (Battambang and Sri Sophorn) are summarized in Tables 10.6-1 to 10.6-3.

Table 10.6-1 Summary of Design of North Section of Existing NR 5

Item	Description	Remarks
Total Length	47.0 km	
Design Speed	100 km/h	
Cross Section	As shown below. Total width: 20.5 m	
Pavement Structure	AC (Binder & Surface Course) 15 cm Base Course: 15 cm Subbase Course: 20 cm	· Only base & subbase courses are executed on shoulder but AC is not executed. · Where practical, existing base course and/or subase course is utilized.
Bridges: No. & Total Length	9 Nos. L= 83.9 m	6 brdgs. are to be widened utilizing existing structure
Others	2 Railroad Crossing	

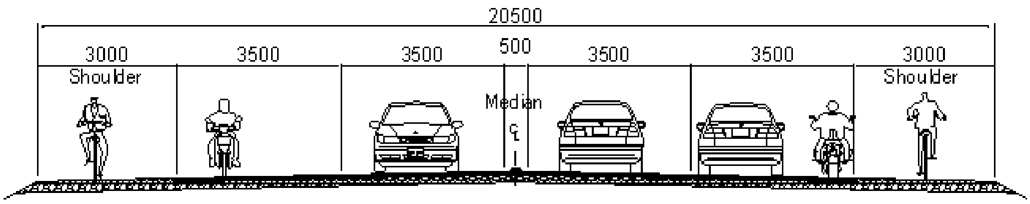


Figure 10.6-1 Typical Cross Section of North Section of Existing NR 5

Table 10.6-2 Summary of Design of Battambang Bypass

Item	Description	Remarks
Total Length	23.1 km	
Design Speed	100 km/h	
Cross Section	As shown below. Total width: 14.0 m	
Pavement Structure	AC (Binder & Surface Course) 10 m Base Course: 15 cm Subbase Course: 25 cm	Thickness of pavement is smaller than that of existing NR 5 because of less traffic volume.
Bridges: No. & Total Length	2 Nos. L = 125.0 m	2 brdgs. are newly constructed
Others	2 Railroad Crossing	

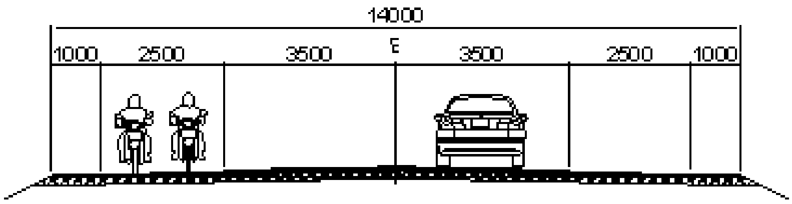


Figure 10.6-2 Typical Cross Section of Battambang Bypass

Table 10.6-3 Summary of Design of Sri Sophorn Bypass

Item	Description	Remarks
Total Length	13.1 km	
Design Speed	100 km/h	
Cross Section	As shown below. Total width: 14.0 m	
Pavement Structure	AC (Binder & Surface Course) 10 m Base Course: 15 cm Subbase Course: 25 cm	Thickness of pavement is smaller than that of existing NR 5 because of less traffic volume.
Bridges: No. & Total Length (m)	2 Nos. L = 110.0 m	2 brdgs. are newly constructed
Others	2 Railroad Crossing	

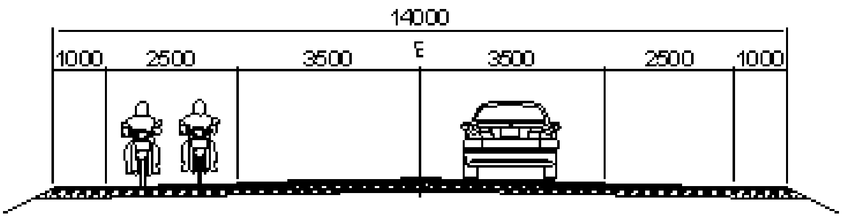


Figure 10.6-3 Typical Cross Section of Sri Sophorn Bypass

CHAPTER 11 BRIDGE PLANNING

11.1 Bridge Design Standards in Cambodia

The Cambodian Road and Bridge Design Standard and Construction Specifications were established in 1999 and are to be used for the design and construction of all new roads and bridges and related rehabilitation works in the Kingdom of Cambodia. The design standards for bridges are:

- CAM PW 04-101-99 Bridge Design Code 1996 (the Base Document)
- CAM PW 04-102-99 Amendments and additions to the Base Document and to the Commentaries on the Cambodian Bridge Design Standard.

The Base Document is in fact the Australian Bridge Design Code 1996 and associated Commentaries. (Note that in Australia and New Zealand, the Australian Bridge Design Code 1996 has now been superseded by the Australian Bridge Design Code AS5100.)

The Base Document is an International Bridge Standard making use of modern limit state design philosophy. The amendments and additions to the Base Document reflect conditions in Cambodia from the viewpoint of loading (traffic, environmental and earthquake loads), design for durability and material requirements. A comparison of nominal traffic loading for a typical 20 m span pre-stressed concrete bridge is presented below. As can be seen the total maximum traffic load effects based on the Cambodian Bridge Design Standard are reasonably comparable to both AASHTO and JRA standards.

Table 11.1-1 Comparison of Nominal Load Effects for 20m span Bridge Cambodian, AASHTO and JRA Standards

		Single lane		Standard 10m wide roadway bridge deck						
Case	**Load Standard**	**Max Shear (kN)**	**Max Moment (kN-m)**	**Impact Factor**	**No. of Lanes**	**Load Mod. Factor ***	**Total Max Shear (kN)**	**Total Max Moment (kN-m)**	**Shear Factor**	**Moment Factor**
1	CAM T44	358.3	1,639.2	0.35	3	0.80	1,161.0	5,311.0	1.00	1.00
2	CAM HLP 240	N/A	N/A	0.10	N/A	N/A	1,333.2	6,160.0	1.15	1.16
3	AASHTO LRFD HL-93	368.1	1,690.8	0.33	3	0.85	1,248.5	5,734.4	1.08	1.08
4	JRA L-Load	N/A	N/A	0.22	N/A	N/A	1,184.0	5,209.7	1.02	0.98

Note:
Case 1 & 2 : Cambodian Bridge Design Standard; Case 3 : AASHTO LRFD; Case 4 : JRA Specifications for Highway Bridges
* Load Modification Factor to account for multiple lane loading

11.1.1 Traffic Loading

The design traffic load specified in the Base Document consists of T44 Truck loading and L44 Lane loading.

The design T44 Truck load is a 44tonne vehicle with five (5) axles and with maximum axle load of 9.8 tonnes (96 kN). One design truck can occupy one standard design lane width of 3.0 m. Refer to Figure 11.1-1. L44 Lane loading shall consist of the loads shown in Figure 11.1-2. The lane loading shall be assumed uniformly distributed over a 3m Standard Design Lane. Only one tandem of concentrated loads shall be used per lane except that one additional tandem of concentrated loads of equal force shall be placed in each lane in one other span in such a position to produce maximum negative effect. L44 Lane loading does not apply for spans less than 10 m.

The Dynamic Load Allowance for T44 and L44 loadings shall be 0.35.

T44 Truck and L44 Lane loadings shall be assumed to occupy one Standard Design Lane of 3 m width.

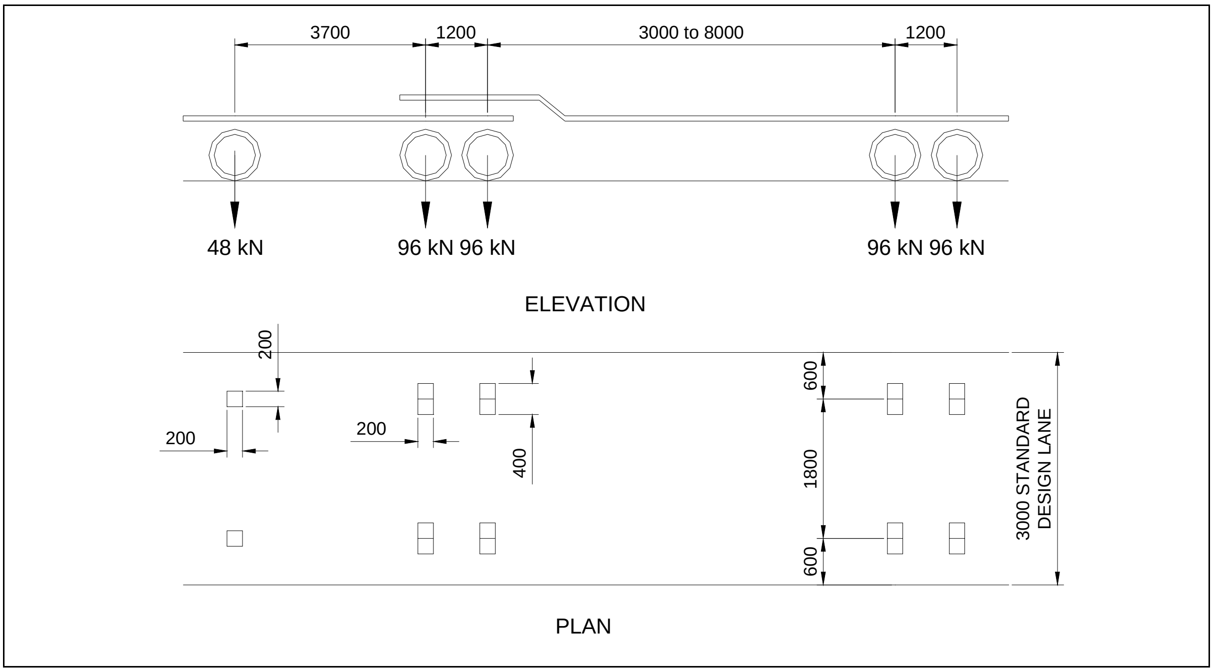
The number of Standard Design Lanes n shall be:

$$n = \frac{b}{3.1}$$

(rounded down to next integer)
where b = carriageway width (in meters) between traffic barriers

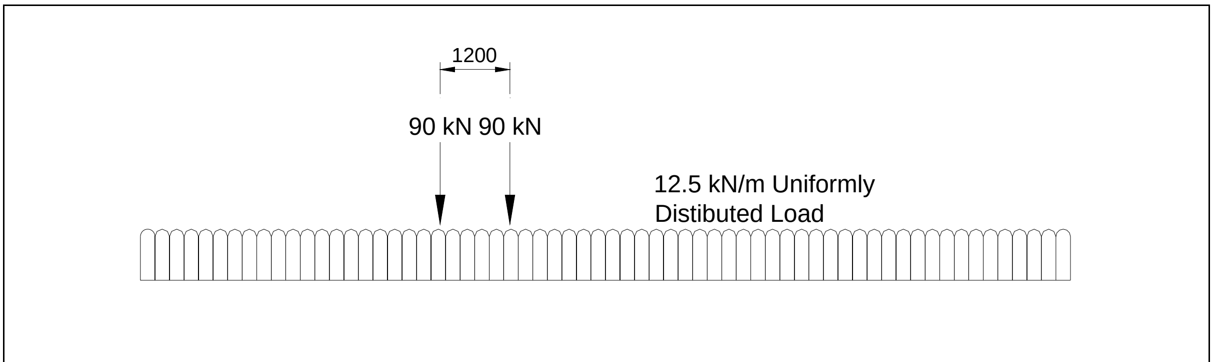
These Standard Design Lanes shall be positioned laterally on the bridge to produce the most adverse effect.

The design of bridges for the simultaneous application of road traffic loading and pedestrian loading is not required.



Source: MPWT, CAM PW 04-101-99 Bridge Design Code 1996

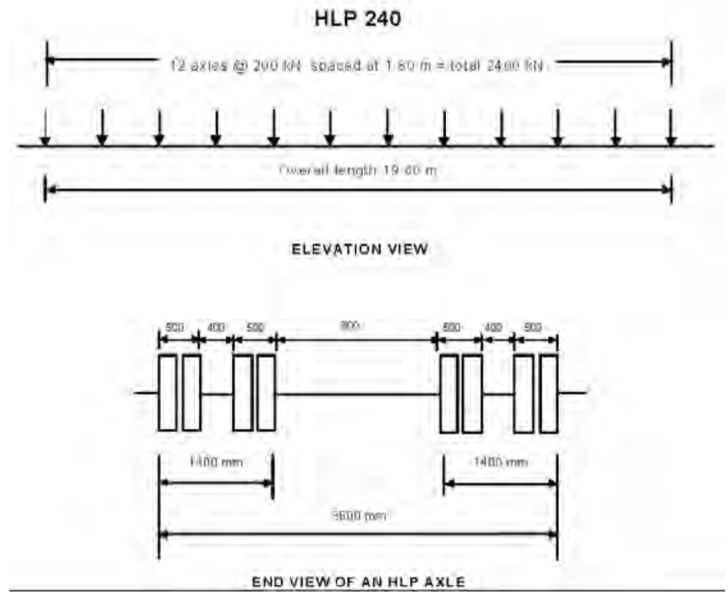
Figure 11.1-1 Design Truck Load T44



Source: MPWT, CAM PW 04-101-99 Bridge Design Code 1996

Figure 11.1-2 Design Lane Loading L44

Heavy Load Platform Loading HLP 240 shall be applied in accordance with the Cambodian Bridge Design Standard. The roads on which Heavy Load Platform Loading apply for bridge design generally will comply with design standards R6/U6, R5/U5 and R4/U4 of the Cambodian Road Design Standard Part 1 – Geometry. On this basis, bridges on National Road No. 5 will be required to support Heavy Load Platform Loading. The configuration of the HLP 240 axle loads is presented in Figure 11.1-3. Heavy Load Platform Loading HPL 240 shall be assumed to centrally occupy two (2) Standard Design Lanes. If the two Standard Design Lanes containing the Heavy Load Platform loadings are positioned such that one or more marked traffic lanes are unobstructed, then a loading of ½ of either the T44 Truck loading or L44 Lane loading shall be applied in those lanes.



Source: MPWT, CAM PW 04-101-99 Bridge Design Code 1996

Figure 11.1-3   Heavy Load Platform Loading

The load modification factors given below shall be applied to T44 Truck and L44 Lane Loading when loading Standard Design Lanes simultaneously. The modification factors shall not apply to Heavy Load Platform loadings.

Number of Standard Design Lanes Loaded	Load Modification Factor
1	1.0
2	0.9
3	0.8
4	0.7

A 70kN single dual-tyred wheel load, with a contact area of 500 mm x 200 mm, shall be applied for all deck elements for which this loading is critical. This wheel load is designated as the W7 Wheel loading.

11.2 Standard Bridges in Cambodia

Standard drawings for pipe culverts, box culverts and bridges are currently being prepared for MPWT approval under The Strengthening of Construction Quality Control Project, JICA.

With regard to bridges, plans are being prepared for carriageway widths of 7 m, 8 m, 10 m, and 12 m for the following bridge types and spans:

- RC Flat Slab (RCS) with spans of 10 m and 12 m
- RC Deck Girder (RCDG) with spans of 12 m, 15 m and 18 m
- Pre-tensioned Precast Plank hollow slab (PSC) with spans of 15 m, 18 m, 20 m and 25 m
- Post-tensioned Precast Concrete Deck Girder (PCDG) with spans of 20 m, 25 m and 30 m

The reinforced concrete flat slab (RCS) bridge is the simplest form of construction applicable to short spans and offers the largest span/depth ratio of all the options, i.e. the deck slab is minimum thickness. This type of construction will therefore have minimal impact on the road profile. The deck is simply supported on a 30 mm thick cement mortar bed and is located with dowels.

The reinforced concrete deck girder (RCDG) bridge is more economic for the longer spans in the range assigned. However this form of construction offers the smallest span/depth ratio of all the options, i.e. the deck construction is relatively deep. Such a relatively deep deck will have a significant effect on the road profile in cases where high flood level controls the deck elevation. The deck also requires the construction of diaphragms, both at the girder ends and in-span, to promote lateral load distribution. The deck is simply supported on rubber pads and is located with dowels.

The pre-tensioned precast plank hollow slab (PSC) bridge offers the advantages of precast construction, in terms of construction speed and construction quality control, and provides a large span/depth ratio for spans up to 25 m. This type of construction will therefore also have minimal impact on the road profile. The planks are pre-tensioned and incorporate voids, circular or rectilinear, to reduce weight. The planks are placed side by side to form the deck with the narrow gap filled with cement mortar. Once the mortar has gained sufficient strength, the planks are transversely post-tensioned using high tensile strength steel bars posted through holes in the planks and anchored in recesses at each side of the deck. The full depth planks do not require any in-situ concrete topping and can directly receive the pavement surfacing. The deck is simply supported on a 30 mm thick cement mortar bed and is located with dowels. This type of bridge deck has become the defector standard in Cambodia for short span bridges, with many examples already constructed ranging from 10 m span length.

The post-tensioned precast concrete deck girder (PCDG) bridge spans up to 30 m in the standard established. This type can in fact be applied to spans up to 40 m or so and is economic for the longer spans in the range assigned. The precast concrete girders again offer advantages in terms of construction speed and construction quality control. The precast girders may or may not incorporate a part of the deck slab, with the reinforced concrete deck slab either totally or partially constructed in-situ. The deck slab may feature transverse prestress. The girders also require diaphragm to promote lateral load distribution. This form of construction however has a relatively small span/depth ratio, i.e. the deck construction is relatively deep. Such a relatively deep deck will therefore have a significant effect on the road profile in cases where high flood level controls the deck elevation. The deck is simply supported on elastomeric pads and is located with dowels.

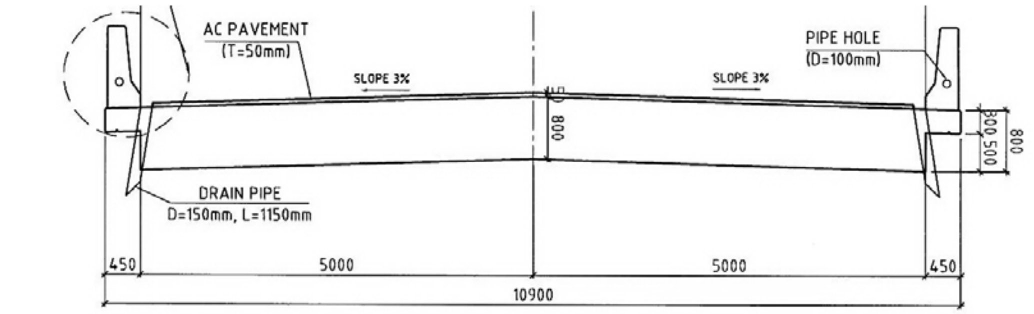
Two types of reinforced concrete abutment are featured in the standard drawings:

- Stub Type
- Cantilever Type

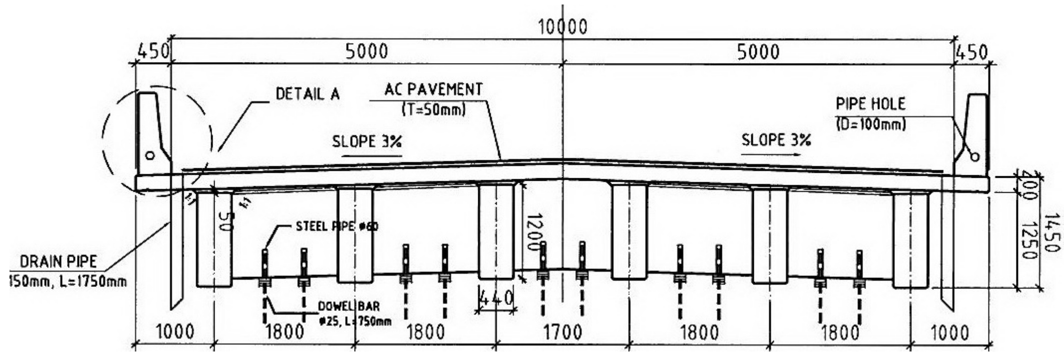
The stub type abutment features a simple coping beam, providing a bearing shelf for the deck, supported on a single row of piles, with the wing walls hung off each side. This type is suitable for all the standard deck forms where the approach embankments are relatively low and where there is no threat of local scour attack.

The cantilever abutment is a substantial structure suitable for high approach embankment situations, or deep waterway locations, and where protection to local scour attack is required. The abutment comprises of a cantilever wall, providing a bearing shelf for the deck, supported on a pile cap with multiple rows of piles. The wing walls are hung off short counterforts at each side. The abutment can support large vertical and horizontal loads.

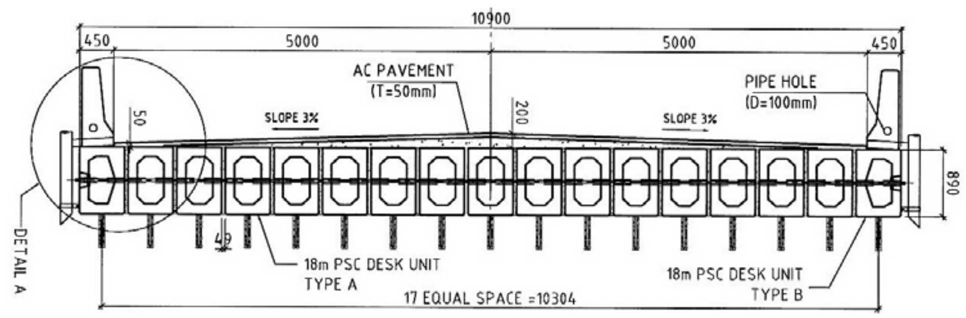
Refer to Figure 11.2-1 for typical sections of the proposed standard bridges (draft). Refer to Figure 11.2-2 for typical abutment layouts for the standard bridges. The standard bridges show a minimum freeboard of 80 cm to high water level.



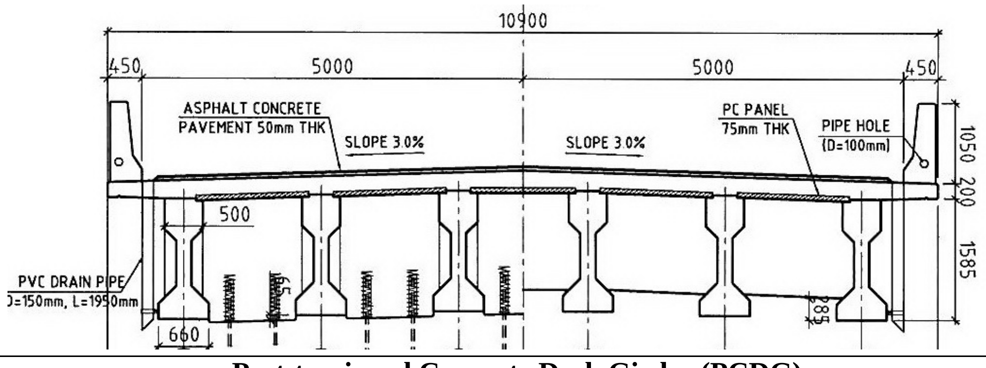
RC Flat Slab (RCS)



RC Deck Girder (RCDG)



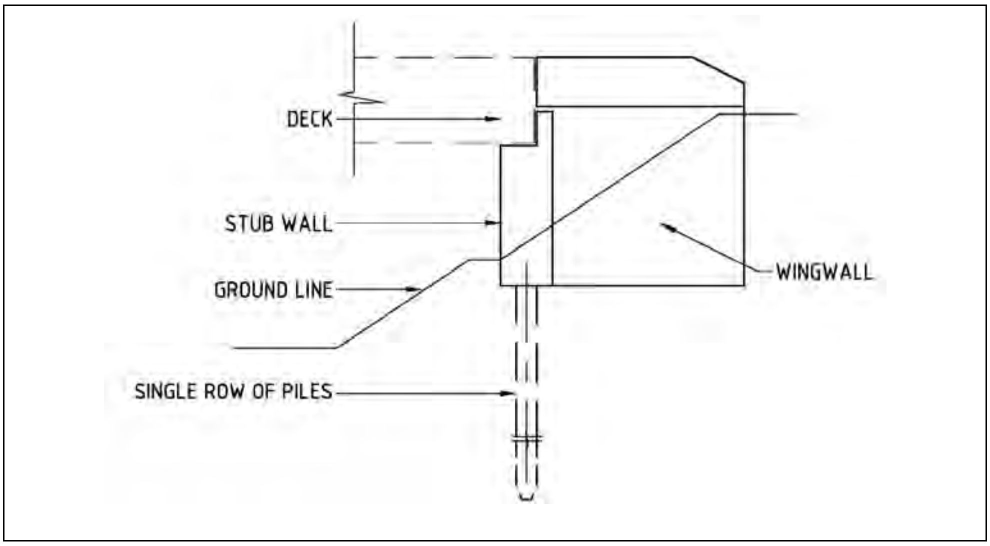
Pre-tensioned Precast Plank (PSC)



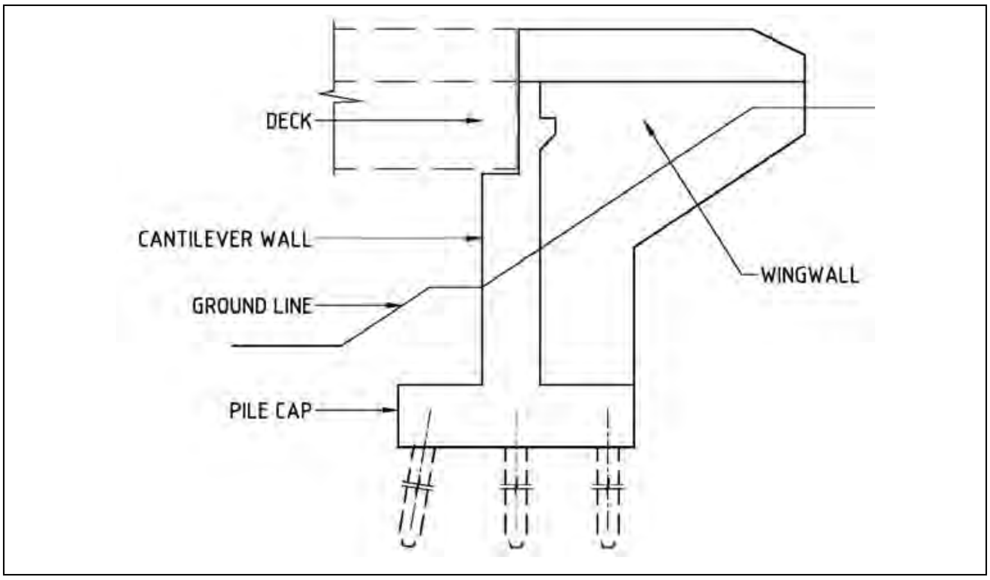
Post-tensioned Concrete Deck Girder (PCDG)

Source: MPWT, The Strengthening of Construction Quality Project, JICA

Figure 11.2-1 Standard Bridge Typical Sections for 10m wide Carriageway



Stub Type Abutment



Cantilever Type Abutment

Source: MPWT, The Strengthening of Construction Quality Project, JICA

Figure 11.2-2 Standard Bridge Abutments

11.3 Inventory of Existing Bridges on the North Section

Table 11.3-1 Inventory of Existing Bridges, North Section

1	2	3	4	5	6	7	8	9
Ref	**Code**	**KP**	**Type**	**Length**	**C/way width**	**Total Width**	**No. of spans**	**Year Built**
		(km)		(m)	(m)	(m)		
1	Br. 78	292.1	RCA	114.6	6.5	8.8	3	1962-3
2	Br. 79	303.4	IG	30.0	7.0	9.6	1	1996
3	Br. 80	304.8	Plank	20.0	10.0	10.8	1	2003
4	Br. 81	307.2	Plank	20.0	10.0	10.8	1	2003
5	Br. 82	312.1	IG	25.5	7.0	9.6	1	1996
6	Br. 83	333.8	Plank	36.0	10.0	10.8	2	2003
7	Br. 84	341.1	RCS	4.9	9.9	10.2	2	Undated
8	Br. 85	342.1	Plank	30.0	10.0	10.8	2	2003
9	Br. 86	346.1	Plank	12.0	10.0	10.8	1	2003
10	Br. 87	347.9	Plank	15.0	10.0	10.8	1	2003
11	Br. 88	349.6	Plank	10.0	10.0	10.8	1	2003
12	Br. 89	351.5	Plank	44.0	10.0	10.8	3	2003
13	Br. 90	356.1	Plank	12	10.0	10.8	1	2003
14	Br. 91	357.2	RCS	14.0	8.4	8.6	3	Undated
15	Br. 92	358.4	PCDG	81.0	10.0	10.8	3	2003

Bridge Code and Year Built from MPWT, Bridge Location National Road No. 5 & 6, 2009

Note:
1. RCA – reinforced concrete arched rib
   IG –Welded steel plate I girder with inside reinforced concrete deck slab
   Plank – precast pre-tensioned concrete plank deck
   RCS – reinforced concrete slab culvert type structure
   PCDG – pre-stressed concrete deck girder
2. Bridge length in column 5 means total bridge length between deck joints, except Br 84 which is total length of railing
3. Year of construction of Br. 78 obtained from Deputy Director of DPWT Battambang

11.4 Condition of Existing Bridges on the North Section

11.4.1 Condition of the Existing Bridge Structures

The bridges on the North Section are generally in good condition. Refer to Photos 11.4-1 and 11.4-2.

Nine (9) of the bridges constructed in 2003 under the ADB PRRP have spans lengths no greater than 20 m and feature precast concrete pre-tensioned plank decks transversely post-tensioned. Such type of construction is the most up-to-date standard bridge deck form in Cambodia for short span bridges. These bridges all feature a full 10.0 m wide carriageway, safety shape concrete barriers and stub type abutments.


Br. 78　KP 292.1


Br. 79　KP 303.4


Br. 80　KP 304.8


Br. 81　KP 307.2


Br. 82　KP 312.1


Br. 83　KP 333.8


Br. 84　KP 341.1


Br. 85　KP 342.1

Photo 11.4-1　Existing Bridges on North Section (1/2)

Br. 86 KP 346.1

Br. 87 KP 347.9

Br. 88 KP 349.6

Br. 89 KP 351.5

Br. 90 KP 356.1

Br. 91 KP 357.2

Br. 92 KP 358.4

Photo 11.4-2 Existing Bridges on North Section (2/2)

Two (2) of the bridges were constructed in 1996 under Australian fund and feature steel plate girder beams with in-situ concrete deck slabs. Close up inspection of the underside of these bridges reveal that both the structural steel and the concrete deck slab soffit are in good condition, with no rusting of the galvanized steel or spalling/scaling/cracking of the concrete. The DBST surfacing has however undergone some patch repair. The 7.0 m carriageway widths of both of these bridges is below current standard and the bridge railings are comprised of scaffolding poles fixed with clamps, considered insufficient to redirect an errant vehicle should it mount the separator curbs at the roadway edge. The abutments are probably stub type.

The existing bridge in Battambang, Br. 78, known locally as Spean Thmor Thmey, is a substantial reinforced concrete ribbed arch structure, crossing the River Sangkae over three (3) spans with a total length of 114 m. This bridge was constructed in 1962 or 1963 by local private investment, according to the Deputy Director of Battambang DPWT. Inspection from the river banks reveals a structure that is in reasonably good condition. The deck pavement is also in fair condition without obvious signs of distress. There were no reported problems raised with this bridge by DPWT following enquiries by the Study Team. The 6.5 m carriageway width of this bridge is below current standard but nevertheless is wide enough for two regular width lanes. Abutment type is unknown.

The existing bridge in Banteay Meanchey, Br. 92, known locally as Se Sin Bridge, is a substantial prestressed concrete beam and slab structure, crossing the River Sri Sophorn over three (3) spans with a total length of 82 m. The girders are precast pre-tensioned Australian standard Super-T type girders with a girder depth of 1500 mm. This bridge was constructed in 2003 under the ADB PRRP. Inspection from the river banks reveals a structure that is in good condition. The deck pavement is also in good condition without obvious signs of distress. There were no reported problems raised with this bridge by the Director of Banteay Meanchey DPWT following enquiries by the Study Team. This bridge features a full 10.0 m wide carriageway and safety shape concrete barriers. The abutments are stub type with raked piles.

Br. 84 and Br. 91 are relatively aged structures that were not replaced under the previous improvement projects, and are both of short span culvert type construction. These structures do not have a recorded year of construction according to the MPWT document "Bridge Location on National Road No. 5 & 6".

- Bridge Br. 84 is a reinforced concrete culvert type structure that features two small span arched openings, each 1.8 m wide and with 1.8 m clear vertical opening. The carriageway width is 9.9 m on the structure. The bridge railings are damaged and do not have the capacity to redirect errant vehicles.

- Bridge Br. 91 is a reinforced concrete culvert type structure that features three spans of 4.5 m and with 3.8 m clear vertical opening. The structure crosses an irrigation channel that was improved in 2010. The carriageway width is 8.4 m on the bridge. The structure is showing clear signs of deterioration with areas of spalled concrete and exposed reinforcement. The bridge railings are damaged and do not have the capacity to redirect errant vehicles.

It is noted from the ADB PRRP construction drawings that during the reconstruction in 2003 of Br. 89, known locally as Mongkol Borei Bridge, the existing 48 m Bailey bridge was replaced by a 43.8 m permanent concrete bridge. This shorter bridge required remedial works to the steep slope protection at the abutments in the form of rock rip-rap to the slopes, rock baskets and geo-textile at the toe of the slopes and vegetated fill surfaces. It is considered by the Study Team, following site inspection, that the 2003 bridge is in fact too short for the site, at least on the Battambang side. The rock rip rap on the Battambang side has subsided and separated from the abutment since the construction exposing the abutment piles.

11.4.2 Flood Conditions at the Existing Bridge Locations

The flood conditions at the location of the existing bridges are presented in Table 11.4-1. The flood data presented is based upon interviews with local residents and measurements made by the Study Team to high water marks on the bridge structures or adjacent structures, where still visible.

Accounts of high flood level at bridge locations north of KP 333 were dominated by references to very high flood waters that occurred in October 2010. The Director of DPWT in Banteay Meanchey informed the Study Team, at a meeting on the 22nd June at DPWT offices, that the flood waters in 2010 were caused by large run-off from the bordering provinces of Thailand. Most of the residents interviewed by the Study Team also attributed the source of the flood waters to be from Thailand. These unusually large flood waters from Thailand combined with high water conditions at the Tonle Sap Lake to create flood conditions that were the most severe in recent living memory of the local inhabitants interviewed. The flood waters from Thailand were exacerbated by a dam break.

Table 11.4-1 Flood Condition at Location of Existing Bridges, North Section

1	2	3	4	5	6	7	8	9
Ref	**Code**	**KP** (km)	**Waterway Width** (m)	**River Clearance** (m)	**Normal Flood Level** (m)	**High Flood Level** (m)	**Flood Breakout**	**Comment**
1	Br. 78	292.1	80.0	no record	no record	4.0	None	
2	Br. 79	303.4	30.0	no record	1.4	1.1	None	
3	Br. 80	304.8	20.0	3.5	3.0	1.5	None	
4	Br. 81	307.2	20.0	2.2	no record	1.2	None	Note 2
5	Br. 82	312.1	25.5	3.7	2.0	0.7	None	Note 2
6	Br. 83	333.8	36.0	4.0	1.3	0.5	None	Note 3
7	Br. 84	341.1	4.0	2.2	0.8	0.4	None	Note 4
8	Br. 85	342.1	30.0	3.5	1.0	-0.1	Yes	Note 2&5
9	Br. 86	346.1	12.0	2.2	0.8	0.3	None	
10	Br. 87	347.9	15.0	3.0	1.0	no record	None	
11	Br. 88	349.6	10.0	2.5	0.8	0.4	None	
12	Br. 89	351.5	44.0	9.0	4.0	3.0	None	Note 6
13	Br. 90	356.1	12.0	2.2	1.2	0.4	None	Note 2&7
14	Br. 91	357.2	10.0	4.1	1.4	0.8	None	Note 8
15	Br. 92	358.4	81.0	9.0	3.0	2.0	None	Note 9

Note:

1. River clearance (Col 5) and Flood Levels (Col 6 & 7) are measured below carriageway level (top of pavement)
2. Waterway dry with some ponding at date of inspection (July 2011)
3. Flood water rose to top of shoulder of approach road in 2010
4. High flood level in 2010
5. Flood 10 cm over bridge and approaches in 2010 – 1 month duration
6. High flood level in 2010. Flooding duration 15days. Flood overtopped south approach road by 0.5m adjacent to Koksvay Primary School.
7. Flood water rose to top of shoulder of approach road in 2010. Run off water from north blocked in 2011.
8. High flood level in 2010. Irrigation channel improved in 2010
9. High flood level in 2010.

11.5 Bridge Rehabilitation Plan on the North Section

The majority of the existing bridges on the North Section are in good condition given their relatively recent construction. Notwithstanding the generally good condition of the existing bridges the following deficiencies are identified:

- Existing carriageway width at Br. 78 in Battambang City is, at 6.5 m, below the required standard width of 10 m for a two (2) lane national road.
- Existing 7.0 m carriageway width at Br. 79 at KP 303.4 is less than the required standard width of 10 m for a two (2) lane national road and features inadequate railing.

- Existing 7.0 m carriageway width at Br. 82 at KP 311.9 is less than the required standard width of 10 m for a two (2) lane national road and features inadequate railing.
- Relatively old structure at Br. 84 at KP 341.1 with inadequate freeboard to maximum flood level and inadequate bridge railings.
- Failure of abutment slope protection at Br. 89 with exposed abutment piles.
- Relatively old structure at Br. 91 at KP 357.2 with inadequate freeboard to maximum flood level, areas of spalled concrete and exposed reinforcement, inadequate bridge railings and insufficient width for standard two (2) lane national road.

All the bridges, except Br. 85, are not overtopped during flood conditions. However most of the bridges do not provide adequate freeboard to maximum flood level. For at least two bridges, Br. 79 and Br. 82, the lower deck section is submerged during periods of maximum flood. Br. 85 was reported to be overtopped by 10 cm during the 2010 flood. However, given the extraordinary nature of the 2010 flood it is not proposed that any of the bridges, other than the bridges that are planned to be reconstructed, should be raised in elevation.

Given that it is proposed to bypass Battambang City it is not considered necessary to recommend any bridge widening works at Br. 78, notwithstanding that the carriageway width is substandard.

The scope of the rehabilitation of the bridges on the North Section will depend on the lane configuration adopted for the road rehabilitation i.e. full 4-Lane divided or opposed 2-Lane plus motorcycle lane. However, irrespective of the final lane configuration, the bridges identified above with deficiencies will require some form of rehabilitation.

11.5.1 Planning of Bridge Widening for 4-Lane Road

The substantial carriageway width required to accommodate a 4-Lane Road will require that all bridges on the North Section will either have to be widened or to be supplemented with an additional adjacent bridge. The bridges that have tangential road approaches are recommended to be equally widened on each side in order to maintain the tangent horizontal alignment of the existing road. Those bridges that have approaches on curved alignment are recommended to be supplemented with an additional bridge of sufficient width to provide the necessary carriageway width for 4-Lane Road. Refer to Table 11.5-1 for a summary of proposed bridge widening for 4-Lane Road.

Refer to Section 11.5.2 for details of bridge widening and Section 11.5.3 for the proposed additional bridges for 4-Lane Road.

Table 11.5-1 Summary of Bridge Widening- Full 4-Lane Design

1	2	3	4	5	6
Ref	**Code**	**KP** (km)	**Existing Type**	**Road Approach**	**4-Lane Widening Concept**
1*	Br. 78	292.1	RCA	Tangent	No widening proposed
2	Br. 79	303.4	IG	Curved	Provide additional bridge LHS
3	Br. 80	304.8	PSC	Tangent/Curved	Widen existing bridge both sides
4	Br. 81	307.2	PSC	Tangent	Widen existing bridge both sides
5	Br. 82	312.1	IG	Curved	Provide additional bridge RHS
6	Br. 83	333.8	PSC	Tangent	Widen existing bridge both sides
7	Br. 84	341.1	RCS	Tangent	Replace bridge with new structure
8	Br. 85	342.1	PSC	Tangent	Widen existing bridge both sides
9	Br. 86	346.1	PSC	Tangent	Widen existing bridge both sides
10	Br. 87	347.9	PSC	Tangent	Widen existing bridge both sides
11*	Br. 88	349.6	PSC	Tangent	Widen existing bridge both sides
12*	Br. 89	351.5	PSC	Curved	Provide additional bridge RHS
13*	Br. 90	356.1	PSC	Tangent	Widen existing bridge both sides
14*	Br. 91	357.2	RCS	Tangent	Replace bridge with new bridge
15*	Br. 92	358.4	PCDG	Curved	No widening proposed

**) These bridges are not included in the improvement project of NR 5 (See Chapter 12).*

Note:

RCA – reinforced concrete arched rib
IG –Welded steel plate I girder with in-situ reinforced concrete deck slab
PSC – precast pre-tensioned concrete plank deck
RCS– reinforced concrete slab culvert type structure
PCDG – pre-stressed concrete deck girder

11.5.2 Rehabilitation of Br. 79 & Br. 82

The two similar single span bridges constructed in 1996 with Australian funding, Br. 79 and Br. 82, feature carriageways that are only 7.0 m wide. The bridges each feature six (6) steel plate girders supporting a deck slab that is 9.6 m wide, accommodating 1.3 m wide walkways each side of the carriageway. Refer to Photo 11.5-1.

Br. 79 KP 303.4
View on Deck

Br. 82 KP 312.1
View on Sidewalk

Br. 79 KP 303.4
View on Railing

Br. 79 KP 303.4
View on Railing Attachment

Br. 79 KP 303.4
View on Girder

Br. 79 KP 303.4
View on K Frame

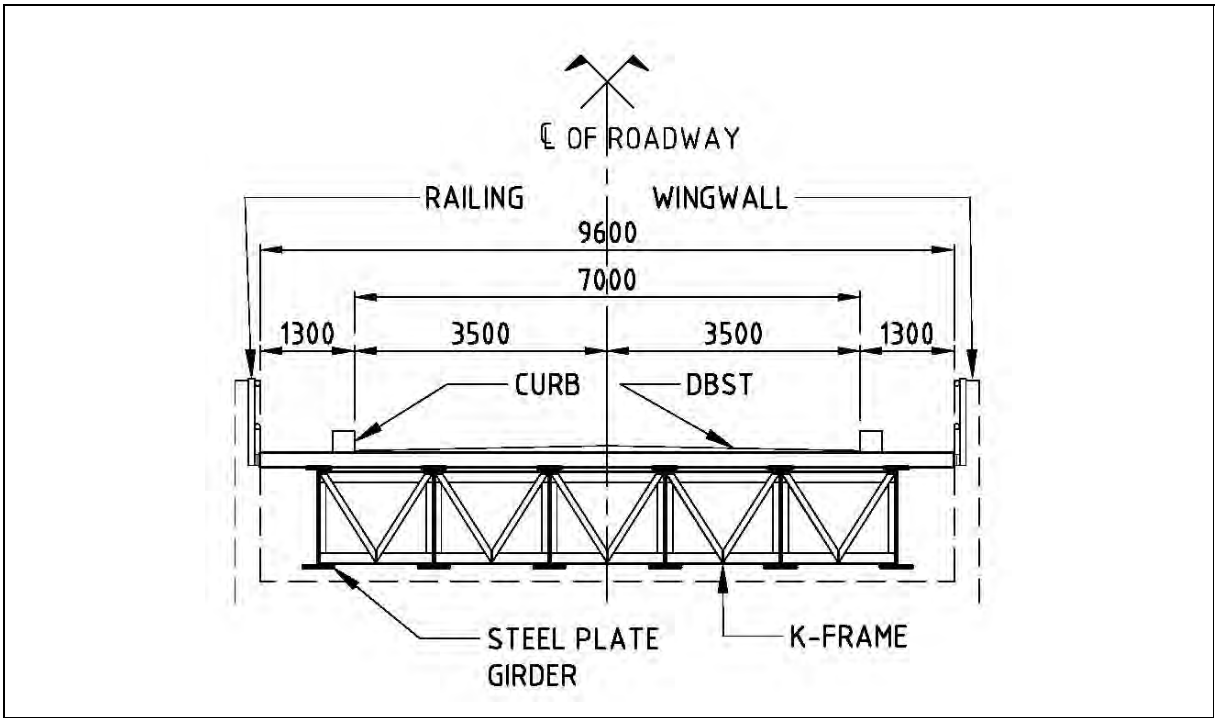
Photo 11.5-1 Existing Bridges Br. 79 and Br. 82

In the case of the 4-Lane Road rehabilitation option, it is proposed to make use of the existing structure to accommodate one of the 2-Lane carriageways and to construct an additional bridge to accommodate the other carriageway.

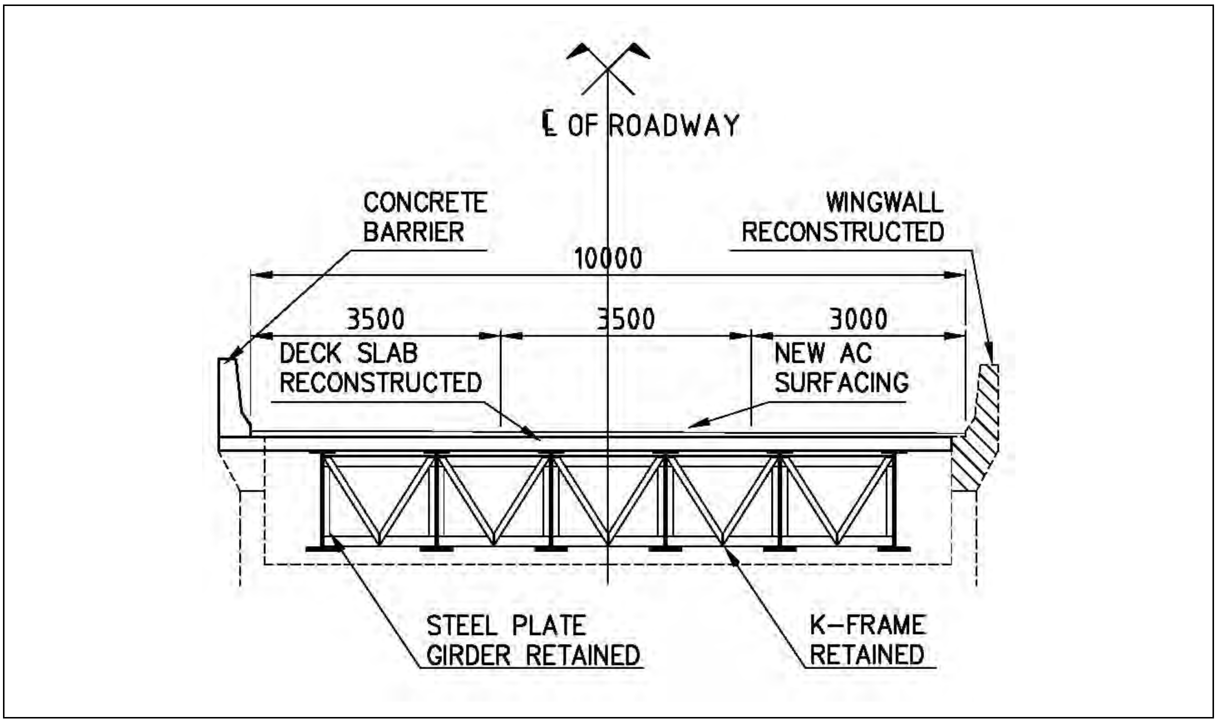
Notwithstanding that the existing bridges are in good condition, the symmetrical layout of the 7.0 m carriageway width cannot accommodate the proposed shoulder for the 4-Lane Road. In the case of adopting a 4-lane width design for the North Section, it is proposed that the deck slab is either partially demolished, or completely demolished, and new deck slab is constructed such that the 2-Lane carriageway plus shoulder can occupy a 10.0 m carriageway width. The width between the existing wing wall faces is 9.6 m and the wing wall faces are vertical. The existing wing walls will therefore be partially demolished and reconstructed with a safety shape profile to accommodate a 10 m width. The bridge railings on the deck will also be replaced with solid concrete safety shape barriers and the decks will be resurfaced with AC pavement. An analysis of the capacity of the existing steel girders will be necessary at the detailed design stage to determine if strengthening of the girders is required. Refer to Figure 11.5-1 for an outline sketch of the proposed rehabilitation.

Construction may be phased at Br. 79 and Br. 82 such that the additional bridges required for the 4-Lane Road are constructed first and put in service before the existing bridges are closed for the required rehabilitation works.

It is noted that, although flood waters do not overtop the deck, water rises above the level of the girder bottom flanges to within 100 cm and 70 cm of the top of the deck at Br. 79 and Br. 82 respectively. These bridges therefore do not provide any freeboard at all to maximum flood level and in fact the lower flanges of the girders of both bridges are submerged under such flood conditions. A freeboard clearance of 80 cm is typically required from high flood water level to the underside of the bridge deck. The bridges are therefore substandard with regard to providing adequate freeboard clearance.



a) Existing Cross-Section



b) Proposed Rehabilitation

Figure 11.5-1 Proposed Rehabilitation at Br. 79 and Br. 82 – 4-Lane Road

11.5.3 Rehabilitation of Br. 84

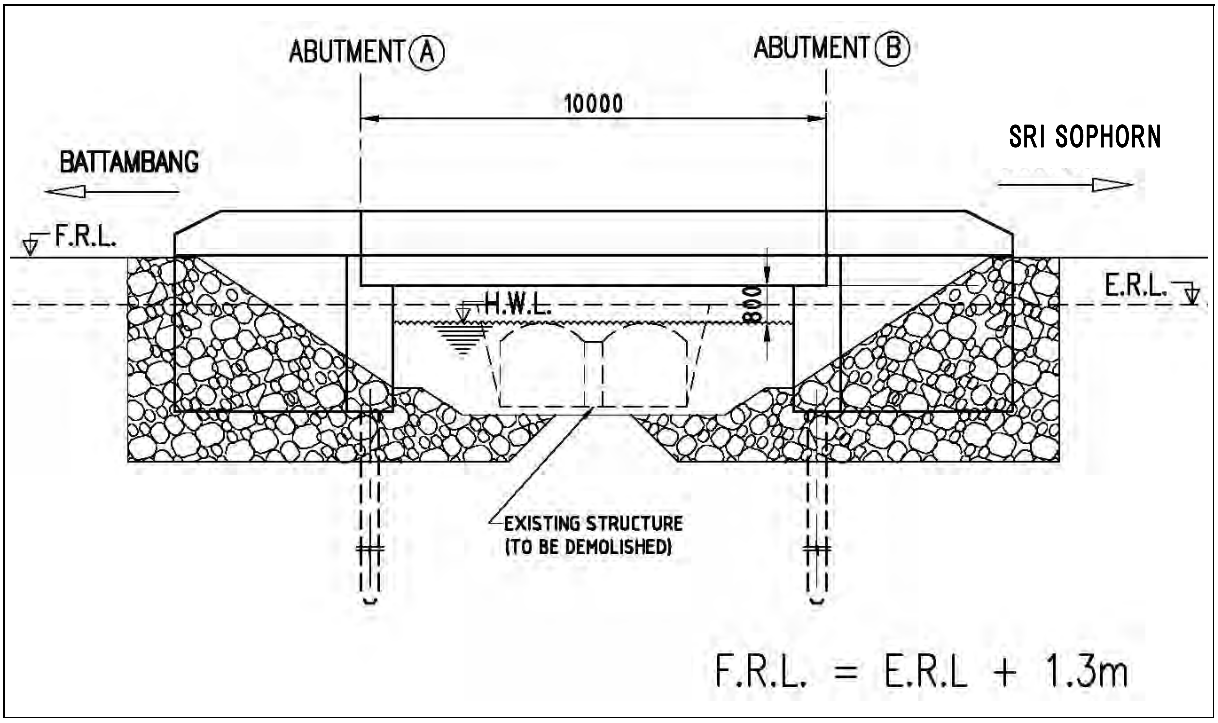
It is proposed to replace the existing structure at this location with a new 4-Lane structure. The existing structure at Br. 84 is in fact a relatively small culvert crossing a minor water channel. The maximum flood level at this location was determined from interviews with local residents during the site inspections of the Study Team. Flood waters do not overtop the structure according to accounts received but flood water level rises to within 40 cm of the road surface (in 2010). In order to protect the proposed pavement works and maintain a minimum 80 cm freeboard beneath the bridge deck surface, the profile of the road at this section must therefore be raised. Local accounts describe overtopping of the road on the approaches to the bridge structure in year 2010, although flood water depth above the road was not significant and it did not severely interrupt traffic flow with motorcycles still able to negotiate the flooded sections. Flood levels at Br. 84 were not significantly different in 2010 from other years, according to local residents.

This structure is designated by MPWT as a bridge location. Should it be the policy of MPWT to make provision for a bridge at this location, it is proposed that a minimum span length bridge is constructed. In accordance with the ongoing study, The Strengthening of Construction Quality Project, the minimum length standard bridge features a span of 10m. Either an insitu reinforced concrete slab (RCS) structure or a pre-tensioned precast concrete plank hollow slab (PSC) bridge can be recommended at this location. In drafting a structure layout for comparison purposes, an allowance of 80 cm freeboard has been made to the maximum flood water level established at this location from the accounts of local residents.

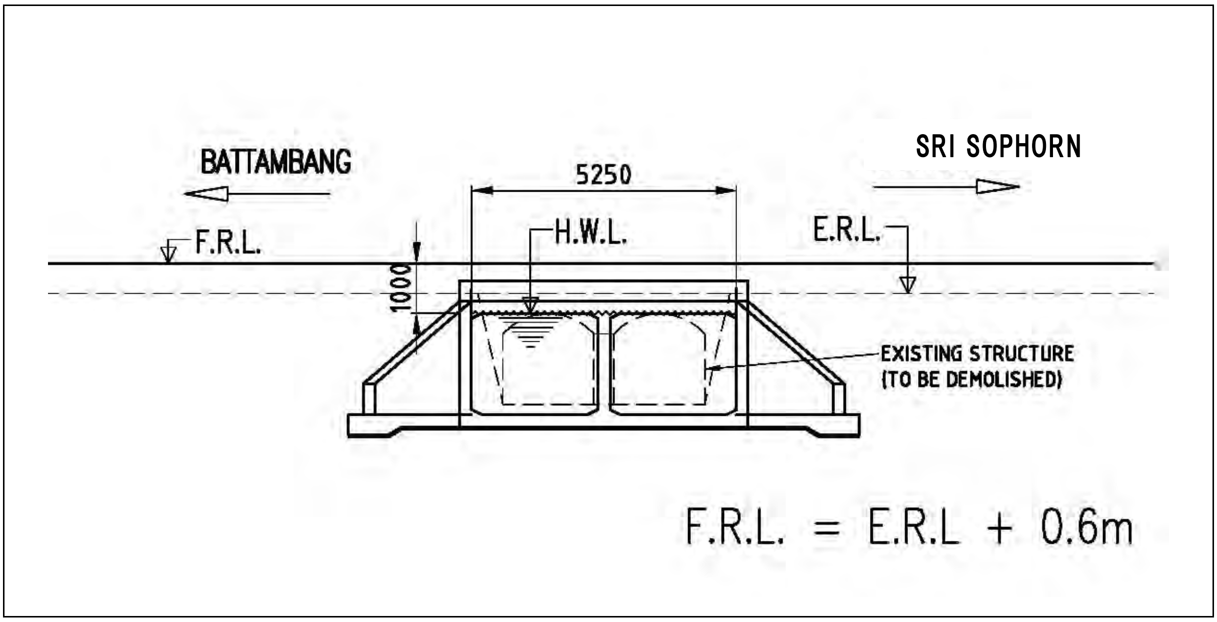
An alternative to a bridge structure at this location is a reinforced concrete culvert. The final size and configuration of the culvert should be determined at detailed design following proper hydrological and hydraulic analysis. For the purpose of illustrating a structural arrangement, a twin cell 2.5 mx2.0 m box culvert has been considered for this study. The finished road level has been set 100 cm above maximum flood level to protect the pavement.

The Study Team inspected this bridge location in November 2010 during the rainy season and found that the water level in the channel was very little changed from that found following inspections made during the dry season in June and July 2011. Notwithstanding the extraordinary food conditions encountered in 2010, it is therefore recommended that a box culvert structure is constructed at this location to replace the existing structure.

Refer to Figure 11.5-2 for elevations on the proposed alternatives.



a) RCS Bridge Alternative



b) Box Culvert Alternative (Recommended)

Note: H.W.L = High Water Level : F.R.L. = Finished Road Level : E.R.L. = Existing Road Level

Figure 11.5-2 Elevations on Structure Alternatives for Br. 84

11.5.4 Rehabilitation of Br. 89

(This bridge is not included in the project sections as described in Chapter 12.)

Location of this bridge is out of proposed project section because of diverting to Sri Sophorn Bypass.

At Br. 89, known locally as Mongkol Borei Bridge, it is proposed to retain the existing structure and to provide an additional bridge to accommodate the 4-Lane Road.

The rock rip rap on the Battambang side of Br. 89 has subsided and separated from the abutment since construction, exposing the abutment piles. The rip rap on this side is not grouted but is instead retained within a wire mesh. The grouted rip rap on the Sri Sophorn side is constructed on a less steep slope and is in reasonable condition.

From the brief inspection undertaken by the Study Team it appears that the steep rip rap slope at the Battambang abutment has suffered a local failure on the upstream side, resulting in loss of support and settlement of the soil beneath the abutment coping, exposing the piles. Refer to Photo 11.5-2.

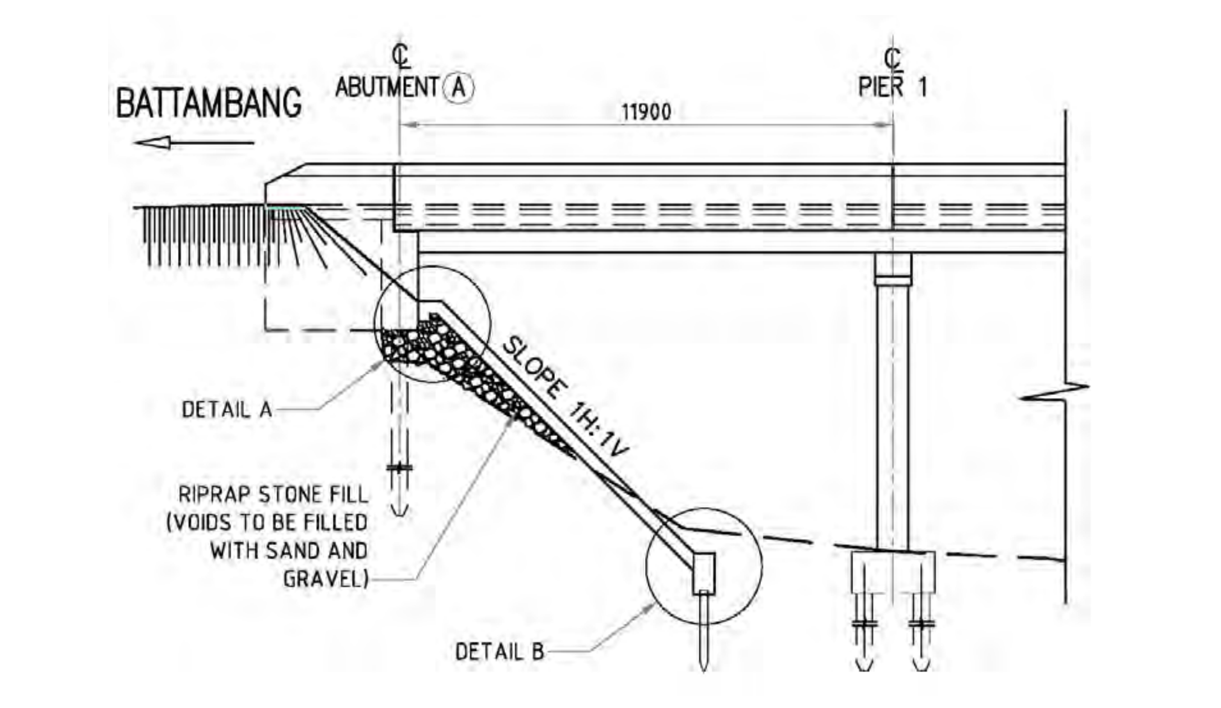
The following rehabilitation works are proposed for the rip rap protection at the Battambang abutment:

- Remove the existing wire mesh covering and the rock rip rap.
- Expose the length of the abutment coping to determine the full extent of the subsided slope.
- Remove any loose soils from beneath the abutment coping around the exposed piles to suitable depth and compact in-situ soils with hand held vibratory plate compactor as necessary.
- Trim the exposed slope and compact with hand held vibratory plate compactor as necessary, fill any subsided area with rock rip rap and fill any small voids with sand and gravel.
- Fill the voids beneath the abutment coping with rock rip rap, any small voids to be filled with sand and gravel.
- Construct a reinforced concrete curtain wall at the toe of the slope supported on timber piles.
- Fix a rebar mat over the entire slope, fix suitable weep hole pipes and cast a concrete slab slope protection to be contiguous with the abutment structure and monolithic with the curtain wall.

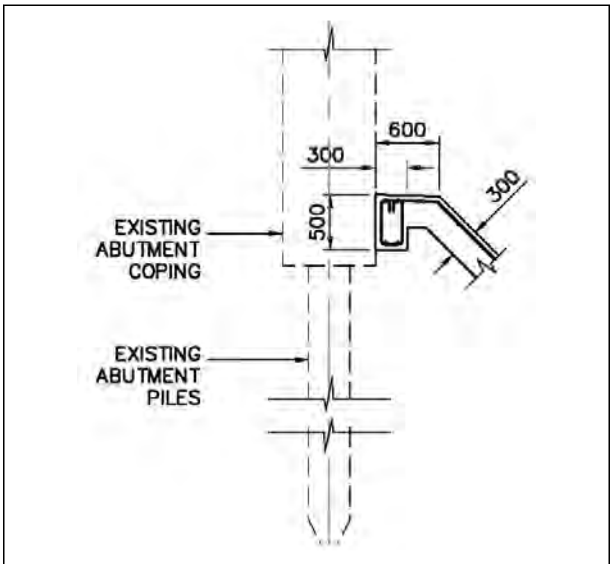
Refer to Figure 11.5-3 for details of the proposed rehabilitation at Br. 89.

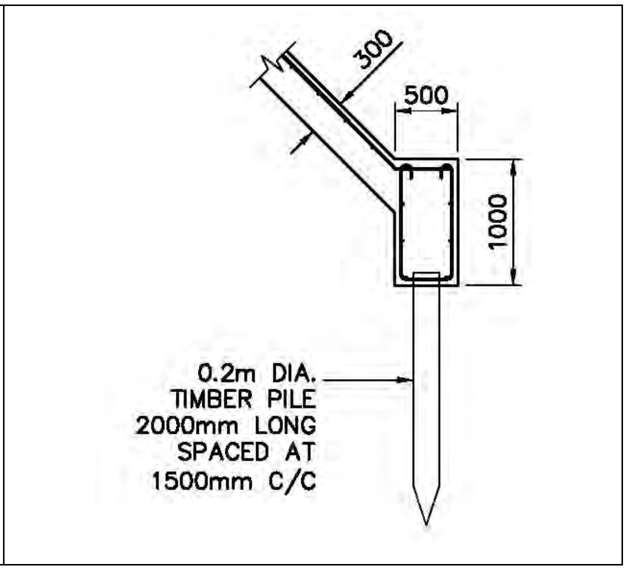
 View on Battambang Abutment showing slope failure into the river	 View on Rip Rap at Battambang Abutment (loose rocks retained in wire mesh)
 View on Sri Sophorn Abutment	 View on Grouted Rip Rap at Sri Sophorn Abutment
 View on Exposed Piles at Battambang Abutment Upstream side	 View on Separated Riprap at Battambang Abutment Wing Wall Upstream side

Photo 11.5-2　Existing Bridge Br. 89　KP 351.5 (Mongkol Borei Bridge)



a) Elevation on Battambang Abutment





b) Detail A **c) Detail B**

Figure 11.5-3 Proposed Rehabilitation at Br. 89

11.5.5 Rehabilitation of Br. 91

(These bridges are not included in the improvement project of NR 5 (See Chapter 12).)

Location of this bridge is out of proposed project section because of diverting to Sri Sophorn Bypass.

Bridger Br. 91 is a reinforced concrete culvert type structure that features three spans of 4.5 m and 3.8 m clear vertical opening. The total length of the bridge is 14.0 m. The carriageway width is 8.4 m on the bridge. The structure is showing clear signs of deterioration with areas of spalled concrete and exposed reinforcement. The bridge railings are damaged and do not have the capacity to redirect errant vehicles.

Given the aged and deteriorated condition of the structure and inadequate carriageway width, it is proposed that this structure is replaced with a new 4-Lane bridge. In consideration of the relatively small size of the existing bridge, and the modest waterway crossed, it is proposed that the new bridge will be constructed at the same position as the existing bridge with provision made during construction for a detour road with temporary bridge. The length of the existing structure and the configuration of the waterway, with no flood water breakout reported at this location, favors a new bridge with a total deck length of 20 m.

Refer to Table 11.5-2 for an outline comparative study of alternatives for consideration. Given that the cost differences for such small span structures are not likely to be substantial, only broad cost considerations have been included in the comparative analysis. The types of construction identified, for both bridge deck and abutment layout, were selected from the standard bridges established by the MPWT, The Strengthening of Construction Quality Project, JICA.

