CHAPTER B-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 project has been divided in two stages based upon the accessibility and similarity of major components of the bridge construction works. Stage-1 includes Bridges No.1, No.2, No.3 and No.8. Stage-2 includes Bridges No.4, No.5, No.6 and No.7, which are on National Road No.11 and near to each other.

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

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

(4) The project sites are not listed under the landmine and UXOs contaminated area but a survey and clearing of landmine and UXOs needs to be carried out before the commencement of construction work, especially at the planned locations of piers in the flume or river.

4.1.3 Major Project Components

The major project components include eight bridges and 200 m of access roads for each bridge. The list of bridges is given in **Table 4.1.1**.

Table 4.1.1 Major Project Components

	Bridge No.	No.1	No.2	No.3	No.4	No.5	No.6	No.7	No.8
Super Structure	Type of Girder	PCDG	RCDG	PCDG	PCDG	PCDG	PCDG	PCDG	RCS
	No. of Span	3	3	4	2	4	3	3	3
	Span Length (m)	20	18	35	21	23	23	18	10
	Bridge Length (m)	60.6	54.6	140.8	42.6	92.6	69.6	54.6	30.6
	Weight of a Girder (ton)	25.4	–	61.3	24.5	29.2	29.2	22.9	–
Substructure	Foundation	RC Pile	RC Pile	Spread & Bore Piles	Cast in place Concrete	Cast in place Concrete	Cast in place Concrete	Cast in place Concrete	RC Pile
	Pile Size (mm)	400 x 400	400 x 400	φ.1,000	φ.1,000	φ.1,000	φ.1,000	φ.1,000	400 x 400
	No. of Piles	98	90	20	24	40	32	24	74
	Pipe Length (m)	1302	846	175	560	952	784	564	407

Ref. *RC Pile: Pre-cast Reinforced Concrete Pile*
Spread : Spread Footing
PCDG: Pre-Cast Prestressed Deck Girder
RCDG: Reinforced Concrete Deck Girder
RCS : Reinforced Concrete Slab

4.1.4 Plan for Procurement and Transportation

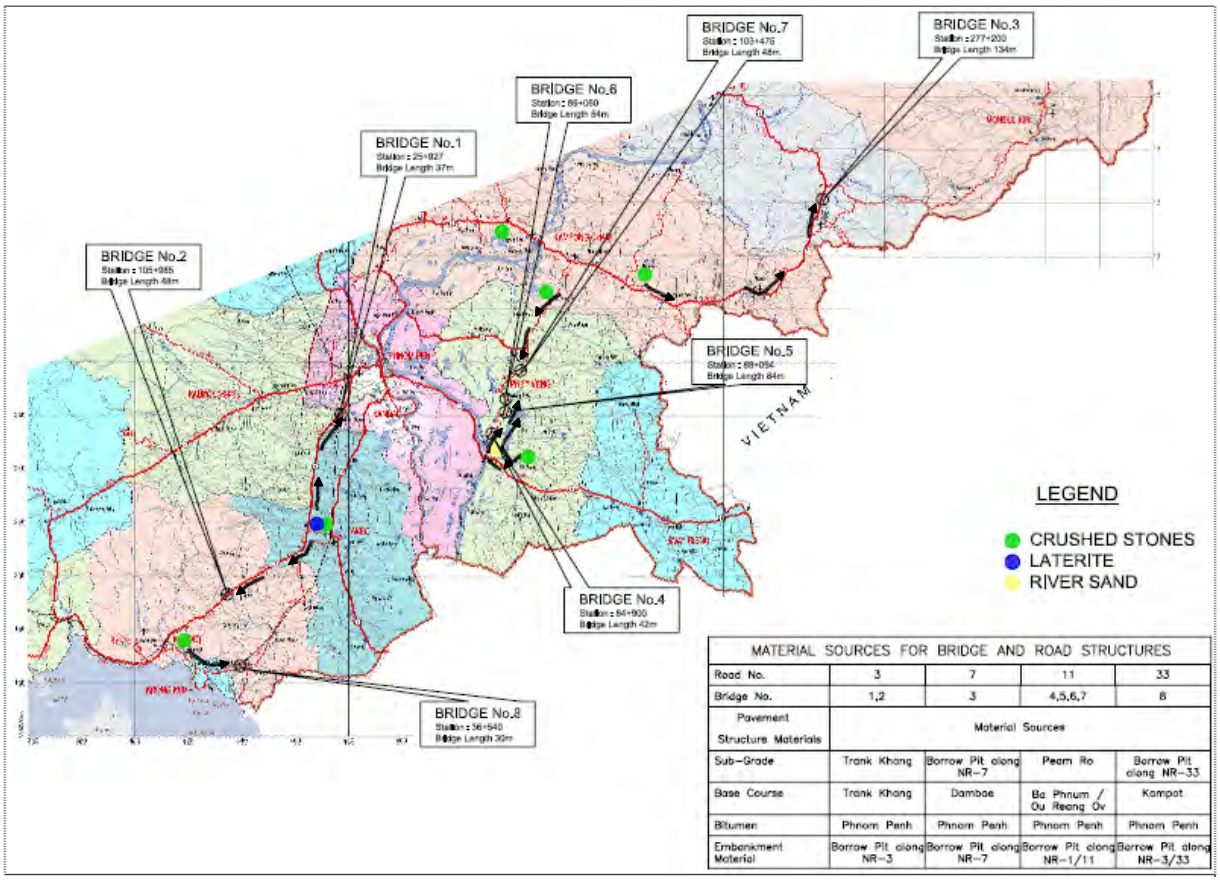
Local material sources for roads and bridge structures for each bridge site are listed in **Table 4.1.2**.

