JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

MINISTRY OF COMMUNICATION, TRANSPORT AND POST
CAMBODIA

BASIC DESIGN STUDY REPORT
ON
THE PROJECT FOR REHABILITATION
OF
NATIONAL ROAD ROUTE 6A
IN
CAMBODIA

APRIL 1993

PACIFIC CONSULTANTS INTERNATIONAL

JICA
BASIC DESIGN STUDY REPORT ON THE PROJECT FOR REHABILITATION OF NATIONAL ROAD ROUTE 6A IN CAMBODIA
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PREFACE

In response to a request from the Supreme National Council of Cambodia, the Government of Japan decided to conduct a basic design study on the Project for Rehabilitation of National Road Route 6A, and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Cambodia a study team headed by Mr. Koichi Miyoshi, Director, Second Basic Design Study Division, Grant Aid Study and Design Department, JICA, and constituted by members of Pacific Consultants International, from November 11th to December 11th, 1992.

The team held discussions with the officials concerned of Cambodia, and conducted a field study at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to Cambodia in order to discuss a draft report, and the present report was prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of Cambodia for their close cooperation extended to the team.

April 1993

Kensuke Yanagiya

Kensuke Yanagiya
President
Japan International Cooperation Agency

April 1993

Mr. Kensuke Yanagiya
President
Japan International Cooperation Agency
Tokyo, Japan

Letter of Transmittal

We are pleased to submit to you the basic design study report on the Project for Rehabilitation of National Road Route 6A in Cambodia.

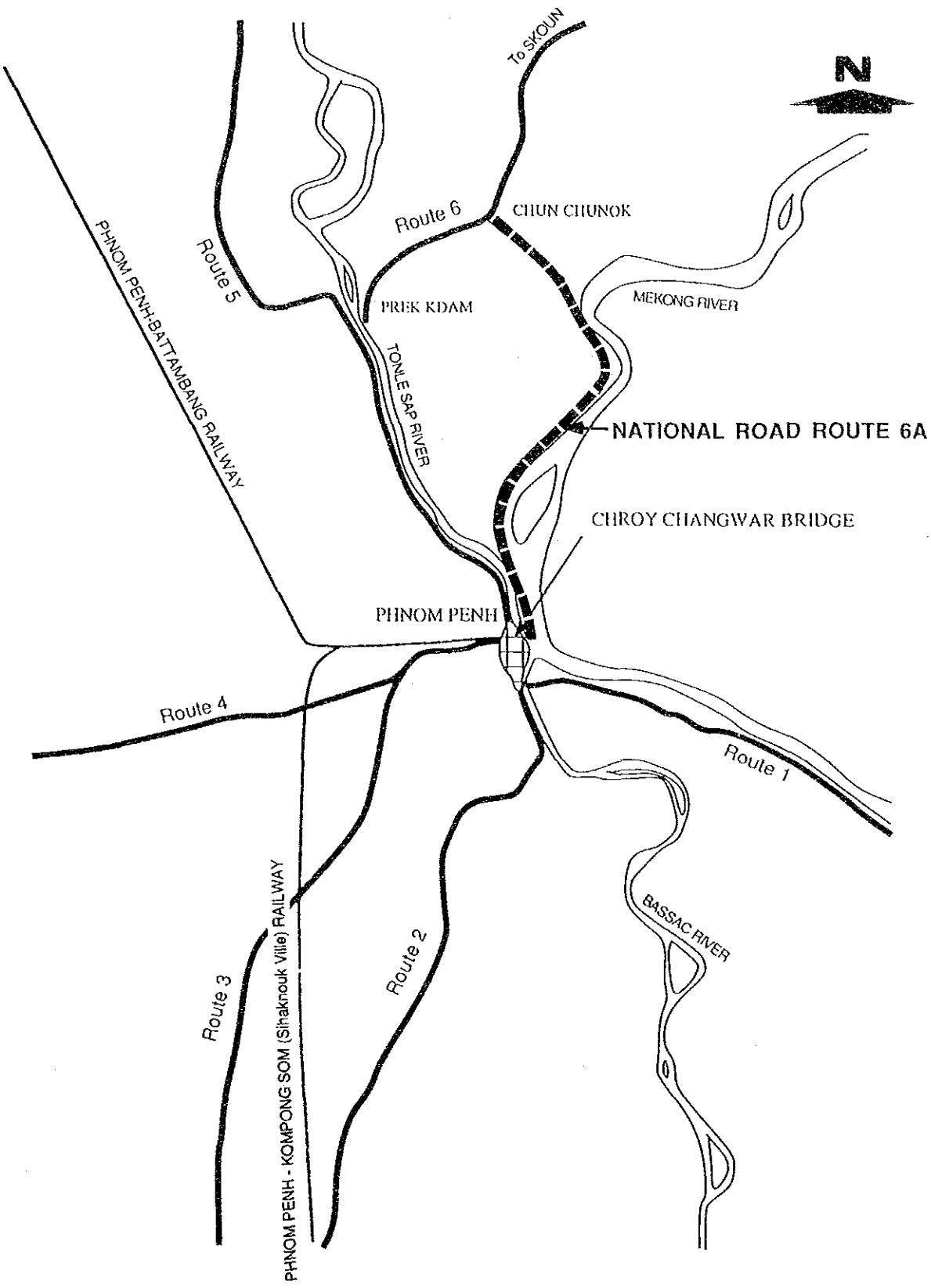
This study has been made by Pacific Consultants International based on a contract with JICA, from November 4th, 1992 to April 30th, 1993. Throughout the study, we have taken into full consideration of the present situation in Cambodia, and have planned the most appropriate project in the scheme of Japan's grant aid.

We with to take this opportunity to express our sincere gratitude to the officials concerned of JICA and the Ministry of Foreign Affairs and Ministry of Construction. We also wish to express our deep gratitude to the officials concerned of the Ministry of Foreign Affairs, Ministry of Communication, Transport and Post, and the Embassy of Japan in Cambodia for their close cooperation and assistance during our study.

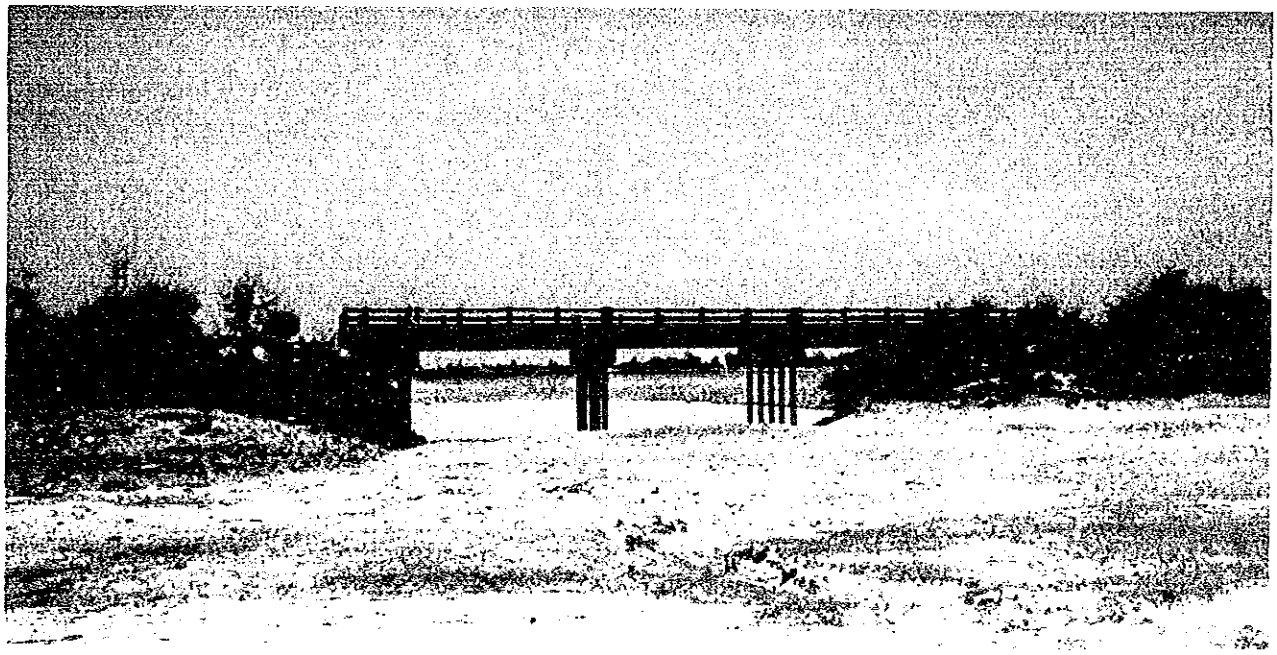
Finally, we hope that this report will be effectively used for the promotion of the project.

Very truly yours,

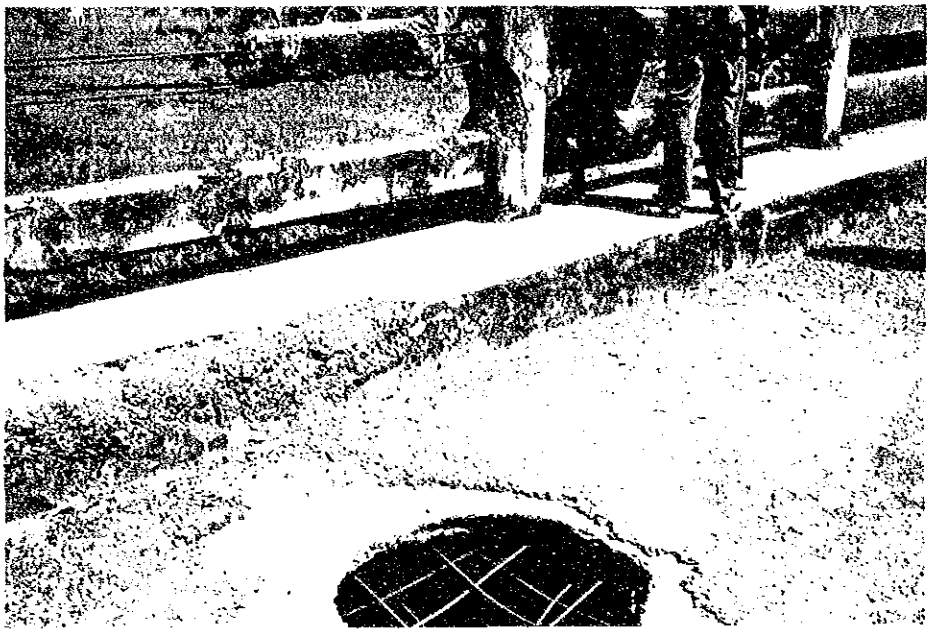
Akira Shikichi
Project Manager
Basic Design Study Team on the Project
for Rehabilitation of National Road
Route 6A in Cambodia
Pacific Consultants International



PROJECT LOCATION MAP



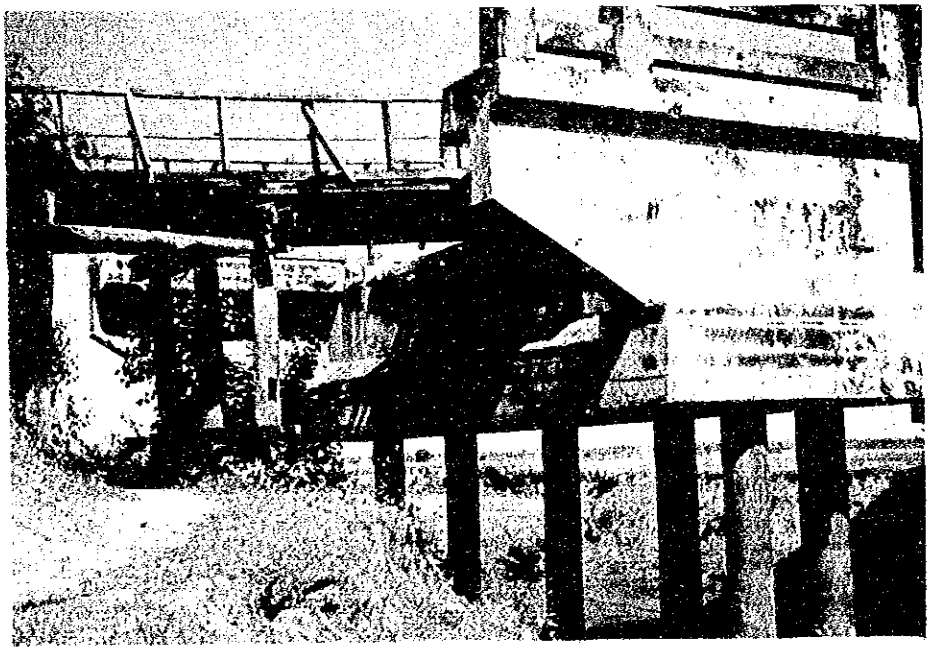
Damage of Bridge Approaches



Damage of Bridge Deck and Railing

Fallen Bridge Spans

Pavement Failure



Washed Abutment Rear

Summary

SUMMARY

Cambodia is located in the southwestern part of the Indochina Peninsula. It lies between 10 and 15 degrees north latitude, and 102 and 108 degrees east longitude. The Country occupies an area of about 182,000 sq.km, sharing 2,438 km of land border with Thailand, Laos and Vietnam, and has 389 km of coastline on the Gulf of Siam.

Official estimates place the 1991 Cambodian population at approximately 8.9 million. The population of the municipality of Phnom Penh was reported as 354,000 in 1981 and as 564,000 in 1987 by the Ministry of Planning and Agriculture. In 1991 the actual population is expected to be considerably higher than the above, somewhere between 800,000 to 1 million.

The Construction of Chroy Changwar Bridge was started in 1960 as a quasi-compensation project by Japan, and was completed in 1963. In parallel with the construction of Chroy Changwar Bridge, the National Road Route 6A (the Route 6A) was planned and built by the nation's own construction fund and technology.

Before the realisation of the Route 6A and Chroy Changwar Bridge, there was a route which utilises Route 5, Prek Kdam ferry crossing and Route 6 to provide the connection between Phnom Penh and its northern hinterland. However this route had been forced the inconvenience of the time-consuming ferry crossing at Prek Kdam.

The Route 6A had played a vital role to connect Phnom Penh with the northern region (9 provinces). However, Chroy Chongwar Bridge together with the several bridges of the Route 6A were destroyed and other road facilities such as road embankment and pavement were also affected by the conflict, and the repetitive floods occurred in the area which lead to further damages. Thus, Route 6A at present is in an impassable condition and is not fulfilling the function of the trunk road in the region.

The rehabilitation of Route 6A will contribute greatly to the social and economic stabilisation and the development of Cambodia and the Project has been given the highest priority in the improvement plan of infrastructures in Cambodia.

In the light of its importance and urgency, the Supreme National Council of Cambodia (SNC) has requested Japan's Grant Aid for the Project.

In response to a request from the SNC, the Government of Japan has decided to conduct a Basic Design Study (the Study) on the Project for Rehabilitation of National Road Route 6A and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Cambodia a study team (the Team) from November 11 to December 11, 1992. In Cambodia the Team had a series of discussions on the Project with the officials concerned of Cambodia.

The summary of the major points of understanding reached between them are:

- The objective of the Project is to rehabilitate Route 6A to provide uninterrupted road transport between Phnom Penh and its northern hinterland, and to contribute toward the enhancement of the nation's economy.

- Road and Bridge Department (RBD), Ministry of Communication, Transport and Post (MCTP) is responsible for the implementation of the Project.

- The following items were requested by the Cambodian side.

  - Rehabilitation of damaged bridges and culverts;
  - Rehabilitation of damaged road embankment; and
  - Rehabilitation of damaged and/or deteriorated pavement.