Refer to Figure 11.5-4 for elevations on the proposed alternatives.

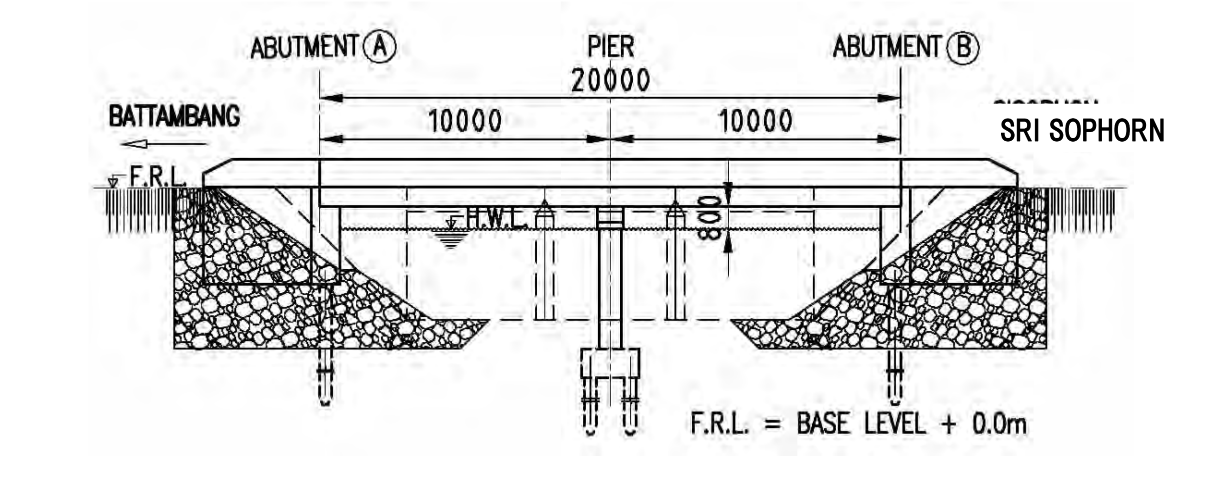
All alternatives are set to give a deck elevation no less than that of the existing road and such to provide at least 80 cm freeboard to design high water level. For the purposes of this study, and in the absence of any detailed hydrological or hydraulic analysis, design high water is set to the normal flood water level according to the findings of the site inspection. The extraordinary 2010 flood water level will not be considered. The design high water level to be adopted for the detailed design will require to be established from detailed hydrological and hydraulic analysis.

Table 11.5-2 Comparative Study of Alternatives for Br. 91

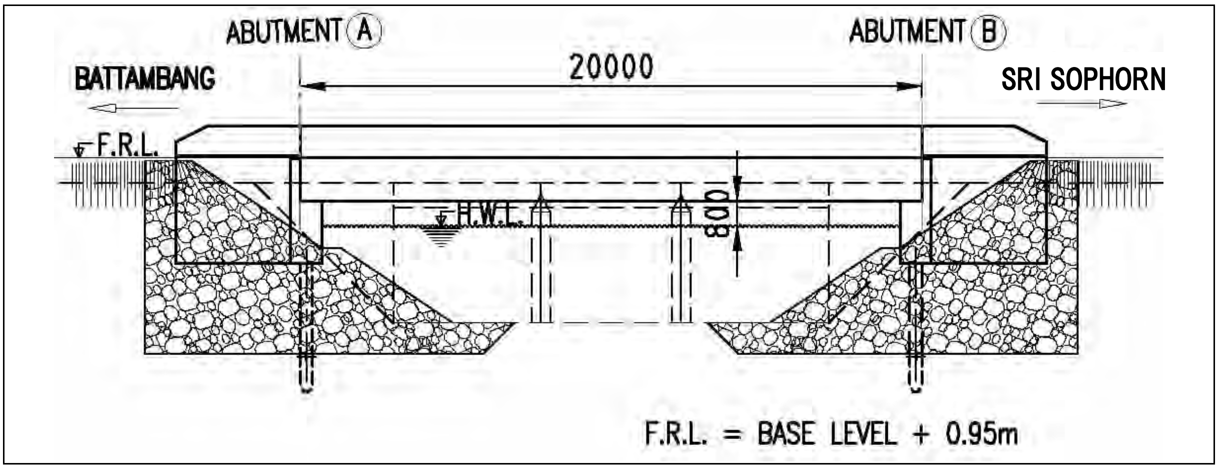
1	2	3	4	5	6
Bridge Type	**Total Length** (m)	**No. of Spans**	**Advantages**	**Disadvantages**	**Comment**
RCS	20	2	• Shallowest depth of deck • Simplest form of construction • No deck diaphragms required • No transverse prestress required • Minimal impact on road profile	• Pier construction required in waterway • Shoring required for in-situ deck construction • Longest construction period • Least economic given the additional foundation costs	2nd Rank
RCDG	20	1	• No pier required • No transverse prestress required • Most economic for the selected span	• Greatest depth of deck • Maximum impact on road profile • Deck diaphragms required • Shoring required for in-situ deck construction • Non standard length (see note 2)	3rd Rank
PSC	20	1	• No pier required • No shoring required for precast deck construction • Relatively shallow depth of deck • Moderate impact on road profile • Shortest construction period • Precasting will promote good quality of concrete finish to the deck	• Transverse prestress required	1st Rank

Note:

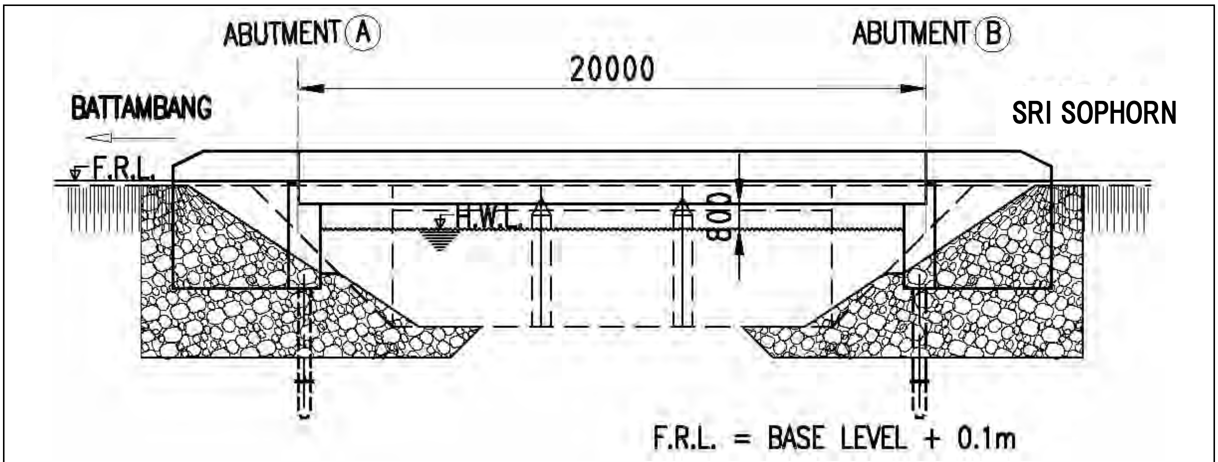
1. Bridge Type:
   RCS – Reinforced Concrete Flat Slab
   RCDG – Reinforced Concrete Deck Girder
   PSC – Pre-tensioned Precast Plank (hollow slab)
2. Standard span lengths are set at 12 m, 15 m and 18 m for RCDG bridges according to *MPWT, The Strengthening of Construction Quality Project, JICA.* Span lengths up to 24m are however standard for RCDG bridges in other countries (Philippines)



a) RCS Alternative



b) RCDG Alternative



c) PSC Alternative

Figure 11.5-4 Elevation on Bridge Alternatives for Br. 91

Note:

1. H.W.L = High Water Level : F.R.L. = Finished Road Level
2. Base Level = F.R.L. for the RCS alternative assuming H.W.L. controls the design and not existing road level.

11.6 Planning of Bridge Widening for 2-Lane Road

The option to provide an opposed 2-Lane Road with 2.5 m wide motorcycle lanes and shoulders will require 14 m wide bridge decks. In this case, the additional bridges proposed for the 4-Lane Road at Br. 79, 82 and 89 cannot be justified. All bridges will therefore be widened or replaced as the case requires.

Refer to Table 11.5-3 for a summary of proposed bridge widening for 2-Lane Road.

Table 11.5-3 Summary of Bridge Widening- 2-Lane Design

1	2	3	4	5	6
Ref	**Code**	**KP** (km)	**Existing Type**	**Road Approach**	**2-Lane Widening Concept**
1*	Br. 78	292.1	RCA	Tangent	No widening proposed
2	Br. 79	303.4	IG	Curved	Widen existing bridge LHS
3	Br. 80	304.8	PSC	Tangent/Curved	Widen existing bridge both sides
4	Br. 81	307.2	PSC	Tangent	Widen existing bridge both sides
5	Br. 82	312.1	IG	Curved	Widen existing bridge RHS
6	Br. 83	333.8	PSC	Tangent	Widen existing bridge both sides
7	Br. 84	341.1	RCS	Tangent	Replace bridge with new structure
8	Br. 85	342.1	PSC	Tangent	Widen existing bridge both sides
9	Br. 86	346.1	PSC	Tangent	Widen existing bridge both sides
10	Br. 87	347.9	PSC	Tangent	Widen existing bridge both sides
11*	Br. 88	349.6	PSC	Tangent	Widen existing bridge both sides
12*	Br. 89	351.5	PSC	Curved	Widen existing bridge RHS
13*	Br. 90	356.1	PSC	Tangent	Widen existing bridge both sides
14*	Br. 91	357.2	RCS	Tangent	Replace bridge with new bridge
15*	Br. 92	358.4	PCDG	Curved	No widening proposed

**) These bridges are not included in the improvement project of NR 5 (See Chapter 12).*

Note:

1. RCA – reinforced concrete arched rib
   IG – Welded steel plate I girder with in-situ reinforced concrete deck slab
   PSC – precast pre-tensioned concrete plank deck
   RCS – reinforced concrete slab culvert type structure
   PCDG – pre-stressed concrete deck girder

11.7 Details of Bridge Widening for 4-Lane Road

Widening of existing bridge by adding deck slab and beam, as necessary, is proposed not only for 2-lane bridges but also for 4-lane bridges. As explained later, substructure may also be widened. Such widening of bridge requires less cost because it does not demolish the existing structure but effectively utilize it. On the other hand, this method requires high-level engineering skill in execution.

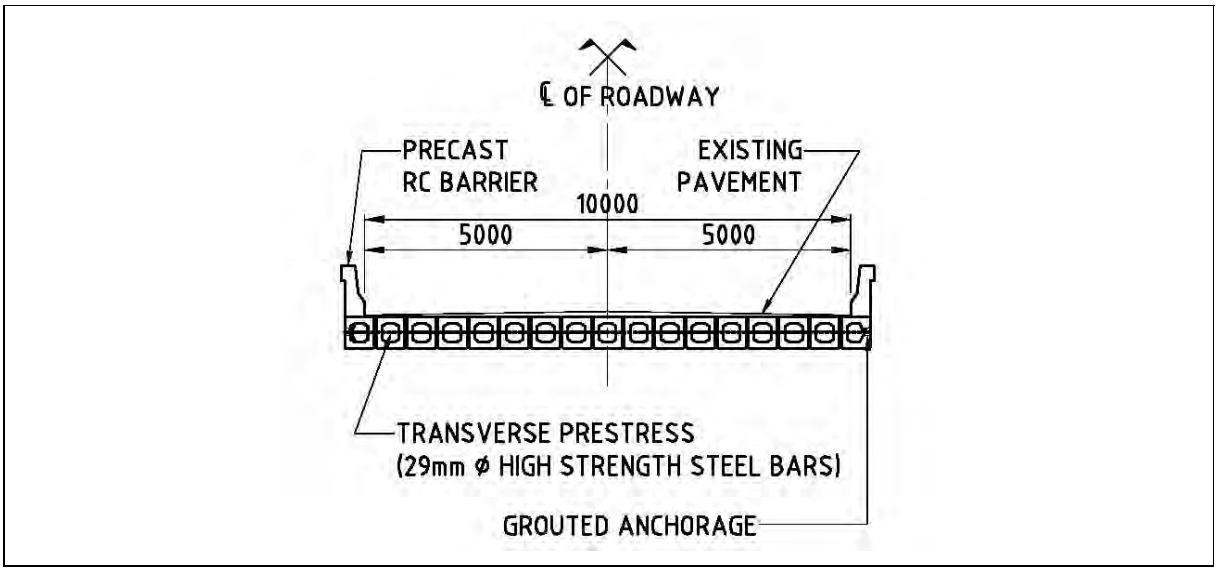
This method has been practically adopted in some developed countries including Japan. On the other hand, there has been no such case in Cambodia. Thus, this Project (widening of NR 5) will become the pilot case for this method in Cambodia.

Adoption of this method requires employment of consultant(s) and contractor(s) who have sufficient experience in this method. Once this method is successfully introduced and disseminated in Cambodia, it will substantially reduce the cost of bridge widening which is foreseen in the future as further strengthening of the function of road network will become necessary to accommodate increased traffic demand which will, in turn, support future socio-economic development.

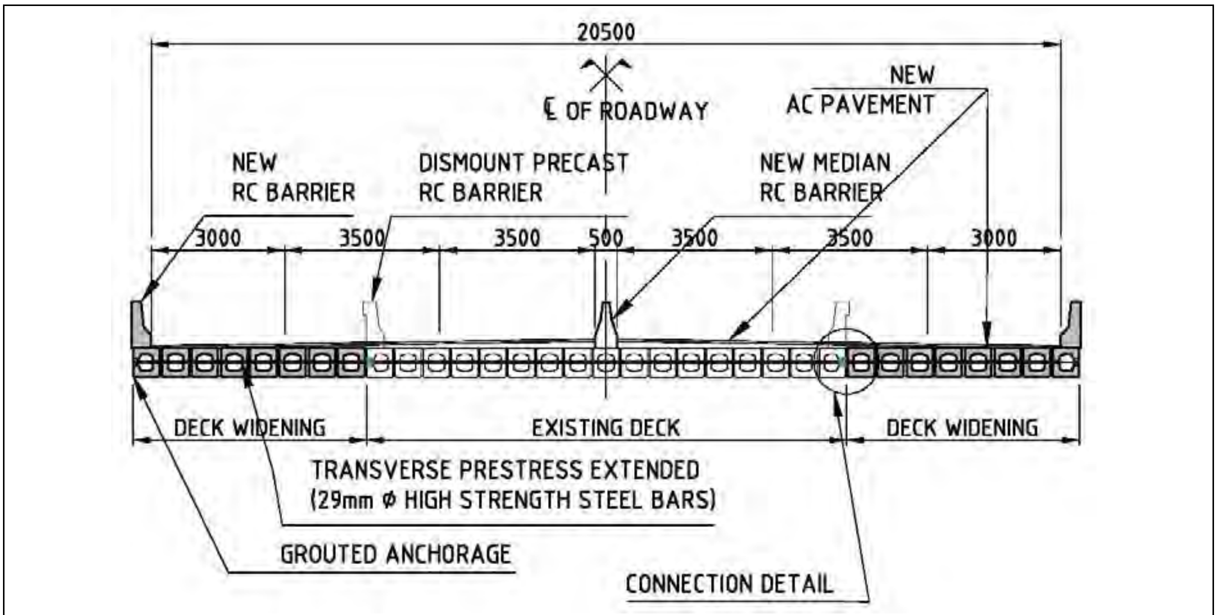
It can be seen from the Table 11.5-1 that all the bridges that are proposed to be widened feature PSC decks. The deck widening concept will therefore be substantially the same for all affected bridges. The deck widening concept will make use of similar section PSC units placed on extended substructure and transversely pre-stressed to the existing units of the deck. Refer to Figure 11.7-1 for a typical cross-section of a widened bridge and Figure 11.7-2 for deck widening details.

Two options are presented to achieve the extension of the transverse pre-stress for the PSC decks. Option 1 proposes to break out the cement mortar at each anchorage recess and to use couplers to extend the pre-stressing bars. Option 2 provides a separate anchorage plate to be attached at each pre-stress location with anchor bolts epoxy grouted into drilled holes. Option 1, using couplers, may not be practicable as the length of existing threaded bar protruding beyond the anchor nut at each anchorage may not be long enough to develop sufficient pre-stress force (350 kN) with the coupler (extended length bars would have been used during construction to enable the pre-stressing operations and then cut back near the anchor nut) or the thread may have been damaged. A trial application of this technique is recommended prior to implementation should this option be selected. Option 2 does not require the breaking out of the cement mortar in the existing anchorage recess. However this option requires the careful location of the drilled holes for the epoxy grouted anchor bolts particularly for the very shallow 10 m span units, in order not to damage the pre-stressing strands in the units.

Refer to Figure 11.7-3 for a typical cross-section of pier widening (example at Br. 85 shown) and abutment widening (stub abutments). Refer to Figure 11.7-4 for details of the widening at a stub abutment.

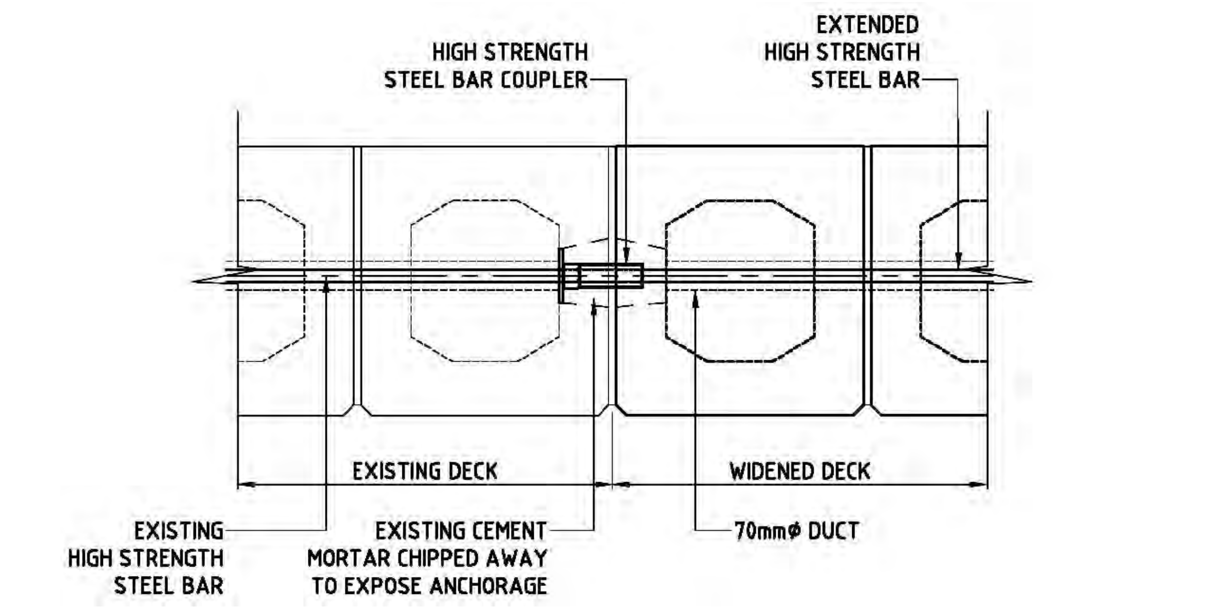


a) Typical Existing Condition of PSC Deck

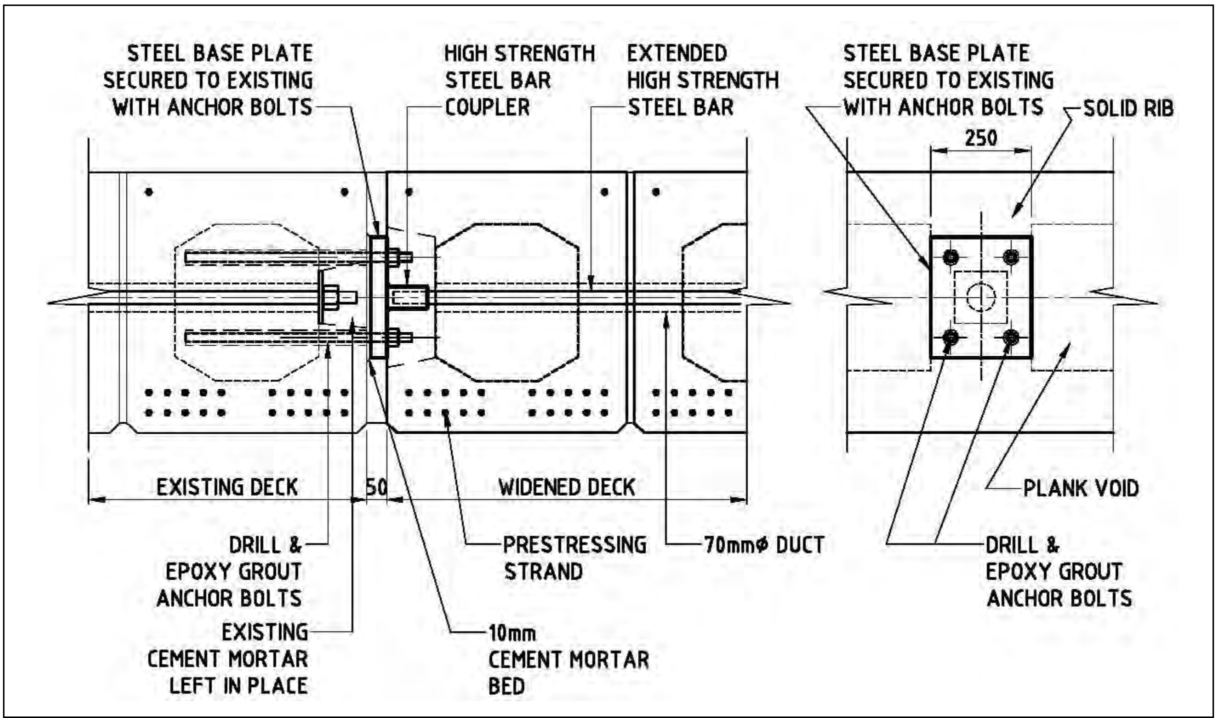


b) Bridge Widening Concept

Figure 11.7-1 Typical Cross-Sections of Widened Bridge for Full 4-Lane

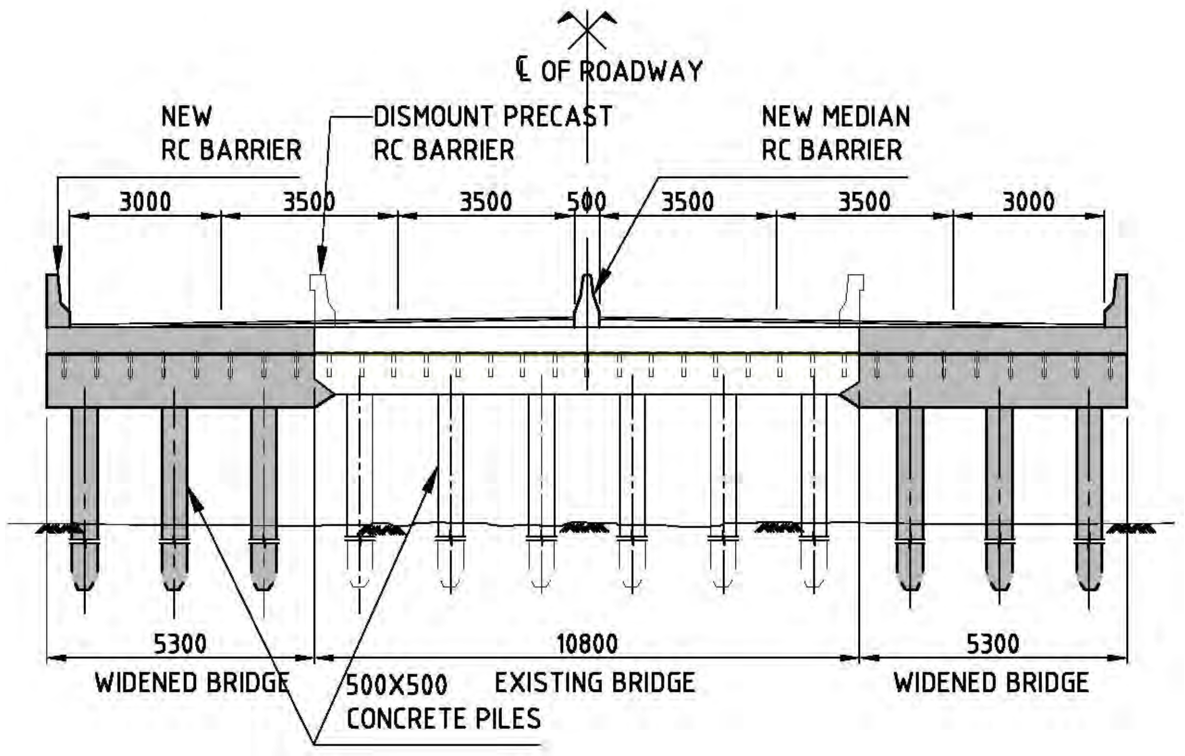


a) OPTION 1 Transverse pre-stress extended with couplers

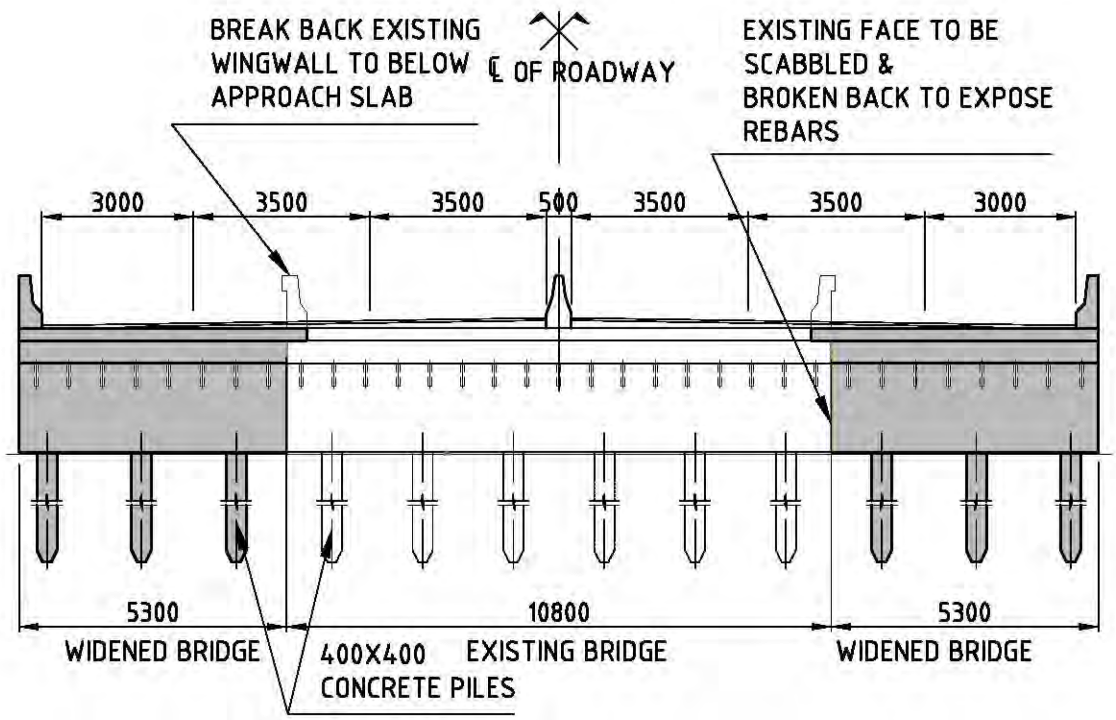


b) OPTION 2 Transverse pre-stress extended with additional base plate anchorage

Figure 11.7-2 Deck Widening Connection Details for Full 4-Lane



a) Pier Widening



b) Abutment Widening

Figure 11.7-3 Typical Cross-Sections of Substructure Widening for Full 4-Lane

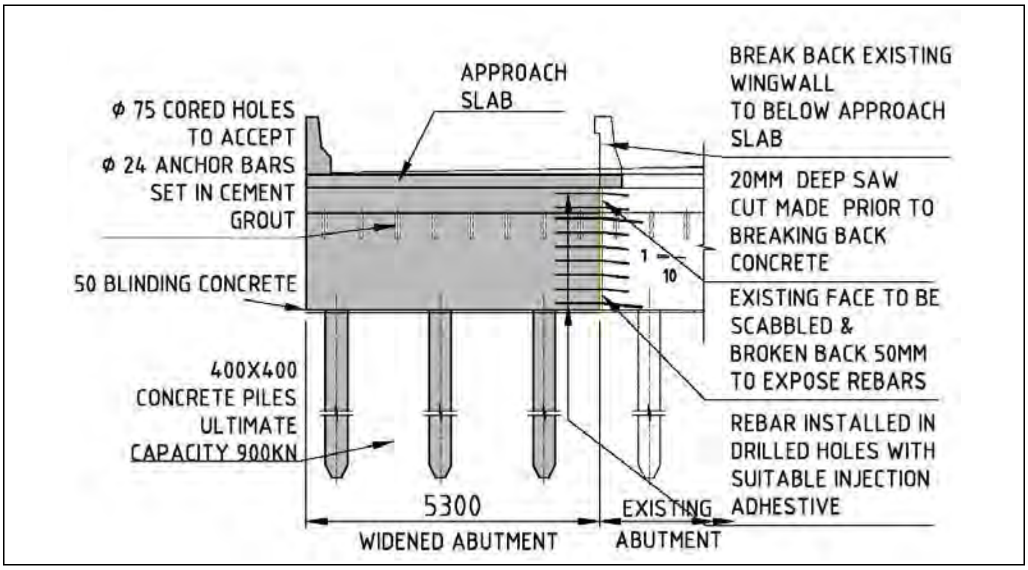


Figure 11.7-4 Abutment Widening Connection Detail for Full 4-Lane

11.8 Additional/Replacement Bridges Required for 4-Lane Road

In accordance with the bridge rehabilitation plan (Section 12.5) the preliminary design of the additional/replacement bridges proposed on the North Section of NR 5 for a 4-Lane Road is presented in Table 11.8-1.

Refer to Figure 11.8-1 for a typical cross-section showing layout of the additional bridge.

The bridge deck types for the additional bridges will be selected from the standard bridge types presented in Section 11.2. Both bridge deck type and substructure layout will be selected to be consistent with the existing bridge construction wherever possible. Bridge length typically will be established based upon the topography and waterway configuration at the locations adjacent to the existing bridges. Given the terrain the additional bridge length will typically be the same as the existing adjacent bridge. In some cases, such as at Br. 89, bridge length will be increased to avoid problems with slope stability at the abutments.

Table 11.8-1 Preliminary Design of Additional/Replacement Bridges on NR 5 - Full 4-Lane Design

1	2	3	4	5	6	7	8
Ref	**Code**	**KP**	**Type**	**Number of Spans**	**Length**	**Span Length**	**Width**
		(km)			(m)	(m)	(m)
1	Br. 79	303.4	PCDG	1	30.0	30.0	10.0
2	Br. 82	312.1	PCDG	1	25.5	25.5	10.0
3	Br. 84	341.1	RCBC	1	5.0	2 x 2.5	Width to suit 4 lane road
4*	Br. 89	351.5	PSC	3	50.0	15 - 20 – 15	10.0
6*	Br. 91	357.2	PSC	1	20.0	20.0	2 x 10.0

**) These bridges are not included in the improvement project of NR 5 (See Chapter 12).*

Note:

PSC – precast pre-tensioned concrete plank deck
PCDG – pre-stressed concrete deck girder'
RCBC – reinforced concrete box culvert

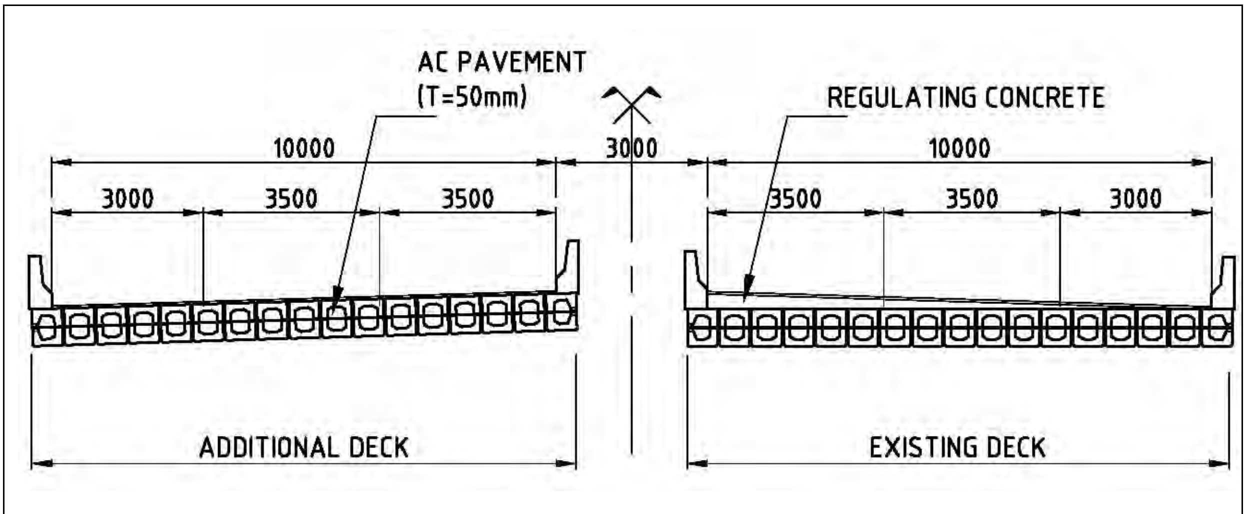


Figure 11.8-1 Typical Cross-Sections of Additional Bridge Deck for Full 4-Lane

11.8.1 Preliminary Design of Substructure

Bridge substructure layout has been selected to be consistent with the existing bridge construction and adopting standard arrangements wherever possible.

Additional bridges, new bridges or replacement bridges will feature standard stub or cantilever type abutments, and standard column type piers.

For all bridges, standard driven precast concrete driven piles are typically proposed, adopting the standard 40 cm x 40 cm section for abutments and pier pile caps, and 50 cm x 50 cm section for pier pile bents.

Pile lengths for each bridge location have been established based upon the geotechnical investigation undertaken for this study and with reference to CAM PW 04-101-99 Bridge Design Code.

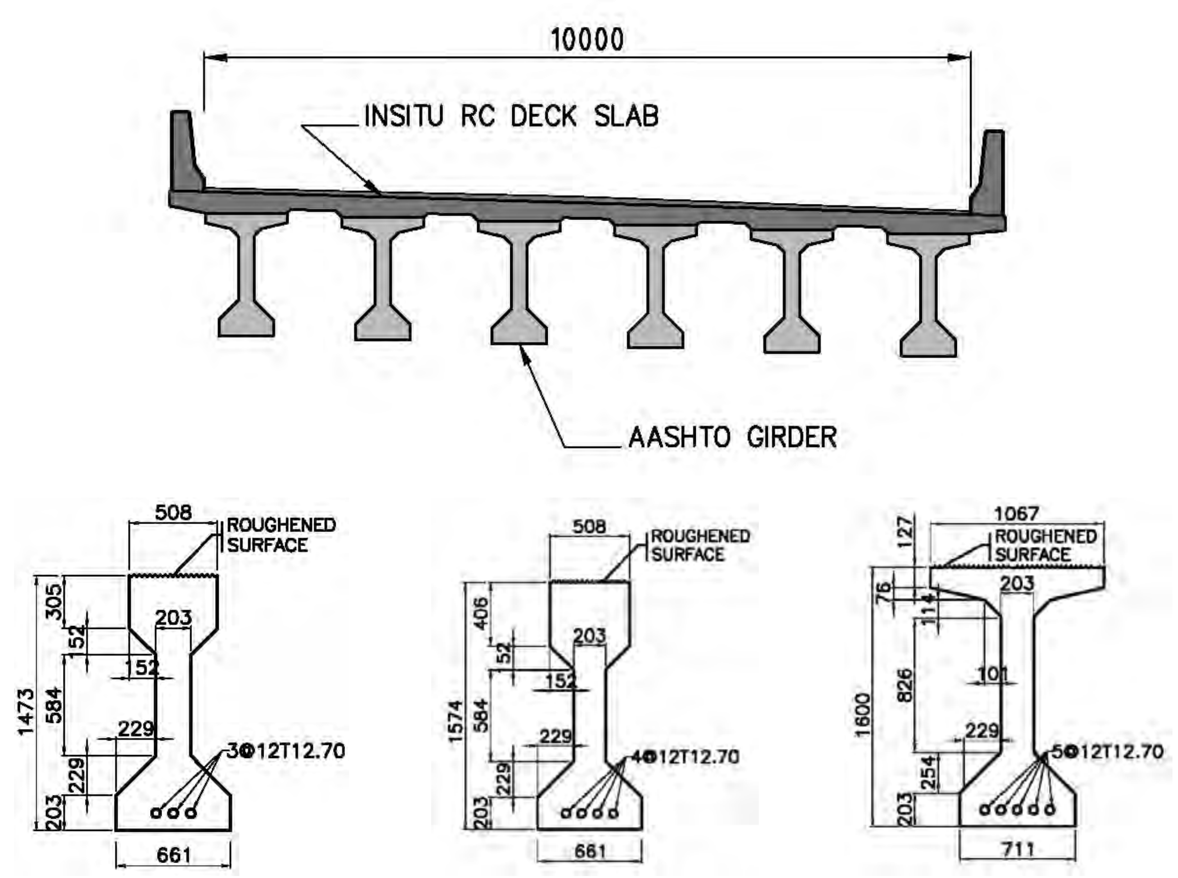
Numbers of piles at each bridge location have been determined based on calculations of design dead load and live load reactions. Calculations of design load reactions have been made with reference to CAM PW 04-101-99 Bridge Design Code.

11.8.2 Preliminary Design of Superstructure

The replacement bridge proposed for Br. 89, the additional bridge at Br. 91 on NR 5 and one (1) bridge on the proposed Battambang Bypass, Br. BB1, feature standard PSC decks.

Three (3) bridges on National Road No. 5 and one (1) bridge on the proposed Battambang Bypass, Br. BB2, are proposed to feature pre-stressed concrete deck girder (PCDG) bridges. The girder selected for these bridges is the AASHTO standard girder type. Refer to Figure 11.11-2 for the arrangement of typical AASHTO girder sections. Six (6) girders are proposed for each 10 m wide deck to be consistent with the standard set under the ongoing Strengthening of Construction Quality Project.

Outline checks have been undertaken to confirm that the girders can support HLP 240 loading, with limits on tensile stress for pre-stressed concrete taken from CAM PW 04-101-99 Bridge Design Code 1996 (the Base Document).



AASHTO Type 4A
Span Length 25m

AASHTO Type 4B
Span Length 30m

AASHTO Type 5
Span Length 35m

Figure 11.8-2 Typical AASHTO Girder Deck and Sections

AASHTO type girders have been selected given that they incorporate a reinforced concrete deck slab that can be made continuous for live load at pier supports. The girders are designed as simply supported for dead and live load, and the slab is designed to be continuous across the pier. This arrangement has already been incorporated into bridges in Cambodia, specifically at Thuok Thla Bridge on National Road 5, located just west of Banteay Meanchey. The advantage of this arrangement is that it eliminates expansion joints and bearings at the piers effectively making the bridge “maintenance free” at these locations. Additionally the monolithic arrangement provides a very robust connection between the deck and the pier head to resist applied longitudinal and transverse forces and also the deck slab continuity promotes a smooth ride profile over the pier for passing traffic.

A typical; arrangement of AASHTO girders made continuous at piers is illustrated in Figure 11.8-3.

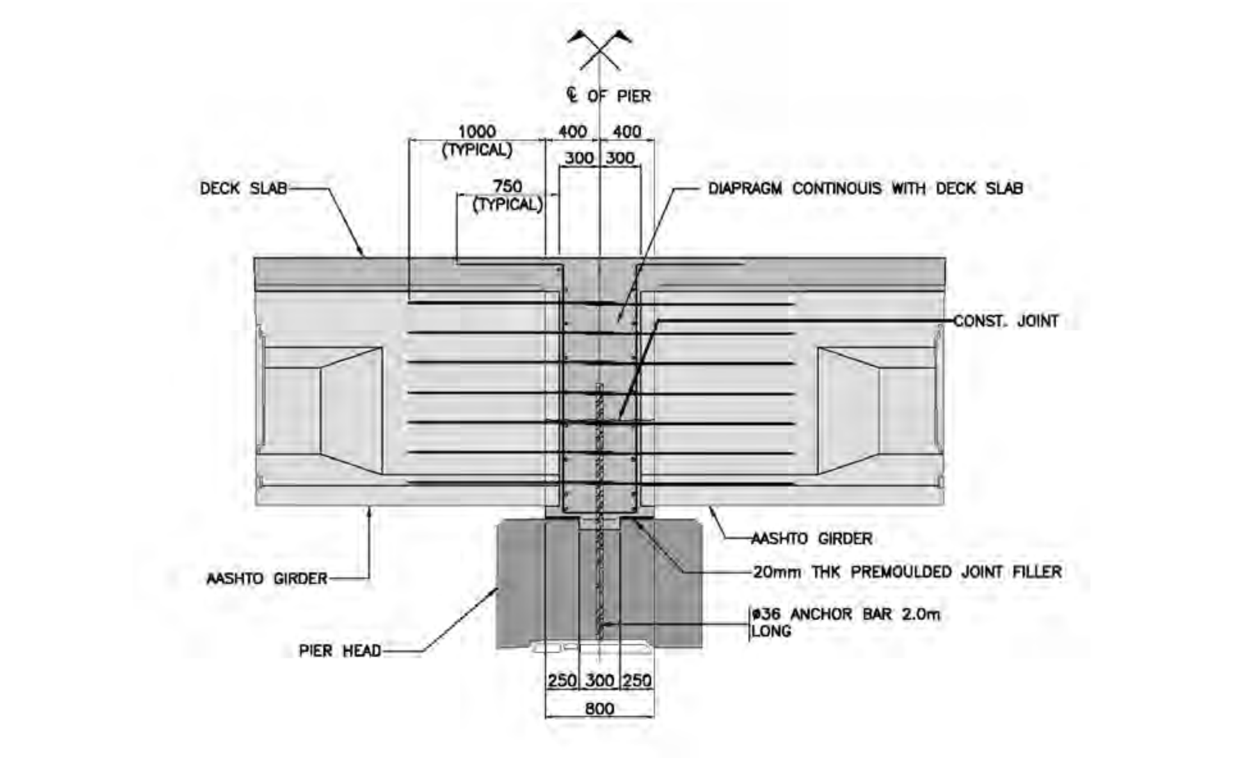


Figure 11.8-3   AASHTO Girder Made Continuous

11.9 Planning of Bridges on Battambang Bypass

An opposed 2-Lane Road with 2.5 m wide motorcycle lanes, requiring a 14m wide bridge deck, is proposed for Battambang Bypass. Two bridges are proposed to be constructed at km 2+020 and km 7+550 (Sangkae River) respectively.

The warrant for a bridge at km 2+020 is based on the reports of flood flow in the channel at this location from local inhabitants obtained during site inspections of the Study Team in November 2011. According to residents flood waters rises more than 2 m in the channel crossed by the bypass alignment. Based on the topographic survey a 20 m long bridge is considered sufficient to span the channel, although final bridge length will have to be determined based on a detailed hydrological/ hydraulic analysis.

The proposed bridge at km 7+550 will cross the Sangkae River. Based on the topographic survey and reports from local residents with regard to maximum flood level, a 105 m long bridge is considered sufficient to span the river, although final bridge length will have to be determined based on a detailed hydrological/ hydraulic analysis. It is also noted that local access roads run parallel with the river at each bank. These access roads can either be raised to connect with the new bypass road level or can aligned to pass beneath the bridge deck at each location, with sufficient headroom provided for the local traffic.

The preliminary design of bridges proposed for Battambang Bypass is presented in Table 11.9-1.

Table 11.9-1 Preliminary Design of Bridges on Battambang Bypass

1	2	3	4	5	6	7	8
Ref	**Code**	**KP**	**Type**	**Number of Spans**	**Length**	**Span Length**	**Width**
		(km)			(m)	(m)	(m)
1	Br. BB1	2.02	PSC	1	20.0	20.0	14.0
2	Br. BB2	7.55	PCDG	3	105.0	3 x 35.0	14.0

Note:

PSC – precast pre-tensioned concrete plank deck
PCDG – pre-stressed concrete deck girder'

11.9.1 Proposed Bridge over Sangkae River on Battambang Bypass

The proposed Battambang Bypass crosses the Sangkae River at km 7+550. The headwaters of the Sangkae River rise in the Cardamom Mountains in Pursat Province to the south west and the river flows north east into the Tonle Sap Lake passing through Battambang City.

At the time of the survey undertaken by the Study Team the river was approximately 50m wide at the crossing point with a maximum depth of 6m. According to accounts from local residents the river rises a further 5 m when it is in flood with a width in the order of 100 m and a depth of 11 m.

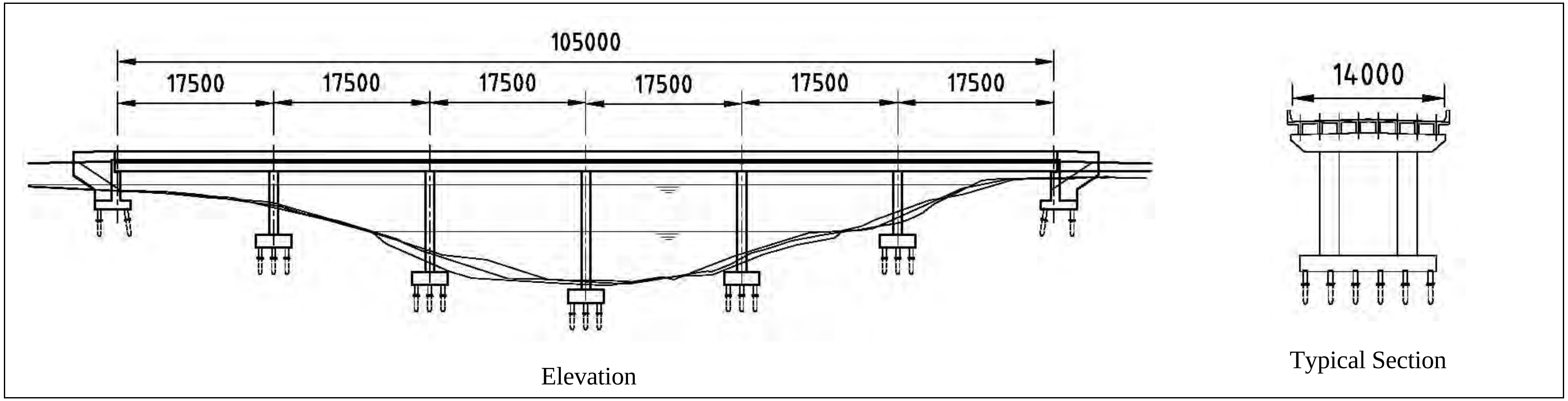
It is proposed to construct a bridge in the order of 105 m long at the crossing of the Sangkae River. Two alternative configurations for the bridge have been studied, namely a six span RCDG structure and a three span PCDG alternative. The RCDG structure is similar to Wat Kor. bridge constructed by MPWT in 2008 over the Sangkae River in Battambang City, a five span RCDG bridge with a total length of 90 m. Refer to Table 11.9-2 for an outline comparative study of the two alternatives and Figure 11.9-1 for typical elevations and sections.

Table 11.9-2 Comparative Study of Alternatives for Sangkae River Bridge

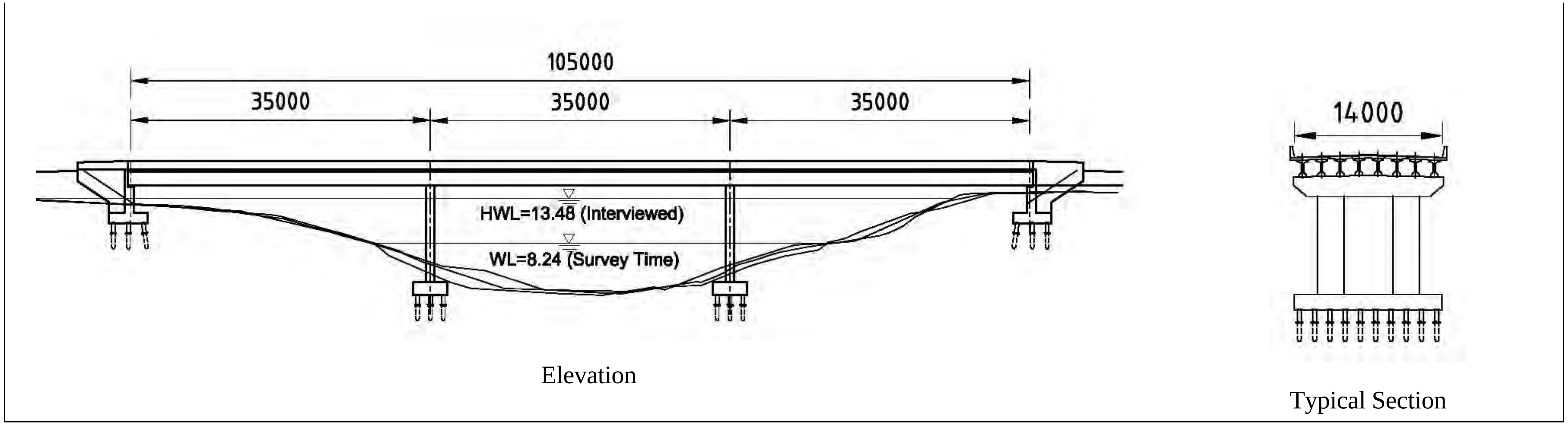
1	2	3	4	5	6
Bridge Type	**Total Length** (m)	**No. of Spans**	**Advantages**	**Disadvantages**	**Comment**
RCDG	105	6	• Simplest form of construction • Precast RC girders weigh only about 17t and can be lifted in using single small capacity cranes, without the need for launching gantries, working progressively from the river banks. • Least impact on the road profile	• Largest number of substructures to be constructed including three (3) piers required to be constructed in the river waterway • Scour hazard is greater than for the PCDG alternative • River channel is obstructed with a centrally placed pier • Longer construction period • Foundation costs are greater than for the PCDG alternative	2nd Rank
PCDG	105	3	• Only two (2) piers required in the river waterway • River channel is substantially unobstructed • Shorter construction period • Foundations pose a lower scour hazard than the RCDG alternative • Girders provide greater support during construction to the in-situ concrete deck, requiring simpler formwork than the RCDG alternative	• Girders weigh about 60t and will require a launching gantry to put in place • Greatest depth of deck • Maximum impact on road profile • Superstructure costs are greater than for the RCDG alternative	1st Rank

Note:

Bridge Type:
RCDG – Reinforced Concrete Deck Girder
PCDG – Pre-stressed Concrete Deck Girder



a) **6-Span RCDG Alternative**



b) **3-Span PCDG Alternative**

Figure 11.9-1 Elevations and Sections on Sangkae River Bridge

Alternative bridge pier configurations for the proposed Sangkae River Bridge have been briefly investigated:

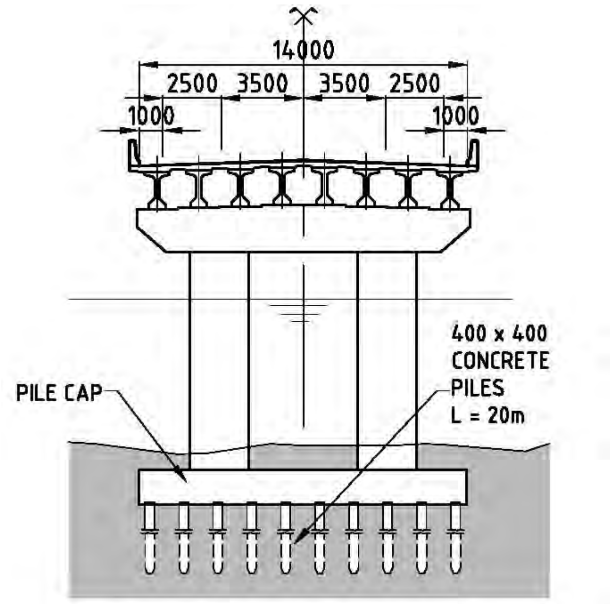
- Conventional pile cap supporting pier columns and coping beam
- Bored pile bent directly supporting a coping beam

Refer to Table 11.9-3 for an outline comparative study of the two pier design alternatives and Figure 11.9-2 for typical sections.

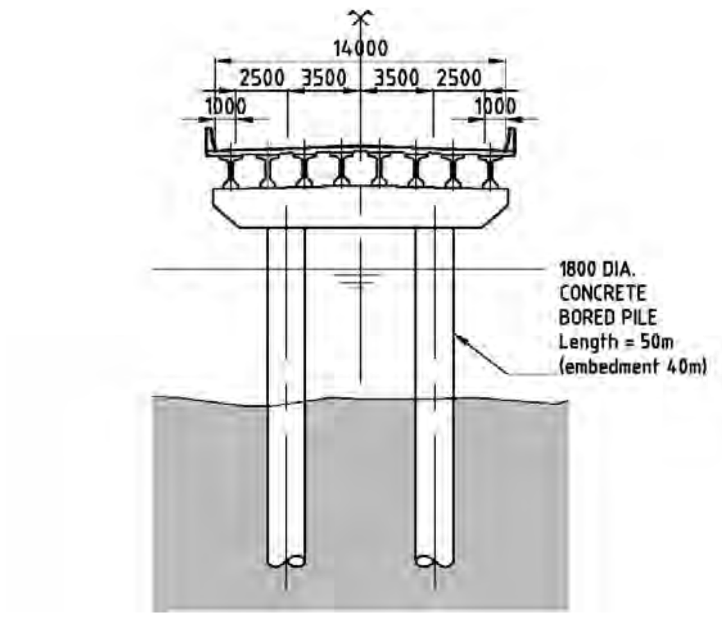
Local access roads run parallel to both of the river banks at the crossing location. Alternative arrangements should be considered in the detailed design in accommodating the access roads, either in allowing the roads to pass beneath the bridge or ramping up the side access to join the local roads to the bypass.

Table 11.9-3 Comparative Study of Alternatives Pier Designs for Sangkae River Bridge

1	4	5	6
Pier Type	**Advantages**	**Disadvantages**	**Comment**
Pile Cap	• Method recently adopted for Wat Kor bridge across Sangkae River • Precast driven RC piles can be used to maximize construction quality and minimize construction risk • Relatively short pile lengths required (approx. 20 m) • Regular construction equipment and methods can be adopted • Very robust in supporting bridge loads and in resisting lateral forces • Pile cap and multiple pile arrangement can tolerate a degree of scouring of the mud-line below the cap without overloading the piles	• Pile caps require cofferdams for construction • Large number of relatively small capacity piles to install • Pile cap construction requires longer construction period than pile bent • Scour hazard is greater than for the pile bent alternative	1st Rank
Bored Pile Bent	• No pile caps required thereby dispensing with need for cofferdams • Shorter construction period • Foundations pose a lower scour hazard than the pile cap alternative	• Larger capacity construction equipment required for the large diameter bored piles • Specialist construction techniques required using bentonite slurry/ reverse circulation methods/ and temporary steel casings that are sensitive to soil conditions and involve more construction risk • Greater environmental hazard during construction particularly with spillage of drilling slurry • Relatively long pile lengths required (approx.. 40 m embedment) • Structure configuration less robust in supporting lateral loads with greater sensitivity to depth of scour	2nd Rank



a) Pile Cap Type Pier



b) Pile Bent Type Pier

Figure 11.9-2 Typical AASHTO Girder Deck and Pier Sections

11.10 Planning of Bridges on Sri Sophorn Bypass

An opposed 2-Lane Road with 1.5 m wide motorcycle lanes, requiring 14 m wide bridge decks, is proposed for Sri Sophorn Bypass. Two bridges are proposed to be constructed at km 4+620 (Mongkol Borei) and km 12+700 (Steung Touch) respectively. The bypass traverses rivers at both locations that require bridge crossings.

The proposed Mongkol Borei bridge at km 4+620 is located approximately 4.3 km upstream of Br. 89 on National Road 5. Br. 89 is a 3 span PSC bridge of total length 44 m. The proposed bridge is also located approximately 300 m upstream of an existing bridge with a total length of about 30 m.

The proposed Steung Touch bridge is located on a tributary to the Sri Sophorn River approximately 670 m from the northern connection point of Sri Sophorn Bypass to National Road 5.

The preliminary design of bridges proposed for Sri Sophorn Bypass is presented in Table 11.10-1. Bridge length and bridge spanning considerations have been driven primarily by topographic considerations with abutments located at set back positions on the river banks. The widespread flood water break out at each location will be addressed with additional flood relief culverts to be constructed at regular intervals along the alignment.

Standard precast concrete driven piles, 40 cm x 40 cm section, are proposed at all foundation locations, with length of 20 m.

Table 11.10-1 Preliminary Design of Bridges on Sri Sophorn Bypass

1	2	3	4	5	6	7	8
Ref	**Code**	**KP** (km)	**Type**	**Number of Spans**	**Length** (m)	**Span Length** (m)	**Width** (m)
1	Br. SP1	4.62	PSC	3	50.0	15-20-15	14.0
2	Br. SP2	12.70	PSC	3	60.0	3 x 20.0	14.0

Note : PSC – precast pre-tensioned concrete plank deck

CHAPTER 12 COST ESTIMATION

12.1 Construction Cost

12.1.1 Section of Works

As described in Chapter 8, improvement of Battambang – Sri Sophorn Section and construction of Battambang Bypass and Sri Sophorn Bypass were selected as the high-priority projects. Start point and end point of Battambang – Sri Sophorn need to be defined more in detail for the purpose of cost estimation and implementation planning.

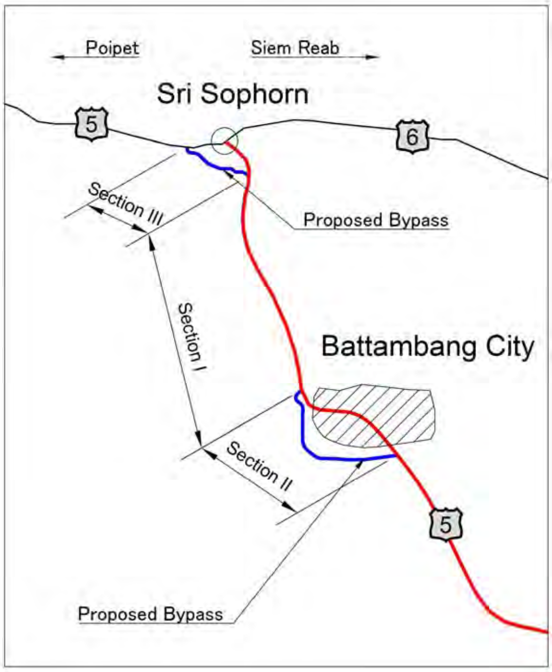


Figure 12.1-1 Map of Sections

Battambang – Sri Sophorn Section is divided into the sections, as shown in Figure 12.1-1, for the purpose of discussing the section of implementation. Here, North Section from the intersection of NR 5 with Battanbang Bypass in the north of Battambang City to the intersection of NR 5 with Sri Sophorn Bypass in the south of Sri Sophorn City is named Section I, Battambang Bypass is named Section II and Sri Sophorn Bypass is named Section III. Start points and end points of these sections are as presented in the Table 12.1-1.

Table 12.1-1 Start Point and End Point of Sections

Section	Description	Start Point	End Point	Length (km)
I	North Section (Battambang – Sri Sophorn)	Intersection of NR 5 with Battambang Bypass in the north of Battambang City	Intersection of NR 5 with Sri Sophorn Bypass in the south of Sri Sophorn City	47.0
II	Battambang Bypass	Intersection of Battambang Bypass with NR 5 in the south of Battambang City	Intersection of Battambang Bypass with NR 5 in the north of Battambang City	23.1
III	Sri Sophorn Bypass	Intersection of Sri Sophorn Bypass with NR 5 in the south of Sri Sophorn City	Intersection of Sri Sophorn with NR 5 in the west of Sri Sophorn City	13.4

The sections to be actually implemented are to be selected through the consultation between the Royal Government of Cambodia (RGC) and the Japan International Cooperation Agency (JICA) in the appraisal process of the Project.

12.1.2 Cost Estimate

The main points of estimation of construction cost are as listed below:

1) Costs are computed in United State Dollars (USD). This is applied to both of Foreign Currency Portion and Local Currency Portion. Although official local currency is Khmer Riel (KHR), USD is widely used in actual business and trades.
2) Costs are computed with prices in the year 2011.
3) Exchange rates of US$ 1 = JPY 79 are used for cost estimation, as necessary.
4) Costs are computed for Section I, II and III respectively.
5) Costs of civil works are computed based on the basic rates collected in Cambodia and counterchecked with experiences in similar projects in the past in Cambodia after adjusting to fit to the Project.
6) Materials and equipment not available in Cambodia, such as cement, reinforcement, pc strand, guardrails, street light, precast beam launching system and fuel are assumed to be imported into Cambodia.

Referring to the Chapter 10 and 11, scope of work and quantities of major works in each section are shown below.

Table 12.1-2 Work Scope in Each Section

Major works	Section I	Section II	Section III
Road length	47.0 km	23.1 km	13.4 km
Road width	20.5 m & 25.5 m	14.0 m	14.0 m
Pipe culvert	15 no.	92 no.	52 no.
Box culvert	28 no. *	18 no.	18 no.
Bridge	9 no. to be rehabilitated	2 no. to be constructed	2 no. to be constructed

** In Section I, one existing bridge to be replaced with box culvert, so number of box culvert is increased (plus two), as length of the culvert is full width of road.*

In addition, two typical cross sections are adopted in Section I as explained in Chapter 10:

Table 12.1-3 Typical Cross Section Used in Section I

Type	Road width	Length
Rural area	20.5 m	44.7 km
Urban area	25.5 m	2.3 km

Based on the consideration as stated above and quantities of work components taken off, unit prices for road works, culvert works and bridge works are computed. The unit prices thus estimated are as shown below:

Table 12.1-4 Unit Price of Works

Description	Unit price (1,000USD)	Remarks
Section I (North Section of NR 5)		
Road works in rural area	785/km	
Road works in urban area	1,040/km	
Pipe culvert (Ave. dia. 1.1 m twin)	9.6/no	Culvert extension + inlet/outlet re-construction
Box culvert (Ave. 3 m x 3 m twin)	46.0/no	Culvert extension + inlet/outlet re-construction
Bridge (construction of sub & super structure)	1.7/m2	1 to 2 spans
Bridge (reconstruction of slab)	0.2/m2	1 span
Section II (Battambang Bypass)		
Road works	830/km	
Pipe culvert (Ave. dia. 1.0 m twin)	9.0/no	
Box culvert (Ave. 3m x 3 m twin)	62.0/no	
Bridge	1.55/m2	1 & 3 spans
Section III (Sri Sophorn Bypass)		
Road works	830/km	
Pipe culvert (Ave. dia. 1.0 m twin)	9.0/no	
Box culvert (Ave. 3m x 3 m twin)	62.0/no	
Bridge	1.55/m2	3 spans

It should be noted that there are two railway level crossings in Section II (Battambang Bypass) and Section III (Sri Sophorn Bypass) respectively. Usually, railway crossings are constructed by contractors employed by railway authority and this principle is proposed to be applied in the Project. As railways are currently being rehabilitated by the contractor under MPWT with ADB fund, it is assumed that all railway crossings in the Project be constructed under the current MPWT contract, when design is ready. In other words, costs of railway crossings are not included in the construction cost below.

With the above data (quantities and rates), the construction costs are computed as below.

Table 12.1-5 Summary of Construction Cost

Item		Quantity	Rate (1,000USD)	Amount (1,000USD)
Section I (North Section of NR 5)				
1)	Road works in rural area	44.7 km	785/km	35,090
2)	Road works in urban area	2.3 km	1,040/km	2,392
3)	Pipe culvert works	15 no	9.6/no	144
4)	Box culvert works	28 no	46.0/no	1,288
5)	Bridge works (addition or widening)	1,880 m2	1.7/m2	3,196
6)	Bridge works (slab replacement)	611 m2	0.2/m2	122
Total of Section I				42,232
Section II (Battambang Bypass)				
1)	Road works	23.1 km	830/km	19,173
2)	Pipe culvert works	92 no	9.0/no	828
3)	Box culvert works	18 no	62.0/no	1,116
4)	Bridge works (new)	1,750 m2	1.55/m2	2,712
Total of Section II				23,829
Section III (Sri Sophorn Bypass)				
1)	Road works	13.4 km	830/km	11,122
2)	Pipe culvert Pipe culvert	52 no	9.0/no	468
3)	Box culvert works	18 no	62.0 / no	1,116
4)	Bridge works (new)	1,540 m2	1.55 / m2	2,387
Total of Section III				15,093
Total of Section I, II and III				81,154

12.2 Consultancy Services

Consultancy services are required to support the implementing agency in all phases of the Project, such as the engineering study stage, tender stage and construction stage.