Table 4.1.2 Location of Quarry and Borrow Pits

Road No.	NR.3	NR.7	NR.11	NR.33
Bridge No.	1,2	3	4,5,6,7	8
Pavement structure materials	**Material Sources**			
Sub-Grade	Trank Khang	Borrow Pit along NR.7	Peam Ro	Borrow Pit along NR.3/33
Base Course	Trank Khang	Dambae	Ba Ohnum / Ou Ream Ov	Kampot
Bitumen	Phnom Penh	Phnom Penh	Phnom Penh	Phnom Penh
Embankment material	Borrow Pit along NR.3	Borrow Pit along NR.7	Borrow Pit along NR.1/11	Borrow Pit along NR.3/33

Judging from the construction volume of bitumen and distances to the sites, it is not economical to put in a plant for bitumen. With proper transportation arrangements and care it is considered that bituminous material can be transported from Phnom Penh.

The locations of local material sources for road and bridge structures are given in **Figure 4.1.1**.



Road No.	3	7	11	33
Bridge No.	1,2	3	4,5,6,7	8
Pavement Structure Materials	Material Sources			
Sub-Grade	Trank Khang	Borrow Pit along NR-7	Peam Ro	Borrow Pit along NR-33
Base Course	Trank Khang	Dambae	Ba Phnum / Ou Reang Ov	Kampot
Bitumen	Phnom Penh	Phnom Penh	Phnom Penh	Phnom Penh
Embankment Material	Borrow Pit along NR-3	Borrow Pit along NR-7	Borrow Pit along NR-1/11	Borrow Pit along NR-3/33

Figure 4.1.1 Location Map of Quarry and Borrow Pits

In Stage-1, a concrete mixing plant should be installed at the site of Bridge No.2, which is located between Bridge No.1 and No.8 so it can also be used to supply ready mixed concrete to these bridge sites as well. The Bridge No.3 site will need a separate one. For Stage-2, it is considered that, due to their close proximity, one concrete mixing plant be installed for all bridge construction sites.

Due to the low quantity of demand and accessibility bituminous material can be supplied from Phnom Penh for all the bridges.

4.1.5 Share of the Works

The share of work responsibility between the Government of Cambodia and external resources is as given in **Table 4.1.3**.