The Team conducted the following surveys in the study area with the cooperation of officials from RBD during their stay in Cambodia.

- Topographic survey;
- Soils and Materials Investigations;
- Visual investigations and various tests of existing bridges;
- Hydrological study;
- Survey concerning the existing construction environment for construction planning.

Consecutive basic design was carried out in Japan based on the result of the above surveys and initial studies conducted in Cambodia. The result of the basic design is summarised as follows:

- All collapsed bridge spans will be reconstructed (8-spans x 12 m/span).

- All damaged piers will be reconstructed utilizing the existing foundation piles (4-piers).

- One damaged abutment will be reconstructed utilising the existing foundation piles.
- All damaged bridge deck slabs (blasted holes) and railings will be restored to their original condition.
- All seriously damaged bridge approaches will be repaired (5-locations) adopting reinforced concrete slab construction method.
- Other bridge damages (i.e., washing away of abutment rear and the damage of girder ends, expansion joints and bridge revetments) will be repaired in a satisfactory manner.
- Two damaged culverts will be reconstructed including new concrete headwalls.
- All major embankment damages (6-locations between Stas. 40 and 42) will be reconstructed.
- All other embankment damages will be repaired providing stone masonry slope protection where necessary.
- Existing damaged or deteriorated pavement will be reconstructed or upgraded using asphalt concrete surface course. Base and subbase courses are provided where required.
- Failure of shoulders will be repaired adopting asphalt treated strips on both sides.

Since Route 6A is situated in an essential part connecting Phnom Penh with its northern hinterland, thus the influenced area will widely cover Phnom Penh and the northern nine provinces.

In the case that Route 6A is entirely rehabilitated, it is obvious that the Project can expect an economically high return which will be gained through the smooth movement of goods and passengers between Phnom Penh and its northern hinterland. The major effects of the Project are summarized in the following:

- Remove the bottleneck created by the present ferry crossing at Prek Kdam, provide for uninterrupted road transport between Phnom Penh and its northern hinterland, and contribute towards the nation's economic enhancement.
- Route 6A will provide important access to the development area which is envisaged in the western side of the Mekong river. Accordingly, the transport mobility and

accessibility of the area will be greatly improved and bring about a striking reduction of traffic cost.

- The influence area of the Project will comprise Phnom Penh and nine provinces and shares about 50 % of the nation's population. In future, the population in the influence area could enjoy the benefits of Route 6A in various forms.

- Rehabilitation of Route 6A will support the immediate needs for quick-impact rehabilitation of nearby rural areas to absorb "returnees".

- Landuse potential along Route 6A will be greatly enhanced. In landuse allocation, inefficient concentrations in Phnom Penh can be decentralised and inefficient dispersions can be integrated.

- Project investment will produce the multiplier effect for the regional economy. Kompong Cham city is the second largest city of the nation. Also, Kompong Cham province has approximately 1.4 million of population and is the center of production of rice and rubber in Cambodia. If Route 6A is rehabilitated, accessibility to the City will be greatly improved and create considerable impact and would enhance employment opportunities.

In view of the above-mentioned effects, implementation of the Project is indispensable not only for providing Route 6A for use as a traffic function, but also for promoting the stabilisation of livelihood and improvement of the living standards.

Definitions and Abbreviations

A. Authorities and Agencies

ADB	Asian Development Bank
CMEA	Council for Mutual Economic Assistance
JICA	Japan International Cooperation Agency
MCTP	Ministry of Communication, Transport and Post
OECD	Organisation for Economic Co-operation and Development
RBD	Road and Bridge Department
SNC	Supreme National Council of Cambodia
UNDP	United Nations Development Programme
UNTAC	United Nations Transitional Authority in Cambodia

B. Other Abbreviations

A	Ampere
AASHTO	American Association of State Highway and Transportation Officials
AC	Asphaltic concrete
@	At the rate
CBR	California Bearing Ratio
cm	Centimetre
cm^2	Square centimetre
El	Elevation
ha	Hectare
km	Kilometre
km^2 or sq.km	Square kilometre
km/hr	Kilometre per hour
kVA	Kilovolt-ampere
kw	Kilowatt
m	Metre
m^2	Square metre
m^3	Cubic metre
mm	Millimetre
n	Number
%	Per cent
ø	Diametre
PC	Prestressed concrete
PCU	Passenger car unit

Photo	Photograph
Project	Project for Rehabilitation of National Road Route 6A
Pt	Point
Rb	Ruble
RC	Reinforced concrete
Route 6A	National Road Route 6A
RN	Route number of national road
σ_{ck}	Allowable stress of concrete
σ_{sa}	Allowable stress of reinforcing steel
Sta.	Station
t	Ton or thickness
t/h	Ton per hour
t/m^2	Ton per square metre
Topo	Topographical or topography
W	Width

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Chapter 1: Introduction

CHAPTER 1 INTRODUCTION

Improvement of social and economic conditions of Cambodia greatly depends on the rehabilitation of infrastructures. The rehabilitation of transport infrastructures, in particular the road facilities, are urgent to provide the basis for the expanded economic activity and safe living conditions, as well as for the resettlement of returned refugees.

National Road Route 6A constitutes the essential part of the route to provide the connection between Phnom Penh and its northern hinterland. However, Route 6A at present is in an impassable condition due to the damages sustained during the conflict, and the route had been forced the inconvenience of the time-consuming ferry crossing at Prek Kdam.

The rehabilitation of Route 6A will contribute greatly to the social and economic stabilisation and the development of Cambodia, and the Project has been given the highest priority in the improvement plan of infrastructures in Cambodia.

In the light of its importance and urgency, the Supreme National Council of Cambodia (SNC) has requested Japan's Grant Aid for the Project.

In response to a request from the SNC, the Government of Japan has decided to conduct a Basic Design Study on the Project for Rehabilitation of National Road Route 6A, and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Cambodia a study team (the Team), headed by Mr. Koichi Miyoshi, Director, Second Basic Design Study Division, Grant Aid Study and Design Department, JICA from November 11 to December 11, 1992.

In Cambodia the Team had a series of discussions on the Project with the officials concerned of Cambodia, and conducted the following surveys in the study area with the cooperation of officials from the RBD:

- Topographic survey;
- Soils and Materials Investigations;
- Visual investigations and various tests of existing bridges;
- Hydrological study;

- Survey concerning the existing construction environment for construction planning.

After the Team returned to Japan, further studies were made. Then, a mission headed by Mr. Akira Fujimoto, Coordinator for International Research Cooperation, Public Works Research Institute, Ministry of Construction was sent to Cambodia from March 20 to March 29, 1993 in order to discuss draft report.

This report deals the study of socio-economic effects of the Project, the examination of viability of the Project for the Japanese Grant Aid Programme, and the basic design for the optimum scheme of the rehabilitation.

The member list of survey team, survey schedule, member list of concerning party in the recipient country, and the copies of minutes of discussions are attached at the end of this report.

Chapter 2: Background of the Project

CHAPTER 2 BACKGROUND OF THE PROJECT

2.1 Background

The National Road Route 6A (the Route 6A) starts at the Chroy Changwar Bridge which is located at the northeast end of Phnom Penh city and terminates at Route 6 near Chun Chunok which is situated about 35 kilometres north of Phnom Penh. The total length of the Route 6A is approximately 44 kilometres.

In the early 1960s the Route 6A was built with the nation's own construction funds and technology. Before the realisation of the Route 6A and Chroy Changwar Bridge, there was a route which utilises Route 5, Prek Kdam ferry crossing and Route 6 to provide the connection between Phnom Penh and its northern hinterland. However, this route had been forced the inconvenience of the time-consuming ferry crossing at Prek Kdam.

In expectation that the speed of the movement of goods and passengers would be much improved by smoother road transportation, the construction of Chroy Changwar Bridge was constructed and completed in 1963 as a quasi-compensation project by Japan, and the construction of the Route 6A was completed timely.

However, the Chroy Changwar Bridge together with the several bridges of the Route 6A were destroyed in 1972 during the Cambodian conflict. Other road facilities such as road embankment and pavement were also affected by the conflict, and the repetitive floods which occurred in the area lead to further damages. Thus, Route 6A at present is in an impassable condition and is not fulfilling the function of the trunk road in the region.

The Project area spread out along the western side of the Mekong river and has a vast agricultural development potential, but the area has suffered from low productivity of cultivated land because of the lack of a trunk road.

The rehabilitation of the Chroy Changwar Bridge and Route 6A will contribute greatly to the social and economic stabilisation and the development of Cambodia, and the Project has been given the highest priority in the improvement plan of infrastructures in Cambodia.

Under such circumstances the Government of Japan has extended Grant Aid for the restoration of the Chroy Changwar Bridge and presently the said project is in the construction stage with completion scheduled in March 1994. It is now urgent to rehabilitate the Route 6A in parallel with the restoration of the Chroy Changwar Bridge.

2.2 Outline of the Request

After discussions with the Basic Design Study Team, the following items were finally requested by the Cambodian side.

(1) Rehabilitation of damaged bridges and culverts;
(2) Rehabilitation of damaged road embankment; and
(3) Rehabilitation of damaged and/or deteriorated pavement.

2.3 Geography and Socio-Economic Situation of Cambodia

2.3.1 Geography

Cambodia lies between 10 ~ 15 degrees north latitude and 102 ~ 108 degrees east longitude. The country occupies an area of about 182,000 square kilometres and is bounded by Viet Nam to the east and southeast, by Thailand to the west and north, by Laos to the north, and by the Gulf of Thailand to the south and southeast.

The terrain of Cambodia consists of low plains. The Central Plain which comprises three-fourths of the total land area is 10 ~ 30 metres above sea level. There is a narrow mountain chain, Dangrek Range, along the border with Thailand and encircling the Central Plain. To the southwest are the Cardamom Mountains, with a high peak of about 1,700 metres. Extending south and southeast from the Cardamoms, the Elephant Range separates the narrow coastal plains from the Central Plain. In the northeast and east there are also several scattered mountains which are surrounding the Central Plain.

The most salient geographical features in the Central Plain is the existence of the Tonle Sap lake. The watershed area of the Tonle Sap lake covers the dominant area of the Central Plain, plateau regions and surrounding mountain chain and ranges. The outlet of the Tonle Sap lake is called Tonle Sap river which flows southeastward and flows into the Mekong river near Phnom Penh.

The climate is influenced by the monsoons and has two distinct seasons, the rainy season and dry season. The temperature is high except in mountainous areas, with an average mean temperature in Phnom Penh of 27.4 degrees Celsius. The relative humidity averages 80 per cent throughout the year.

2.3.2 Population

Official estimates place the 1991 Cambodian population at approximately 8.9 million, growing at a rate of 2.3 per cent annually between 1981 and 1987 and at a rate of more than 2.8 per cent annually after 1987 (see Table 2.1 and Figure 2.1).

Table 2.1 Population of Cambodia

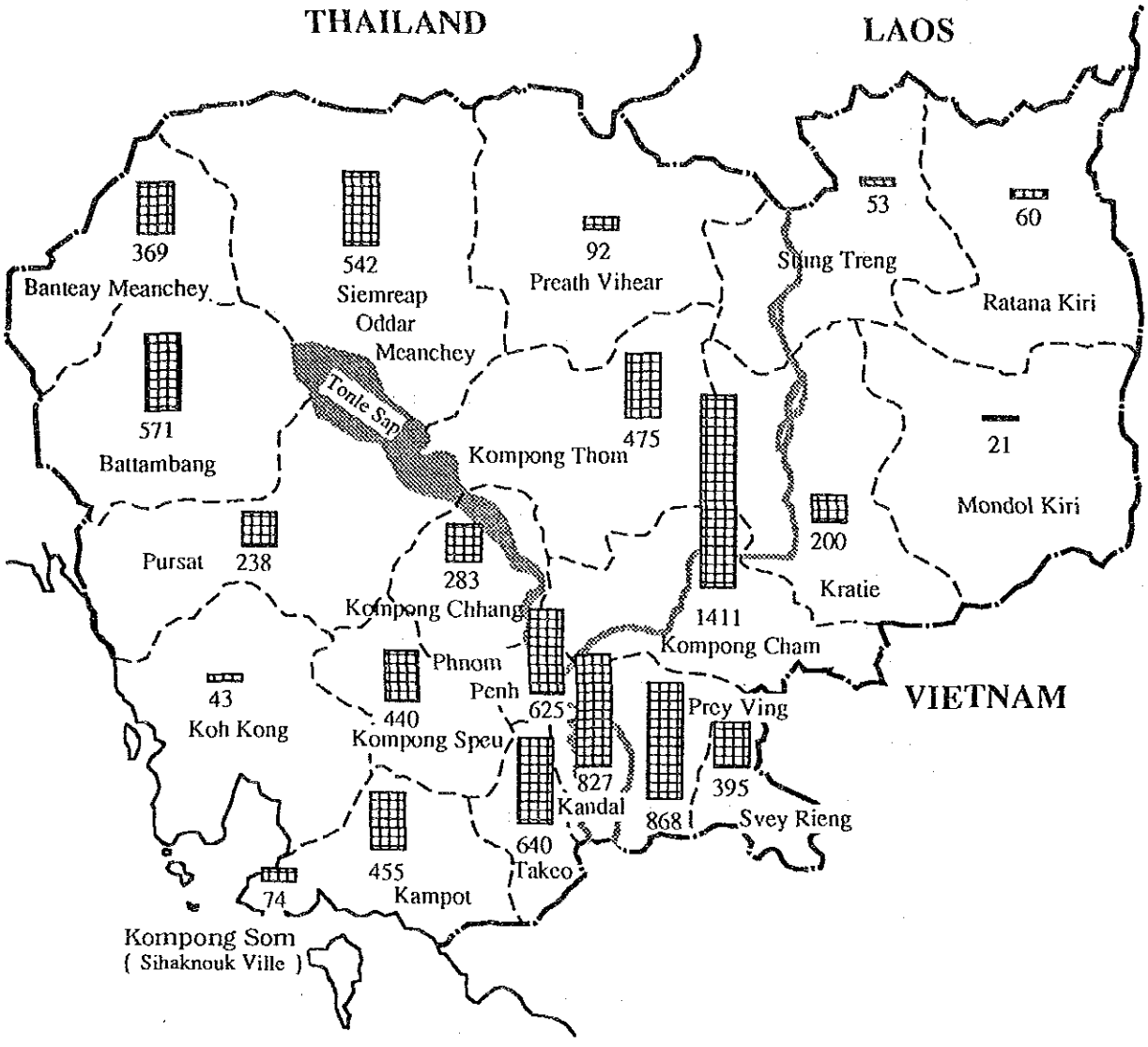
Year	Population (million)	Growth Rate (% per annum)
1963	6.00	—
1969	7.00	2.6
1981	6.70	-0.3
1987	7.90	2.8
1990	8.68	3.2
1991	8.92	2.8

Source: Ministry of Planning quoted in Economic Intelligence Unit Report

2.3.3 Economic Situation

Restoration of economic situation of Cambodia originally envisaged that this would be achieved based on a system of socialism combined with the function of market mechanisms in which the private sector plays an important role. Farmers have been allowed to sell their produce since 1979 and the role of the private sector was officially recognised in 1985. The right to own private property and to inherit land have been permitted by law in 1989. Since 1989 foreign investment has been legalised and now the privatisation programme is proceeding for the economic recovery of Cambodia. Per capita income at the end of the 1960s was about $110 in Cambodia compared with $150 in Thailand. However per capita income in Cambodia was estimated at $130 in 1988 whereas per capita income in Thailand had increased to about $1,000 in the same year[1/] .

