PRE-FEASIBILITY STUDY ON THE HIGH PRIORITY PROJECTS

CHAPTER 1 HIGH PRIORITY PROJECTS FOR PRE-FEASIBILITY STUDY

1.1 Short Term Projects in Master Plan

To establish a realistic and effective implementation program, the Study team adopted the basic concept for an implementation program of the Master Plan as follows:

(1) On-going projects should be completed in the short-term plan

National road, especially 1 and 2-Digit roads are very important road network forming the national and regional economy, therefore, all the on-going rehabilitation projects related for 1-Digit and 2-Digit roads being implemented or committed by international funding agencies and donors shall be completed in the short term plan.

(2) Access to the provincial capital should be improved as soon as possible

Taking into consideration an importance of administration services by government to rural areas, 2-Digit roads linking to provincial capitals with a poor condition should be improved as early as possible either in short-term or medium-term plan.

(3) Implementation of Urgent Bridge Rehabilitation Program

Although most of 1-Digit and some important 2-Digit roads have already been rehabilitated, many of temporary bridges are still left behind in narrow and poor conditions in the completed sections of 1-Digit and 2-Digit roads. The rehabilitation of these temporary bridges are included as a part of upgrading works in the master plan, however, upgrading of these roads are planned in the medium-term of long term plan. Since the bridge on major road results to major impact and loss in the local socio-economic activities, when collapsed, the Study Team recommends that these bridges should be improved as soon as possible and implemented under the "Urgent Bridge Rehabilitation Program".

Based on the above concept, the Study Team set the target of implementation for short-term, medium-term and long-term by the result of project evaluation and available funds based on the financial study.

The projects proposed in the short term plan (2006 -2010) are shown as follows:

Table 1 Priority Projects Proposed in the Short term Plan (2006 - 2010)

Projects Proposed in the Short Term		Length (km)	Improvement Measures	Funding Source	Existing Condition
1-Digit NR	NR.1 (1-1, PP-Neak Leuong)	60.0	Road upgrading	Japan	Under construction
	NR.1 (1-2, Neak Leuong Bridge)	2.0	New bridge const.	Japan	F/S
	NR.2 (2-2, Takeo-VN Border)	57.0	Road upgrading	Japan (Non project fund)	Completed
	NR.3 (3-2, Kampot-Veal Rinh)	54.0	Road upgrading	Korea, WB	Under construction
	NR.5 (5-5, Sisophon -Thai Border)	47.0	Road upgrading	ADB	Under construction
	NR.6 (6-4, Siem Reap - Sisophone)	48.0	Road upgrading	ADB	Under construction
	NR.7 (7-3,4 Kratie-Laos Border)	193.0	Road upgrading	China	Under construction
2-Digit	NR.33 (33-1, Kampong Trach-Lork)	17.0	Road upgrading	ADB	Committed

Table 1 Priority Projects Proposed in the Short term Plan (2006 - 2010)

Projects Proposed in the Short Term		Length (km)	Improvement Measures	Funding Source	Existing Condition
NR	NR.48 (Chamker Loung-Thai Border)	161.0	Road upgrading	Thailand	Under construction
	NR.57 (Battambang-Pailin-Thai Border)	103.0	Road upgrading	-	-
2-Digit NR	NR.62 (62-1, Thanal Baek - Tbeng Meanchey)	243.0	Road upgrading	WB	Under construction
	NR.64 (Svay Thom - Dang Rek)	134.0	Road upgrading	Thailand	Committed
	NR.65 (Dam Deck - Trapeang Prey)	21.0	Road upgrading	WB	Under construction
	NR.71 (Treung -Kompong Thmar	58.0	Road upgrading	ADB, WB	Under construction
	NR.72 (Kreat Tboung - Smach)	14.0	Road upgrading	Local	Completed
	NR.78 (78-2, Bang Lung - Vietnam Border)	70.0	Road upgrading	Vietnam	Committed
Urgent Bridge Rehabilitation Program					
	Phase I: South-east Block	-	Bridge rehab.	-	-
	Phase II: North-west Block	-	Bridge rehab.	-	-

1.2 Pre-feasibility Study Projects

Pre-feasibility study projects were selected on the following reasons, excluding the under construction and committed projects:

(1) The Improvement of National Road No. 57 (Battambang – Pailin – Thai Border)

Reasons for selection:

i) This road is very important route linking-up from Battambang to Pailin city and is applicable to the basic concept (2).

ii) This route is assessed in the highest rank as a result of project evaluation in terms of economic and social impacts.

iii) The Cambodian government gives a high priority to the development and life improvement in this area.

(2) Urgent Bridge Rehabilitation Program (Phase I: South-east Block)

Reasons for selection:

i) This program is assessed in the highest rank and is applicable to the basic concept (3).

ii) South-east block was selected as the first phase of implementation taking into account an impact of regional economy and its big population.

iii) The Cambodian government gives a high priority to the development and life improvement in this area.

PACKAGE A

THE PROJECT FOR IMPROVEMENT OF NATIONAL ROAD NO.57

CHAPTER A-1 INTRODUCTION

1.1 General

In the Road Network Development Master Plan Study, JICA Study Team has proposed road network development plan in 2020 and implementation plan of road development including prioritization of the projects and improvement measures.

The Improvement of National Road No.57 was selected as one of the highest priority projects and therefore the pre-feasibility study was conducted.

1.2 Purpose of Pre-feasibility Study

The purpose of this Pre-feasibility Study is to comprehensively evaluate the feasibility of improving this road based on the following aspects;

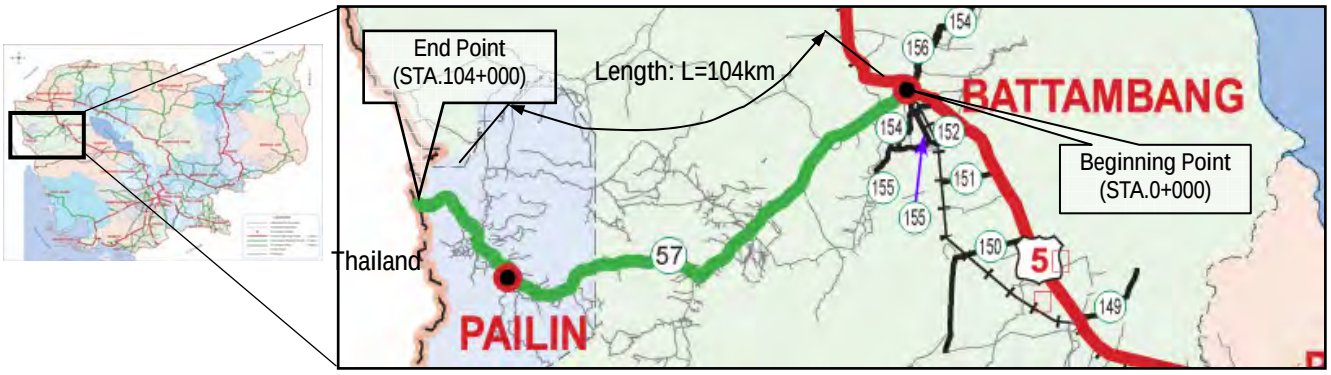
(1) Estimation of the project cost based on the preliminary design and the implementation plan based on the optimum construction method and schedule
(2) Economic and financial analysis
(3) Estimation of maintenance cost
(4) Estimation of landmine/UXO survey and clearing

1.3 Project Description for Improvement of National Road No.57

National Road No.57 (NR.57) is located in flat, rolling terrain and mountainous area of the northwest part of Cambodia. This route length is 104km connecting the province of Battambang with Pailin city to Thai Border. The existing roadbed is generally laterite, and there are 14 temporary bridges and 3 concrete bridges on this route.

The improvement target of this road is as follows;

(1) to upgrade the road to all weather condition
(2) to upgrade the road capacity sufficient to meet national demand
(3) to upgrade the bridges to be permanent
(4) to upgrade the road with proper safety facilities against traffic accidents



CHAPTER A-2 GENERAL CONDITION AND ENGINEERING SURVEY

2.1 Natural Condition

2.1.1 Geography and Geology on the Project Site

The geographical conditon of NR.57 is classified into the following;

(1) Low Elevation and Flat Area – the section beginning in the urban district of Battambang city,

(2) Rolling terrain Area – the midsection, in the middle of Battambang province

(3) Mountainous Area – the end section from the border of Pailin city and Battambang province to the Thai Border

The profile of the existing national road NR.57 is shown in **Figure 2.1**.

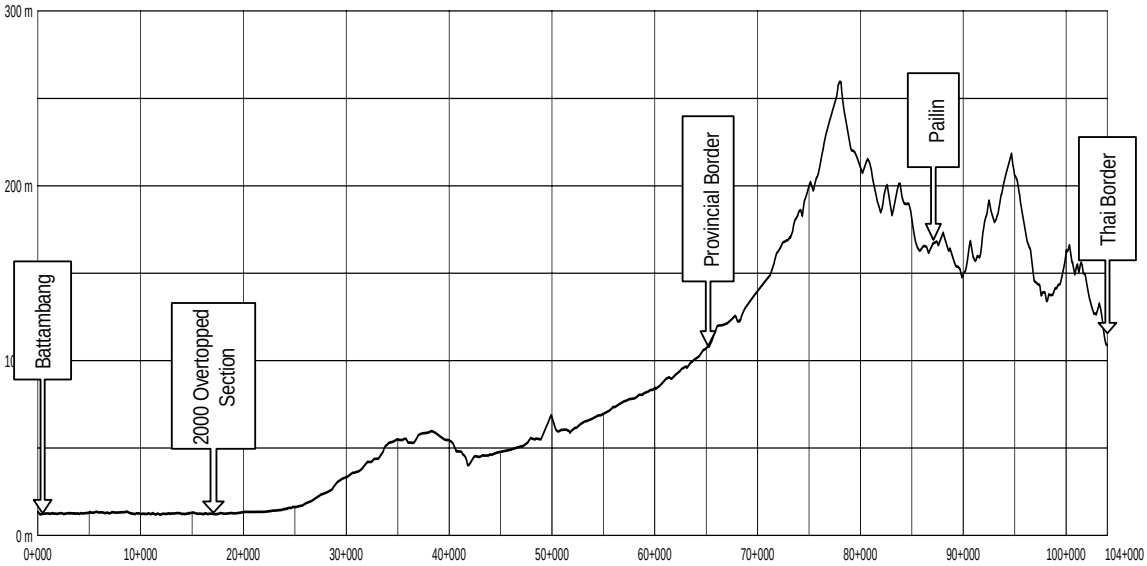
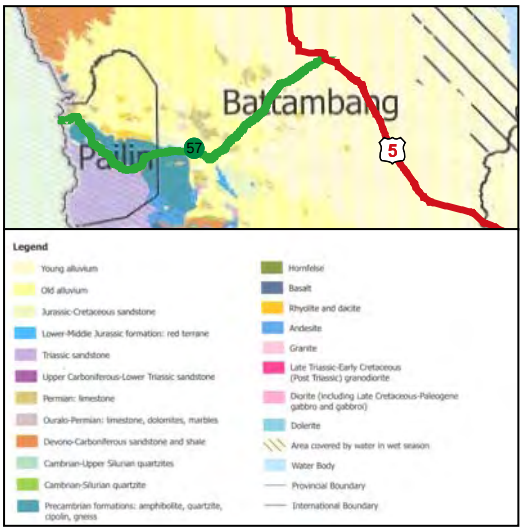


Figure 2.1 Profile of the Exiting NR.57

The general geological conditions in the vicinity of the project site are shown in **Figure 2.2**.