It is recommended that the consultancy services in all phases of the Project shall be carried out by a consultant employed through the selection procedure of consultant as indicated in the Implementation Schedule of Table 13.3-1. It should be noted that arrangement of consultant shall be subject to the discussions between the RGC and JICA.

Major tasks to be undertaken by the consultant, including professional assignment schedule, are described below.

12.2.1 Major Tasks to be Undertaken by Consultant

(1) Scope of Work

Scope of work for consultant consists of the following tasks.

a. Engineering study and basic/detail design
b. Project Master Program
c. Preparation of tender documents for construction
d. Assistance to the Employer in bidding and bid evaluation
e. Construction supervision
f. Inspection for provisional hand over
g. Inspection for final hand over
h. Training to Cambodian engineers

(2) Detailed Task Requirements

Above tasks are undertaken in two major stages, namely, engineering study stage, and selection of contractors and construction supervision stage. Detailed task requirements of each stage are as listed below.

A. Engineering Study Stage

Task 1-1. Review the previous and on-going related studies and data collected.
Task 1-2. Conduct traffic survey.
Task 1-3. Analyze the traffic demand forecast and capacity requirement.
Task 1-4. Field survey and investigation

- a. Alignment investigation, topographic survey and mapping.
- b. Soil condition, geological data, water level and deep well impact.
- c. River, canal, drainage networks, etc.
- d. ROW adjacency.
- e. Utilities survey.
- f. Road traffic survey for traffic management planning during construction.
- g. Hydrological survey.
- h. Survey on cultural/historic heritage and archaeological survey.

Task 1-5. Assist the Employer in processing, monitoring and reporting on land acquisition

- a. Resettlement plan and procedure for land arrangements.
- b. Land acquisition plan and resettlement action plan (LAP/RAP).
- c. LAP/RAP monitoring and report.
- d. Temporary land arrangement.
- e. Assist the Employer in public consultation.

Task 1-6. Prepare the construction arrangement plan

- a. Land for construction activities (permanent and temporary).

b. Utilities relocation, removal or protection.

c. Traffic management plan and road detour/alternative road design.

d. Public relation and stakeholder socialization materials.

Task 1-7. Design standards and design criteria.

Task 1-8. Prepare detail design for civil works (road, structures etc.).

Task 1-9. Review and update the project master program.

Task 1-10. Review the environmental impact assessment (EIA) and conduct supplemental EIA.

Task 1-11. Prepare tender documents including pre-qualification documents.

Task 1-12. Cost estimation by tender packages.

Task 1-13. Public relation.

Task 1-14. Training on design and tendering to Cambodian engineers.

B. Selection of Contractors & Construction Stage

Task 2-1.Selection of contractors

a. Pre-qualification of bidders, including invitation for pre-qualification.

b. Tender call and pre-tender conference.

c. Tender evaluation and clarification.

d. Contract negotiations and contracting.

Task 2-2. Establish project management system.

Task 2-3. Review the contractors submittals and design interface.

Task 2-4. Site inspection and factory inspection.

a. Confirm to use/follow approved materials, drawings, working methods and schedule.

b. Confirm to follow approved quality control system.

c. Confirm to follow approved mitigation of environmental impact.

d. Confirm third party safety.

e. Confirm to follow health and safety plan.

f. Confirm to follow traffic management plan.

Task 2-5. Public relation during construction.

Task 2-6. Monitor environment management plan.

Task 2-7. Issue interim payment certificates .

Task 2-8. Review and report for alteration, variation and solution of disputes.

Task 2-9. Initiate meetings and reports.

Task 2-10. Inspect testing and as-built drawings at completion.

Task 2-11. Prepare guideline for HIV/AIDS protection activities.

Task 2-12. Inspect and report during defects liability period.

Task 2-13. Inspect testing for final hand over.

Task 2-14. Training on tendering, contract management, construction management and maintenance of road to Cambodian engineers.

12.2.2 Consultant Assignment Schedule

Based on the tasks to be undertaken by the consultant, professional assignment schedule is proposed as shown in the Tables 12.2-1 and 12.2-2 for the engineering study and for the selection of contractors and construction supervision, respectively.

Table 12.2-1 Assignment Schedule for Engineering Study

	title	2013	2014	2015	2016	2017	2018	2019	2020	total
Basic Design, Detail Design and Preparation of Tender Document (International)										
1	Project Manager	4	4	-	-	-	-	-	-	8
2	Road, Pavement & Strctural Expert	3	3	-	-	-	-	-	-	6
3	Construction Planner / Cost Expert	-	3	-	-	-	-	-	-	3
4	Specification/Quality Management Expert	-	2	-	-	-	-	-	-	2
5	HIV/AIDS Protection Campaign Expert	-	2	-	-	-	-	-	-	2
6	Traffic Demand Forecast Expert	2	-	-	-	-	-	-	-	2
7	Natural / Social Environment Expert	1	2	-	-	-	-	-	-	3
8	Capacity Development Expert	-	1	-	-	-	-	-	-	1
	Total	10	17	-	-	-	-	-	-	27
Basic Design, Detail Design and Preparation of Tender Document (Local)										
1	Deputy Project Manager	4	3.5	-	-	-	-	-	-	7.5
2	Civil Engineer - 1	3	5	-	-	-	-	-	-	8
3	Civil Engineer - 2	3	5	-	-	-	-	-	-	8
4	Geotechnical Engineer	3	1	-	-	-	-	-	-	4
5	Traffic Management Engineer	-	3	-	-	-	-	-	-	3
6	Untilities Management Engineer	-	3	-	-	-	-	-	-	3
7	Cost Engineer	1	3.5	-	-	-	-	-	-	4.5
8	Specification Engineer	-	3	-	-	-	-	-	-	3
9	Quality Management / Safety Engineer	-	3	-	-	-	-	-	-	3
10	HIV/AIDS Protection Campaign Assistant	-	2	-	-	-	-	-	-	2
11	Traffic Demand Forecast Assistant	3	-	-	-	-	-	-	-	3
12	Natural / Social Environment Engineer	3	3	-	-	-	-	-	-	6
	Total	20	35	-	-	-	-	-	-	55

Table 12.2-2 Assignment Schedule for Selection of Contractors and Supervision

title		2013	2014	2015	2016	2017	2018	2019	2020	total
Tender Process and Costruction Stage (International)										
1	Project Manager	-	6	10	11	11	6	1	1	45
2	Road, Pavement & Structural Expert	-	-	7	11	5	-	-	-	23
3	Construction Planner / Cost Expert	-	-	8	10	11	6	-	-	35
4	Specification/Quality Management Expert	-	-	7	-	-	-	-	-	7
5	HIV/AIDS Protection Campaign Expert	-	-	3	-	-	-	-	-	3
6	Natural / Social Environment Expert	-	-	2	-	-	-	-	-	2
7	Capacity Development Expert	-	-	1	1	1	-	-	-	3
Total		-	6	38	33	28	12	1	1	118
Tender Process and Costruction Stage (Local)										
1	Deputy Project Manager	-	8.5	12	12	12	7.5	0.5	0.5	53
2	Civil Engineer - 1	-	-	7	12	7	3	-	-	29
3	Civil Engineer - 2	-	-	7	12	7	-	-	-	26
4	Geotechnical Engineer	-	-	7	5	-	-	-	-	12
5	Traffic Management Engineer	-	-	7	6	5	-	-	-	18
6	Untilities Management Engineer	-	-	7	11	-	-	-	-	18
7	Cost Engineer	-	2.5	12	12	12	7	-	-	45.5
8	Specification Engineer	-	3	10	5	-	-	-	-	18
9	Quality Management & Safety Engineer	-	2	12	5	-	-	-	-	19
10	Resident Engineer for Section I	-	-	7	12	12	7.5	1	-	39.5
11	Resident Engineer for Section II	-	-	7	12	7.5	1	-	-	27.5
12	Resident Engineer for Section III	-	-	7	12	7.5	1	-	-	27.5
13	HIV/AIDS Protection Campaign Assistant	-	-	7	-	-	-	-	-	7
14	Natural / Social Environment Engineer	-	-	7	2	2	2	2	1	16
Total		-	16	116	118	72	29	3.5	1.5	356

12.2.3 Roles of Professional Staff

Roles of professionals are summarized in the Table below.

Table 12.2-3 Roles of Professionals

Professionals	Role of Professionals during Engineering Study, Selection of Contractors and Supervision
[Internationa Professional]	
Project Manager	Overall management during engineering study, contractor selection and supervision stage
Road, Pavement & Structural Expert	Plan, survey, design and control on construction of road, pavement and structures
Construction Planner / Cost Expert	Plan of overall construction and calculation & analysis of project costs and variations
Specification/Quality Management Expert	Compilation of specification and review & control on quality and safety
HIV/AIDS Protection Campaign Expert	Campaign and public relation on HIV/AIDS protection
Traffic Demand Forecast Expert	Conduct of traffic survey and computation of traffic demand forecast
Natural / Social Environment Expert	Review of EIA, conduct of supplemental assessment during engineering stage and guide for monitor of environmental management plan during construction
Capacity Development Expert	Plan and conduct of training to Cambodian engineers
[Loca Professional]	
Deputy Project Manager	Overall management and assistance of project manager
Civil Engineer - 1	Plan, survey, design and control on costruction of road, pavement and structures Assiting the expert
Civil Engineer - 2	ditto
Geotechnical Engineer	Plam, survey, design and review on plans submitted in regard to geotechnical matters Assiting the expert
Traffic Management Engineer	Survey and plan of traffic safety / management and review of those submitted Assisting the expert
Untilities Management Engineer	Survey and plan of utilities relocation etc. and review of utilities management plan submitted Assisting the expert
Cost Engineer	calculation & analysis of construction costs and assiting the expert
Specification Engineer	Compilation of specification and review & control on specification Assisting the expert
Quality Management & Safety Engineer	Compilation of requirements in regard to quality & safety and review & control on them Assisting the expert
Resident Engineer for Section I	Review on construction plan submitted and check & inspection on daily activities on site in Section I
Resident Engineer for Section II	Ditto in Section II
Resident Engineer for Section III	Ditto in Section III
HIV/AIDS Protection Campaign Assistant	Campaign and public relation on HIV/AIDS protection Assisting the expert
Traffic Demand Forecast Assistant	Conduct of traffic survey and assisting computation of traffic demand forecast
Natural / Social Environment Engineer	Assisting the expert for review of EIA, conduct of supplemental assessment during engineering stage and monitor of environmental management plan during construction

12.2.4 Organization of Consultant

Consultant organization during the engineering study, selection of contractors and supervision stage are indicated below.

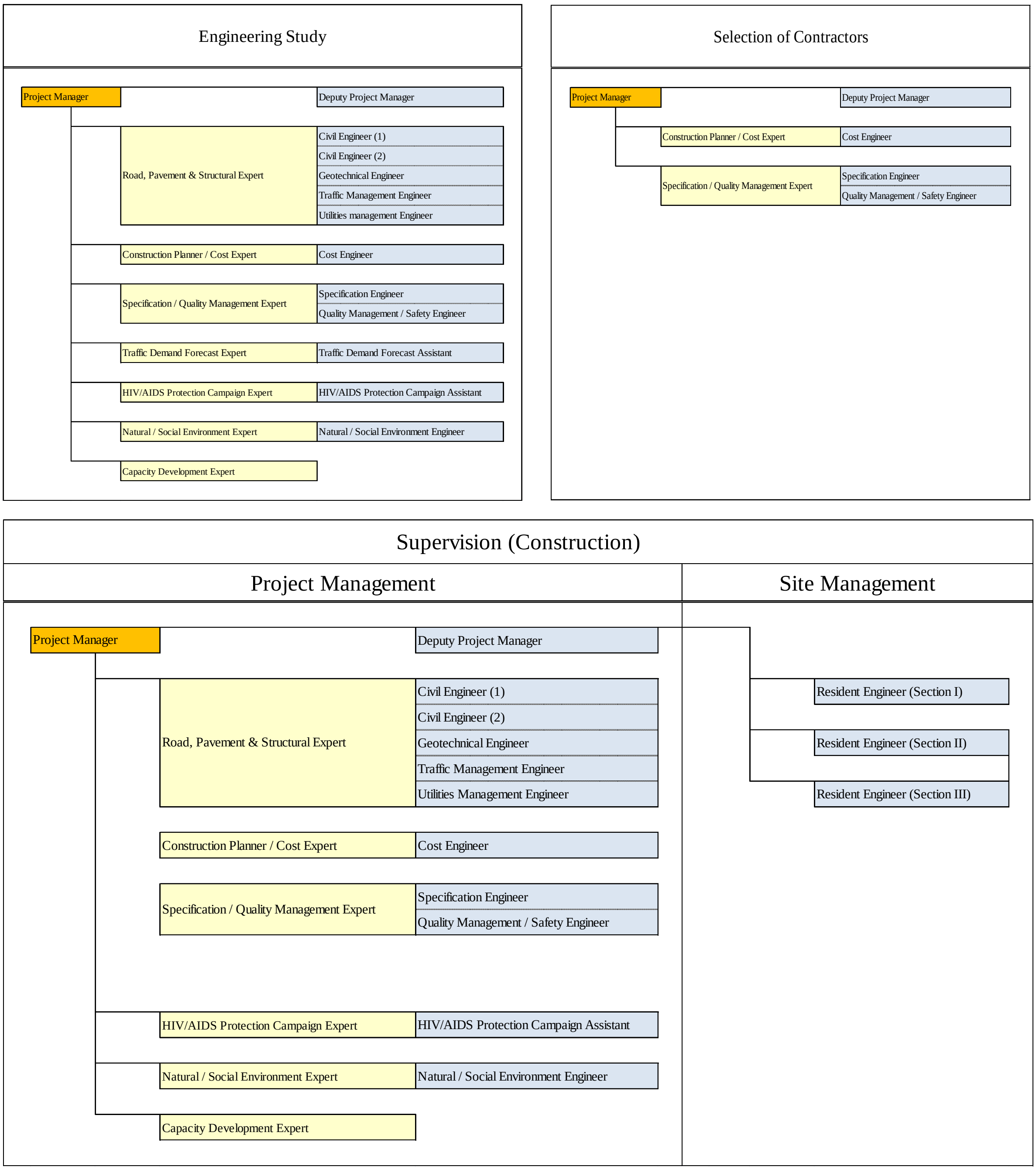


Figure 12.2-1 Organization of Consultant

12.2.5 Cost of Consulting Services

With the above schedule of professionals (international and local), costs of consulting services are computed.

In addition, it is recommended that training to technical and administrative staff in MPWT be conducted under the consultancy services in order to develop their capacity for designing, tendering, contract management, construction management and maintenance of roads as well as public relation and public consultation.

There are two schemes for the training, which are on the job training (OJT) etc. in Cambodia and technical training in developed countries, such as Japan. The former is the OJT and regular workshops during the engineering study, selection of contractors and supervision stage in Cambodia and the latter is proposed several times of overseas training. The cost for the latter is calculated assuming training in Japan with total 10 staff.

Total cost for consulting services including the training mentioned above is shown below.

Table 12.2-4 Cost of Consulting Services

Description	Amount (1,000USD)
1) Engineering Study Stage (Basic/Detail Design & Tender Documents)	1,529
2) Tender Process and Construction Stage	6,570
Total	8,099

12.3 Cost Born by the RGC

Costs born by the Royal Government of Cambodia (RGC) are those for the following items.

1) Land Acquisition and Resettlement Cost
2) Utilities Relocation, Removal and/or Protection Cost
3) Detection and Removal Cost of Mines and UXOs
4) Taxes
5) Administration Cost

It is to note that the above items shall be undertaken by the RGC and special attention shall be paid by the RGC and JICA (also by the consultant) not to hinder the progress of the Project due to insufficiency of budget for those items to be prepared by the RGC.

12.3.1 Land Acquisition and Resettlement Cost

Based on what is written in Chapter 17 and 18, the land acquisition and resettlement cost are estimated as shown below.

Table 12.3-1 Land Acquisition and Resettlement Cost

Description	Amount(1,000USD)
Land Acquisition and Resettlement Cost	6,321

12.3.2 Cost of Relocation, Removal and/or Protection of Utilities

Various utilities, such as electric and telephone cables with posts, have been installed along the National Road 5 and some of them need to be relocated for the Project, depending on the final design. Underground utilities such as water pipes, optic cables and electric cables are also found attached to the bridges in Section I as shown in Photo 12.3-1. Also, some of underground utilities will need to be relocated and/or replaced for the Project, depending on the final design of the Project. Those situated near bridges which shall be replaced or widened definitely need to be removed and re-installed.

Photo 12.3-1 Utilities at Bridges

The JICA Team has discussed the matters with the counterparts and it was agreed as current practice in Cambodia that these relocations, removals and/or protections be carried out by relevant organizations with the Government fund, unless those were laid illegally.

It is difficult to compute the magnitude of this task in the Project at this stage and referring to past results for utilities relocation, removal and/or protection in road widening projects, cost per km for the Project will be allowed USD 80,000/km (similar to those in NR 1 phase 1 to 3) for whole stretch of section I and 10% of length of Section II and III, because of new road.

Table 12.3-2 Utilities Relocation, Removal and/or Protection Cost

Description	Length	Rate (1,000USD/km)	Rate (1,000USD/km)
1) Section I	47.0 km	80	3,760
2) Section II	23.1 km x 10 %	80	185
3) Section III	13.4 km x 10 %	80	107
Total			4,052

12.3.3 Cost of Detection and Removal of Mines and UXOs

In accordance with the Minutes of Discussion on the Preparatory Survey for NR 5 Rehabilitation Project between JICA and MPWT of November 19, 2010, clearance of landmines and UXOs was carried out for Battambang Bypass (Section II) and Sri Sophorn Bypass (Section III), whereas clearance has not been done for widening part of NR 5 between Battambang and Sri Sophorn (Section I). The clearance for Section I shall be carried out before construction work commence. The cost for this part is computed with same basis of Section II and III carried out.

Table 12.3-3 Detection and Removal Cost of Mines and UXOs

Description	Area (1,000 m2)	Rate (USD/m2)	Amount (1,000USD)
1) Clearance in road area	1,000	0.20	200
2) Clearance in bridge area	25	5.00	125
Total			325

12.3.4 Taxes

In cost estimation for taxes, value added tax and import tax for the project are calculated and summarized as shown in Table 12.5-1.

12.3.5 Administration Cost

Organization of the Employer for the Project is being established, the details of which are described in Section 13.2.1.

Following the past cases of Yen Loan projects, the cost of administration is assumed at 1.64 % of the total of construction cost, consultancy services and other costs. Hence the administration cost is estimated at USD 2.0 million.

12.4 Escalation

Escalation factors are applied to the project cost, as it is computed with the prices in year 2011.

1) Different escalation factors are applied on the foreign currency portion and local currency portion although both are estimated in terms of USD. Two point one percent (2.1 %) is used for foreign currency portion and six point six percent (6.6 %) is used for local currency portion, considering the averaging price escalation in the past few years.

2) Project cost is computed in USD and the escalation factor for foreign currency is applied on the items directly related to international market prices like imported materials, fuel, major construction equipment and systems etc. and the escalation factor for local currency is applied on those related to domestic market prices like workers, earthwork and quarry material.

12.5 Summary of Project Cost

The summary of project cost computed in Sections 12.1 to 12.4, is shown below.

Table 12.5-1 Summary of Project Cost

Items		Amount (million USD)	Remarks
JICA Portion			
1-1	Construction cost		
	Section I (North Section of NR 5)	42.3	
	Section II (Battambang Bypass)	23.8	
	Section III (Sri Sophorn Bypass)	15.1	
	Total of Construction Cost	81.2	
1-2	Consulting Services	8.1	
1-3	Price Escalation for above	13.1	
1-4	Contingency	9.7	
	Total of Project Cost (JICA Portion)	112.1	
RGC Portion			
2-1	Land Acquisition and Resettlement Cost	6.3	
2-2	Utilities Relocation / Removal / Protection Cost	4.1	
2-3	Detection and Removal Cost of Mines and UXOs	0.3	
2-4	Price Escalation	0.7	
2-5	Contingency	0.5	
2-6	Employer's Administration Cost	2.0	
2-7	Taxes	11.8	
	Total of Project Cost (RGC Portion)	25.7	
	Grand Total	137.8	

12.6 Contract Package

There are three sections in the Project briefed in the Table 12.1-2 Work Scope in Each Section. Although there is difference between Section I and Section II/III, as Section I is improvement of existing road and Section II/III are new roads, components of each section are in common and consist of earthworks, pavement works and structural works (culverts and bridges). It is also true that Section I to III are continuous.

Hence JICA Team recommends that Section I, II and III shall be in one package, because work features are similar, no coordination is required if one package and more importantly large size package is believed to attract good and competitive contractors to participate for tender.

12.7 Annual Progress

Annual progress is calculated by expanding project cost to each year in accordance with the implementation schedule discussed in Chapter 13.3. Then, escalation factors for foreign currency (2.1%/year) and local currency (6.6%/year) are applied to the amount of each year.

Annual progress, after applying escalation factor, is shown below.

Table 12.7-1 Annual Progress

(Unit: million USD)

Items	Year	2013	2014	2015	2016	2017	2018	2019	Total
Annual Progress with Escalation	JICA portion	1.4	1.2	31.0	35.8	27.2	12.5	3.0	112.1
	RGC portion	1.2	7.8	7.7	4.1	3.2	1.4	0.3	25.7
	Total	2.6	9.0	38.7	39.9	30.4	13.9	3.3	137.8

It is to note that annual progress for the RGC will be heavy in the first few years due to land acquisition and resettlement and JICA Team reminds that sufficient budget shall be arranged by the RGC in each year, particularly in first few years. As land acquisition and resettlement are pre-requisite to commencement of construction, special attention on progress of land acquisition and resettlement in the years 2014 and 2015 shall be paid.

12.8 Repayment Schedule

JICA loan conditions applying to Cambodia are as follows.

- Interest rate: 0.01 %
- Repayment period: 40 years
- Grace period: 10 years

As shown in Table 12.7-1 Annual Progress, loan will be commenced in the year 2013 and the total cumulative amount including interest at the end of grace period is calculated below.

Table 12.8-1 Loan Amount in Grace Period

(Unit: million USD)

Year	Loan amount	Cumulative loan amount	Total amount including interest
2013	1.4	1.4	1.4
2014	1.2	2.6	2.6
2015	31.0	33.6	33.6
2016	35.8	69.4	69.4
2017	27.2	96.6	96.6
2018	12.5	109.1	109.1
2019	3.0	112.1	112.1
2020	0	112.1	112.2
2021	0	112.1	112.2
2022	0	112.1	112.2

After the grace period, repayment shall be started with equal amount with interest and the amount per year is calculated with the following formula.

$$\text{Repayment per Year} = \frac{P \times I}{1 - (1 + I)^{-t}}$$

Where 'P' is total amount at the end of grace period, 'I' is interest rate and 't' is repayment period.

With the above formula, repayment is calculated approximately USD 3.7 million per year in thirty years from 2023 till 2052.

12.9 Value Engineering

Value analysis and engineering (VA/VE) is a systematic method to improve the "value" of objects by using examination of function. In the field of value analysis and engineering, value is defined the ratio of function to cost; i.e. Value = Function / Cost.

Value can be, therefore, increased by either improving the function, reducing the cost or both. In construction, quality is usually specified in technical specification and therefore VA/VE is often meant to be achieved by lowering costs. However, to provide objectives with better function by even higher price may be within the meaning of VA/VE, as long as the value becomes higher.

Process of feasibility study is to select best option out of several ones and in this sense, feasibility study itself is similar to carry out VA/VE process and selection of best option is resulted from VA/VE.

In this study, items of VA/VE are summarized below.

Table 12.9-1 Items of Value Engineering

Item		Criteria	Chapter Reference
Road & pavement design	To select best option of typical cross section of road in Section I, II and III	Road geometry and future traffic demand	10
	To utilize existing material of sub-base course & base course into new design in Section I	Thickness & CBR of existing sub-base and base course	10
	To use laterite for sub-base material instead of quarry product	CBR	10
Bridge design	To utilize existing sub-structure of Br. 79 & 82 instead of demolition and new construction	Capacity of substructure to carry enough load	11
	Widening of existing bridges instead of reconstruction	Cost, existing condition, constructability, and traffic management	11
	Span configuration (number of spans and span length) for bridges in Battambang and Sri Sophorn Bypass	Cost, river width and water depth, soil conditions, girder launching equipment requirements, and site access	11
	Choice of pile foundation type for additional bridge in Battambang and Sri Sophorn Bypass. Use of either driven piles or bored piles.	Cost, soil conditions, river water depth, piling equipment requirements, and site access.	11
	Incorporate deck continuity at piers for additional bridge in Battambang and Sri Sophorn Bypass, instead of using simple supports.	Response under lateral loads, performance in service under wheel loads, and maintenance implications.	11
	Construct box culverts, instead of bridge, as the rehabilitation of existing bridge.	Span length and bearing capacity of the ground	11

CHAPTER 13 IMPLEMENTATION PLAN

13.1 Execution Plan

13.1.1 Road works

In this Project, there are two type of road works, which are widening of the existing road (Section I) and construction of bypasses around the cities of Battambang and Sri Sophorn (Section II and III).

Section I is to widen the existing NR 5 on both sides or either side to accommodate two lanes on both directions from one lane on both direction, by mainly filling road body. Since NR 5 is a part of major road network in Cambodia, hindrance to the traffic needs to be minimal during construction. Therefore, construction works should be carried out half by half to maintain traffic capacity similar to that of the existing road during construction.

On the other hand, works of Sections II and III are construction of new roads mainly in paddy field or vacant land, and construction of road is relatively straight-forward.

In either case, necessity of special technology is not anticipated.

Generally, construction of road is executed in the process as shown below:

1) Work area is cleared and unsuitable material, if any, is removed.
2) Embankment is constructed by filling soil in horizontal layers with specified thickness and compaction; tests are conducted to confirm required dimension and quality.
3) Slope is formed as specified and protected with sodding except those near river where rip-rap are placed as the slope protection.
4) Sub-grade is prepared before pavement structure is constructed.
5) Sub-base course and base-course are spread and compacted as specified, and tests are conducted to confirm required dimension and quality.
6) Asphalt concrete is laid on top of the base course as specified, and tests are conducted to confirm required dimension and quality.

Major materials needed for the road works of this Project are common embankment materials and quarry products for pavement works. The JICA Team’s field survey indicated that such materials are obtainable from lands adjacent to, or near NR 5, although such materials are subject to laboratory tests before being used for embankment. Whereas for aggregates, there are three quarries near the routes of the Section I, II and III, producing aggregates for concrete, asphalt concrete, sub-base course, base course and crusher-runs for pavement works. Locations of these quarries are shown in Figure 13.1-1. The materials produced at the quarry in the city of Sri Sophorn were used in the road project funded by ADB. These materials are shown in Photo 13.1-1.

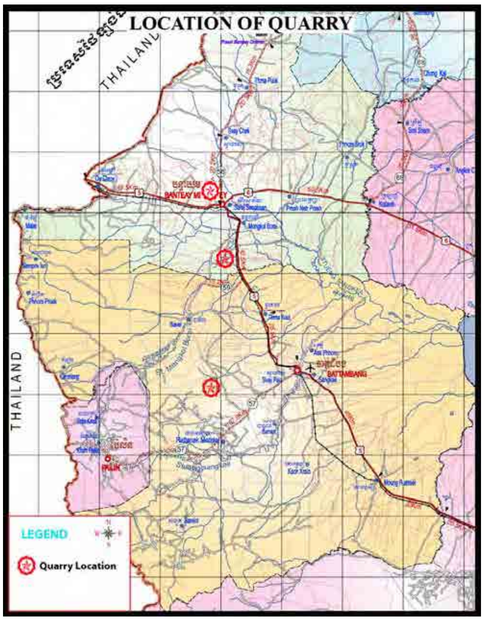


Figure 13.1-1 Location of Quarry

Photo 13.1-1 Quarry in Sri Sophorn

The JICA Team’s survey indicated that there is no commercial asphalt plant in this region. However it was confirmed that several contractors in Cambodia possess movable asphalt plants. Capacities of these movable plants are 60–80 tons/hour. It is normal practice in Cambodia that these movable plants are mobilized and used for the project like NR 5 Rehabilitation Project.

Process of road works for Section I allowing the flow of traffic is described below.

Filling works are carried out in one side first. After completion of filling up to existing road level and additional space for traffic to travel is available, traffic is shifted using newly filled space. Then filling on the other side is commenced. This practice is shown in Figure 13.1-2 below. If embankment needs to be filled higher than the existing road surface, the works shall be executed as shown in Figure 13.1-3.

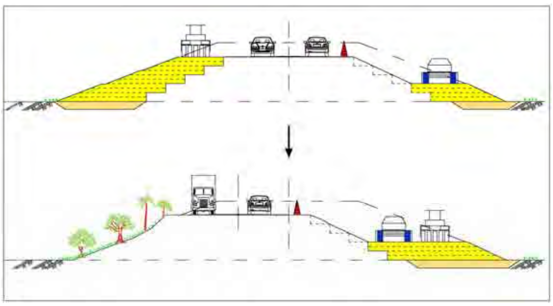


Figure 13.1-2 Embankment Works (1)

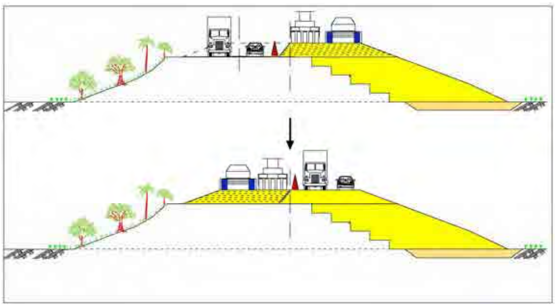


Figure 13.1-3 Embankment Works (2)

After embankment and sub-grade preparation is completed, sub-base course and base course works are carried out with the same manner as embankment, as one side is being carried out while the other side is maintained for traffic. These are shown in Figures 13.1-4 and 13.1-5 respectively.

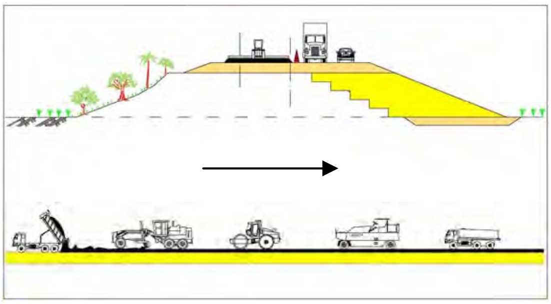


Figure 13.1-4　Sub-Base Course Works

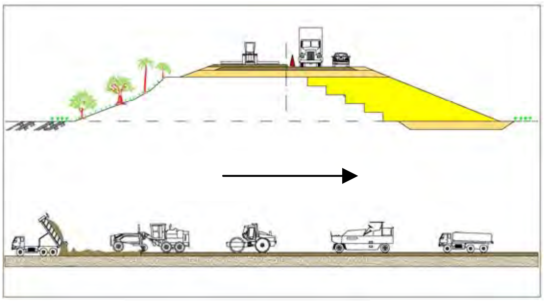


Figure 13.1-5　Base Course Works

Following the base course works, asphalt concrete works are carried out. The asphalt concrete works are also done in one side first, then done in the other side. These are shown in Figure 13.1-6 below.

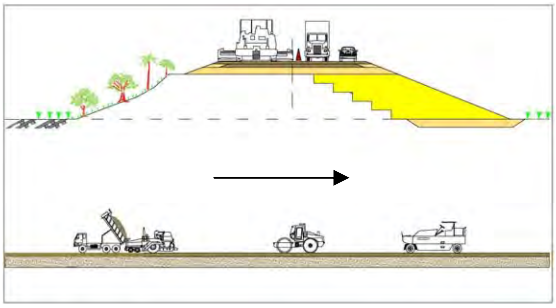


Figure 13.1-6　Asphalt Concrete Works

As for Battambang Bypass and Sri Sophorn Bypass, the works can be executed without consideration for traffic except at intersections with existing roads, where certain measures are necessary to maintain traffics on the existing roads.

13.1.2　Bridge works

There are also two types of bridge works, which are rehabilitation to existing bridges (on the existing NR 5) and new bridge construction (on the bypasses).

Three kinds of bridge works are planned as the rehabilitation of the bridges on the existing NR 5; construction additional bridges, widening of existing bridges and construction of a new bridge after demolishing the existing bridges. These are described in Chapter 11 in detail and the basic aspects for construction plans are summarized in Table 13.1-1. It should be noted that temporary bridge for detour is required for Bridge 84 during replacement of existing bridge and temporary bridges for construction of additional bridge or widening of existing bridges are required for Bridge 83 and 85 because such works need work platform in river streams.

Table 13.1-1 Bridge Rehabilitation in Section I

bridge ID		KP (km)	details of existing bridge					way of rehabilitation	(two lanes x 2) scheme						remarks
			length (m)	c/way width (m)	super st (m2)	span (no)	span length (m)		I sub st (no)	II super st (m2)	III slab to replace (m2)	IV bridge removal	V detour bridge	VI temp br	
1	Bridge 79	303.4	30.0	7.0	210.0	1	30.0	additional bridge to construct existing slab to replace	2	300	330	-	-	-	
2	Bridge 80	304.8	20.0	10.0	200.0	1	20.0	existing bridge to widen	2	200	-	-	-	-	connection to existing bridge is requried
3	Bridge 81	307.2	20.0	10.0	200.0	1	20.0	existing bridge to widen	2	200	-	-	-	-	ditto
4	Bridge 82	312.1	25.5	7.0	178.5	1	25.5	additional bridge to construct existing slab to replace	2	250	281	-	-	-	
5	Bridge 83	333.8	36.0	10.0	360.0	2	18.0	existing bridge to widen	3	360	-	-	-	required	connection to existing bridge is requried
6	Bridge 84	341.1	4.9	9.9	48.5	2	2.5	replace with box culvert	-	-	-	to remove	required	-	
7	Bridge 85	342.1	30.0	10.0	300.0	2	15.0	existing bridge to widen	3	300	-	-	-	required	connection to existing bridge is requried
8	Bridge 86	346.1	12.0	10.0	120.0	1	12.0	existing bridge to widen	2	120	-	-	-	-	ditto
9	Bridge 87	347.9	15.0	10.0	150.0	1	15.0	existing bridge to widen	2	150	-	-	-	-	ditto

In summary, 9 bridges in Section I are to be rehabilitated as listed below:

Table 13.1-2 Summary of Bridges in Section I

Way of rehabilitation		Bridge nos.
a	Additional bridge	2 nos. (Br. 79, 82)
b	Existing bridge widened	6 nos. (Br. 80, 81, 83, 85, 86, 87)
c	Replace with new box culvert	1 no. (Br. 84)
d	Re-construction of existing bridge slab	2 nos. (Br. 79, 82)

In Section II and III, there are two bridges to be newly constructed as described in Chapter 11 and the basic aspects are summarized in Table 13.1-3 below.

Table 13.1-3 Bridge Construction in Section II and III

	bridge ID	KP (km)	length (m)	c/way width (m)	super st (m2)	span (no)	span length (m)	scheme	full four lanes scheme			remarks
								Sub struct. (no)	sub st (no)	super st (m2)	temp br	
Section II (Battambang Bypass)												
1	Bridge 1	2.02	20.0	14.0	280.0	1	20.0	new bridge	2	280	-	
2	Bridge 2	7.55	105.0	14.0	1,470.0	3	35.0	new bridge	4	1,470	required	
Section III (Sisophon Bypass)												
1	Bridge 1	4.60	50.0	14.0	700.0	3	15-20-15	new bridge	4	700	required	
2	Bridge 2	12.75	60.0	14.0	840.0	3	20.0	new bridge	4	840	ditto	

Generally, bridge construction is executed in the process as described below:

- Piling works

  If required, preliminary test pile shall be constructed to confirm pile capacity prior to working pile constructions. Then working piles shall be commenced in the following procedures.

  a) Setting out pile positions
  b) Driving piles as per drawings with data (number of blow per each length etc.)
  c) At final depth, taking data (hammer height, settlement and rebound per blow etc.) for calculating pile capacity
  d) Re-driving, if required

Some piles selected from working piles shall be tested to confirm the capacity and quality with either static load test or test by dynamic method.

- Sub structure

  Because all sub structures are near or in rivers or canals, temporary shoring shall be installed before excavation. Shoring is also necessary to minimize smearing of water in the river. Temporary shoring in general shall be watertight and well braced to sustain earth pressure during excavation. Typical shoring sketch (plan and section) is shown below.

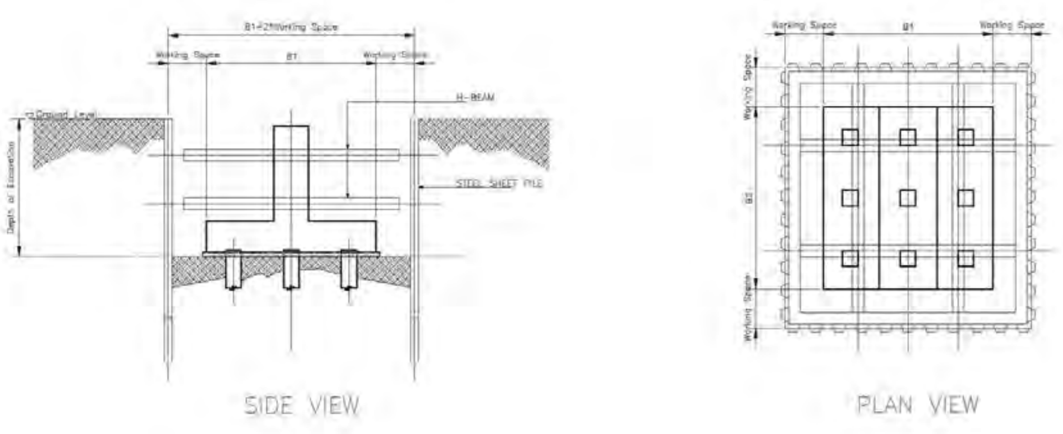


Figure 13.1-7 Schematic View for Structural Excavation

When excavation is completed, pile heads shall be treated as specified without damage to the piles and then lean concrete is placed. Following the lean concrete, reinforcing bars shall be arranged and forms be installed. Prior to placing concrete of footing, inspection shall be conducted and then concreting be done as per requirements in the specification.

Walls, columns and column heads shall be constructed with treatment of construction joint and firm scaffolding and supports shall be provided. All the while, concrete shall be cured with appropriate method in a period specified.

After properly backfilled, temporary shoring shall be removed carefully without damaging concrete structures.

- Super structure
  PCS (prestressed concrete slab) and PCDG (prestressed concrete deck girder) type shall be such that girders with tensioning is to be produced in casting yard, delivered to site, erected and then slab is to cast in-situ. Girders shall be produced in casting yard and quality control for casting, tensioning and grouting shall be done properly. Delivery and erection of girders shall be planned and carried out as per requirements spelled out in the specification.

  In case of the existing bridges to be widened in Section I (Bridge 80, 81, 83 and 85-87), new PCS beams shall be added to the existing beams with due diligence, as described in Chapter 11.

13.1.3 Widening of Existing Bridge

Six bridges are proposed to be widened as listed in Table 13.1-1. Widening of existing bridge is practiced in the developed countries such as Japan in recent years. The general process of widening is explained in Chapter 11. Details of bridge widening need to be designed and finalized by bridge design engineer and general contractor, respectively, with good experience in bridge widening works.

13.1.4 Other Structure Works

Pipe/box culvert works mainly consist of two kinds of works, earth work and concrete work. Earth work for culverts shall be executed in a manner similar to that described in Sub-section 13.1.1 Road Works. Likewise, concrete works for culverts shall be executed in a manner similar to that described in Sub-section 13.1.2 Bridge Works. In case of culverts in Section I, pipe/box culverts need to be extended as the road is widened, and these extension works shall be done in conjunction with embankment works stated in Section 13.1.1.

13.1.5 Traffic Management during Construction

When works for section I are carried out allowing existing traffic, influence to the traffic needs be minimal. Therefore, traffic management is one of the most important tasks during construction, particularly in town areas. Basically, traffic capacity of road similar to that of existing condition should be provided during construction. This can be achieved by providing same carriageway width. But sometimes providing detours or alternative routes and other measure may be adopted in order to minimize interference to road users. The same principle shall be applied in constructing Battambang Bypass (Section II) and Sri Sophorn Bypass (Section III) at intersections with the existing roads.

Figure 13.1-8 below shows a general flow chart for preparing traffic management plan.

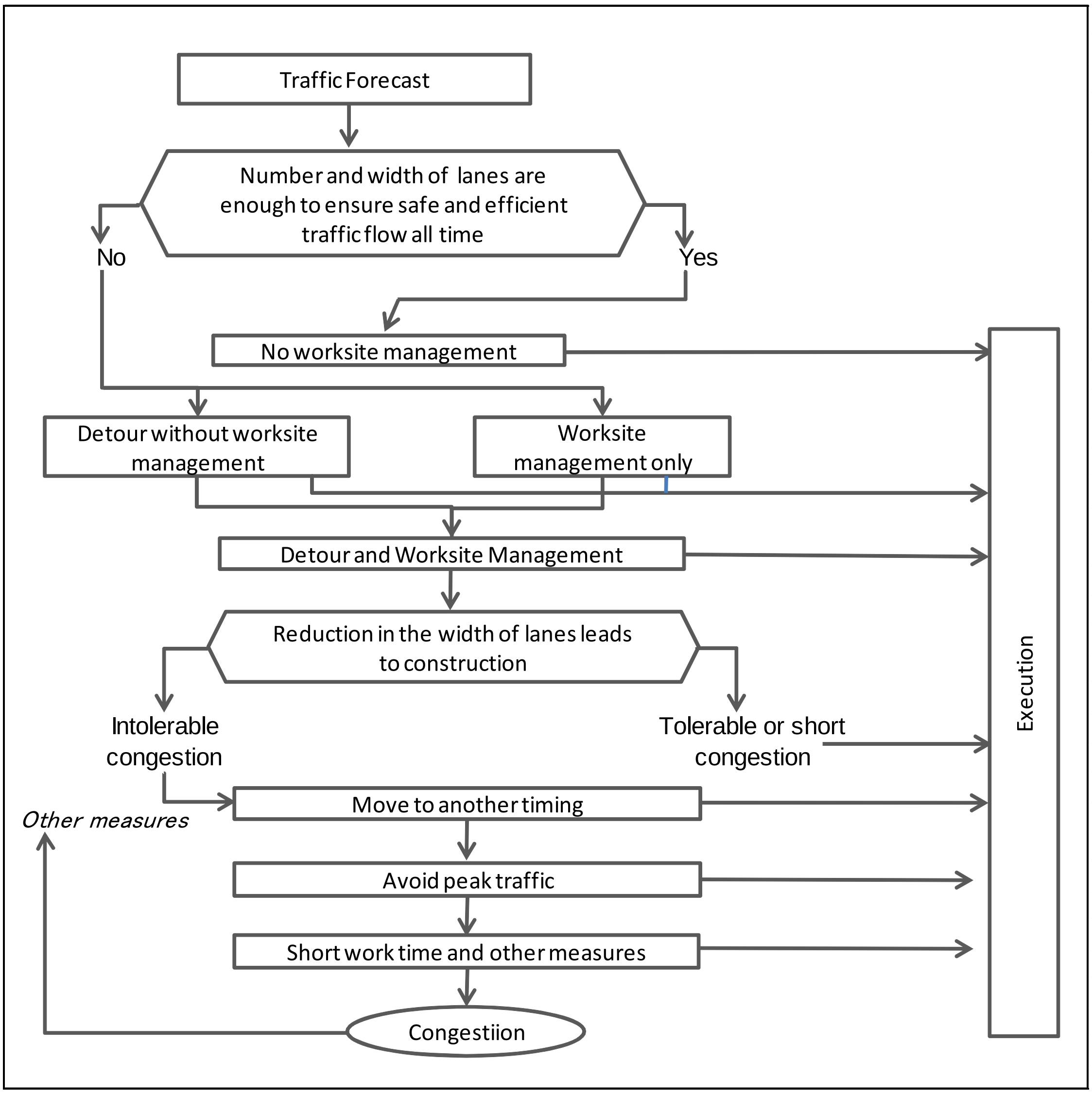


Figure 13.1-8 Flow of Traffic Management Plan

13.1.6 Utilities

Utilities such as electric cable, street light post, telephone line, water pipe and so on shall be checked thoroughly along the route prior to commencing construction. The following activities shall be conducted before, during and after construction.

1) Contact relevant authorities to find out as-built documents and drawings for utilities
2) Survey on actual locations of underground utilities on site using detectors
3) Excavation of trial pits with certain interval to find out exact locations of utilities
4) Temporary relocation, removal and/or protection to utilities, as required
5) Reinstatement of utilities after construction works completed

As per experiences in the similar projects in Cambodia, relocation, removal, protection and reinstatement of utilities shall be carried out by relevant utility organizations or their designated companies. Those shall be under separate local contracts between the RGC and the utility organizations or companies in order to avoid negative impacts on civil works for the Project.

13.2 Organization in Implementation

13.2.1 Employer

As requested by JICA, the Minister of Public Works and Transport has prepared a proposal to the Prime Minister in September 2011 that the Joint Coordinating Committee (JCC) to lead and manage the rehabilitation project of NR 5 as well as NR 1 (Asian Highway AH-1) under Japanese Loan be established and the proposal is being processed. The JCC will be organized with participation from the MPWT, the Ministry of Economy and Finance (MEF), the Council of Ministers and relevant provincial governments.

In addition, the Project Management Unit (PMU) for managing the Project will be planned to set up in the MPWT. Figure 13.2-1 shows possible organizational structure of the PMU under the JCC.

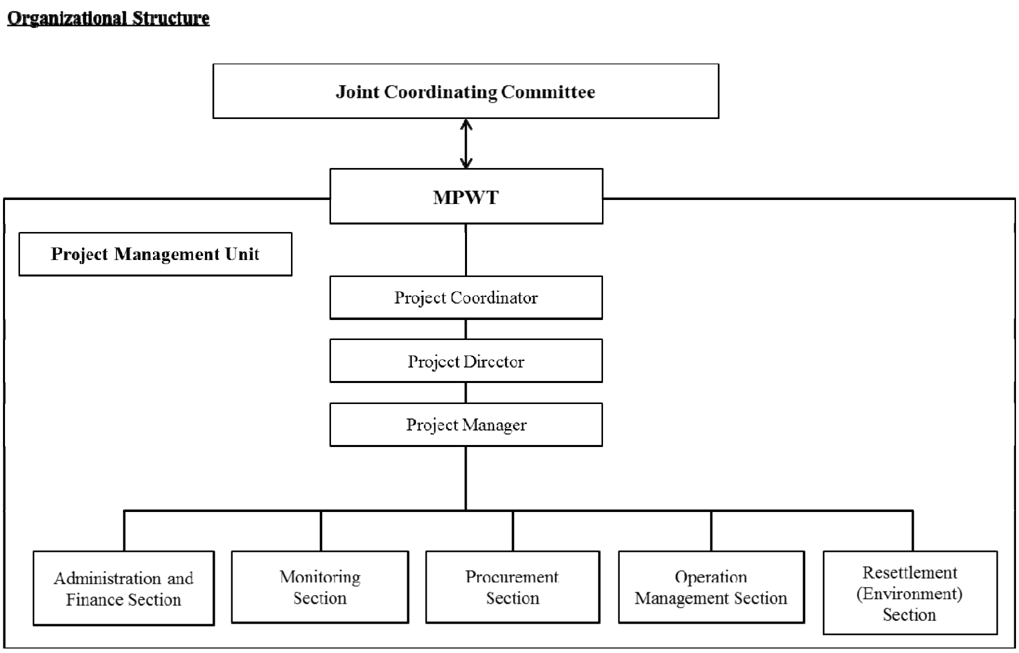


Figure 13.2-1 Organization of Employer

The JCC and PMU shall be established within a few months in order to have constructive and effective discussions and negotiations with JICA for loan agreement. The PMU during the engineering study and selection of contractors may be small organization and during construction stage shall be in full scale.

MPWT has certain experiences in procurement and project management under ADB and foreign country loans (e.g. China and Korea etc.) and other agencies have some experience in JICA loans like the Port Authority of Sihanoukville and Phnom Penh Water Supply Authority. Hence, it is thought that MPWT has certain level of knowledge and capability for project management and JICA Team recommends to enhance their capacity through trainings mentioned in Section 12.2.

13.2.2 Consultant

Consultant shall be selected after the loan agreement through the Guideline for the Employment of Consultants under Japanese ODA Loans and be contracted with the Employer in accordance with the contract concurred by JICA. Organizations of the consultant during the engineering services, the selection of contractors and supervision stage are indicated in Section 12.2.4.

13.2.3 Contractor

Contractor(s) shall be selected through the Guideline for the Procurement under Japanese ODA Loans and be contracted with the Employer in accordance with the contract recommended by JICA. As detail design and bill of quantities are prepared by the consultant, the conditions of contract between the Employer and Contractor shall be the Bank Harmonized Edition of the General Conditions of Contract prepared by the International Federation of Consulting Engineers (Fédération Internationale des Ingénieurs-Conseils, or FIDIC). Under the FIDIC conditions, the relation between the Employer, the consultant (the Engineer) and the Contractor are shown in the Figure 13.2-2 below.

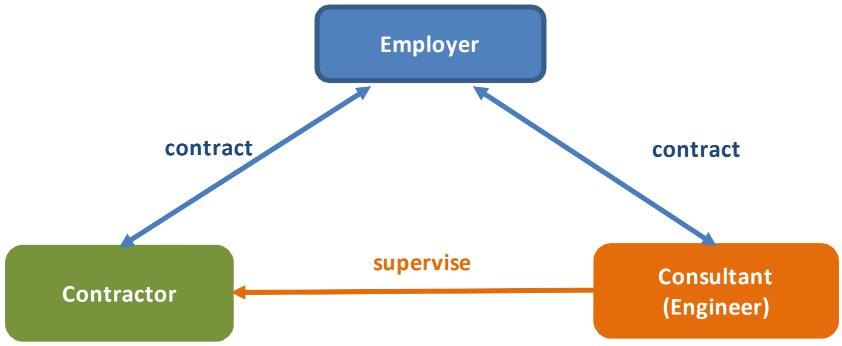


Figure 13.2-2 Relation of the Employer, Consultant and Contractor

13.3 Implementation Schedule

The JICA Team discussed with JICA and MPWT counterpart as well as various stakeholders of the Project and local consultants/contractors with regard to the implementation of the Project. Followings are the most probable schedule in each task considering the results of the above discussion.

(i) Feasibility study (FS)

The JICA Team has commenced the Survey in February 2011 and after incorporating Sri Sophorn Bypass, a Final Report is submitted in October 2012.

(ii) Royal Government of Cambodia (RGC) Action for Approval on FS

According to the interviews to staff in relevant departments in RGC regarding ODA loan, RGC needs to accept the FS and to prepare a formal request to Japanese Government. This task is estimated to take a few months.

(iii) Negotiation of Loan Agreement

The standard processing time period for ODA loan project is set by the Japanese Government and a process will start as soon as receipt of formal request from RGC. The major activities for the process are as follows.

1) Fact finding mission from JICA
2) JICA appraisal mission
3) Signing of loan agreement

Necessary time set in the standard process time period is nine months for the process and this is not easy to achieve, if referring to the experiences in the past. It is expected that signing on the loan agreement will be made in January 2013.

It means that this task will take 10 months.

(iv) Selection of Consultant

There is standard schedule for the consultant selection, which consists of three major stages as follows;

1) Short-listing and Request for Proposal Preparation Stage (approximately 2.6 months)
2) Proposal Stage (approximately 5.3 to 5.8 months)
3) Contract Negotiation and Signing Stage (approximately 2.6 months)
   Total 10–11 months

Referring to the precedent projects in Cambodia under JICA, duration of selection of consultant varied from 10 months to 24 months and it took 10 months in the most recent project (West Tonle Sap Irrigation and Drainage Rehabilitation and Improvement Project). Therefore, the JICA Team assumes that selection of consultant take 12 months by taking advance action prior to the formal loan agreement.

(v) Engineering Study and Supervision

Selected consultant shall carry out engineering study and tender process/evaluation for contractors followed by construction supervision.

The first task, the engineering study consists of basic design & detail design and preparation of tender documents. Usually the tender documents (pre-qualification document and tender document) will be compiled simultaneously with detail design or soon after basic design.

As the project is not very complicated, it is estimated that the engineering study, including the preparation of tender documents, be completed in 9 months, though 10 months period was set at the time of appraisal for the most recent project in Cambodia (West Tonle Sap Irrigation and Drainage Rehabilitation and Improvement Project).

The tender process/evaluation for contractors usually consists of two stages; pre-qualification (PQ) stage and tender stage. The former starts during the detail design and the latter is commenced as soon as the detail design is completed. The duration of this task is discussed in ‘(vi) Selection of Contractors’ below. Supervision will follow the selection of contractors.

(vi) Selection of Contractors

The selection of contractors starts from PQ stage and then proceeds to tender stage. The following task and duration will be in standard time frame in JICA.

1) Prequalification	3 months
2) Preparation of tender document	3 months
3) Tender period	2 months
4) Tender evaluation	2 months
5) JICA concurrence to the evaluation result	1 month
6) Contract negotiations	2 months
7) JICA concurrence to contract	1 month
8) L/C opening	1 month
Total	15 months

According to the past experience in previous projects in Cambodia, average duration is much longer (approximately 19 months), however the above process could be believed to achieve in 15 months as stated above with due efforts of every party concern.

(vii) Land Acquisition / Resettlement

The length of time required for the land acquisition and relocation is dependent mainly on the number of affected family. Now JICA is providing the technical assistance “Project on Capacity Enhancement of Environmental and Social Considerations for Resettlement”. The result of this technical assistance is expected to provide the positive effect to the land acquisition and relocation for NR 5 Project.

So far, most of the precedent project under Japanese ODA Loan has no problem on land acquisition and relocation, as land was cleared before the commencement of civil works in several projects in the past. According to the study at this stage, the JICA Team conclusion on the estimated necessary time is 19 months.

(viii) Detection and Removal of Mines / UXOs

The prerequisites of calculation of duration for detection and removal of mines / UXOs are as follows;

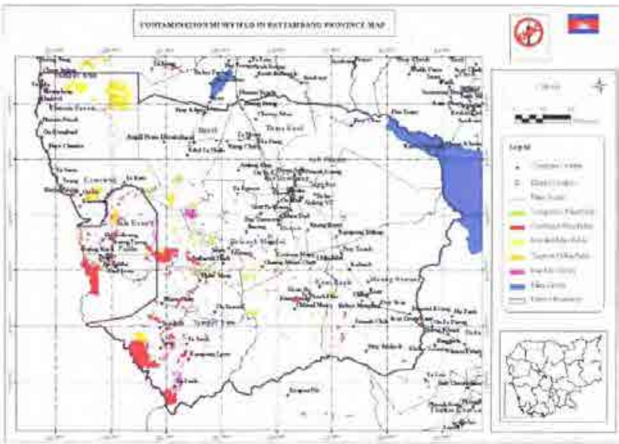


Figure 13.3-1 Contamination Minefield in Battambang Province

- Route to detect and remove mines and UXOs is Section I (North Section) only, as Battambang and Sri Sophorn Bypass have been detected and removed during the FS.
- There is no confirmed/suspected mine field. (Ref. the Figure 13.3-1 Contamination Minefield in Battambang Province.)
- The detection shall be done in dry season. Water in paddy field, much water in the soil must be avoided.
- Soon after detection of landmines and UXOs, demining works shall be followed smoothly.
- There is no problem for detection and removal works with the land owners, after the completion of land acquisition.

The organization of detection and demining shall be the Cambodia Mine Action Center (CMAC) or the Cambodian Royal Army. The necessary period for the detection on landmine and UXO is estimated to be around 4 months in dry season.

(ix) Construction

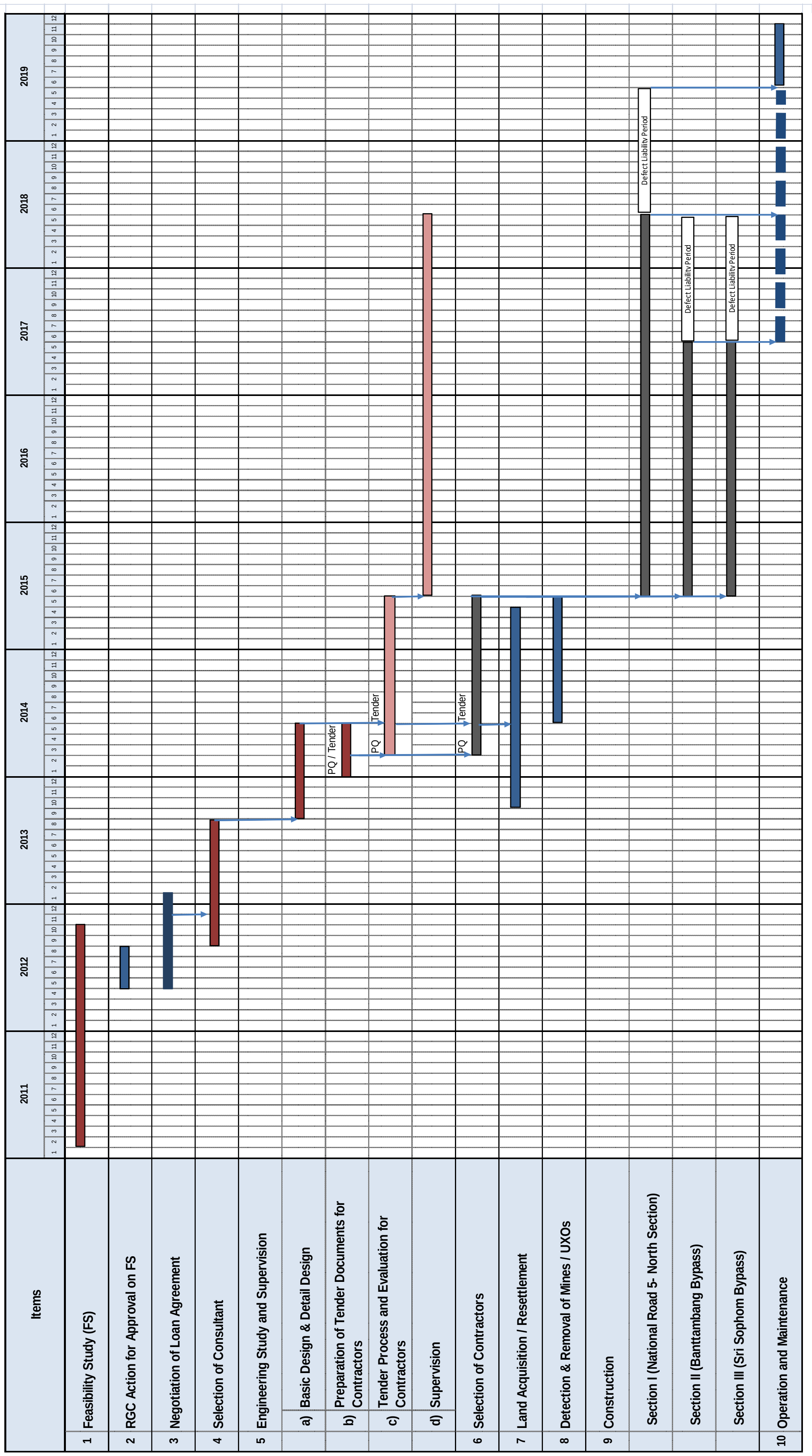
There are three work sites in this Project, which are 1) North Section of National Road 5 (Battambang to Sri Sophorn) (Section I), 2) Battambang Bypass (Section II) and 3) Sri Sophorn Bypass (Section III). The scope of work in each project is shown below.

Description	North Section of NR 5 (Section I)	Battambang Bypass (Section II)	Sri Sophorn Bypass (Section III)
Road length	47.0 km	23.1 km	13.4 km
Bridge no.	9 nos.	2 nos.	2 nos.
Culvert no.	43 nos.	110 nos.	70 nos.

Based on the above and the execution plan, construction is estimated to take 3 years for North Section of National Road 5 (Section I) and 2 years for Battambang Bypass (Section II) and Sri Sophorn Bypass (Section III) respectively.

With the explanation in the above, the implementation schedule is drawn and prepared. The schedule is shown in Table 13.3-1 Implementation Schedule.

Table 13.3-1 Implementation Schedule for National Road 5 Rehabilitation Project



CHAPTER 14 MAINTENANCE AND OPERATION PLAN

14.1 Maintenance and Operation Cost

14.1.1 Organization in Charge of Road Maintenance

The functions of Ministry of Public Works and Transport (MPWT) are stipulated in the Sub-decree on the Organization and Function of MPWT and those of Department of Public Works and Transport (DPWT) in provinces and cities are stipulated in the Declaration on the Management and Process of DPWT. The important articles in the Sub-Decree and Declaration in respect of road maintenance are extracted and shown in Table 14.1-1 below.

Table 14.1-1 Functions and Duties of MPWT and DPWT with Respect to Maintenance

[**Sub-Decree**]

Article 3: MPWT has functions and duties as below;

(2nd Clause)

- Completion, maintenance and management of road, bridge, port, railway, maritime and state building infrastructure.

Article 11: General Department of Public Works and Transport is responsible for direction, introduction, following up and control of construction and maintenance of road and bridge infrastructure, public building construction and construction management, maintenance of national vestiges assigned by the Royal Government of Cambodia. General department is …

Article 12: Road Infrastructure Department (RID) is responsible for:

- Completion, maintenance, management and make regulation for business on road infrastructure, such as road, local road, ferry dock, ferry and urban street.
- For this responsibility, department has two functions.

a) Organize maintenance program and manage roads and bridges

- Selecting data and utilizing data to understand road network.
- Manage technical documents on roads and road network related documents.
- Organize budget, divide follow-up means and control the maintenance.
- Manage public properties, road transport, water transport and rail transport.

b) Manage road and bridge working site.

- Study, manage and organize road and bridge maintenance program.
- Organize budget, divide follow-up means and control road and bridge working site.
- Assess complete working site.
- Manage ferry docks and ferry.

Article 23: In the whole Cambodia, there are Provincial Departments of Public Works and Transport that is responsible for implementation and coordination with Ministry activities. Arrangement and operation of local organization is defined by other document.

[**Declaration**]

Article 1: This proclamation indicates the management and process of the base units under supervision of MPWT- so called Department of Public Works and Transport, Provinces and Cities has the following duties;

(4th Clause)

- Control and maintain all completed works of infrastructures, such as roads, bridges, ports, airports, drainage system, drainage & exhaust pipe stations, harbors, buildings, land plots.

Referring to the above, it is noted that Road Infrastructure Department (RID) under General Department of Public Works and Transport in MPWT and DPWT are responsible for maintaining all roads and bridges in Cambodia. Figure 14.1-1 shows the organizational chart of RID, including number of staff (*italic*) in each office and unit.

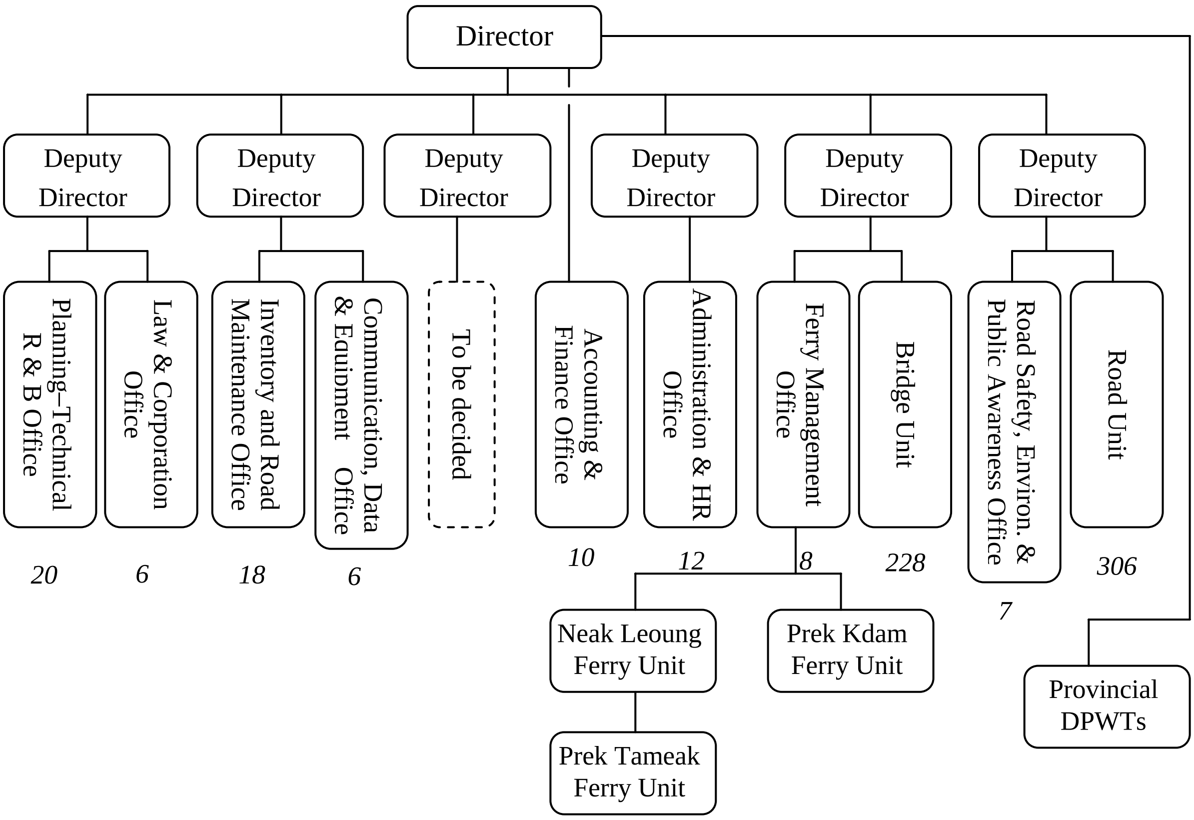


Figure 14.1-1 Organizational Chart of Road Infrastructure Department, MPWT

14.1.2 Practice of Road Maintenance and Operation

MPWT prepared and compiled four guidelines together with JICA experts in 2008 and the maintenance works are being carried out in accordance with those guidelines. Four guidelines are as listed below:

- Guideline for Regular Inspection
- Guideline for Supervision of Routine Maintenance
- Guideline for Supervision of Periodic Maintenance
- Guideline for Repairing Defects of Roads

According to the guidelines, road maintenance works are classified into three types: namely, routine, periodic and emergency.