1/ UNDP (1992), Comprehensive paper on Cambodia.



REHABILITATION OF NATIONAL ROAD ROUTE 6A	**Figure 2.1 Population by Province in Cambodia**

Agriculture plays an important role in the national economy. It shares 45 per cent[2/] of total economic output and about 80% of population are engaged in agriculture. The major food crops is paddy. Paddy production increased from 0.6 million tonnes in 1979 to about 2.0 million tonnes in 1982 and fluctuated around that level until 1987. After economic liberalisation the production increased to 2.6 million tonnes in 1989. However the production declined again in 1991 because of severe floods. Consequently Cambodia faced a deficit estimated at 70,000 tonnes during the 1990/1991 season and a deficit of about 180,000 tonnes during the 1991/1992 season[3/]

Cambodia has made gradual progress in expanding its external trade (see Table 2.2). Its principal exports in recent years have been rubber crepe, unprocessed timber, red maize, soyabeans, sesame and tobacco. Since 1986 there has also been growing informal and quasi-official trade with Thailand and Singapore via Kompong Som (Sihaknouk Ville) and Koh Kong ports[4/] . The withdrawal of assistance of former CMEA countries in 1990 and the exacerbation of balance in payment of convertible currencies has led to the need to boost export performance.

Table 2.2 Trend of Foreign Trade

Description	1987	1988	1989	1990
CMEA zone (Rb million)				
Exports	22.5	23.0	26.8	42.0
Imports	-113.0	-120.0	-110.9	-132.5
Balance	-90.5	-97.0	-84.1	-90.5
Convertible zone ($ million)				
Exports	4.7	12.0	17.4	16.6
Imports	-8.4	-10.0	-24.1	-37.6
Balance	-3.7	2.0	-6.7	-21.0

Source: The Economist Intelligence Unit (1991 - 1992), Country profile of Cambodia.

2/ ADB (1991), economic report on Cambodia.
3/ UNDP (1992), Comprehensive paper on Cambodia.
4/ The Economist Intelligence Unit (1991 - 1992), Country profile of Cambodia.

Foreign assistance averaged about $150 million per annum during the 1986 - 90 plan period (see Table 2.3) but Soviet assistance which averaged about $120 million per annum during the same period is set to fall by about 80 per cent in 1991[5/] .

Table 2.3 Official Development Assistance to Cambodia (Commitments 1984 - 1989)*

Unit: $ million

Description	1984	1985	1986	1987	1988	1989
Bilateral of which:	100.4	115.2	180.8	193.2	201.7	18.8
CMEA	92.0	112.0	177.0	183.1	192.0	–
Australia	1.7	0.3	–	2.3	1.7	5.8
Belgium	–	–	0.3	0.1	0.1	–
Canada	–	–	–	–	–	0.1
Finland	0.3	0.3	–	–	–	0.7
France	2.5	0.3	0.3	1.3	0.4	0.9
West Germany	0.2	0.3	–	–	0.8	0.6
Japan	–	–	–	–	0.9	0.2
Netherlands	0.2	0.6	0.2	0.2	0.5	1.0
Norway	–	0.1	–	0.1	–	–
Sweden	3.3	1.2	2.3	2.1	0.8	3.1
Switzerland	–	0.1	0.4	0.1	0.3	0.2
UK	–	–	–	–	0.2	0.5
USA	0.1	–	0.2	3.9	4.0	5.7
Multilateral of which:	8.7	7.1	7.6	5.2	8.8	5.9
EC	0.3	0.3	0.4	0.2	3.4	0.6
UN agencies	8.4	6.8	7.1	5.0	5.4	5.4
Total of which:	109.1	122.3	188.4	198.4	210.5	24.7
Grants	42.9	60.2	74.6	68.4	68.2	24.6
Loans	66.1	62.1	113.7	130.0	142.3	0.2

* Includes disbursed and undisbursed assistance.
Source: OECD, Geographical distribution of financial flows to developing countries

5/ The Economist Intelligence Unit (1991 - 1992), Country profile of Cambodia.

2.4 Transportation System of Cambodia

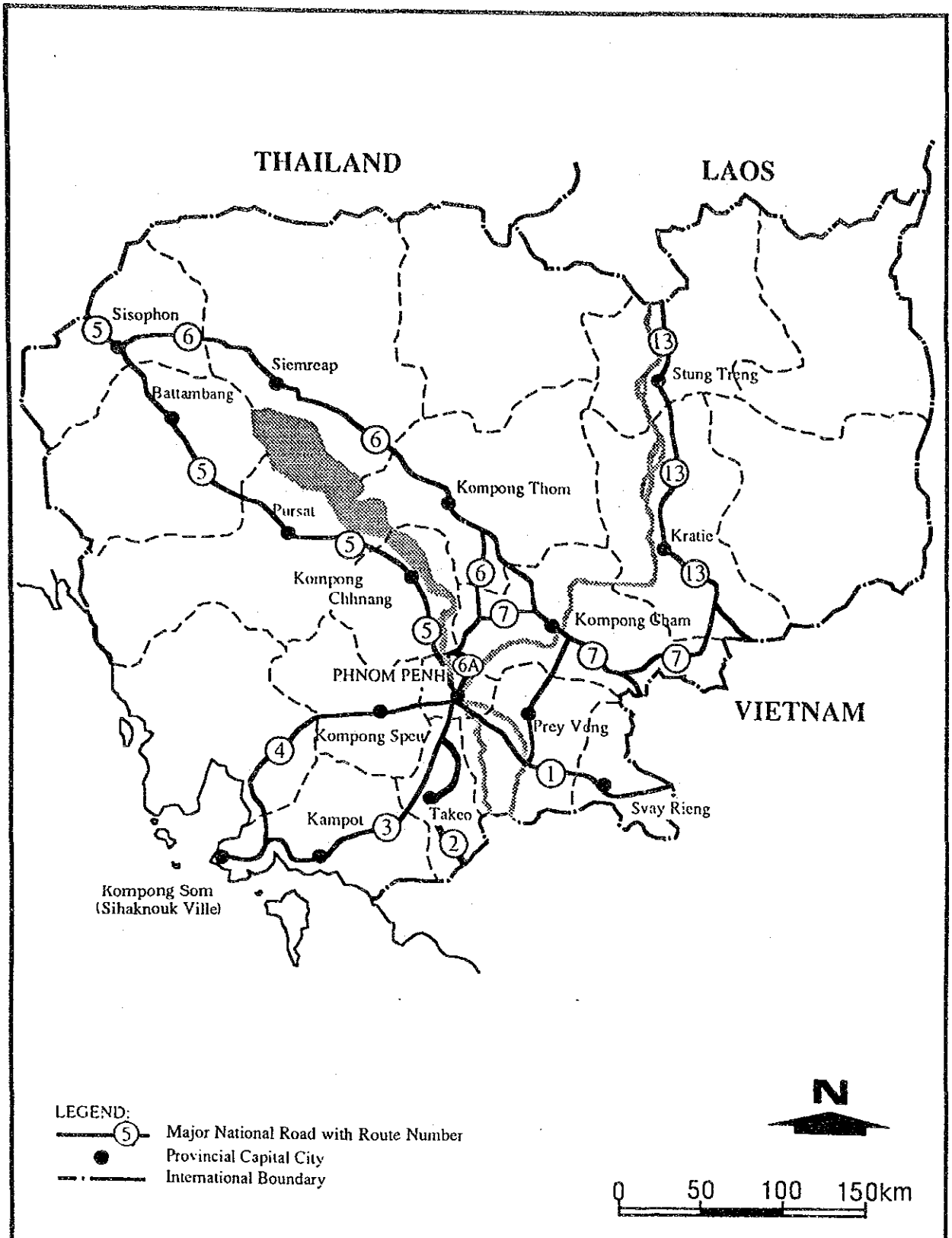
2.4.1 Road Transport

The length of national and provincial roads in Cambodia was 3,500 km and 3,100 km respectively in 1989. These roads, 6,600 km in total, in which asphalt paved and gravel/laterite roads account for 2,600 km and 3,080 km respectively. The primary national road routes radiate from Phnom Penh, connecting provincial capital cities (see Table 2.4 and Figure 2.2). Existing conditions of these roads are generally poor even on the national roads because of the lack of maintenance over the past 20 years.

Table 2.4 Primary National Road Network

National Road Route Number	Route	Length (km)
1	Phnom Penh ~ Vietnam border	167
2	Phnom Penh ~ Takeo ~ Vietnam border	120
3	Phnom Penh ~ Kampot ~ Veal Renh	202
4	Phnom Penh ~ Kompong Som (Sihaknouk Ville)	226
5	Phnom Penh ~ Kompong Chhnang ~ Pursat ~ Battambang ~ Thai border	407
6	Prek Kdam ~ Kompong Thom ~ Siem Reap ~ Sisophon	386
6A	Chroy Changwar ~ Chun Chnok	44
7	Skun ~ Kompong Cham ~ Vietnam border	179
13	Snoul ~ Kratie ~ Stung Treng ~ Laos border	300

Source: Department of Road and Bridge, MOC



REHABILITATION OF NATIONAL ROAD ROUTE 6A

Figure 2.2 Major National Road Network in Cambodia

2.4.2 Rail Transport

Cambodia has a total length of 648 km of metre-gauge single track railway:

- 386 km from Phnom Penh through Pursat, Battambang and Sisophon to the Thai border; and

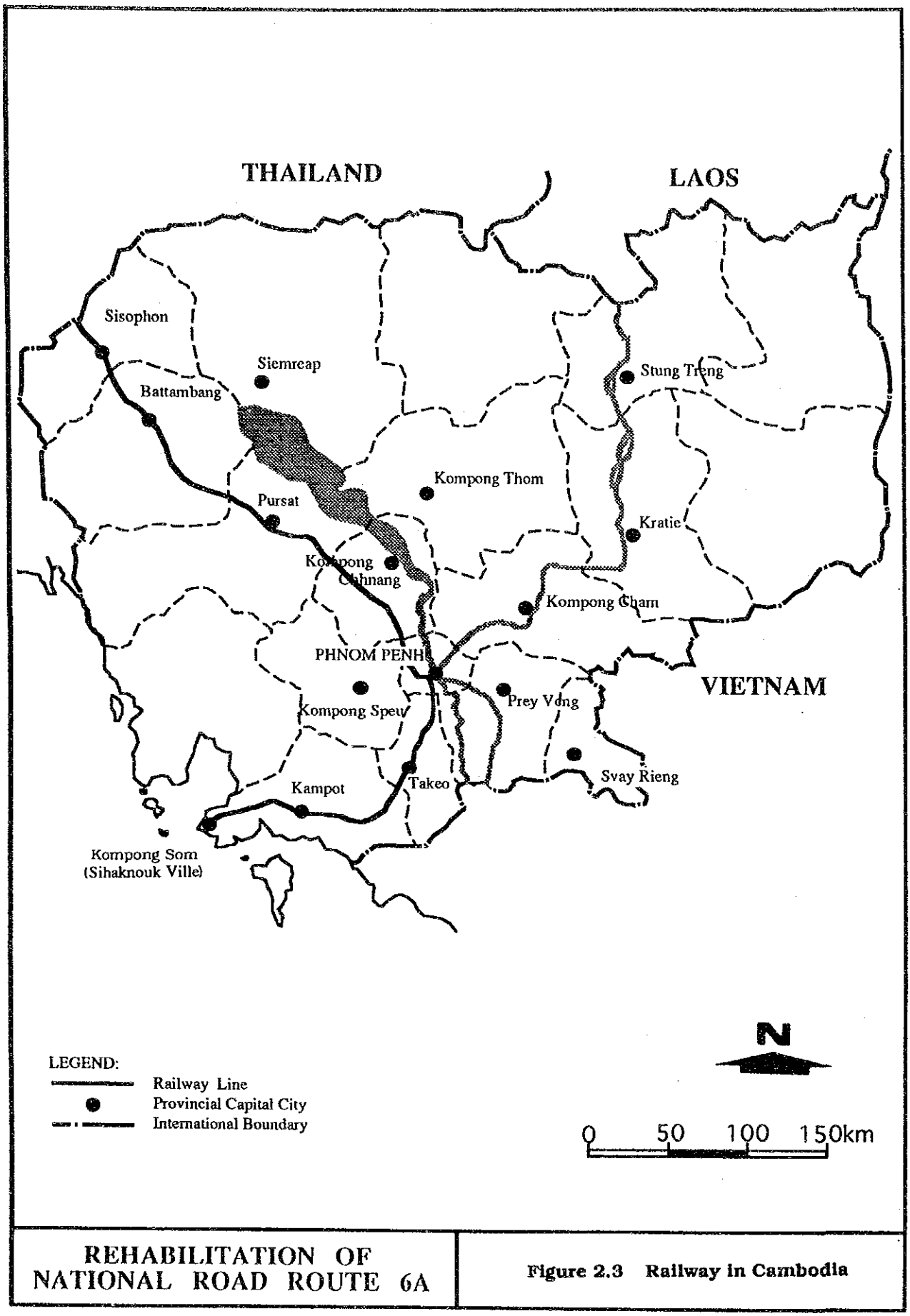
- 262 km from Phnom Penh through Takeo and Kampot to Kompong Som (Sihaknouk Ville) (see Figure 2.3).

2.4.3 Port and Inland Water Transport

Inland water transport is playing an important role of Cambodian transportation system although the supporting systems are in a state of serious deterioration. Cambodia has two international ports, Phnom Penh river port and Kompong Som (Sihaknouk Ville) seaport. In addition, there are several smaller river ports in Mekong, Tonle Sap and Bassac river systems (Kompon Cham, Kratie, Kompong Chhnang, etc.).

2.4.4 Air Transport

Four airports are presently in operation for civil aviation (Phnom Penh, Siemreap, Battambang and Stung Treng). Phnom Penh airport is the only international airport in Cambodia at present.



REHABILITATION OF NATIONAL ROAD ROUTE 6A	**Figure 2.3 Railway in Cambodia**

2.5 Outline of the Project Area

2.5.1 Project Location

The location of the Project is shown in the Location Map. Route 6A starts at the Chroy Changwar Bridge which is located at the northeast end of Phnom Penh city and terminates at Route 6 near Chun Chunok. The total length of Route 6A is approximately 44 kilometres.