Table 4.1.3 Share of Work between the Government of Cambodia and the External Resources

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 removal of landmine and UXOs			○	Before the work commencement
Project Preparation	Land acquisition & compensation etc. needed for the construction works		○	Site office, stock and work yards,
	Preparation works other than the above	○		
	Shift Public Utilities such as Water supply lines, Power supply lines, communication cables		○	Before the work commencement
	Removal of existing bridges		○	
Project components	Construction of bridges and roads, other related works	○		

4.2 Preliminary Cost Estimate

4.2.1 Construction Cost

The project cost was estimated in June 2006, and consists of the foreign and local cost as well as tax. The foreign components include the cost of imported materials, services of foreign expatriates, and profits etc. The local components include local procurement, wages of workers, supervision and materials locally procured. The local currency is converted to US$.

(1) Market Price, Unit Cost of Major Construction Items

Market prices for materials and workers in June 2006, are listed in **Table 4.2.1**.

Included are the costs of the RCC (the Road Construction Center) equipment, which are donated under the Grant Aid Program of the Government of Japan.

Table 4.2.1 Unit Price of Major Materials and Workers (1/2)

CODE	Title	Spec.	Unit	Local (US$)
Worker				
R01	Supervisor		day	23.00
R02	Bridge Worker		day	11.00
R05	Rigger		day	9.50
R06	Labor		day	7.20
R07	Carpenter		day	11.20
R08	Steel Worker		day	10.50
R09	Welder		day	11.50
R10	Painter		day	9.50
R11	Traffic Controller		day	8.50
R12	Simple Labor		day	4.80
R13	Equipment Operator		day	19.00
Aggregate				
B01	Rubble	500~800mm	m^3	5.80
B02	Cobble	200~400mm	m^3	5.80
B03	Crushed Stone	0~50mm	m^3	7.30
B04	Fine Aggregate		m^3	1.80
B05	Coarse Aggregate	5~40mm	m^3	10.00
B06	A/C course Aggregate	0~20mm	m^3	11.70
B07	Filler for A/C		m^3	6.50
B08	Sub-Base Material	C-30	m^3	8.90
B11	Base Course Material	M-40	m^3	9.80
B12	Laterite		m^3	1.60
B13	A/C(Asphalt Concrete)		t	57.60
Construction Equipment				
M03	Backhoe	Bucket 0.8m^3	day	143.00
M06	Bulldozer	21ton	day	170.00
M07	Road roller	10~12ton	day	108.00
M08	Motor Grader	L=3.1m	day	161.00
M09	Tire Roller	8~10ton	day	107.00
M11	Vibro-Roller	3~5ton	day	91.00
M12	Dump Truck	10ton	day	95.00
M17	Truck Crane	40t	day	223.00
M18	Crawler Crane	40t	day	234.00
M19	Trailer	20t	day	163.00
M22	Road Sprinkler	6m^3	day	69.00
M23	Asphalt Finisher	2.4~4.5m	day	288.00
M27	Power Generator	50KVA	day	48.00
M28	Power Generator	100KVA	day	60.00
M36	Pile Driver		day	433.00
M39	Concrete Mixer	0.5m^3	day	60.00
M40	Portable Concrete Mixe	5m^3	day	133.00
Steel Material				
S01	H-Steel		ton	760.00
S02	I-Steel		ton	760.00
S05	Steel Panel t=9mm		ton	630.00
S06	Steel Panel t=12mm		ton	640.00
S09	Round Steel Bar		ton	655.00
S10	Deformed Steel Bar	D10~D32	ton	610.00
S13	PC Tendon		ton	1,050.00

Table 4.2.1 Unit Price of Major Materials and Workers (2/2)