Table 14.1-2 summarizes typical activities of each type of maintenance work.

Table 14.1-2 Typical Maintenance Activities

Type	Activity
Routine Maintenance	Clearing of pavement
	Mowing and maintenance of plants
	Clearing of ditches and culverts
	Repair of traffic signs and road markings
	Shoulder grading
	Pothole patching and crack sealing
	Repair of sealants and expansion joints of bridges
	Repair of cut and fill slopes
Periodic Maintenance	Re-graveling
	Resealing/surface dressing
	Overlay
	Maintenance of traffic signs and road markings
Emergency maintenance	Removal of debris or obstacles from natural causes
	Repair of damage caused by traffic accidents

Routine maintenance is planned based on regular (daily) inspection of the condition of road on the items as listed below:

- Pavement: potholes, cracks, ruts/settlements, deformations, local aggregate loss, edge break, scratches, bleeding etc.
- Cut and fill slopes
- Drainage
- Bridges: bottom, expansion joint etc.
- Other structures and facilities: markings, guardrails/handrails, signboards etc.

The results of regular inspection are categorized into three ranks as listed below.

Table 14.1-3 Rank of Defects

Rank A	Severe defects that may be harmful to traffic or structure and it requires urgent countermeasures.
Rank B	Defects that may be harmful to traffic or structure and it requires countermeasures but not urgent.
Rank C	Small defects that do not require countermeasures but it requires continuous observation.

The results of regular inspection are promptly reported to the operation office for follow-up maintenance works to be undertaken either continually throughout a year or at certain intervals every year.

Periodic maintenance is substantial repairs carried out at an appropriate time interval (every 3-year, 5-year, 8-year, 10-year etc.) based on the age, investment and initial design of the road. It could also be required when vehicle weight and traffic volume increased. It includes reconstruction, improvement, or rehabilitation works on any road section.

Emergency maintenance basically comprises works to restore road and road related facilities to their normal operating conditions after they are damaged by road accidents or natural causes. It is impossible to foresee the frequency, but such maintenance requires immediate action.

In addition to the above three types of maintenance, there is still another type of maintenance called ‘preventive maintenance’. The term “preventive maintenance” refers to repair that addresses causes of deterioration leading to the need for costly rehabilitation work in future.

14.1.3 Necessity of Capacity Enhancement for Road Maintenance

In the past, actual works of road maintenance have been executed mainly by DPWT and the Army under contracts with MPWT. In this case, type of pavement has been mainly DBST or Macadam. DPWTs and the Army have capacity for such types of pavement but they are not supposed to have sufficient capacity for maintenance of AC pavement. Thus, a new system needs to be introduced for maintenance of roads with AC pavement, including to increase staff in the road maintenance office of MPWT and DPWT, and capacity enhancement for maintenance of AC pavement is necessary.

In this connection, it is the fact that technical cooperation projects are being implemented in the MPWT, such as Strengthening Construction Quality Control Project (SCQCP) under JICA and Road Asset Management Project (RAMP) under ADB and WB. As roads are currently being improved in Cambodia and AC pavement roads are increasing, it is highly needed to have capacity development project for road maintenance in Cambodia and JICA Team recommends to plan and commence such projects near future.

14.1.4 Budget for Road Maintenance and Operation Works

In the budget situation for road maintenance and operation works under MPWT, it is found that budget has been increased in recent years and the following table shows budget in each category of works under MPWT.

Table 14.1-4 Budget for Road Maintenance under MPWT

Unit: USD million

Items	2007	2008	2009	2010	2011
Routine maintenance	5.7	8.8	17.1	17.9	16.1
Periodic maintenance	12.2	14.3	13.3	15.0	26.6
Emergency maintenance	1.6	1.9	2.4	2.9	3.7
Flood restoration works	2.4	2.4	0	0	0
Total	21.9	27.4	32.8	35.8	46.3

Source: Road Infrastructure Department, MPWT

As per discussion with staff in the road maintenance of Road Infrastructure Department (RID) under MPWT and in the Department of Public Works and Transport (DPWT) in Battambang and Banteay Meanchey Province, it is found that there are budget for routine maintenance of road spent by MPWT as well as by DPWTs. The amounts of expenditure spent for routine maintenance in 2011by respective organizations are as the following.

- Routine maintenance of paved road by MPWT: USD 3,000/km
- Routine maintenance of NR 5 by DPWT, Battambang: USD 2,500/km
- Routine maintenance of NR 5 by DPWT, Banteay Meanchey: USD 2,100/km

It is noted that two kinds of budgets for routine maintenance, namely by MPWT and DPWTs are spent on NR 5. Thus, the cost of routine maintenance for NR 5 is the total of MPWT budget and DPWT budget which amounts to approximately USD5,000 to 5,500 per kilometer on average in 2011.

14.1.5 Maintenance and Operation Cost

As described in Chapter 10 Highway Design, the design period of the pavement is 10 years. Thus, overlay of 5 cm thickness becomes necessary every 10 year after completion as the periodic maintenance. Also, routine maintenance needs to be implemented every year after completion.

Unit rate of future routine maintenance cost of the Project road is estimated at USD 5,000/km although the current unit rate of routine maintenance cost is slightly higher than this. The reason for this is that the existing pavement of NR 5 is DBST, while the future pavement will be asphalt concrete which generally requires less maintenance work than in DBST. Hence routine maintenance cost for the Project in each year is estimated as follows:

Table 14.1-5 Routine Maintenance in Section I, II and III

Section	Unit Rate (USD 1,000/km)	Length (km)	Amount (USD1,000)
Section I	5	47.0	235
Section II	5	23.1	116
Section III	5	13.4	67
Total			418

Periodic maintenance cost in each 10-year is computed as follows based on unit price of USD 14/m2 of overlay (5 cm thick asphalt concrete).

Table 14.1-6 Periodic Maintenance in Section I, II and III

Items	Unit Rate (USD)	Length (km)	Amount (1,000USD)
Section I			
Rural Area	USD 14/m2 x 15.0 m x 1,000 = USD 210,000/km	44.7	9,387
Urban Area	USD 14/m2 x 20.0 m x 1,000 = USD 280,000/km	2.3	644
Total of Section I			10,031
Section II	USD 14/m2 x 12.0 m x 1,000 = USD 168,000/km	23.1	3,881
Section III	USD 14/m2 x 12.0 m x 1,000 = USD 168,000/km	13.4	2,251
Total of Section I - III			16,163

In summary, road maintenance and operation cost after completion is estimated in the price of 2011 as shown below.

- Routine maintenance: USD 418,000/year
- Periodic maintenance: USD 16,163,000/10-year

14.2 Annual Road Maintenance and Operation Cost

Road maintenance and operation costs after completion of the Project is calculated in the prices of 2011 as described in Section 14.1 above. Thus, escalation factor needs be applied in order to have annual cost in future years. Escalation factor is assumed as follows.

1) Escalation factor in year 2012 to 2023: 2.1% and 6.6%/year for foreign and local currency portions, respectively, as stated in the section 12.4.
2) Escalation factor from year 2024: 1% and 2%/year for foreign and local currency portions, after twelve years growth with escalation in 1) above
3) It is assumed that items directly related to international market prices like imported materials, fuel, major construction equipment and systems etc. are applied to the factor for foreign currency and those related to domestic market prices like workers, earthwork and quarry material to the factor for local currency.

Annual road maintenance and operation cost in each year is as shown below.

Table 14.2-1 Annual Road Maintenance and Operation Cost

unit: 1,000USD

Year	Costs with 2011 price			Costs with escalation applied		
	Routine maintenance	Periodic maintenance	Total	Routine maintenance	Periodic maintenance	total
2019	418	-	418	544	-	544
2020	418	-	418	564	-	564
2021	418	-	418	584	-	584
2022	418	-	418	605	-	605
2023	418	-	418	627	-	627
2024	418	-	418	636	-	636
2025	418	-	418	644	-	644
2026	418	-	418	653	-	653
2027	418	16,163	16,581	662	25,605	26,267
2028	418	-	418	671	-	671
2029	418	-	418	680	-	680
2030	418	-	418	690	-	690
2031	418	-	418	699	-	699
2032	418	-	418	709	-	709
2033	418	-	418	719	-	719
2034	418	-	418	729	-	729
2035	418	-	418	739	-	739
2036	418	-	418	749	-	749
2037	418	16,163	16,581	759	29,361	30,121
2038	418	-	418	770	-	770
2039	418	-	418	781	-	781
2040	418	-	418	792	-	792
2041	418	-	418	803	-	803
2042	418	-	418	814	-	814
2043	418	-	418	825	-	825
2044	418	-	418	837	-	837
2045	418	-	418	849	-	849
2046	418	-	418	861	-	861
2047	418	16,163	16,581	873	33,746	34,619
2048	418	-	418	885	-	885
2049	418	-	418	898	-	898
2050	418	-	418	910	-	910

CHAPTER 15 PROJECT EVALUATION

To analyze logically the Project performance and assess the Project's operational and effectiveness conditions, appropriate indices are established based on the goals, objectives and functional characteristics of the Project. The section of NR 5 between Battambang and Sri Sophorn, and both Battambang Bypass and Sri Sophorn Bypass, have the direct objective of facilitating transportation of goods and passengers. As a result of improvement in the traffic/transport, the Project will contribute to socio-economic development of Cambodia as well as to promote regional development. With this concept, goals and objectives of the Project can be stated as follows:

- To facilitate transportation of goods and passengers (Direct objective)
- To mitigate road traffic congestion of roads in Battambang City and Sri Sophorn City.
- To promote regional development along National Road No. 5.
- Prevention of degradation of environment (mainly living environment) against increase in traffic demand

Based on these goals and objectives, indicators of the performance to be achieved during the Project life in specific and measurable terms are selected. Selected indices can, if measured, contribute to attaining better performance of the Project.

15.1 Evaluation Index

Performance of a project is usually evaluated in two areas; degree of achievement in operation and effectiveness. Degree of achievement in operation, in case of a road project, mainly refers to traffic volume. Effectiveness of a road project is degree of improvement (or mitigation of degradation) of traffic conditions against increase of traffic demand.

Selection of Operation and Effect Indicators

Operation and effect indicators to evaluate and monitor the project performance and its effectiveness are selected as shown in Table 15.1-1. The indicators are divided into two; indicators for direct benefit accruing use of the road and those for indirect benefits which are brought about as the results of improvement in traffic/transport conditions.

Table 15.1-1 Performance Indicator with Project Operation and Effectiveness Measurement

Impact Indicators	Definition	Purpose of Indicator	Method of Measurement
1. Indicator for Direct Benefit			
Traffic Volume	Average Traffic Volume (V) = ΣVi / ΣKm Where; Vi: traffic volume on each link in terms of PCU Km: Length on each link	To evaluate to what extent the movement of people and goods is encouraged.	Traffic Volume Counting
Reduction of traffic congestion	Vehicle congestion degree (V/C ratio) is mitigated. Average Congestion Degree (V/C) = ΣV-Km /ΣC-Km Where; V-Km: traffic volume on each link in terms of PCU times length of each link C-Km: capacity on each link in terms of PCU times length of each link		Calculation of V/C ratio using the traffic volume measured in above.
Reduction of travel time	Average travel time required for the whole length of the project road	To evaluate the effect of road improvement on the traffic/ transport and living environment, as well as public expenditure	Travel speed survey
Reduction of travel cost	Saving in total travel time cost for all vehicles running on the project road		Survey on the levels of bus charge and trucking charge
Savings in road maintenance cost	Road maintenance cost is reduced from DBST to AC pavement.		Annual maintenance cost
Emission gas reduction	Reduction in vehicle emissions and vehicle noise can be lead to environmental benefits		Surveillance of NO_2
2. Indicator for Indirect Benefit			
Promotion of regional development	Reduced transportation costs and the time cost saving for economic activities promote development of regional economic and industrial activities	To evaluate the extent of the regional development.	Population, Regional GDP, No. of factories, increase of job opportunity, etc.
Product market expansion	Product market is expanded owing to transport time reduction.		Distance between the place of production and place of consumption
Creation of employment opportunities with project construction	Employment opportunities will increase during the construction period.		Number of people locally employed during construction

15.2 Consideration on Indirect Benefits not Listed in the Table Above

In addition to the those listed in Table 15.1-1 above, some more indirect benefits can occur.

15.2.1 Promotion of Poverty Reduction

Poor people's inability to access jobs and services is an important element of the social exclusion that defines poverty. Regional and transport development can reduce poverty, by contributing to economic growth.

- During the construction period, poor people can work as unskilled construction workers
- After construction, this Project road will promote development of the region along the Project road by enhancing promotion of agriculture, industry and commerce. It is expected that job opportunities are increased in proportion with economic development.

15.2.2 Investment Promotion of Foreign Firms

NR 5 is expected to promote economic activities such as foreign and domestic investment in and around Battambang or Sri Sophorn by providing efficient land transport to Thailand and Phnom Penh. GMS regional economic cooperation is expected to create opportunities for various types of investments.

15.2.3 Relation to rice export

With the road improvement, it is assumed that the product market is expanded owing to reduction in transport time and therefore is more active in the regions.

- To increase rice production and increase the quality.
- To increase facilitation of trade and investment
- To promote regional economic growth along National Road No. 5.

15.3 Operation and Effect Monitoring Plan

The operation and effect of the Project will be monitored by measuring impact indicators. The targets of the indictors are estimated in accordance with the planned monitoring timing as shown in Table 15.3-1.

Table 15.3-1 Operation and Effect Indicator

Indicators	Road	Original (2011)	Present (Yr)	2 years after completion, projected as Yr 2020
Daily Traffic (PCU/day)	NR 5 main road	8,491		16,575
	Battambang bypass	-		7,077
	Sri Sophorn bypass	-		7,164
Travel Time (minute)	-	(Existing NR 5) 103		(2 bypasses + Improved NR 5) 86

15.4 Economic Analysis

15.4.1 Methodology

Economic analysis is carried out to compare project cost against benefits derived from the project in the regional economy using “benefit-cost” analysis. Such economic analysis is a necessary tool to facilitate the Project implementation.

Economic evaluation was conducted in terms of comparative analysis between benefits and costs. Benefits contain 1) time saving benefit and 2) vehicle operating cost saving benefit, while costs consist of construction cost, land acquisition cost and operation /maintenance cost. Indicators adopted here for economic evaluation are the conventional “Economic Internal Rate of Return (EIRR)”, “Benefit-cost ratio (B/C ratio)” and “Net Present Value (NPV) of the benefit”. Evaluation was conducted on the basis of transport demand forecast.

The economic analysis procedure as illustrated in Figure 15.4-1 is employed in this study. In order to estimate the benefit, traffic assignment to the road networks with and without the Project is considered.

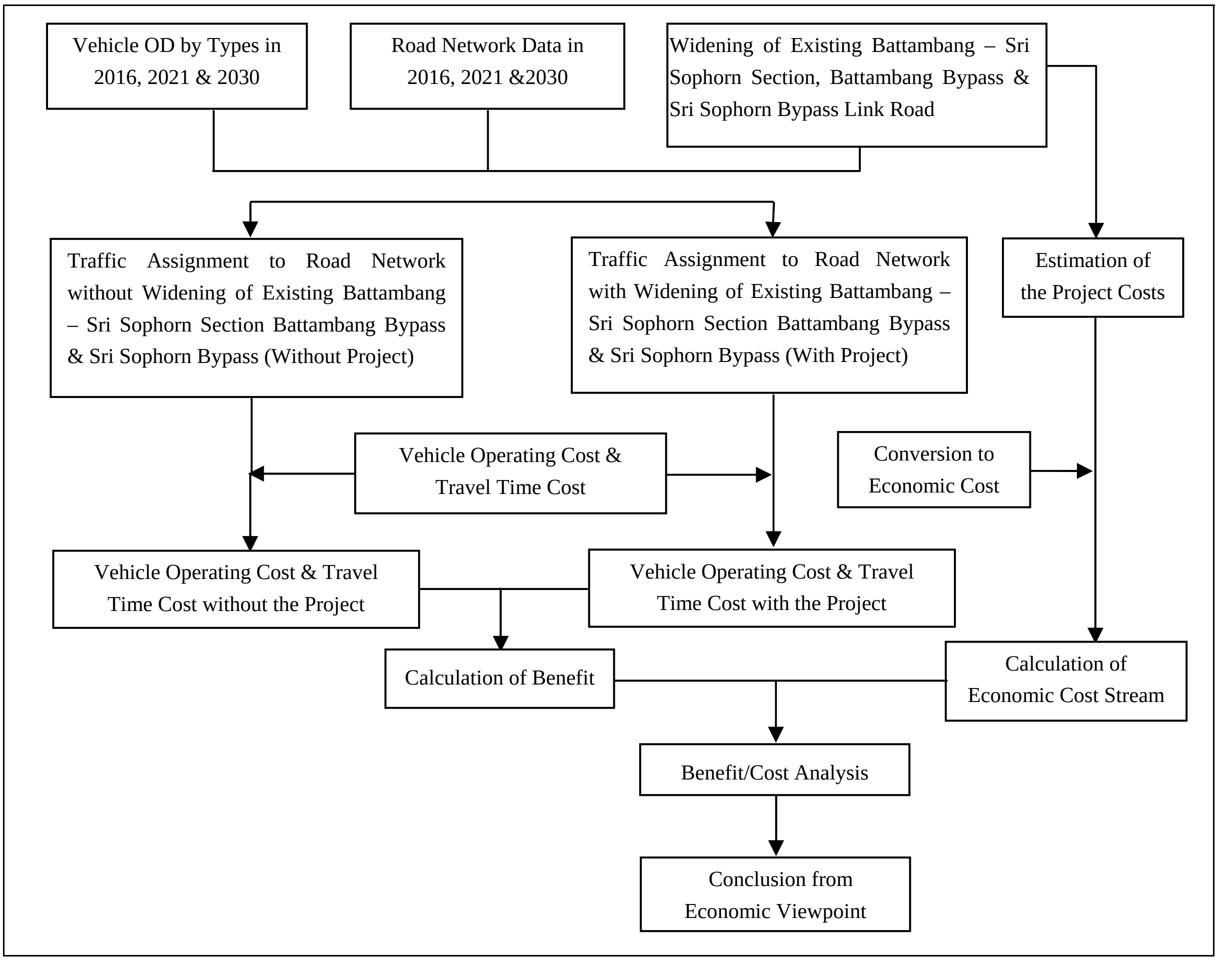


Figure 15.4-1 Procedure for Economic Analysis

Following the above-mentioned procedure, the economic analysis is made for the following road sections:

The section between north of Battambang city and Sri Sophorn (4 lanes), Battambang Bypass (2 lames + MC) and Sri Sophorn Bypass (2 lanes + MC).

15.4.2 Presumption for Economic Evaluation

(1) Implementation Plan of the Project and Evaluation Period

The economic analysis is based on the Project implementation schedule proposed in Chapter 13 as shown in Table 15.4-1. The evaluation period is assumed to be 30 years from 2018 to 2047 taking the service life of the Project into account.

Table 15.4-1 Project Implementation Schedule for Economic Analysis

	2012	2013	2014	2015	2016	2017	2018
Detailed Design							
Land Acquisition/Resettlement							
Construction							
North Section							
Battambang Bypass							
Sri Sophorn Bypass							
Operation and Maintenance							

(2) Evaluation Period and daylily factor

A 30 year evaluation period after opening to public. The annualized factor of the daily benefits is assumed to be 340 days per year taking into consideration the weekly variation in the volume of traffic on the roads.

(3) Discount rate

A discount rate of 12% is assumed, taking into account the opportunity rate for capital in Cambodia.

(4) Economic Indicators

In order to evaluate the road projects from an economic view point, the following economic indicators were estimated:

- Economic internal rate of return (EIRR)
- Benefit-cost ratio (B/C Ratio)
- Net Present Value (NPV)

(5) "With Project" and "Without Project"

"With Project" covers the situation where the proposed road improvement and new bypass are implemented, and "Without Project" covers the situation where no such investment takes place. The quantified economic benefits, which would be realized from the implementation of the project, are defined as savings in vehicle travel costs (vehicle operating costs and vehicle travel time costs) derived from the difference between "With Project" and "Without Project".

15.4.3 Estimated Benefits

In the evaluation, some basic parameters were estimated such as 1) Vehicle Operating Cost (VOC) and 2) Travel Time Cost (TTC).

- Vehicle operating costs (VOC), is the physical costs of operating a vehicle such as consumption of fuel, lubricants, spare parts, deprecation, crew costs, etc;
- Travel time costs (TTC), is the value of time spent in traveling that could be used in the other activities.

(1) Vehicle Operating Cost (VOC)

The VOC estimated in "the Study on the Road Network Development in the Kingdom of Cambodia" implemented by JICA in 2006 was used as the basic reference for this survey. The VOC in this Survey was estimated considering consumer price in 2011. Inputs for vehicle operating costs required for calculating the VOC are as follows.

<u>Vehicle Price</u>

The vehicle price is estimated on the basis of average prices for new vehicles purchased from vehicle dealers. Most of vehicles are imported to Cambodia as second hand reconditioned vehicles. However, as second hand price is uncertain and depends on the frequency of use, a new vehicle prices are used in this Survey. For the purpose of calculating the economic price of each vehicle taxes and import duties have been subtracted from the retail price. The resulting economic price includes elements of Cost Insurance and Freight (CIF) price, retailer's margin, and includes transportation cost.

<u>Tire Cost</u>

The economic costs of tires have been assessed in the same way as vehicle prices. Various suppliers in Phnom Penh were surveyed to assess average prices of different types (motorcycle, passenger car, bus and truck) of tire. New tires are subject to import duty, and VAT, the rate of which varies depending on type of tire. Custom Import duty is principally charged at 15% of the CIF value of the tire. The current rate of VAT and special tax is 10% for all types of tire (Special tax for motorcycle tire is tax free). For the purpose of calculating the economic price of each vehicle tire, taxes and import duties have been subtracted from the retail price. The resulting economic price includes elements of CIF price, retailer's margin, and includes transportation cost.

Fuel and Lubrications

Fuel and lubricants prices have been estimated based on a survey of market prices. There are a number of suppliers in Cambodia operating competitively. Three (3) types of fuel are available, diesel and two (2) types of gasoline, namely super and regular. Fuels are subject to import duty, special tax, and VAT.

For the purpose of calculating the economic price of fuel and lubricants, these taxes and import duty have been subtracted from the retail price. The resulting economic price includes elements of CIF price, customs import duty, value added tax and retailer’s margin.

Spare Parts Cost

Spare parts costs are as applied 1% of the vehicle price (economic price).

Maintenance Labor Cost

Maintenance costs have been estimated based on a survey of the average monthly cost of skilled supervisors and mechanics. Labor costs are estimated assuming average working hours of 200 hours per month.

Table 15.4-2 Maintenance Labor Cost

	Motor Cycle	Car	Pick-up	Mini Bus	Large Bus	Light Truck	Medium Truck	Heavy Truck
Wages per month								
Supervisor	375	375	375	375	375	375	375	375
Mechanic	250	250	250	250	250	250	250	250
Owner	0	0	0	0	0	0	0	0
Maintained by (%)								
Supervisor	10	25	25	25	50	25	50	50
Mechanic	40	50	50	50	50	50	50	50
Owner	50	25	25	25	0	25	0	0
Maintenance hours per year	40	70	70	250	300	250	300	350
Average hourly rate for services	0.46	1.01	1.01	3.59	4.35	3.59	4.35	5.07
Shadow wage rate factor	1	1	1	1	1	1	1	1
Economic rate	0.46	1.01	1.01	3.59	4.35	3.59	4.35	5.07

Crew Cost

The crew costs have been estimated based on a survey of unit costs per drivers and conductors or assistants, number of staff per vehicle, and number of hours per vehicle. In Cambodia, unit costs for drivers are estimated at around US$200 to $250 per driver depend on the type of vehicle, while unit cost for conductors or assistants are estimated to be one half of the average monthly cost of skilled supervisor and semi-skilled worker respectively. Crew costs are estimated assuming average working hours of 200 hours per month.

Table 15.4-3 Crew Cost

	Motor Cycle	Car	Pick-up	Mini Bus	Large Bus	Light Truck	Medium Truck	Heavy Truck
Number of drivers	0.25	0.75	0.75	1	1	1	1	1
Average monthly wage rate	200	250	250	250	250	250	250	250
Working Hour	200	200	200	200	200	200	200	200
Average hourly rate for driver	0.250	0.938	0.938	1.250	1.250	1.250	1.250	1.250
Skilled wage factor - Semi-skilled	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Driver cost (Economic)	0.250	0.938	0.938	1.250	1.250	1.250	1.250	1.250
Number of conductors	0	0	0	0.5	1	1	1	1
Average monthly wage rate	0	0	0	125	125	125	125	125
Working Hour	200	200	200	200	200	200	200	200
Average hourly rate for conductor	0.000	0.000	0.000	0.313	0.625	0.625	0.625	0.625
Skilled wage factor - Unskilled	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48
Conductor cost (Economic)	0.000	0.000	0.000	0.150	0.300	0.300	0.300	0.300
Total Crew Cost	0.250	0.938	0.938	1.400	1.550	1.550	1.550	1.550

Depreciation

Depreciation cost can be expressed as a percent of new vehicle cost and is given by the following formula:

Vehicle per 1,000 veh-km = DEP/ New vehicle prices

A vehicle is a medium-term asset. The purchase cost represents an investment which yields services over several years. The market value of the asset declines with both the passage of time and with amount and type of usage.

It is this loss of market value that represents vehicle depreciation. The vehicle depreciation per km is a function of the average annual depreciation and annual utilization.

DEP = ADEP/AKM

Where: ADEP: Average annual depreciation, expressed as % of average new vehicle cost

ADEP: (1 / LIFE)*100

LIF is average vehicle service life

AKM: Average number of kilometers driven per vehicle per year

<u>Insurance Cost</u>

Insurance cost was assumed to be 1% or 3% of vehicle price.

<u>Overhead Cost</u>

Overhead cost was calculated at 10% of the sub-total of the VOC (see Table 15.4-4).

Based on the above mentioned discussion and estimations the basic vehicle operating costs are calculated and are shown in Table 15.4-4.

Table 15.4-4 Vehicle Operating Cost by Vehicle Type

Unit USD/ 1,000km

Type	Item	Motor Cycle	Car	Pick-up	Mini Bus	Large Bus	Light Truck	Medium Truck	Heavy Truck
Distance related VOC	Fuel cost	207.0	3,104.4	3,104.4	4,035.8	13,574.8	6,593.5	16,677.6	27,518.1
	Lubricant cost	6.5	39.6	44.0	58.7	513.3	182.5	529.8	529.8
	Tire cost	16.3	70.9	70.9	80.4	860.6	221.9	520.5	1125.1
	Maintenance cost	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4
	Depreciation cost	0.6	13.4	13.2	15.8	35.6	13.7	25.9	30.6
	S-total	239.7	3,237.7	3,241.9	4,200.0	14,993.7	7,021.0	17,763.2	29,212.9
	Overhead cost	0.0	0.0	324.2	420.0	1,499.4	702.1	1,776.3	2,921.3
	Total	239.7	3,237.7	3,566.1	4,620.0	16,493.1	7,723.1	19,539.5	32,134.2
Time related VOC	Crew cost	100.0	515.6	515.6	1,680.0	2,712.5	1,860.0	3,177.5	3,177.5
	Maintenance cost	4.6	10.1	10.1	35.9	43.5	35.9	43.5	50.7
	Insurance cost	28.1	648.8	640.8	256.3	576.7	267.0	587.4	694.2
	Depreciation cost	0.3	7.2	7.1	8.5	19.2	7.4	14.0	16.5
	S-total	133.0	1,181.6	1,173.6	1,980.8	3,351.8	2,170.3	3,822.3	3,938.9
	Overhead cost	0.0	0.0	117.4	198.1	335.2	217.0	382.2	393.9
	Total	133.0	1,181.6	1,290.9	2,178.9	3,687.0	2,387.4	4,204.5	4,332.8
Total		372.7	4,419.3	4,857.1	6,798.9	20,180.1	10,110.5	23,744.0	36,467.0
VOC/ 1000 km		37.3	147.3	161.9	226.6	288.3	252.8	276.1	424.0

(2) Travel Time Cost (TTC)

Travel time costs (TTC), also referred to as Value of Time (VOT), are important components of road user costs. The concept of travel time costs is based on a premise that the time spent in traveling has an ‘opportunity cost” and could be used in an alternative activity which also produce or may produce some significant utility (benefit). If the alternative activity can have monetary value assigned to it, this can be used as a part of road user cost in the economic appraisal of the projects, particularly road improvement projects.

To estimate the travel time costs, the Average Wage Approach method is taken into consideration. The wage rates of vehicle occupants are assessed and then their average rate is estimated to reflect the value of time of occupants in different vehicles. An assessment of number of passengers in working time and non-working time is made for each vehicle type. The TTC for working time is then taken as the estimated wage rate. The TTC for non-working time is not taken into account in this study.

Unit costs were converted to unique passenger vehicle cost averaged by share of volume of each type of vehicle, which were forecasted by the Study. Converted and calibrated unit VOC in 2016, 2021 and 2030 are shown in Table 15.4-5.

Table 15.4-5 Forecast of Time Value per vehicle by Vehicle Type

Unit: USD/hour

Year	Motorcycle	Light Vehicle	Bus	Truck
2011	0.52	7.38	5.95	1.18
2016	0.66	9.43	7.60	1.51
2021	0.84	11.91	9.60	1.90
2030	1.23	17.47	14.08	2.79

(3) Construction Cost, Maintenance Cost and Land Acquisition Cost

The cost of construction, maintenance and land acquisition presented in Chapter 12 and Chapter 14 are used in the economic evaluation. Some basic presumptions assumed in the economic analysis are as follows:

- Escalation factor : Price escalation is not taken into account for construction cost, maintenance cost and land acquisition cost.
- Tax and import duty : Value added tax and import duty are excluded from cost.
- Land acquisition cost : Land acquisition cost is included.

(4) Cost Benefit Analysis

The section between north section of Battambang city and Sri Sophorn, and Battambang Bypass and Sri Sophorn Bypass.

The research of the economic analysis is shown in Table 15.4-6. The economic analysis is based on the annual user's benefit and cost estimate shown in Table 15.4-4, construction of north Battambang city and Sri Sophorn city (4-lane) and Battambang Bypass (2-lane) and Sri Sophorn Bypass (2-lane) is evaluated in terms of EIRR, BCR and NPV with assumed operation period of

30 years. Evaluation of the economic viability is undertaken through these three approaches and using discount rate of 12.0%. Compared with such large value of discount rate, it can be said that economic viability is estimated at a feasible level.

Table 15.4-6 Result of Economic Analysis

Indicator	Result
EIRR	22.6
B/C	3.18
NPV（Million USD）	150.02

The cost-benefit analysis stream are the 30 year project life is shown in Table 15.4-7.

Table 15.4-7 Cost Benefit Stream of the Project Unit: USD

SQ	Year	Project Cost	Maintenance Cost	Total Cost	Saving VOC	Saving Value of Time	Benefit	Net Benefit	Discount Cash Flow (at 12%)		
									Cost	Benefit	Net Benefit
	2012										
	2013	2,300,000		2,300,000				-2,300,000.0	1,833,545.9	0.0	-1,833,545.9
	2014	8,000,000		8,000,000				-8,000,000.0	5,694,242.0	0.0	-5,694,242.0
	2015	32,100,000		32,100,000				-32,100,000.0	20,400,130.3	0.0	-20,400,130.3
	2016	31,900,000		31,900,000				-31,900,000.0	18,100,916.7	0.0	-18,100,916.7
	2017	23,500,000		23,500,000				-23,500,000.0	11,905,831.3	0.0	-11,905,831.3
1	2018	10,500,000		10,500,000	2,219.34	5,600,590.1	5,602,809.5	-4,897,190.5	4,749,666.8	2,534,426.5	-2,215,240.3
2	2019	2,400,000	418,000	2,818,000	7,147.71	13,223,923.8	13,231,071.6	10,413,071.6	1,138,142.9	5,343,807.9	4,205,665.0
3	2020		418,000	418,000	7,673.35	15,549,349.3	15,557,022.6	15,139,022.6	150,735.0	5,610,018.3	5,459,283.3
4	2021		418,000	418,000	8,237.58	25,598,153.0	25,606,390.6	25,188,390.6	134,584.8	8,244,572.4	8,109,987.6
5	2022		418,000	418,000	8,582.21	29,481,064.7	29,489,647.0	29,071,647.0	120,165.0	8,477,568.8	8,357,403.8
6	2023		418,000	418,000	8,941.24	33,743,155.1	33,752,096.3	33,334,096.3	107,290.2	8,663,322.5	8,556,032.3
7	2024		418,000	418,000	9,315.24	38,416,279.7	38,425,594.9	38,007,594.9	95,794.8	8,806,154.6	8,710,359.8
8	2025		418,000	418,000	12,939.81	43,534,772.2	43,547,712.0	43,129,712.0	85,531.1	8,910,724.7	8,825,193.6
9	2026		418,000	418,000	13,480.98	49,135,628.6	49,149,109.6	48,731,109.6	76,367.0	8,979,358.6	8,902,991.5
10	2027		16,581,000	16,581,000	14,044.73	55,258,704.2	55,272,748.9	38,691,748.9	2,704,720.3	9,016,182.7	6,311,462.4
11	2028		418,000	418,000	14,632.00	61,946,925.0	61,961,557.0	61,543,557.0	60,879.3	9,024,350.1	8,963,470.8
12	2029		418,000	418,000	15,243.77	69,246,514.2	69,261,758.0	68,843,758.0	54,356.5	9,006,770.6	8,952,414.1
13	2030		418,000	418,000	15,881.06	96,208,341.7	96,224,222.7	95,806,222.7	48,532.6	11,172,284.4	11,123,751.7
14	2031		418,000	418,000	16,675.11	101,018,758.8	101,035,433.9	100,617,433.9	43,332.7	10,474,016.6	10,430,683.9
15	2032		418,000	418,000	27,195.57	106,069,696.7	106,096,892.3	105,678,892.3	38,689.9	9,820,287.1	9,781,597.2
16	2033		418,000	418,000	38,726.39	111,373,181.5	111,411,907.9	110,993,907.9	34,544.6	9,207,359.8	9,172,815.2
17	2034		418,000	418,000	40,662.71	116,941,840.6	116,982,503.3	116,564,503.3	30,843.4	8,631,899.8	8,601,056.4
18	2035		418,000	418,000	42,695.84	122,788,932.6	122,831,628.5	122,413,628.5	27,538.7	8,092,406.0	8,064,867.3
19	2036		418,000	418,000	44,830.64	128,928,379.3	128,973,209.9	128,555,209.9	24,588.1	7,586,630.7	7,562,042.5
20	2037		16,581,000	16,581,000	47,072.17	135,374,798.2	135,421,870.4	118,840,870.4	870,847.5	7,112,466.2	6,241,618.7
21	2038		418,000	418,000	37,069.33	142,143,538.2	142,180,607.5	141,762,607.5	19,601.5	6,667,357.7	6,647,756.2
22	2039		418,000	418,000	38,922.80	149,250,715.1	149,289,637.9	148,871,637.9	17,501.4	6,250,647.8	6,233,146.5
23	2040		418,000	418,000	53,194.49	186,484,183.6	186,537,378.1	186,119,378.1	15,626.2	6,973,378.1	6,957,751.8
24	2041		418,000	418,000	54,524.36	191,146,288.2	191,200,812.5	190,782,812.5	13,952.0	6,381,886.2	6,367,934.2
25	2042		418,000	418,000	55,887.46	195,924,945.4	195,980,832.8	195,562,832.8	12,457.1	5,840,565.5	5,828,108.3
26	2043		418,000	418,000	42,963.49	200,823,069.0	200,866,032.5	200,448,032.5	11,122.4	5,344,779.3	5,333,656.9
27	2044		418,000	418,000	58,716.77	205,843,645.7	205,902,362.5	205,484,362.5	9,930.7	4,891,776.2	4,881,845.5
28	2045		418,000	418,000	60,184.69	210,989,736.9	211,049,921.5	210,631,921.5	8,866.7	4,476,848.8	4,467,982.0
29	2046		418,000	418,000	46,266.98	216,264,480.3	216,310,747.3	215,892,747.3	7,916.7	4,096,824.0	4,088,907.2
30	2047		16,581,000	16,581,000	55,887.46	195,924,945.4	195,980,832.8	179,399,832.8	280,389.6	3,314,093.7	3,033,704.1
	Total	110,700,000	60,611,000	171,311,000			3,255,134,352.2	3,083,823,352.2	68,929,182.0	218,952,765.4	150,023,583.3

(5) Sensitive Analysis

A sensitivity analysis is conducted to see the influence of fluctuation of benefit and construction cost. Sensitivity analysis is made on the cases with +10% in the cost and -10% in the benefit. These changes in cost and benefit are supposed to represent unfavorable scenarios. The results of the sensitivity analysis are shown in Table 15.4-8.

Table 15.4-8 Results of the Sensitivity Analysis

Case		Economic Indicator	Benefits		
			-10%	Base Case	10%
Costs	-10%	NPV (USD million)	135.02	156.92	178.81
		B/C	3.18	3.53	3.88
		EIRR (%)	22.6%	23.8%	24.9%
	Base Case	NPV (USD million)	128.13	150.02	171.92
		B/C	2.86	3.18	3.49
		EIRR (%)	21.4%	22.6%	23.6%
	10%	NPV (USD million)	121.24	143.13	165.03
		B/C	2.60	2.89	3.18
		EIRR (%)	20.4%	21.5%	22.6%

15.5 Justification of the Project

The significant benefits of the project are summarized as the enhancement of traffic safety and environmental conservation by well-designed Asphalt paved road; the integration of production and consuming centers in terms of regional context; and the reduction of transport cost to provide better market accessibility for more competition toward low prices and to increase job opportunities for the local poor especially in the development corridor between Battambang and Sri Sophorn. It is also anticipated that local people will have better access to social facilities including schools, Pagodas and other public facilities.

The project will also stimulate the development of the Asian Highway No. AH1 and induce incremental demand of domestic cargo as well as international trade to Thailand. Such transformation will accrue considerable degrees of both direct and indirect benefits, especially by relieving transport constraints such as traffic bottlenecks of the city and town and traffic safety, and strengthening social and cultural links between settled areas in the country.

CHAPTER 16 NOTES FOR IMPLEMENTATION AS JAPANESE ODA LOAN PROJECT

Through the long experiences of implementation of Japanese ODA loan projects, JICA has found many important points which need attention from the view point of smooth implementation of projects as well as to fully achieve the objectives of projects. Among those points, some are pertinent to this Project.

16.1 Start-up Stage

Start-up delay is one of the focused areas identified in "2011 Joint Country Portfolio Performance Review (JCPPR)" held on April 28 and 29, 2011, jointly by Ministry of Economy and Finance (MEF), Asian Development Bank (ADB), Japan International Cooperation Agency (JICA) and the World Bank. There are some issues discussed in JCPPR such as recruitment of consultant, project launch workshop and project administration manual. Three issues are focused here.

16.1.1 Land Acquisition, Relocation and Mitigation Plan for Affected Families

The issue "Land Acquisition, Relocation and Mitigation Plan for Affected Families" is one of the most important points in the start-up stage. Many projects have faced difficulties with this issue. JICA has tackled with this issue based on its guidelines. However, some projects such as National Road No. 1 and Neak Loeang Bridge have received criticism on this issue.
So far, most of the precedent projects under Japanese ODA Loan have no problem on land acquisition and relocation. In the projects of 'Sihanoukville Port', 'Phnom Penh Water' and 'Telecom Cambodia' land acquisition was completed before the commencement of civil works. For the most recent project under Japanese ODA Loan, West Tonle Sap Irrigation and Drainage Rehabilitation and Improvement Project, this issue would not be so serious because almost of land has already acquired. However, now only EDC cannot prepare the necessary land for the construction of transmission lines. The delay of land acquisition is affecting the schedule of construction.

JICA is providing technical assistance on this issue through the Project on Capacity Enhancement of Environmental and Social Considerations for Resettlement. Under this project, Basic Resettlement Procedures (BRP) is expected to be established by the end of March 2012. The result of this technical assistance project would be very helpful for the NR 5 project. It is expected that the problem of land acquisition and resettlement could be mitigated with the good collaboration between the two projects.

16.1.2 Internal Approval Procedures

In the JCPPR, the development partners indirectly pointed this issue. There are two major points; delay in decision making and insufficient capacity of staff regarding the project implementation procedures.

For the Japanese ODA loan projects, not only the decision in project executing agency but also that of MEF is necessary. Sometimes the final decision needs long time because of the long decision making line in the authorities.

So far, there have been ten Japanese ODA loan projects implemented in Cambodia. For MPWT, this is the first project financed by Japanese ODA loan. It is necessary for MPWT staff to familiarize themselves with the procedures of project implementation under Japanese ODA loan.

Also, provision of a procurement specialist by JICA, if implemented, is expected to be effective to assist MPWT in approval procedure.

16.2 Procurement Stage

The delays in procurement procedures was also pointed out in the JCPPR. JCPPR identified four issues; enhancing procurement capacity, strengthening governance and building capacity of staff in public procurement, strengthening and streamlining procurement oversight and monitoring, ensuring reasonableness and reliability of cost estimates. In case of Japanese ODA Loan projects, two issues among the issues, enhancing procurement capacity and strengthening and streamlining procurement oversight and monitoring are important points.

JCPPR proposed some measures for this issue. The main points are; strengthening and streamlining the Procurement Review Committee and the quality control of procurement document. It is recommended that JICA consider the following measures:

(i) Use of Sample Procurement Documents prepared by JICA
(ii) Procurement Seminars to not only MPWT but also Procurement Review Committee members including representatives of MEF.

JICA sometimes extends technical assistance to the implementing agency for smooth procurement. The objective of the procurement assistance is to develop the capacity of the executing agency in the employment of project consultants including, among others, the following:

(i) Preparation of a short-list of consultants
(ii) Finalization of TOR
(iii) Preparation of request for proposal including LOI, etc.
(iv) Preparation of technical proposal evaluation criteria
(v) Proposal evaluation and report preparation
(vi) Contract negotiations

Employment of Competent Consultant and Good Contractor

In the procurement stage, most important thing is to employ competent consultant and good contractors. Competent consultants and good contractors, in many cases, can prevent many risks, such as poor work quality, delay in progress and cost overrun, from occurring.

To recruit a good consultant, weight of financial proposal in the evaluation of proposal with QCBS needs to be as small as possible. In case of consultant services, low price becomes possible only with low-priced experts who often do not have required skill/knowledge/experience.

Offering large-size contract packages is generally believed to be one of practical measures for employing good contractors. In addition to this, diligent prequalification and bid evaluation are also important. However, it is a fact that there have been several cases in the past where contractors with poor ability were employed. Employment of a competent consultant can prevent to certain extent the problem caused by a contractor with poor capacity.

16.3 Construction Stage

In the construction stage, the development partners including JICA faced some delay and difficulties. The major problems are insufficient quality of civil works and construction safety.

16.3.1 Construction Quality Control

Quality control is utmost important aspect in road construction/rehabilitation. However, MPWT has suffered in the past from substandard quality and consequent premature deterioration of roads which resulted in unexpectedly high maintenance cost and hindrance to traffic. Photo 16.3-1 shows examples of roads where quality is poor.

Photo 1: NH48 Near Koh Kong (in 2010)

Photo 2: NH7 Near Kratie (in Apr., 2009)

Photo 16.3-1 Examples of Road with Poor Quality

The JICA Team considers employment of competent consultant and good contractors is the key to successful quality management. The followings are possible measures for employing good contractors:

(i) Packaging
In order to attract qualified international constructors, the most important point is the size of contract. It is recommended to make the size of procurement package as much as possible.

(ii) Pre-qualification
In order to achieve the quality of civil works, PQ condition is important factor. It would be necessary to incorporate the following conditions in addition to the fundamental conditions; experience in large scale civil work contract, experience in the project financed by Japanese ODA loan, experience of the contract which is based on the sample document of JICA, experience of the FIDIC contract.

(iii) Local Competitive Bidding
In order to keep the quality of civil works, it is recommended to avoid LCB except for small package. As pointed out in the JCPPR, in Cambodia, the capacity of local constructor is still limited.

(iv) Two-Envelope Bidding
In order to select qualified international contractor, it is necessary to use Two-Envelop Bidding following the JICA guidelines. The specification for and evaluation of technical proposal are important points.

16.3.2 Construction Safety

Here the term construction safety refers to two kind of safety; safety of workers and safety of the third party which is traffic and people around the work site.

It is one of the main concerns of JICA in Japanese loan projects that projects are implemented without accidents. Construction safety tends to be given little attention, if not neglected, in many developing countries and it has been the case also in Cambodia. However, with rapid socioeconomic development, safety is becoming one of the important issues. Thus, diligent attention needs to be given this aspect.

Examples of measures for enhancing safety may include the following:

(i) Detailed specification for safety measures in bidding documents
(ii) Strict condition in technical specification on the experience on construction safety
(iii) Continuous training and seminars for MPWT staff, such as the "Seminar on Safety Management and Quality Management of Infrastructure Projects in Cambodia" on Feb. 21, 2011, organized by JICA
(iv) Use of result of study on Construction Safety Management of ODA Projects implemented by the Overseas Construction Association of Japan, Inc. (OCAJI)

Competent consultant and good contractors usually can considerably contribute to both types of safety for worker and third party because good site management is the base of such safety. It should be noted that safety measures often needs some cost. Thus, cost for required safety measures need to be reflected in the cost estimation.

16.4 Operation and Maintenance Stage

16.4.1 Budget for Operation and Maintenance

In 2010, maintenance budget was increased from USD 32.8 million in 2009 to USD 35.8 million (9% increased). This budget will be allocated for the maintenance of the following structures:

1. Routine Maintenance USD 17.9 Million
1.1 National and provincial road (A/C) USD 7.9 Million
1.2 National and provincial road (Laterite) USD 5.9 Million
1.3 Traffic inspection USD 0.1 Million
1.4 Culvert construction at key infrastructure USD 4.0 Million
2. Periodic Maintenance USD 15.0 Million
3. Emergency maintenance USD 2.9 Million

However, the above budget is not sufficient for the maintenance works. So far, the large scale maintenance and improvement works have been financed by Development Partners' assistance. This Project is to improve the pavement type of NR 5 from DBST to AC, and is expected to reduce annual maintenance cost. However, rehabilitation of AC pavement becomes necessary every 10 years in usual practice and MPWT needs to prepare relatively large fund for this pavement rehabilitation.

16.4.2 Traffic Safety

This Project is to widen the carriageway of existing NR 5 and separate slow traffic, such as motorcycles and moto-rumoks, and high-speed traffic, such as passenger cars. As a result, the chances of traffic accidents are expected to be reduced in general.

On the other hand, there is a possibility that some pedestrians cannot respond to the increased speed of vehicles, especially that of high-speed vehicles, and may commit miss judgment when crossing the road and hit by a vehicle. Thus it is recommended that campaign to raise awareness of roadside residents against increased vehicle speed be implemented as the road improvement approach to completion. Also so-called ‘3Es’ (engineering, education and enforcement) should be practiced.

16.4.3 Enforcement against Overloaded Trucks

It is widely known that overloaded trucks severely damage pavement. Thus, enforcement against overloaded trucks is indispensable to secure expected life period of pavement and achieve expected project benefit.

The locations of weighing station on National Road No. 5 are;

(i) Lung Vek (Kampong Chhnang 048+000),
(ii) Kleang Moeung (Pursat 191+800),
(iii) Anlung Vil (Battambang 282+000), and
(iv) Koun Domrei (B. Meanchey 389 + 000).

Effective operation of these weighing stations is expected to substantially reduce overloaded trucks. MPWT should continue its effort, with cooperation of traffic police, for effective operation of weighing stations.

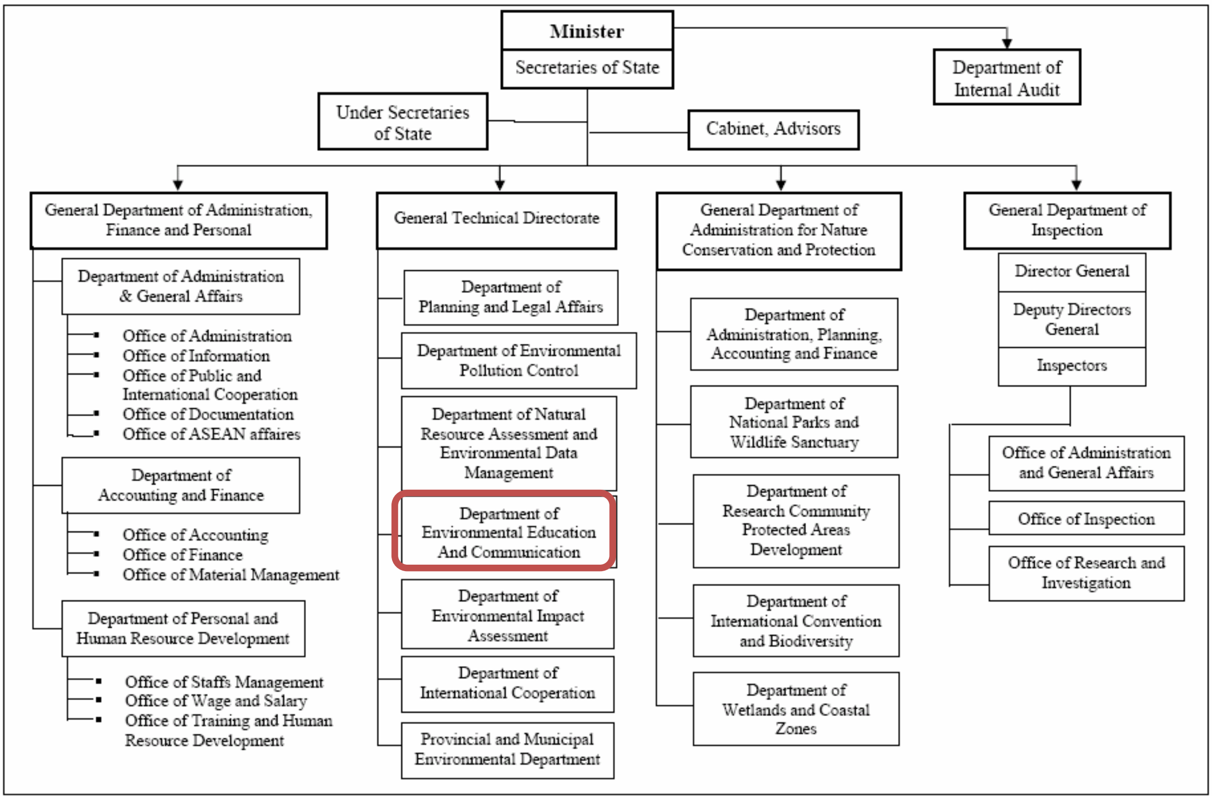
CHAPTER 17 ENVIRONMENTAL AND SOCIAL CONSIDERATION

Environmental and Social Consideration has been a key issue in Cambodia in decade since the concept of "Resettlement" had been introduced first in this country in the Project of National Road No.1 funded by ADB. Collaterally legal aspects regarding Environmental and Social Consideration have improved in these several years with new sub-decrees and declarations drafted and promulgated. The situation regarding these laws and regulations, however, shows complication in terms of accuracy and consistency among them and raises dispute among related authorities, donors, NGOs and other related organizations in terms of implementation.

The purpose of this chapter in the Draft Final Report is to clear up the system, related laws and regulations, and their tasks and issues from the view point of environmental and social consideration and resettlement.

17.1 Institutional Setup and Legal and Policy Framework for Environmental and Social Considerations in Cambodia

17.1.1 Organization in charge of EIA/IEIA in Ministry of Environment



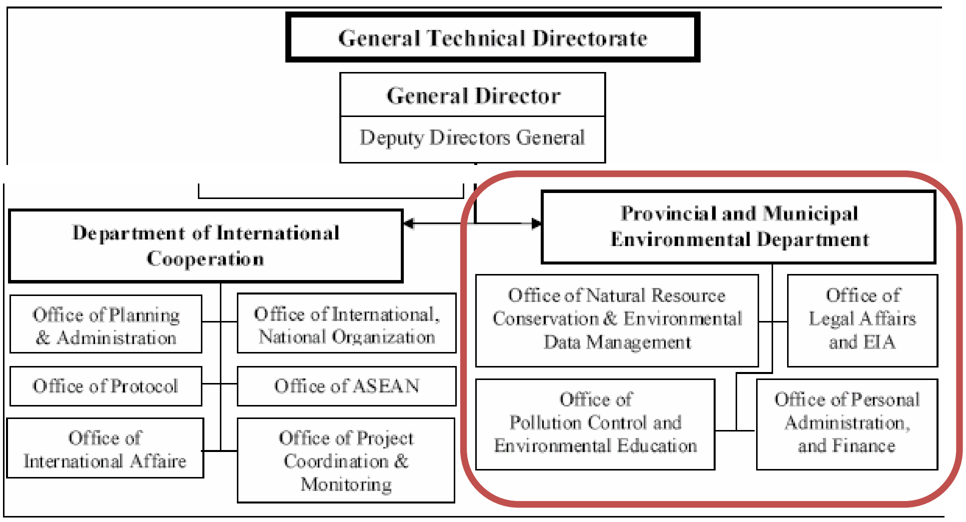
Source: Department of Environmental Impact Assessment, Ministry of Environment

Figure 17.1-1 Organization of DEIA

The Department of Environmental Impact Assessment (DEIA) is a structure of the MOE since its establishment in 1994. However, the declaration of its organization and functioning has been adopted only on December 2005. This department is set under the General Technical Department. Its main role and responsibility is focused on reviewing the EIA/IEIA report and monitoring the environmental management plan of both public[1] and private development projects. It works according to the application of the 1996 Law on Environmental Protection and Natural Resource Management and the 1999 Sub-Decree on Environmental Impact Assessment Process. Under DEIA five (5) offices share the responsibilities for projects of national level, which are Office of Administration and Accounting, Office of Planning and Statistics, Office of Project Review, Office of Project Monitoring, and Office of Disputed Legislative and International Cooperation. Growing importance of works, the Department's personal has been increased from 16 staff in 1998 to 49 staffs in 2011.

17.1.2 Organization in charge of EIA/IEIA in Province and Municipality

Provincial and Municipal Environment Department (PMED) is in charge of projects on regional level.



Source: Department of Environmental Impact Assessment, Ministry of Environment

Figure 17.1-2 Organization of PMED

[1] Definition of "public" by MOE is;
- Line ministries, the Council for Development of Cambodia (CDC), etc.;
- Provincial Environmental Departments;
- Local government authorities: Provincial, district, commune and village authorities;
- NGOs
- The Project Proponents (Government, Private Sectors, Joint-Ventures, Consultant Companies);
- Local communities and local people in and surrounding the project site.

17.2 Legal and Policy Framework for Environmental and Social Considerations in Cambodia

17.2.1 Fundamental Law and Regulations

(1) Law on Environmental Protection and Natural Resource Management (1996)

It is the fundamental law of environment in Cambodia in which chapter III stipulates Environmental Impact Assessment (EIA). Article 6 in this chapter stipulates that EIA shall be conducted on every project and activity of the private or public, and shall be approved by the Ministry of Environment (MOE) before being submitted to the Royal Government of Cambodia (RGC) for decision. It also stipulates that this assessment shall also be conducted for existing activities that have not yet been assessed for environmental impact.

(2) Sub-Decree on Environmental Impact Assessment Process (1999)

This sub-decree stipulates the definition of “EIA”, obligation of submission of EIA Report, target project types and public participation. Sub-Decree stipulates the criterion of necessity of EIA in Cambodia as type of project and their size and capacity. (Table 17.2-1)

(3) Prakas (Declaration) on Guideline for Conducting Environmental Impact Assessment Reports (2000)

This Declaration stipulated first that Department of Environmental Impact Assessment (DEIA) in MOE is the unit in charge of EIA.

(4) Prakas (Declaration) on General Guideline for Conducting Initial and Full Environmental Impact Assessment Reports (2009)

This Declaration stipulates the approval procedure of IEIA/EIA of project each on national level and municipality/provincial level (Figure 17.1-1) and detail instruction of application form and documents which should be attached. Also Declaration allows the project owner to hire consultant company, which must be registered in Ministry of Commerce (MOC) and be recognized by MOE beforehand, to prepare IEIA/EIA report with.

17.2.2 EIA System in Cambodia

(1) Overview of EIA System in Cambodia

If project owner should conduct EIA and submit the report to get approval depends on type of projects and their size and capacity (Table 17.2-1). The type of project is divided in four (4) groups, Industrial, Agricultural, Tourism and Infrastructure, and each group has its own criteria according to their activities. The project owner must conduct IEIA in order to comply with EIA requirement. According to this sub-decree the project of national road construction needs EIA when construction length is 100 km and more.

Table 17.2-1 List of Projects and its Criteria required IEIA or EIA in Cambodia

No.	Type and Activities of Projects	Size / Capacity
A	**INDUSTRIAL**	
B.	**AGRICULTURE**	
C.	**TOURISM**	
D.	**INFRASTRUCTURE**	
1.	Urbanization development	All sizes
2.	Industrial zones	All sizes
3.	Construction of bridge-roads	>= 30 Tones weight
4.	Buildings	Height >= 12 m or floor >= 8,000 m^2
5.	Restaurants	>= 500 Seats
6.	Hotels	>= 60 Rooms
7.	Hotel adjacent to coastal area	>= 40 Rooms
8.	National road construction	>= 100 Kilometers
9.	Railway construction	All sizes
10.	Port construction	All sizes
11.	Air port construction	All sizes
12.	Dredging	>= 50,000 m^3
13.	Damping site	>= 200,000 people

Source: Sub-Decree on Environmental Impact Assessment Process (1999), JICA Study Team

When Department of Environmental Impact Assessment (DEIA) in MOE and Municipality/Provincial Department of Environment (DE) receive the application, they must start approval procedure each on national level and municipality/provincial level with following the general guidelines.

(2) Institutions Responsible for IEIA/EIA

The Department of Environmental Impact Assessment (DEIA) in MOE and Municipality/ Provincial Department of Environment (DE) are in charge of review and making comment on the IEIA or EIA report of public/private project each on national level and municipality/provincial level following the general guidelines. MOE and Municipality/Provincial DE are also responsible to prepare the official letter for approval or require the project's owner for revision of the IEIA or Full EIA report.

(3) IEIA/EIA Approval Procedure in Cambodia

“PRAKAS on General Guideline for Conducting Initial and Full Environmental Impact Assessment Report, 02 September, 2009” stipulates the approval procedure of IEIA or EIA report. The approval procedure of IEIA or EIA report (Figure 17.2-1) should be within 30 (thirty) working days from the date of official receipt of the report by the DEIA or Municipality/ Provincial DE.

The approval procedure of IEIA or EIA report to Ministry for projects on national level is as follows:

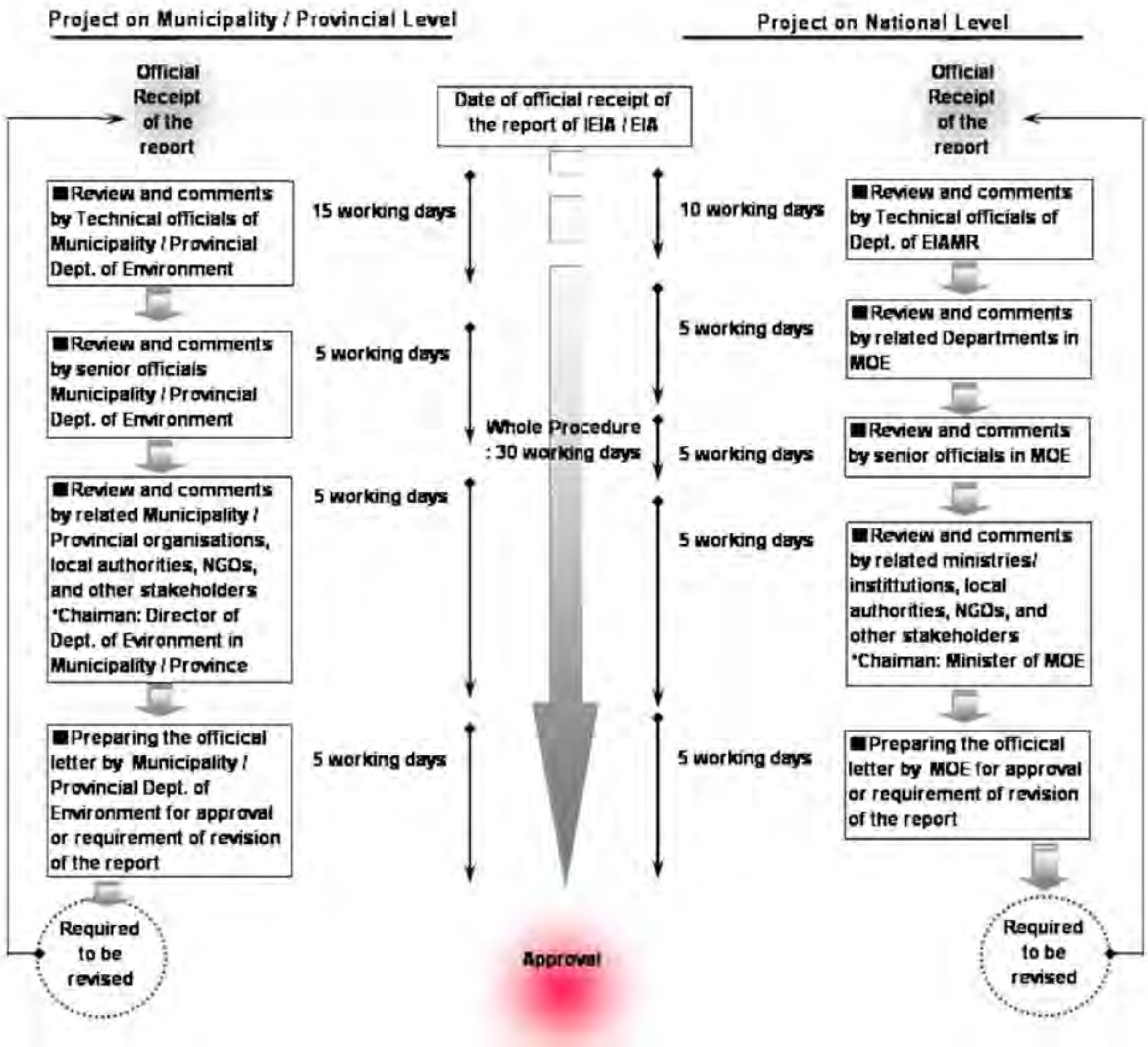
- 10 working days for technical officials of Department of Environmental Impact Assessment Monitoring and Review including days of field work,
- 5 working days for related departments in Ministry of Environment,
- 5 working days for senior officials of Ministry of Environment,
- 5 working days for Ministry of Environment with participants from concerned ministries/institutions, local authorities, Non Government Organizations and other stakeholders related to the investment project. Minister of Ministry of Environment is the Chairman in the meeting,

The approval procedure of IEIA or EIA report to Municipality/Provincial DE for projects on municipality/provincial level is as follows:

- 18 working days for technical officials of Municipality/Provincial DE including days of field work,
- 5 working days for senior official of Municipality/Provincial DE,
- 5 working days for related departments of Municipality and Province with participants from concerned departments/institutions, local authorities, Non Government Organizations and other stakeholders related to the investment project. The Director of Municipality/ Provincial DE is the Chairman in the meeting.

MOE or Municipality/Provincial DE has 5 working days to prepare the official letter for approval or require the project's owner for revision of the IEIA or Full EIA report.

In case Ministry of Environment or Municipality/ Provincial DE provide comment to the project's owner to revise, Ministry of Environment or Municipality/ Provincial DE make revision within 30 days of working day after date of official receipt of the revised report.



Source: PRAKAS on General Guideline for Conducting Initial and Full Environmental Impact Assessment Report, 02 September, 2009.