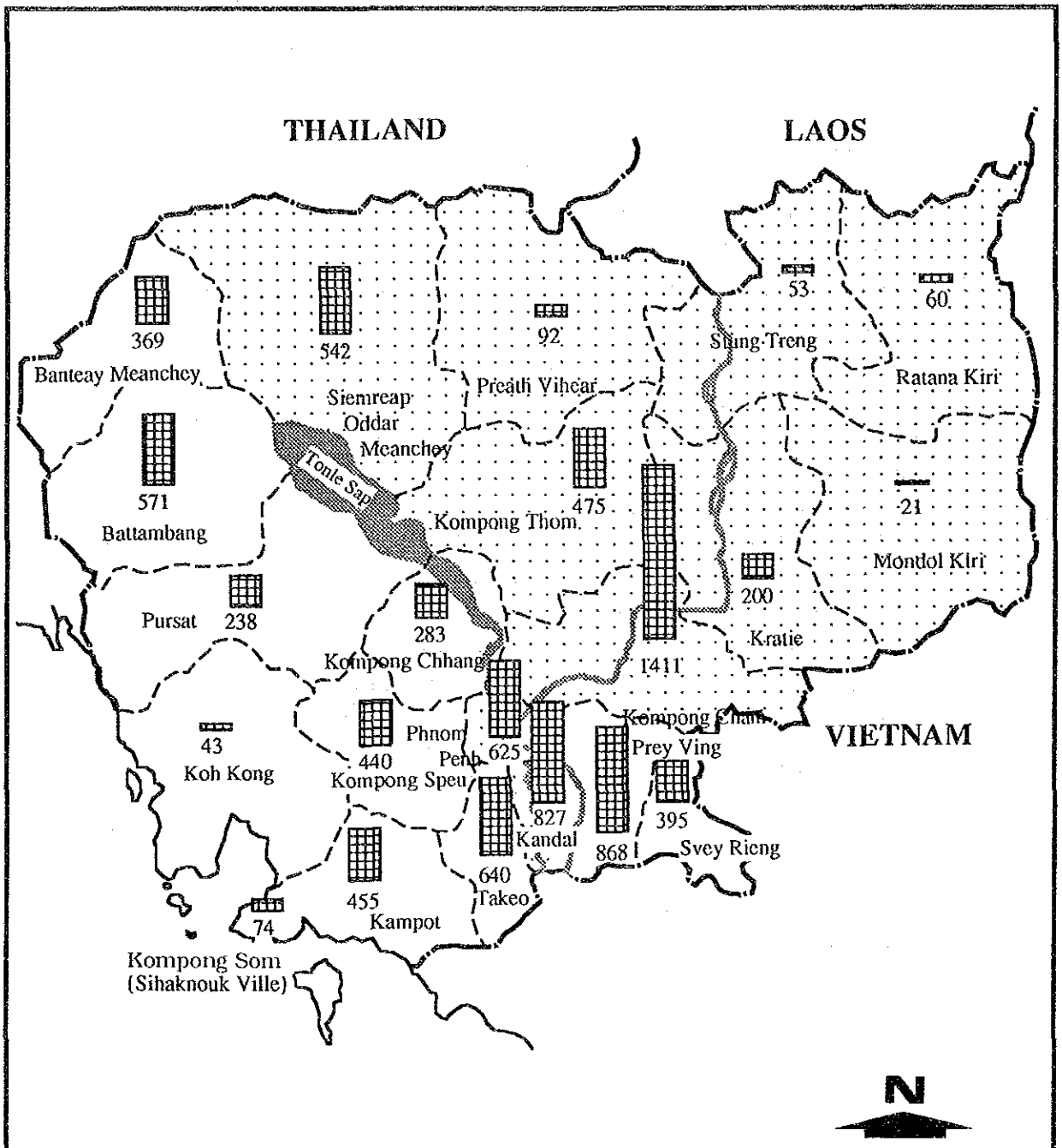
2.5.2 Influence Area

(1) Influence Area

The implementation of the Project will create favorable impacts for traffic, socio-economic development, administration and countermeasures for natural calamities. Since Route 6A is situated in an essential part to connect Phnom Penh with the northern hinterland, thus the influence area will widely cover Phnom Penh and the northern nine provinces (see Figure 2.4).

(2) Population of Influence Area

Population of each province included in the influence area is shown in Table 2.5. The population of Cambodia was 8.682 million in 1990, and the share of the influence area of national population measures at 50 per cent (i.e., 4.306 million).



Source: UNDP (1990), Report of the Cambodia Infrastructure survey missions

REHABILITATION OF NATIONAL ROAD ROUTE 6A	**Figure 2.4 Influence Area**

Table 2.5 Population in 1990 ('000)

	Province	Area (km^2)	Population (1990)
*	Kompong Cham	10,498	1,411
	Prey Veng	4,883	868
*	Kandal	3,813	827
	Takeo	3,818	640
*	Phnom Penh (M)	46	625
	Battambang	19,044	571
*	Siem Reap	10,897	542
*	Kompong Thom	12,251	475
	Kampot	9,862	455
	Kompong Speu	7,016	440
	Svey Rieng	2,966	395
	Banteay Meanchey	5,678	369
	Kompong Chhnang	5,520	283
	Pursat	12,692	238
*	Kratie	11,094	200
*	Preah Vihear	14,350	92
	Kompong Som (Sihaknouk Ville) (M)	69	74
*	Ratanakiri	10,781	60
*	Stung Teng	11,209	53
	Koh Kong	11,140	43
*	Mondolkiri	14,916	21
	Total	181,916	8,682

Notes: * denotes the provinces included in the influence area.
(M) denotes Municipality.

Source: UNDP (1990), Report of the Cambodia infrastructure survey missions

Chapter 3: Outline of the Project

CHAPTER 3 OUTLINE OF THE PROJECT

3.1 Objective

The objective of the Project is to rehabilitate Route 6A to provide uninterrupted road transport between Phnom Penh and its northern hinterland, and to contribute toward the enhancement of the nation's economy.

3.2 Study and Examination of the Request

3.2.1 Scope

The Study Team held discussions with the officials concerned of Cambodia and conducted a field survey at the study area. In the course of discussions and field survey the Study Team and the Cambodian side examined the Project and confirmed the following.

(1) The outline of the rehabilitation is as shown in Table 3.1.

Table 3.1 Scope of Rehabilitation

Items	Damages	Intended Rehabilitation
Bridge	Collapse of Span	Reconstruction
	Destruction of Pier	Repair
	Destruction of Abutment	Repair
	Destruction of Girder	Repair
	Destruction of Slab	Repair
	Destruction of Bridge Railing	Repair
	Failure of Approach Fill	Refill & Slope Protection
Pipe Culvert	Destruction of Pipe	Reconstruction
	Destruction of Headwall	Reconstruction
	Failure of Backfill	Refill
Road Embankment	Failure of Embankment	Reconstruction & Slope Protection
	Settlement	Filling
	Excavation (Dug' Holes)	Filling
	Failure of Slope	Refill & Slope Protection
	Erosion of Slope	Refill
Pavement	Deterioration of Carriageway	Repavement
	Failure of Shoulder	Repair

(2) Major damaged road embankment (between stations 40 and 42) will be restored to their original condition.

(3) Damaged and/or deteriorated pavement will be restored to their original condition.

3.2.2 Outline of the Rehabilitation

The above scope was further examined and both sides agreed to the following outline of the rehabilitation.

(1) The outline of bridge rehabilitation is as shown in Table 3.2;

(2) The outline of culvert rehabilitation is as shown in Table 3.3;

(3) The traveledway width (total width of carriageway and shoulders, i.e., the top width of road embankment) will be generally 10 metres and the pavement in the carriageway of 7.0 metres will be restored to the original condition (see Figure 3.1); and

(4) The bridge deck will be restored to its original condition which is shown in Figure 3.1.

The locations of existing bridges, culverts and major embankment damages are shown on Figure 3.2.

3.3 Project Description

3.3.1 Executing Agency and Operational Structure

Road and Bridge Department (RBD), Ministry of Communication, Transport and Post (MCTP) is responsible for the implementation of the Project. The organization of MCTP and RBD is shown in Figures 3.3 and 3.4.

Table 3.2 Outline of Bridge Rehabilitation

No.	Bridge Name	Bridge Length (m)	Carriageway Width (m)	Station	Intended Rehabilitation					
					Girder	Deck Slab	Railing	Pier	Abutment	Approaches
1	Prek Leab	1 x 12 = 12	9	6 + 500	○	○	○	—	○	●
2	Khtor 1st	2 x 12 = 24	9	7 + 700	●	○	●	○	○	●
3	Khtor 2nd	1 x 12 = 12	9	8 + 600	○	●	●	—	○	●
4	Prek Ta Sun	2 x 12 = 24	9	9 + 900	●	●	●	○	●	●
5	Bac Kheang	1 x 12 = 12	9	9 + 900	○	○	○	—	○	●
6	Prek Vongsar	5 x 12 = 60	9	10 + 400	○	●	●	○	○	●
7	Prek Chik	1 x 12 = 12	9	11 + 400	○	○	○	—	○	●
8	Prek Suon Choeum	3 x 12 = 36	9	11 + 900	○	●	●	○	○	●
9	Prek Tamin	2 x 12 = 24	9	13 + 100	○	○	●	○	○	●
10	Prek Ta Soam	1 x 12 = 12	9	15 + 500	○	○	●	—	○	●
11	Prek Ta Pich	1 x 12 = 12	9	16 + 500	○	○	●	—	○	●
12	Prek Tabek	2 x 12 = 24	9	17 + 500	○	○	●	○	○	●
13	Prek Thmei	2 x 12 = 24	9	18 + 600	○	○	●	○	○	●
14	Prek Kheng	10 x 12 = 120	9	29 + 000	●	●	●	●	○	●
15	Prek Tambang 1st	2 x 12 = 24	9	29 + 600	○	○	○	○	○	●
16	Prek Tambang 2nd	3 x 12 = 36	9	29 + 500	○	○	○	○	○	●
17	Prek Hok Leng	3 x 12 = 36	9	31 + 700	○	○	○	○	○	●
18	Prek Ta Oun	3 x 12 = 36	9	32 + 100	○	○	○	○	○	●
19	Deam Chrey	2 x 12 = 24	9	32 + 600	○	○	●	○	○	●
20	Prek Bak	3 x 12 = 36	9	33 + 500	●	●	●	●	○	●
21	Chung Prek	2 x 12 = 24	9	35 + 400	○	○	○	○	○	●
22	Prek Kra Pocs	10 x 12 = 120	9	37 + 100	○	●	○	●	○	●
23	Kompong Prasath	3 x 20 = 60	9	37 + 800	●	○	○	○	●	●
24	Kompong Pras 1st	7 x 12 = 84	9	40 + 100	●	●	●	○	●	●
25	Kompong Pras 2nd	1 x 12 = 12	9	41 + 100	●	●	●	—	○	●
26	Kompong Pras 3rd	3 x 12 = 36	9	41 + 800	○	○	○	○	○	●
	Total	936 m								

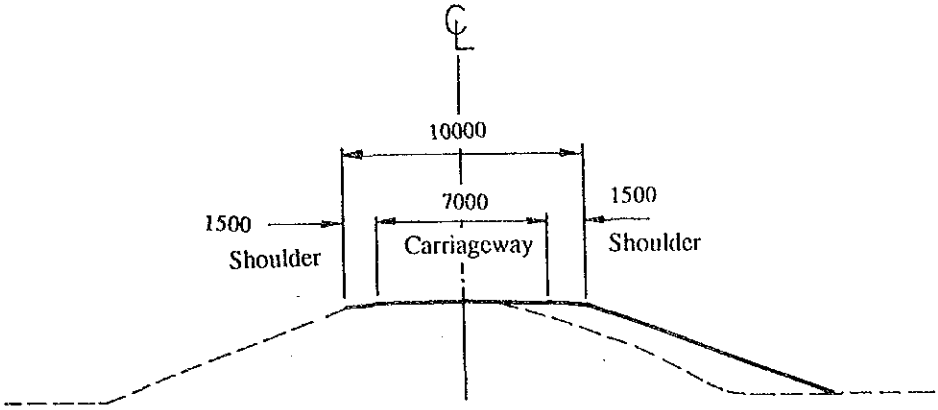
Note: ○ : No rehabilitation ● : To be rehabilitated — : Not existing 1 span is about 12 meters and 1 segment is about 3 meters.

Table 3.3 Outline of Pipe Culvert Rehabilitation

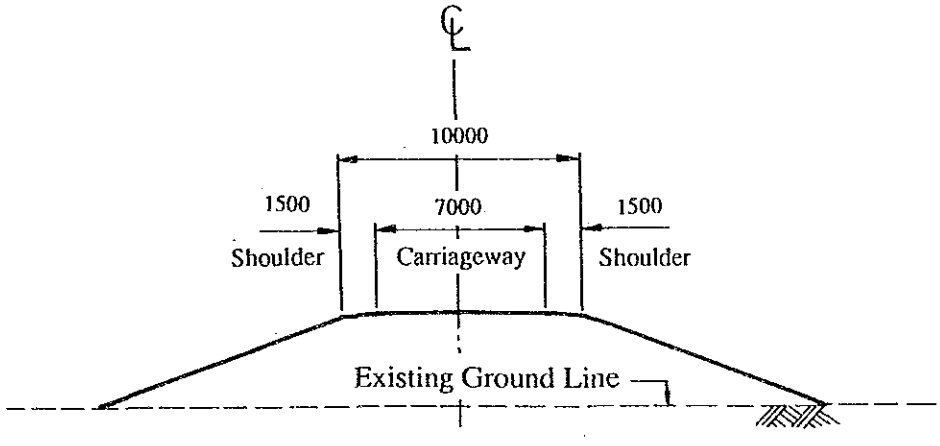
No.	Name of District	Station	Size of Pipe (m)	No. of Cells	Intended Rehabilitation				Embankment Height (m)	Flood Level from RoadSurface (m)
					Pipe	Headwall Mechong	Headwall Tonle Sap	Filling		
1	Russey Keo	7+270	1.5	2	○	○	○	●	3.0	-1.5
2	Russey Kec	8+140	1.5	1	○	○	○	○	1.5	-1.3
3	Muk Kompoul	10+770	1.5	1	○	○	○	●	3.0	-1.2
4	Muk Kompoul	12+450	1.5	3	●	●	●	●	1.7	-1.6
5	Muk Kompoul	12+740	1.5	2	○	○	○	○	1.5	-1.5
6	Muk Kompoul	14+300	1.5	1	○	○	○	○	1.5	-1.2
7	Muk Kompoul	14+800	1.5	1	○	○	○	○	2.0	-1.5
8	Muk Kompoul	16+880	1.5	1	○	○	○	○	1.5	-1.2
9	Muk Kompoul	26+660	1.5	1	●	●	●	●	3.0	-0.0

Legend : ○ : No rehabilitation

● : To be rehabilitated



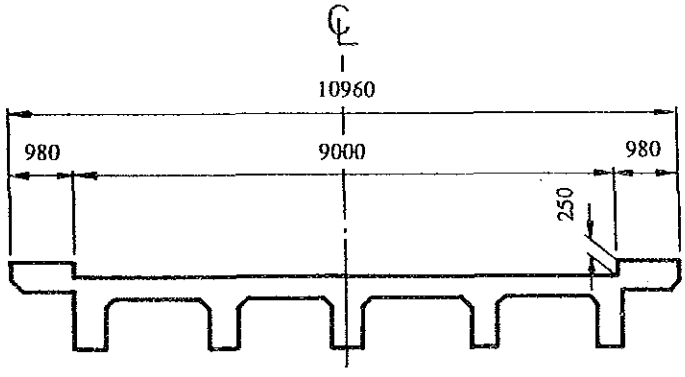
Rehabilitation



Reconstruction at
Damaged Section

Typical Cross Section of Roadway

Scal:1/300



Typical Cross Section of Bridge Deck

Not to Scale

REHABILITATION OF NATIONAL ROAD ROUTE 6A	**Figure 3.1 Typical Cross Sections**

N

Chi Lear Quarry Site

BATHEAY DISTRICT
(KOMPONG CHAM PROVINCE)

KANG MEAS DISTRICT
(KOMPONG CHAM PROVINCE)