CODE	Title	Spec.	Unit	Local (US$)
C02	Cement		ton	72.00
C03	Ready Mixed Concrete	18N/mm^2	m^3	48.00
C04	Ready Mixed Concrete	21N/mm^2	m^3	51.08
C05	Ready Mixed Concrete	24N/mm^2	m^3	52.86
C06	Ready Mixed Concrete	30N/mm^2	m^3	54.64
C07	Ready Mixed Concrete	40N/mm^2	m^3	62.50
Worker				
E01	Civil Engineer	20 years	month	1,595.00
E02	Civil Engineer	10 years	month	920.00
E03	Civil Engineer	5 years	month	570.00
E04	Surveyor	10 years	month	920.00
E05	Surveyor's assistant		month	388.00
E06	Power Engineer	10 years	month	920.00
E07	Power Engineer's Assistant		month	570.00
E08	Chief Auditor	10 years	month	820.00
E09	Chief Clark	10 years	month	618.00
E10	Typist		month	313.00
E11	Driver		month	288.00
E12	Security Guard		month	200.00
Fuel				
F01	Diesel		L	0.790
F02	Gasoline		L	1.000
F03	Prime Cost	CSS-1	ton	287.00
F04	Tack Coat	MC70	ton	355.00
F05	Straight Asphalt	Grade 60/70	ton	277.00
Others				
K01	PC Concrete Pile	400*400, 6m	m	86.00
K02	Concrete Pile	400*400、10.9m	No.	970.00
K03	Bailey Bridge		Month	4,800.00
K05	Wooden Peg	ϕ 150, L=1500	No.	2.40
K06	Wooden Peg	ϕ 150, L=2000	No.	3.20
Construction Equipment(RCC)				
RC01	Backhoe (RCC)	0.6m^3	Day	195.00
RC02	Vibro-Roller(RCC)		Day	27.00
RC03	Motor Grader (RCC)	3.1m	Day	164.00
RC04	Road Roller (RCC)	10～12t	Day	111.00
RC05	Truck Crane 2.9t (RCC)		Day	68.00
RC06	Crawler Crane (RCC)		Day	460.00

Ref. RCC "the Road Construction Center"

(2) Construction Cost

The construction cost consists of direct and indirect costs, and temporary and permanent facilities. The costs of direct and permanent facilities are estimated by using the unit prices, as listed in **Table 4.2.2**, whereas indirect costs and temporary works are estimated on the basis of percentages obtained from past projects in Cambodia.

Table 4.2.2 Unit Price of Construction Works

Work Item		Unit	Unit Price (US$)
Earth Work			
	Stripping	m^2	0.21
	Removal of top soil	m^3	1.92
	Embankment	m^3	2.57
	Sub-Grade	m^3	2.76
	Shoulder Filling	m^3	3.82
	Shoulder Preparation	m^2	0.94
	Sodding	m^2	1.67
Slope Protection			
	Gabion Mat	m	40.60
	Wet Masonry	m^2	58.28
Pavement			
	Sub-Base (t=16cm)	m^2	2.81
	Base (t=15cm)	m^2	4.31
	Binder (t=5cm)	m^2	7.92
	Surface (t=4cm)	m^2	7.17
Bridge Structure			
	Precast RC Pile (400x400mm)	m	103.11
	Bored Pile (φ=1,000mm),CIP Pile	m	152.40
	Leveling Concrete (18N/mm)	m^3	52.21
	Rebar	ton	707.00
	Form Work	m^2	8.63
	Concrete (24N/mm2)	m^3	55.63
	PC Girder Casting	m	388.28
	PC Girder Installation	m	118.81
	Shoe	Set	510.91
	Expansion Joint	m	579.57
	Bridge Plate	No.	280.00
Drainage			
	Surface Drainage	Set	183.00
	Pipe Installation φ＝1,000mm	No.	46.00
Road Facilities			
	Guide Post	No.	17.81
	Guide Rail	m	56.82
	Road Marking (Yellow Center Line)	m^2	10.00
	White Side Line	m^2	9.50
	Cross Line	m^2	9.50
	Traffic Signal	No.	195.00
	Hamper	m^2	7.34

(3) Conditions of Cost Estimation

For the purpose of cost estimates, the costs of temporary and indirect works have been estimated based on similar projects in Cambodia and are given in **Table 4.2.3**.