Figure 17.2-1 IEIA/EIA Approval Procedure in Cambodia

17.2.3 Consistency with JICA Guidelines for Environmental and Social Considerations (April, 2010, JICA New Guidelines)

JICA New Guidelines of Environmental and Social Consideration (JICA New Guidelines) aims at encouraging a recipient government to conduct appropriate environmental and social examinations at various stages of a feasibility study or project preparation, as well as appropriate participation of stakeholders to ensure transparent procedures and decision making. Adequate support and confirmation to be provided by JICA are also stipulated in the New Guidelines. Therefore it is important to examine and understand the consistency and verification between the regulations in Cambodia and donor policies.

(1) Requirements of the JICA New Guideline

The major requirement to be fulfilled by the recipient country can be summarized as follows:

- Integration of environmental and social considerations into the project planning and implementation decision-making process with multiple alternatives and mitigation plan.
- Preparation of various EIA-related documents in official or familiar language in a host country as well as in understandable language and form for local people.
- Openness of EIA-related documents and availability for access and copying at any time by stakeholders.
- Conducting appropriate environmental and social monitoring.

The key points of the process of environmental and social examination in line with the Guidelines are as follows:

- Categorization of each project to determine the required level of environmental and social examination.
- Approval of government of the recipient country through the official procedure, if there is the approval system in the recipient country.
- Examination, as early as possible in the project preparation and design stage, of various environmental and social impacts and measures, for both the main project design and multiple alternatives.
- Examination of environmental impacts, measures, and alternatives in close harmony with economic, financial, institutional, social and technical analysis of the project with quantitative analysis as much as possible and qualitative analysis as well.
- Information disclosure and consultation with stakeholders to have social acceptability with minutes of meeting to confirm the contents of consultation.
- Appropriate consideration to be paid to socially vulnerable groups, such as indigenous peoples, those subject to involuntary resettlement, etc.
- Monitoring after project implementation to confirm the effectiveness of measures, as well as the occurrence of any unforeseen situations.

(2) Comparison and Verification of between Cambodian System and Guideline

The table below shows the consistency of the EIA system in Cambodia with JICA New Guidelines. The key points of the process of environmental and social examination in line with the Guidelines are as follows:

Table 17.2-2 Comparison between EIA System in Cambodia and New JICA Guideline

Major Requirements / Key Points of JICA New Guideline	System in Cambodia
Integration of environmental and social considerations into planning and decision-making process	- EIA Guideline in Cambodia stipulates stakeholder involvement at an early stage of project planning, to the greatest extent possible.
Openness of EIA-related documents in understandable language	- EIA report is prepared in Khmer. Documents for stakeholder meeting are also prepared in plain Khmer for understanding for meeting participants who are not familiar with environmental issues.
Categorization of the proposed project	- EIA Guideline in Cambodia classifies a project, including road project, into four (4) major categories based on project type and scale.
Examination of various impacts and measures	- EIA Guideline in Cambodia provides the general scope for examination of impacts and measures, such as physical, biological and social-economic aspects. - Not clearly stated about alternative plan.
Information disclosure and stakeholder consultation	- EIA Guideline in Cambodia ensures information disclosure and public consultation with description of type of group.
Consideration for socially vulnerable groups, involuntary resettlement, etc.	- Legal framework for resettlement does not exist in Cambodia. Laws and sub-decrees exist for land acquisition and compensation and several laws and sub-decrees are under deliberation. However, and dispute and argument makes unstable situation as the legal system for land acquisition and compensation.
Monitoring after project implementation	- EIA Guideline in Cambodia stipulates that an environmental management plan, including a monitoring plan, should be included in EIA.

Source: Law on Environmental Protection and Natural Resource Management (1996),
Sub-Decree on Environmental Impact Assessment Process (1999),
Prakas (Declaration) on Guideline for Conducting Environmental Impact Assessment Reports (2000),
Prakas (Declaration) on General Guideline for Conducting Initial and Full Environmental Impact Assessment Reports (2009),

From the examination of consistency and verification, there is not considerable gap between the EIA system in Cambodia and JICA New Guidelines.

17.2.4 Environmental Standard

Major environmental standards to be considered for the project are summarized as follows.

(1) Air Quality

Sub Decree on Air and Noise Pollution Control (1999) provides the maximum allowable limits for ambient air pollutants.

Table 17.2-3 Ambient Air Quality Standard in Cambodia

No.	Parameter	1 Hour Average mg/m^3	8 Hour Average mg/m^3	24 Hour Average mg/m^3	1 Year Average mg/m^3
1	Carbon monoxide (CO)	40	20	-	-
2	Nitrogen dioxide (NO2)	0.3	-	0.1	-
3	Sulfur dioxide (SO2)	0.5	-	0.3	0.1
4	O zone (O_3)	0.2	-	-	-
5	Lead (Pb)	-	-	0.005	-
6	Total Suspended Particulate (TSP)	-	-	0.33	0.1

Source: Sub Decree on Air and Noise Pollution Control (1999), Annex 1

(2) Noise

Sub Decree on Air and Noise Pollution Control (1999) provides the maximum allowance of noise level in public and residential area.

Table 17.2-4 Maximum Permitted Noise Level in Public and Residential Area (dB(A))

No.	Area	Period of time		
		From 6:00 to 18:00	From 18:00 to 22:00	From 22:00 to 6:00
1	Quiet areas - Hospitals - Libraries - School - Kindergarten	45	40	35
2	Residential area: - Hotels - Administration offices - House	60	50	45
3	Commercial and service area and mix	70	65	50
4	Small industrial factories intermingling in residential areas	75	70	50

Remark: This standard is applied to control of noise level of any source of activity that emitted noise into the public and residential area.
Source: Sub Decree on Air and Noise Pollution Control (1999), Annex 13

17.3 Site Description

17.3.1 Natural Environment

The project area is located at the Southern-Western border of Tonle Sap Lake which is well-known as the largest freshwater inland lake in South-East Asia (Figure17.3-1). In the flood season, especially from September to November, expanded lake area due to flood water coming from Mekong to Tonle Sap approaches to vicinity of NR 5. Therefore, it could be said that the project area has gentle and transitional relation to natural environment of Tonle Sap ecosystem. On the other hand, there is no integrated study on natural environment in the project site.

(1) Protected Areas

In Cambodia, protected conservation areas cover around 5.4 million hectares. There are 7 national parks, 9 wildlife sanctuaries, 3 protected landscape areas, and 3 protected areas. The national parks are located in the coastal zone, the mountainous areas, and cover 742,300 million hectares in total. Wildlife sanctuaries in these regions cover 4.138 million hectares. The protected landscapes area covers 97,000 hectares. Archaeological and cultural sites and protected areas cover 403,900 hectares.

In general, Right of Way (ROW) and its surrounding area of NR 5 have been already cultivated and developed for human activities with variety of land use form, such as agricultural land, residential area, commercial spots, and so on. Therefore, there is not specified environmental protected area within NR 5 project site. However, there are wetlands as natural habitat of agro-ecosystem, and eastern side of NR 5 has indirect connection to Tonle Sap Lake Biosphere.

Figure 17.3-1 and Table 17.3-1 show each location and information of protected area comparatively near to NR 5 Project section which regulated by Law on Protected Area (2008). The Law defined protected areas as below;

(i) National parks
(ii) Wildlife sanctuaries
(iii) Protected landscapes
(iv) Multiple use areas
(v) Ramsar sites
(vi) Biosphere reserves
(vii) Natural heritage sites and
(viii) Marine parks

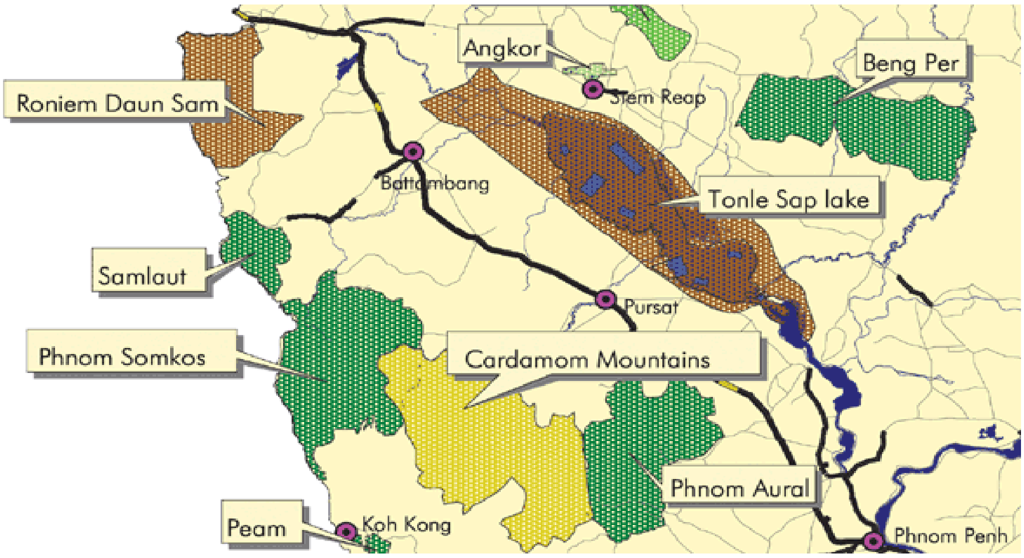


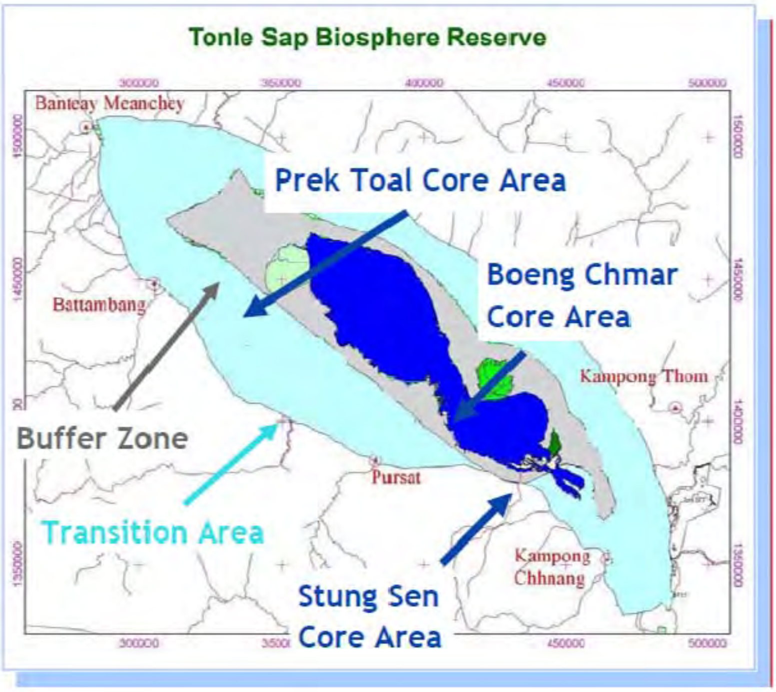
Figure 17.3-1   Location of Protected Area

Table 17.3-1 Basic Information on Protected Area near to NR 5

Name	Management Type	Size (ha)	IUCN* Category	Distance from NR 5
Roniem Daun Sam	Wildlife Sanctuary	178,750	III	Far
Samlaut	Multiple Use Area	60,000	III	Far
Phnom Somkos	Wildlife Sanctuary	333,750	IV	Far
Cardamom Mountains	Protected Forest	402,000	-	Far
Phnom Aural	Wildlife Sanctuary	253,750	III	Partially near
Tonle Sap	Multiple Use Area	316,250	IV	Partially near

*IUCN: International Union for Conservation of Nature

The Tonle Sap Lake (Great Lake) is the largest freshwater lake in Indochina Region, with the area of 2,500-3,000 km^2 in the dry season, and 10,000 - 15,000 km^2 in the flooding season. The area surrounding the lake was set as Tonle Sap Biosphere Reserve (TSBR) in 1997 under UNESCO's initiative. TSBR spans almost 1.4 million hectares (8% of Cambodia's total area) and includes the lake and most of the surrounding area bordered by the National Routes 5 and 6. The area has (1) Core areas, (2) Buffer areas, and (3) Transition areas as shown in the Figure 17.3-2 and Table 17.3-2. In general the project site (NR 5) has some distance from core zone of TSBR including flooding forest where the vulnerable species are living.



Source: Government Boucher TSBR funded by ADB, TSBR Secretariat[2]

Figure 17.3-2 Location Map of Tonle Sap Biosphere Reserve

[2] Dr. Neou Bonheur, Tonle Sap Biosphere Reserve Secretariat (TSBRS), "The Tonle Sap Biosphere Reserve" (Brochure), funded by ADB TA: Tonle Sap Environmental Management Project (TSEMP)

Table 17.3-2 Tonle Sap Biosphere Reserve (TSBR)

Category	Size (ha)	Environmental Characteristics	Province & District
Core Areas	43,000	Strictly protected; - Flood forest - Water bird - Freshwater Fish - Reptiles	・ Koh Chiveang Commune, Ek Phnom District, Battambang Province ・ Peam Bang Commune, Stong District, Kampong Thom Province ・ Phat Sanday Commune, Kampong Svay District, Kampong Thom Province
Buffer Areas	541,482	- Used for Environmental education, tourism, and etc.	・ Outside of flood forest
Transition Areas	899,600	- Flexible for development for economic activities	・ Southern edge with NR 5

Source: Royal Decree on the Establishment and Management of Tonle Sap Biosphere Reserve (2001)

Transition Areas where NR 5 makes border edge is defined as below;
"Transition area may contain a variety of agricultural activities and human settlements. Here all stakeholders have to cooperate to achieve sustainable development."

(2) Flora

(i) Forest

Forest area in Cambodia is classified into (1) Concession Forests and (2) Protected Forests, however, there are no remarkable forest zone along NR 5 Project section because of high level land use by human activities. The two main forest area located nearby to NR 5 are below;

Cardamom Mountains:

Where wild life is widely confirmed in the area of Southern-Eastern side of NR 5, however, it may not be affected directly by the project because of the distance and connectivity. Illegal logging from these protected is one of the urgent social issues to be solved.

Tonle Sap Lake:

Well known as rich flooding forest where about 200 species of plants have officially been recorded, and much species still left to be discovered.

(ii) Vegetation

Vegetation along the NR 5 is mainly agricultural crops such as; rice, fruit trees including palms, vegetables and some areas are covered with shrubs, grasses and sparse trees.

Photo 17.3-1 Sample of Roadside Vegetation along North Section of NR 5

On the other hand, the area where annual flood comes periodically and wetland area are observed along NR 5 with typical fresh water vegetation same as the Mekong Delta region. Northern-Western side of NR 5 is the border of Transition Areas of Tonle Sap Biosphere Reserve where development activities are flexibly admitted.

(3) Fauna

There are not so many kinds of animal species in the project site because the area is generally very narrow right of way (ROW) along the existing national road. However, there is possibility to find wild animals that depends on habitats nearby NR 5, especially in the section of new alignment for the bypass. There has not been conducted comprehensive study to confirm fauna along NR 5, therefore, the Survey implemented interview survey to local residents. Because the answer (name of species) form local people is sometime not so sophisticated, some local name could not be written in English and/or Scientific name. In this background, the list of species below does NOT mean such species have officially or scientifically confirmed or found in the just area of the project site. It could be said that there are some degree of possibility to find such kind of fauna and species in or near the project site.

(i) Amphibian and Reptile

According to interview with local people along NR 5, there are some amphibian species as describe in the Table 17.3-3. There is no strictness on the result of interview, however, there might be some sort of Amphibian and Reptile species including frog, snake, tortoise which depends on wetland in the vicinity of NR 5.

Table 17.3-3 Amphibian and Reptile Species Which Exist in the Project Area

No.	Khmer Name	English Name	Scientific Name	IUCN Category
1	Kangkebkob[1]	Rugulose bullfrog[2]	Hoplobatrachus rugulosus[2]	LC
2	Kingkouk	Common Asian toad[1]	Bufo melanostictus[1]	LC
3	Kanchanchek	Tree frog[1]	N/A	*
4	Thlain	Skink[1]	N/A	*
5	Bangkuoy Slab	Gliding lizard[1]	N/A	*
6	Bankuoy Thamada	Fence lizard[1]	N/A	*
7	Bankuoy Snaeng	Horned lizard[1]	N/A	*
8	Puos Prey	Chinese Ratsnake[3]	Ptyas korro[1]	N/A
9	Puos Khiev	Bleu snake[4]	N/A	*
10	Kantheay	Asian softshell turtle[1]	Amyda cartilaginea[5]	Vulnerable
11	Andaeuk Toek	Turtle[4]	N/A	*

Source: interview with local people, August, 2011 (Khmer)

1 Royal University of Phnom Penh, Cambodia, Center for Biodiversity Conservation.
2 Neang, T. & Holden, J. (2008). *A Field Guide To The Amphibians of Cambodia*, p. 87, Fauna Flora International, Phnom Penh, Cambodia.
3 http://en.wikipedia.org/wiki/Ptyas_korros
4 Translated word by word from Khmer
5 Bryan L. S., Peter P. v. D., Douglas B. H. (2001). Photographic Guide to the turtles of Thailand, Laos, Vietnam and Cambodia. p.32, Wildlife Conservation Society, ISBN 0-9632064-6-X 5.00
6 LC: Least Concern (Not yet threatened or endangered)
* Unable to check due to insufficient information of scientific name of the species.

(ii) Birds

According to interview to the local people along NR 5, there are some wild birds as described in the Table 17.3-4. There might be some sort of birds which migrates across the NR 5 between Tonle Sap Lake and western mountainous area. In the flooded forests of Tonle Sap Lake next to the project site, there are around 100 species of birds, of which at least 16 belong to species of globally threatened according IUCN ranking. Pelicans, storks, ibis, darters and cormorants nests in the flooding forests.

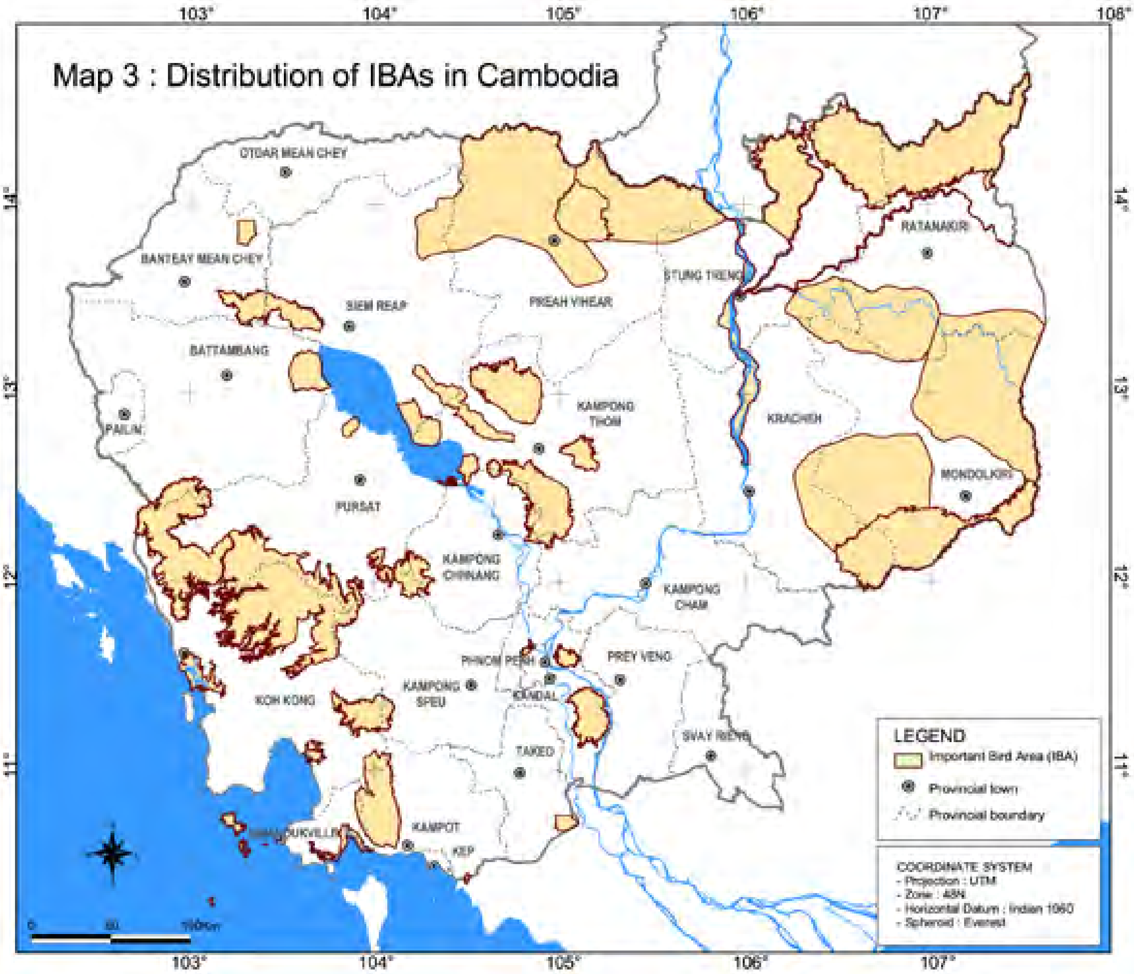
Table 17.3-4 Bird Species Which Exist in the Project Area

No.	Khmer Name	English Name	Scientific Name	IUCN Category
1	Pro Voeuk	Lesser Whistling-duck	Dendrocygna javanica	LC
2	Lolok Bay	Spotted Dove	Streptopelia chinensis	LC
3	Lolok Slab Beytang	Emerald Dove	Chalcophaps indica	LC
4	Sarikakeo Vong	Common Hill Myna	Gracula religiosa	LC
5	Popech Trocheakchnoth	Streak-eared Bulbul	Pycnonotus blanfordi	LC
6	Chab Tet	Common Tailorbird	Orthotomus sutorius	LC
7	Kruoch	Partridge	N/A	-
8	Krouch ourt	Barred Buttonquail	Turnix suscitator	LC
9	Sek Krech	Vernal Hanging Parrot	Loriculus vernalis	LC
10	Kroling Kroloung	Black-collared Starling	Sturnus nigricollis	LC
11	Chab Kanlong	Olive-backed Sunbird	Nectarinia jugularis	LC
12	Chab Dangkov	Prinia	Prinia sp.	LC
13	Chab Dangko Loeung	Yellow-bellied Prinia	Prinia flaviventris	LC
14	Chab Kanlong Phloeung	Fire-breasted Flowerpecker	Dicaeum ignipectus	LC
15	Chab Kanlong Khiev	Purple Sunbird	Nectarinia asiatica	LC
16	Chek Tum	Black-naped Oriole	Oriolus chinensis	LC
17	Tradev Toch	Green Bee-eater	Merops orientalis	LC
18	Sek Sork	Red-breasted Parakeet	Psittacula alexandri	LC
19	Sek Soam	Alexandrine Parakeet	Psittacula alexandri	LC
20	Antep Khmao	Black Drongo	Dicrurus macrocercus	LC
21	Papol Kbal Beytang	Orange-breasted Green Pigeon	Treron bicincta	LC
22	Tea Toeuk	Water duck**	N/A	-
23	Mean Toeuk Khmao	Common Moorhen	Gallinula chloropus	LC
24	Ka Ek	Large-billed Crow	Corvus macrorhynchos	LC
25	Ta Vao	Asian koel	Eudynamys scolopacea	LC
26	Khleng Srak	Common Barn Owl	Tyto alba	LC
27	Chab Srok	Plain-backed Sparrow	Passer flaveolus	LC
28	Chab Phtas	Eurasian Tree Sparrow	Passer montanus	LC
29	Chab Krok	Striated Grassbird	Megalurus palustris	LC
30	Porpich	Bulbul	Pycnonotus sp.	LC
31	Kha Ek Teouk	Cormorant	Plalacrocorax sp.	-

LC: Least Concern (Not yet threatened or endangered)

Source: Interview with local people, August 2011.

An international NGO, Birdlife International, in cooperation with the Ministry of Environment and Ministry of Agriculture, Forest and Fisheries defined Important Bird Area (IBA) for the protection of birds and its habitat (Figure 17.3-3). NR 5 Project Section is not included this areas, however, some birds from such area may migrate the project areas.



Source: Birdlife International in Indochina[3]

Figure 17.3-3 Important Birds Area

(iii) Fishes and Crustaceans

Wetlands along NR 5 including ponds and small rivers running into Tonle Sap Lake have direct or indirect connection to Tonle Sap aquatic ecosystem. Especially in the flooding season, water from the Tonle Sap Lake gives indirect influences to the area of eastern side of NR 5 which nominated as the transitional zone of Tonle Sap Biosphere Reserve. Over 200 species of fish occupy the Tonle Sap.

[3] Hout, S. K., Bunnat, P., Poole, C. M., Torodoff, A. W., Davidson, P. & Delattre, E., Directory of Important Bird Areas in Cambodia – Key Sites for Conservation, 2003

Tonle Sap is also well known as traditional fishing which is one of the most important income sources of the region. In the flooding season, the fishing area (community fishing lots) are located by NR 5 closely (Figure 17.3-4).

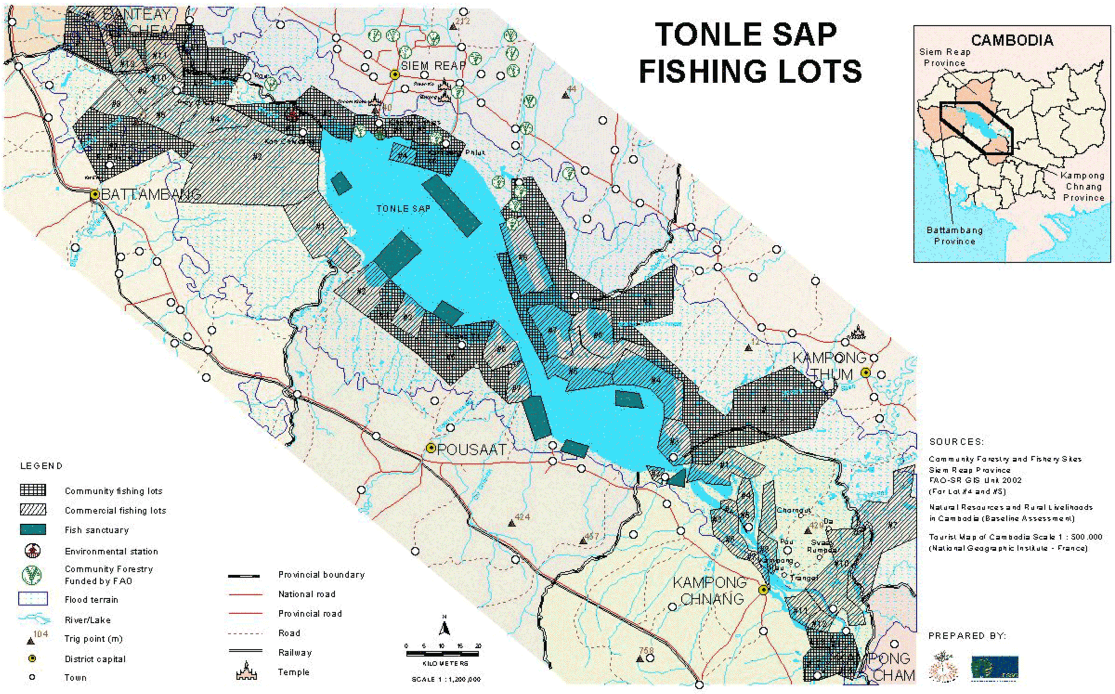


Figure 17.3-4 Tonle Sap Fishing Lots and Location of NR 5

According to the field observations and interview with local people in the Project Area, there are some fish species in the Steung Sangkae River, O Ta Ke Stream and Steung Serey Saophoan River such as Trey Angdeng, Trey Chhlonh, Trey Sa, Trey Chhpin, Trey Kanhchos, etc. Common fish that can be found are given in the Table 17.3-5 below.

Table 17.3-5 Fish Species Which Exist in the Project Areas

No.	Khmer Name	English Name	Scientific Name	IUCN Category
1	Trey Kampleanh Sre	Three spot gourami	Trichogaster trichopterus	N/A
2	Trey Changva	Barilius nanensis	Opsarius koratensis	N/A
3	Kampeus	Oriental river Prawn**	Macrobrachium Nipponese	N/A
4	Trey Changvamol	Kottelat rasbora	Rasbora hobelmani	N/A
5	Trey Chhlat	Bronze featherback	Notopterus	N/A
6	Trey Realtob	Siamesae mud carp	Cirrhinus siamensis	N/A
7	Trey Chhpin	Java barb (Silver barb)	Barbonymus gonionotus	N/A
8	Trey Sa	N/A	N/A	*
9	Trey Kanhchos Thmar	Asian bumblebee catfish	Pseudomystus siamensis	N/A
10	Trey Chhlaing	Asian redtail catfish	Hemibagrus sp.	N/A
11	Trey Andeng Tun	Broadhead catfish	Clarias macrocephalus	Near Threatened
12	Trey Andeng Roeung	Walking catfish	Clarias batrachus	LC
13	Trey Kesh	Reddish sheatfish	Kryptopterus bleekeri	N/A
14	Trey Kranh	Climbing perch	Anabas testudineus	Data Deficient
15	Trey Changva Neang	N/A	Garra fasciacauda	N/A
16	Antung	Onegilled eel	Ophisternon bengalense	LC
17	Trey Khachhoeung	Frecklefin eel	Macrognathus maculatus	N/A
18	Trey Chhlonh	Peacock eel	Macrognathus siamensis	N/A
19	Trey Kantrab	Catopra	Pristolepis fasciata	LC
20	Trey Krola Bey	N/A	N/A	*
21	Trey Chhdov	Giant snakehead	Channa micropeltes	N/A
22	Trey Tra Auon	Borneo glass catfish	Ompok engeneiatus	N/A
23	Trey Phtork	Snakehead murrel	Channa striata	LC
24	Kdam	Crab	N/A	*
25	Trey Kroem Kdam	Croaking gourami	Trichogaster vittata	N/A

Source: Interview with local people, August, 2011

English and Scientific name source: Fisheries diary 2012, Regional Fisheries Livelihoods Programme for South and Southeast Asia (RFLP)

* Unable to check due to insufficient information of scientific name of the species.

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17.3.2 Climate

The climate of Battambang Province is as described in Page 2-3 of Chapter 2. The types and volume of the available data are relatively limited. Thus, the influence of the recent Global Warming to the local climate cannot be analyzed.

17.3.3 Land Use

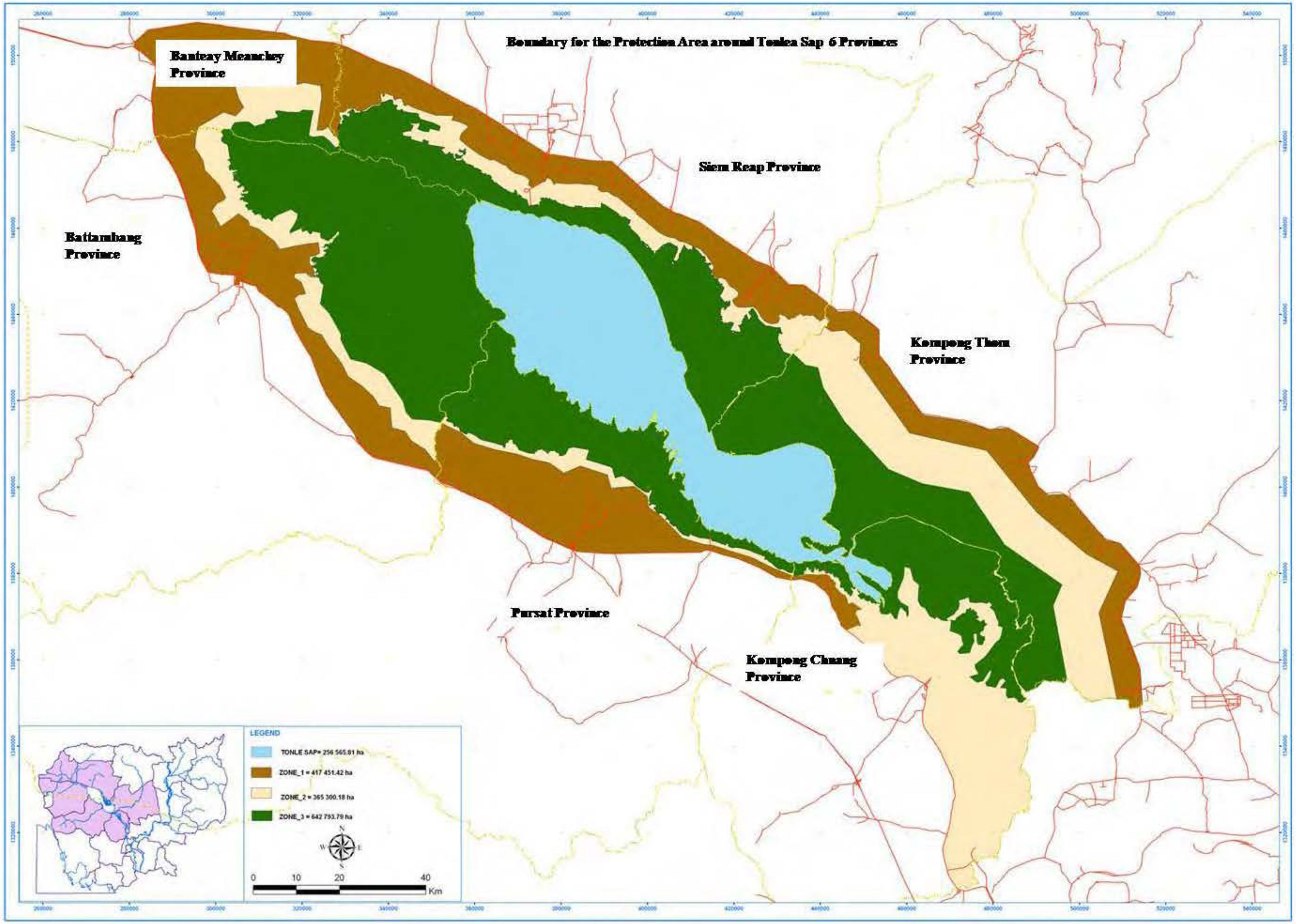
(1) Tonle Sap Multiple Management Use Area

Tonle Sap Multiple Use Management Area, 316,250 ha, is long standing ethological reserve. Great biological, hydrological and cultural diversity are observed with economic importance in the region. As classification of Protected Area in Cambodia, Tonle Sap is classified as “Multiple Use Management Area” which is the areas to provide for the sustainable use of water resources, timber, wildlife, fish, pasture and recreation with the conservation of nature primarily oriented to support these economic activities, as Category VI: Protected area managed mainly for the sustainable use of natural ecosystems as IUCN equivalent. This area allows economic activities in this region without disturbing ecosystem as sustainable use.

Also Tonle Sap Authority classified Tonle Sap Area as three land use classification as Figure 17.3-5 on its own accord.

Zone 1 (Brown) : Human habitation and irrigation activity are allowed.
Zone 2 (Beige) : No activity is allowed except irrigation activity.
Zone 3 (Green) : Strictly protected area.

NR 5 is attaching to Zone 1 in several areas, but not going into Zone 2 & 3.

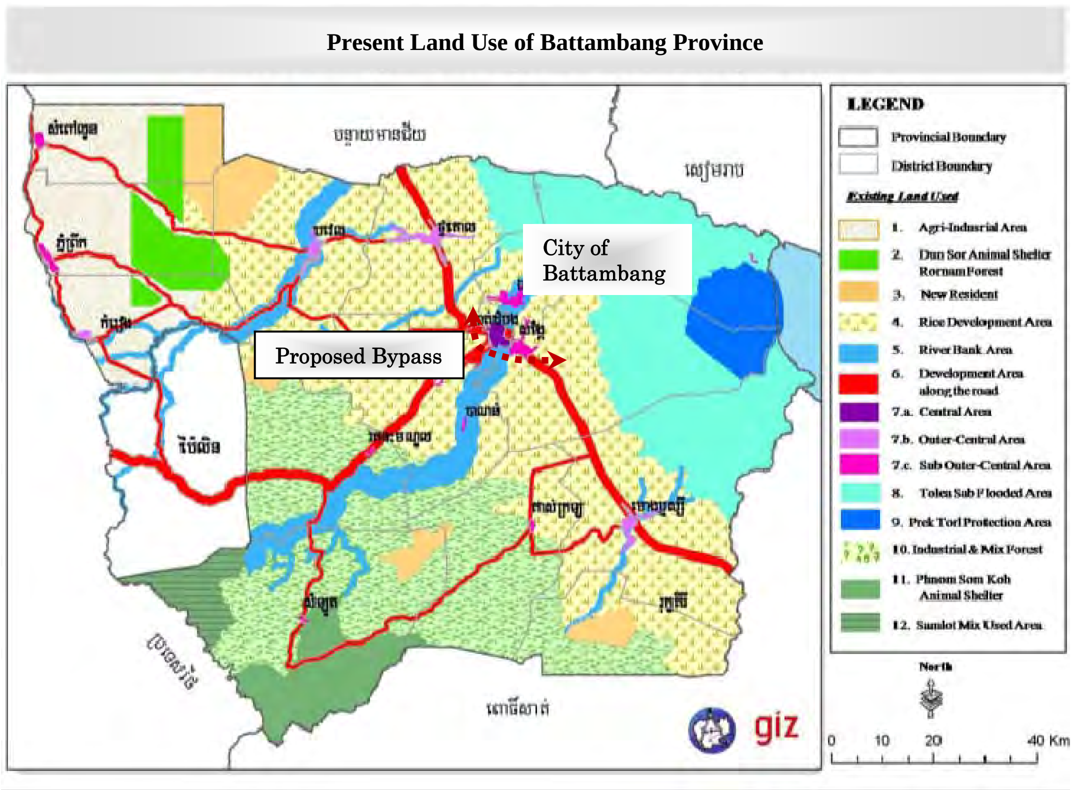


Source: Tonle Sap Authority

Figure 17.3-5 Land Use Classification of Tonle Sap Multiple Management Use Area

(2) Battambang Province

Battambang Province is situated in the north-western part of Cambodia about 300 km from Phnom Penh via NR 5. The Province borders on Banteay Meanchey Province, Siem Reap Province and Pursat Province. The western boundary is formed by the enclave of Pailin Province and the national borderline to the Kingdom of Thailand. At its eastern tip the province is connected to Tonle Sap Lake. Battambang Province takes up an area of about 11,803 km² comprising 13 districts, one municipality, 96 communes, and 741 villages[4]. 952,306 inhabitants were recorded in the Province in 2005[5].



Source: Dept. of Land Management, Urban Planning, Construction and Cadastre, Battambang Province, MLMUPC,
JICA Study Team

Figure 17.3-6 Present Land Use Plan of Battambang Province

City of Battambang as provincial city, about 115.44 km² as total area, is situated at the centre of Province. The average annual rate of population growth since 1998 is approximately 1.8%.

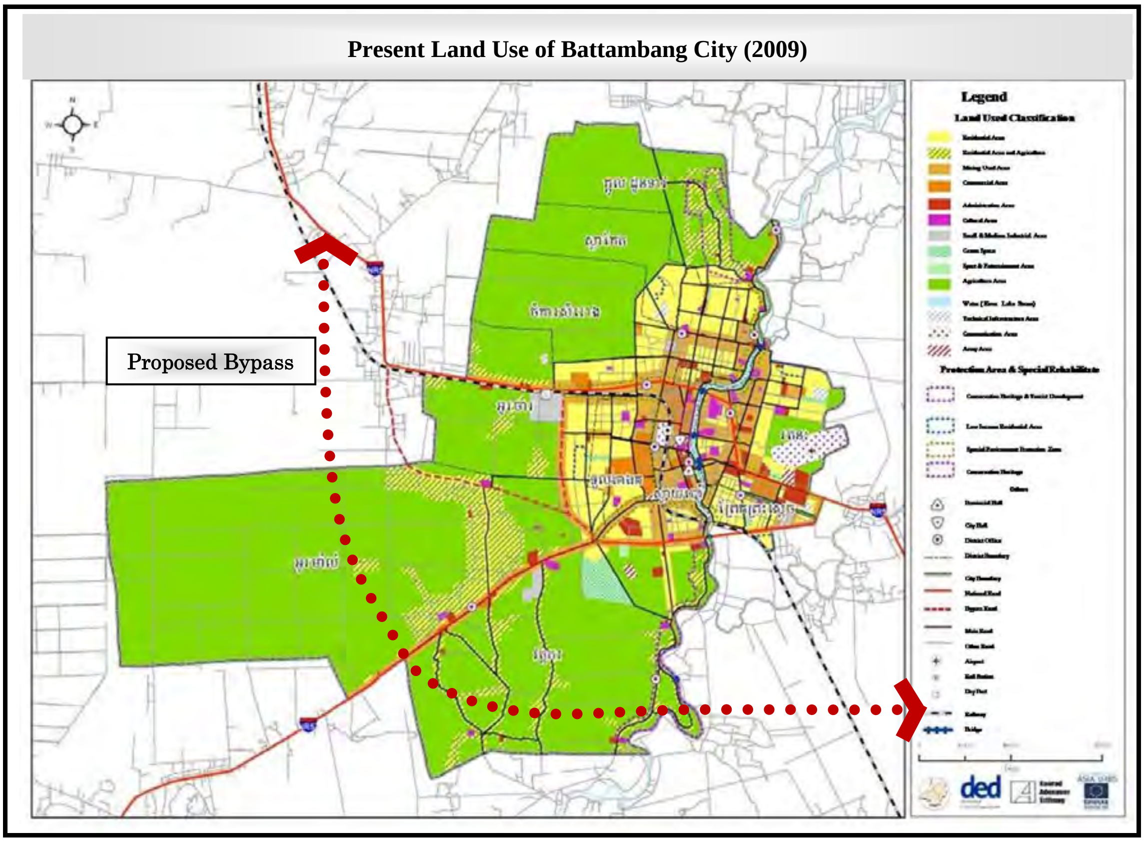
Approximately 74% of the total area of the City (85.5 km²) is agricultural area[6]. The

[4] Ministry of Interior, 2006
[5] Commune Database, Department of Planning Battambang Province
[6] Calculation based on GIS-mapping on the base of Orthophotos from 2005 and on Topographic Map 1:100,000 by the Department of Geography 1998

Municipality is comprised of 10 communes and 62 villages. Today classified as rural communes are: Kdol Doun Teav, O Mal and Wat Kor Communes. Classified as urban communes[7] are: Prek Preah Sdech, Svay Por, Tuol Ta Ek, Rattanak, O Char, Chamkar Somrong and Slaket.

NR 5 crosses through Battambang City from north-west to south-east, connecting to Sri Sophorn, Poipet in the north and to Pursat and Phnom Penh in the south. NR 57 meets NR 5 in the urban centre of Battambang City and connects Battambang in south-west direction to Pailin. The National railway line from Phnom Penh to Sri Sophorn crosses the City from south-east to north-west with a railway station in the urban centre of Battambang. Battambang airport is situated close to the urban centre, which, however, stopped service in 2003.

A distinguished feature of Battambang City is the Sangker River. Its origin is at the Krorvanh (Cardamon) Mountains; it further meanders through the south-western part of Battambang Province, flows from south to north through Battambang City, continuous further northeast though the province and eventually flows into Tonle Sap Lake.



Source: Dept. of Land Management, Urban Planning, Construction and Cadastre, Battambang Province, MLMUPC, JICA Study Team

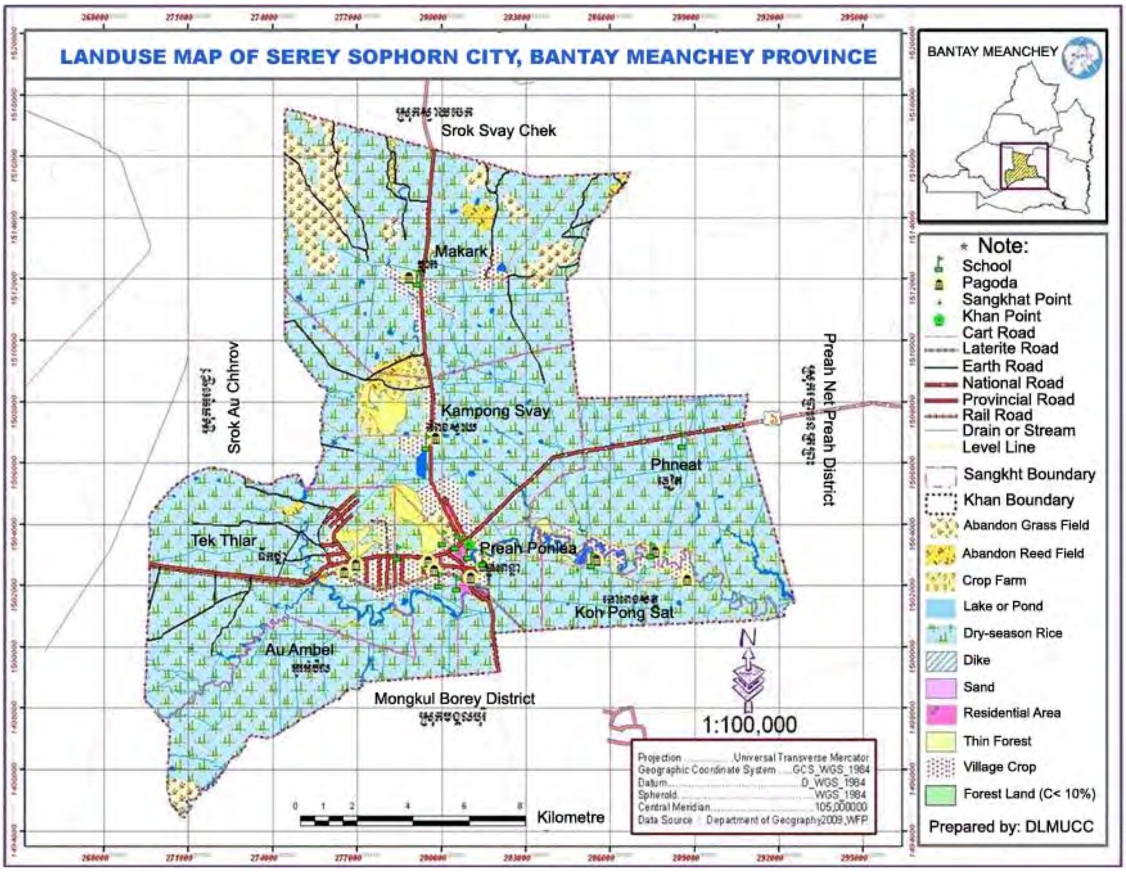
Figure 17.3-7 Present Land Use Plan of Battambang City

[7] Definition of "Urban": A Commune is defined as "urban " with the situation of;
i) Population density: > 200 people/km², .ii) Population of Commune: > 2,000, iii) Non- Agriculture as occupation: >51%. (Sub-Decree No.18, MLMUPC, January 2008, Dept. of Urban Planning, MLMUPC)

(3) Banteay Meanchey Province

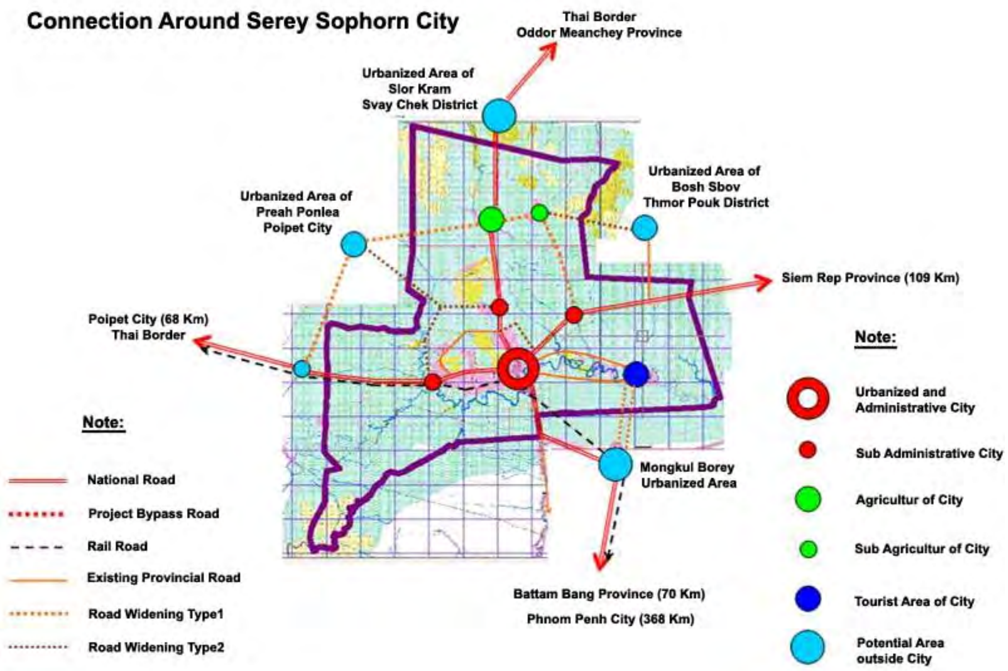
City of Sri Sophorn as provincial city, about 55,088 ha as the total area, is situated at the centre of Province. The total population is 95,110 in 2008 and the population growth since 2005 is approximately 4.8 %. 46.9% of the total land is agricultural land and 53% of the total number of family in City is engaged in agriculture. Mongkol Borei District has 26,097 ha as its total area situated south of Sri Sophorn. The total population is 166,926 in 2008 and the population growth since 2005 is approximately 12.6%. 84% of the total number of family is engaged in agriculture, though Agricultural land is 29.9% of the total land.

Sri Sophorn is the junction of NR 5 and NR 6 connecting Phnom Penh, Siem Reap and Thailand. In this context DMLUPCC in Bantay Meanchey Province has planned the development plan in 2025 based on the connection concept and spatial plan. The New Sri Sophorne Bypass will contribute to this future plan.



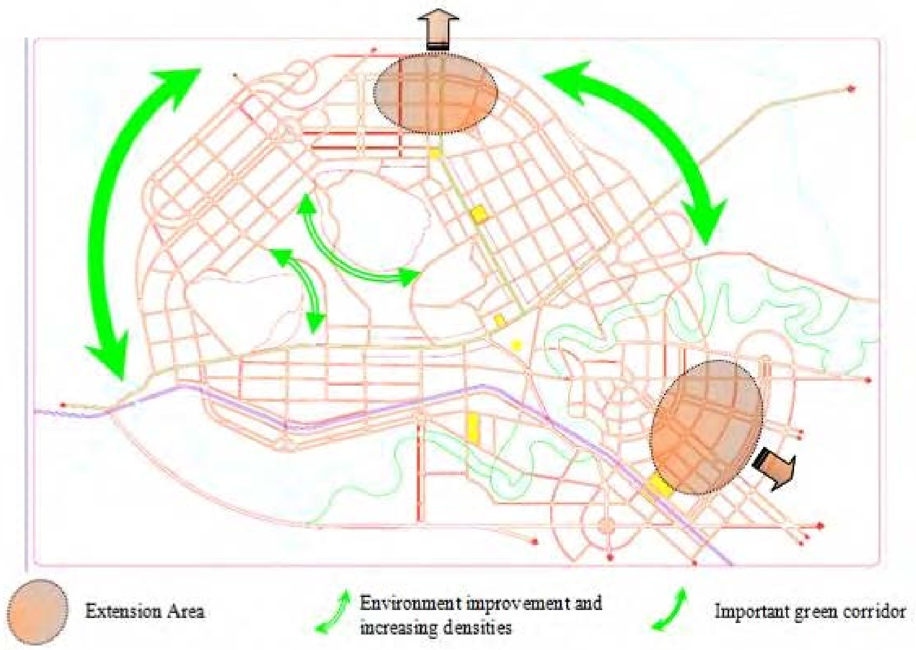
Source: Dept. of Land Management, Urban Planning, Construction and Cadastre, Bantay Meanchey Province, MLMUPC

Figure 17.3-8 Present Land Use of Sri Sophorn City, Bantay Meanchey Province



Source: Dept. of Land Management, Urban Planning, Construction and Cadastre, Bantay Meanchey Province, MLMUPC

Figure 17.3-9 Connection Concept Around Sri Sophorn City, Banteay Meanchey Province



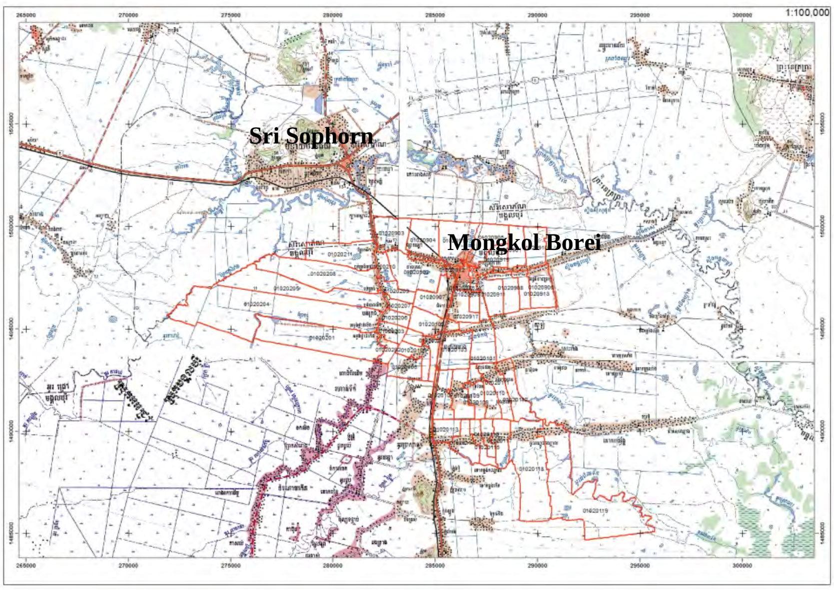
Source: Dept. of Land Management, Urban Planning, Construction and Cadastre, Bantay Meanchey Province, MLMUPC

Figure 17.3-10 Concept of Spatial Plan of Sri Sophorn City, Bantay Meanchey Province

Source: Dept. of Land Management, Urban Planning, Construction and Cadastre, Bantay Meanchey Province, MLMUPC

Figure 17.3-11 Development Plan of Sri Sophorn City (2025), Bantay Meanchey Province

In Bantay Meanchey Province the land titling project supported by DANIDA, DFID and NZAid is on-going. The area in where land registration has been completed is as shown in Figure 17.3-9.



Source: Dept. of Land Management, Urban Planning, Construction and Cadastre, Bantay Meanchey Province, MLMUPC

Figure 17.3-12 Area Where Land Registration has been Completed in Bantay Meanchey Province by the Land Title Project Assisted by DANIDA-DiID-NZAid

17.4 Categorization of the Project

Category A projects defined by JICA New Guidelines generally includes;

i) vital sectors, such as transportation,
ii) projects having sensitive characteristics, such as large-scale involuntary resettlement, or
iii) projects located in/ around sensitive areas.

Under this circumstance, this project is classified as a Category A project, since it belongs to the transportation sector and also expected large-scale involuntary resettlement in the target area, despite the length of the target area is less than 100km as stipulated in Sub-Decree on Environmental Impact Assessment Process (1999). Accordingly, the project will not need to proceed into the official procedure for EIA approval prescribed in Cambodian legislation. However it is recommended that MPWT, as the project proponent, follow the procedures in line with what are required for EIA in the relevant legislations, as much as possible, before implementation of the project.

17.5 Examination of Potential Environmental Impact and Scoping

To identify potential impacts on the environment during the pre-construction, construction and operation stages of the project, the environmental scoping list and matrixes has been formulated for the target section of NR 5 and selected Bypass plan. EIA has been conducted according these Items and Scoping.

17.5.1 Environmental Scoping

(1) Environmental Matrix

Environmental Matrices for Improvement of NR 5, construction of Battambang Bypass are given in Tables 17.5-1 and 17.5-2, respectively. Environmental Scoping Matrix of construction of Sri Sophorn Bypass is same to that of construction of Bttambang Bypass, and thus, readers are referred to Table 17.5-2.

Table 17.5-1 Environmental Scoping Matrix of Improvement of North Section of NR 5

		Item	Overall Rating	Negative Impact												Positive Impact						
				PS		CS					SS					CS			SS			
				Deterioration of Life due to Resettlement	Land Acquisition, vanishing of Buildings	Inflow of construction worker, setting up camp for work	Rehabilitation of Pavement	Movement of Construction Vehicles/ Machine	Setting up temporary facilities	Obstruction on traffic	Increment of Traffic Volume	Increment of travelling speed	Increment of population along the road	Increment of commercial establishment and economical activities	Increment of traffic accident	Inflow of construction worker, setting up camp for work	Rehabilitation of Pavement	Movement of Construction Vehicles/ Machine	Improvement of traffic congestion	Improvement of road structure and road surface	Shortening of travelling time	Enhancement of economic activities along the road and local economy (including the access to the market for transport agro-products)
Pollution	1	Air	**B+**			**B-**	**B-**	**B-**		**B-**	**B-**	**B-**	**B-**	**B-**					A+	D		
	2	Water	**C**			C	C	C	C				C	C								
	3	Soil Contamination	**D**			D	D	D	D				D	D	D							
	4	Waste	**B-**			**B-**	**B-**	D	**B-**		**B-**		**B-**	**B-**								
	5	Noise/Vibration	**B-**				**B-**	**B-**	**B-**	**B-**	**B-**	**B-**	D	D						B+		
	6	Subsidence	**C**				C						**B-**	**B-**								
	7	Malodor	**B-**				**B-**	**B-**	**B-**		**B-**	**B-**										
	8	Global warming	**B+**					**B-**		**B-**	**B-**	**B-**							A+	D		
Natural Environment	1	Topography	**B-**				**B-**		D													
	2	Sedimentation	**B-**				**B-**		**B-**													
	3	Ecosystem	**D**					D	D		D	D	D	D	D							
	4	Hydrology	**C**				C		D													
	5	Natural preserve	**D**			D	D	D	D				D	D								
Social Environment	1	Involuntary Resettlement	**A-**	**B-**	**A-**																	D
	2	Local Economy as Employment and livelihood	**A+**		D											A+	A+	A+	A+		A+	A+
	3	Land use and local resources	**B+**		D														B+		B+	B+
	4	Social structure such as Provincial government	**B-**		**B-**		**B-**				**B-**	**B-**							D		B+	D
	5	Existing Infrastructure	**A+**		D		**B-**	D	D	**B-**	**B-**	**B-**	**B-**						A+		A+	

		Item	Overall Rating	Negative Impact												Positive Impact						
				PS		CS					SS					CS			SS			
				Deterioration of Life due to Resettlement	Land Acquisition, vanishing of Buildings	Inflow of construction worker, setting up camp for work	Rehabilitation of Pavement	Movement of Construction Vehicles/ Machine	Setting up temporary facilities	Obstruction on traffic	Increment of Traffic Volume	Increment of travelling speed	Increment of population along the road	Increment of commercial establishment and economical activities	Increment of traffic accident	Inflow of construction worker, setting up camp for work	Rehabilitation of Pavement	Movement of Construction Vehicles/ Machine	Improvement of traffic congestion	Improvement of road structure and road surface	Shortening of travelling time	Enhancement of economic activities along the road and local economy (including the access to the market for transport agro-products)
	6	Poor, indigenous, minority people	**B+**	**B-**	**B-**					D					**B-**	D	B+	D	B+	D	D	D
	7	Uneven distribution of harm and benefit	**A-**	**A-**	**A-**																	
	8	Confrontation of stakeholders	**B-**											**B-**								
	9	Gender	**B+**	**B-**											**B-**						B+	B+
	10	Children's right	**B-**	**B-**						**B-**	**B-**	**B-**			**B-**						B+	
	11	Cultural heritage	**D**				D														D	
	12	Risks for infectious disease such as AIDS/HIV	**B-**			**B-**					**B-**		**B-**								B+	
	13	Landscape	**D**				D		D													
	14	Working environment	**B+**							**B-**	**B-**	**B-**				B+	A+				A+	A+
Other	1	Accident	**B-**	D			**B-**	**B-**	**B-**	**B-**	**B-**	**B-**			**B-**					A+		

Rating: A-: Big Negative Impact A+: Big Positive Impact C: Impacts are not clear, need more investigation.
B-: Certain Negative Impact B+: Certain Positive Impact D: No Impacts, or Impacts are negligible, no further study required.
B±: Nature of positive and negative impacts are different, or those who are subject to impacts are different.

Table 17.5-2 Environmental Scoping Matrix of Construction of Battambang Bypass

		Item	Overall Rating	Negative Impact										Positive Impact						
				PS		CS				SS				CS			SS			
				Deterioration of Life due to Resettlement	Land Acquisition, vanishing of Buildings	Inflow of construction worker, setting up camp for work	Construction of Bypass	Movement of Construction Vehicles/ Machine	Setting up temporary facilities	Traffic movement on the Bypass	Increment of population along the road	Increment of commercial establishment and economical activities	Increment of traffic accident	Inflow of construction worker, setting up camp for work	Construction of Bypass	Movement of Construction Vehicles/ Machine	Decrease number of through traffic into the city and intercity traffic	Decrease the traffic congestion and accidents in the city	Shortening of travel time	Enhancement of economic activities along the road and local economy (including the access to the market for transport agro-products)
Pollution	1	Air	B+			B-	B-	B-		A-	B-	B-					A+	A+		
	2	Water	C			C	C	C	C		C	C								
	3	Soil Contamination	D			D	D	D	D	D	D	D	D							
	4	Waste	B-			B-	B-	D	B-	B-	B-	B-								
	5	Noise/Vibration	B-			D	D	D	D	B-	D	D					B+			
	6	Subsidence	C				C				B-	B-								
	7	Malodor	B-				B-	B-	B-	B-	D	D					B+	B+		
	8	Global warming	B+			B-	B-	B-		A-							A+	A+		
Natural Environment	1	Topography	B-				B-													
	2	Sedimentation	B-				B-		B-											
	3	Ecosystem	B-				B-	D	D	B-	B-									
	4	Hydrology	C				C													
	5	Natural preserve	D				D	D	D		D	D								
Social Environment	1	Involuntary Resettlement	B-	B-	B-															
	2	Local Economy as Employment and livelihood	A+		D					B-				A+	A+	A+	B+		A+	A+
	3	Land use and local resources	A-		A-														B+	B+
	4	Social structure such as Provincial government	B-		B-		B-			B-							D		B+	D
	5	Existing Infrastructure	A+			D	D	D	D	D							A+	A+	A+	
	6	Poor, indigenous, minority people	B±	B-	B-								B-	B+	B+	D		D	D	D
	7	Uneven distribution of harm and	A-	B-	A-							B-								

		Item	Overall Rating	Negative Impact										Positive Impact						
				PS		CS				SS				CS			SS			
				Deterioration of Life due to Resettlement	Land Acquisition, vanishing of Buildings	Inflow of construction worker, setting up camp for work	Construction of Bypass	Movement of Construction Vehicles/ Machine	Setting up temporary facilities	Traffic movement on the Bypass	Increment of population along the road	Increment of commercial establishment and economical activities	Increment of traffic accident	Inflow of construction worker, setting up camp for work	Construction of Bypass	Movement of Construction Vehicles/ Machine	Decrease number of through traffic into the city and intercity traffic	Decrease the traffic congestion and accidents in the city	Shortening of travel time	Enhancement of economic activities along the road and local economy (including the access to the market for transport agro-products)
		benefit																		
	8	Confrontation of stakeholders	**B-**									**B-**								
	9	Gender	**B±**	**B-**															B+	B+
	10	Children's right	**B-**	D									**B-**					B+	B+	
	11	Cultural heritage	**D**				D												D	
	12	Risks for infectious disease such as AIDS/HIV	**B-**			**B-**				**B-**	**B-**								B+	
	13	Landscape	**D**				D	D	D											
	14	Working environment	**B+**			**B-**		**B-**											A+	A+
Other	1	Accident	**B-**	D			**B-**	**B-**	**B-**	**B-**			**B-**					A+		

Evaluation: A-: Big Negative Impact A+: Big Positive Impact
B-: Substantial Negative Impact B+: Substantial Positive Impact
C: Impacts are not clear, need more investigation
D: No Impacts or Impacts are negligible, no further study required

(2) Reason of Assessment

The reasons of assessment used in preparing the Environmental Matrices are presented in Tables 17.5-3 to 17.5-5.

Table 17.5-3 Reason of Assessment of National Road No. 5 North Section

(i) Large Impact Items

Item	Reason of Assessment
Social Environment	
Involuntary Resettlement & Land Acquisition	・Many houses/buildings and households relocation are required due to widening of National Road No. 5. ・Area within 30m from the centerline of NR 5 has been designated as the Row by Cambodian regulation. Thus, land required for the Project is already the government property.
Local economy such as employment and livelihood	・During construction stage, local economy will be enhanced because many local people will be employed as construction worker, as well as food, fuel and necessary goods consumed at the work site will be locally purchased. ・During service stage, economic activities will be promoted due to improvement of traffic and transportation conditions and more employment opportunities will be derived from shortening of travelling time.
Existing Infrastructure and Services	・There will be negative impact on the existing infrastructures including electric power line and telecommunication line which need to be relocated due to the widening of the road. ・On the other hand, positive impact is also expected because access to the site of such infrastructures will be improved. ・Also, access to public services such as hospital and school will also be improved. ・While the negative impacts occur only during construction and can be substantially mitigated by proper planning and implementation of relocation affected infrastructures, the positive impacts last for long period.
Uneven distribution of harm and benefit	・Under present Cambodian Law, provisions for (1) secure the payment to illegal settlers, (2) estimation for the compensation of resettlement, (3) assistance to the recovery of living are insufficient. Eventually unfairness may arise.