The geology of the area that NR.57 traverses can be divided into two (2) sections, the first half (from the beginning point in Battambang city to around STA.50), in the low land, is covered by young and old alluvium. The second half contains Lower-Middle Jurrasic formation. The hill lying on the west side of NR.57 is composed mainly of Triassic sandstone.



Base map: The Altas of Cambodia, National Poverty and Environment Maps, Save Cambodia's Wildlife with Support from Danida

Figure 2.2 Geology of the Project Site

2.1.2 Hydrology and Geology on the Project Site

The annual rainfall for the project site is in the range of 1,200-1,400mm and 1,400-1,600mm, which comparatively can be considered on average to be less than that the average for the whole country of 1,400-1,600mm.

This is a tropical monsoon region, and the annual mean temperature is about 27°C, while that of the area after STA.63 is 1-2°C lower since the elevation there goes over 100m.

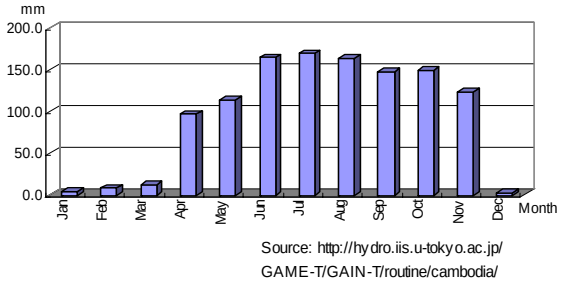


Figure 2.3 Monthly Rainfall Distribution at Battambang

2.2 Socio-Economic Condition

2.2.1 Population

This 104km road passes through three (3) districts in Battambang province and Pailin in Krong Pailin towards the Thailand border. The population along NR.57 in 2005 was estimated at approximately 177,970 persons, with 148,600 in Battambang and 29,370 in Pailin. It is expected to increase to 201,780 in 2010, 227,550 in 2015, and 254,320 in 2020.

2.2.2 Land Use

Figure 2.4 shows the existing land use along NR.57.

The land use at the beginning of the road in Battambang Province consists predominantly of paddy field but towards Pailin changes to shrub as well as coniferous and deciduous forest due to it being a highland area.

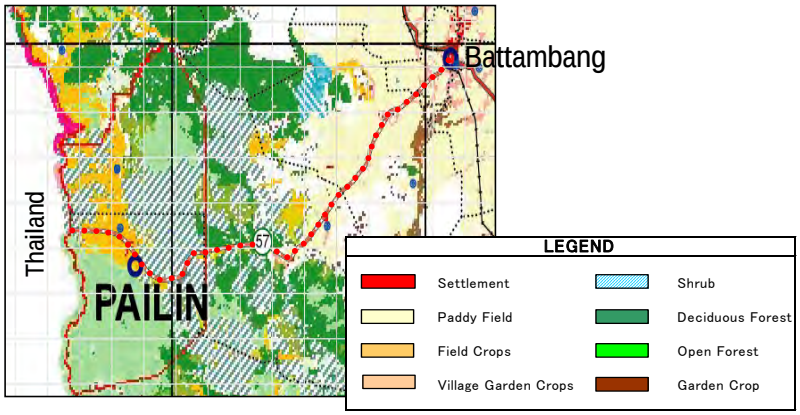


Figure 2.4 Existing Land Use along NR.57

However, the land use in Pailin area is being converted to plantations of cash crops due to having the advantages of accessibility to the Thai border.

2.2.3 Number of Vehicles

The number of vehicles by districts is shown in **Tables 2.1**.

The highest motorization rate is observed at Svay Pao district in Battambang Province and among the others the next highest is at Pailin district. This is due to the comparatively high incomes in these two districts. The lowest motorization rate is observed at Rattonak Mondol. This may be due to it being a low-income district.

Table 2.1 Number of Vehicles in Direct Influence Area of NR.57, 2005-2020

Province/District		Type	2005	2010	2015	2020
Battambang	Svay Pao	Motor Cycle	1,562	1,953	2,363	2,883
		Car/Tractor	242	317	399	491
		Total	1,804	2,269	2,762	3,373
	Baran	Motor Cycle	4,069	5,086	6,154	7,508
		Car/Tractor	1,061	1,390	1,751	2,154
		Total	5,129	6,475	7,905	9,661
	Rattonak Mondol	Motor Cycle	1,423	1,779	2,152	2,626
		Car/Tractor	396	519	653	804
		Total	1,819	2,297	2,806	3,430
	S-Total	Motor Cycle	7,054	8,817	10,669	13,016
		Car/Tractor	1,698	2,225	2,803	3,448
		Total	8,752	11,042	13,472	16,464
Pailin	Pailin	Motor Cycle	2,114	2,304	2,489	2,812
		Car/Tractor	256	263	434	530
		Total	15,700	19,815	24,183	29,555
Total		Motor Cycle	9,168	11,122	13,158	15,828
		Car/Tractor	1,954	2,488	3,237	3,978
		Total	24,453	30,857	37,655	46,019

Notes: 2005: Estimated on the basis of 2004 village data
2010, 2015,2020: forecasted based on the growth rate in the Master Plan

2.3 Engineering Survey

2.3.1 Topographic Survey

A topographic survey for the preliminary design for the improvement of NR.57 has been carried out in accordance with the following scope of work: (1) Control Point Survey: 31 points, (2) Road Centerline Profile Survey: 104 km (500 m pitch), (3) Road Cross-Section Survey: 31 sections (40 m width), and (4) Photo Mosaic Preparation: 104 km.

An aerial photo mosaic (1/10,000, A3 size) has been prepared using aerial photos taken at the scale of 1/40,000 and/or 1/25,000 to cover the road near the Thai border where the photo coverage existed.

2.3.2 Geotechnical Investigation

The geotechnical investigation for the preliminary design of bridges along NR.57 has been carried out in accordance with the following scope of work: (1) Mechanical Boring (3 sites with 4 boreholes), (2) Standard Penetration Test at 1.0m intervals, and (3) Laboratory Tests to determine the basic soils sample properties. Borehole log is shown in **Figure 2.5**.

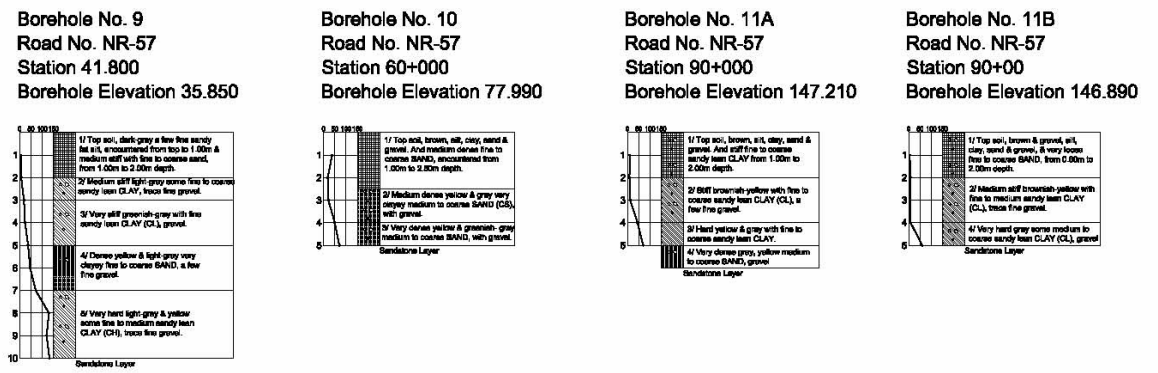


Figure 2.5 Borehole Logs

2.3.3 Drainage Survey

A survey on existing drainage structures such as pipe culverts and box culverts along NR.57 is conducted. Deposit the bushes and grass has grown around their inlets or outlets. However, a further detailed survey on flood marks and/or a site inquiry, by interviews, is necessary to examine the past high-water level records at inlets or outlets.

During the investigation stage of the pre-feasibility Study, about 20 cm of overtopping on the road surface was observed in the year 2000 around STA.17.

CHAPTER A-3 PRELIMINARY DESIGN

3.1 Design Concept and Criteria

3.1.1 Design Concept and Criteria for Road

Existing road alignment has been maintained as far as possible to minimize construction cost, to avoid landmine contamination area as well as to minimize negative socio-environmental impacts during construction. Vertical profile of the road is raised basically by additional new pavement layers thicknesses.

The design standard used for road design is basically based on the Cambodia Road Design Standard, Department of Public Works and Transport (MPWT), 2003. When no provision exists in this standard other international standards, such as AASHTO (A Policy on Geometric Design of Highways and Streets, 2001), JRSO (Japan Road Structure Ordinance), AASHTO Guide for Design of Pavement Structures, 1993) etc. have been applied.

The summary of geometric design criteria applied in the design is given in **Table 3.1**.

Table 3.1 Summary of Geometric Design Criteria

Design Elements			Type/Value	Remarks
1	Road Classification		R4/U4	
2	Terrain		Plain/Rolling/Mountainous	
3	Design Vehicles (L x W x H)		16.7 x 2.6 x 4.1	WB- equivalent
4	Design Speed (km/hr)		90 (60)	(60) at Urban/Mountainous
5	Cross-Sectional Elements	Formation Width (m)	14.0	
		Carriageway Width (m)	13.0	
		Traffic Lane Width (m)	3.5	
		Paved Shoulder Width (m)	3.0	AC Binder Course only
		Unpaved Verge Width (m)	0.5	
		Crossfall of Roadway (%)	3.0	6% for unpaved shoulder
		Slope of Earthworks		
		Fill	V : H = 1:2.0	1:1.5 for shallow fill
		Cut	Varies	Varies with soil condition
6	Horizontal Alignment	Horizontal Curve		
		Minimum Radius (m)	335 (135)	() for Design Speed 60km/hr
		Superelevation		
		Maximum Superelevation (%)	6.0	
		Minimum Radii without Se (m)	1500	
7	Vertical Alignment	Maximum Grade (%)	6	
		Vertical Curve		
		Minimum K-value		
		Crest Curve	40 (15)	() for Design Speed 60km/hr
		Sag Curve	30 (15)	() for Design Speed 60km/hr

The typical cross sections used for the design is given in **Figure 3.1**, based on a total formation width of 14m.