PO GNEA LY DISTRICT

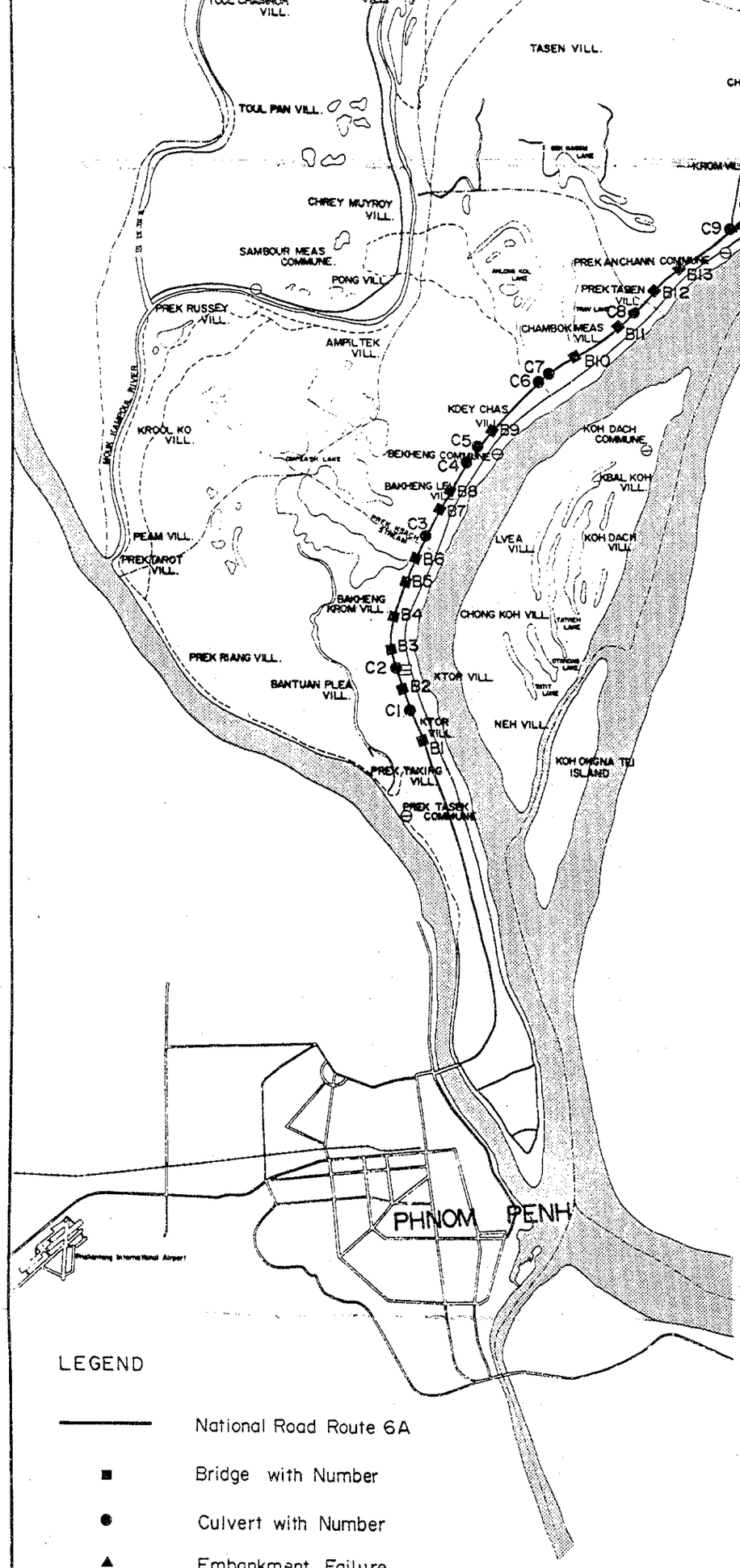
KHSACH KANDAL DISTRICT
(KANDAL PROVINCE)

KHSACH KANDAL DISTRICT
(KANDAL PROVINCE)

CLA KRAHM VILL.
BEK CHANG VILL.
CHBAR AMPEU VILL.
BENG RUSSEY VILL.
STUNG CHVENG VILL.
O SVAY VILL.
MESAR VILL.
SANGKAEP VILL.
PHNOM DEL VILL.
CHUNG TEK VILL.
CHUNG CHNOK VILL.
POPEK VILL.
KOMPONG PREAH VILL.
PREK TAKOY VILL.
KOR HEH VILL.
ANLONG KOKI VILL.
KRONG SVAY VILL.
PRALECH SANDAN VILL.
PEAR VILL.
KOMPONG PRASAT VILL.
CHETEAL PLUAH VILL.
POK KOR COMMUNE
SVAY AMPEA COMMUNE
SVAY AMPEA VILL.
PREK DAMBANG COMMUNE
TMEI VILL.
PREK YIEYTENG VILL.
RUSSEY CHROY VILL.
BENG CHUNLEN VILL.
PREK TASOMM VILL.
RUSSEY CHROY COMMUNE
CHROY METREY LEU VILL.
CHROY METREY KROM VILL.
KOH ROKA VILL.
CHHE BOUN VILL.
ANNLONG SLENG VILL.
TOUL CHAMROH VILL.
TASEN VILL.
CHHE TEAL VILL.
LEU VILL.
TOUL PAN VILL.
KANDAL VILL.
KROM VILL.
CHREY MUYROY VILL.
PREK TMEY VILL.
SAMBOUR MEAS COMMUNE.
PONG VILL.
PREK ANCHANN COMMUNE
PREK TASEN VILL.
PREK RUSSEY VILL.
CHAMBOK MEAS VILL.
AMPIL TEK VILL.
KDEY CHAS VILL.
KROOL KO VILL.
SEKHENG COMMUNE
KOH DACH COMMUNE
BAKHENG LEU VILL.
KBAL KOH VILL.
PEAM VILL.
PREK TAROT VILL.
LVEA VILL.
KOH DACH VILL.
BAKHENG KROM VILL.
CHONG KOH VILL.
PREK PEANG VILL.
BANTUAN PLEA VILL.
KTOR VILL.
NEH VILL.

B26 B25 B24 B23 B22 B21 B20 B19 B18 B17 B16 B15 B14 B13 B12 B11 B10 B9 B8 B7 B6 B5 B4 B3 B2 B1
C9 C8 C7 C6 C5 C4 C3 C2 C1

LIST OF EXISTING BRIDGES



LIST OF EXISTING BRIDGES

No.	Bridge Name	Station	Bridge Length (m)
1	Prek Leab	6+570	1x12= 12
2	Khtor 1st	7+710	2x12= 24
3	Khtor 2nd	8+590	1x12= 12
4	Prek Ta Sun	9+190	2x12= 24
5	Bac Kheang	9+840	1x12= 12
6	Prek Vongsar	10+360	5x12= 60
7	Prek Chik	11+380	1x12= 12
8	Prek Suon Choeurn	11+820	3x12= 36
9	Prek Tamin	13+040	2x12= 24
10	Prek Ta Soam	15+460	1x12= 12
11	Prek Ta Pich	16+520	1x12= 12
12	Prek Tabek	17+470	2x12= 24
13	Prek Thmei	18+560	2x12= 24
14	Prek Kheng	29+040	10x12= 120
15	Prek Tambang 1st	29+630	2x12= 24
16	Prek Tambang 2nd	29+810	3x12= 36
17	Prek Hok Leng	31+790	3x12= 36
18	Prek Ta Oun	31+940	3x12= 36
19	Deam Chrey	32+400	2x12= 24
20	Prek Bak	33+330	3x12= 36
21	Chung Prek	35+210	2x12= 24
22	Prek Kra Poes	36+880	10x12= 120
23	Kompong Prasath	37+500	3x20= 60
24	Kompong Pras 1st	39+890	7x12= 84
25	Kompong Pras 2nd	40+520	1x12= 12
26	Kompong Pras 3rd	41+210	3x12= 36
	Total		936

LIST OF EXISTING CULVERTS

No.	Station	Size of Pipe (m)	No. of Cell
1	7+270	1.5	2
2	8+140	1.5	1
3	10+770	1.5	1
4	12+450	1.5	3
5	12+740	1.5	2
6	14+300	1.5	1
7	14+800	1.5	1
8	16+880	1.5	1
9	26+660	1.5	1

LEGEND

- National Road Route 6A
- Bridge with Number
- Culvert with Number
- Embankment Failure
- Existing Trunk Road
- Existing Railway Line
- River
- Lake or Pond

REHABILITATION OF
NATIONAL ROAD ROUTE 6A

Figure 3.2 **Locations of Existing Bridges, Culverts and Major Embankment Failures**

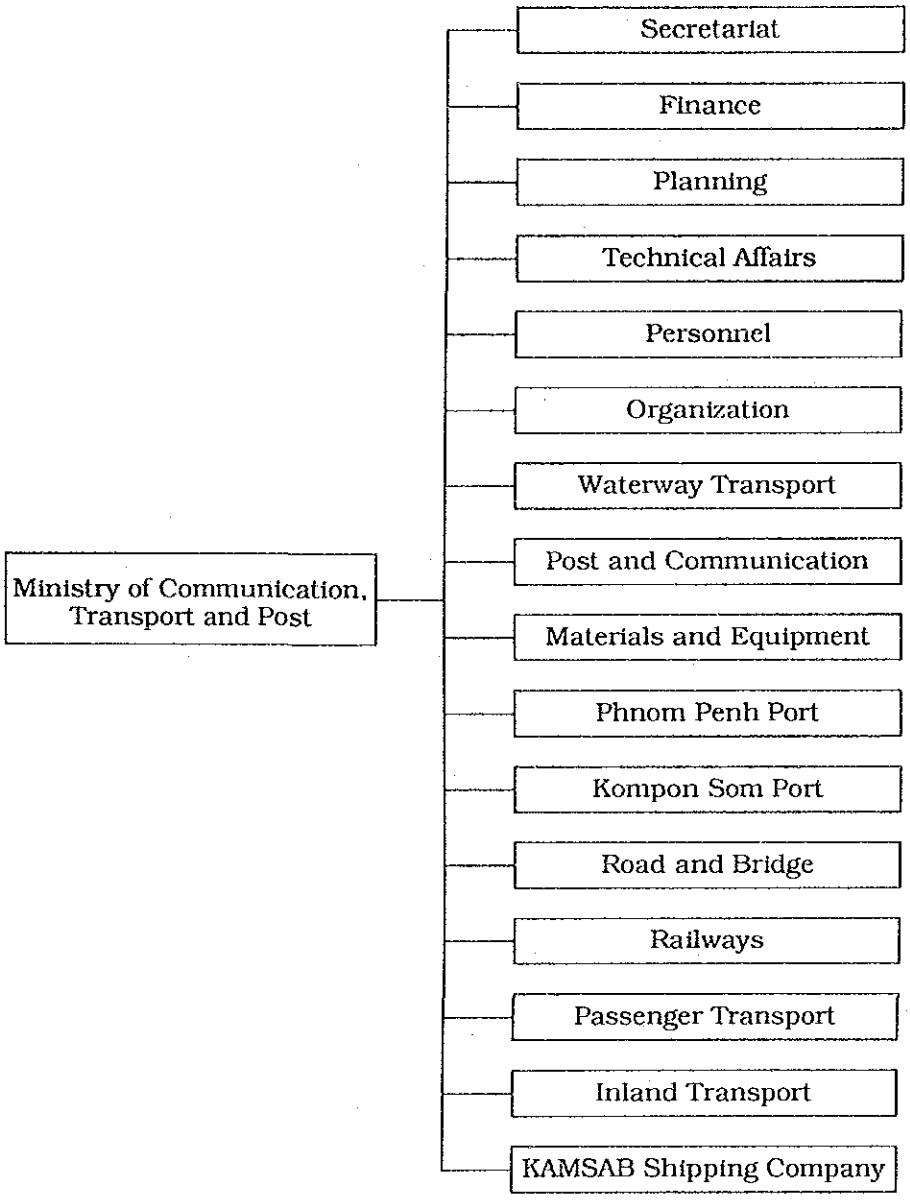


Figure 3.3 Organisation of the Ministry of Communication, Transport and Post

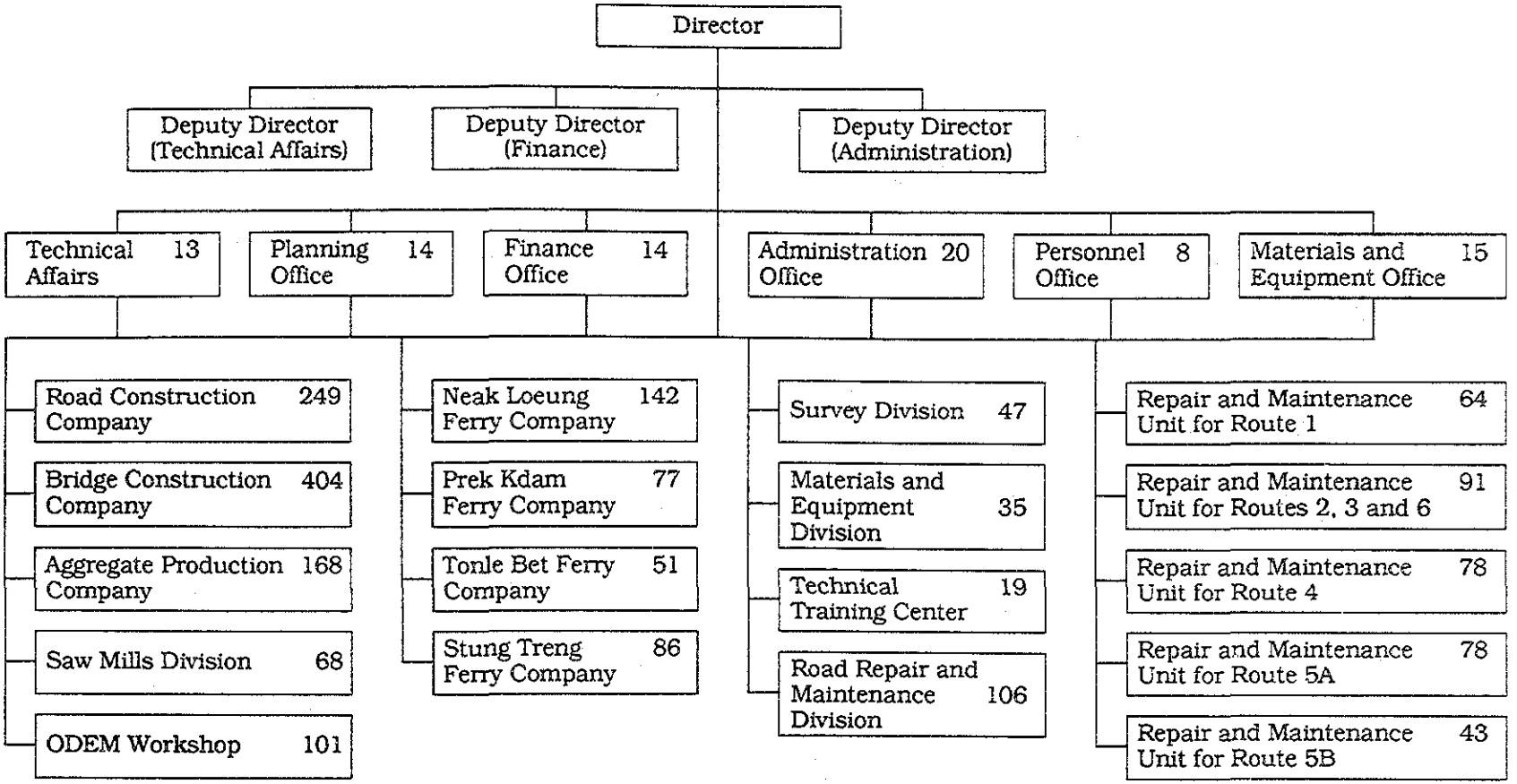


Figure 3.4 Organisation of the Road and Bridge Department (RBD)

3.3.2 Plan of Operation (Activity)

RBD is responsible for road administration including planning, design, construction, operation and maintenance of all national roads, as well as, major bridges in provincial roads. RBD is also responsible for the supply and distribution of road and bridge construction materials (i.e., asphalt, aggregate, steel beams, prefabricated bridge members, etc.).