(ii) Substantial Impact Items

Item	Reason of Assessment
Pollution	
Air Pollution	・Emission from construction equipment, dust arisen by construction activities, air pollutant due to traffic congestion during construction stage is anticipated. ・Emission from traffic due to increment of vehicle during service stage is anticipated. ・On the other hand, total volume of air pollutant is expected to be reduced due to mitigated traffic congestion.
Waste	・Solid waste and polluted water are anticipated to be produced by construction activities. ・In service stage, rubbish thrown from the vehicle may be increased because traffic volume will increase.
Noise/Vibration	・Noise and Vibration arising from construction equipment/vehicle during construction stage is anticipated. ・Increase of noise and vibration during service stage is anticipated due to increase of traffic volume and travel speed of vehicles. ・On the other hand, noise and vibration may be improved due to smooth surface of road.
Malodor	・There is a possibility that malodor arises from the construction equipment, particularly asphalt mix plant, during construction. ・Malodor of exhaust gas produced by imperfect combustion of poorly maintained vehicle and exhaust gas from congested traffic are anticipated during service stage.
Global Warming	・CO_2 emission from construction equipment during construction stage is anticipated. ・On the other hand, in long term CO_2 is expected to be reduced since CO_2 emission per km will be reduced as traffic congestion will be mitigated. (See Appendix-1)
Natural Environment	
Topography/Geography	・Existing National Road No. 5 is of embankment structure in general. There will some alteration of topography as additional embankment will be constructed on the both sides, or one side, of existing road for widening of the road. ・There may be temporary changes in topography during construction stage as temporary construction facilities may be set up on a temporary embankment.
Sedimentation	・There is a possibility that filled soil will flow into the river due to heavy rain during construction stage and eventually sediment at the bottom of Tonle Sap Lake. However, impact of this is considered to be relatively small.

Item	Reason of Assessment
Social Environment	
Land use and local resources	・It is expected that transportation of rice which is principal local product of the region will be strengthened due to improved transportation condition, and geographical range of rice consumption will be expanded.
Community Organization including Organization for Local Governance	・There may be negative impact on community meeting and other community activities because of alteration of physical structure of the community (such as location of community center and relative position of houses) caused by land acquisition. ・Separation of community may occur due to the widened carriageway and increase of traffic volume which makes crossing the road from one side to the other makes difficult and hamper communication of the people. ・On the other hand, positive impact that communication between the regions is strengthened due to shortening of travel time is also expected.
Poor, Indigenous and Minority People	・There is a possibility that poor people may face disadvantage in the compensation for resettlement. ・On the other hand, job opportunities for poor people will be increase during construction such as employment as construction worker or open small businesses such as selling drinks and foods to construction workers. ・There are no indigenous or minority people known to be living near the Project road.
Conflict of interest within roadside communities	・There is a possibility that conflicts arise in the roadside communities as the benefit and harm derived from the road improvement may vary among the stakeholders.
Gender	・Effort to reflect the opinion of the female on the road design is encouraged . ・Increase of employment opportunity for female due to the shortening of commuting time and development of economic activities in the region and improvement of daily life such as shortening of time spent on going to/come back from market are also expected.
Children's Right	・Some children may face some difficulty going to school due to relocation of their houses. ・Children are the vulnerable to risk of traffic accident which is caused by the increase of traffic volume and vehicle speed. ・On the other hand, there are positive impacts such as improvement of traffic safety during going to, and coming back from, school due to separation of pedestrians and bicycles from higher speed traffic and shortening of travel time to/from school.
Risks for infectious disease such as AIDS/HIV	・Infectious disease may brought by migrant construction workers during construction stage. In service stage, long-distance truck drivers and other transport business people may bring infectious disease. ・On the other hand, access to large-scale hospitals will be improved resulting in improved opportunity for better treatment.
Working Environment	・Safety and sanitation, as well as third party accidents, during construction stage needs to be addressed. ・During construction, job opportunities for local workers will increase because there will be large demand for work force at construction site. ・In service stage, commuting time to/from work place will be shortened and fatigue during commutation will be eased owing to comfortable riding condition.
Accident	・Construction worker or third party may be involved in the accident during construction stage. ・Possibility of accidents may increase during servicing stage due to increased travel speed of vehicles.

(iii) Items that impacts are not clear, and further investigations are needed

Pollution	
Item	Reason of Assessment
Water	・Water quality may be worsened due to the development of surrounding area where commercial buildings and factories are constructed. ・Water qualities of 3 rivers near the proposed bridges are to be surveyed.
Land Subsidence	・There are soft ground areas along the proposed road. Subsidence is anticipated near the road caused by the weight of additional embankment which is added to the existing road for widening. Further study will be conducted in detailed design stage. ・In service stage, there is a possibility that development of local industries will cause increase in pumping up of ground water resulting in land subsidence. However it is difficult to measure impact of road improvement.
Hydrology	・During construction, water flow in the river or channel may be temporarily altered, however its duration is short and area is limited. Thus, the impact is anticipated to be small. Examination on the hydrology shall be conducted during detailed design stage because it is needed for design of road drainage facilities.

(iv) Items that no Impacts, or impacts are negligible, no further study required

Item	Reason of Assessment
Natural Environment	
Soil Contamination	・ There is a possibility that newly filled soil on the proposed widening of road may be eroded and flow into the nearby agricultural land. However, the area of impact is limited and recovery to original condition is possible by removing the eroded soil.
Ecosystem	・ Proposed area is basically agricultural land and towns, and no endangered species are found in the record. Impact on the ecosystem is supposed to be minimal, except short period during construction, because the project is widening of existing road.
Natural Reserve	・ No natural reserve exists near the Project road.
Social Environment	
Cultural Heritage	・ There is no known cultural heritage near the project road.
Landscape	・ Alteration of landscape is anticipated because additional embankment will be constructed on both side, or one side, of the existing embankment of National Road No. 5. However embankment height will be low and impact on the landscape will be limited. ・ Some alteration of landscape during construction due to setting up of construction facilities may be anticipated, but those are temporary and small area.

Table 17.5-4 Reason of Assessment of Battambang Bypass

(i) Large Impact Items

Item	Reason of Assessment
Social Environment	
Involuntary Resettlement & Land Acquisition	・ Approximately 340,000m2 of agricultural land and unused land is to be converted to the land for road. ・ Approximately 55 or less houses may be affected.
Local economy such as employment and livelihood	・ During construction stage, local economy will be enhanced because many local people will be employed as construction worker, as well as food, fuel and necessary goods consumed at the work site will be locally purchased. ・ During service stage, economic activities will be promoted due to improvement of traffic and transportation conditions and more employment opportunities will be derived from shortening of travelling time.
Land use and local resources	・ Bypass is to traverse agricultural land to avoid resettlement and considerable area of agricultural land will be lost. ・ On the other hand, access from south-western part of Battambang City to NR 5 will be improved and transportation of rice which is principal local product of the region will be strengthened, and geographical range of rice consumption will be expanded.
Existing infrastructure and services	・ Positive impact on the existing infrastructures such as power cable and telephone line is expected because access to the site shall be improved by construction of a new road. ・ Access to public services such as hospital and school is improved.
Uneven distribution of harm and benefit	・ Under present Cambodian Law, provisions for (1) secure the payment to illegal settlers, (2) estimation for the compensation of resettlement, (3) assistance to the recovery of living are insufficient. Eventually unfairness may arise. ・ Due to the change of traffic flow, the income of the shops which are operating along the existing National Road No. 5 (within the urbanized area of Battambang City) may be reduced while newly set up shops along newly constructed bypass will start business and make profit from that.

(ii) Substantial Impact Item

Item	Reason of Assess
Pollution	
Air pollution	・ Emission from construction equipments, dust arisen by construction activities, air pollutant due to traffic congestion during construction stage is anticipated. ・ Emission from traffic in the newly constructed bypass during service stage is anticipated, but emission will be reduced in the existing urban area because considerable portion of the traffic in the city will be diverted to the bypass. No substantial change in total emission from traffic is anticipated. ・ Development of local industrial and economic activities induced by the bypass may cause increase in emission of exhaust gases.
Waste	・ Solid waste and polluted water are anticipated to be produced by construction activities. ・ In service stage, it is anticipated that rubbish be thrown from the vehicle to the roadside where there has not been such phenomena.
Noise/Vibration	・ Noise and Vibration arising from construction equipment/vehicle during construction

Item	Reason of Assess
	stage is anticipated. ・ Increase of noise and vibration during service stage is anticipated along the newly constructed bypass. However, the bypass is remote from urbanized area and impact will be limited.
Malodor	・ There is a possibility that malodor arises from the construction equipment, particularly asphalt mix plant, during construction. Such malodor may be transported by wind and reach to the urbanized area although it will be diluted. ・ Malodor of exhaust gas produced by imperfect combustion of poorly maintained vehicle is anticipated during service stage. However, the bypass is remote from urbanized area and impact will be limited.
Global warming	・ CO2 emission from construction equipments during construction stage is anticipated. ・ New CO2 emission from the traffic on the bypass is anticipated. On the other hand, CO 2 existing urban area will be reduced. Thus, no substantial change in total emission is anticipated. ・ Development of local industrial and economic activities induced by the bypass may cause increase in emission of CO2.
Natural Environment	
Topography/Geography	・ Topography will be altered because new embankment is constructed in the flat agricultural land.
Sedimentation	・ There is a possibility that filled soil will flow to the river due to heavy rain during construction stage and eventually sediment at the bottom of Tonle Sap Lake cannot be denied. However, the Bypass is located upstream-side of National Road No. 5 and Battambang City and more than 50km away from Tonle Sap Lake. Thus, the impact should be minimal.
Ecosystem	・ There is a possibility that bypass may separate the activity area of wild animal. The area that the bypass traverses has been developed either as agricultural area or residential area, and existence of endangered species has not been reported. ・ Bypass is located upstream-side of National Road No. 5 and Battambang City and more than 50Km away from Tonle Sap Lake. Thus, the impact should be minimal.
Social Environment	
Involuntary Resettlement	・ Approximately 55 or less houses may be affected.
Community organization including organization for local governance	・ There will be negative impact that community structure may change due to the separation by the newly constructed bypass. ・ On the other hand, positive impact that communication between the regions is strengthened due to shortening of travel time is also expected.
・ Poor, Indigenous and Minority People	・ There is a possibility that poor people may face disadvantage for the compensation of resettlement. ・ During construction, there will be substantial demand for construction workers. Also, some people can operate small business such as selling drinks and foods to construction workers. ・ In service stage, increase of income of the poor is expected caused by increase of job/business opportunity due to shortening of travelling time. ・ Minority people are not living in the proposed area.
・ Conflict of interest within roadside communities	・ There is a possibility that conflicts arise in the roadside communities as the benefit and harm derived from the road improvement may vary among the stakeholders.
Gender	・ At the planning stage, opinion of the female shall be reflected on the road design. ・ Positive impact that employment opportunity for female increase due to the shortening of travelling time and development of local economy in the region is generally expected.
Children’s Right	・ Some children may face some difficulty going to school due to relocation of their houses. ・ Children are the vulnerable to risk of traffic accident which is caused by the traffic on the bypass. ・ On the other hand, there is positive impact that risk of traffic accident in the existing urban area is reduced owing to the reduction of traffic volume.
Risks for infectious disease such as HIV/AIDS	・ Infectious disease may brought by migrant construction workers during construction stage. In service stage, long-distance truck drivers and other transport business people may bring infectious disease. ・ On the other hand, access to large-scale hospitals will be improved resulting in improved opportunity for better treatment.
Working Environment	・ Safety and sanitation, as well as third party accidents, during construction stage needs to be addressed. ・ During construction, job opportunities for local workers will increase because there will be large demand for work force at construction site. ・ In service stage, commuting time to/from work place will be shortened and fatigue during commutation will be eased owing to comfortable riding condition.

Item	Reason of Assess
Accident	・ Construction worker or third party may be involved in the accident during construction stage. ・ Numbers of traffic accidents in the urban area is expected to decrease while there will be new cases of traffic accidents on the bypass in the service stage.

(iii) Items that impacts are not clear, need more investigation

Item	Reason of Assessment
Pollution	
Water	・ Water quality may be worsened due to the development of surrounding area where commercial buildings and factories are constructed. ・ Water quality of the river located at the proposed bypass will be surveyed.
Land Subsidence	・ There are soft ground areas along the proposed bypass. Land subsidence is anticipated near the road caused by the weight of additional embankment which is added to the existing road for widening. Further study will be conducted in detailed design stage. ・ In service stage, there is a possibility that development of local industries will cause increase in pumping up of ground water resulting in land subsidence. However it is difficult to measure impact of road improvement.
Hydrology	・ Impact on the surface water flow may be anticipated because a new embankment is constructed in the flat agricultural land. ・ However, hydrology in the area surrounding of the bypass will be studied and drain facilities will be planned/designed in the detail design stage so that the influence of bypass construction will be minimal.

(iv) Items that no Impacts, or impacts are negligible, no further study required

Item	Reason of Assessment
Pollution	
Soil Contamination	・ There is a possibility that newly filled soil on the proposed bypass may be eroded and flow into the nearby agricultural land. However, the area of impact is limited and recovery to original condition is possible by removing the eroded soil.
Natural Environment	
Natural Reserve	・ No natural reserve exists near the proposed bypass.
Social Environment	
Cultural Heritage	・ No cultural heritage has been known near the proposed bypass.
Landscape	・ Alteration of landscape is anticipated because embankment will be constructed in the flat agricultural land. However filling height shall be low and the impact on the landscape will be limited.

Table 17.5-5 Reason of Assessment of Sri Sophorn Bypass

(i) Items of Large Impact

Item	Reason of Assessment
Social Environment	
Involuntary Resettlement & Land Acquisition	・ Approximately 190,000m2 of agricultural land and unused land is to be converted to the land for road. ・ Approximately 55 or less houses may be affected.
Local economy such as employment and livelihood	・ During construction stage, local economy will be enhanced because many local people will be employed as construction worker and provision for food, fuel and necessary goods shall be purchased at the work site. ・ During servicing stage, economic activities will be enhanced due to improvement of traffic and transportation condition and more employment opportunities derived from shortening of travelling time.
Land use and local resources	・ Bypass is to traverse agricultural land to avoid resettlement and considerable area of agricultural land will be lost. ・ On the other hand, access from south-western part of Sri Sophorn City to NR 5 will be improved and transportation of rice which is principal local product of the region will be strengthened, and geographical range of rice consumption will be expanded.
Existing Infrastructure and Services	・ Positive impact on the existing infrastructures such as power cable and telephone line is expected because access to the site shall be improved by construction of a new road. ・ Access to public services such as hospital and school is improved.
Uneven distribution of harm and benefit	・ Under present Cambodian Law, (1) Secure the payment to illegal settlers, (2)Estimation for the compensation of resettlement, (3) Assistance to the recovery of living are provided insufficiently, eventually unfairness may be arisen. ・ Due to the change of traffic flow, the income of the shops which are operating along the existing National Road No. 5 (within the city of Sri Sophorn) may be reduced, but newly set

Item	Reason of Assessment
	up shops along newly constructed Bypass shall start business and make profit from that.

(ii) Item of Substantial Impact

Item	Reason of Assessment
Pollution	
Air	· Emission from construction equipments, dust arisen by construction activities, air pollutant due to traffic congestion during construction stage is anticipated. · Emission from traffic in the newly constructed bypass during service stage is anticipated, but emission will be reduced in the existing urban area because considerable portion of the traffic in the city will be diverted to the bypass. No substantial change in total emission from traffic is anticipated. · Development of local industrial and economic activities induced by the bypass may cause increase in emission of exhaust gases.
Waste	· Solid waste and polluted water are anticipated to be produced by construction activities. · In service stage, it is anticipated that rubbish be thrown from the vehicle to the roadside where there has not been such phenomena.
Noise/Vibration	· Noise and Vibration arising from construction equipment/vehicle during construction stage is anticipated. · Increase of noise and vibration during service stage is anticipated along the newly constructed bypass. However, the bypass is remote from urbanized area and impact will be limited.
Malodor	· There is a possibility that malodor arises from the construction equipment, particularly asphalt mix plant, during construction. Such malodor may be transported by wind and reach to the urbanized area although it will be diluted. · Malodor of exhaust gas produced by imperfect combustion of poorly maintained vehicle is anticipated during service stage. However, the bypass is remote from urbanized area and impact will be limited.
Global warming	· CO_2 emission from construction equipments during construction stage is anticipated. · New CO_2 emission from the traffic on the bypass is anticipated. On the other hand, CO_2 existing urban area will be reduced. Thus, no substantial change in total emission is anticipated. · Development of local industrial and economic activities induced by the bypass may cause increase in emission of CO_2.
Natural Environment	
Topography/Geography	· Topography will be altered because new embankment is constructed in the flat agricultural land.
Sedimentation	· There is a possibility that filled soil will flow to the river due to heavy rain during construction stage and eventually sediment at the bottom of Tonle Sap Lake. However, the Bypass is located upstream-side of National Road No. 5 and Sri Sophorn City and more than 80km away from Tonle Sap Lake. Thus, the impact should be minimal.
Ecosystem	· There is a possibility that bypass may separate the activity area of wild animal. The area that the bypass traverses has been developed either as agricultural area or residential area, and existence of endangered species has not been reported. · Bypass is located upstream-side of National Road No. 5 and Sri Sophorn City and more than 80Km away from Tonle Sap Lake. Thus, the impact should be minimal.
Social Environment	
Involuntary Resettlement	· About 5 houses may be affected.
Community organization including organization for local governance	· There will be negative impact that community structure may change due to the separation by the newly constructed bypass. · On the other hand, positive impact that communication between the regions is strengthened due to shortening of travel time is also expected.
Poor, Indigenous and Minority People	· There is a possibility that poor people may face disadvantage for the compensation of resettlement. · During construction, there will be substantial demand for construction workers. Also, some people can operate small business such as selling drinks and foods to construction workers. · In service stage, increase of income of the poor is expected caused by increase of job/business opportunity due to shortening of travelling time. · Minority people are not living in the proposed area.
Conflict of interest within roadside communities	· There is a possibility that conflicts arise in the roadside communities as the benefit and harm derived from the road improvement may vary among the stakeholders.
Gender	· At the planning stage, opinion of the female shall be reflected on the road design. · Positive impact that employment opportunity for female increase due to the shortening of travelling time and development of local economy in the region is generally expected. · Generally impact shall be limited or considered as setoff between negative and positive items.

Item	Reason of Assessment
Children's Right	· Some children may face some difficulty going to school due to relocation of their houses. · Children are the vulnerable to risk of traffic accident which is caused by the traffic on the bypass. · On the other hand, there is positive impact that risk of traffic accident in the existing urban area is reduced owing to the reduction of traffic volume.
Risks for infectious disease such as AIDS/HIV	· Infectious disease may brought by migrant construction workers during construction stage. In service stage, long-distance truck drivers and other transport business people may bring infectious disease. · On the other hand, access to large-scale hospitals will be improved resulting in improved opportunity for better treatment.
Working Environment	· Safety and sanitation, as well as third party accidents, during construction stage needs to be addressed. · During construction, job opportunities for local workers will increase because there will be large demand for work force at construction site. · In service stage, commuting time to/from work place will be shortened and fatigue during commutation will be eased owing to comfortable riding condition.
Accident	· Construction worker or third party may be involved in the accident during construction. · Numbers of traffic accidents in the urban area is expected to decrease while there will be new cases of traffic accidents on the bypass in the service stage.

(iii) Items that impacts are not clear, need more investigation

Item	Reason of Assessment
Pollution	
Water	· Water quality may be worsened due to the development of surrounding area where commercial buildings and factories are constructed. · Water quality of the river located at the proposed bypass will be surveyed.
Subsidence	· There are soft ground areas along the proposed Bypass. Subsidence near the road is anticipated due to the soil weight which is filled on the rice field generally. Further investigation for subsidence is required in detailed design stage. · Subsidence due to the pumping up ground water derive from enhanced economic activities along the road is anticipated. However it is difficult to examine the cause by the construction of the bypass.
Hydrology	· Impact on the surface water flow may be anticipated because a new embankment is constructed in the flat agricultural land. · Hydrology in the area surrounding of the bypass will be studied and drain facilities will be planned/designed in the detail design stage so that the influence of bypass construction will be minimal.

(iv) Items that no Impacts, or impacts are negligible, no further study required

Item	Reason of Assessment
Natural Environment	
Soil Contamination	· There is a possibility that newly filled soil on the proposed bypass may be eroded and flow into the nearby agricultural land. However area soil eroded may be limited and recovery to original condition is possible after removing the eroded soil.
Social Environment	
Cultural Heritage	· No cultural heritage near proposed bypass.
Landscape	· Alteration of landscape is anticipated because embankment will be constructed in the flat agricultural land. However filling height shall be low and the impact on the landscape will be limited.

17.5.2 Present Condition of Air Quality, Water Quality, Noise and Vibration

Current condition of air quality, water quality, noise and vibration was surveyed to be used as the base line data for future monitoring, as well as to examine if there exist any critical problems.

(1) Air Quality

Current air quality was surveyed at three points along the Project road. At each survey point, Samples of air quality were taken at two locations, one at roadside and another 200 m away from the road. Sampling at the locations 200 m away from the road was to know the background concentration of the survey point.

Table 17.5-6 Points of Air Quality Survey

Location No.	Location	Reason of Selecting Survey Point
AQ-1	Middle point between Sri Sophorn City and Mongkol Borei (KP 356)	To know the current air condition near, but not within, the city of Sri Sophorn where air quality is relatively poor compared to other points on the North Section.
AQ-2	Boundary of urbanized area of Battambang City (KP 300)	To know the current air condition near, but not within, the city of Battambang where air quality is relatively poor compared to other points on the North Section.
AQ-3	Intersection of Battambang Bypass and NR 57	To be used as the baseline data to be compared after opening of the bypass.

Factors of air quality that were surveyed are Nitrogen Dioxide (NO_2), Sulfur Dioxide (SO_2) and Suspended Particular Matter (SPM). The data obtained are shown in Table 17.5-7, together with Cambodian environmental standards.

Table 17.5-7 Surveyed Air Quality

No.	Location & Date	Ambient Air Pollutants Concentration (mg/m^3)			
		SPM10**	SPM2.5**	NO_2	SO_2
1	BMCH* KP 356, Road Site (August 06, 2011)	0.061	0.024	0.006	0.004
2	BMCH KP 356, 200 m away from Road Site (August 13, 2011)	0.027	0.014	0.004	0.003
3	BB KP 300, Road Site (August 07, 2011)	0.065	0.031	0.007	0.005
4	BB KP 300, 200 m away from Road Site (August 12, 2011)	0.038	0.26	0.005	0.003
5	BB Bypass intersection with NR 57, Road Side (August 08, 2011)	0.021	0.011	0.011	0.005
6	BB Bypass intersection with NR 57, 200 m away from Roadside (August 11, 2011)	0.013	0.008	0.005	0.003
7	Duration (Hour)	24	24	24	24
8	Method/Equipment	High volume sampler	Low volume sampler	Saltzman method	Pararosaniline Method
9	Standard of Ministry of Environment	0.33*** (24 hr)	0.33*** (24 hr)	0.1 (24 hr)	0.3 (24 hr)

* BMCH: Banteay Meanchey; BB: Battambang

** SPM10: Suspended particular matter of 10 microns or smaller; SPM 2.5: Suspended particular matter of 2.5 microns or smaller

*** The Cambodian Environmental Standards stipulates concentration of Total Suspended Particles (STP). SPM10 and SPM2.5 were measured because equipment for measurement of TSP is not available in Cambodia.

As can be seen in the above table, current concentrations of NO_2 and SO_2 are considerably lower than the values of Cambodian Standard while that of SPM measured at Point 5 is higher than that of Cambodian Standard.

(2) Water Quality

Samples for measurement of water quality were taken from three rivers which are flowing into Tonle Sap Lake and crossed by NR 5 or the bypasses. Samples were taken near the crossing point with the road and 2 km downstream. Figure 17.5-1 shows the locations of sampling of water.

Items of water quality analysis were pH, Total Suspended Solid (TSS), BOD and COD. Table 17.5-8 shows the result of analysis:

Table 17.5-8 Result of Water Quality Analysis

No.	Location	Date of Sampling	pH (-)	TSS/SS (mg/l)	BOD (mg/l)	COD (mg/l)
1	Battambang (KP 305), O Ta Ke Stream	08 August 2011	7.59	94	0,85	2.48
2	Battambang (KP 305), O Ta Ke Stream 2Km away from NR 5	08 August 2011	7.32	86	1,00	3.19
3	Battambang Bypass, Stung Sangke River	09 August 2011	7.97	120	0,40	1.87
4	BB Bypass, Stung Sangke River 2Km away from propose bypass	09 August 2011	7.91	96	0,60	2.04
5	Near Sri Sophorn (KP 358) Serey Sri Sophorn River	08 August 2011	7.96	46	2,05	4.62
6	NR 5 near Sri Sophorn (KP 358) 2Km away from NR 5	08 August 2011	7.53	42	1,73	3.97
7	Method/Equipment	-	ph-EC & TDS meter	Method 2540 D	Method 5210 B	JIS K
8	Standard of Ministry of Environment (Water quality standard along public water for aquatics biodiversity conservation)	-	6.5-8.5	25-100	1.00-10 .0	-

As can be seen in the above table, current values of pH and BOD are within the ranges of Cambodian Standard, while value of TSS is much higher than that of Cambodian Standard.

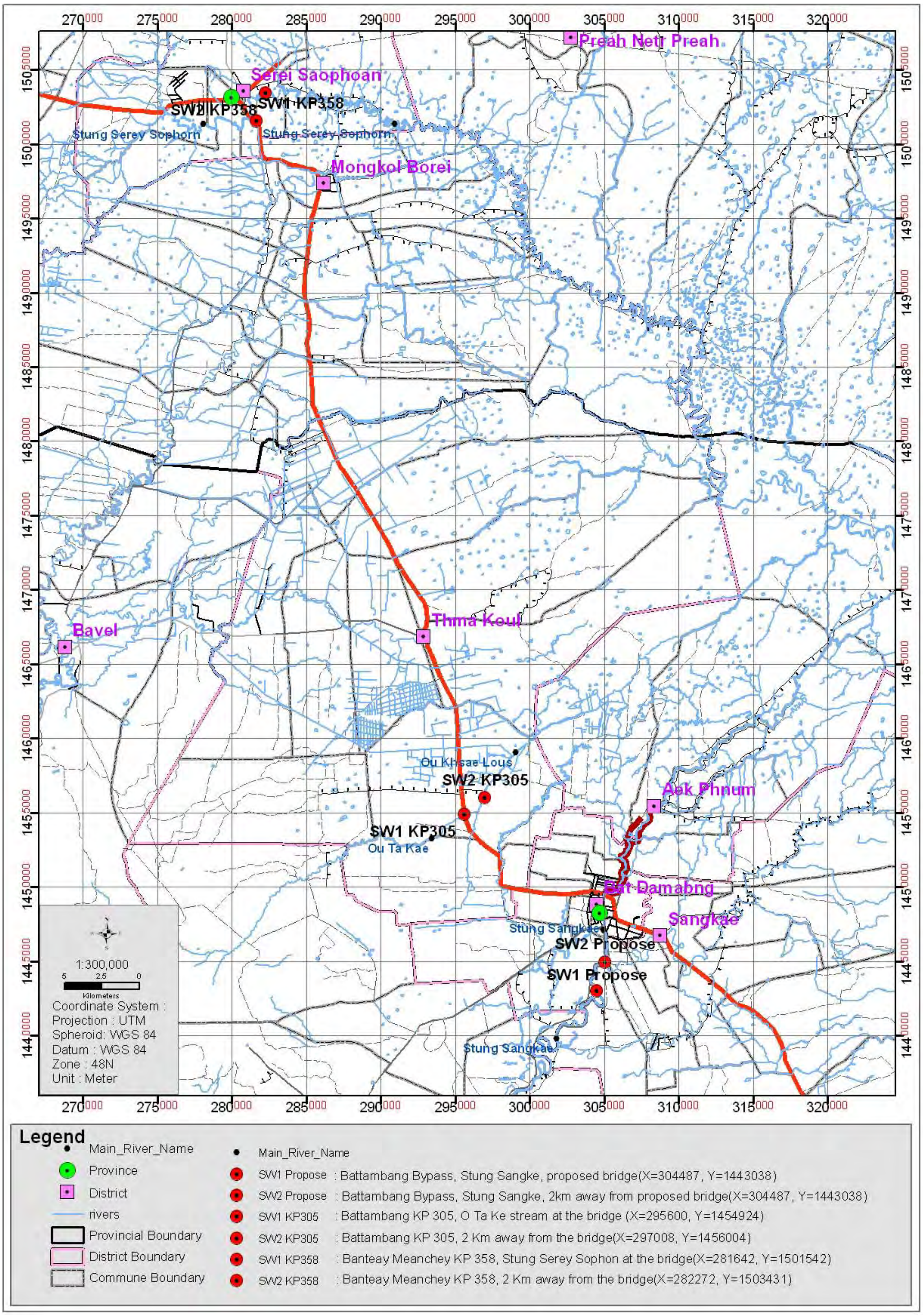


Figure 17.5-1 Location of Sampling of Water

(3) Noise and Vibration

Noise and vibration under current situation were measured at three points which are same to those for measurement of air quality (KP 356, KP 300 and intersection of Battambang Bypass and NR 57). At each point, noise and vibration were measured at the roadside (boundary of ROW: approximately 6 m from the centerline of the road). Figures 17.5-2 to 17.5-7 shows the measured level of noise and vibration. The Cambodian Standards for noise are shown in Table 17.5-9. (Table 17.5-9 is identical with afore-mentioned Table 17.2-4.)

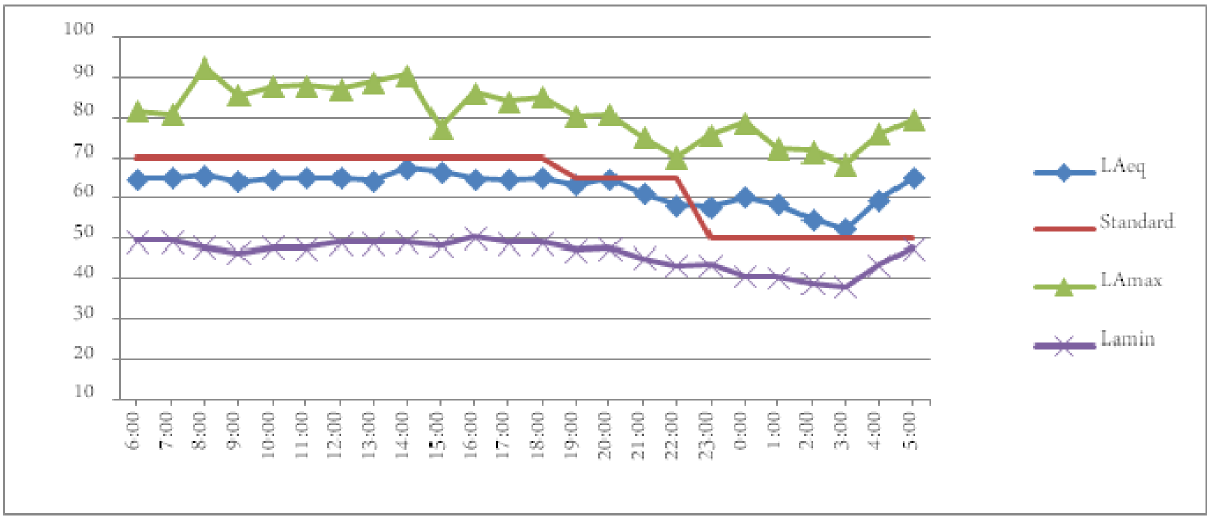


Figure 17.5-2 Noise Level at KP 356 (Roadside)

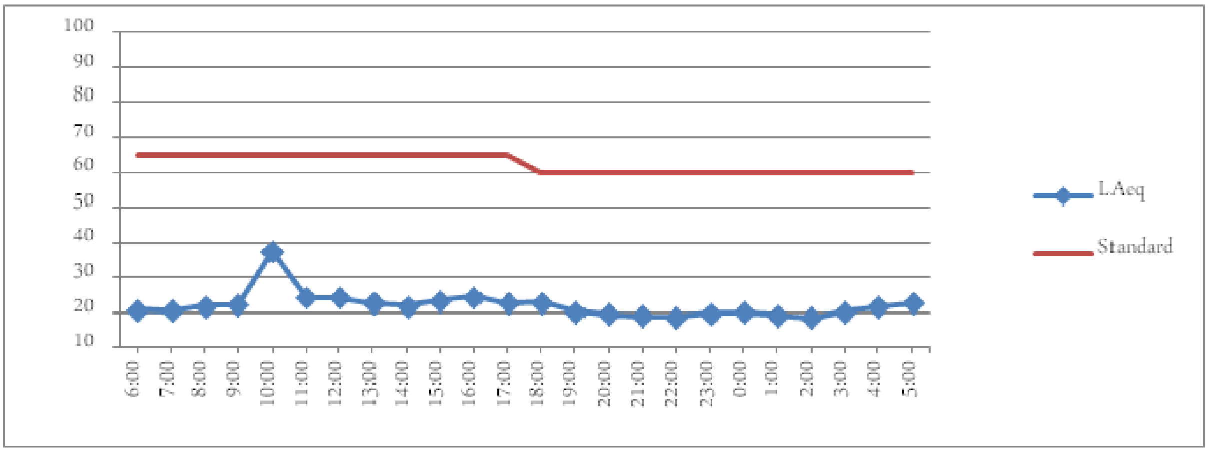


Figure 17.5-3 Vibration Level at KP 356

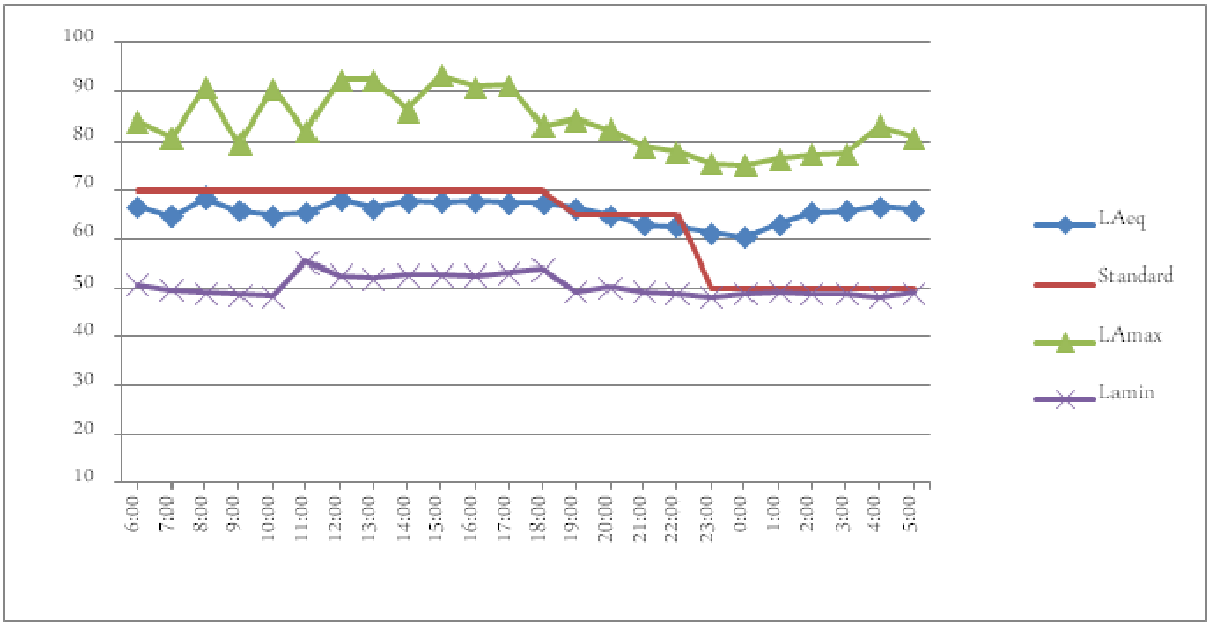


Figure 17.5-4 Noise Level at KP 300 (Roadside)

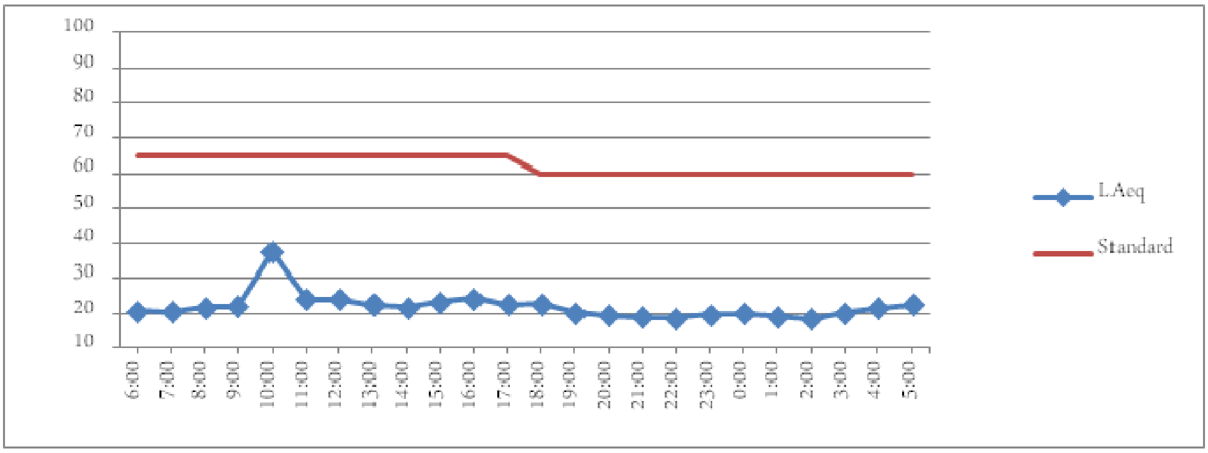


Figure 17.5-5 Vibration Level at KP 300 (Roadside)

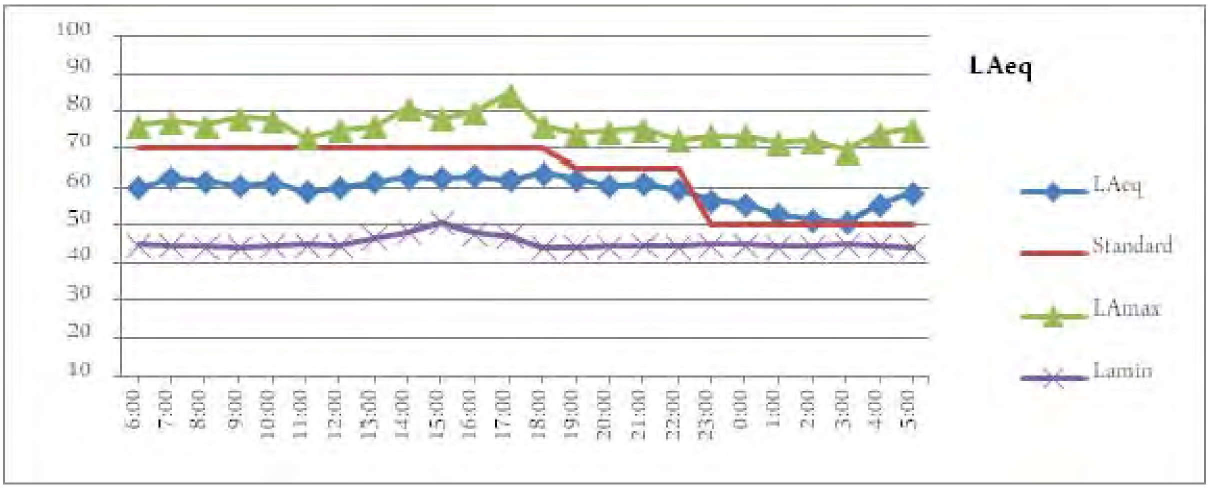


Figure 17.5-6 Noise Level at Future Intersection of Battambang Bypass and NR 57 (Roadside)

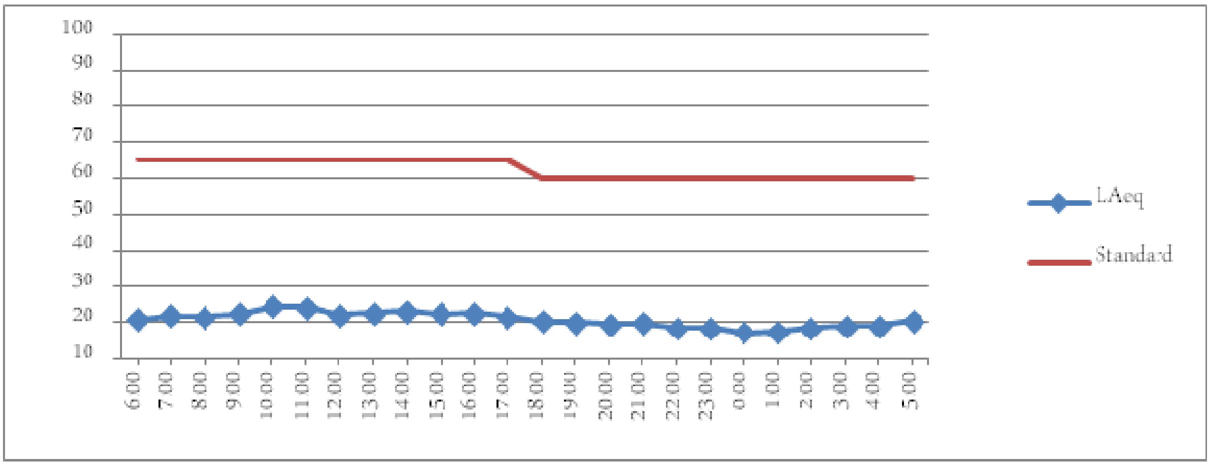


Figure 17.5-7 Vibration Level at Future Intersection of Battambang Bypass & NR 57 (Roadside)

Table 17.5-9 Cambodian Standard for Noise Level

No.	Area	Period of time		
		From 6:00 to 18:00	From 18:00 to 22:00	From 2:00 to 6:00
1	Quiet areas - Hospitals - Libraries - School - Kindergarten	45	40	35
2	Residential area: - Hotels - Administration offices - House	60	50	45
3	Commercial and service areas and mix	70	65	50
4	Small industrial factories intermingling in residential areas	75	70	50

As can be seen in the above figures, noise level at three locations are within Cambodian Standard during daytime and evening and exceeds Cambodian Standard during midnight. Relatively high noise level during midnight may be attributed to sources other than traffic, such as noise of nearby generator and Karaoke. However, the magnitudes of such noise sources are not known.

17.5.3 Estimation of Impact of Road Improvement

Impact of the improvement of NR 5 on the living environment (noise and gas emitted by traffic) is estimated to know whether or not the impact is critical. Since there are no established method for estimating noise and emission gas in Cambodia, the methods widely used in Japan are adopted.

- So-called ‘Plume Model’ and ‘Puff Model’ are used for calculation of dispersion/dilution of emission gases.
- The model proposed by Japan Society of Acoustics is used for calculation of noise.

These models are adjusted using the measured data of current situation as presented in Subsection 17.5.2 above. However, the adjusted model shows some deviations from the actually measured data depending on the time zone. Thus, this adjustment cannot eliminate all the discrepancies between the measured data and calculated values. In addition, the data as listed below, which are indispensable for the above models, are not available in Cambodia.

- Data of wind (average wind speed and prevailing wind direction at the site): used in calculation of dilution of emission gas.
- Data on amount of gas (NO2, SO2, etc.) emitted by one vehicle by type of vehicle (large vehicle, passenger car, motorcycle, etc.)
- Data on level of noise emitted by ne vehicle by type of vehicle (large vehicle, passenger car, motorcycle, etc.)

Thus, the estimation needs to be made based on arbitrary assumptions for these factors. The assumptions adopted in the estimation, as well as details of the models used are presented in Appendix 17-1. Basic conditions of estimation of noise level and concentration of emission gases are as follows:

- Both noise level and concentration of emission gases are estimated at KP 300 (in the north of Battambang City)
- Both noise level and concentration of emission gases at 20 m from the center line of the road are calculated.
- Traffic volumes as shown in the table below are used:

Year	**Year 2021**		
Vehicle Type	MC	LV	HV
Traffic Volume	24,647	6,492	1,527

(1) Noise Level

The results of estimation of noise are as shown in Table

Table 17.5-10 Estimated Noise Level

Time Zone	Estimated Noise Level (LAeq; dB)	Cambodian Standard (Commercial, Service & Mixed Area)
6:00 – 18:00	67.7	70
18:00 – 22:00	66.2	65
22:00 – 6:00	64.9	50

It should be noted that these noise levels are calculated at 20m from the centerline of the road (future boundary of ROW) while the current noise level was measured at approximately 6m from the centerline (current boundary of ROW). Thus, increase from the current noise level as described in Subsection 17.5.2 is relatively small.

(2) Emission Gas

Table 17.5-11 Estimated Concentration of Emission Gases (Unit: mg/m3: PPM)

Pollutant	Background	Emission Gas From NR 5	Total	Cambodian Standard
NO_2	0.005	0.00117	0.00617	0.1
SPM	0.300	0.00022*	(0.30022)*	0.33
SO_2	0.003	0.00038	0.00338	0.3

*The accuracy of the measured background concentration is to the order of 1/100 PPM. Thus, the estimated emission from NR 5 is negligibly small.

While the estimated levels of concentration of NO_2 and SO_2 are well below the Cambodian Standard, the estimated level of concentration of SPM is much higher than Cambodian Standard. The high level of concentration of SPM is attributed to the background concentration which has been actually measured. The cause of high concentration of SPM has not confirmed in this survey. However, in case of the air quality survey conducted for ‘The Study on the Transport Master Plan in the Phnom Penh Metropolitan Area in the Kingdom of Cambodia’ (JICA study; 2001), the color of filter paper was yellowish brown and it was suspected that the main composition of SPM was soil dust.

17.6 Alternative Analysis

(1) North Section of NR 5

For the improvement of the North Section of NR 5, three alternatives of cross section were studied as described in Section 10.2. Table 17.6-1 shows the alternatives cross section and Table 17.6-2 compares advantages and disadvantages of these alternatives.

Table 17.6-1 Description of Alternatives (Existing NR 5)

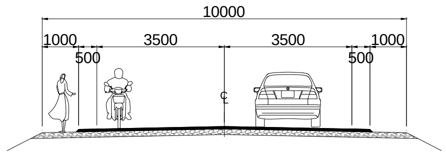
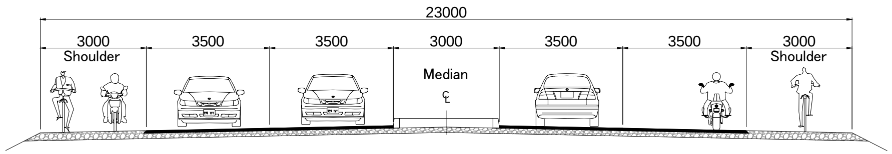
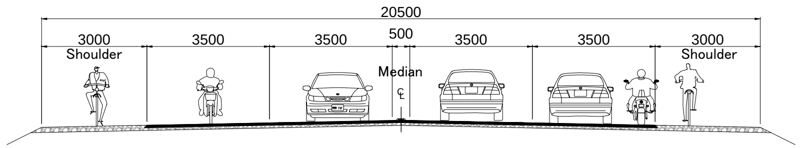
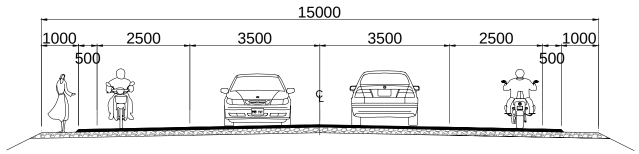
Alternative	Description	Conceptual Drawing of Cross Section
R-0: Zero-Option	Existing condition is maintained: Nothing is done.	
R-1: 4 Lane + 3 m Median + 3m Shoulder	Secure sufficient traffic capacity to accommodate the traffic volume in the future with safety. Slow traffic and high-speed traffic are separated. Separation of traffic in opposed traffic is secured.	
R-2: 4 Lane with 0.5 m Median division	Secure sufficient traffic capacity to accommodate the traffic volume in the future with safety. Slow traffic and high-speed traffic are separated. Median division is narrowed to reduce road width and minimize No. of houses/buildings to be relocated.	
R-3: 2 Lane + Motorcycle Lane	Secure minimum traffic capacity to accommodate the traffic volume in the near future. Slow traffic and high-speed traffic are separated. There is no separation of traffic in opposed direction.	

Table 17.6-2 Advantage and Disadvantage of Alternatives

Alternative	Advantage	Disadvantage	Remark
R-0	<u>Environmental & Social Aspect</u> ・ No resettlement is required, basically.	<u>Environmental & Social Aspect</u> There is high possibility that traffic congestion occur caused by future increase in traffic demand. Emission of pollutants will increase by the traffic congestion even if the traffic volume is the same.	
	<u>Technical and Socio-Economic Aspect</u> ・ No project cost is required.	<u>Technical and Socio-Economic Aspect</u> ・ Situation of 'mixed traffic' consisting with slow vehicles, such as agricultural tractors, animal carts, bicycles and motorumocks, and high-speed traffic, such as passenger cars, travelling on the same lane will continue in the future. This will cause traffic accidents and reduction in travel speed. This, in return, will hamper sound socio-economic development of the region. ・ The existing pavement (DBST) is susceptible to break and will impose increasing financial burden to the Government.	
R-1	<u>Environmental & Social Aspect</u> ・ Increase in emission of air pollutants caused by increase of traffic demand in future will be mitigated due to mitigation in traffic congestion	<u>Environmental & Social Aspect</u> ・ Large number of houses and buildings is necessary.	
	<u>Technical and Socio-Economic Aspect</u> ・ Smooth traffic will be secured. ・ Socio-economic development of the region will be promoted by smooth road transport. ・ Regional economy will be activated by employment of local people as the construction works and procurement of various consumables from local shops.	<u>Technical and Socio-Economic Aspect</u> ・ Large project cost is required. ・ Increase in travel speed of vehicles may become the cause of increase of traffic accidents.	Risks of traffic accident can be mitigated by implementing traffic safety measures, such as installation of traffic safety devices (guard rail etc), traffic enforcement and traffic safety campaign to roadside residents and drivers.

R-2	<u>Environmental & Social Aspect</u> ・ Increase in emission of air pollutants caused by increase of traffic demand in future will be mitigated due to mitigation in traffic congestion	<u>Environmental & Social Aspect</u> ・ Large number of houses and buildings is necessary, although the extent is less than in R-1.	
	<u>Technical and Socio-Economic Aspect</u> ・ Smooth & safe traffic will be secured, although to less extent than in R-1. ・ Socio-economic development of the region will be promoted by smooth road transport. ・ Regional economy will be activated by employment of local people as the construction works and procurement of various consumables from local shops.	<u>Technical and Socio-Economic Aspect</u> ・ Large project cost is required. ・ Increase in travel speed of vehicles may become the cause of increase of traffic accidents.	
R-3	<u>Environmental & Social Aspect</u> ・ Same to R-2 ・ Number of houses/buildings is less than in R-2.	<u>Environmental & Social Aspect</u> ・ Large number of houses and buildings is necessary, although the extent is less than in R-2.	
	<u>Technical and Socio-Economic Aspect</u> ・ Same as R-2 ・ Project cost is smaller than that of R-2.	<u>Technical and Socio-Economic Aspect</u> ・ Large project cost is required, although less than that of R-2. ・ Increase in travel speed of vehicles may become the cause of increase of traffic accidents. ・ There is a possibility that traffic congestion may occur if any of the alternative routes, such as NR 6 is closed due to natural calamity or severe traffic accident and the traffic divert to NR 5.	・ Same as R-2 as for traffic safety

As the result of study and discussion with MPWT, Alternative R-2 was selected as the optimum option, while Alternative R-3 was selected as the reserve option to be adopted in case of constraint of fund forces to adopt this alternative.

(2) Battambang Bypass

Alternatives of the route of Battambang Bypass were studied as described in Section 9.1 of Chapter 9. The study on the alternative routes was conducted in two steps. In the first step, total 6 alternative routes, 3 alternatives proposed by DPWT of Battambang Province and 3 alternatives proposed by the JICA Team, were compared as shown in Table 9.2-1.

In the study of alternative routes, the following factors were considered:

- Number of houses which need to be relocated
- Traffic function as a bypass
- Willingness of roadside residents for road improvement
- Formation of future expansion of urbanized area
- Loss of agricultural land
- Impact to Tonle Sap Lake

With regard to the number of houses to be relocated, impacts of the alternatives proposed by DPWT were much larger than those of the alternative proposed by the JICA Team. Difference of number of houses to be relocated among the three alternatives proposed by JICA was relatively small.

The JICA Team recommended Alternative JICA-1, and this proposal was agreed by MPWT and DPWT Battambang, in principle. This route was also shown to the participants of the 1st Stakeholder Meeting and accepted.

In the second step, site survey was conducted and further discussions were held among MPWT, DPWT Battambang and JICA Team to fine-tune Alternative JICA-1. After the site survey and several discussions with MPWT, DPWT Battambang and JICA Team, a new alternative route JICA-1C which is the combination of Alternative JICA-1 and JICA-2 was proposed by JICA Team. This alternative is to make the south connection point of the bypass with the existing NR 5 closer to the city of Battambang. This adjustment was made to make the bypass easier for the citizens of Battambang City to access the bypass. This alternative has been agreed by MPWT, DPWT Battambang and JICA Team.

(3) Sri Sophorn Bypass

Alternatives of the route of Sri Sophorn Bypass were studied as described in Section 9.2 of Chapter 9. Four alternatives, including one proposed by DPWT of Banteay Meanchey Province, were compared as shown in Table 9.2-1.

Although construction of Sri Sophorn Bypass was proposed by the Provincial government of Banteay Meanchey to avoid relocation of large number of houses which becomes necessary to widen the existing NR 5, the alternative proposed by DPWT was to bypass only the city of Sri Sophorn and relocation of houses in the town of Mongkol Borei located about 3km south of Sri Sophorn was still necessary. Thus, the main objective of the alternatives proposed by JICA Team was to bypass the town of Mongkol Borei and further decrease the number of houses to be relocated.

After discussions among MPWT, DPWT Banteay Meanchey and JICA Team, Alternative JICA-2 was adopted.

17.7 Environmental Management Plan

Generally, EMP should apply within the project pre-construction, construction and serving time stages because it continuous to joint and distribute on whole project development. The EMP does not apply following the check list only, it shall use for response to the project activities and flexibility of environmental significance that will be unexpected and expected. For the reason, the EMP will provide the regulation monitoring to be evaluation, environmental management at that site to qualify the EMP needed, examine the plan of experience and issue happened.

17.7.1 Objective and Target of EMP

EMP related with environmental impacts due to the road improvement and bypass construction with the monitoring process. The environmental management plan (EMP) consists of a set of mitigation and monitoring measures to be taken into consideration to eliminate adverse environmental and social impacts, offset them or reduce them to acceptable levels. The plan also includes the actions needed to be taken to implement these measures.

The EMP is considered an operational document that will be frequently updated by the project team to reflect the activities on site. As activities commence, the EMP will be reviewed and revised according to various project activities.

The Project Supervisor will be appointed by the Developer for continuous presence on-site for close inspection and management of the project activities. A number of control measures will be applied as follows:

- Ensuring the application of all mitigation measures.
- Following up on the application of the monitoring plan.
- Application of the Emergency Response Plan.

A: Target Planning:

- Identify a organization and administration for environmental monitoring including the responsible identification of staff, cooperation, communication and conducting EIA process.
- Discuss the reserve procedure for environmental management, therefore, the issue happened was identified and the mitigation measure was adopted before the construction stage.

B: Methodology

Methods based for arrange the EMP as described below:

- Review the mitigation measure planning
- Discuss with engineers concerning to the project design stage
- Experiences are acceptable through environmental examination activities related to the past.

17.7.2 Environmental Management Plan

Environmental management is essential to ensure that impacts identified are prevented and mitigated by the Environmental Management Plan (EMP).

The EMP consists of the following components: Management Requirements to support timely and effective implementation of environmental project components, mitigation measures, emergency and monitoring plans. These include institutional aspects as well as appropriate staffing and training. Therefore, a dedicated MPWT and environmental agencies must be assigned the responsibilities of managing and monitoring the implementation of the EMP to ensure proper consideration of the environmental and social aspects of the entire life cycle of the NR 5 Project (BB-Sri Sophorn) for both purposes of legal compliance and for environmental responsibility.

Mitigation/management measures to identify feasible and cost effective measures that will reduce potentially significant adverse environmental impacts to acceptable levels.

Monitoring and validation to provide information about key environmental aspects of the project, particularly the environmental impacts of the project and the effectiveness of mitigation measures.

It should be noted that good environment, both natural environment and living environment, cannot be attained only by mitigating the negative impact of road improvement/construction. Rather, more comprehensive measures, including the following are necessary. Further, in view of the world-wide social issue of "Global Warning", it is duty of any nation to exert best effort to suppress CO_2 emission, including those from traffic.

- Reduction of total traffic demand for road, such as promotion of public transport including bus and rail transport (for reduction of emission gases and prevention of global warming)
- Promotion of good maintenance of vehicles, including introduction of vehicle inspection system
- Preparation and implementation of more detailed plan or regulation on land use for the area along NR 5 and the bypasses
- Regulation/legislation on development of the currently undeveloped land (agricultural land, unused land, swamp etc) to prevent undesirable form of development and deterioration of natural and/or living environment
- Regulation of massive pumping of ground water, disposal of solid waste, regulation and monitoring on quality of industrial waste water

MPWT and MOE are recommended to consult relevant ministries/agencies on the above environmental measures.

Tables 17.7-1 and 17.7-2 presents environmental mitigation plan during construction stage and service stage (after opening to traffic).

Table 17.7-1 Environmental Mitigation Plan in Construction Stage

Environmental Impact	Project Activities	Proposed Mitigation Measures	Budget USD	Institutional Responsibilities	
				Implement-action	Supervision
A. Physical Environment					
Air pollution	Air quality impacts due to gaseous and dust emissions from construction equipment and construction activities	- The contractor shall prepare and strictly implement a dust control plan - Wherever possible, use electrically-powered equipment - Contractors will be required to conduct daily routine equipment and machinery check-ups to ensure that these are in adequate working conditions - Regular maintenance service of construction equipment and machineries shall be practiced and machineries shall strictly comply with the national standard - Clean road surfaces of debris/spoils from construction equipment and vehicles - Store excavated materials outside road reserve, but where there is no area, spoils shall be loaded and transported immediately - Undertake daily cleaning of paved routes around the construction sites - Impose speed limits on construction vehicles to minimize road dust in areas where sensitive receptors, such as hospitals and health-care facilitiesare located - Provide prior notification to the community on schedule of construction activities - Solid wastes shall be regularly removed from the work depot to the final disposal sites - Proper work schedules should be prepared considering not concentrating the construction equipment at a certain point for long time - Water shall be sprayed during construction, particularly in town and villages, to ensure that dust is minimized throughout the construction zone - If the residents and pedestrians complain about the dust and gas, the supervision consultant and contractors should reconsider the construction method - The regulation on fuel quality, importing old cars and emission gas control is to be prepared by MoE in the future. This regulation will improve the air quality, if the air pollution levels exceed significantly the standard. - Trucks carrying soils and gravels should be covered to avoid spills of soil/gravel and dust	Included in contract of civil works	Contractor	MPWT/ PIU, Supervision Consultant
Water quality	Water pollution due to bridge construction Spill of waste oil and other waste	- Installation of cofferdam as necessary - Strict control of waste oil and other waste - Concrete casting and road surfacing shall be closely supervised to prevent spillage - All formworks shall be secured prior to casting to ensure failure will not occur - Temporary sanitation facilities such as portable toilets and garbage bins shall be provided by the contractors to ensure that the domestic wastes to be generated by the construction personals are properly handled and not thrown into the rivers or streams to prevent further pollution - Contractors will be required to conduct daily routine equipment and machinery check-ups to ensure that they are in the adequate working conditions	Included in contract of civil works	Contractor	MPWT/ PIU, Supervision Consultant

		- Regular maintenance service of construction equipment and machineries shall be implemented - Contractors will be prohibited from washing the construction tools along the rivers, streams, reservoirs and other public water to prevent further pollution - In construction works near water bodies such as O Ta Ke stream and Steung SS River and bridge construction works across the Steung Sangkae River, the supervision consultant and contractor should monitor and control the turbid water as necessary - The wastewater septic tank facility in the workers camp and/or other necessary locations shall be properly maintained			
General wastes	General wastes produced through construction activities	- Separate solid waste into hazardous, non-hazardous and reusable waste streams and store temporary on site - Undertake regular collection and disposal of wastes to sites approved by authorities - Office building for construction contractor shall be provided with toilets and septic tanks to handle domestic sewage - Offices, workshops (a temporary building where some works (cutting and bending of re-bars, necessary welding works and repair of tools and equipment, etc.) and other areas within the depot shall be provided with waste collection bins or receptacles - Contractor shall be required to facilitate proper re-use and disposal plan, and manage the construction waste - Because the surplus soil containing bentonite may cause negative impact on drainage condition in agricultural land; the proper disposal site should be selected - Bitumen, diesel and waste oil shall be handled and stored carefully to prevent leakage or spill. Waste oil shall be collected, stored in drums and disposed at a site approved by the Engineer (according to provincial authority's advice) - Waste oil storage shall be in drums, raised off the ground, covered to keep rain out and surrounded by a bund to contain any spills and simplify clean up - The Contractor shall prepare Spill Contingency Plan (including measures to be taken and equipment to be used) to ensure adequate clean-up of any spills - The supervision consultant shall monitor the waste disposal - Provincial authorities should maintain close consultation with the contractor on the collection of garbage	Included in contract of civil works	Contractor	MPWT/ PIU, Supervision Consultant
Noise and vibration	Noise and vibration impacts due to operation of construction equipment and other activities	- Installation of temporary noise barrier fence such as corrugated metal sheets around the construction sites to maintain noise level within permissible level, if necessary - All construction equipment and vehicles shall be well maintained - No noisy construction including related activities shall be carried out during night (6:00pm-6:00am) to avoid noise disturbance to adjacent residential and commercial areas, and other noise-sensitive areas - As much as possible, use quiet equipment and working method - Provide prior notification to the community on schedule of construction activities - A proper work schedules should be prepared not to concentrate the construction equipment at a certain point for long time	Included in contract of civil works	Contractor	MPWT/ PIU, Supervision Consultant

		- Noise suppressors such as mufflers shall be installed whenever deemed necessary to maintain the noise generated by the various heavy equipment and other construction machinery within permissible limits - The explanation and consultation to the affected persons prior to the construction should be conducted to obtain the understanding about the potential impacts including information of the positive impacts such as promotion of the local socio-economic activity. If the local people complain about noise and vibration, the consultant of the supervision and the contractors should reconsider the construction technique - The proper countermeasures to reduce noise and vibration such as slow speed in curve sections, installation of sound barrier and adoption of expansion and contraction joint should be included in the plan and design - In residential area, the noise around the works site and across the proposed bridge and intersection NR 57 should be periodically monitored. If the noise level reaches a significant level such as exceeding the environmental standards, the mitigation measures on noise control should be conducted			
Subsidence	Local land subsidence caused by the weight of additional embankment for widening of NR 5 and new embankment of bypasses	- Detailed soil investigation at subsidence-prone locations (In the detailed design stage, the detailed geological surveys should be conducted. The proper structure design and construction technique should be considered on the basis of the survey results.) - Observation of movement of ground surface - Rectification of tilted structures/houses and ground surface to the original condition - The consultant of supervision and contractor should monitor the ground subsidence. If the ground subsidence occurs, the consultant and contractors should reconsider the construction technique	Included in contract of civil works	Contractor	MPWT/ PIU, Supervision Consultant
Global Warming	Emission of CO_2 from construction equipment	- Contractors will be required to conduct daily routine check-up and proper maintenance of construction equipment and machinery to secure correct combustion of engines and to ensure that they are in the adequate working conditions, and they will strictly comply with the national standard - Use equipment powered with electric motor where available and possible - The regulation on fuel quality, importing old cars and emission gas control is to be prepared by MOE in the future. This regulation will improve the air quality, if the air pollution levels exceed significantly the standard.	Included in contract of civil works	Contractor	MPWT/ PIU, Supervision Consultant
B. Natural Environment					
Topography	Additional embankment for widening of NR 5 and new embankments for bypasses will alter topography	- Cover slopes of new embankments with vegetation - Temporary embankment for construction facilities shall be removed and original topography is recovered as soon as the facility becomes unnecessary - Design height of the embankment as low as possible	Included in contract of civil works	Contractor	MPWT/ PIU, Supervision Consultant

Sedimentation	There is a possibility that filled soil will flow into the river due to heavy rain	- Embankment slopes are covered by vegetation as soon as possible to minimize erosion of slopes - Embankment works are executed in dry season as much as possible	Included in contract of civil works	Contractor	MPWT/ PIU, Supervision Consultant
Hydrology	Flow of river water may be altered during bridge construction New embankment of bypasses may alter the flow of surface water	- Install sufficient number of bridges and culverts at necessary locations of bypasses - Project will not change existing discharge condition - Materials will be properly disposed of so as not to block rivers, streams and watercourses - In the design stage, the detailed hydrological and drainage capacity survey shall be conducted. The proper structure design and execution scheme will be considered on the basis of the survey results.	Included in contract of civil works	Contractor	MPWT/ PIU, Supervision Consultant
Ecosystem	Proposed area is basically agricultural land and towns. Even though there was no direct record and report in the Project area, there are possibilities that some sort of endangered species, such as tortoise, might range over the vicinities of the Project site.	- Compensatory planting of domestic tree spices to the limited area under the elevated structures should be considered as necessary - Provision of cross drainage (pipe culverts) may help crossing of road by animals, reptiles and amphibious.	Included in contract of civil works	Contractor	MPWT/ PIU, Supervision Consultant
C. Social Environment					
Land use and local resources	Bypass is to traverse agricultural land to avoid resettlement and considerable area of agricultural land will be lost.	- Improve productivity of agriculture, especially that of rice production by introduction of high-productivity species and other methods	To be filled later	Provincial authorities	MPWT and MOE
Community organization including organization for local governance	There may be negative impact on community meeting and other community activities because of alteration of physical structure of the community (such as location of community	- Hold sufficient local stakeholder meetings in every stage and establish mutual understanding	To be filled later	Provincial authorities	MPWT and MOE

	center and relative position of houses) caused by land acquisition. Separation of community may occur due to the widened carriageway and increase of traffic volume which makes crossing the road from one side to the other makes difficult and hamper communication of the people.				
Existing Infrastructure	There will be negative impact on the existing infrastructures including electric power line and telecommunication line which need to be relocated due to the widening of the road.	- Social service utilities such as electric power line and telecommunication line will be diverted before starting the construction activity - Confirm the necessity of alternative sites in census survey and in case of need, secure the site	To be filled later	IRC and MPWT	MPWT
Confrontation of stakeholders	There is a possibility that conflicts arise in the roadside communities as the benefit and harm derived from the road improvement may vary among the stakeholders.	- Prevent or solve the conflicts through free and prior consultations between affected people and competence authorities - Encourage the cadastral registration programme	To be filled later	Provincial authorities	MPWT and MOE
Gender	At the planning stage, effort to reflect the opinion of the female on the road design is encouraged.	- Feminine gender will be invited and join local stakeholder as well as male gender - Interview to feminine gender while in census survey will be considered	To be filled later	Provincial authorities	MPWT and MOE

Children’s right	Some children may face some difficulty going to school due to relocation of their houses.	- Secure the accessibility to go to school/hospital when select resettlement places.	To be filled later	Provincial authorities	MPWT and MOE
Risks for Infectious disease such as AIDS/HIV	Infectious disease may be brought by migrant construction workers	- Contractors will be required to conduct periodical health check and education about the HIV/AIDs and other infectious disease to his personnel	To be filled later	Contractor and Provincial authorities	MPWT and MOE
Working environment	Safety and sanitation of construction personnel as well as third party accidents	- Construction personnel shall be provided with necessary safety gears such as protective hard cap - Contractor shall provide safety camps, sanitation water, food and toilets as necessary - Contractors shall communicate with the provincial hospital in case of emergency	Included in contract of civil works	Contractor	MPWT/ PIU, Supervision Consultant
Accident	Construction workers or third party may be involved in accident	- Construction personnel shall be provided with necessary safety gears such as protective hard cap etc. - Traffic management to secure traffic safety shall be planned and implemented to minimize traffic congestions - Traffic enforcers and flagmen will be designated along the narrow road and construction site to assist in directing traffic flow	Included in contract of civil works	Contractor	MPWT/ PIU, Supervision Consultant

Table 17.7-2 Environmental Mitigation Plan in Service Stage

Environmental Impact	Project Activities	Proposed Mitigation Measures	Budget USD	Institutional Responsibilities	
				Implement-action	Supervision
Physical Environment					
Air quality	Air quality impacts due to emissions of vehicle	- All vehicles shall be well-limited of gas emission and shall meet MOE's emission standards - Impose speed limits on all vehicles to minimize emission in areas where sensitive area such as residential and hospital areas - The regulation on fuel quality, importing old cars and emission gas control is to be prepared by MoE in the future. This regulation will improve the air quality, if the air pollution levels exceed significantly the standard. - Monitoring of ambient air away from NR 5 and bypasses (so-called "background air quality) will give an indicator of improvement or deterioration that might have occurred around survey stations of air quality	To be filled later	Provincial authorities	MPWT & MOE
Water quality	Water quality in rivers & streams may worsen due to increase of population and economic/industrial activities. There is a possibility that the water quality will be aggravated in service stage due to increase of population and economic/industrial activities in the region induced by the road improvement. However, measurement of such aggravation of water quality is difficult.	- Improve sewerage system and increase capacity of sewage water treatment plant - Prohibit dumping of garbage into rivers and streams - All commercial buildings and factories have to install the garbage bins and disposal the garbage into a landfill. Sewage has to go through septic tanks before being discharged into the public drainage system.	To be filled later	Provincial authorities	MOE
Waste	Waste from bus/taxi stations and different activities along the road	- Waste collection bins shall be provided by provincial authorities in every bus station for users. Other shop owners must arrange the garbage bins. - BTB and BMCH provincial authorities shall advise the transportation service companies to arrange the garbage bins or garbage package in their vehicles. - Garbage in the service stage shall be properly collected and disposed or recycled regularly in compliance with rules in BTB and BMCH Provinces - station shall be provided toilets and other facilities - Solid waste generated from different activities shall be collected and disposed or recycled in accordance with rules in the Provinces.	To be filled later	Provincial authorities	MPWT & MOE

		- Provincial authorities shall install a sign board not to throw rubbish from vehicle to the roadside - Provincial authority shall educate all passengers about the rubbish management in their vehicles not to throw the rubbish to the roadside - Provincial authority shall impose fine all people who throw the rubbish to the roadside			
Noise/vibration	Increase of noise/vibration due to increase in traffic volume and vehicle speed	- The proper countermeasures to reduce noise and vibration such as speed regulation and installation of sound barrier especially near school and hospital should be included in the plan and design - In residential area, the noise along the widening of north section of NR 5 and the bypasses should be periodically monitored. If the noise level reaches a significant level such as exceeding the environmental standards, the mitigation measures on noise, such as speed regulation, should be implemented. Coordination with related agencies and local authorities will be made to reduce the noise/vibration impact.	To be filled later	Provincial authorities, including traffic police	MPWT & MOE
Malodor	Malodor may be emitted by poorly maintained vehicles	- Enforcement of poorly maintained vehicles - Establishment of vehicle inspection system - The Government' action to promote good maintenance of vehicles and compliance to MOE's regulation on the quality of vehicle emission gas should be implemented.	To be filled later	MPWT	MPWT

17.7.3 Monitoring Plan

Environmental monitoring program is a vital process of any management plan of the proposed development projects. This helps in signalling the potential problems that might result from the proposed project and allow for prompt implementation of effective corrective measures, ensuring that environmental protection is achieved through early detection of negative environmental impacts. The environmental monitoring will be required for the construction and serving time stages.