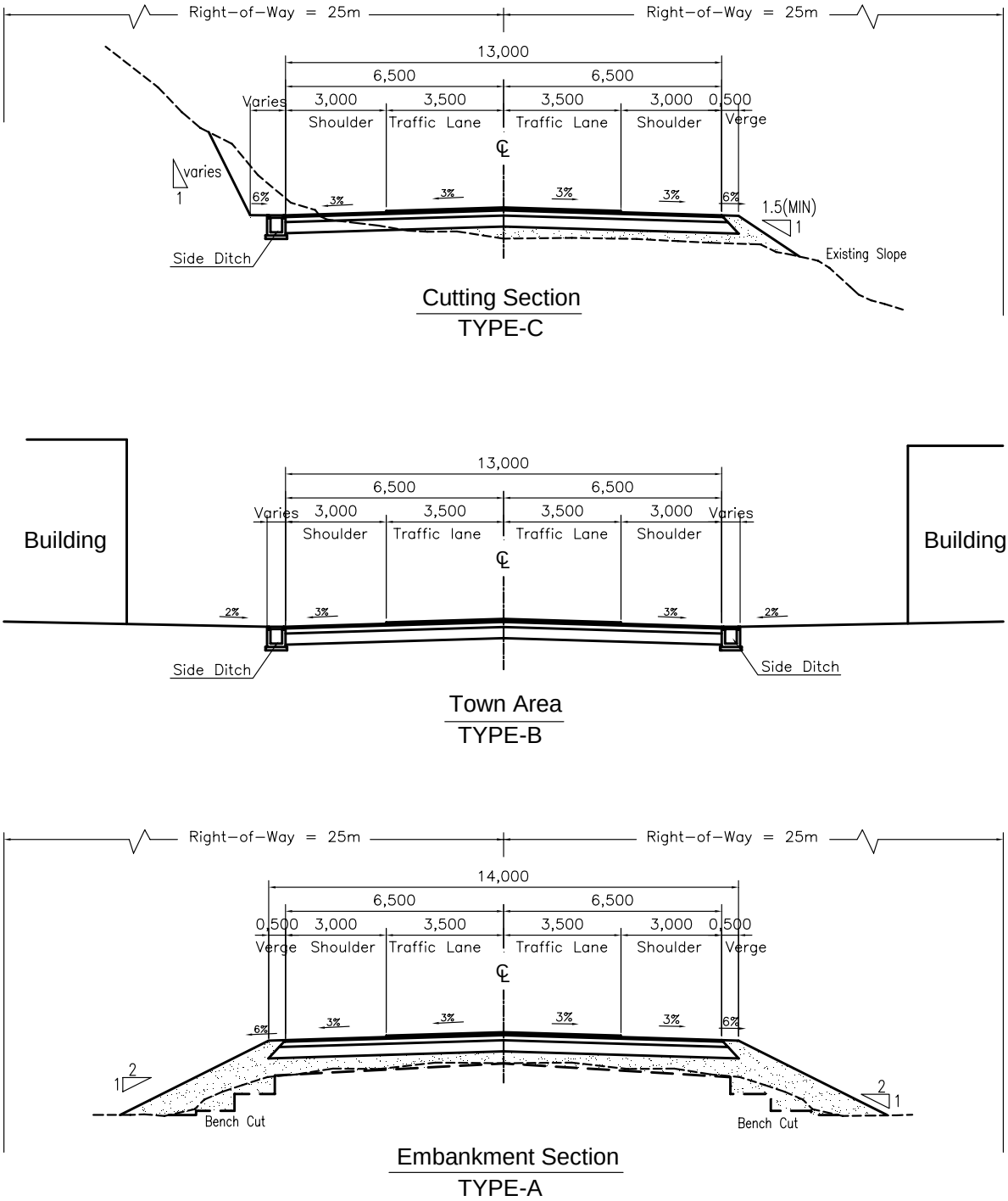


Figure 3.1 Typical Cross Sections

Road Design Standard of Cambodia presents the typed design for pavement structures and does not include detailed procedure. So the AASHTO Guide for Design of Pavement Structure has been applied for the pavement design.

The summary of design criteria, applied in the pavement design based on the AASHTO method, is given in **Table 3.2**.

Table 3.2 Summary of Design Criteria for Pavement Design

Design Input Requirements			Value	Reference
1	Design Variables	Performance Period (years)	10	General
		Analysis Period (years)	10	General
		Traffic		
		Equivalent Single Axle Load (ton)	8.2	AASHTO
		Directional Distribution Factor, D_D	0.6	AASHTO
		Lane Distribution Factor, D_L	1.0	AASHTO
		Reliability (%)	85	AASHTO
		Overall Standard Deviation	0.45	AASHTO
2	Performance Criteria	Initial Serviceability Index, p_0	4.2	AASHTO
		Terminal Serviceability Index, p_t	2.2	AASHTO
		Design Serviceability Loss, ΔPSI	2.0	AASHTO
3	Material Properties	Effective Roadbed Soil Resilient Modulus, M_R (psi)	1500 × CBR	General
		Layer Coefficient for Subbase Course, a_3	from CBR	AASHTO chart
		Layer Coefficient for Base Course, a_2	from CBR	AASHTO chart
		Layer Coefficient for Asphalt Concrete, a_1	Resilient Mod.	AASHTO chart
4	Pavement Characteristics	Drainage Coefficients for Base and Subbase Course, m_2, m_3	1.0	AASHTO

3.1.2 Design Concept and Criteria for Bridge and Structures Along NR.57

(1) Design Concept

The following design concepts are adopted to establish the design criteria:

- The bridge shall have the same functional standard as the road,
- The existing bridge alignment/location shall be maintained as much as possible,
- The bridge shall be designed to have minimum adverse social impact,
- Environmental preservation shall be a primary concern,
- The bridge shall incorporate appropriate traffic safety facilities in design and construction.
- The scale and type of bridge shall be determined based on:
  - Bridge Length and Superstructure
  - Substructure and Foundation, and
  - Structure Type

(2) Design Criteria

The following design criteria shall be adopted for NR.57 Bridges:

Table 3.3 Design Criteria for Bridges

<table>
<tr><th>Item</th><th>Design Criteria</th></tr>
<tr><td>1) Applicable Design Standards</td><td>

Australian Bridge Design Code, CAM PW.04.101.99, AUSTROADS, 1996
Cambodian Bridge Design Standard (CBDS),CAM PW.04.102.99, MPWT, 2003
Cambodian Road Design Standard, Part 3. Drainage (CRDS), CAM PW.03.103.99, MPWT, 2003
Standard Specifications for Highway Bridges, AASHTO, 1996
Specifications for Highway Bridges, Japan Road Association, 1996, 2002
Specification for River Facilities, Japan River Association, 1998.

The basic design requirements will be referred to the Cambodian Bridge Design Standard (CBDS). However, when the said guidelines do not cover other aspects of design or when a safer, more efficient requirement is needed, the design of bridges shall refer to other standards.
</td></tr>
<tr><td>2) Design Flood Frequency and Minimum Freeboard</td><td>

Flood Frequency one in fifty years (50 years)
Freeboard

1.0m for river discharge >500 - 2,000 m^3/s
0.80m for river discharge >200 - 500 m^3/s, and
0.60m for river discharge < 200 m^3/s

</td></tr>
<tr><td>3) Bridge Length</td><td>
Total bridge length is decided based on:

the maximum design flood water level (DFL) and discharge
no constriction of river discharge flow, and
existing topographic and natural condition

</td></tr>
<tr><td>4) Typical Cross-section</td><td>

No. of Lanes – 2

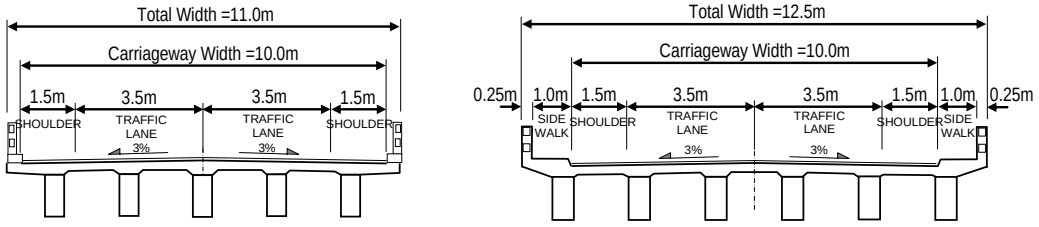
<table>
<tr><th colspan="5">Bridge Width (m)</th></tr>
<tr><th>Area</th><th>Traffic Lane</th><th>Shoulder/ Motorbike Lane</th><th>Sidewalk</th><th>Total</th></tr>
<tr><td>Rural</td><td>2 @ 3.5</td><td>2 @ 1.5</td><td>-</td><td>10.0</td></tr>
<tr><td>Urban</td><td>2 @ 3.5</td><td>2 @ 1.5</td><td>2 @ 1.0</td><td>12.0</td></tr>
</table>
See Figure 3.2 for the typical cross-sections.
</td></tr>
<tr><td>5) Bridge vs Box Culvert</td><td>
The choice between bridge and box culverts depends on:

Waterways with width less than 6.0m shall be provided with box culverts,
Streams/waterways with discharge less than 30 m^3/s, box culvert is provided,
Bridge will be provided in areas where existing topography requires bridge crossing even if water discharge is less than 30 m^3/s.

</td></tr>
</table>

Table 3.3 Design Criteria for Bridges

Item		Design Criteria
6) Design Loads	i. Dead Load	Shall include weight of permanent members plus superimposed loads
	ii. Live Load	• T44 Truck Loading, • L44 Lane Loading, and • Heavy Load Platform Loading (HLP240)
	iii. Earthquake Forces	Uniform acceleration coefficient, a = 0.05
	iv. Wind Load	Quasi-static approach using Cambodian wind map
	v. Thermal Effects	As required in CBDS
7) Design Properties of Materials		• Concrete : f'c = 25, 32, 40, 50 MPa • Reinforcing Bars : Plain, fy = 250 MPa; Deformed, fy = 400 MPa • Prestressing Steel : fp = 1750 – 1860 MPa
8) Geotechnical Consideration		Allowable Bearing Capacity • 0.40m x 0.40m RC Driven Pile : 500kN • ϕ1.0m RC Cast-in-Place Pile : 2000kN • Spread Footing on Sandstone : 800 – 1000 kPa



(a) Rural Areas (b) Urban Areas

Figure 3.2 Typical Bridge Cross-Section

3.2 Road Design

3.2.1 Existing Road Conditions

NR.57 is a secondary (2-Digit) national road with highway/arterial function connecting the province of Battambang with the province of Pailin on the northwest section of Cambodia. The road stretches 104km long with mostly laterite pavement structure and about 300m concrete pavement at the Thailand border. About 64km of the road is within Battambang province passing

through several communes and districts. The road also passes through some temples and tourist destinations including Wat Phnum Sampov, Wat Snoeng and Phnum Yat. It also provides connection to roads leading to Ou Ta Vav Waterfalls. At around Km3 from the beginning point, the road crosses the Cambodian railway.

Landmine contamination map indicates than more than half of the road length of NR.57 is still suspected of being contaminated. Contamination map from the Cambodian Mine Action Center (CMAC) indicates that the section from Km0 to about Km50 is cleared from landmine but beyond that section, most of the roadside along NR.57 are suspected of being contaminated with landmines. This indicates that road development of NR.57 will have to consider the landmine contamination problem seriously.

The traffic survey conducted in the year 2005 along NR.57 showed mostly motorcycles at 76% share plying the route. Since NR.57 connects Thailand with Battambang, heavy vehicles with commercial loads are also seen along this route. Most of these trucks are heavily loaded causing collapse of one Bailey bridge in September 2005.

3.2.2 Road Improvement

(1) Design of Horizontal Alignment

- As stated in the design concept, the road will generally follow the existing alignment to avoid any adverse socio-environmental effects and also to reduce the total construction cost.
- The alignment design is based on the Ortho Mapping produced from the Aerial Photographs of scale 1/40,000 (year 2002) or 1/25,000 (year 1992).
- The initial urban section of Battambang till the intersection shortly after Km 2 may not need any improvement.
- Although the profile seems flat till Km70+000, occasionally there are some grades about or slightly above 2% after Km50+000. The profile grade after Km70+000 is rolling to mountainous with grades occasionally as high as 6%, especially near bridge approaches.

  There are about 12 curves not complying to design speed of 90 km/hr for NR.57 from Km0 to Km50 and about 61 curves from Km50 to Km104. Out of these, the first three sharper curves within 4 km from Battambang are within the urban area of Battambang.

  From these data and also from the nature of topography, it has been considered that the section from Km0+000 to Km50+000 is recommended to be improved with a design speed of 90 km/hr. and the section from Km50+000 to the end with a design speed of 60 km/hr. However, for the first section, design speed is recommended to be reduced to 60 km/hr locally for some of the curves.