In the RBD organisation, construction work has been carried out by two autonomous companies, road construction and bridge construction. The maintenance activities of national road are performed by the independent road repair and maintenance units as shown in Table 3.4.

Table 3.4 Repair and Maintenance Units

No.	Responsible National Road	Number of Personnel
1	Route 1	64
2	Routes 2, 3 and 6	91
3	Route 4	78
4	Route 5A	78
5	Route 5B	43
Total		354

The total number of RBD staff is 1,995 with:

- Director and deputy director 4
- Chiefs (offices) 84
- Staff members (companies, units, etc.) 1,907

3.3.3 Operation and Maintenance Plan

The scope of operation and maintenance works for the trunk road is broadly divided into the following two major components:

- Road Maintenance; and
- Traffic Management.

(1) Road Maintenance

Trunk road maintenance together with traffic management has the two basic goals of providing traffic safety and smooth traffic flow. The maintenance function can be divided into routine maintenance, periodic maintenance and incidental maintenance.

Routine maintenance is based on routine (daily) inspection of the condition of pavement, cut and fill slopes, drainage, bridges and other structures and facilities to monitor any defects and damages to them. The results of routine inspection should be promptly reported to the maintenance office for follow-up maintenance works as required. The annual cost for routine maintenance for Route 6A will be about 60 thousand US dollars.

Periodic maintenance is based on detailed inspection to be performed at certain time intervals such as weekly, monthly or yearly depending on the type and kind of facilities, including checking and testing the conditions of various structures and facilities. Defects and damages will be reported for repairs or remedies. Periodic maintenance also covers such works as cleaning of pavement and sign boards, maintenance of road marking and painting.

Incidental maintenance is basically the work to be carried out to restore the trunk road and the related facilities to their normal operating condition after they are damaged by road accident or natural causes.

Maintenance works will include:

- Cleaning of pavement;
- Cleaning of ditches and culverts;
- Pavement repair such as patching and resurfacing;
- Repair of expansion joints of bridges;

- Repair of fill slopes and slope protections;
- Repair of damage to road facilities caused by traffic accident; and
- Betterment work including pavement overlay and widening.

(2) Traffic Management

Traffic management means traffic control and removal of disabled cars which have been involved in traffic accidents. Highway patrols will be conducted to find damage to road facilities, traffic accidents, illegal parking, disabled cars and other extraordinary conditions which disturb traffic safety.

Traffic control includes general control for speed, overloading and emergency lane use (under unusual conditions such as traffic accidents, adverse weather and operation of maintenance works). Control and prohibition of illegally overloaded trucks will be conducted in cooperation with traffic police.

(3) Improvement of Maintenance Organisation

Road and Bridge Department (RBD) will be in charge of the operation and maintenance of National Road Route 6A after the rehabilitation. However, the budget allocation to the RBD is not sufficient at present. The budget is not divided for construction and for maintenance separately. Thus, no adequate administrative control can be expected in the operation and maintenance of the said Route 6A. In view of this, the understanding of the importance of the maintenance operation will be emphasised and on-the-job training concerning the maintenance works will be carried out during the construction period.

3.4 Technical Cooperation

Implementation of the Project will be carried out based on the similar methodology which has been employed for the restoration of Chroy Changwar Bridge. One of important objectives of the Project is to maintain close contact with Cambodian counterparts and the Government officials concerned with the Project, and to promote the technical transfer to them as much as possible.

3.5 Present Status of National Road Route 6A

3.5.1 Damaged Bridges and Culverts

(1) General

Route 6A has 26 bridges (see Table 3.2) which totals 936 m of bridge length. Bridge structures are standardised with 12 metres typical span length except the Kompong Prasath Bridge which has a 20 metres of span length. Bridge length varies between 12 and 120 metres.

The structural types of superstructure and substructure are as follows:

1) Superstructure

Reinforced concrete T-girders

2) Substructure

Pile bent type abutments and piers except for the Kompong Prasath Bridge in which wall type abutments and piers are adopted.

There are nine culverts in Route 6A. All culverts are reinforced concrete pipe with a size of 1.5 metres diameter. The maximum number of barrels provided is three as shown in Table 3.3.

(2) Investigations and Tests

The following investigations and tests were carried out for damaged bridges:

- Visual investigations of superstructures and substructures;
- Visual investigations of steel pipe piles and steel pipe pier columns;
- In-situ compression strength test using the Schmidt Hammer;
- Compression test of existing concrete by core sampling and laboratory tests;
- Deformation test of bridge structures using survey equipment;
- Visual investigations of bridge approaches; and
- Visual investigations of culverts.

(3) Damages to Bridges

Patterns of bridge damages are summarised in Table 3.5 and present status of damaged bridges are shown in Figure 3.5 together with the cause and envisaged countermeasures of each damage pattern.

Table 3.5 Summary of Bridge Damage Patterns

Pattern Number	Damage Pattern	Course of Damage	Possible Repair/Rehabilitation
1	Collapse of superstructure	Blasting	Reconstruction of collapsed spans(s)
2	Damage of abutment/ pier/girder/deck slab	Blasting	Repair of damaged portion
3	Holes in deck slab	Blasting/rocket bomb	Repair of damaged portion
4	Damage of bridge railing	Blasting/rocket bomb/removal	Repair of damaged portion
5	Washed away/ settlement of bridge approaches	Washing away/ settlement/loss of backfill materials by seepage and surface water	Placing and compaction of backfill material and installation of approach slab and slope protection

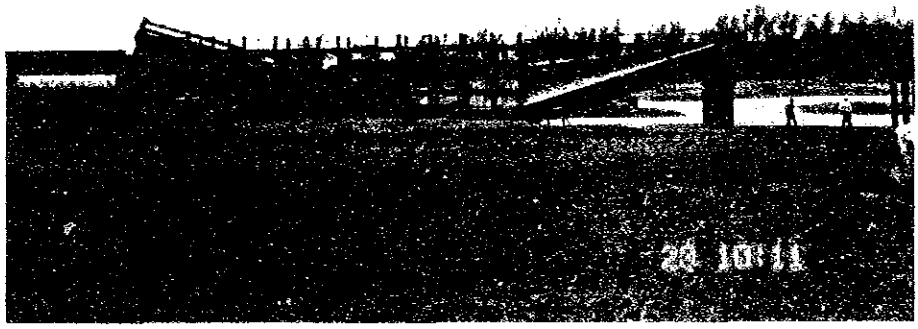
Pattern 1:	Collapse of Superstructure	
Existing Condition	No. 14 Prek Kheng Bridge	Three spans of superstructure are collapsed and two piers are destructed. Wooden bridge is provided for collapsed spans.
	No. 24 Kompong Prass 1st Bridge	One span of superstructure is collapsed and one abutment is destructed. Wooden bridge is provided for a collapsed span.
Photo		
Cause of Damage	Superstructure is collapsed due to the destruction (by blasting) of abutment/pier(s).	
Possible Counter-measure	1. Removal of collapsed superstructure and destructed substructure. 2. Reconstruction/repairing of superstructure and substructure.	

Figure 3.5 Present Status of Damaged Bridges (1)

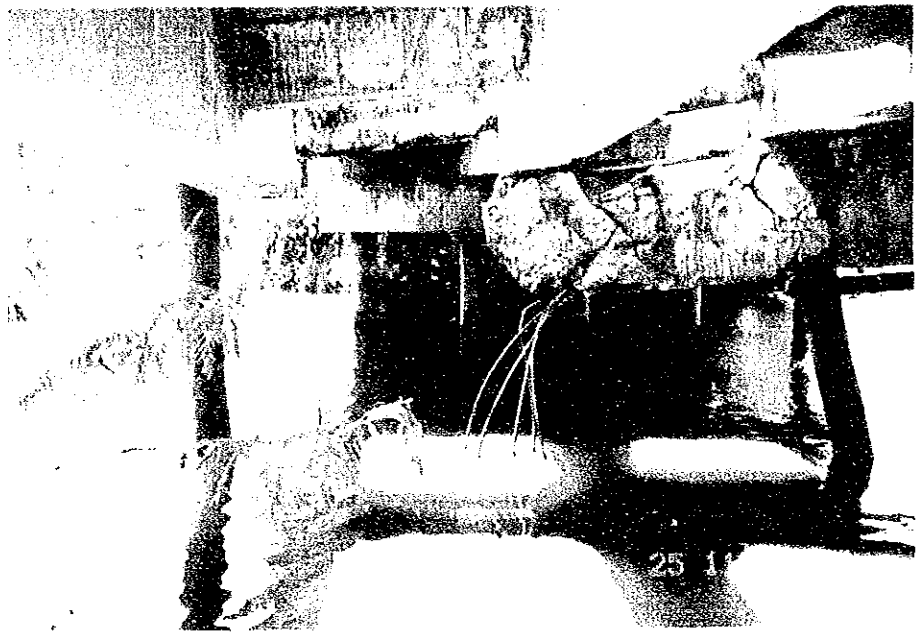
Pattern 2.(1): Portion of a pier is destructed together with girder(s) and deck slab		
Existing Condition	No. 20 Prek Bak Bridge	Two pier columns are destructed and one pier column is crooked. Girders and deck slab are also damaged.
	No. 22 Prek Kra Poes Bridge	One pier column is destructed and two pier columns are crooked. Girders and deck slab are also damaged.
Photo		
Cause of Damage	Blasting	
Possible Counter-measure	1. Removal of damaged superstructure and substructure. 2. Reconstruction of superstructure (i.e., two spans) and substructure.	

Figure 3.5 Present Status of Damaged Bridges (2)

Pattern 2.(2): Portion of an abutment is destructed together with girder(s) and deck slab		
Existing Condition	No. 4 Prek Ta Sun Bridge	One abutment is damaged at two outside girders together with nearby girders and deck slab.
	No. 23 Kompong Prasath Bridge	One abutment is damaged at two outside girders together with nearby girders and deck slab.
Photo		
Cause of Damage	Blasting	
Possible Counter-measure	Partial repair of damaged abutment, outside girders and deck slab	

Figure 3.5 Present Status of Damaged Bridges (3)

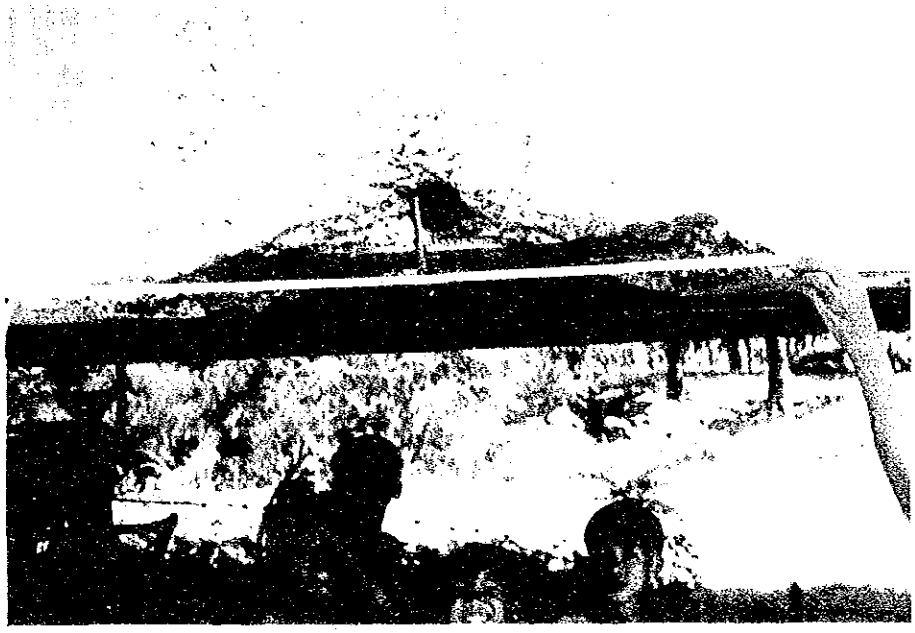
Pattern 2.(3): Minor Damages of Girders		
Existing Condition	No. 2 Khtor 1st Bridge	Concrete girder is damaged and reinforcing steel is exposed for about 1.0 metre
	No. 25 Kompong Pras 2nd Bridge	Concrete girder is damaged and reinforcing steel is exposed for about 2.5 metres.
Photo		
Cause of Damage	Blasting	
Possible Counter-measure	Repair of damaged portion of concrete girders	

Figure 3.5 Present Status of Damaged Bridges (4)

Pattern 3:	Holes/Damages in Deck Slab
Existing Condition	No. 3 Khtor 2nd – One location No. 4 Prek Ta Sum – One location No. 6 Prek Vangsar – One location No. 8 Prek Suon Choeurn – Two locations No. 25 Kompong Pras 2nd – Three locations
Photo	
Cause of Damage	Blasting/rocket bomb
Possible Counter-measure	Restoration by placing reinforcing steel and concrete

Figure 3.5 Present Status of Damaged Bridges (5)

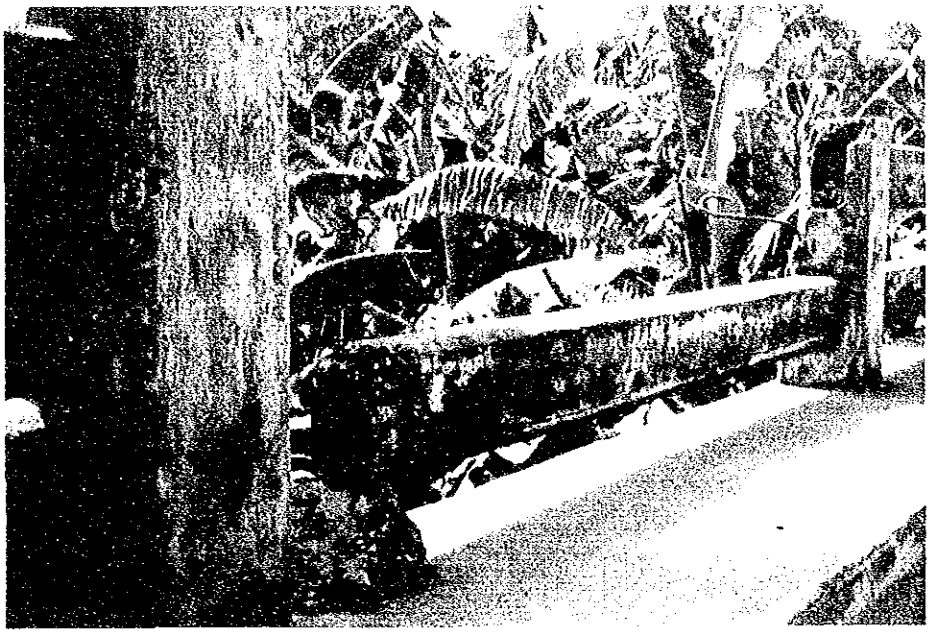
Pattern 4:	Damage of Bridge Railing
Existing Condition	Fifteen bridges have major or minor damage. All bridge railing have been removed in case of Prek Kheng Bridge (No. 14, 10 spans).
Photo	
Cause of Damage	Blasting/rocket bomb/removal
Possible Counter-measure	Restoration by using similar design of existing structure

Figure 3.5 Present Status of Damaged Bridges (6)

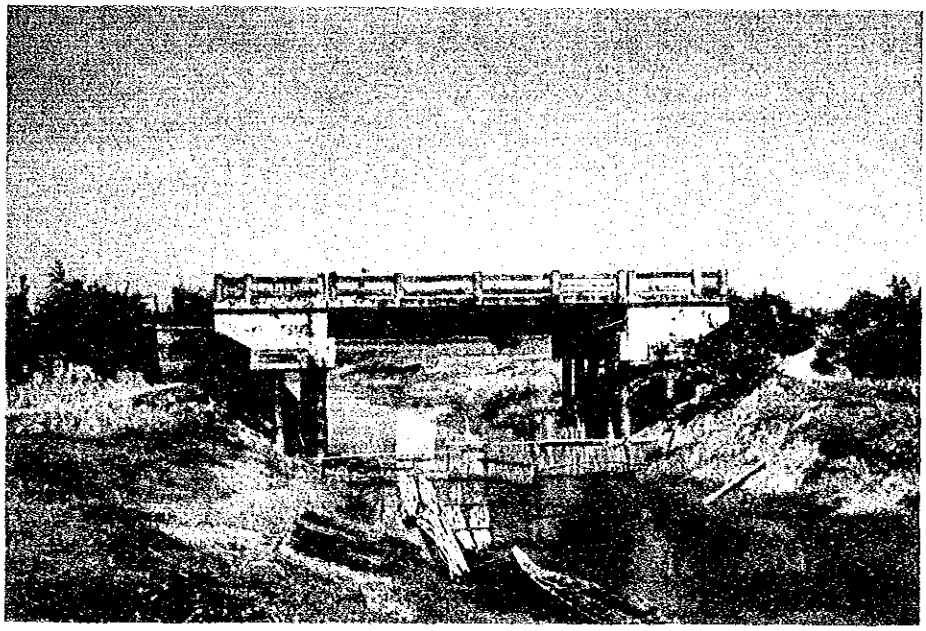
Pattern 5.(1): Damage of Bridge Approaches (Washed Away)		
Existing Condition	No. 7 Prek Chik Bridge	Embankment behind abutment is washed away at both approaches (see photo).
	No. 26 Kompong Pras 3rd Bridge	Embankment behind abutment is washed away at both approaches.
Photo		
Cause of Damage	Cause of initial failure is not clear but inundated water is adding damages by the water flow during high water seasons.	
Possible Counter-measure	1. Steel sheet piling around existing abutments. 2. Restoration of road embankment. 3. Construction of stone slope protection.	