Table 4.2.3 Share of Temporary and Indirect Works

Construction Works		
Direct Cost	A	(a+b)
Direct Construction Work	a	
Site Temporary Work	b	a*15%
Temporary Works in Common	B	a*12%
Site Management	C	a*24%
General Management	D	(A+B*C)*8%
Detailed Design and Supervision		
Detailed Design and Construction Supervision		10%

The cost estimation mentioned above comprises the following items:

Site temporary works include:

1. Temporary work on site, including land leasing for a detour etc.
2. Machine use and depreciation
3. Dispatch of Engineers
4. Others

Temporary works in common include:

1. Preparation work, including leasing fees for detours and others
2. Plant installation
3. Import, transportation and other costs for imported materials and equipment
4. Security cost
5. Quality control
6. Building and maintenance of project offices and consumable goods

Site management includes:

1. Labor management cost
2. Safety precaution costs for sanitary and others
3. Insurance cost
4. Wages and other allowances of project staff and workers
5. Welfare cost
6. Transportation and communication cost
7. Others

General management includes:

1. Management cost of head office
2. Profit

(4) Cost Estimation

The quantities and cost estimation have been carried out based mainly upon the drawings and the conditions mentioned above. The summary of construction costs, which is to be born by the external resources, is as follows:

Construction Costs	(x 1,000 US$)
No.1	1,195.4
No.2	1,031.3
No.3	2,693.3
No.4	898.2
No.5	1,836.7
No.6	1,355.3
No.7	1,112,5
No.8	587.2
Total of Civil Works	**10,709.9**
Detailed Engineering & Construction Supervision	**1,071.0**
Total Construction Cost	**11,780.9**

1) Staged cost of the external resources

Components	Preliminary Cost Estimate（x 1,000 US$）	
	Stage-1 (4 Bridges)	Stage-2 (4 Bridges)
Bridge Construction	5,507.30	5,202.60
Detailed Design, Construction Supervision	550.70	520.30
Sub-Total	6,058.00	5,723.90
Total	**11,780.90**	

2) The following are the costs to be born by the Government of Cambodia:

Items	Cost (in x 1,000 US$)
Land Acquisition	Nil
Compensation to the Residents	US$ 15.0
Relocation of Public Utilities	US$ 16.6
Gross Total	**US$ 31.6**

(5) Total Project Cost

Based on the above estimation, the total project cost is estimated at US$. 11,812,500.

(Unit : x 1,000 US$)

Items	External Resources	Cambodia Government
Construction Cost	10,709.9	
Detailed Design & Construction Supervision	1,071.0	
Compensation to the Residents		15.0
Relocation of Public Utilities		16.6
Total	11,780.9	31.6
Gross Total	**11,812.5**	

4.2.2 Conditions

Cost estimation has been made on the conditions mentioned below:

1 Time of Cost Estimation: June 2006

2 Exchange Rate:

1.0 US Dollar = 4,113.5 Riels

3 Construction Period:

The project consists of two stages as mentioned in the implementation schedule.

4 Others:

The project is to be implemented with finance from external resources based on international bidding.

4.3 Maintenance Plan

4.3.1 Bridge Maintenance System

It is a known fact that bridges start to deteriorate the day after construction is completed, so it is our intention to slow down the deterioration process with proper preventive maintenance. Maintenance is necessary to keep these bridges in an "as-built" condition and/or protect it from inevitable deterioration due to the influence of traffic, environment and natural forces.

The proposed bridges under this study are all concrete bridges, which require minimal maintenance compared to steel bridges. However, concrete bridges are subject to both external and internal factors including direct forces from external sources (e.g. traffic loading, etc.), environmental factors, material deterioration, construction faults and structural factors. Under these circumstances, a proper bridge inspection and maintenance program is necessary.

(1) Concept of Preventive Bridge Maintenance

Bridges are key elements of the road network. The strategic location and the high level of serviceability, which the road user expects, requires that particular attention be given to the systematic inspection and maintenance of the bridges.

Maintenance of bridge facilities is necessary in order to:

- Keep the basic function of a roadway to provide a safe and efficient transportation system on a day-to-day basis,
- Keep the bridge in its current as-built condition and protect it from further deterioration due to its environment, traffic vibrations and other forces, and
- Preserve the intended structural carrying capacity of the bridge and safeguard the safety of the public using it.

The connotation of maintenance as a remedial action implies that the intention is to "fix" what is wrong with any part of the bridge, leads to the development of "reactive" maintenance. That is, *maintenance planning is focused at creating programs in response to problem conditions that arise or are generally evident*.