- There were about 8 curves in total that do no comply a design speed of 60 km/hr in the whole stretch of NR.57. Out of these, four curves are improved to meet a minimum design speed of 60 km/hr. One curve is at the urban intersection of Battambang and other three are urban intersections in Pailin and are hence retained as existing.

(2) Improvement in Vertical Alignment

- Design of profile was based on the profile survey data, which was conducted along NR.57 at a distance of every 500m (maximum).
- Improvement of vertical alignment was based on the design concept of applying additional pavement structure above the existing road surface. So the profile was generally set at a level higher than the existing surface by additional thickness of new pavement, except at the section where overtopping of about 20 cm during heavy rainy season was reported. Profile grade is increased by a minimum of 1 m along this section.

(3) Improvement in Cross Sections

- Cross section survey was done at every 3 km (maximum) and was used as basis for design and earthwork quantity calculations.
- Since detailed data were not available at this stage, the improvement of cross section was based on the concept of widening on both sides.
- Out of the total length of 104 km of road, typical cross section Type A, for embankment, is predominant with a total length of about 64 km. The cross section Type B for town area applies for a total length of about 20 km and the remaining as Type C.

3.2.3 Pavement Design

Traffic survey was conducted at 3 different locations along NR.57. The results of traffic assignment show different values for four different sections along NR.57 based on Network Analysis. The results show that the initial section from beginning point to the intersection at Km17 has substantially higher traffic volume. Though some differences were observed between the forecasted values of other remaining three sections, no substantial difference was observed in terms of designed pavement thickness. Therefore, from pavement design aspects two sections were used,

⇒ Km0 to Km17 and,

⇒ Km17 to the end.

The highest forecasted values among the three were used for the latter section.

The performance and analysis periods are taken as 10 years as mentioned in the design criteria. The opening year of improvement of NR.57 is taken as the beginning of year 2011. From the

results of traffic forecasts, the Design ESAL for initial and end sections are estimated to be 0.9 million and 0.3 million respectively.

From the results of traffic volume, NR.57 can be divided into two different sections as explained earlier. Similarly, as mentioned in the Design Criteria, the whole road can be divided into two stretches based on the subgrade CBR values. Therefore, NR.57 can be divided into three different sections for pavement design, as shown in Table.3.2.1. The required Structural Numbers (SN) and the designed pavement thicknesses for the respective sections of NR.57 are then calculated and are also given in **Table 3.4**.

Table 3.4 Designed Pavement Thicknesses for Different Sections of NR.57

Section		Design ESAL (million)	Design CBR (%)	SN	Asphalt Concrete		Base (CBR≥80)	Subbase (CBR≥30)
From	To				Surface	Binder		
Km0	Km17	0.9	4	3.46	4 cm	5 cm	20	25
Km17	Km50	0.3	4	2.91	4 cm	5 cm	15	20
Km50	Km104	0.3	6	2.51	4 cm	5 cm	15	15

3.2.4 Drainage Design

Sufficient precipitation data is not available along NR.57 for drainage analysis. During site inspection and local hearing it was observed that no serious flood prone area existed except a short section near Km17 with an inundation of about 20cm for a few hours. Site inspection was carried out for all road openings, with the concept that existing openings are adequate except at the flood prone area. Therefore, it was considered that the improvement will apply equivalent opening sizes of the existing ones. The flood prone area is flat plain with the road slope of less than quarter of a percent. It is difficult to precisely quantify the opening in this area under such condition. Based on such observations, it was considered to apply pipe culverts with opening sizes of one meter in this section.

3.3 Bridge Design

3.3.1 Existing Bridge Conditions

The existing bridges along NR.57 can be summarized as:

- Old RC Slab Bridges – there are sixteen (16) RC continuous slab bridges found to exist along the alignment with bridge lengths ranging from 7m to 14m (number of span varies from 2 to 3). The carriageway width for these bridges varies from 5.5m to 7.0m. Substructure types are mostly masonry abutment and wall type masonry piers. Although most of these bridges are in fair condition, at least three bridges have partial or full span collapsed and backfilled with embankment. Majority of these bridges have deck slabs with worn-out surface (exposed aggregates).

- Steel Bailey Bridges – 14 Steel Bailey bridges exist along the alignment with bridge lengths from 12m to 48m (consisting of 1 and 2 spans). The carriageway widths of bailey bridges are on average 4.2m, except for one relatively new bridge at Km73+121 with 7.0m wide carriageway. Most of these bridges are constructed above old collapsed bridges so that previous piers and abutments of the old bridges still exist. Load limit for bailey bridges are posted at 10tons to 15tons with one bridge having a load limit of 25tons (Km68+363). Most of the bailey bridges are in poor condition except for the new bridge replacements in fair condition. Two of the bailey bridges (Km60+081 and Km63+252) are in very poor condition with load limits of 10 tons. The bridge at Km63+252 has deformed out-of-plane with some members buckling or sheared-off which makes it in very dangerous condition.

- New RC Slab Bridge – two relatively new reinforced concrete slab bridges are found with 8.7m (1-span at Km83+223) and 28.3m (3-span at Km82+128) bridge lengths. The bridge at Km83+223 is supported by the abutment of the old bridge while the bridge at Km82+128 has new concrete abutments and multiple column piers. The 1-span bridge (Km83+223) is in fair condition but with rutting and exposed aggregates at deck slab and exhibits excessive vibration during passage of heavy trucks. On the other hand, the 3-span bridge (Km82+128) exhibits signs of distress with visible diagonal cracks at the top of the deck slab and noted sagging of the spans.

- RC Girder Bridge – one 4-span reinforced concrete girder bridge exist at Km90+071 (new road alignment), downstream of the original NR.57 alignment. The bridge is in good condition but has only 7.0m carriageway. Although this route is not the original NR.57 alignment, the bridge serves as the link to reach Thailand border.

3.3.2 Hydrologic Analysis and River Hydraulic

Preliminary hydrologic and river hydraulic analysis was conducted for bridges on rivers and streams based on the available topographic maps (Scale 1:100,000) to derive design flood discharge at each bridge's site. The results of the hydrological analysis are used to indicate the

preliminary hydraulic design data for the corresponding bridges.

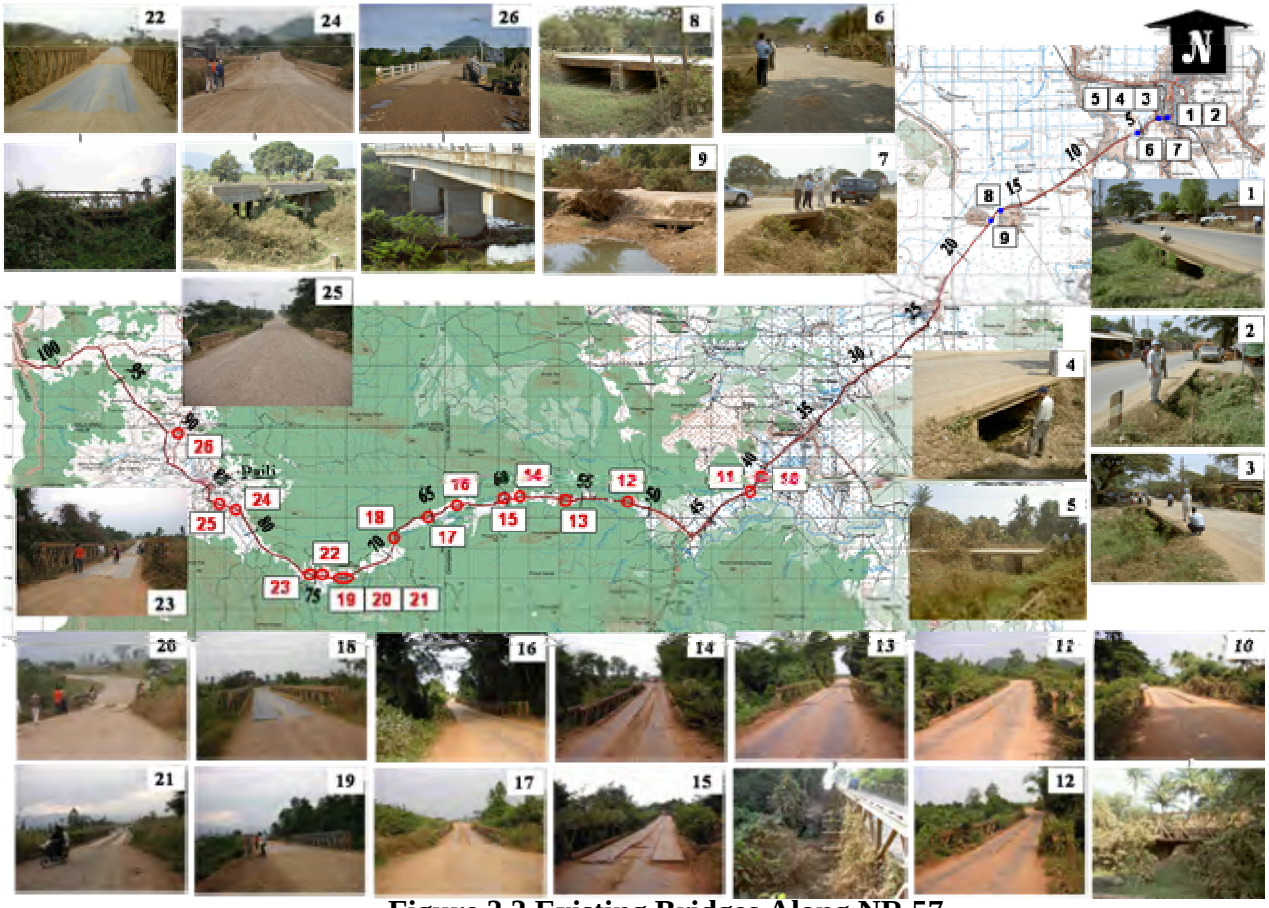


Figure 3.3 Existing Bridges Along NR.57

3.3.3 Policy on Selection of Bridge Type

In this study, the most appropriate bridge type is selected by evaluating the various factors in bridge planning including economy, durability, vertical alignment, environmental impacts, constructability and maintainability. **Table 3.5** presents the choice of structure type.

Table 3.5 Selection of Bridge Structure Type

Choice of Foundation	Choice of Superstructure	Choice of Material
• Spread Foundation – for foundation on sandstone layer (depth < 5m), • RC Driven Pile – for soft upper soil layers until 20m deep	• For bridge spans 12m or less, cast-in-place reinforced concrete slab bridge and integral slab bridge is preferred since: o it requires less structure depth and o this type has the least cost at this span range, and • For bridge spans greater than 12m until 20m, cast-in-place reinforced concrete girder bridge is preferred since this is most cost-effective at this range. • For bridge spans greater than 20m, prestressed concrete I-girder is preferred since: o this is cost competitive at this span range, and o construction period is shorter using precast girders	Concrete is preferred over steel bridges since: • concrete bridges requires minimal maintenance compared to steel bridges, • steel bridges generally cost more than concrete bridges, and • experience in bridge construction in Cambodia is directed more to concrete bridges.

3.3.4 Bridge Planning

(1) Existing Bridge Location

Since national road NR.57 is an existing road, the bridge locations will more or less be on the same site except where improvement of the geometric alignment is made. Moreover, bridges with minimal discharges are proposed to be replaced by RC box culverts (RCBC). However, although the preliminary discharge calculations for some streams and rivers indicate small river discharges, bridges are proposed on these locations due to topographic condition requiring bridge to span these sites.