Figure 3.5 Present Status of Damaged Bridges (7)

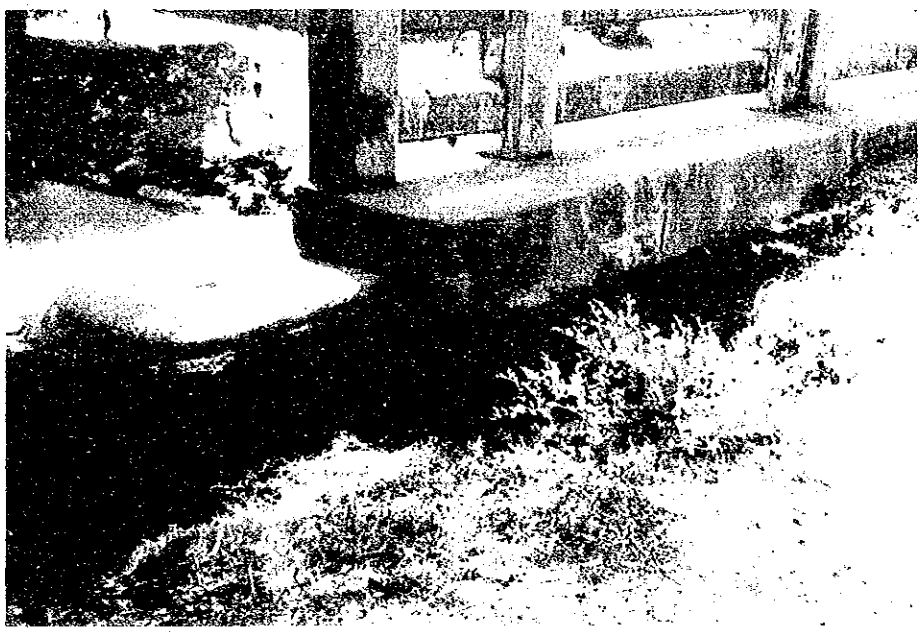
Pattern 5.(2): Damage of Bridge Approaches (Settlement)	
Existing Condition	Bridge approaches are settled and the surface of road embankment slopes are eroded by water flow without exception.
Photo	
Cause of Damage	Settlement of backfills of abutments and loss of materials by seepage/surface water.
Possible Counter-measure	1. Placing and compaction of backfill material. 2. Installation of approach slabs. 3. Construction of stone slope protection.

Figure 3.5 Present Status of Damaged Bridges (8)

(4) Damages to Culverts

The following two culverts are damaged and require reconstruction.

1) Concrete Pipe Culvert at Sta. 12 + 450

This culvert consists of three barrels of reinforced concrete pipe in 1.5 metres diametre and concrete straight headwalls with wings (see Photo 3.1). The culvert is completely damaged by blasting and now the culvert cannot function to pass the water. Possible remedial method will be reconstruction of the culvert.

2) Concrete Pipe Culvert at Sta. 26 + 660

This culvert consists of a single barrel reinforced concrete pipe in 1.5 metres diametre and concrete headwalls with wings (see Photo 3.2). The entire culvert structure has subsided and does not provide the function of a drainage pipe in the area. Possible countermeasure will be the replacement with a larger size of culvert and raising the invert elevation.

Photo 3.1 Three Barrel Concrete Pipe Culvert at Sta. 12 + 450

- Completely damaged by blasting and cannot pass water.

Photo 3.2 Single Barrel Concrete Pipe Culvert at Sta. 26 + 660

- Damaged and sunken and does not have the function to drain the water.

3.5.2 Road Embankment and Embankment Slopes

The damages of road embankment and embankment slopes consist of the following five categories:

- Washing away of road embankment (see Photos 3.3 through 3.6);
- Settlement of embankment (see Photos 3.7);
- Failure of embankment slope (see Photos 3.8 and 3.9);
- Erosion of embankment slope (see Photo 3.10); and
- Damage of embankment slopes by crossing traffic (see Photo 3.11).

There are 7 locations of severe embankment damage as summarised in Table 3.6.

Table 3.6 Summary of Severe Damage of Road Embankments

No.	Location	Damaged Road Length (m)
1.	Prek Chik Bridge	16
2.	Sta. 40 + 364 ~ Sta. 40 + 394	30
3.	Sta. 40 + 444 ~ Sta. 40 + 515	71
4.	Sta. 41 + 269 ~ Sta. 41 + 343	74
5.	Sta. 41 + 530 ~ Sta. 41 + 570	40
6.	Sta. 41 + 944 ~ Sta. 41 + 982	38
7.	Sta. 42 + 010 ~ Sta. 42 + 046	36
	Total	305

The Study Team interviewed several specialists and engineers who participated in the construction of Route 6A or presently working in RBD, as well as the inhabitants along the route to learn the cause of damage and hydrological background in parallel with the site survey and studies.

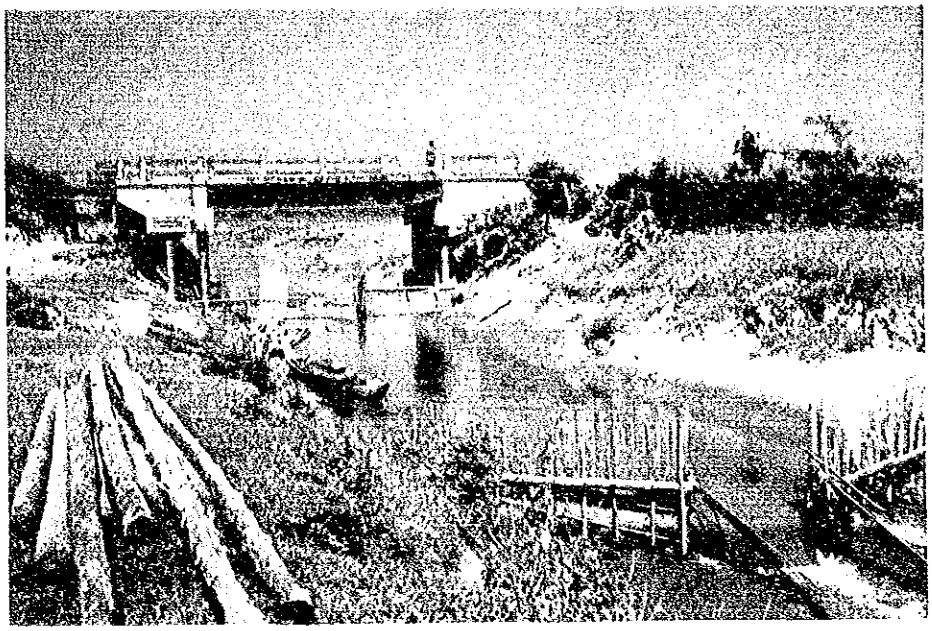


Photo 3.3

Damage of Bridge Approaches (Washed Away)

Photo 3.4

Severe Embankment Damage (Washed Away)

Photo 3.5

Severe Embankment Damage (Washed Away and Ponded)

Photo 3.6

Severe Embankment Damage (Washed Away)

Photo 3.7

Settlement of Embankment

Photo 3.8

Failure of Embankment Slope

Photo 3.9

Failure of Embankment Slope

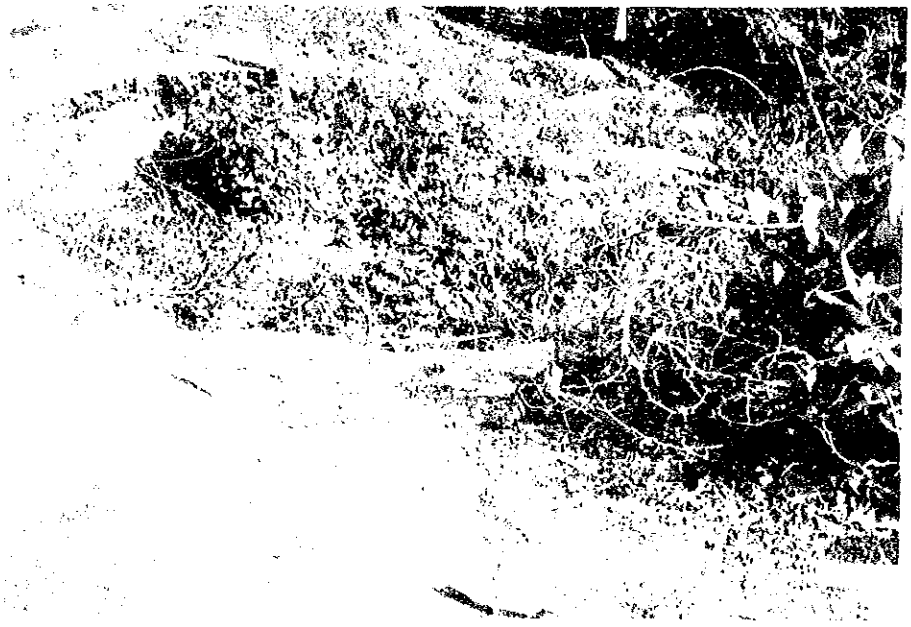


Photo 3.10

Erosion of Embankment

Photo 3.11

Damage of Embankment Slope by Crossing Traffic

(1) At Prek Chik Bridge (Sta. 11 + 400) the water flows toward the Ompeach lake during high water season of the Mekong river and the direction of water flow changes to the opposite direction when the water level of the Mekong river is lowered (i.e. about two months). After the nearby culvert (3-barrels) at Sta. 12 + 450 was blasted and clogged, the washed away materials of abutment backfill have proceeded and is in the present condition. The maximum water surface was observed at about 0.8 metre below existing road surface level.

(2) There are six locations of road embankment damage between Sta. 40 + 364 and Sta. 42 + 046. The embankment is completely washed away and water flows further scoured the bottom of watercourse, thus the area is depressed and forming small ponds (see Photos 3.4 and 3.5) which retains water even in the dry season. The Study Team gathered the information concerning the cause of damage and analysed them together with the physical background of the site. As a result of the study the following obvious facts became clear:

- Initial embankment damage was caused by blasting or digging trenches;

- Water flows in the flood seasons accelerated a large scale embankment failure at the above-mentioned locations which lead to the break up of the embankment;

- Repeated water flow at these openings resulted in further scouring at the bed of water courses and several depressed areas have appeared in the flat terrain, and these are filled with the water;

- Subsurface soil strata in these depressed areas consist of hard clay or silty clay to silt;

- There exists hard clay at the embankment damages between Sta. 40 + 444 and Sta. 40 + 515 (see Photo 3.5) and the soil is judged impermeable, thus the ponded water remains until the low water season.

(3) The cause of roadway settlement is considered to be the accelerated construction of the embankment, not by the settlement of embankment

foundation, since the region has a favorable subsurface soils conditions (see Boring logs compiled in Appendix 5).

(4) There was observed remarkable failures of embankment slopes at many locations where the embankment height is more than five metres. But failures of embankment slope is generally in small scale and these areas are protected by dense vegetation at present. These failures of embankment slope may be owing to the excess of pore water pressure in the embankment body during the receding period of the flood waters.

(5) Erosion of embankment slope was also observed at many locations. Once the embankment slope or pavement is damaged by blasting, nearby parts of slopes will be eroded by concentrated flow of road surface drainage water, and this gradually spreads the damaged area which sometimes lead to the failures of embankment slope.

(6) The other roadway and embankment damage is due to the crossing traffic. Presently wagons drawn by cattle is the major traffic. For the convenience of the crossings of these wagons, sometimes the road surface has become rutted and lowered in the past.

3.5.3 Pavement

Data concerning the pavement design which was applied for the construction of Route 6A are not available at present. From the field investigation data, the Team judged the outline of old design as follows:

(1) Road Section between Sta. 0 + 00 and Sta. 10 + 363 (Prek Vongsar Bridge)

Surface course	Hot-mix asphaltic concrete (asphalt pavement)
Base and subbase	Macadam/crushed rock, total thickness of about 20 cm

(2) Road Section between Sta. 10 + 423 (Prek Vongsar Bridge) and Sta. 44 + 210 (Chun Churok terminus)

Surface course	Single or double bituminous surface treatment
Base	Macadam base

The damage to pavement consists of the following:

- Longitudinal cracks and deterioration of asphalt pavement between Sta. 0 + 00 and Sta. 10 + 363 (see Photo 3.12);

- Loss of asphalt treated surface between Sta. 10 + 423 and Sta. 44 + 210 (see Photo 3.13), except about a 2.5 kilometres section near the Chunok terminus;

- Damage to the edge strips of pavement due to the settlement or deterioration of shoulders (see Photos 3.15 through 3.17); and

- Damages to pavement by blasting and the inflow of rain water (see Photos 3.10 and 3.14).

The existing widths of surface course, base and subbase in the Route 6A are summarised in Table 3.7.

Table 3.7 Existing Widths of Surface Course, Base and Subbase

Description	Road Section	Existing Average Width (m)
Surface Course (Asphalt Pavement)	Sta. 0 + 00 ~ Sta. 10 + 363	6.5
Base and Subbase	Sta. 0 + 00 ~ Sta. 10 + 363	6.0
Base and Subbase (Macadam Base)	Sta. 10 + 423 ~ Sta. 44 + 210	6.0

3.6 Socio-Economic Background of the Project Site and Traffic Condition

3.6.1 Project Site and Administrative Settings

The Project Site is defined as the direct influence area of the Project which mainly spreads in Moukampoul District of Kandal Province. Moukampoul is composed of 11 sub-districts and 55 villages and surrounded by Batheay and Kang Meas Districts of Kompong Cham Province in the north, Khsach Kandal District of Kandal Province in the east, Russey Koy, Chroy and Changwar Districts of Kandal in the south and Russey Keo and Po Gnea Ly Districts of Kandal Province in the west.