The merits, of moving away from a reactive maintenance focus to a preventive maintenance approach, are evident in the long run. *It is more cost-effective to perform preventive maintenance activities than to allow a known condition to get progressively worse until the entire member or structure has to be replaced.*

Timely and economic planning of preventive maintenance and repair work is precisely programmed through a systematic bridge maintenance system. The concept of preventive maintenance for bridges is concisely illustrated in **Figure 4.3.1**.

During the course of this study the typical defects, found on bridges, that are in need maintenance attention are shown in **Photo 4.3.1**.

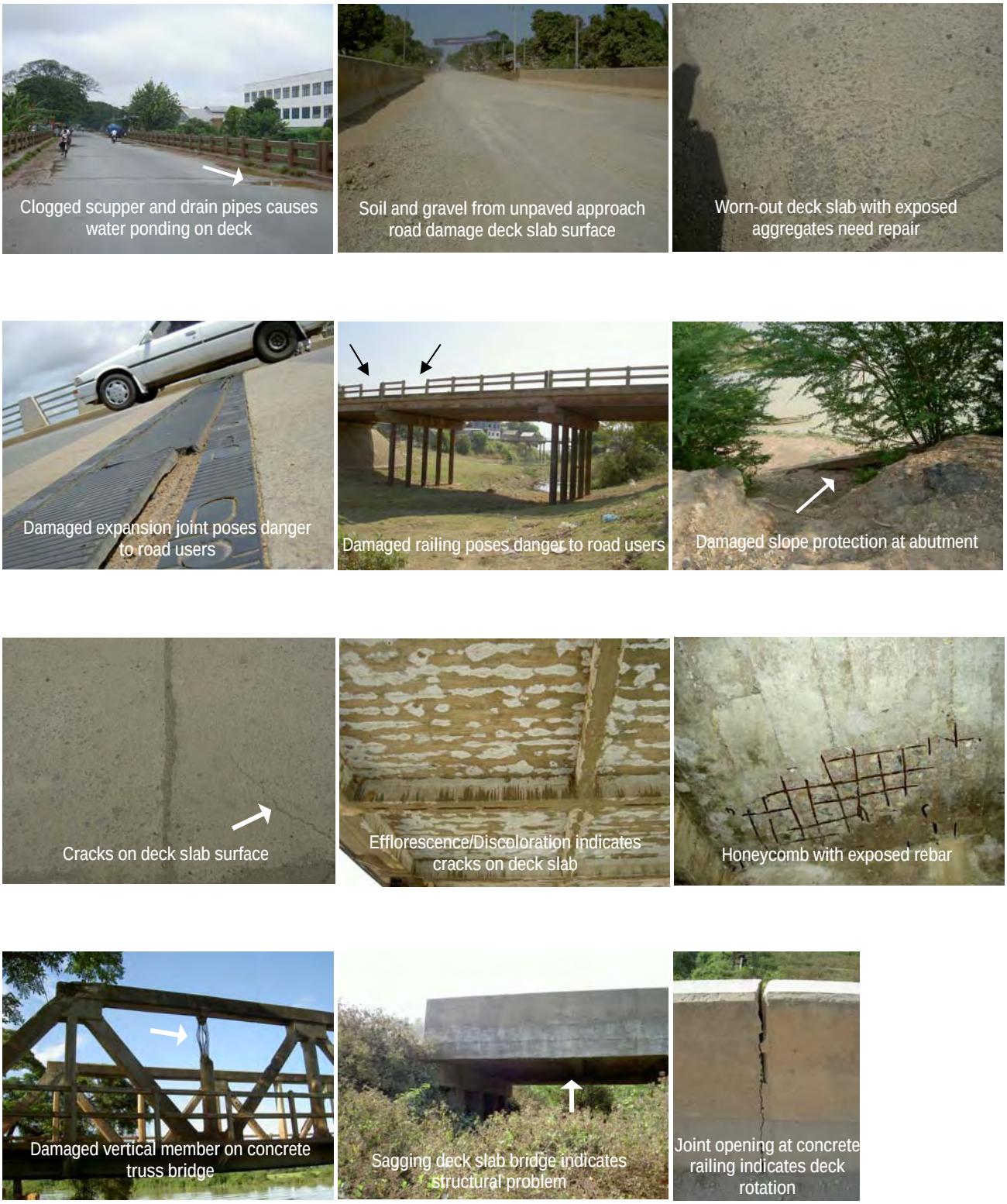


Photo 4.3.1 Typical Defects and Damages in Cambodia Concrete Bridges, Requiring Maintenance Attention