The main objectives of environmental monitoring are:

- To assess the changes in environmental conditions,
- To monitor the effective implementation of mitigation measures,
- To warn significant deteriorations in environmental quality for further prevention action.

Monitoring programs will be designed for a number of parameters. The monitoring results will be fed into the decision making process as a trigger for the implementation of corrective actions, in order to maintain compliance with environmental laws and regulations, ensure environmental protection and workplace safety, as well as ensure appropriate operation of the mitigation measures and the management plans.

In order to meet the above objectives for the Project of improvement of the North Section of NR 5 (Battambang – Sri Sophorn) and construction of Battambang Bypass and Sri Sophorn Bypass, the following parameters need to be monitored:

- Air quality
- Noise and vibration,
- Surface water quality,
- Subsidence
- General waste management
- Hydrology

In some instances and upon availability of baseline measurements, it may be needed that the monitoring program is to be initiated before construction begins to measure background levels of different parameters such as air quality, noise and water quality (as performed in this Survey). This monitoring information will serve as baseline values for comparison.

It is important to note here that environmental monitoring is a dynamic process. The proposed locations, parameters, and frequencies are subject to further changes, based on the results of the first monitoring round (s).

(1) Pre-Construction Stage

a. Land acquisition and resettlement

Monitoring of land acquisition including resettlement and compensation is the most important event to be monitored in the pre-construction stage. Process of land acquisition shall be monitored to verify that it be done in accordance with Land Acquisition Plan (LAP) and Resettlement Action Plan (RAP).

The MPWT and Inter-ministerial Resettlement Committee shall monitor the process of land acquisition and resettlement. Detailed description of this monitoring is given in Section 18.10, Chapter 18.

b. Air quality, water quality, noise and vibration

As explained in '(2) Construction Stage' below, air quality, water quality noise and vibration is usually surveyed shortly before the construction works start. This is in order to obtain the most up-to-date data which can be compared to the data during and/or after construction. However, if considerable annual or seasonal fluctuation of the data is anticipated, especially in air quality and water quality, surveys shall be conducted to obtain base-line data.

c. Hydrology

At the time of design of road drainage facilities, such as culverts, surveys on rivers and streams, as well as water flow during flood season, shall be conducted so that drainage facilities with sufficient dimension shall be installed at adequate locations to minimize alteration of flows of surface water.

(2) Construction Stage

a. Air quality

Visual inspection of exhaust gases from construction equipment shall be carried out by the construction contractor, under the supervision of the project.

Ambient air quality and noise levels will be monitored before the construction and at regular intervals during the construction stage.

The results of monitoring prior refer to a baseline to which the air quality survey during construction is compared. It is expected that the existing baseline conditions are not indicating high pollution from traffic. Results of ambient monitoring are compared to limits set in 'Sub-Decree on Air Pollution Control and Noise/Vibration Disturbance, 2000'.

Sites for air quality monitoring includes the storage facilities for dust generating materials, construction depots, diesel engine areas, etc. Parameters recommended for air quality monitoring are; Suspended Particulate Matter (SPM, usually expressed as SPM with diameter of 10 microns or smaller: SPM10, or 2.5 microns or smaller: SPM2.5), Carbon Monoxide (CO), Nitrogen Dioxides (NO_2) and Sulphur Dioxide (SO_2), which comply with national standard of Ministry of Environment.

b. Noise and vibrations

Sites for noise and vibrations monitoring include areas with heavy machinery and equipments e.g. pavement breakers, etc. Increased noise intensity is anticipated to mainly impact on site workers and communities neighbouring construction sites. As such, measurement of noise during the construction activities shall be conducted when the noise level is suspected to exceed the standard. Noise levels recorded shall be compared to levels set within the standard of Ministry of Environment.

Moreover, measurements beyond the site shall be conducted to delineate noise emissions in the intersection bypass and NR 57, KP 300, KP 356 and ROW boundary of road, where the residential area is located, as well as in the proximity of neighbouring establishments. Levels detected shall be compared to the baseline measurements and to levels set within the national standard.

c. Surface water

Construction of embankment for the two bypasses is anticipated to influence the flow of the surface water. However, sufficient drainage facilities are to be provided so that the construction of the bypasses shall not alter the current tributaries. Also the areas influenced by the bypasses are mainly limited to the area surrounded by the bypass and the existing NR 5. Thus, the influence of bypass construction to the flow of surface water is considered to be very small.

Thus, the main concern on the surface water is contamination of river waters caused by foundation works for bridges. Therefore, water quality needs to be monitored during construction stage.

Water quality samples were taken from O Take Stream, Stung Sangke River and Serey Sophon River, and such factors as pH, BOD and COD have been measured in this Survey. These data can serve as the base line data for monitoring. Water quality needs to be maintained to meet the standard of Ministry of Environment of Cambodia. However, values of TSS under the current situation are exceeding the Cambodian Standard. Therefore, MPWT needs to consult MoE on this aspect prior to the commencement of construction works of bridges.

d. General waste

Monitoring of the liquid/slurry and solid waste disposal shall be strictly followed (through documentation of waste handling procedures/operations).

e. Subsidence

Subsidence during construction is mainly caused by new embankment of bypasses and/or additional embankment for widening of the existing NR 5. Land subsidence caused by such embankment usually occurs in the close vicinity of the embankment. Such subsidence is detected by the local residents through deformation of houses/building and/or uneven water depth in the rice fields near the embankment.

The contractor and supervision engineers shall visit roadside residents and farmers to check if such phenomena are seen. If such phenomena are seen, they shall be rectified. Methods of rectification vary depending on the type and cause of problem but typically include the following:

- In case of rice paddy, horizontalness or flatness of ground surface may be disturbed. In such case, the ground surface is re-shaped by bulldozer, etc. and top soil is added as necessary.
- In case of tilting of a house, the foundation structure is strengthened and deformed structure is corrected by jacking-up the settled points and cracks, etc. are repaired. If necessary, monetary compensation is also considered.
- In case of important building such as hospital, measurement device is installed on the building or on the ground surface nearby and tilting of building or subsidence of ground surface is monitored. Such measuring devices have accuracy of 1mm. If any settlement or tilting is detected, necessary measures including tentative halting of the construction works and installation of additional foundation of the building and/or other measures are executed.

f. Hydrology

Monitoring of flow change and obstruction of Stung Sangke, O Ta Ke and Stung Serey Sophon caused from bridge construction. Furthermore, soil erosion rates, slope stability of land faces, water sediments load, effectiveness of soil conservation measures, changes in soil texture and structure will be monitored at frequent. This will be done for the entire length of alignment, focusing on areas of higher sensitivity to erosion.

(3) Service Stage

Currently, environmental monitoring for roads are practically non-existent in Cambodia. It is recommended that MPWT and MOE start close consultation on the scheme of environmental monitoring for roads which can be actually practiced.

a. Air quality

Virtually serious air pollution is not anticipated on the Project. However a slight increase in the ambient air quality parameters such as SO_2, NO_2, and Suspended Particulate Matter ($SMP_{2,5}$ & SPM_{10}) might arise due to increase in traffic volume.

It is proposed to monitor ambient air quality for the locations and parameters shown in table below. Monitoring results will be compared to permissible limits for air pollutants in emissions (Sub-decree on air control pollution and Noise/Vibration disturbance). Parameters are to be the CO, NO_2, SO_2, and Suspended Particulate Matter ($SMP_{2,5}$ & SPM_{10}). Monitoring would be carried out 2 times a year (rainy season and dry season) at 6 locations.

b. Noise and vibrations

Noise intensity is anticipated to mainly impact the people living or working near the site. Noise monitoring would, therefore, include areas near bus/taxi station where vehicular parking make the noise levels to increase during the morning and evening hours. Monitoring in these areas would be carried out once per year. The measured noise levels will be compared to the levels surveyed in this Preparatory Survey

Moreover, sites for ambient noise monitoring should include segments of the alignment that are very close to residential areas.

c. General waste

In the servicing stage, main source of the waste associated with road is the rubbish thrown or fall from the vehicles. Road surface cleaning is desirable from view point of not only environment but also traffic safety.

Currently, there is no established road cleaning for national roads. MPWT is recommended to establish road patrol/cleaning squad in the future. The waste thus collected shall be treated by the Provincial Government as a part of solid waste treatment.

Monitoring can be done through observation of solid wasted collected by road cleaning.

d. Subsidence

Land subsidence during servicing stage is mainly caused by excess pumping of ground water, which is associated with increased industrial activities. Thus, monitoring of ground water level is necessary. This monitoring should be implemented as a part of monitoring and regulation of ground water usage by the Provincial Government.

Table 17.7-3 Environmental Monitoring and Management System for Widening and Bypass

Parameters	Location	Means of Monitoring	Frequency	Responsible Agency	
				Implemented by	Supervised by
A-Construction Stage					
Air quality SPM10, SPM2.5, SO_2 and NO_2,	- BB-KP 300 (road site) and 200 m away from road site. - BB- Bypass intersection with NR 57 (road side) and 200 m away from road site. - BMCH-KP 356 (road site) and 200 m away from road site.	Investigation was implemented when dust level happened during construction activities. Dust level reduction should be carried out by sample collection and laboratory analysis	2 times in dry season and 2 times in rainy season	Contractor and engineer	MPWT/ PIU, Supervision Consultant, MoE
Water quality pH, TSS, BOD and COD for surface water.	- BB- KP 305, O Ta Ke stream at the bridge and 2 Km away from the bridge. - BB-Bypass, Stung Sangke, proposed bridge and 2 km away from proposed bridge. - BMCH-KP 358, Serey Sophon River at the bridge and 2 km away from the bridge.	Engineer shall monitor the water quality that will flow into Tonle Sap Lake. The sample collection and laboratory analysis were applied.	2 times in dry season and 2 times in rainy season	Contractor and engineer	MPWT/ PIU, Supervision Consultant, MoE
Noise/Vibration	- BB-KP 300, ROW boundary - BB- Bypass intersection with NR 57, ROW boundary - BMCH-KP 356, ROW boundary	Noise and vibrations of heavy machinery and equipments.	When noise exceeding the standard is suspected	Contractor and engineer	Consultant, MPWT/PIU MoE
General waste	-A long the road and public gathering - Waste storage at construction site	- Volumes of waste for re-use, recycle and/or final disposal. - Treatment procedures and final fate of solid wastes.	Every day	Contractor and engineer	MPWT/ PIU, Supervision Consultant, MoE
Subsidence	Along the widening of NR 5 and bypass construction	- Visit and interview to the local residents & farmers on tilting/deformation of houses/buildings & uneven water depth in rice fields - Measurement of tilting of important buildings by installing incline-meter	- Any time such complaints are heard - 24-hr monitoring	Contractor and engineer	MPWT/ PIU, Supervision Consultant
Hydrology	Stung Sangke River (proposed bridge), O Ta Ke Stream and Stung Serey Sophon River (Other rivers/streams as necessary)	- Control river or stream bank erosion. - Flow change and obstruction of flow and pollution of water caused by bridge construction - Implementation of water conservation practices.	Everyday during works are executed in the river/ stream; samples are taken & water quality is analyzed when pollution is suspected	Contractor and engineer	MPWT/ PIU, Supervision Consultant

B-SERVICE STAGE					
Air quality SPM10, SPM2.5, SO_2 and NO_2	- BB-KP 300 (roadside) and 200 m away from roadside. - BB- Bypass intersection with NR 57 (roadside) and 200 m away from roadside. - BMCH-KP 356 (roadside) and 200 m away from roadside.	Sampling collection and analysis of air quality	2 times in dry season and 2 times in rainy season	Provincial authority	MPWT and MOE
Noise/Vibration	- BB-KP 300, ROW boundary - BB- Bypass intersection with NR 57, ROW boundary - BMCH-KP 356, ROW boundary	Noise and vibrations from vehicle and other transportation	1 times in dry season and 1 times in rainy season	Provincial authority	MPWT and MOE
General waste: Solid waste and garbage	On & along the road	- Measurement of solid waste collected by road cleaning - Type of treatment (Amount and Way of recycle)	1 time per year	Provincial authority	MPWT and MOE
Subsidence	Region along NR 5	Survey of ground height and ground water level	To be decided when subsidence actually occur	Provincial authority	MOE
Ecosystem	Area along NR 5 & Bypasses	Visual observation of animals, reptiles & amphibious	2 times per year (1time in dry season and 1 time in flood season)	Provincial authority	MOE

17.7.4 Staffing and Training

In order to ensure the competence of the project personnel in undertaking the environmental management procedures and plans, training will be conducted for the personnel according to their particular responsibility.

- Training programs shall include guidelines for safety, actions required in case of emergency, fire protection at construction site, environmental risk analysis, etc.
- Training of staff is also important to ensure proper implementation and monitoring of mitigation measures. Accordingly, the training plans shall be developed in accordance with the management and monitoring programs of the present study.
- Training programs shall be directed towards different levels of expertise at the project, i.e. workers, engineers, senior engineers, etc. Such training program will involve different aspects of environmental as well as workplace health and safety.
- Staff training activities shall include first aid training, quality control and environmental management and monitoring training as well as road construction safety precautions. Staff will also be trained on the use of heavy equipment and engine.

- Operation workers would also be trained on safe handling of equipment and wastes and on the use of protective equipment.
- All staff will also be required to attend annual refresher courses.
- Contractors that perform work on site will be required to show evidence of appropriate health, safety and emergency response training. An orientation program will be developed to advise contractors and site visitors on basic health, safety, and emergency procedures such as emergency signals and evacuation routes. Contractors on short-term assignments who do not have safety and emergency response training will work under the supervision of the company staff.

Table 17.7-4 Institutional Strengthening and Training for Implementation Requirements

Institutional Strengthening Activity	Position(s)	Responsibilities		Cost Estimates ($)
		Implementation	Supervision	
Establishing the responsible Institution	•Director •Environmental Specialist •Health Specialist •Safety Specialist	Institutional capacity building consultant	- MPWT/Supervisor - Management	To be filled
Training of road construction staff	•Director •Environmental Specialist •Health Specialist •Safety Specialist	Training and environmental consultant	- MPWT/Supervisor, - Management	To be filled
Environmental awareness	MPWT general staff and site inspectors	Public awareness and environmental consultant	- MPWT/Supervisor, - Environmental consultant	To be filled
Training of environmental inspectors	Staff of different MPWT, PWT Department of Provinces and operations regions	Training and environmental consultant	- MPWT/Supervisor, - Environmental consultant	To be filled
Training of Contractors	Construction Contractors	Public awareness and environmental consultant	- MPWT/Supervisor, - Environmental consultant	To be filled

17.8 Stakeholder Meeting (refer to Section 18.5, Chapter 18)

Interagency coordination and stakeholder involvement are important components of both project planning and the EIA process itself. Based on this understanding, Cambodian EIA sub-decree stipulates the necessity of initiation of stakeholder meetings in the course of the EIA study. Also stakeholder involvement is clearly stated in JICA New Guidelines to realize the integration of environmental and social considerations into the process of project planning and design, to the maximum extent possible.

The First Stakeholder Meetings (SHMs) were conducted in 4 provinces, namely Kampong Chhnang, Pursat, Battambang and Banteay Meanchey. Relevant stakeholders attended in the meeting such as Provincial Governor, DPWT and District Governors. The meetings were conducted smoothly and the Project was mostly welcome and gained the promise of full support from the stakeholders. Also attendants agreed to cooperate to implement resettlement plan and to solve prospective issues on implementation of resettlement.

Detailed explanation on the stakeholder meetings are given in Subsection 18.5, Chapter 18.

CHAPTER 18 RESETTLEMENT ACTION PLAN

18.1 Legal and Policy Framework

18.1.1 Legal and Policy Framework for Resettlement and Land Acquisition in Cambodia

Cambodia has experienced severe social, economic, and political turmoil during the last quarter century. Before the Khmer Rouge came into power in 1975, private land ownership was widespread, governed by the Cambodia Civil Code of 1920. Under the Khmer Rouge from 1975 to 1979, however, private property was abolished and all records were destroyed. After the Khmer Rouge regime, the new government introduced usufruct rights to facilitate the orderly occupation, by people returning to the urban areas, of vacant land and structures. However, all land in Cambodia remained the property of the state until private ownership was fully restored in 1989. The current legislation governing land ownership is the Land Law of October 1992 and of August 2001, which recognizes claims to land made after the downfall of the Khmer Rouge in 1979. Against this background, the fundamental systems for resettlement, namely: i) land management system; ii) policy and system for land acquisition, illegal occupation, and resettlement; and iii) methodology to fill up the gap between development partners' (DPs') policy and the Cambodian laws and regulations on resettlement, are still improving. Therefore, compromise between them is necessary in terms of dealing with resettlement issues caused by development projects.

(1) Relevant Laws

(a) 1993 Constitution

The1993 Constitution of Cambodia established tow governing principles pertaining to land acquisition.

Article 44 states the following:

All persons, individually or collectively shall have the right to ownership. Only Khmer legal entities and citizens of Khmer nationality shall have the right to own land. Legal private ownership shall be protected by law. The right to confiscate properties from any persons shall be exercised only in the public interest as provided for under the law and shall require fair and just compensation in advance.

(b) Land Law

The Land Law of 2001 (NS/RKM/0801/14, 20 July 2001) governs land and property rights in Cambodia based on the provisions of the 1993 Constitution. The law defines the scope of ownership of immovable properties such as land, trees and fixed structures.

Article 5 states the following:

No person may be deprived of his ownership, unless it is in the public interest. Any ownership deprivation shall be carried out in accordance with the governing procedures provided by law and regulations, and after the payment of fair and just compensation in advance.

Other provisions of the Land Law that are relevant to land acquisition, compensation and resettlement include the following:

- **Article 6** states that only legal possession as provided by law can be transformed to land ownership.
- **Article 7** states that any **regime** of ownership of immovable property prior to 1979 shall not be recognized.
- **Article 15 states**;

"*the following properties are included as public properties of state and public legal entities: a) any* property *that has a natural origin, such as forests, courses and banks of navigable and floatable rivers or natural lakes and seashores; b) that is made available for public use such as quays of harbors, port, railways, railways station and airports; or, c) any property which is made available, either in its natural state or after development, for public use such as roads, tracks, oxcart ways, pathways, gardens or public parks and reserved lands.*"

- **Article 18** states;

"*the following are null and void and cannot be made legal in any form whatever: a) any entering into possession of public properties of State and public legal entities and any transformation of possession of private properties of State into ownership rights that was not pursuant to the legal formalities and procedures that have been stipulated prior to that time, irrespective of the date of creation of possession or transformation; e) any entering into possession of private properties of State, through any means, that occurs after this law comes into effect*".

- **Article 19** states the following:

A*ny persons whose land title or factual circumstance fall within the scope of* ***Article 18*** *of this law shall not have the right to claim compensation or reimbursement of expenses paid for the maintenance or management of immovable property that was illegally occupied. Any illegal and intentional of fraudulent acquisition of public properties of state or of public legal entities shall be penalized pursuant to article 259 of this law. The penalties shall be doubled where any occupation of public properties causes damages or delay to works undertaken in the general interest, especially the occupation of roadway reversed land*.

- Ownership of immovable properties described in **Article 25** is granted by the state to indigenous minorities[1] as collective ownership. This collective ownership includes all of the rights and protections as enjoyed by private owners. The exercise of collective ownership rights shall be subject to the responsibility of the traditional authorities and decision-making mechanisms of the indigenous community, according to their customs and subject to the laws of general enforcement related to immovable property such as *the law on environmental protection*. (**Article 26**)
- Persons with legally valid possession of land for five years (at the time the law came into effect) are allowed to be registered as the owner of the land (**Article 30**). Persons who (at the time the law came into effect) held legal possession but had not yet completed the five years were allowed to remain in possession until they were eligible to be registered as the owner. (**Article 31**)
- Any beginning of occupation for possession shall cease when this law comes into effect (**article 29**). After this law comes into force, any new occupant with title to an immovable property belonging to the public bodies or private persons shall be considered as illegal occupant and shall be subject to the penalties provided in **Article 259** of this Law (**Articles 34**).
- **Article 38** states that "*in order to transform into ownership of immovable property, the possession shall be unambiguous, non-violent, notorious to the public, continuous and in good faith*".
- Landless people may apply for land for residential and subsistence farming purposes at no cost, as part of a social land concessions scheme. The concessionaire may obtain ownership of this land after fulfilling conditions set out in a separate *Sub-Decree on Social Land Concessions*. (**Articles 50 and 51**).

(c) **Expropriation Law February 2010:** Procedures for acquiring private properties for national or public interest

- **Article 2:** the **law** has the following purposes: (i) ensure reasonable and just deprivation of a legal right to ownership of private property; (ii) ensure payment of reasonable and just prior compensation; (iii) serve the public and national interests; and (iv) development of public physical infrastructure.
- **Article 7:** Only the state may carry out an expropriation for use in the public and national interests.

[1] As per Article 23 of the Land Law, "*An indigenous community is a group of people that resides in Cambodia whose members manifest ethnic, social, cultural and economic unity and who practice a traditional lifestyle, and who cultivate the lands in their possession according to the customary rules of collective use.*"

- **Article 8:** The state shall accept the purchase of the remaining part of the real property left over from an expropriation at a reasonable and just price at the request of the owner of land/or the holder of rights in the expropriated real property, if he is no longer able to live near the expropriated scheme or build a residence or conduct any business.
- **Article 16** states that "Prior to make any expropriation project proposal, the Expropriation Committee shall conduct a public survey by recording of a detailed description of all entitlements of the owners and/or of the holder of real right to immovable property and other properties subject to compensation as well as recording of all relevant issues.
- In conducting the survey, the Expropriation Committee shall organize public consultations at the Capital, Municipal-Provincial, and District-Khan authority levels with Commune/Sangkat councils and Village or community representative to be affected by the expropriation to provide specific and concise information and collect inputs from all stakeholders regarding the proposed basic public infrastructure project.
- In order to set a dateline for the expropriation or relocation or compensation, the Expropriation Committee shall conduct a dateline interview with all concerned parties about the issues of immovable property to be affected by the public physical infrastructure project.
- Within 30 (thirty) working days after the completion of the survey, the Expropriation Committee shall produce a report with recommendations and submits it to the Royal Government for approval."
- **Article 22:** Stipulates the amount of compensation to be paid to the owner of and/or holder of rights in the real property, which is based on the market value of the real property or the replacement cost as of the date of the issuance of the *Prakas* on the expropriation scheme. The market value or the replacement cost shall be determined by an independent commission or agent appointed by the expropriation committee.

(d) Other Relevant Regulations

- The private ownership of land was re-established in 1989, and confirmed in *the 2001 Land Law* (**Article 4**). Cambodians are able to register the land they occupy with the local Cadastral Administration Office, whereupon a certificate of land title is granted. Issuing land titles is a lengthy process and most offices have a major backlog of applications. People are given a receipt and until the official title deed is issued, this receipt is accepted as a proof of real occupant of the land for land purpose or sale.
- The present legal status of land use in Cambodia can be classified as follows:
  - **Privately owned land with title**: The owner has official title to land, and both owner and the Cadastral Administration Office have a copy of the deed.

- **Privately owned land without title**: The owner has made an application for title to land, and is waiting for the issuance of a title deed. The Cadastral Administration Office recognizes the owner.
- **Land use rights certified by the Government**: In this case, a receipt for long-term land use has been issued. This land use right is recognized by the Cadastral Administration Office.
- **Lease land**: The Government or private owners lease the land, usually for a short period. There is provision for the owner to reclaim land if it is needed for development.
- **Non-legal occupation**: The user has no land use rights to State land that he occupies or uses. The Cadastral Administration Office does not recognize the use of this land.

• **Sub-Decree on Social** Land **Concession, March 2003 -** provides for allocations of free private state land to landless people of residential or family farming, including the replacement of land lost in the context of involuntary resettlement.

• **Prakas No. 6: Measures to Crack Down on Anarchic Land Grabbing and Encroachment** sets ROW for road and railway. In support of this *Prakas*, MEF on 6 April 2000 issued *Decree No. 961* prohibiting compensation for structures and other assets located in the ROWs. Some Road dimensions are modified by *the Sub-decree No.197* adopted on 23 November 2009 on to Management of ROW along the national road and railway in Cambodia.

Table 18.1-1 Road ROW Dimensions

Road Category	ROW Dimensions under Prakas No. 06	ROW Dimensions under Decree No. 197
National Road 1, 4, 5	30 m from the centerline	30 m from the centerline
Other 1-Digit National Roads	25 m from the centerline	25 m from the centerline
2-Digit National Roads	25 m from the centerline	25 m from the centerline
Provincial Roads	20 m from the centerline	Not specified
Commune Roads	15 m from the centerline	Not specified

Source: Sechkdey Prakas No.6, "Measures to Crack Down on Anarchic land Grabbing and Encroachment" (1999)

18.1.2 Policy Gap Assessment

Law and regulation framework on resettlement and land issues are still in the stage of development in Cambodia, and some implementation documents and institutions are not yet prepared completely. However, RGC understands such situation and DPs' safeguard policies, and considers supplemental measures and assistances in RAP cases case by case.

Thus, in terms of practical operation, there is not so much crucial gap between Cambodian country system and JICA Guidelines' concept and requirements (see Table 18.1-2). Some other discussing points which are not mentioned clearly or concretely in Cambodian country system are also considered based on JICA Guidelines, RAP, and other relevant documents to fulfill gaps.

Table 18.1-2 Verification and Comparison between the Cambodian System and the New JICA Guidelines for Environmental and Social Considerations (April 2010)

	Item	New JICA Guidelines Policy	Law/Regulation in Cambodia (Officially Promulgated)	Actual Operation (Gap-filling Measures)
1	Support system for socially vulnerable groups	It is necessary to give appropriate consideration to vulnerable groups.	*Sub-Decree on Social Land Concession* provides allocations of free private state land to landless people of residential or family farming, including the replacement of land lost in the context of involuntary resettlement.	Income restoration program (IRP) and assistance (allowance) to vulnerable groups will be prepared.
2	Assistance to restore and improve living standards	Living standards and income opportunities, and production levels of project affected people should be improved or at least restored to pre-project levels.	The government has no clear policy or procedure to restore the livelihood of APs.	Income restoration program (IRP) will be prepared.
3	Enhancement of public participation in planning and implementation of RAP	Appropriate participation of affected people and their communities should be promoted in planning, implementation and monitoring of involuntary RAPs and measures taken against the loss of their means of livelihood.	It is clearly declared in *the Expropriation Law* (***Article 16****)* that in conducting a survey of entitlements, public consultations shall be organized to provide specific and concise information and collect inputs from all stakeholders regarding the proposed basic public infrastructure project and that a dateline interview with all concerned parties shall be conducted.	Stakeholder meetings and interview of AHs shall be conducted at appropriate stages according to JICA Guidelines and *the Expropriation Law*.
4	Compensation for land acquisition with replacement cost	Prior compensation will be done with replacement cost, which means that compensation for lost assets must be made in full amount at replacement cost and at current market price.	The amount of compensation to be paid to the owner of and/or holder of real right to the immovable property shall be based on the market price or replacement cost as of the date of the issuance of the declaration on the expropriation project. (the *Expropriation Law* (**Article 22**))	AHs will be compensated at replacement cost. The replacement cost will be calculated based on the detailed measurement survey just before implementing resettlement.

5	AHs residing in the Project affected area before cut-off date	People to be resettled involuntarily and those whose means of livelihood will be hindered or lost should be sufficiently compensated and supported by the project proponents in appropriate time.	Under *the Land Law 2001*, those who have occupied ROW or public property are not entitled to any compensation or social support.	Assistance to AHs who are residing in the Project affected area (including public state land) at the time of cut-off date will be prepared (Compensation for properties without land is compensated at replacement cost and resettlement site will be prepared for landless AHs).
6	Grievance redress mechanism	Grievance redress system must be formulated and must function appropriately.	Grievance redress system is stipulated in *the Expropriation Law*; however, it has provisions to exclude public infrastructure projects.	Grievance redress system will be formulated.

18.2 Project Resettlement Policy

18.2.1 Objective

The objective of the project resettlement policy is to ensure that AHs are not worse off because of the project. The project should provide an opportunity for the local people to derive benefits from it, and it should likewise serve as an occasion for the local people to participate in its planning and implementation, thereby engendering a sense of ownership over the same.

18.2.2 Key Principles

The key principles for resettlement and compensation in this project are as follows:

(i) Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives. When, after such an examination, avoidance is proved unfeasible, effective measures to minimize impact and to compensate for losses must be agreed upon with the people who will be affected.

(ii) People who must be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported by RGC in a timely manner. Prior compensation, at full replacement cost, must be provided as much as possible. RGC must make efforts to enable people affected by projects and to improve their standard of living, income opportunities, and production levels, or at least to restore these to pre-project levels. Measures to achieve this may include: providing land and monetary compensation for losses (to cover land and property losses), supporting means for an alternative sustainable livelihood, and providing the expenses necessary for the relocation and re-establishment of communities at resettlement sites.

(iii) Appropriate participation by affected people and their communities must be promoted in the planning, implementation, and monitoring of resettlement action plans and measures to prevent the loss of their means of livelihood. In addition, appropriate and accessible grievance mechanisms must be established for the affected people and their communities.

(iv) Resettlement action plans must be prepared and made available to the public. In preparing a resettlement action plan, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance. When consultations are held, explanations must be given in a form, manner, and language that are understandable to the affected people.

18.2.3 Cut-off Date

For the project, the cut-off date coincides with the first day of the census of APs and the IOL thereat was conducted. The cut-off date for the existing NR 5 and BTB Bypass is on 1st August 2011, and for SS Bypass is on 6th February 2012. This would mean that any land occupation or transfer, or structures to be built on affected land after the cut-off date will not be entitled to any compensation including the land use right.

The cut-off date was informed to AHs at stakeholder meetings before and after the cut-off dates at stakeholder meetings during RAP preparation stage. At those meetings, AHs were informed that all structures constructed after the cut-off date (IOL survey) will not be entitled for any compensation from the Project, and that all people have to stop constructing any new buildings in the delineated area. The information will be continuously disseminated to prevent further population influx.

18.3 Eligibility

Persons not covered in the census are not eligible for compensation and other entitlements, unless they can show proof that;

(i) they have been inadvertently missed out during the census and IOL and certified by local authorities, or

(ii) they have lawfully acquired the affected assets following completion of the census and IOL and prior to the conduct of detailed measurement survey.

Eligible AHs include anyone who, at the cut-off date of the project, was located within the project area or any of its component or subproject or part thereof, and would have his/her:

(i) Standard of living adversely affected;

(ii) Right, title or interest in any house, land (including residential, commercial, agricultural and grazing land), water resources, or any other movable or fixed assets acquired or possessed, in full or in part, temporarily or permanently, by public sector acquisition; or

(iii) Business, occupation, place of work, or residence or habitat adversely affected by public sector intervention.

An AH refers to a household that consists of all members residing under one roof and operating as a single economic unit who is adversely affected by the project. For resettlement purposes, project-affected persons will be considered as members of the project-affected households including single headed household.

18.3.1 Entitlements

The project entitlements were developed and presented as shown in Table 18.3-1. The entitlements adopted were guided by the applicable national laws and regulations and JICA Guidelines. The entitlements and assistance may be revised based on the actual status of impact, as necessary, in the updated version of the RAP.

Table 18.3-1 Entitlement Matrix

TYPE OF LOSS	ELIGIBLE PERSONS	ENTITTLEMENTS	IMPLEMENTATION ISSUES
A. LOSS OF LAND			
OUTSIDE ROW (PRIVATE LAND)			
I. Loss of Land (all kinds); **Either Partial or Entire Land is Lost**	All Affected Households (AHs) with recognized proof of ownership whose land will be acquired (for the construction of bypass roads in Battambang (BTB) and Sri Sophorn (SS)).	AHs have two options: 1) Land replacement (land to land): Land replacement will be provided with similar land quality and productivity potential. 2) cash compensation at replacement cost.	・ AHs to be notified at least 90 days in advance before the start of civil works in the locality of the actual date that the land will be acquired by the project. ・ Inter-ministerial Resettlement Committee (IRC) will ensure payment of all compensation and allowances for which AHs are entitled to at least 30 days prior to the scheduled start of civil works. ・ IRC will support the AHs to separate or transform the affected land title certificate. Cost of the procedure will be borne by RGC.
INSIDE ROW (PUBLIC STATE LAND)			
I. Partial Loss of Residential and/or Commercial Land, in which the **remaining** land is **STILL VIABLE** for continued use.	AHs with main house and/or small shop (independent/family-owned business)	・ AHs must be removed entirely from PRW and no cash compensation is available for affected land in ROW. ・ No new permanent structures (i.e. structures on a foundation or wooden house larger than the affected one) are permitted to be constructed in the ROW.	・ AHs to be notified at least <u>90 days</u> in advance before the start of civil works in the locality of the actual date that the land will be acquired by the project. ・ IRC will ensure payment of all compensation and allowances for which AHs are entitled to at least <u>30 days</u> prior to the scheduled start of civil works. ・ Remaining ROW is still **public state land**.

TYPE OF LOSS	ELIGIBLE PERSONS	ENTITTLEMENTS	IMPLEMENTATION ISSUES
II. Entire Loss of Residential and/or Commercial Land, or the remaining land is **NOT VIABLE**[2] for continued use (Landless AHs)	AHs with main house and/or small shop (independent/family-owned business) and no more remaining land.	• No cash compensation for affected land in ROW. • Land replacement by land in a resettlement site or nearby villages provided by RGC. A land plot will be 7.0m x 15.0m = 105.00m2 per landless AH. • Basic infrastructures such as access roads, latrines, drainages, and pumping wells will be provided as part of resettlement development. Electricity connection will also be provided if available in the area. However, AHs will bear the security deposit for electricity consumption required by service provider because the deposit will be refunded to AHs once the consumption is terminated. • Land title for the land plot in the resettlement site with names of husband and wife will be provided to each household after five consecutive years of living on the land at no cost.	• AHs to be notified at least 90 days in advance before the start of civil works in the locality of the actual date that the land will be acquired by the project. • IRC will ensure payment of all compensation and allowances for which AHs are entitled to at least 30 days prior to the scheduled start of civil works. • IRC will ensure allocation of replacement land with sufficient time (at least 90 days) for AHs to rebuild and relocate completely before the scheduled start of civil works. • IRC will support the AHs to acquire land title certificate after five consecutive years of AHs' living on the land. Cost of the procedure will be borne by RGC. • Remaining ROW is still public state land.
III. Loss of Productive Land Use ; **Either Partial or Entire Land is Lost**	All AHs occupying land or using land in the Provisional Road Width (PRW)	• No cash compensation is available for affected land in ROW. • See also [*C. LOSS OF CROPS AND TREES*]	• AHs to be notified at least 90 days in advance before the start of civil works in the locality of the actual date that the land will be acquired by the project. • AHs will not be moved from the ROW outside the PRW without justifiable cause (i.e. unless or until the land is required by the government for road improvement purposes). • Remaining ROW is still **public state land**.
B. LOSS OF STRUCTURES			
I. Loss of House, House and Shop, Shop/Store**; Either Partial or Entire**	Owners with or without acceptable proof of ownership over the land.	• Cash compensation at replacement cost without deduction for depreciation or salvageable materials (i.e. present cost of construction materials in the locality plus cost of labor). • If AH belongs to any of the **vulnerable**	• AHs to get cash compensation at least three months ahead of civil works in the locality to allow the AHs sufficient time to gradually reorganize the house and/or shop, thereby

[2] The size of viable land will be discussed between IRC-WG and the affected households during the detailed measurement survey.

TYPE OF LOSS	ELIGIBLE PERSONS	ENTITTLEMENTS	IMPLEMENTATION ISSUES
Structure is Lost.		**group**, see Section E below. ・ AHs are entitled to get **disruption allowance** as stated in Section E below. ・ AHs also are entitled to have **transport (moving) allowance** as stated in Section E below.	avoiding any disruption in their livelihood. ・ AHs must completely cut, move back or relocate their houses/structures to new site within 30 days after receiving compensation. ・ If the structure is found no longer viable for living, compensation will be paid for the entire structure and the AH will also be entitled to other allowances.
	Renters	Renters are entitled to get allowances as below: ・ **Transportation (moving) allowance**: US$40 ・ **Disruption allowance**: A lump sum cash assistance of US$44.80. ・ **Rental allowance**: equivalent to two months rent of a similar building in the locality. ・ If AH belongs to any of the **vulnerable group**, see Item E. ・ Provision of information in finding alternate rental accommodation.	・ AHs to be notified at least 90 days in advance before the start of civil works in the locality of the actual date that the land will be acquired by the project. ・ AHs to get cash compensation at least 30 days ahead of civil works in the locality to allow the AHs sufficient time to gradually reorganize the house and/or shop, thereby avoiding any disruption in their livelihood. ・ AHs must completely cut, move back or relocate their houses/structures to new site within 30 days after receiving compensation. ・ If the structure is found no longer viable for living, compensation will be paid for the entire structure and the AH will also be entitled to other allowances.
II. Other Structures (porch, extended eaves, spirit house, fence, etc.)	Owners of the structures with or without acceptable proof of ownership over the land.	・ Cash compensation at replacement cost without deduction for depreciation or salvageable materials (i.e., present cost of construction materials and labor in the locality).	・ AHs to be notified at least 90 days in advance before the start of civil works in the locality of the actual date that the land will be acquired by the project. ・ IRC will ensure payment of all allowances for which AHs are entitled to at least 30 days prior to the scheduled start of civil works.

TYPE OF LOSS	ELIGIBLE PERSONS	ENTITTLEMENTS	IMPLEMENTATION ISSUES
C. LOSS OF CROPS AND TREES			
I. Loss of Crops	Owners of crops regardless of land tenure status	• To the extent possible, AHs will be **allowed to harvest** their annual and perennial crops prior to construction. • If crops cannot be harvested due to construction schedule, AHs are entitled to cash compensation for the affected crops at replacement cost.	• Annual Crops – AHs will be given 90 days' notice that the land on which their crops are planted will be used by the project and that they must harvest their crops before the civil work. • Remaining ROW is still **public state land**.
II. Loss of Fruit or Shade Trees	Owners of trees regardless of land tenure status	• Fruit trees will be compensated in cash as per replacement cost.	• AHs to be notified at least 90 days in advance before the start of civil works in the locality of the actual date that the land will be acquired by the project. • Remaining ROW is still **public state land**.
D. LOSS OF COMMON PROPERTY RESOURCES			
I. Partial or Entire Loss of Community and/or Public Assets	Affected communities or concerned government agencies who own the assets	• Replacement by similar structures and quality at the area identified in consultation with affected communities and relevant authorities.	• Communities to be notified at least 90 days in advance before the start of civil works in the locality of the actual date that the land will be acquired by the project. • Remaining ROW is still **public state land**.
E. ALLOWANCES AND ASSISTANCES			
I. Transport (moving) Allowance	AHs that relocate their house or house/shop	• Shops and stalls made of light and temporary materials: US$20 • Regular shops and houses moving into the residual area of the ROW: US$40 • Regular shops and houses relocating within the same village outside of the ROW: US$60 • Houses relocating in another village outside of the ROW: US$70	• Owners of houses or houses/shops are entitled to a one time transport allowance only. • Remaining ROW is still **public state land**.
II. Severely Affected and/or Vulnerable AHs Allowance	Severely affected households[3] and Vulnerable AHs	• One time cash assistance equivalent to **USD 100** per Severely Affected households and/or Vulnerable AHs. • See also *[IV.* Income *Restoration Program (IRP)]*	• As indicated above, relocating landless AHs are entitled to replacement land with title at no cost to them.

[3] "Severely affected households" include but not limited to the AHs who will (i) lose 10% or more of their total productive land (income generating) and/or assets, and (ii) have to relocate due to the Project.

TYPE OF LOSS	ELIGIBLE PERSONS	ENTITTLEMENTS	IMPLEMENTATION ISSUES
III. Disruption Allowance	Relocating AHs to residual or adjacent areas (whose house type 1A to 2G) with floor area is less than 60m^2.	• One time cash assistance equivalent to USD33.	• Allowance shall be paid at the same time with compensation.
	Relocating AHs to residual or adjacent areas (whose house type 1A to 2G) with floor area is 60m^2 or more.	• One time cash assistance equivalent to USD100.	
	Relocating AHs to residual or adjacent areas (whose house type from 2H or higher)	• One time cash assistance equivalent to USD150.	
	Relocating AHs to a new resettlement site	• One time cash assistance equivalent to **US$200**	
IV. Temporary loss of business income during relocation	Owners of shop who relocate their shop	• Lump sum cash assistance of USD50.	
V. Income Restoration Program (IRP).	Severely AHs, Vulnerable AHs and Relocating AHs	• An IRP will be provided during resettlement implementation.	• In-kind assistance to strengthen or initiate income-generating activities will be decided in consultation with eligible AHs. Forms of assistance may include, but are not limited to, agricultural extension assistance, technical and other assistance to develop existing or new income-generating activities and project-related employment. • Special attention to the needs of and opportunities for the vulnerable AHs.
F. TEMPORARY IMPACTS DUE TO ROAD CONSTRUCTION AND MAINTENANCE			
I. Affected **assets** during construction	Owners of crops	• Compensation for lost assets in cash at replacement, or • Compensation as leasing fee based on replacement cost, and temporarily affected land will be returned to original owner/occupant.	• Construction and maintenance will be carried out so as to minimize damage. • Construction will be required by contract to stay within PRW.

TYPE OF LOSS	ELIGIBLE PERSONS	ENTITTLEMENTS	IMPLEMENTATION ISSUES
II. Damage to fields and private or community infrastructure including bund walls and channels, etc	Owners or person using the field	• Repair of damage or payment for repair of damage at replacement cost.	• As part of the civil works contract, all access roads/driveways to properties adjacent to the road will be repaired or replaced including culverts and other facilities, to a condition equal to or better than at present. • The disruption period will be minimized as much as possible. • The contractor will repair the land back to its original condition before returning to the owners.

18.4 Project Impacts

18.4.1 Methodology Used in Preparing the Resettlement Plan

The following sections describe the processes and methods employed in the survey on adverse social impacts for improving NR 5. The impact survey involved the conduct of IOL wherein all fixed assets (i.e., lands used for residence, commerce, agriculture, including ponds; dwelling units; stalls and shops; miscellaneous structures, such as fences, wells, trees with commercial value; etc.) located inside the PRW were identified, measured. The owners of those properties were identified, and their replacement values were also calculated. Likewise, the severity of impact on the affected assets and to the livelihood and productive capacity of AHs were determined. Photographs of the affected assets along with the AHs had also been taken. Also, information on the members of the AHs, sources of livelihood, income level, and ownership of productive assets had been gathered. The impacts survey and census of AHs were conducted in August-September 2011 and February 2012.

(1) Data Gathering Instrument

The basic tool used in the IOL and census of AHs was the survey questionnaire. Detailed socio-economic information on AHs whose main structures (i.e., houses and shops excluding government buildings) will be partially or entirely affected was obtained with the use of the survey questionnaire in Khmer. The questionnaire covered concerns on socio-economic conditions of the AH, in addition to basic information on the household head, such as gender, age, educational attainment, and primary source of income. It also included the affected assets and income, and their perception on the Project (see *Appendix 18-1: Inventory of Loss and Socio-Economic Survey Questionnaire Form* for a copy of the impact survey questionnaire).

(2) Survey Team

In addition to the Study Team leader (resettlement specialist), a recruited team of 38 local research assistants including 1 field survey coordinator, 4 field supervisors, 16 enumerators, 10 local assistants, 3 data entry clerks, 1 data developer, and 4 replacement cost (market rates) researchers was organized to help prepare the RAP. Except for the data developer, the rest of the local research assistants were based in the field. Field data gathering for NR 5 and BTB Bypass commenced on 1st August 2011 and was completed on 14th September 2011, while for SS Bypass it was from 6th to 20th February 2012. The research team was accompanied by commune or village officials during their data gathering activities.

(3) Setting of the Cut-off Date

The IOL and census of AHs were preceded by public consultation meetings in commune centres along NR 5. Among others, the purpose of the public meetings was to brief the local population about the Project background, activities of the survey team, the policy of JICA and the Cambodian government on involuntary resettlement for the NR 5 Project, including the policy requirement on the cut-off date. The local people were informed that the cut-off date is the first day of holding the IOL and census of the AHs, which was on 1st August 2011 for the exiting NR 5 and BTB Bypass and on 6th February 2012 for SS Bypass.

(4) Basic Unit Costs Used in the Resettlement Plan

In line with the IOL activities, an RCS of affected assets in the Project area was carried out by the research team. The main objective of the RCS is to determine the rate of land prices based on actual transaction records of the affected areas, of affected main and secondary[4] structures, and of fruit trees, trees and crops. Based on the results of RCS, the AHs will receive compensation at replacement cost (reflecting market price) from RGC for their loss of land and property due to the Project.

The methodology employed in the RCS included the following:

(i) **Sale/Market comparison method:** This method is based on data provided from recent sales of properties that are highly comparable to the subject property in the vicinity. The method is very useful for cost calculation of structure, land, crops and trees.

(ii) **Contingent valuation method:** Survey based on willingness to accept (WTA) and/or willingness to pay (WTP). This method was used for land price estimation because of land transactions at the project area are minimal in 2011.

[4] This includes fences, wells, pig pens, toilets, kitchens, etc.

(iii) **Income approach:** Sum of stream of incomes and sales proceeds. The principle here is that the value of a property is related to its ability to produce cash flow. The technique relies heavily on current market transactions involving the sale of comparable properties. This method was used for estimating the prices of crops and tree, particularly to calculate the compensation rates for temporary impact of agricultural land.

(iv) **Replace cost approach:** This method was useful for structure cost calculation. The value of a structure is based on the current cost for building the concerned structure and labor cost. For this study, the value of structure and labor cost are derived from the current cost based on market price without depreciation.

(a) Unit Costs of Land

The affected private lands were divided into 4 main categories: rice field, orchard, residential and commercial lands. The way to obtain data on market rates is to gather data on recent land sales, however sale cost recording could not be found at/around the Project area. Therefore, data of recent sales were collected by direct interviews with (i) land owners at/around the Project area who are both AHs and non-AHs, and (ii) local authorities at/around the Project area. Per results of the RCS, the unit costs of land covered with recognized proofs of ownership, structures, crops, perennials, and timber trees in districts and communes traversed by the Project road are provided.

(b) Unit Costs of Structures

The houses/structures affected by the Project have been categorized into two main groups – house/dwelling and other structures. The methodology employed for costing house/structures were composed of quantity survey and detailed measurement of the component parts of each structure. Labour costs were also assessed at market prices for the structure as a whole based on the information provided by local building contractors on regional basis.

Although there are 4 main standard categories, some subcategories were introduced based on actual materials in each category. As a result of the survey, a total of 24 categories were identified in the Project area. The unit prices of a typical structure for each category are provided.

Other structures such as wells and fences, and cultural assets such as stupa (Chedey), have to be compensated at their market price, and the results of the specific rates of structures are provided.

(c) Unit Costs of Crops and Trees

The primary data was collected through interviews on the income at which owners/cultivators of crops and trees at the Project area. The market rates of crops and trees have been calculated based on the yield and the period of maturity of trees and crops as determined from interviews with farmers along NR 5.

The formula used for fruit trees is as follows:

(Number/Quantity of harvest per year) x (Market price) x (Number of years it will mature) + cost of seedling

In order to simplify the study, perennial trees that have a growth period of more than five years have been classified in to the following three types:

- Sapling tree (1-3 years), as it can replanted ; 1/3 of full price,
- Young tree (3-5 years), bearing some fruit ; 2/3 of full price,
- Mature tree (more than five years), fully bearing fruit ; compensate full price.

According to the survey, there are some trees that have a growth period of less than five years. Trees are also equivalent to full compensation cost if mature. Otherwise, their compensation value is their cost as a sapling tree or as a young tree.

18.4.2 Inventory of affected Assets

(1) Land

The inventory of affected land (PRW: 20 m - 20 m on both sides from the centreline of the road) in ROW (30 m - 30 m) of NR 5 was not performed since the ROW is a public state land. It will not be compensated by the Project for the affected area (20 m - 20 m). Nevertheless, the survey team also determined the categories of the land occupants or users, and if the affected lands are accompanied with immovable assets such as trees, houses, shops and/or other structures.

There were instances when the survey team could not complete their interviews with the AHs because the owners of the affected houses and shops were either closed or unattended during the survey. In such case, the survey team was only able to estimate the area of ROW lands used for residential or commercial purposes (i.e., footprint of the structures), and those that are fenced. These estimates will be validated and corrected as necessary during the updating of the RAP, with the assistance of commune officials who will also sit as members of the Provincial Resettlement Sub-committee-Working Group (PRSC-WG), the main resettlement body that is tasked to carry out the DMS.

A total of 1,556,605.71 m² of land will be required for the construction of the two bypasses (BTB and BMCH). It comprises 1,456,493.26 m² of private land, and 100,112.45 m² of flooded forest land (state land). Of these, 86.32% (1,343,597.54 m²) is used for growing rice. Table 18.4-1 shows the affected land area and the number of owners identified as AHs.

Table 18.4-1 Number of Affected Households who will Lose their Private Lands (due to Battambang and Banteay Meanchey Bypasses)

District/ Krong	Rice Field		Orchard		House Plot/ Home Garden		Commercial		Flooded Forest	
	AH	m^2	AH	m^2	AH	m^2	AH	m^2	AH	m^2
Mongkol Borei	93	303,296.75	3	5,799.04	17	9,169.90	0	0.00	1	268.25
Krong Sri Sophorn	40	171,394.68	1	5,911.34	0	0.00	0	0.00	1	99,844.20
Banteay Meanchey	133	474,691.43	4	11,710.38	17	9,169.90	0	0.00	2	100,112.45
Thma Koul	95	182,728.96	0	0.00	9	5,731.90	1	3,347.33	0	0.00
Krong Bat Dambang	196	425,005.36	14	24,865.94	26	24,273.91	0	0.00	0	0.00
Sangkae	133	261,171.79	8	14,880.06	20	18,916.30	0	0.00	0	0.00
Battambang	424	868,906.11	22	39,746.00	55	48,922.11	1	3,347.33	0	0.00
Total	**557**	**1,343,597.54**	**26**	**51,456.38**	**72**	**58,092.01**	**1**	**3,347.33**	**2**	**100,112.45**

Data source: Project Survey conducted in August-September 2011 and February 2012

(2) Main Structures

A total of 704 AHs along NR 5 and the bypasses will have their main structures (house, house-shop and/or shop/restaurant) affected by the Project. The total AHs is comprised of 681 AHs along NR 5, and 23 AHs along the two bypasses.

Table 18.4-2 Number of Affected Households who will Lose their Main Structures according to Type of Use

Road section	Province	District	AHs According to Type of Structure					
			House	House-Shop	Shop/ Restaurant	Shelter	Other Structures	Total
NR 5	BMCH	Mongkol Borei	224	130	5	177	39	**575**
		Krong Sri Sophorn	0	0	0	0	0	**0**
		Subtotal (BMCH)	224	130	5	177	39	**575**
	BTB	Thma Koul	223	97	2	329	49	**700**
		Krong BTB	0	0	0	0	0	**0**
		Sangkae	0	0	0	0	0	**0**
		Subtotal (BTB)	223	97	2	329	49	**700**
	Total (NR 5)		**447**	**227**	**7**	**506**	**88**	**1,275**
Bypass	BMCH	Mongkol Borei	3	0	0	0	0	**3**
		Krong Sri Sophorn	0	0	0	0	0	**0**
		Subtotal (BMCH)	3	0	0	0	0	**3**
	BTB	Thma Koul	3	0	0	1	0	**4**
		Krong BTB	11	0	0	0	0	**11**
		Sangkae	6	0	0	0	2	**8**
		Subtotal (BTB)	20	0	0	1	2	**23**
	Total (Bypasses)		**23**	**0**	**0**	**1**	**2**	**26**
Total	BMCH	Mongkol Borei	227	130	5	177	39	**578**
		Krong Sri Sophorn	0	0	0	0	0	**0**
		Subtotal (BMCH)	227	130	5	177	39	**578**
	BTB	Thma Koul	226	97	2	330	49	**704**
		Krong BTB	11	0	0	0	0	**11**
		Sangkae	6	0	0	0	2	**8**
		Subtotal (BTB)	243	97	2	330	51	**723**
	Total (the Project)		**470**	**227**	**7**	**507**	**90**	**1,301**

Data source: Project Survey conducted in August-September 2011 and February 2012

Table 18.4-3 Floor Area (in m^2) of Affected Main Structures by Type of Materials

Structure Uses	Area of Each Type of Structure (m^2)																					
	1A	1B	1C	1D	2A	2B	2C	2D	2E	2F	2G	2H	2I	2J	2K	2L	3A	3C	3D	4B	4C	4D
House	38.1	105.0	89.3	0.0	362.6	977.0	315.3	195.0	162.0	346.3	4,424.5	683.3	5,257.1	2,586.6	154.6	742.1	200.0	76.5	105.9	136.6	17.5	45.6
House/ shop	12.0	0.0	0.0	0.0	98.3	677.7	196.7	56.5	98.6	134.1	2,743.2	190.1	1,869.1	1,248.5	0.0	275.1	0.0	29.4	0.0	31.2	0.0	0.0
Shop/ restaurant	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	49.6	15.0	45.0	82.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Grange/ storage	42.0	0.0	0.0	0.0	83.3	0.0	31.4	13.4	11.7	0.0	265.0	30.0	104.8	94.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Craft/ workshop	0.0	0.0	0.0	0.0	166.6	422.3	549.5	0.0	0.0	64.2	614.7	15.3	1,066.6	289.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other	82.5	0.0	59.3	53.0	500.7	2,004.7	906.2	34.1	259.6	235.5	6,250.9	213.7	2,853.8	1,808.4	0.0	10.2	0.0	22.0	0.0	40.0	0.0	0.0
Total	174.7	105.0	148.7	53.0	1,211.4	4,081.6	1,998.9	299.0	531.9	780.2	14,347.9	1,147.4	11,196.3	6,110.1	154.6	1,027.4	200.0	127.9	105.9	207.8	17.5	45.6

Data source: Project Survey conducted in August-September 2011 and February 2012

(3) Affected Crops and Trees

The start of civil works and the cropping schedule of AHs cultivating within the ROW and bypass will be synchronized to allow smooth transition between harvesting of standing crops and the start of road construction in a particular section of the Project road. With regard to fruit and timber trees, a total of 38,363 various species and age along NR 5 and the two bypasses have been counted during the IOL. Except for some trees along BTB Bypass, most are not commercially grown, meaning they are sporadically planted inside the ROW.

18.5 Socio-Economic Profile Of The Affected Households

During the IOL survey, an SES of AHs was also conducted. Most AHs, losing partially or entirely their assets such as structures, lands and/or trees, were interviewed for the purpose of gaining more information on their situation and present living standards. This activity was carried out aiming to prepare a more responsive RAP for people and households affected by the Project. Since there were instances when the AHs were unattended to during the survey, only 1,656 AHs along the existing NR 5 and the bypasses have been interviewed. The number of AHs interviewed represented 73.11% of all AHs.

The topics investigated in the survey were basic demography, literacy and education, economically active population, housing condition, possession of durable goods and livestock, household expenditure and income.

Additionally, the survey was also directed to studying the perception of AHs on the Project.

18.5.1 Population and Household Composition

The total number of household was 1,656, which is equivalent to a total of population of 8,302, comprising of 4,231 females (51.0%) and 4,071 males (49.0%). Shown in Table 18.5-1 are the details on population, sex ratio, as well as, household size of the two provinces. The average household size of 5.0 is the same between Battambang and Banteay Meanchey provinces.

Table 18.5-1 Population and Household Composition

Stratum	Number of H/H	Average H/H size	Population						Sex Ratio (Male to Female)
			Both	Male		Female			
				No.	%	No.	%		
Battambang	976	5.0	4,893	2,378	48.6	2,515	51.4		94.6
Banteay Meanchey	680	5.0	3,409	1,693	49.7	1,716	50.3		98.7
Total	1,656	5.0	8,302	4,071	49.0	4,231	51.0		96.2

18.5.2 Vulnerable Household

Based on the IOL, the vulnerable AHs are 434 AHs as counted on family basis. The SES indicates different vulnerable groups, which include elderly without support from their families, widows and female-headed households, physically and mentally handicapped people, and poor households with income below the national poverty line. Table 18.5-2 shows that 14.8% of surveyed samples are widows and female-headed households. Poor women, as heads of household, have put themselves by necessity to take men's roles and responsibilities, due to absence of male labor and inability to hire adult male labor. Female-headed households indeed face double burden of taking care of the well-being of family members and many aspects, as compared to households with couples. Based on the survey results, nearly 2% of household heads are disabled. Aged[5] household heads are 19.7%, and about 2% of AHs are living below the national poverty line (<USD20/capita/month). About 4.5% of them are landless households.

Table 18.5-2 Vulnerable Household (Head)

Stratum	No. of H/H	Aged (≥60 Yrs)		Female H/H		Disable H/H		Landless		< US$20/month/cap.	
		No.	%	No.	%	No.	%	No.	%	No.	%
Battambang	976	187	19.2	148	15.2	14	1.4	6	0.6	24	2.5
Banteay Meanchey	680	139	20.4	97	14.3	15	2.2	68	10.0	8	1.2
Total	1,656	326	19.7	245	14.8	29	1.8	74	4.5	32	1.9

Data source: Project Survey conducted in August-September 2011 and February 2012
** Sex Ratio: (Number of male)/(Number of female)x100(%)*

5 Aged was defined as a person who is more than 60 years old and without young to support.

18.5.3 Literacy of the Affected Households Heads and Spouses

The literacy rate of male household heads is 95.2% while that of female spouses is 88.1%. There is a small gap between the literacy rates of male household heads and their spouses. Among the 245 female household heads, only 176 (71.8%) are literate. Women in general receive less education than men, and are less literate by about 5% to even more than 10%. Therefore, women enter the labor market with lower education and less vocational skills than men.