(2) Bridge Length and Span Lengths

The bridge length and span length are decided based on the existing topography at bridge site, existing bridge and span lengths and conditions, river design flood discharge, maximum flood water level, the condition of the river and banks depth of superstructure to minimize approach road profile adjustment and depth of existing water to minimize construction of piers on river. Basically, the bridge length should span the river banks.

(3) Deck Elevation

In this study, the geometric properties (horizontal alignment and vertical profile) of the national road NR.57 will be improved based on the functional requirements. As such, the approach roads' alignment and vertical profile leading to bridge sites will be improved. However, the minimum freeboard or vertical clearance requirement from the design high (flood) level to the bottom of the major structural element (girders or slab) shall be kept.

3.3.5 Bridge Design

Twelve sites are identified to require bridges based on river discharge, site condition and site topography. The rest of the stream or river sites are proposed to be provided with reinforced concrete box culvert with sufficient opening to discharge the anticipated flood water.

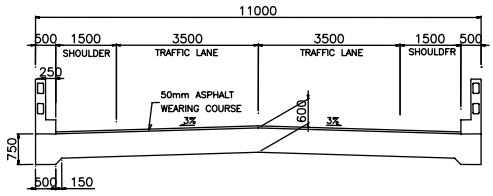
The preliminary design was undertaken to determine the outline form of bridges at identified location. This preliminary design is, however, based on the limited available topographic maps, site investigation undertaken by the study team, and the limited geotechnical survey conducted at three bridge location sites. No detailed topographic survey, as well as river cross-section survey was conducted during the study.

Table 3.6 presents the proposed bridge types and bridge lengths for the twelve bridges while **Figure 3.4** illustrates the basic bridge cross-sections for RC Slab, RCDG and PCDG bridges. The twelve bridges are illustrated in **Figure 3.5**.

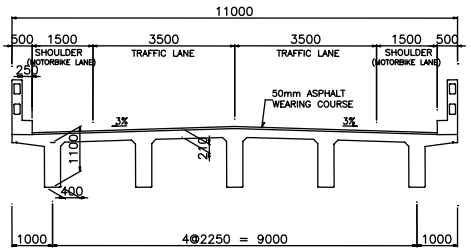
Table 3.6 Proposed Bridges on NR.57

Bridge No.	Station	Deck Elev. (m)	Total Length (m)	Superstructure			Substructure	
				Type	Spans (m)	Deck Width (m)	Pier	Abutment
1	040+693	49.03	15.0	RC Integ. Slab (D=600)	1 @ 14		-	Integral Type on RC Driven Pile (0.4x0.40m)
2	041+788	40.70	24.6	RC Slab (D=600)	2 @ 12		Wall Pier on RC Driven Pile (0.4x0.40m)	Seat Type Cantilever on RC Driven Pile (0.4x0.40m)
3	051+724	59.29	24.6	RC Slab (D=600)	2 @ 12		Wall Pier on RC Driven Pile (0.4x0.40m)	Seat Type Cantilever on RC Driven Pile (0.4x0.40m)
4	058+814	80.71	18.6	RCDG (D=1100)	1 @ 18		-	Seat Type Cantilever on RC Driven Pile (0.4x0.40m)
5	059+991	86.77	48.6	PCDG (AASHTO Type IV-A)	2 @ 24	Shoulder : 2@1.50	Column Pier on Spread Footing	Seat Type Cantilever on RC Driven Pile (0.4x0.40m)
6	063+089	95.97	33.6	RCDG (D=1100)	2 @ 16.5	Traffic Lane : 2@3.50	Column Pier on Spread Footing	Seat Type Cantilever on RC Driven Pile (0.4x0.40m)
7	065+279	108.25	14.0	RC Integ. Slab (D=600)	1 @ 13	**Total : 10.00**	-	Integral Type on RC Driven Pile (0.4x0.40m)
8	068+198	123.14	24.6	RC Slab (D=600)	2 @ 12		Wall Pier on Spread Footing	Seat Type Cantilever on RC Driven Pile (0.4x0.40m)
9	072+946	169.60	18.6	RCDG (D=1100)	1 @ 18		-	Seat Type Cantilever on RC Driven Pile (0.4x0.40m)
10	081+945	184.80	33.6	RC Slab (D=600)	10+12+10		Wall Pier on Spread Footing	Seat Type Cantilever on RC Driven Pile (0.4x0.40m)
11	083+060	183.12	13.0	RC Integ. Slab (D=600)	1 @ 10		-	Integral Type on RC Driven Pile (0.4x0.40m)
12	089+838	147.57	72.6	RCDG (D=1100) 1-Lane Bridge	4 @ 18	Sidewalk : 1@1.00 Shoulder : 1.50+0.50 Traffic Lane : 1@3.50 **Total : 6.50**	Column Pier on Spread Footing	Seat Type Cantilever on Spread Footing

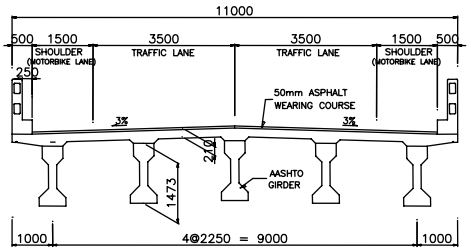
NOTES :
1. PCDG is Prestressed Concrete Deck Girder Bridge
2. RCDG is Reinforced Concrete Deck Girder Bridge
3. RC Slab is Reinforced Concrete Cast-in-Place Slab Bridge
4. RC Integ. Slab is Reinforced Concrete Cast-in-Place Slab with Integral Abutment



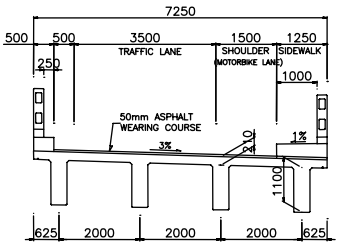
a. Typical RC Slab Bridge



b. Typical RCDG Bridge



c. Typical PCDG Bridge



d. RCDG Bridge Widening (Br. No. 12)

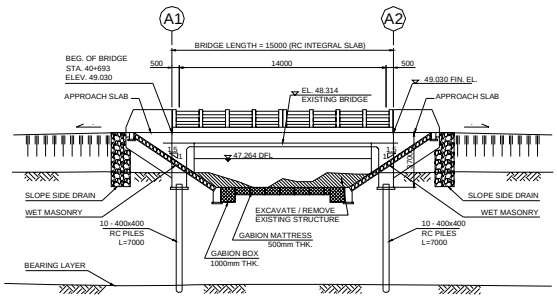
Figure 3.4 Basic Bridge Cross-Sections for NR.57

Widening of Bridge No.12 (Sta. 089+850)

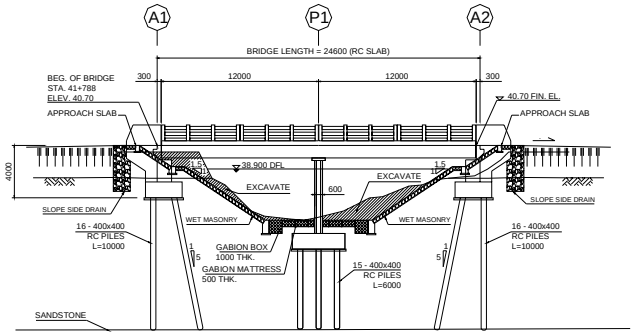
In order to increase the traffic capacity of Bridge No.12 (Sta. 089+850), the bridge is proposed to be widened by constructing a parallel bridge of similar bridge configuration as the existing bridge. The new bridge is 7.25m wide as shown in **Figure 3.4 d.** with one traffic lane plus shoulder and sidewalk. The existing bridge will be reconfigured to accommodate one traffic lane plus shoulder and sidewalk.

River Protection

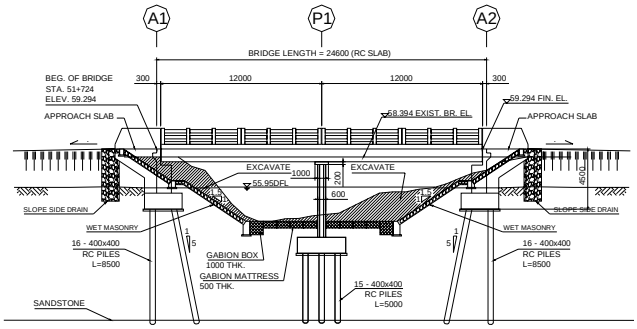
In order to protect the bridge foundations and abutments against high flood flow velocities and possible scour, wet masonry protection is provided in front of and around the abutments with gabion box cut-off perimeter at the toes of the wet masonry. Moreover, the top of pier footings and pile caps are located at a minimum depth of 1.0m below the river bed with 0.5m thick gabion mattress provided at the river beds.



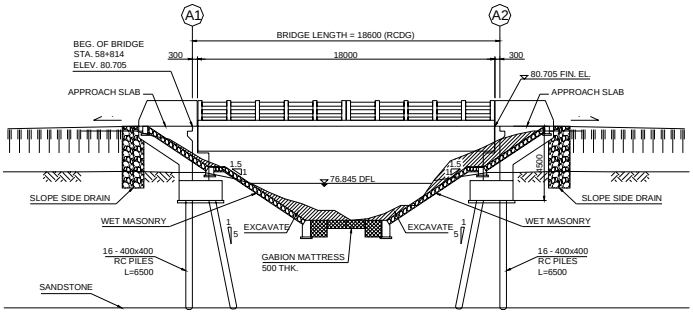
BRIDGE NO.1 REINFORCED CONCRETE INTEGRAL SLAB BRIDGE
STA. 40+693 BRIDGE LENGTH=15.00m



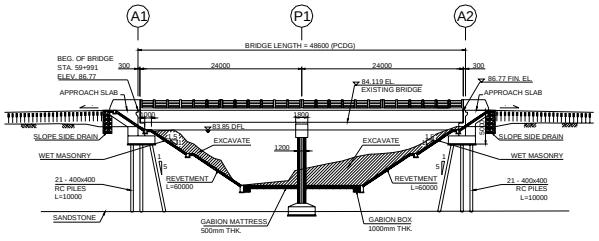
BRIDGE NO.2 REINFORCED CONCRETE SLAB BRIDGE
STA. 41+788 BRIDGE LENGTH=24.60m



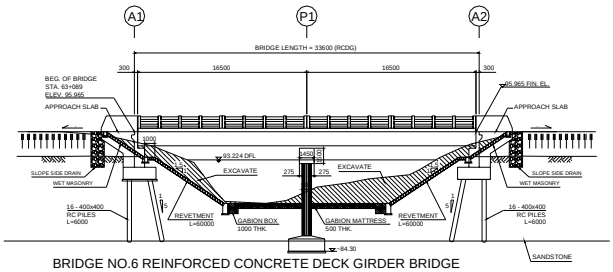
BRIDGE NO.3 REINFORCED CONCRETE SLAB BRIDGE
STA. 51+724 BRIDGE LENGTH=24.60m