Photo 4.3.1 illustrates some of the typical defects and damages in existing bridges in Cambodia. It is observed that the condition of old existing bridges is progressively getting worse due to lack of bridge maintenance. Although relatively newly constructed bridges are in a fair to good condition, it is prudent to say that serious attention should be given to preventive maintenance of these bridges if these important assets are to be preserved.

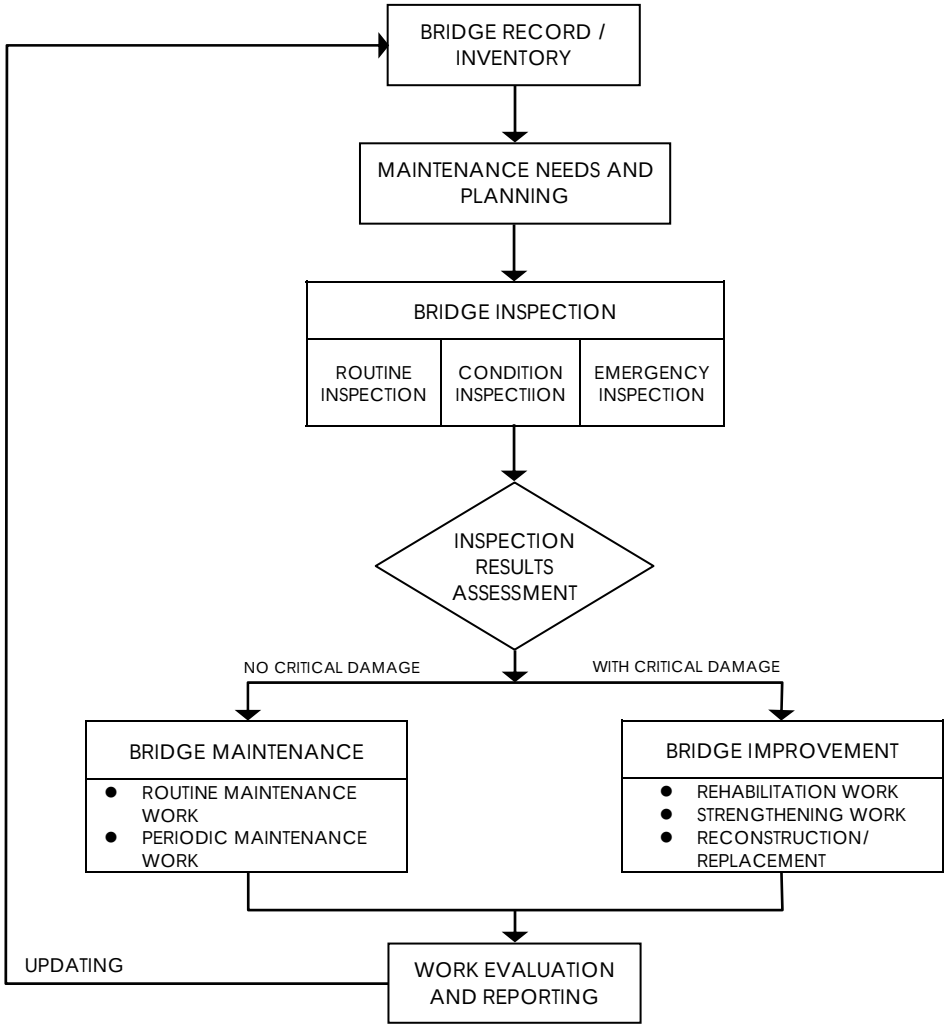


Figure 4.3.1 Bridge Maintenance Concept

A historical record and inventory of the bridges is the key to a successful bridge management system. The need for maintenance is usually based on this record followed by a proper bridge inspection. The basic inspection requirements include routine inspection (for routine maintenance), condition inspection (to determine periodic maintenance needs or intervention improvement work) and emergency inspection (following accidents or natural catastrophes).