Table 18.5-3 Literacy of Affected Households' Heads and Spouses

Stratum	Male HH Heads (%)	Female HH Heads (%)	Female Spouses (%)
Project Survey	95.2	71.8	88.1
BTB	94.9	72.3	87.1
BMCH	95.5	71.1	87.5

Data source: Project Survey conducted in August-September 2011 and February 2012

18.5.4 Educational Attainment of the Population

Since 2000, education for all Cambodians has been re-energized by the world's commitment to the Millennium Development Goal (MDG). Based on its commitment toward the MDG, RGC, with assistance from donors and NGO communities, has made efforts to develop a National Education Plan. Furthermore, the Ministry of Education, Youth and Sport has developed the Education for All (EFA) policy documents. Cambodian MDG (CMDG) aims 'to ensure that by 2015, children everywhere will be able to complete a full course of 9-year basic education'.

Table 18.5-4 Education Attainment of the Population

Stratum	Sex	No or Little	Primary Not Completed	Completed Primary Education	Completed Lower Secondary Education	Completed Upper Secondary Education	Post-Secondary Education
		%	%	%	%	%	%
Project Survey	Male	9.8	25.6	26.8	20.4	10.0	7.4
	Female	16.0	29.8	24.6	17.0	7.8	4.9
	Both	13.0	27.7	25.6	18.7	8.9	6.1
BTB	Male	9.5	25.9	26.0	20.8	10.2	7.6
	Female	15.9	29.0	24.0	17.8	8.5	4.9
	Both	12.8	27.5	24.9	19.2	9.3	6.2
BMCH	Male	10.2	25.2	27.8	19.9	9.8	7.0
	Female	16.3	30.9	25.5	15.8	6.7	4.8
	Both	13.2	28.1	26.7	17.8	8.2	5.9

Data source: Project Survey conducted in August-September 2011 and February 2012

In the Project area, 13.0% of the population has no or only little education. The difference between sexes is nearly double with 9.8% for males and 16% for females. Around 25.6% has at least completed primary education. The low proportion of persons completing primary education is a problem because for children to be classified as literate, they must at least complete grades 4 or 5. As shown in Table 18.5-4, there are only 8.9% who have completed upper secondary schooling, and 6.1% who have attended post-secondary education. The gap between sexes increases for higher level of education, i.e. 7.4% of males have post-secondary education, compared to females, which is only 4.9%.

18.5.5 Affected Households' Heads Engaged in Farming and Non-farming

About 40.5% of household heads are working on farms, while non-farming is 53.7%. (Other rests (5.8%) are aged or disable and unable to work.) Table 18.5-5 shows that the percentage of household heads working on farms is highest in BTB with 46.2%, at locations where the bypass mostly traverses through rice fields and orchard land. A sizeable number of male and female household heads surveyed (591 persons or 41.9% and 79 persons or 32.2%, respectively) are engaged in farming.

Table 18.5-5 Farming and Non-farming Affected Households' heads

Stratum	Number of Households		Non-farming		Farming	
			No.	%	No.	%
Project Survey	Male	1,411	762	54.0	591	41.9
	Female	245	127	51.8	79	32.2
	Total	1,656	889	53.7	670	40.5
BTB	Male	828	402	48.6	395	47.7
	Female	148	71	48.0	56	37.8
	Total	976	473	48.5	451	46.2
BMCH	Male	583	360	61.7	196	33.6
	Female	97	56	57.7	23	23.7
	Total	680	416	61.2	219	32.2

Data source: Project Survey conducted in August-September 2011 and February 2012

18.5.6 Main Sources of Income of Affected Households

According to the survey, the main sources of income of the AHs include 59% agricultural production, followed by 56.6% business/trade, and 47.2% depend on wages/salary. Remittance is also a main source of household income with 14.3%, which includes most family members migrating to other places to find jobs and send money back home.

Table 18.5-6 Main Sources of Income of the AHs

Province	Project Survey		BTB		BMCH	
Number of Households	1,656		976		680	
Item	No.	%	No.	%	No.	%
Wages/salary	781	47.2	403	41.3	378	55.6
Farming hired labor	84	5.1	62	6.4	22	3.2
Business/trade	938	56.6	540	55.3	398	58.5
Agricultural production	977	59.0	630	64.5	347	51.0
Livestock	226	13.6	163	16.7	63	9.3
Fishing	27	1.6	18	1.8	9	1.3
Equipment making	42	2.5	33	3.4	9	1.3
Equipment rental	22	1.3	21	2.2	1	0.1
Transportation	61	3.7	35	3.6	26	3.8
House/land rental	112	6.8	72	7.4	40	5.9
Remittance	236	14.3	138	14.1	98	14.4
Other	256	15.5	221	22.6	35	5.1

Data source: Project Survey conducted in August-September 2011 and February 2012

18.5.7 Household Income of the Affected Households by Sex

For purposes of the survey, household income included earnings and receipts from all sources received by all household members during the last year. Participants in the economic activity include employers, own account workers, employees or unpaid family workers, rentals (house, land, equipment, etc.) or recipient of pensions, grants, etc.

A significant number (74.1%) of male household heads reported that they are earning an annual income of USD 3,000 or higher, while 8.2% reported an annual income between USD 2,500 and USD 3,000. Only 0.6% of the male household heads reported that their earnings are less than USD 500 a year.

Table 18.5-7 Annual Income (USD) of AHs Headed by Males

Stratum	<= 500		500+ - 1,000		1,000+ - 1,500		1,500+ - 2,000		2,000+ - 2,500		2,500+ - 3,000		3,000+		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Project	8	0.6	16	1.1	53	3.8	89	6.3	84	6.0	115	8.2	1,046	74.1	1,411	100.0
BTB	5	0.6	11	1.3	37	4.5	55	6.6	54	6.5	64	7.7	602	72.7	828	100.0
BMCH	3	0.5	5	0.9	16	2.7	34	5.8	30	5.1	51	8.7	444	76.2	583	100.0

Data source: Project Survey conducted in August-September 2011 and February 2012

Likewise, a significant number (53.5%) of female household heads reported that they are earning an annual income of USD 3,000 or higher, while 13.1% reported an annual income between USD 2,000 and USD 2,500. Only 0.8% of female household heads reported that their earnings are less than USD 500 a year.

Table 18.5-8 Annual Income (USD) of AHs Headed by Females

Stratum	<= 500		500+ - 1,000		1,000+ - 1,500		1,500+ - 2,000		2,000+ - 2,500		2,500+ - 3,000		3,000+		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Project	2	0.8	16	6.5	23	9.4	22	9.0	32	13.1	19	7.8	131	53.5	245	100.0
BTB	2	1.4	12	8.1	13	8.8	15	10.1	22	14.9	10	6.8	74	50.0	148	100.0
BMCH	0	0.0	4	4.1	10	10.3	7	7.2	10	10.3	9	9.3	57	58.8	97	100.0

Data source: Project Survey conducted in August-September 2011 and February 2012

Table 18.5-9 shows the sources of cash income of all interviewed households (1,656). It reveals that the average monthly household income is USD 340.00. Business/trade is the main source of income for 52.7% of the households in the Project area. Wages or salary is the second main source of income for 20.3% of the households, while the third is agricultural production with 14.7%.

Table 18.5-9 Average Annual and Monthly Income by Household and Capita

Items	Total Annual Income Share		Number of Households by Income Sources*	
	USD	%	Number	%
Wages/salary	1,370,718	20.3	781	20.8
Farming hired labor	24,463	0.4	84	2.2
Business/trade	3,559,239	52.7	936	24.9
Agricultural production	989,361	14.7	977	26.09
Livestock	32,825	0.5	226	6.0
Fishing	3,194	0.0	27	0.7
Equipment making	107,669	1.6	42	1.1
Equipment rental	46,425	0.7	22	0.6
Transportation	104,833	1.6	60	1.6
House/land rental	22,979	0.3	112	3.0
Remittance	35,400	0.5	236	6.3
Other	455,264	6.7	256	6.8
Total	6,752,370	100.0	3,759	100.0
Currency	Annual		Monthly	
Total	6,752,370 USD		562,698 USD	
Household income**	4,078 USD		340 USD	
Capita income***	816 USD		68 USD	

** Each household gets income from more than one source*
*** [Household income]=[Total Annual Income]/[Total Number of Interviewed HHs]=6,752,370/1,656*
**** A HH has 5 persons in average. (Capita income=Household income / 5)*
Data source: Project Survey conducted in August-September 2011 and February 2012

18.5.8 Credit

People have taken credits or loans from various agencies, both private/official and non-official credit institutions. The survey showed that 45.6% (755 of 1,656) of the total interviewed households are able to access credit. Most of the credit sources include 15.9% from government/bank institutions, 20.0% from NGOs, 25.8% from credit providers, 22.4% from relatives, 13.4% from landlords/traders, and 2.5% from other sources.

Table 18.5-10 Credits Acquired During the Last Year

	Number of HHs	Received credits		Private Bank*		NGOs/ Society		Landlord/ Traders		Credit Providers		Relatives		Others	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Project	1,656	755	45.6	120	15.9	151	20.0	101	13.4	195	25.8	169	22.4	19	2.5
BTB	976	439	45.0	67	15.3	86	19.6	60	13.7	114	26.0	97	22.1	15	3.4
BMCH	680	316	46.5	53	16.8	65	20.6	41	13.0	81	25.6	72	22.8	4	1.3

** No AHs take credit from government institution.*
Data source: Project Survey conducted in August-September 2011 and February 2012

Generally, most people acquire loans for various reasons, such as for farming, health treatment, starting/improving business, and family support. As shown in Table 18.5-11, most households (62.9%) get loans for improving their businesses. It is followed by farming activities with 26.1%, and then by health care with 15.4%. As for the remaining, 14.0% is for supporting family members, 10.6% is for schooling costs, 8.2% is for food consumption, and 8.1% is for building/repairing houses. Only 4.5% acquire loans to finance special ceremonies or weddings.

Table 18.5-11 Purposes of Acquiring Credit

Items	Project		BTB		BMCH	
	No.	%	No.	%	No.	%
Number of Households	755		439		316	
Food consumption	62	8.2	25	5.7	37	11.7
Health care	116	15.4	54	12.3	62	19.6
Schooling costs	80	10.6	29	6.6	51	16.1
Building/repairing house	61	8.1	23	5.2	38	12.0
Ceremony/wedding	34	4.5	13	3.0	21	6.6
Farming	197	26.1	138	31.4	59	18.7
Business improving	475	62.9	253	57.6	222	70.3
Supporting family members	106	14.0	55	12.5	51	16.1
Others	22	3.0	16	3.6	6	1.9

Data source: Project Survey conducted in August-September 2011 and February 2012

18.5.9 Sanitation

(1) Water Sources for Drinking and Cooking

Of the interviewed households in the Project area, only 2.1% use pipe water from waterworks and 12.7% from protected wells. Moreover, 41.6% buy clean water during the dry season for their daily consumption. Approximately, 65.2% use rainwater during the wet season, while 2.6% use water from the stream/river. On average, people spend around one hour per day to fetch water for their household consumption. Lake/pond was the source of drinking water for 23.6% (or 390 AHs) of the 1,656 AHs surveyed, while 2.6% still use water from unprotected wells (see Table 18.5-12 for details).

Table 18.5-12 Water Sources for Drinking and Cooking

Stratum	Number of HHs	Stream/River		Lake/Pond		Protected Well		Unprotected Well		Rainwater		Buying		Waterworks	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Project	1,656	43	2.6	390	23.6	210	12.7	43	2.6	1,080	65.2	689	41.6	34	2.1
BTB	976	28	2.9	289	29.6	159	16.3	28	2.9	665	68.1	338	34.6	26	2.7
BMCH	680	15	2.2	101	14.9	51	7.5	15	2.2	415	61.0	351	51.6	8	1.2

Data source: Project Survey conducted in August-September 2011 and February 2012

About 72.2% of AHs always boil their drinking water. Boiling water is by far the most common method. In addition, 8.9% also do it sometimes, while 19% never boil water for drinking.

Table 18.5-13 Households Boiling Water for Drinking

Stratum	Number of Households	Households Boiling Water for Drinking					
		Always		Sometimes		Never	
		No.	%	No.	%	No.	%
Project Survey	1,656	1,195	72.2	147	8.9	314	19.0
BTB	976	743	76.1	91	9.3	142	14.5
BMCH	680	452	66.5	56	8.2	172	25.3

Data source: Project Survey conducted in August-September 2011 and February 2012

Approximately 42.5% of interviewed households have to buy water for washing/bathing during the dry season. Lake/pond, well and rainwater are also the most common water sources for the local people (see Table 18.5-14 for detailed information).

Table 18.5-14 Water Sources for Washing and Bathing

Stratum	Number of HHs	Stream/River		Lake/Pond		Protected Well		Unprotected Well		Rainwater		Buying		Waterworks	
		%	No.	%	No.	%	No.	%	%	No.	%	No.	%	No.	%
Project	1,656	63	3.8	498	30.1	283	17.1	60	3.6	382	23.1	704	42.5	60	3.6
BTB	976	34	3.5	373	38.2	200	20.5	35	3.6	250	25.6	277	28.4	50	5.1
BMCH	680	29	4.3	125	18.4	83	12.2	25	3.7	132	19.4	427	62.8	10	1.5

Data source: Project Survey conducted in August-September 2011 and February 2012

(2) Toilet

The type of toilet facility is taken as a measure of sanitary condition. There have been some changes in toilet facilities in dwelling places in Cambodia over the last seven years. In 2004, about 75% of all households still do not have a toilet facility in their dwelling places (CSES 2004).

In the Project area, 79.8% of households have a latrine. Only 20.2% of households do not have access to toilet facilities as they depend on “open defecation” or sharing toilets with their neighbours.

(3) Energy Sources for Lighting and Cooking

Battery is still the most commonly used energy source for lighting in Cambodia's rural areas. However, in the Project area, about 4% of the surveyed AHs claimed that they use rechargeable car batteries for lighting. Moreover, 90.1% use publicly provided electricity as their source, while 4.6% use kerosene lamp. About 1.5% claim that they use private generators.

Table 18.5-15 Energy Sources for Lighting

Stratum	Number of HHs	Private Generator		State Electricity		Battery		Gas/Kerosene	
		No.	%	No.	%	No.	%	No.	%
Project Survey	1,656	25	1.5	1,492	90.1	67	4.0	76	4.6
BTB	976	22	2.3	845	86.6	47	4.8	63	6.5
BMCH	680	3	0.4	647	95.1	20	2.9	13	1.9

Data source: Project Survey conducted in August-September 2011 and February 2012

Based on the survey results, 23.3% of interviewed households use liquefied petroleum gas as their source for cooking, while 66.2% and 45.2% use firewood and charcoal, respectively. About 7.5% of interviewed households in the Project area use electricity as their energy source for cooking.

Table 18.5-16 Energy Sources for Cooking

Stratum	Number of HHs	Firewood		Charcoal		Gas/Kerosene		State Electricity	
		No.	%	No.	%	No.	%	No.	%
Project Survey	1,656	1,097	66.2	748	45.2	386	23.3	125	7.5
BTB	976	674	69.1	384	39.3	231	23.7	57	5.8
BMCH	680	423	62.2	364	53.5	155	22.8	68	10.0

Data source: Project Survey conducted in August-September 2011 and February 2012

18.5.10 Transportation

Bicycles are more commonly used as a mode of transportation in rural areas, while motorcycles are more conveniently and more commonly used in urban areas. In the study, it reveals that around 62.5% of interviewed households have bicycles and 77.2% have motorbikes. Only a small amount of households have trucks, at about 3.3%, and 10.8% have a car/pickup/minivan. It was estimated that the average value of transport equipment in the Project area is around USD 1,597 per household.

Table 18.5-17 Transport Equipment and Their Values

Mode of Transport	Total Value (KHR)	Total Households = 1,656	
		No.	%
Bicycle	83,156,600	1035	62.5
Motorbike	4,648,626,400	1279	77.2
Bamboo rail	1,000,000	1	0.1
Car/pickup/minivan	4,443,450,900	179	10.8
Truck	1,391,700,000	54	3.3
Boat without engine	8,724,000	23	1.4
Grand Total	10,576,657,900 (KHR)		
Average/Household	6,386,871 (KHR)	1,597 (USD)	

Exchange rate: USD 1 = KHR 4,000
Data source: Project Survey conducted in August-September 2011 and February 2012

18.5.11 Household Appliances

Telephones are the most common household appliance among the AHs surveyed, with 1,497 households (90.4%) reporting that they own at least one up to more than five. The second most common appliance is TV/VRC/VCP (84.6%). Table 18.5-18 shows the percentage of households owning other types of electrical appliances, such as 24.2% owning radio/cassette players, and 10.3% owning refrigerators. A small proportion of households owns equipment for convenience such as generators at 4.2%, washing machines at 3.9%, and air conditioners at 3.7%. It was estimated that the average value of other assets in the target area is around USD 173 per household.

Table 18.5-18 Household Appliance and Its Values

Stratum	Total Value (KHR)	Total Households = 1,656	
		No.	%
Radio/cassette player	27,986,000	400	24.2
TV/VCR/VCP	367,608,300	1401	84.6
Sewing machine	16,410,000	41	2.5
Air conditioner	106,400,000	62	3.7
Washing machine	41,975,000	64	3.9
Refrigerator	143,593,000	170	10.3
Telephone	367,331,503	1497	90.4
Generator	71,815,000	70	4.2
Grand Total	1,143,118,803 (KHR)		
Average/Household	690,289 (KHR)	173 (USD)	

Exchange rate: USD 1 = KHR 4,000
Data source: Project Survey conducted in August-September 2011 and February 2012

18.5.12 People Perception on the Project

(1) Satisfaction with the Project

The AHs showed their satisfaction with the project with 13.2% reporting that the project is "very good" and 52.6% saying it is "good". However, about 30.3% of the total households said it is both "good and bad".

Table 18.5-19 Satisfaction with the Project

Items	Project		BTB		BMCH	
	No.	%	No.	%	No.	%
Number of H/H	**1,656**		**976**		**680**	
No answer	15	0.9	6	0.6	9	1.3
Bad	50	3.0	31	3.2	19	2.8
Good and bad	501	30.3	292	29.9	209	30.7
Good	871	52.6	476	48.8	395	58.1
Very good	219	13.2	171	17.5	48	7.1
Total	**1,656**	**100.0**	**976**	**100.0**	**680**	**100.0**

**"Good" and "Bad": The percentage of answer to the question "Three Most Important Benefits of the Project" in the survey.*
"Bad": Project they will: 1) loss of good trading site; 2) loss of land use in PRW; 3) affect on house/shop; 4) Decrease household income due to construction civil works; 4) Loss of occupation.
Data source: Project Survey conducted in August-September 2011 and February 2012

(2) Important Benefits of the Project

In the improvement areas, around 67.33% of AHs believed that the project will help decrease travel congestion/accident and 49.76% said it will improve access to other facilities. About 40.46% have responded that the project will improve cargo transportation. Please refer to Table 18.5-20 for more detailed information.

Table 18.5-20 Three Most Important Benefits of the Project

Benefit	Total H/H=1,656							
	Total		First Most Important		Second Most Important		Third Most Important	
	No.	%	No.	%	No.	%	No.	%
Improve cargo transportation	670	40.46	355	52.99	190	28.36	125	18.66
Increase land price	225	13.59	46	20.44	97	43.11	82	36.44
Reduce daily expenditures	112	6.76	7	6.25	38	33.93	67	59.82
Decrease congestion/accident	1,115	67.33	628	56.32	344	30.85	143	12.83
Improve access to other facilities	824	49.76	237	28.76	314	38.11	273	33.13
Prevent flooding	37	2.23	4	10.81	14	37.84	19	51.35
Improve travel of tourist	421	25.42	103	24.47	189	44.89	129	30.64
Improve environment	326	19.69	45	13.80	109	33.44	172	52.76
Push development to outskirts area	453	27.36	109	24.06	111	24.50	233	51.43
Attract more investment	113	6.82	8	7.08	49	43.36	56	49.56
Create more direct/indirect job	300	18.12	41	13.67	110	36.67	149	49.67
Improve local product marketing	115	6.94	8	6.96	19	16.52	88	76.52

Data Source: Project Survey conducted in August-September 2011 and February 2012

(3) Perception of AHs on Relocation

In terms of the perception of AHs concerning relocation due to the Project, 90.8% of interviewed households said that they agree to move from the PRW but will need some assistance from the Project. Meanwhile, 6.8% replied that they will voluntarily move without any compensation or assistance. About 2.1% did not answer. However, 0.2% of AHs refused to move from the PRW. (see Table 18.5-21 for details)

Table 18.5-21 Perception of AHs on Relocation

Stratum	Number of Households	No Answer		Refuse to Relocate		Agree with Assistance		Voluntarily Move	
		No.	%	No.	%	No.	%	No.	%
Project	1,656	35	2.1	4	0.2	1,504	90.8	113	6.8
BTB	976	20	2.0	3	0.3	870	89.1	83	8.5
BMCH	680	15	2.2	1	0.1	634	93.2	30	4.4

Data source: Project Survey conducted in August-September 2011 and February 2012

18.6 Organizational Framework

The owner of the Project is the Executing Agency (EA) which is MPWT; therefore, it has overall responsibility for the successful implementation of the RAP. The EA will be assisted by a number of offices within and outside MPWT, starting with the Project Management Unit (PMU) which is tasked with undertaking the Project. The Environmental Section of PMU (PMU-ES) will be established to work closely with the RD (Resettlement Department) of the Inter-ministerial Resettlement Committee (IRC) for the preparation, updating, and implementation of the RAP.

18.6.1 The Environmental Section of the Project Management Unit (PMU-ES)

PMU-ES of MPWT under guidance of IRC will work closely with RD/MEF as the lead arm of the PMU in the preparation and implementation of the RAP.

Its tasks include the followings:

(i) Secure the approval of the RAP by IRC;

(ii) Secure prior approval from IRC and JICA for any variations in the approved RAP;

(iii) Secure the database of AHs and assets that will be gathered during the preparation and updating of the RAP;

(iv) Prepare progress reports on RAP implementation for submission to MPWT, PMU and JICA.

18.6.2 The Inter-ministerial Resettlement Committee (IRC) and the Resettlement Department (RD)

IRC is a collegial body headed by the representative from MEF and composed of representatives from concerned line ministries, such as the Ministry of Interior; MPWT, MLMUPC; MEF and MAFF. Created by the Prime Minister through *Decision No.13, dated 18 March 1997,* in connection with the resettlement of AHs in the Highway 1 Project (Loan 1659-CAM), IRC has since been involved in other foreign-assisted government infrastructure projects with involuntary resettlement. IRC will be established on ad hoc basis for each project upon the request from Executing Agency. RD is a secretariat of IRC and will work closely with other relevant institutions to deal with all resettlement issues caused by the project. The IRC will be established for NR 5 project.

The institutional setup for resettlement and land acquisition is indicated in Figure 18.6-1.

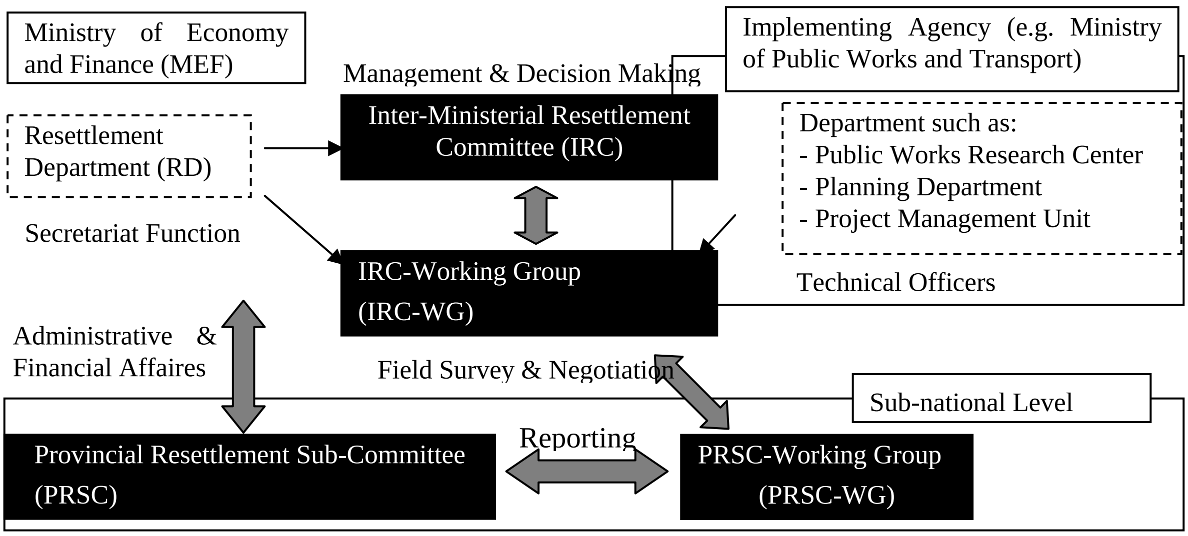


Figure 18.6-1 Inter-Ministerial Resettlement Committee (IRC) and relevant organizations

IRC will assume the function of a quasi-regulatory body, ensuring that funds for resettlement are spent properly and that the RAP is carried out as intended. The technical arm of IRC is its RD.

The RD will assist IRC in the following tasks:

(i) Reviewing and approving the RAP, ensuring its consistency with JICA Guidelines and, later, the loan agreement;

(ii) Submitting the approved RAP to JICA;

(iii) Request to Provincial Governor to establish PRSC and PRSC-WG;

(iv) Orienting, as needed, PRSC and its WG (PRSC-WG) on their tasks relative to RAP updating and implementation;

(v) Manage and supervise the implementation of RAP such as DMS;

(vi) Negotiation and Contract making with APs;

(vii) Securing from the national treasury the budget for carrying out the RAP, ensuring that funds are available in a timely manner and in sufficient amounts;

(viii) Ensuring the approval of all disbursements connected with the implementation of the RAP, such as payment for compensation and other entitlements, acquisition and preparation of replacement plots, operational expenses of personnel, etc.;

(ix) Ensuring that funds for resettlement are spent judiciously; and

(x) Hire External Monitoring Agency to monitor the implementation of the RAP, ensuring that this is carried out in compliance with the Project resettlement policy and with the loan agreement.

18.6.3 Provincial Resettlement Sub-Committee

The Provincial Resettlement Sub-Committee (PRSC) is a collegial body at the provincial level. Headed by the Provincial Governor or Provincial Vice-Governor, its members are provincial department directors of line ministries represented in IRC, and also the chiefs of the districts and communes traversed along the Project road.

The technical arm of PRSC is PRSC-WG, which is headed by the Director (or a representative) of the Provincial Department of Public Works and Transport (PDPWT). The regular members of PRSC-WG come from the Provincial Government, the Provincial Department of Economy and Finance (PDEF), and the Ministry of Interior.

In an effort to make the whole process of resettlement effective, participatory and transparent, the chiefs of the affected communes and villages in affected communes will seat in PRSC-WG to tackle matters concerning their respective areas of jurisdiction.

PRSC, through PRSC-WG, will have the following functions:

(i) Facilitate a sustained public information campaign, ensuring that the public, especially the AHs, are updated on any development regarding the Project and resettlement activities;

(ii) Cooperate with IRC-WG in conducting the implementation of RAP and assist public consultation and information disclosure meeting;

(iii) Manage the delivery of compensation and other entitlements to the AHs;

(iv) Receive and act on the complaints and grievances of AHs in accordance with the Project resettlement policy; and

(v) Maintain a record of all public meetings, grievances, and actions taken to address complaints and grievances.

18.7 Implementation Schedule

During the detailed design stage, DMS and RCS will be conducted under management of IRC-WG. DMS will be implemented by IRC-WG in close cooperation with PRSC-WG and relevant local authorities. RSC will be updated by independent agency hired by IRC. Based on the result of DM an RCS, IRC will calculate compensation amount and request budget disbursement to RGC.

During the DMS, consultation meeting will be held and project information booklet will be distributed to all AHs by IRC-WG assisted by PRSC-WG. The information program will precede the marking of the PRW. Grievance procedures and structure will be established prior to DMS. The preparation for the updating of the RAP will follow immediately after the final identification survey and DMS.

After the compensation amount is expected to be undertaken simultaneously for different sections of the road, the compensation process, including agreement and certified record of quantities and valuation of properties and physical payment of cash compensation and formal transfer of property in the form of land will take place before any construction start in a designated stretch of the road. Compensation payments are made at least 30days before construction starts. The external monitor will be conducted during all of the above stages of implementation of the RAP. The external monitor’s benchmark survey will be carried out prior to any physical relocation of AHs and AH structures.

IRC will mobilize its working group to work closely with PRSC-WG and the EMA before commencement of any resettlement activities, i.e., before RAP updating. Land acquisition and relocation of AHs will not commence until the updated RAP has been reviewed and approved by both IRC and JICA.

MPWT will ensure that contractor will not be issued notice to commence for any part of a section of a road to begin construction work unless it has (a) satisfactorily completed in accordance with the approved updated RAP, compensation payment and relocation; (b) ensured that income restoration program is in place; and (c) area required for civil works is free of all encumbrances. Table 18.7-1 summarizes the various inter-related activities connected with the updating and implementation of the RAP.

Table 18.7-1 Indicative Schedule of Resettlement Activities

ACTIVITIES	SCHEDULE
JICA Approval of Draft RAP	Aug 2012
RAP Updating following Detailed Design	October 2013 to March 2014
Submission and JICA Approval of Updated RAP	April 2014
Implementation of the Approved Updated RAP	May 2014-May 2015
Internal Monitoring (Submission of Quarterly Progress Reports)	May 2014-
External Monitoring (Intermittent)	June 2014 to Feb 2016
Post-evaluation	May-June 2017
Start of Civil Works*	June 2015

** For sections where there are no resettlement impacts.*

18.8 Public Participation and Consultation

Stakeholders of the Project include provincial/district, commune/village officials, local people along the existing NR 5, BTB and SS Bypass, and managers and staff of PDPWT (See Table 18.8-1). Participation provides for the opportunity and the process by which stakeholders influence and become co-responsible for development initiatives and decisions that affect them. Through participation, the needs and priorities of the local population are solicited; the adverse social impacts of the Project, including the corresponding mitigating measures, are collectively identified; and the commitment and feeling of ownership over the Project is engendered among the AHs.

18.8.1 Participatory Activities in RAP Planning

The public, especially the AHs, local governments and road users will be consulted and their opinions solicited, and they will in fact participate in the preparation of the RP. Table 18.5-1 below summarizes the roles and responsibilities of the executing agency, local governments, and the AHs in the RP preparation.

Table 18.8-1 Roles and Responsibilities of Key Stakeholders in the RP Planning

Project Process Stage	Participatory Activities and Participants	Outputs	Responsible Institution
Preparation or Feasibility	Briefing of the provincial, district, commune, village officials, local people along NR 5 and BTB Bypass, and PDPWT about the Project technical assistance, the resettlement impact, and activities of the consultant (provincial and first commune stakeholder meeting).	The local population including AHs and their representatives, local government officials, and managers and technical staff of PDPWT participated in the meeting and were consulted on the objectives, planning and impact of the project and of resettlement.	MPWT and Consultant (JICA Study Team)
	Conduct of IOL, census of APs, social impact assessment, and RCS.	An IOL, census of AHs and RCS were conducted and the results were included in the RAP.	Consultants (JICA Study Team), assisted by local authorities and PDPWT.
	Discussion/consultation with IRC-RD and PMU-MPWT about the proposed project resettlement policy.	IRC were made fully aware of and consulted about social impact and resettlement policy.	Consultant (JICA Study Team)
	Initial disclosure meeting with AHs to discuss the results of the IOL and gather suggestions on how to minimize and mitigate impacts, and discuss about relocation options (second commune stakeholder meeting).	AHs and community leaders are informed of social impact and any damage or loss of property including land losses, and consulted on impact mitigation and resettlement including any relocation.	MPWT and Consultant (JICA Study Team)
	Drafting of the RAP and project information booklet (PIB)[6] and submission to PMU-MPWT, IRC-RD and JICA for review and approval.	Draft of RAP and PIB will be provided to and reviewed by MPWT, IRC-RD and JICA for approval.	Consultant (JICA Study Team)

18.8.2 Public Consultations during RP Preparation

During RAP preparation stage, the following public consultations were held at different stages.

(i) Provincial stakeholder meeting

(ii) Public Consultation Meeting (before cut-off date)

(iii) Public Consultation Meeting (after cut-off date)

(1) Schedule of Stakeholder Meeting

The stakeholder meetings were held along the NR 5 as schedule below:

[6] The Project information booklet will be written in Khmer. The PIB will be distributed to each AH during the DMS, and updated PIB will be distributed before signing contract with AHs. An English version draft of PIB in *Appendix 1: Project Information Booklet (English Draft Version)* will be translated in Khmer and be distributed during the DMS. The updated PIB to be distributed before signing contract with AHs, information of rehabilitation options (including outline of IRP) will be added.

Table 18.8-2 Public Meetings Held Regarding National Road No. 5 and the Two Bypasses

Province	District/Commune	Venue	Date	Participants
Provincial Stakeholder Meeting				
Kampong Chhnang	Krong Kampong Chhnang	PDPWT Office	18 May 2011 at 9:00 am	9
Pursat	Krong Pursat	PDPWT Office	18 May 2011 at 3:00 pm	7
BTB	Krong Bat Dambang	PDPWT Office	19 May 2011 at 9:00 am	14
BMCH	Krong Sri Sophorn	PDPWT Office	19 May 2011 at 3:00 pm	13
Public Consultation Meeting (before cut-off date)				
BMCH	Mongkol Borei District - Banteay Neang - Reussei Kroak - Battrang	Mongkol Borei District Centre	28 July 2011 at 8:00 am	Male=70 Female=40
BMCH	Krong Sri Sophorn - Preah Ponlea - Au Ambil	Samathiphall Pagoda	28 July 2011 at 10:00 am	Male=80 Female=70
BMCH	Mongkol Borei District - Phnom Tauch - Au Prasat	Mongkol Borei CPP Office	28 July 2011 at 2:00 pm	Male=90 Female=35
BTB	Local authorities from Thma Kaul district	PDPWT Office	28 July 2011 at 4:00 pm	Male=13
BTB	Local authorities from Krong Bat Dambang and Sangkae district	PDPWT Office	29 July 2011 at 8:00 am	Male=18
BTB	Thma Kaul district - Boeung Pring - Chrouy Sdao	Boeung Pring Commune Centre	29 July 2011 at 2:00 pm	Male=70 Female=20
BTB	Thma Kaul district - Ta Poung - Ta Moeum	Ta Poung Commune Centre	29 July 2011 at 4:00 pm	Male=60 Female=100
BTB	Thma Kaul district - Au Taky - Chrey	Au Taky Commune Centre	30 July 2011 at 8:00 am	Male=80 Female=30
BTB	Krong Bat Dambang - Aumal	Aumal Commune Centre	30 July 2011 at 9:30 am	Male=27 Female=7
BTB	Krong Bat Dambang - Watt Kor	Watt Kor Commune Centre	30 July 2011 at 11:00 am	Male=70 Female=20
BTB	Sangkae - Watt Ta Moem - Au Dambang I	Ta Moeum Pagoda	30 July 2011 at 2:00 pm	Male=45 Female=50
BTB	Sangkae - Anlong Vil - Au Dambang II	Kampong Svay Pagoda	30 July 2011 at 4:00 pm	Male=90 Female=120
BMCH	Mongkol Borei District - Bat Trang	Serey Mongkol Pagoda	23 January 2012	Male = 35 Female = 20

Province	District/Commune	Venue	Date	Participants
	- Reussei Kroak		at 9:00 am	
BMCH	Krong Sri Sophorn - Toeuk Thla - Au Ambil	Serey Mongkol Pagoda	23 January 2012 at 2:00 pm	Male = 35 Female = 20
Public Consultation Meeting (after cut-off date)				
BMCH	Mongkol Borei District - Banteay Neang - Reussei Kroak - Battrang	Mongkol Borei District Centre	29 February 2012 at 4:00 pm	Male=60 Female=63
BMCH	Krong Sri Sophorn - Tuek Thla - Au Ambil	Tuek Thla Commune Centre	29 February 2012 at 2:00 pm	Male=23 Female=15
BMCH	Mongkol Borei District - Phnom Tauch - Au Prasat	Au Snguot Pagoda	29 February 2012 at 10:00 am	Male=45 Female=27
BTB	Thma Kaul district - Boeung Pring - Chrouy Sdao	Boeung Pring Commune Centre	1 March 2012 at 8:00 am	Male=22 Female=10
BTB	Thma Kaul district - Ta Poung - Ta Moeum	Ta Poung Commune Centre	1 March 2012 at 10:00 am	Male=31 Female=19
BTB	Thma Kaul district - Au Taky - Chrey	Au Taky Commune Centre	1 March 2012 at 2:00 pm	Male=32 Female=16
BTB	Krong Battambang - Aumal	Aumal Commune Centre	1 March 2012 at 4:00 pm	Male=35 Female=32
BTB	Krong Battambang - Watt Kor	Watt Kor Commune Centre	2 March 2012 at 8:00 am	Male=38 Female=26
BTB	Sangkae - Watt Ta Moem - Au Dambang I	Ta Moeum Pagoda	2 March 2012 at 10:00 am	Male=34 Female=18
BTB	Sangkae - Anlong Vil - Au Dambang II	Kampong Svay Pagoda	2 March 2012 at 2:00 pm	Male=40 Female=34

(2) Key Points Raised and Discussed

(a) PROVINCIAL Stakeholder Meetings

Four provincial stakeholder meetings were conducted continuously in Kampong Chhnang (included Kandal and Kampong Speu province), Pursat, BTB and BMCH province. During the meetings, a representative of MPWT made a short presentation which focused on background of NR 5 and its current situation, the Project and its impacts (positive and negative), result of initial survey, information about schedule of IOL and baseline survey (in July 2011). All participants were also provided with opportunities to discuss on bypass option.

The key points raised and discussed during the pre-IOL public meetings are the followings and the questions and responses of the meeting are summarized in Table 18.8-3.

(i) Background of NR 5 and its current situation;

(ii) Project background and its impacts, both positive and negative;

(iii) Initial survey results and information about the schedule of IOL and baseline survey which will start in July 2011;

(iv) Discussion about the bypass options;

(v) Cut-off date: 1st August 2011 and 6th February 2012, and eligible persons for compensation;

(vi) Discussion of other issues, including question and answer portion.

Table 18.8-3 Questions and Responses of the Provincial Stakeholder Meeting

Question/Request	Response
Kampong Chhnang province	
They are satisfied with the Project, but worried about whether the compensation will be fair.	**Representative of MPWT**: The compensation rate will be based on the market price which will be studied by an Independent Agency, who has wide experience of asset evaluation and resettlement planning.
The best bypass option should be the one which has least affect on houses and other structures. In term of compensation payment, they would like to have detailed RCS and set up a "cut-off date" to prevent encroachment.	**Wrap up of discussion**: The best bypass option is Consultant 1 (C1), because: - Less affected houses if comparing to other options; - No job or business will be affected; - Even though there is more affect on rice fields, there is less impact on the livelihoods of AHs resulting from effects on houses or shops; - The bypass is shorter about 7 km than the existing NR 5; - There is more potential for developing and extending the Kampong Chhnang city.
Pursat province	
People knew about ROW (30m-30m) and that it is state land and there will be no compensation for the affected land in the ROW. They suggested the Project construct one bridge in Kam Peat village between PK: 155 and PK: 158 to provide protection from water from upstream of NR 5 which might cause the road to be destroyed further.	**MPWT**: There is no compensation for land in PRW (ROW), but the Government will compensate for affected assets (structures and trees/crops). **Representative of MPWT**: The middle section of NR 5 is still in a good condition. It is better to rehabilitate north and south section first. A request will be made to Local Authority to instruct the Provincial Resettlement Sub-Committee to protect the ROW from any further influx of illegal settlers. Receiving the request, the Project will conduct a study abouta bridge between PK: 155-158.

Question/Request	Response
Battambang province	
He proposes that MPWT select the Consultant 3 bypass option (C3) due to some reasons: - Small impact on houses; and - In northern area, there is not yet any high way.	**MPWT**: Asked that the participants should have more options and also to discuss about negative impact on each option. In case C3 is not feasible, another option shall be considered. **Governor of Moung Reussei district**: He knew that the area for C3 is subject to flooding. In some places the water level is about 2m high or more. **Wrap up of discussion**: After discussion about C3, the participants have found: - The land in the area is not suitable to construct a road because it requires the construction of many bridges for relief water from upstream to Tonle Sap Lake. That would require much more cost than the other options; - The land is also very soft and low. It is difficult to construct the foundation of the road; - The area is close to Zone 2 of Tonle Sap Area that requires permission from Tonle Sap Authority for the Project implementation. Another problem is that Tonle Sap Authority will not allow people to settle in Zone 2. In case people can settle there, it will also have problems for flooded forest that will be cleared by relocated people for their business purposes; - It will affect fauna and flora (fish migration and flooded forest) by changing direction of water flow from southern to northern of NR 5 and will create more flooding in southern area that already flooded in some years.
C3 would have many challenges that will require consultation with Tonle Sap Authority and MOE regarding environmental impact. Therefore, participants proposed to find out another bypass option. Participants also requested the road should develop as four lanes so that it provides sufficient space for traffic.	**Wrap up of discussion**: After discussion, the participants agreed to select C1 due to several reasons as follow: - With C1, there is less number of affected houses than the other options except for C3; - C1 has more potential for development and extension of BTB city; - It will have less impact on the environment, because the bypass will traverse through rice field and far away from Tonle Sap Lake. For the area, there is also a master plan of BTB provincial governor; - C1 is also close to BTB railway station. It is easier for cargo transfer between truck and train.
Banteay Meanchey province	
Participants proposed the option of 25m-25m PRW, as it is better than 20m-20m PRW, because Asian Highway should be international standard. They proposed that MPWT construct one bypass to reduce traffic in the town and also decrease hundreds of AHs. **Governor of Mongkol Borei and Serey Soaphaon district**: Supported these ideas proposed by the participants.	**Representative of MPWT**: He will bring the idea of the bypass construction to Minister to get approval, because in this step the study does not include the bypass option.

Question/Request	Response
Vice governor of BMCH: The bypass option is very important, because: 1) It will reduce traffic volume in city, as well as accident; 2) It will reduce negative social impact of the Project; and 3) It will provide a big push for the extension of the city.	

(b) Public Consultation Meeting (before cut-off date)

A few days before the IOL commenced on 1st August 2011 and 6th February 2012, the first of a series of public meetings with stakeholders (e.g., road users, residents of traversed communities, transport operators, government agencies, civil society, etc.) was held in BTB and BMCH Provinces by the PMU-MPWT and the Consultant (JICA Study Team) for the purpose of discussing the following:

(i) Project technical assistance background and objectives;

(ii) Main activities of the research team (i.e., conduct of socio-economic household survey, IOL, RCS, etc.);

(iii) The Project's policy on involuntary resettlement; and

(iv) Probable positive and adverse impacts of the Project, and recommendations on how to avoid and mitigate negative impacts.

After an introduction of Local Authority, Director of International Cooperation Department (ICD)/MPWT described the background of NR 5 and its current situation, background of the Project and its impacts, both positive and negative. Then, results of the Initial Survey and information about the schedule of IOL and baseline survey which will start in August 2011 and February 2012 were presented. The Cut-off date is 1st August 2011 for BTB bypass and NR 5 and 6th February 2012 for SS/BMCH bypass. In each meeting, there was also an open floor for discussion among the participants. The results of discussion are summarized in Table 18.8-4:

Table 18.8-4 Questions and Responses of the Public Consultation Meeting (before cut-off date)

Question	Response
Will the Project compensate for land improvement in PRW?	**ICD/MPWT**: If the people have been filling the land (for house construction or business activity against a pond resulted from previous road construction) in PRW, the land improvement will not be compensated, because after the road construction all the land in PRW will be reinstated by a contractor. After the Project implementation, it will be the same as or better than the original condition. All AHs do not need to worry about it, because the government and the development partner have been strongly considering the action to be taken for the project impact.
The Project implementation will affect my house. The remained land will be too small. What can the Project do for that?	**ICD/MPWT**: During the Project implement phase, RGC would have a clear policy to help AHs. In case you do not have any more land or the remained land is not suitable for living, the Project will solve the problem.
One of AHs has paid much for refill his plot in PRW, because previously it was a flooded land. Would the Project compensate for the land improvement?	**ICD/MPWT**: The Project will not compensate for the affected land in PRW because it is the ROW (public state land). Land improvement also will not be compensated, because after the road construction all the land in PRW will be reinstated as the original condition or better. The study team will conduct IOL on 1st August 2011. From that day (Cut-Off Date), all people have to stop constructing any new buildings in PRW (20m from road center line for both sides, so in total it is 40m). The IOL will record all affected structures, land and crops/trees. Local authorities and people have to closely cooperate with the study team. **Vice governor of Serey Saophoan city**: Widening of NR 5 is the government project for public interest. This means the Project is benefit for all peoples. In addition, all AHs will receive compensation for all the affected private properties.
How does the calculation apply for PRW, and from where 20m each side starts? **Participant**: We all are very happy with the Project and strongly commit to participate.	**ICD/MPWT**: the PRW will be defined as20m on each side from the road center line. So in total, it is 40m. **Vice governor of Mongkol Borei district**: The previous ROW was 25m-25m (Praka No.6), however referring to new sub-decree No.197, ROW is 30-30m. Every development project always affects properties to a greater or lesser, so all the participants are asked to cooperate with the study team.
If the project affects all my land in PRW, how does the project restore it?	**ICD/MPWT**: There are two options: 1) In case you do not have any more land, you will become landless. After DMS, the inter-mistrial committee will set up IRC-WG to solve the problem based on the policy of the approved RAP. 2) In case you have another land outside the PRW, the Project will compensate for all affected private properties (structure, crop/tree) and you can settle on your land.
When will the civil works start?	**ICD/MPWT**: According to the plan, it will be started in the middle of 2014, after feasibility study and detailed design are conducted.
Will the Project pay for the affected drainage pipes?	**ICD/MPWT**: Affected pipes will be replaced with new ones, if they are public property. In case it is a private property, the Project will compensate to the owner with replacement cost. It means people can restore their drainage by the compensation to be provided. **ICD/MPWT**: If there are affected water systems or cables, the budget for reconstruction will be covered by the budget for construction.

Question	Response
If the construction work affects religious worship places such as spirit houses, how does the Project compensate for the community?	**ICD/MPWT**: In this case, the Project will discuss with the community to find a suitable place to reconstruct it. It will ensure that the new one is the same as or better than the old one.
What size the Project will take for the PRW from Au Taki to BTB city?	**ICD/MPWT**: The section is under discussion whether the road will be widened or not, because the Project will construct another bypass around BTB city.
Where will BTB bypass be located?	**ICD/MPWT**: The bypass will start from Poster of Home advertising sign, crosses the road of H.E Prach Chan, then goes to NR 57 before it crosses Sang Ker River and continues to Kamnab pagoda along NR 5. The bypass construction will affect private land, therefore the Project will compensate to the owners at the replacement cost based on the market price. From 1st August 2011, people will not be permitted to build any structure on the PRW, particular for the bypass area. For bypass road, the study team will identify PRW alignment by pegging out in August. After, that any construction in the PRW will not be allowed, and only cropping will be permitted.
What is the size of the actual road after the construction? Is it still 40m width?	**ICD/MPWT**: No, the Project will take 40m for the road construction area (PRW), but do not mean that the actual road is 40m width. The actual road size is about 20m.According to the government policy, the Project will try to minimize its resettlement impact as much as possible.
In Sangkat Aumal, where the bypass will be constructed, most of people have land ownership certificate. If the Project affects a small part of their lands, who will responsible for making a new land ownership certificate? It costs too much, about USD 1,500 per one case.	**ICD/MPWT**: According to the Project policy, in this case (a part of land will be effected) the AH will not need to pay for any documentation or tax for the procedure required due to the Project impact. It means the Project will be responsible for this.
During the placing of the poles (to make the PRW alignment), will the local authorities join the process?	**ICD/MPWT**: Of course, the local authorities have to be involved during that time and from the beginning of the Project study.
The Project has to consider severely affected persons who cannot restore their properties by the amount of compensation provided.	**ICD/MPWT**: The government would not make someone to be suffered by the Project development. The Project policy will be approved, not only by the Cambodia government, but also by a donor of the Project. Moreover, the compensation rates (the replacement cost based on the market prices) will be studied by the independent agency. In addition, the compensation rate will refer to the different types of houses such as zincs house, concrete house, etc. It also includes labor force and construction materials and transportation fee. The construction material price will refer to the prices in the local areas of AHs. And for the trees, the compensation will refer to the different types and ages of trees such as small or medium trees. The Project is developed for public interest. It is different from private investments. The public interest was strongly considered for the Project.
Can people continue to farm on their land in the PRW of bypass?	**ICD/MPWT**: People can continue to use their land until they receive compensation payment. However, in order to avoid any loss, permanent structures such as houses or shops will not be allowed to be built.

Question	Response
Land in PRW or ROW of NR 5 belongs to the government, but people have planted their crops and trees in the area. If the crops/trees are affected by the project, do the Project compensate for it or not?	**ICD/MPWT**: The Project will compensate in order to support AHs, because their incomes will be temporarily decreased by the Project Impact.
How much per m^2 will the Project compensate for affected private land?	**ICD/MPWT**: The compensation rate is based on the market price, so the answer will be available at the Project implementation stage. Because the price in that year is the market price for the land acquisition. The current price is a market price for year 2011. It is not compensation rates because the Project will be implemented in the middle of 2014. * At the SHM, the rates of RCS conducted during the RAP preparation were not provided to AHs because the rates will not be applied for the actual compensation, however, AHs were provided with the information about "how to calculate the compensation rates".

(c) Public Consultation Meeting (after cut-off date)

After an introduction of Local Authority, Director of ICD/MPWT, presented the background of NR 5 and its current situation, the Project Entitlement such as Public Participation and Consultation, Compensation and other Allowance Entitlement, Income Restoration and Grievance Procedure. Meanwhile, summary results of the IOL Survey and Socio-economic Profile of AHs were also presented. In each meeting, there was also an open floor for discussion among the participants. The results of discussion are summarized in Table 18.8-5:

Table 18.8-5 Questions and Responses of the Public Consultation Meeting (after cut-off date)

Question	Response
What is the actual width of the ROW of NR 5?	**ICD/MPWT**: Referring to *sub-degree No.197*, dated on November 23rd 2009, chapter 3 and **Article 7&8** states that ROW is the state land (**Article 15** of *Land Law*). For National Road grade1 (one digit number e.g. NR-1, 2, 3, 4, 5, etc.), ROW will be required up to 30m for each side from the road center line. But the Project will require only 20m for each side. It means the ROW is still remained 10m for each side. Therefore, the affected land, in PRW along NR 5, will not be compensated.
How about the remained land of the ROW, can people use it?	**ICD/MPWT**: Even though the ROW width is 30m on each side, the Project requires only 20m in each side at the moment. Therefore, people still can use the remained land in ROW in purpose of farming only. They cannot construct any permanent structure or sell it to others.
Where is the Sri Sophorn bypass located? And is there a ROW for the bypass?	**ICD/MPWT**: The bypass will start from district police military office in Mongkol Borei across to Teuk Thla village/Sangkat, Sri Sophorn city close to Teuk Thla Bridge. The bypass road will not claim for any ROW, because the affected land is private land.
How will the Project compensate for private land and fruit trees?	**ICD/MPWT**: The will be divided into two types: i) Affected private land will be compensated at replacement cost based on the market price. The compensation rates will be studied by an independent agency that has wide experience of evaluation and resettlement issues. We cannot tell you the compensation rates right now, because the Project will be implemented from the middle of 2014. Therefore, the market price is the price at the year of implementation.; and ii) Compensation rates of affected fruit trees will be referred to the kind and the age of the trees. The calculation is a multiple of the period of the fruit tree to get mature (bear fruit) and its annual yield, plus seedling cost.
When the project starts to implement, some households living in PRW will become landless. They request the Project to find a place for them to live.	**ICD/MPWT**: If those AHs are really landless, the Project will prepare a resettlement site for them and provide a land ownership certificate after living there for five years.
Can people use the remained land in ROW (10m) for the economic activity?	**ICD/MPWT**: At the moment, the Project requires the PRW only 20m in each side, so 10m will be remained. The remained land will be out of the Project responsibility. It depends on the local authority to manage it. (Some places are required by local authorities for their local plan development, so they will not allow people to stay there. Other places are not required for any development, so people can continue to stay there.)
They request the Project to install drainage system for protecting water flood that leads to erosion of the road.	**ICD/MPWT**: During the detailed design, engineer will come to conduct water level investigation along the road and also will study where the drainages need to be placed. The Project will be funded by JICA therefore the study will be very detailed and accurate.
What will happen with the new structures (after cut-off date) in the PRW?	**ICD/MPWT**: It is a problem for structure owners. The Project already announced that 1st August 2011 is a cut-off date, and the study team also made a video record along the NR 5 to identify which structure will be eligible for receiving compensation from the Project. Please note that all structures constructed after the cut-off date (IOL survey) will not be entitled to get the compensation from

Question	Response
	the Project. Due to *Land Law*, they will be faced with an administrative measure if they still speculate on the Project.
My house is 8m x 6m, and 2m x 6m of it will be affected by the Project. How can the Project help?	**ICD/MPWT**: It depends on you. If you feel that it is too small for your household living and prefer to relocate to other place, the Project will help. In case you want to continue to stay at the original place, you have a right to do so. The Project will compensate for lost of house and other assets.
Can people get compensation from the Project, if their land ownership certificate is mortgaged by a Bank?	**ICD/MPWT**: In case people do not have any document to prove that they are the owner of the affected land, they have to get a letter from local authority to be certified that they are the owner. Then, they are eligible to get the compensation from the Project.
How long time will be provided to AHs for their relocation?	**ICD/MPWT**: The Project will give enough time to AHs for relocating. It will inform AHs at least 3 months before asking them to vacate their land.
In case a farm land (out of existing ROW) is partially affected, the remained land is small, and cannot be used for farming, what will the Project do with the remained land?	**MPWT**: People have two options: - They can ask IRC-WG to include the remained land in the property affected list for getting compensation. But the remained land will be a state land for only public/community use; or - They can keep it for commercial purpose (construct a flat, shop, etc.), because it can be more beneficial for them after the construction of bypass road.

18.9 Grievance Redress[7]

Grievances of AHs in connection with the implementation of the RP will be handled through negotiation with the aim of achieving consensus. Complaints will pass through three stages before they may be elevated to a court of law as a last resort. MPWT will shoulder all administrative and legal fees that will be incurred in the resolution of grievances and complaints.

18.9.1 First Stage: Commune Level

An aggrieved AP may bring his/her complaint to the commune leader. The commune leader together with the representative/s of the PRSC-WG coming from the district offices will call for a meeting to decide on a course of action to resolve the complaint within 15 days following the lodging of the complaint by the aggrieved AP. The commune leader is responsible for documenting and keeping file of all complaints that are coursed through it.

18.9.2 Second Stage: PRSC-WG

If after 15 days, the aggrieved AP does not hear from the commune leader, or if the AP is not satisfied with the decision taken by the commune and district officials, the complaint can be brought to the office of the PRSC-WG (provincial level), either in writing or verbally. It is

[7] In Cambodia at the moment, there is no resettlement sub-degree. Therefore, all development projects were applied by "Donner/Cambodia Government policy for specific project". To apply with the policy, the Grievance Redress has to be considered. In the Final Stage of the Grievance Redress, if AH is not satisfied with the decision taken by IRC/GR, the complaint may be brought to a court of law for adjudication. In this stage the land law and land expropriation law will be applied.

incumbent upon said member of the PRSC-WG to notify the other members of the group. The team leader of the PRSC-WG will call for a meeting to decide on a course of action to resolve the complaint within 15 days following the lodging of the complaint by the aggrieved AP. The PRSC-WG is responsible for documenting and keeping file of all complaints that are coursed through it.

18.9.3 Third Stage: IRC

If after 15 days the aggrieved AP does not hear from the PRSC-WG, or if the AP is not satisfied with the decision taken by the PRSC-WG, the complaint may be brought to the office of the IRC, through the IRC-RD, either in writing or verbally. In this stage, the IRC has 30 days within which to resolve the complaint to the satisfaction of all concerned. The IRC is responsible for documenting and keeping file of all complaints that reach it.

18.9.4 Final Stage: Court of Law

If after 30 days following the lodging of the complaint, the aggrieved AP is not satisfied with the decision taken by the IRC, or if the AP does not hear from the IRC, the complaint may be brought to a court of law for adjudication. The rules of court will be followed in the resolution of the complaint.

18.10 Relocation Strategy

IRC-WG in collaboration with PRSC will acquire a piece of land for preparing a resettlement site based on consultation with entitled AHs or their representatives. The location of the land will be as close as possible to their original land and will have acess to nearby or on-site primary and secondary schools, health facilities and market facilities.

In case the owner of affected private land opts for land-to-land compensation, replacement lands will be as close as possible to such land that was lost to the AHs, and their size is equivalent to the affected land. All replacement lands will be provided for free with secure tenure status. IRC will facilitate Ministry of Land Management, Urban Planning and Construction (MLMUPC) to provide the secure tenure status.

Each landless AH will be provided a plot of land of 105m^2 (7m x 15m) for free. After 5 consecutive years of living on the land, title to the land plot (secure tenure status) will be provided to the AHs. Similarly to private land owners who opt for land replacement, IRC will facilitate Ministry of Land Management, Urban Planning and Construction (MLMUPC) to provide the secure tenure status.

Prior to relocation of AHs, site development will ensure basic infrastructure including the following:

(i) Source of water supply;
(ii) Electricity to site and, as necessary, local distribution system; and
(iii) Road access to and within the site

All basic infrastructures at the relocation site should be ready before AHs are asked to relocate there. Furthermore, impact on livelihood activities of all shop owners will be minimized. IRC-WG and PRSC-WG will consult with landless AHs about the relocation and civil work schedule including site development schedule during the DMS.

18.10.1 Summary Cost of Resettlement Site Development

The land location and price were identified and surveyed by the consultant team during the project preparation, and the budget for resettlement site development was estimated. Since the final selection of the land locations for both Thmakol and Mongkul Borei Districts will be done during the RAP implementation through consultation with entitled AHs, the budget for relocation development will be revised based on the actual land location selection and its price.

(1) Resettlement Site at Thmakol District

In Thmakol District, BTB Province, there are only six landless AHs.

Since the number of landless AHs is relatively small, AHs are provided two options;

(i) A land plot for each landless AH as integration in the nearby village and
(ii) Cash assistance for site development including latrine, deep well, electricity connection fee, drainage system, etc. was estimated at USD 1000.00 per AH (USD 1,000 x 6 = USD 6,000).

(2) Resettlement Site at Mongkol Borei District

In Mongkul Borei District, there are 68 landless AHs. AHs are encouraged to relocate to a new resettlement site with basic infrastructures such as access roads, latrines, drainages, and pumping wells, etc. Each landless AH will receive a land plot of 105 m^2 (7 m x 15 m).

18.11 Income Restoration Strategy

<u>Restoring the incomes of AHs, whose means of livelihood has been disturbed or removed, is a high</u> priority for RGC and JICA. This is of particular concern with respect to households whose livelihoods as well as property are lost, even temporarily, as a result of the road improvement.

Therefore, an Income Restoration Program (IRP) will be developed during resettlement implementation stage, after DMS is conducted. IRC will contract out to implement IRP.

Possible measures to restore livelihood depend on sort of income sources. Based on the IOL, the vulnerable AHs of 434 AHs, severely affected households of 176 AHs and the relocating AHs of 74 AHs will be entitled to an IRP to restore income and livelihood as affected by the project. Thus, the contents of income restoration should be discussed based on situations and need assessment of target groups. The result of SES and other surveys such as DMS can be utilized for the discussion to design an effective IRP.

18.12 Costs And Budget

The cost for resettlement will be covered from the government counterpart funds. Funds for the implementation of the RAP are part of the Project Cost. The land acquisition and resettlement cost has been estimated based on results of the IOL and the RCS conducted during the Project Study in August-September 2011.

18.12.1 Procedures for Flow of Funds

IRC will request the resettlement budget from MEF and the compensation amount will be transferred to relevant PDEF for releasing compensation and allowances to AHs. Payment of compensation and other entitlements will be in cash and will be distributed in public place (commune centre, school, pagoda etc.). The AHs will be notified through the village chiefs with regards to the schedule of payment of compensation and other entitlements.

18.12.2 Updating of the Compensation Rates and Inflation Adjustment

An RCS were conducted by local consultant during the project preparatory study as basis unit rate to estimate the cost for resettlement and land acquisition. Since compensation to AHs will be commenced in 2014 (tentative schedule), the conducted RCS will be updated to reflect the current market price of affected property. The RCS updating will be conducted in parallel with the DMS.

18.12.3 Estimated Costs for Resettlement

The estimated costs for resettlement and land acquisition based on the RCS and the IOL during the project preparatory study is USD 6,320,570.06, which includes cash compensation for USD 4,999,991.93, external monitoring and income restoration of USD 449,999.27, administration cost of 10% equivalent to USD 499,999.19, and contingency of 7.41% or equivalent to

USD 370,579.66. The Government will ensure timely provision of funds for resettlement costs and will meet any unforeseen obligations in excess of the resettlement budget in order to satisfy resettlement objectives.

18.13 Monitoring and Evaluation

18.13.1 Internal Monitoring

PMU-ES in close coordination with IRC will conduct an internal monitoring on resettlement implementation. The monitoring will include progress reports, the status of the RAP implementation, information on location and numbers of people affected, compensation amounts paid by item, and assistance provided to AHs. The report of monitoring results will be prepared by MPWT and submitted to IRC and JICA on quarterly basis.

The following indicators will be monitored periodically by PMU-ES/MPWT:

(i) Compensation and entitlements are computed at rates and procedures as provided in the approved RAP;

(ii) AHs are paid as per agreed policy provided in the RAP by the Project authorities;

(iii) Public information, public consultation and grievance redress procedures are followed as described in the approved RAP;

(iv) Public facilities and infrastructure affected by the Project are restored; and

(v) The transition between resettlement and civil works is smooth.

18.13.2 External Monitoring

The external monitor has the specific responsibility of studying and reporting on measures for income restoration and on social and economic situations of AHs particularly disrupted by the road works, including all households whose houses or shops and stalls are relocated. The external monitor also has the responsibility of reviewing potentials for job opportunities and training for AHs, including women and youth, which would be assisted by provincial authorities, and for which the Commune Resettlement Committees and local NGOs may provide additional support.

IRC will hire an External Monitoring Agency (EMA) to carry out external monitoring and post-implementation evaluation. The TOR for the engagement of the EMA is provided in *Appendix 18-3: Terms of Reference for External Monitoring Agency*. The external monitoring reports will be submitted to IRC on quarterly basis, and then IRC will forward to MPWT/PMU and JICA. The post evaluation will be conducted within one year after all resettlement activities are completed.

The EMA will assess (i) the achievement of resettlement objectives, (ii) changes in living standards and livelihoods, (iii) the restoration of the economic and social conditions of the AHs, (iv) the effectiveness, impact and sustainability of assistance measures, (v) the need for further mitigation measures, if any; and, (vi) identify strategic lessons for future policy formulation and planning. The EMA will also be responsible for checking the procedures and resolutions of grievances and complaints. The EMA may recommend further measures to be taken to redress unresolved grievances.

CHAPTER 19 CONCLUSION AND RECOMMENDATION

19.1 Conclusion

Based on what have been described in the preceding chapters, followings can be concluded:

- Improvement of Battambang – Sri Sophorn Section of Natinal road No. 5 and construction of Battambang Bypass and Sri Sophorn Bypass is justified considering the following aspects:
  - ✓ There is no strong opposition to the Project among the stakeholders, including the people who are anticipated to be relocated.
  - ✓ The Project is expected to yield economic benefit such as EIRR of 22%
  - ✓ No significant adverse impact on natural and living environment of the Project Area is anticipated.
- The Project cost for widening of Battambang – Sri Sophorn Section of NR 5 into 4 lanes and construction of Battambang Bypass and Sri Sophorn Bypass is estimated at approximately USD136.4 million, including cost for land acquisition and resettlement, UXO detection and demining, administration and price escalation.
- Implementation period is estimated to be 5 years and a half starting from 'Selection of Consultants for Detailed Design, Assistance in Procurement of Civil Works and Construction Supervision' until 'Opening of the Road to Traffic'.

19.2 Recommendation

To achieve the objective of the proposed Project, the followings are recommended:

- Improvement of Battambang – Sri Sophorn Section of NR 5 and construction of Battambang Bypass and Sri Sophorn Bypass is recommended to be implemented.
- To maintain the function expected on Sri Sophorn Bypass and Battambang Bypass, respective provincial governments are recommended to implement measures for preventing undesirable development of road side land along the bypasses, including;
  - Prevention of undesirable urbanization along the bypass,
  - Regulation on disorderly development, such as construction of industrial facilities, along the bypass, and
  - Preservation of agricultural lands along the bypass.
- MPWT is recommended to employ competent consultants for the consultat services of detailed design/assistance for procurement of civil works/construction supervision to minimize risks possible to occur during construction.
- MPWT is recommended to request to JICA for technical assistance for implementation of

Yen loan project.

- Survey on improvement of Prek Kdam – Thlea Ma'am Section and construction of Kampong Chhnang Bypass need to be urgently studied.