BRIDGE NO.4 REINFORCED CONCRETE DECK GIRDER BRIDGE
STA. 58+814 BRIDGE LENGTH=18.60m

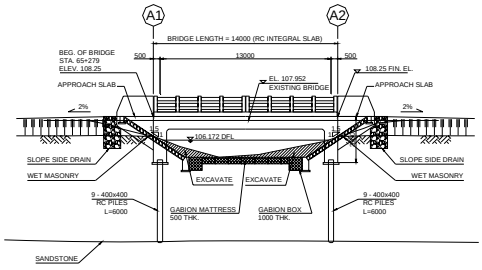


BRIDGE NO.5 PRESTRESSED CONCRETE DECK GIRDER BRIDGE
STA. 59+991 BRIDGE LENGTH=48.60m

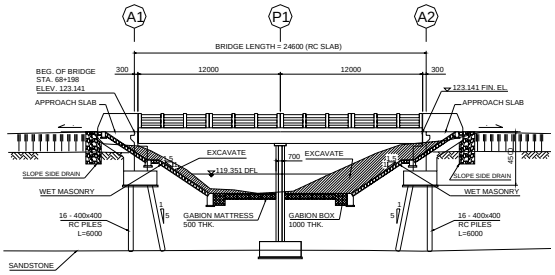


BRIDGE NO.6 REINFORCED CONCRETE DECK GIRDER BRIDGE
STA. 63+089 BRIDGE LENGTH=33.60m

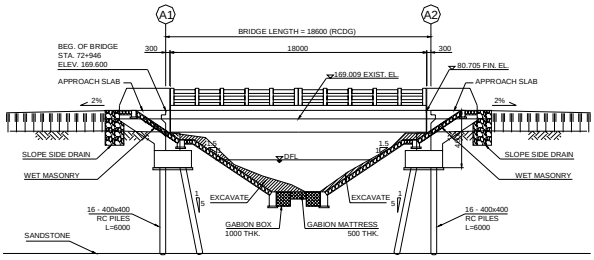
Figure 3.5(a) Proposed Bridges



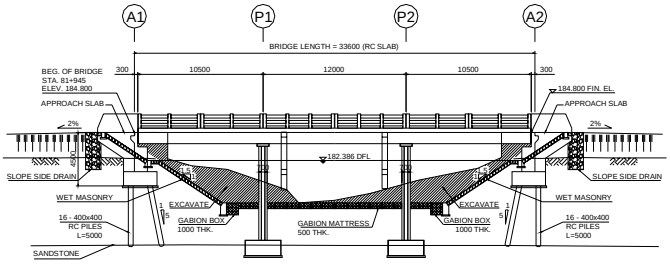
BRIDGE NO.7 REINFORCED CONCRETE INTEGRAL SLAB BRIDGE
STA. 65+279 BRIDGE LENGTH=14.00m



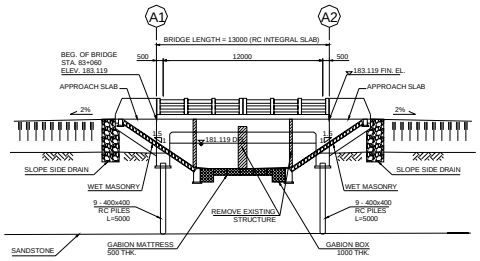
BRIDGE NO.8 REINFORCED CONCRETE SLAB BRIDGE
STA. 68+198 BRIDGE LENGTH=24.60m



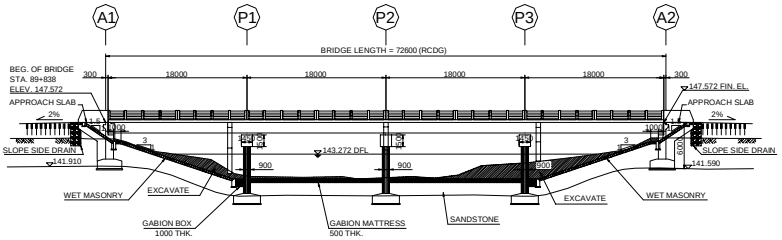
BRIDGE NO.9 REINFORCED CONCRETE DECK GIRDER BRIDGE
STA. 72+946 BRIDGE LENGTH=18.60m



BRIDGE NO.10 REINFORCED CONCRETE SLAB BRIDGE
STA. 81+945 BRIDGE LENGTH=33.60m



BRIDGE NO.11 REINFORCED CONCRETE INTEGRAL SLAB BRIDGE
STA. 83+060 BRIDGE LENGTH=13.00m



BRIDGE NO.12 REINFORCED CONCRETE DECK GIRDER BRIDGE
STA. 89+838 BRIDGE LENGTH=72.60m

Figure 3.5(b) Proposed Bridges

CHAPTER A-4 CONSTRUCTION PLAN, COST ESTIMATE AND IMPLEMENTATION PROGRAM

4.1 Construction Plan

4.1.1 Construction Policy

The construction plan has been prepared based on the following policies:

1) Proper consideration shall be given to local regulations required in Cambodia for construction work to proceed.

2) The construction method and schedule shall be agreeable with local conditions and local practice.

3) Local construction equipment and materials shall be utilized as much as possible. When necessary these can be imported from Thailand or other countries, based on the most economical within the range of specified quality.

4.1.2 Considerations on Construction Planning

The following are considered in planning the construction schedule, taking into account the local conditions:

1) The clearance of landmines and UXOs is indispensable prior to the commencement of the detailed design, due to the fact that NR.57 is notorious for serious landmine contamination.

2) The project is divided into two stages, based upon the progress of landmine clearance. Stage-1 includes the improvement of the road and facilities from Km3 to Km50, where landmines have already been cleared and it is safe within 15m on each side of the road. Stage-2 comprises of the rest of NR.57, where landmines are yet to be cleared and it is recommended that the clearing be carried out during the detailed design period for Stage-1.

3) Commencement of the construction work is scheduled to start in November, in order to avoid interference by high water levels during the rainy season, which in Cambodia, starts in May and ends in October.

4) To ensure on-going traffic is not disturbed during construction work, a detour is provided for each bridge site adjacent to the existing bridge.

4.1.3 Landmines and UXO

As stated in the preceding section, NR.57 is notorious for landmine and UXO contamination. Landmines have already been cleared up to approximately 50 km from Battambang along NR.57.

The clearance is limited to 15 m on each side from the road centre. Landmine and UXO clearance is indispensable prior to the commencement of the detailed design.

From the information provided by CMAC, it will take about four months with a cost of three hundred thousand US$ to clear the remaining area.

4.1.4 Major Project Components

The project includes the whole length of NR.57, including the town sections. The section up to about Km3 from the start is inside the urban area of Battambang and is excluded from the scope of the improvement under the present project.

Major components of the project are the road rehabilitation of 101 km(from Km3 to Km104), replacement of 12 bridges amounting to a total length of 340m, and replacement of culverts with a total length of 2,500m. Major components of the project are listed in **Table 4.1**.

Table 4.1 Project Components

Road Component	**Total Road length = 101 km**			
	Culverts			
	S.N.	**Total No.**	**Total Length**	**Type**
	1	22	418	RCBC-1
	2	11	2098	RCBC-2
	3	22	418	RCBC-3
	4	63	1197	RCPC-1
	5	10	190	RCPC-2
	6	2	38	RCPC-3
	Total	**130**	**2470**	
Bridge Component	**Bridge No.**	**Length**	**Bridge Type**	**Foundation Type**
	1	15.0	RCS	RC Pile
	2	24.6	RCS	RC Pile
	3	24.6	RCS	RC Pile
	4	18.6	RCDG	RC Pile
	5	48.6	PCDG	RC Pile/Spread
	6	33.6	RCDG	RC Pile/Spread
	7	14.0	RCS	RC Pile
	8	24.0	RCS	RC Pile/Spread
	9	18.6	RCDG	RC Pile
	10	33.0	RCS	RC Pile/Spread
	11	13.0	RCS	RC Pile
	12	72.6	RCDG	Spread Footing
	Total	**340.2**		

Note: RCPC – Reinforced Concrete Pipe Culvert, RCBC – Reinforced Concrete Box Culvert, 1,2,3 stand for no. of cell
RCS – Reinforced Concrete Slab, RCDG-Reinforced Concrete Deck Girder, PCDG-Precast Prestressed Deck Girder and RC Pile – Precast Reinforced Concrete Pile (400x400)

4.1.5 Procurement and Transportation Plans

The area along NR.57 is not well developed, due to the contamination by landmines and UXOs. Accidents from landmine explosions still occur in the daily life of the residents along the road. Because of this security issue, the development of material sources has not progressed well except for some existing ones. There are, however, potential areas for crushed stone and aggregate. Local material sources for road and bridge structure are listed in **Table 4.2**.

Table 4.2 Material Sources for Road and Bridge Structures

Type of Materials	Material Sources
Laterite (for Road Body & Sub-Grade)	Sala Kroa, Banon, Moung Ruessei
Sand (for Sub-Base)	Banon
Crushed Stone (Sub-Base, Base and Agrregate)	Dei Kraham and hills of Pailin
Bitumen (for Pavement)	Asphalt Plant near Banon for Stage-1 and Pailin for Stage-2
Embankment material (Road Body & Sub-grade)	Borrow Pit along NR.57

For Stage-1 road construction the material is predominantly for filling. Filling material for the roadbed and sub-base can be supplied from Banon, which is located 20km from Battambang. For Stage-2, Sala Troa might have an advantage for the supply of material. So far other potential areas, near Pailin, for the supply of road structure materials have not been so well explored.

4.1.6 Share of the Works

The project is considered to be financed by External Resources. The share of work responsibility between the External Resources and the Government of Cambodia is shown in **Table 4.3**.

Table 4.3 Share of Work between External Resources and the Government of Cambodia

Item	Content	Share		Remarks
		Other Countries	Cambodia	
Procurement of Equipment and Materials	Purchase and transport of equipment and material	○		
	Custom clearance of the above		○	
	Improvement of road for inland transport		○	
Survey and evacuation of landmine and UXO			○	Before the work commencement
Project Preparation	Land acquisition & conpensation etc. needed for the construction works		○	Site office, stock and work yards,
	Preparation works other than the above	○		
	Shift of Public Utilites such as Water supply line, Power supply line, communication cable		○	Before the work commencement
	Removal of existing bridges		○	
Project components	Construction of bridges and roads, other related works	○		

4.2 Cost Estimate

4.2.1 Construction Cost

For the purpose of cost estimates, the costs of temporary and indirect works have been estimated based on similar projects in Cambodia and elsewhere and age given in **Table 4.4**.

Table 4.4 Share of Temporary and Indirect Works

For NR.57 (Road: 101km, 12 Bridges: 340m)

Construction Works			
	Direct Cost	A	(a+b)
	Direct Construction Work	a	
	Site Temporary Work	b	a*10%
	Temporary Works in Common	B	a*5%
	Site Management	C	a*7%
	General Management	D	(A+B+C)*6%
Detailed Design and Supervision			
	Detailed Design & Construction Supervision		10%

The summary of estimated construction costs is given in **Table 4.5**.

Table 4.5 Estimated Construction Cost

Construction Cost of NR.57	Amount (x 1,000 US$)
Km3 - Km104	35,529
12 Bridges on NR.57	3,888
Pipe and Box Culverts on NR.57	3,378
Total of Construction Works	42,795
Engineering Works	
Detailed Design & Construction SV	4,280
TOTAL CONSTRUCTION COST	**47,075**

(1) Shared cost by External Resources

Components	**Preliminary Cost Estimate（x 1,000 US$）**	
	Stage-1 (~50km)	**Stage-2 (50km~)**
Road &Bridge Construction	29,573	22,222
Detailed Design, Construction Supervision	2,057	2,222
Sub-Total	22,631	24,444
Grand Total	**47,075**	

(2) Shared cost by the Government of Cambodia

Items	**(Equivalent in x1,000 US$)**	**Remarks**
Land Acquisition	28.4	
Clearing of Land Mines and UXOs	300.0	(0.57US$/$m^2$)
Relocation of Public Utilities (Electricity, Water & Communication)	10.0	
Total	338.4	

(3) Total Project Cost

The Total Project Cost is estimated as the total of the cost shared by external resources and by the Government of Cambodia and is estimated to be US$ 47,413,400.