Photo 3.12

Longitudinal Cracks and Deterioration of Asphalt Pavement

Photo 3.13

Loss of Asphalt Treated Surface

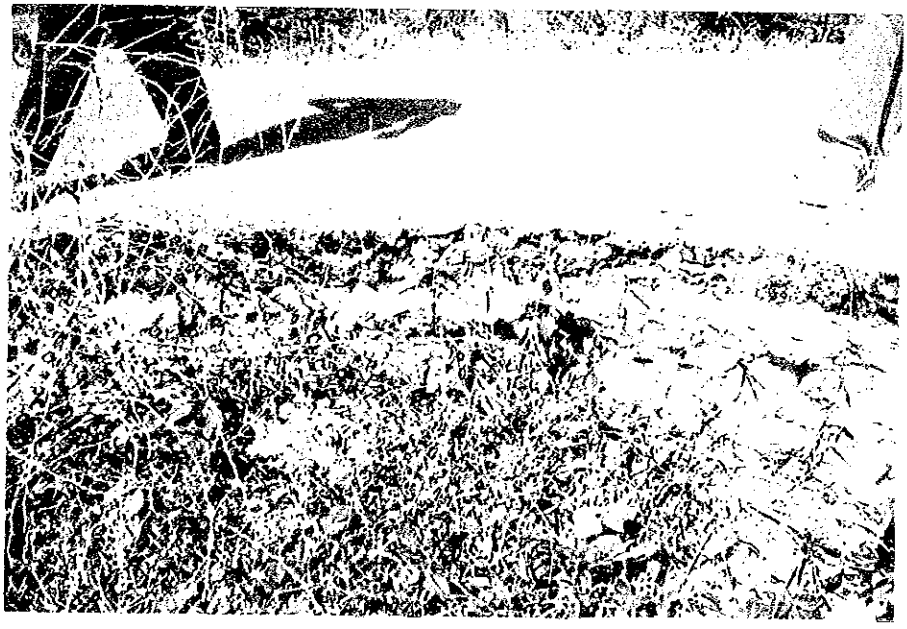


Photo 3.14

Damage of Pavement by Blasting and Inflow of Rain Water

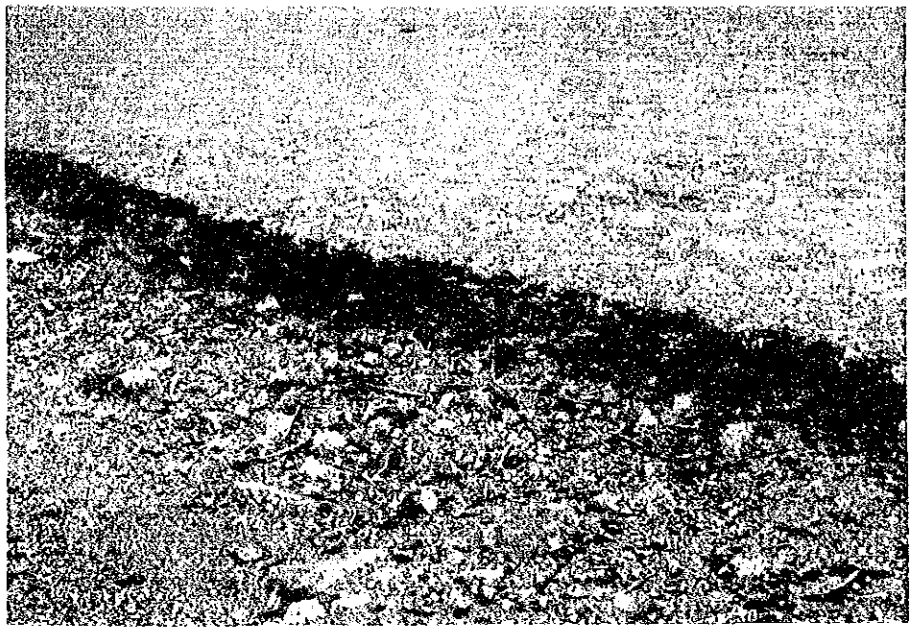


Photo 3.15

Damage of Edge Strips of Pavement

Photo 3.16

Damage of Edge Strips of Pavement

Photo 3.17

Damage of Edge Strips of Pavement

3.6.2 Landuse

The total area of Moukampoul District is 275 km^2 and the main landuse is shown in Table 3.8.

Table 3.8 Landuse of Moukampoul District

(Area in ha)

Paddy Area	Arable Land	Orchard	Lakes and Marshes	Built-up Area	Shrubbery	Rivers and Water Courses
4,128	1,307	5,614	35	1,285	11,796	4,382

Note: The total area of shrubbery which can be transformed into cultivated areas is estimated at 1,765 ha.

Source: Department of Road and Bridges Department, MOC

3.6.3 Population, Industry and Public Facilities

Only old information before the conflict is available concerning the demographic situation (RBD). The population of Moukampoul District is 60,660 (i.e., 11,860 families). The leading economic sector in the region is agriculture and the majority of the population is engaged in agricultural production, predominantly the cultivation of paddies. Main products in the arable land are kidney beans, peanuts, eggplant and tobacco.

Draught animals (cattle and water buffalo) are used extensively in the cultivation. The livestock/draught animals population is shown in Table 3.9.

Table 3.9 Livestock and Draught Animals

Cattle	Water Buffalo	Horse	Pigs	Domestic Fowls
20,191	418	160	10,365	48,313

The district is producing several kinds of industrial and handicrafts. Table 3.10 shows the number of operators by item of production.

Table 3.10 Number of Operators

Rice Mill	Saw Mill	Blocks/ Bricks	Water Pot	Ice Making	Silk Cloth	Scarf
45	6	6	2	3	1,000	750

Table 3.11 shows the number of public facilities related to health care, education and cultural activities in the Moukampoul District.

Table 3.11 Number of Public Facilities

Hospital	Clinic	Elementary School	Other Schools	High School	Kinder-garten	Pagoda	Mosque
2	11	36	6	1	8	30	2

3.6.4 Traffic Volumes

Traffic count survey was carried out in the framework of the "Basic design study on the project for restoration of Chroy Changwar Bridge" (the Previous Study) on 4 April 1992 near the Project Site. The result of traffic count survey is shown in Table 3.12.

Table 3.12 Result of Traffic Count Survey

(veh./day, both directions)

Location	Vehicle Type					Total in PCU
	Bicycle/ Motorcycle	Car/ Pickup	Medium Vehicle	Heavy Vehicle	Bus	
RN 5 KM15	3,790	775	86	198	33	2,503
P. Kdam Ferry	954	322	28	71	3	798
RN 6 Chun Chunok	1,358	260	35	53	1	828
RN 6 Skoun	1,000	153	11	31	2	536

3.7 Physical Conditions of the Project Site

3.7.1 Topography

(1) Terrain Condition

Moukampoul District is generally flat, in particular the central area is lowlying and forms a saucer terrain. The altitudes of existing ground level along Route 6A are generally 2.0 m (at the bottom of small rivers) to 10.0 m, and the existing grade of Route 6A varies from 11.0 m to 12.5 m.

(2) Topographical Survey

The Study Team conducted a topographical survey along Route 6A in the period between 15 November and 9 December 1992 to obtain the necessary data for the basic design. The output of the survey is as follows.

1) Plans and profiles of the existing Route 6A for the entire length of the Route 6A to the scales of 1:1,000 for horizontal distance and 1:200 for vertical distance.

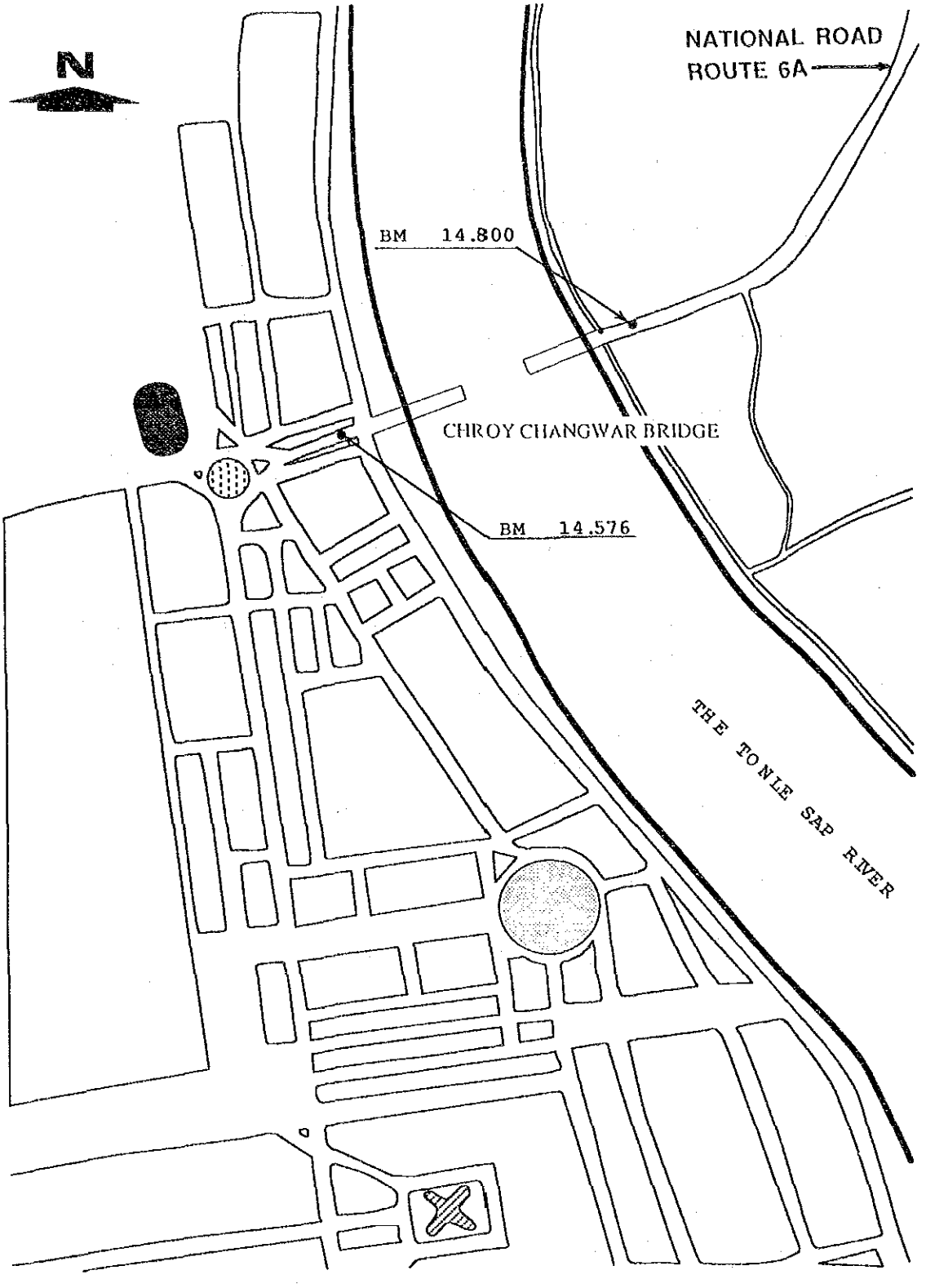
2) Topographical maps and plans and profiles of damaged 6 bridges to a scale of 1:200 for horizontal and vertical distances.

3) Topographical maps and plans and profiles of 6 locations of severely damaged road embankment to a scale of 1:200 for horizontal and vertical distances.

The survey comprises the following items:

- Traverse survey and leveling; and
- Plane-table survey.

No coordinate value was given in the plans/maps since the Project covers only the items of rehabilitation. The leveling is based on the bench mark (Elevation 14.800) which was established during the Previous Study. See Figure 3.6 for the bench mark location.



REHABILITATION OF NATIONAL ROAD ROUTE 6A

Figure 3.6 Bench Mark used for the Survey

3.7.2 Geology and Soils Conditions

(1) Geology

1) Geological Sequence

Geologically, the Project Site is formed mainly of sedimentary formations of Quaternary Age. The geological sequence found in the Site is shown in Table 3.13.

Table 3.13 Geological Formation

Geological Age	Formation	Description	Soil Symbol
Quaternary:			
Holocene	Alluvium	Clay, silt and organic soil	Ac
		Fine to coarse sand	As
Pleistocene	Diluvium	Clay and silt	Dc
		Fine to medium sand	Ds
Mesozoic:			
Cretaceous period	Sandstone	Hard clay	Mc
		Weathered sandstone	Ss
Triassic	Igneous rocks	Granite, diorite, Rhyolite and Dacite	

2) Characteristics of the Formations

i. Alluvium Deposit

Alluvium deposit is widely distributed in the Project Site and is mainly composed of cohesive soils (Ac) and sandy soils (As). The thickness of the deposits ranges from 12m to 24m.

- Cohesive Soils (Ac)

Cohesive soils consist of brown, dark brown, dark bluish grey and dark grey silty clay. The thickness of cohesive soils layers ranges from 5m to 15m. The N-value of dark

grey, dark bluish grey clay strata and blackish grey organic clay ranges from 4 to 8. The N-value of brown, dark brown clay ranges from 5 to 8.

- Sandy Soils (As)

  Sandy soils consist of brown, dark brown silty/clayey fine/medium grain sand. These soils strata are intercalated with lenses of the abovementioned cohesive soil layers. The thickness of the layers range from 1m to 8.5m and the N-value ranges from 3 to 5 in loose layers, and from 19 to 37 in dense layers.

ii. Diluvium Deposit

Diluvium deposit is extensively distributed in the stretch between Sta. 40 and Chun Chunok terminus and is composed of cohesive soils and sandy soils.

- Cohesive Soils (Dc)

  Cohesive soils consist of light brown and brown silty/sandy clay and clay. The thickness layers range from 1m to 12.4m. The N-value ranges from 17 to 52.

- Sandy Soils (Ds)

  Sandy soils consist of light brown and yellowish brown fine to medium grain sand and silty fine grain sand. The N-value ranges from 17 to 42 in general, but from 28 to 62 with lamina of silt where the lamina of silt exists.

iii. Bed Rock

- Weathered Clay (Mc)

  The Mc layer (sandstone with shale) in the project area is composed of yellow to yellowish brown stiff to hard clay. The Mc layer is found at the depth -12.5m to -24m below ground level. The N-value ranges from 25 to 51.

- Sand Stone (Ss)

  The formation is extensively distributed in the Project Site and is composed of yellow to yellowish brown fine sand stone with shale in weakly weathered status. The N-value is more than 65. The formation is situated at the distance from -10m to -25m from ground level.

- Igneous Rock

  Igneous rock is composed of granite, diorite, rhyolite and dacite and is widely distributed near Chun Chunok.

3) Soils and Materials Investigations

i. Purpose of the Investigations

The purpose of the investigations is to obtain data for the basic design of embankment, pavement, bridges and other structures.

ii. Field Work and Laboratory Testing

The field work and laboratory testing were executed by Transport Engineering Design Institute (Ho Chi Min city, Viet Nam). The Study Team planned and supervised the investigations. Machine boring with standard penetration tests (1m interval) was conducted at 6 locations (Boring logs and soil profiles are shown in Appendix A-5). Concrete core boring was also conducted for weathering tests and compression tests. Test pit sampling was made at possible sources of embankment materials.

The following laboratory testings were conducted for the collected soils samples.

- Specific gravity
- Natural water content
- Particle size distribution
- Liquid limit
- Plastic limit & plasticity index
- Compaction