Table 4.6 Total Project Cost

Unit:1,000US$

	External Resources	Cambodia Government
Construction Cost	42,795.0	
Detailed Design & Construction Supervision	4,280.0	
Land Acquisition		28.4
Landmine and UXO Clearance		300.0
Relocation of Public Utilities		10.0
Total	47,075.0	338.4
Grand Total	47,413.4	

4.3 Maintenance Plan

4.3.1 Preparation of Maintenance Plan

NR.57 is 104.2 km long from the intersection of NR.5 to the Thai border. The jurisdiction of the first half of 66.0 km belongs to the DPWT in Battambang and the rest of 38.2 km belongs to the DPWT in Pailin. The project road is to be maintained in accordance with the following classification:

(1) Routine maintenance

Based on the result of the meeting held between the MPWT and MEF in 2006, this activity will be performed by Force Account. The details of the activity are as follows:

1) Preparation of the road inventory based on a daily patrol
2) Cleaning of road surface, side ditches, culverts, patching pot-holes, sealing of cracks
3) Trimming and cutting trees/grass and minor repair other than the ones carried out during periodic maintenance

(2) Periodic maintenance

This activity will be carried out on a Contract-Out basis. The details of the activity are as follows:

1) Replacement of damaged culverts
2) Patching and overlay of the defective road surface requiring a medium/large scale repair

(3) Typical organization of maintenance activity

In comparison the maintenance capability of the DPWT in Pailin is less than that of the DPWT in Battambang**.** However, under the present organization, the DPWT in Battambang is obliged to support the DPWT in Pailin in terms of personnel and equipment. Present organization charts of both DPWTs are shown in **Figure 4.1**.

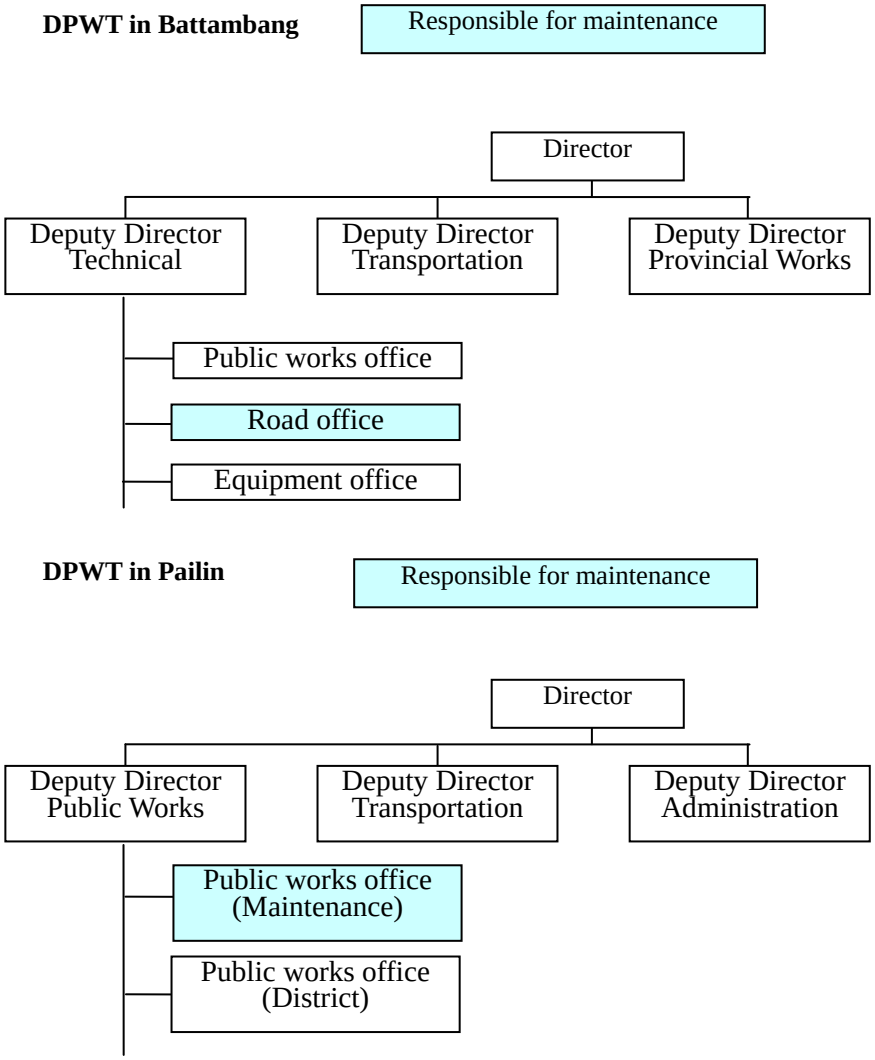


Figure 4.1 Organization chart of concerned the DPWTs concerned

4.3.2 Maintenance Operation Plan

Maintenance operation plan consists of the following three components:

(1) Organization and Operation

As road authorities where this project is located, the MPWTs and DPWTs of Battambang and Pailin will undertake the maintenance of the proposed improvement of national road No.57.

These provinces belong to the west region where the study team presented the proposal requesting considerations to perform training, personnel exchange and equipment supply. The DPWT in Battambang is the group leader in the region. The DPWT in Battambang will maintain NR.57 in good road condition and, at the same time, support the DPWT in Pailin in terms of personnel and equipment.

(a) Implementation and Arrangement of Maintenance Activities

A critical issue is the upgrade the service capacity of the maintenance system, to cope with the demand of the country's economic development. Without appropriate maintenance works the road is deterioring with increasing speed. Under such conditions and with limited technical and financial resources, the road authorities still have to take full responsibility for maintaining this asset.

Demarcation of maintenance works between the MPWT and the DPWT is shown in **Table 4.7**.

Table 4.7 Demarcation of Maintenance Management

Activity	MPWT	DPWT
Daily and Monthly Patrol	1. Evaluation of monthly inspection record by Public Works Research Center (PWRC).	1. Patrol to be conducted to check road condition, structure, facilities, obstacles, illegal occupancy and so on. 2. Visual inspection and road serviceability check are conducted. 3. Inspection sheet to be recorded.
Routine Maintenance Works	1. Assessment of DPWT's budget request by DOR. 2. Preparation of project estimation by DOR. 3. Bidding and preparation of contract, force account or contract-out to be determined by a bidding committee. 4. Supervising of project by DOR. 5. Inspection of project by DOR.	1. Preparation of routine maintenance plan based on daily and monthly patrol record for the request of budget to MPWT. 2. Implementation or supervising of project. 3. Preparation of routine progress & final report
Periodic Maintenance Works	1. Preparation of project estimations, bill of quantities, designs & spec. by PWRC. 2. Bidding and preparation of contract by a bidding committee. 3. Supervising and reporting of project by PWRC. 4. Hand over of management to DOR.	1. Inspection sheet shall be recorded conducting regular patrol. 2. Transfer of management from PWRC.
Emergency Works	1. Conducting inspection by PWRC & DPWT 2. Preparation of project estimations, designs & spec. by PWRC. 3. Bidding and preparation of contract by PWRC 4. Supervision and reporting of project by PWRC. 5. Hand over of management to DOR.	1. Conducting inspection by PWRC & DPWT 2. Transfer of management from PWRC.

(b) Operation of Maintenance Works

The operation of the maintenance program will follow the Maintenance Guideline and project management cycle so that maintenance of NR.57 will contribute greatly in strengthening the present efforts of the government to implement the Road Maintenance Policy at a provincial level.

The proposed organization for routine maintenance is shown in **Figure 4.2**.

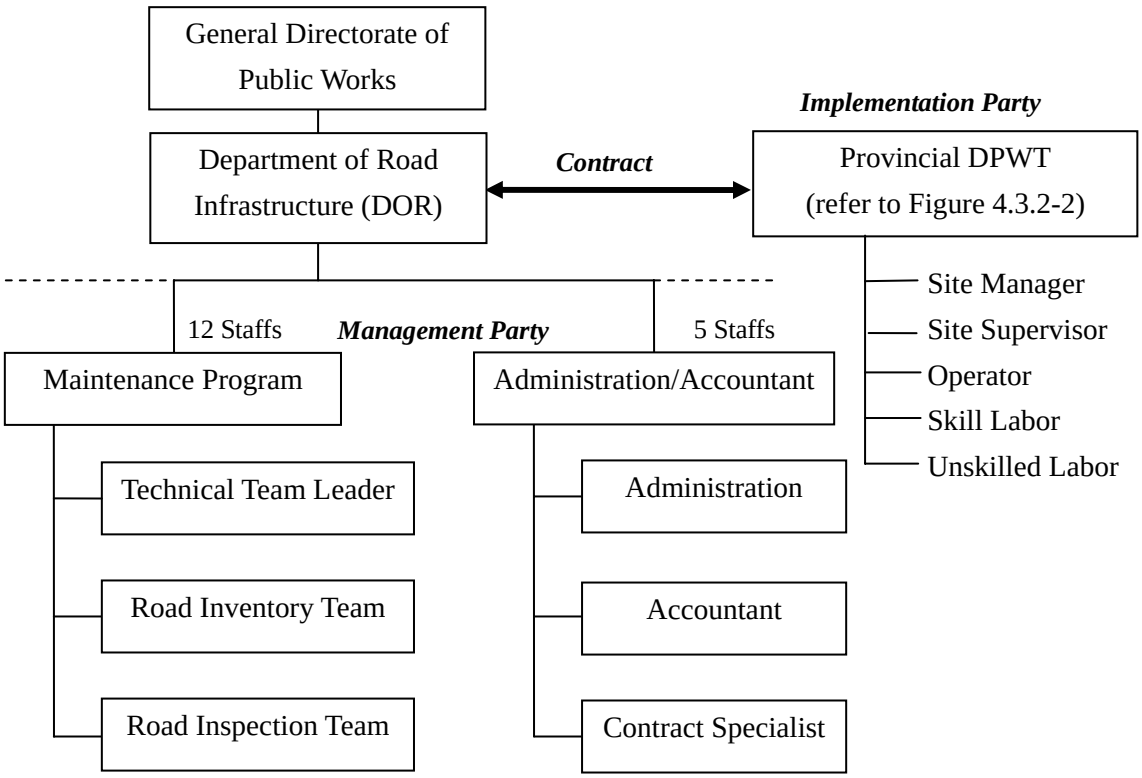


Figure 4.2 Routine Maintenance Management in Short Term

(2) Financial Plan

(a) Required Maintenance Cost

Total maintenance cost for NR.57 is estimated to be about $0.131million per annum, as shown in **Table 4.8**, by applying a unit maintenance cost per km, which consists of a routine patrol cost, cleaning-up cost and patching work to the subject length of the NR.57.

Table 4.8 Estimation of Annual Maintenance Cost for NR.57

NR.57	Dist.(km)	Unit Maintenance Cost ($/km)		Maintenance Cost ($ mil/year)		
		Patrol	Patching	Patrol	Patching	Total
Battambang - Pailin	104.0	32	866	0.0401	0.0904	0.131

Frequency of Patrol: 1 time a month
Frequency of Patching : 1 time a year

(b) Financial Plan

With regard to the future financing plan for urgent projects, there are two alternatives as described below:

Alt. 1; Financing by Road Maintenance Added Tax

On the basis of the expected amount of gasoline the expected revenue from added tax or road maintenance special fund in 2010 is forecasted to be about $30 million, of which about $22.0 million is scheduled for the maintenance of the existing roads in the nation. The required maintenance cost of $0.13 million is far below the $8 million balance between the expected revenue and expenditure of the fund.

Alt. 2; Financing by charging a maintenance charge on road users

This is a method to cater for the maintenance cost by charging a fee on the road users. This type of charge has already been introduced on the sections on NR.4 nearby Phnom Penh where a certain amount of fee is being charged on vehicles passing on the route.

If the level of charge is equivalent to that presently charged on NR.4 a simple analysis suggests that the fund achieved from fees levied by this method would be about $ 0.154 million in 2010, which is a sufficient amount of revenue to cover the maintenance cost; refer **Table 4.8**.

It can be concluded that one of these methods can be used to procure road maintenance funds from road users, therefore reducing the burden of extra expenses on the MPWT.

Table 4.8 Comparison of Maintenance Expenditure and Revenue from Road-user Charge

Year 2010	Required Maintenance Cost ($ mil./year)	Expected Revenue from Road User Charge ($ mil./year)
Cost & Revenue	0.131	0.154

4.4 Implementation Plan

4.4.1 Project Components

The construction of NR.57 consists of a total of 101 km of road component including a total of 2470m of culverts and a bridge component of 12 bridges with a total length of 340m.

4.4.2 Implementation Schedule

The schedule below has been prepared with the following considerations:

(1) Preparation Work

Clearance of landmines and UXOs is essential before the commencement of the detailed design of Stage-2. Four (4) months is considered necessary to carry out the work in parallel to the detailed design of Stage-1.

(2) Detailed design

The main scope of works for the detailed design includes the review of the preliminary design including preliminary design drawings, construction planning, procurement planning and cost estimation. The period required for the detailed design is estimated to be 6 months.

(3) Preparation of Tender Documents

Main tasks scheduled from public announcement to the establishment of the construction contract are as follows:

- Preparation of tender documents
- Public announcement
- Pre-qualification of bidders
- Tendering
- Tender evaluation
- Promotion of contract establishment

The period required for the above is estimated to be 3 months.

(4) Construction supervision

The followings are the major items:

- Collation and approval of survey data and construction planning
- Quality control
- Schedule control
- Progress quantity check
- Safety management
- Handover

It is estimated that a total time of 5 years will be required for both the stages; 2 years for Stage-1

and 3 years for Stage-2.

(5) Construction Equipment

All construction equipment, which is not already available, will have to be imported as there is no local leasing company. For some equipment such as backhoe, bulldozer and tire roller, large size crane, reverse circulation drill and vibration-hammer, it is believed that there is enough in Cambodia at present to cope with the demand. If required equipment may be sourced from Thailand.

(6) Construction Schedule

The construction schedule has been prepared based upon the quantities involved in the major construction work and construction method. The quantities are as shown in **Table 4.9**.

Table 4.9 Quantities of Major Construction Work Items

Title of Work		Major Item	Unit	Quantity
Road (101 km)				
	Earth Work	Embankment	m^3	313,000
		Sub-Grade	m^3	313,000
	Pavement	Sub-Base	m^2	1,393,600
		Base Course	m^2	1,372,800
		Binder	m^2	1,369,000
		Surface Course	m^2	780,000
Bridge(12 Bridge)				
	Total Length of 12 bridges		m	340.2
Culvert (130 Culverts) 1 Cell			m	2,470

(7) Implementation Schedule

The Project Implementation Schedule has been prepared based on the above considerations and is as shown in **Figure 4.3**.

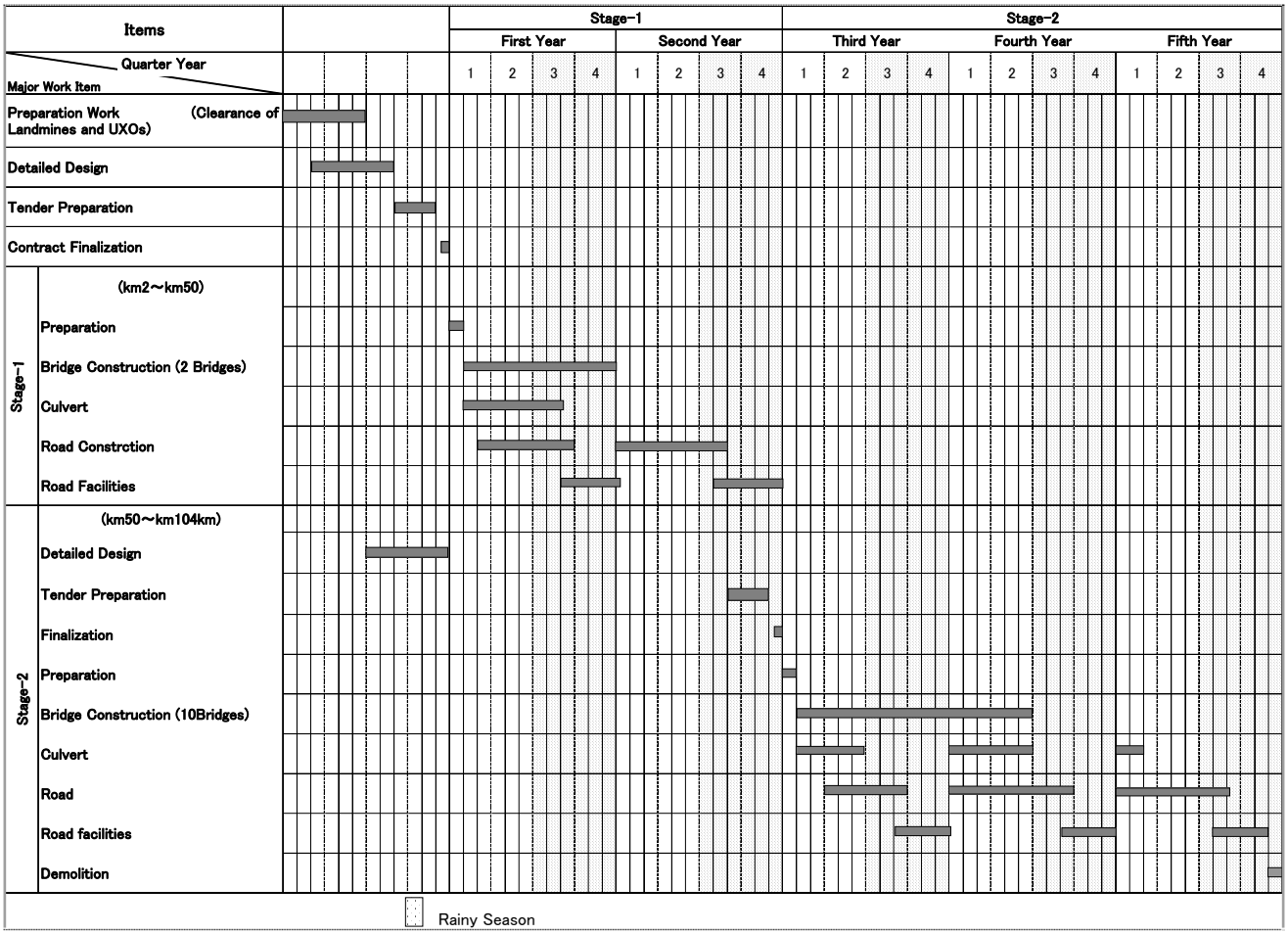


Figure 4.3 Project Implementation Schedule

CHAPTER A-5 PROJECT EVALUATION

The purpose of this chapter is to evaluate the project for National Road No.57 from the traffic, economic, financial, and regional development points of view.

5.1 Economic Analysis

(1) Economic Benefits

Economic benefits are assumed to two (2): a) saving in vehicle operating cost (SVOC) and b) saving in travel time cost (STTC), which are both derived from difference between "With the Project" and Without the Project" Special consideration in calculation of economic benefits is made a factor of dry season and rainy season. The economic benefits are estimated to be US $ 4.47 in 2010 million and US $ 8.99 million in 2020 with an average annual growth rate of 7.2 %. .

(2) Economic Costs

The economic costs, converted from the financial costs deducted transfer elements and standard conversion factor (SCF), are estimated. The economic cost of the initial investment totals US $ 42.84 million. Annual maintenance cost which includes both routine and periodical maintenance is estimated to be US $ 0.386 million.

(3) Cost Benefit Analysis

The results of the cost benefit analysis are summarized as shown in **Table 5.1**. The cost benefit analysis shows that the NR.57 improvement project is economically feasible based on a discount rate of Cambodia being assumed to be 12 %.

Table 5.1 Economic Indications of Cost Benefit Analysis

NPV (US $ '000)	9,814.0
Benefit Cost Ratio (B/C Ratio)	1.26
EIRR (%)	14.34

Notes: 1) Project life is assumed to be 25 years
2) Discount rate is 12 %

5.2 Financial Analysis

In the Master Plan Study, the overall financial analysis of the implementation program for the improvement and rehabilitation projects proposed has been examined. As a result, the implementation program as shown in **Table 5.2** of the Master Plan Study was recommended. This project is principally in accordance with the recommended implementation program and there are no problems for the implementation of the project from a financial point of view.

Table 5.2 Financial Analysis of the Project

(US Dollar Million)

Description	Short Term (2006-2010)
A.. Fund to be Procured	
(1) International fund	428
(2) Domestic fund	135
Total	563
B. Proposed Implementation Program in M/P	
(1) Improvement / Rehabilitation	403
・ NR.57 Improvement Project	47
(2) Maintenance	157.7
(3) Urgent Rehabilitation Program	(20)
Total	516
C. Amount of Balance	47

5.3 Other Impacts on Regional Development

The project will provide a practicable and efficient transport facility within the area influenced by NR.57. As a result the following benefits are expected on the development of the region:

a) Since economic activities within the area influenced by NR.57 will be stimulated, the project will contribute to economic growth of Batambang and Pailin Provinces,
b) Foreign and local investments in the area are expected to increase in the agricultural sector and also the service sector. As a result an increase in household income can be expected.
c) Population in the direct influence area of NR.57, which totals 178 thousand in 2005 and 254 thousand in 2020, will receive the benefits such as increased household income and job opportunities.

CHAPTER A-6 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

The Pre-Feasibility Study for NR.57 has shown that this project is technically and economically viable with a high economic internal rate of return as discussed in Chapter FS-A-5.

This project should be implemented as early as possible due to its importance as indicated in the implementation schedule proposed in Chapter FS-A-4.

6.2 Recommendations

It is recommended that the Royal Government of Cambodia take the following actions to ensure that this project is implemented successfully.

6.2.1 Preparation Aspects

(1) Allocation of Budget for Project Preparation

(2) Clearing of Landmines and UXOs

6.2.2 Management Aspects

(1) Operation and Maintenance

(2) Recycling of the Existing Temporary Superstructure

(3) Education on Traffic Safety, Rules and User Behavior

6.2.3 Environmental Aspects

According to the annex of the sub decree No.72.ANRK.BK, August 11, 1999, a full scale EIA is required for the project of NR.57 of which project length is 104 km.

However the necessary survey could not be conducted at the time that this Pre-Feasibility Study for NR.57 was prepared, because this study is still preliminary study level.

In this context, it is recommended that the EIA should be conducted as soon as possible once it has been decided to proceed with the project. When conducting the EIA, the following should be considered and included in the EIA by the MPWT, as the project owner.

(1) Samlaut Multiple Use Area
(2) Resettlement
(3) Others; local economy, land use, local resources, infection disease, air pollution, noise, vibration, environmental management plan, landmines & UXOs

In addition to the above points, there should be information disclosure to not only the PAPs but also all stakeholders, such as other people along NR.57, NGOs, etc.