If the inspection results indicate that there is no critical damage or area of concern in the bridge, ordinary maintenance work is done (such as routine and periodic maintenance). However, when critical damage is found in the bridge a more detailed inspection follows which will determine the necessary bridge improvement work to be done.

After every maintenance or improvement activity, it is necessary to update the bridge historical record to detail any changes done to the bridge. This will become the basis for future maintenance work planning.

(2) Routine Maintenance Works

Routine maintenance works for bridges are small scale activities normally performed as a regular preventive maintenance activity on a monthly, quarterly or annual basis. The objectives of routine maintenance shall be:

- To maintain the bridge in its current state or operating condition, and
- To prevent early deterioration of bridge members/elements by keeping it safe and clean.

Typical routine maintenance activities are listed in **Table 4.3.1**. Planning for these activities is either done as a part of a regular maintenance routine or as a result of a routine/maintenance inspection.

Table 4.3.1 Routine Maintenance Activities

Item No.	Main Task	Member/ Location	Sub-Tasks	Frequency
1.0	Cleaning	Bridge Deck	• Removal of debris/litter on deck surface • Sweeping	• Monthly/As Often As Possible
		Sidewalk	• Sweeping • Removal of hazards	• Monthly
		Scuppers	• Removal of debris at inlet	• Monthly/Quarterly
		Drain Pipes	• Cleaning drain pipes to remove clogging	• Monthly/Quarterly
		Expansion Joint	• Cleaning joint opening from incompressible material	• Monthly/Quarterly
		Bearings	• Clean bearings to remove dirt that could accumulate and impede movement	• Annually
		Culverts	• Remove vegetation and debris from inlet • Remove saplings/tress growing in embankment above culverts	• Annually or after flood • Annually or after flood
		Stream Beds	• Clean debris off pier	• Annually or after flood
2.0	Sealing Minor Cracks	Bridge Deck	• Sealing surface cracks	• When needed
		Sidewalks and Railings	• Sealing surface cracks	• When needed
		Approach Slab Joints	• Seal joints between approach slab and backwall	• Annually
3.0	Sealing Asphalt Cracks/Potholes	Deck Wearing Course	• Sealing asphalt cracks and repairing small potholes	• Annually or when needed
4.0	Repair/Seal Expansion Joint	Expansion Joint	• Repairing or sealing expansion joint	• Annually or when needed
5.0	Minor Repair (No structural bearing)	At Various Locations	• Minor repair of damaged or defective bridge element with no structural bearing	• When Needed

(3) Periodic Maintenance Works

Periodic maintenance works for bridges are maintenance activities performed after a certain number of years requiring additional resources for implementation to restore the condition of some bridge elements due to wear and deterioration. The scope of the work is normally larger than routine maintenance. The objectives of periodic maintenance are:

- To maintain the original function of the bridge and its elements, and
- To prevent further deterioration of bridge members/elements.

Typical periodic maintenance activities are listed in **Table 4.3.2**. Planning for these activities is done as a result of periodic inspection.

Table 4.3.2 Periodical Maintenance Activities

Item No.	Main Task	Member/ Location	Sub-Tasks	Frequency
1.0	Asphalt Wearing Course Replacement	Bridge Deck Wearing Course	• Replace entire asphalt wearing course on deck	• Every 12 – 15 years or after condition inspection
2.0	Expansion Joint Replacement	Expansion Joint	• Replace damaged/deteriorated expansion joint	• Every 10 – 12 years or after condition inspection
3.0	Repair/seal concrete cracks	Bridge Deck	• Repair/Seal cracks	• As needed; After condition inspection
		Girders	• Repair/Seal cracks	• As needed; After condition inspection
		Abutments	• Repair/Seal cracks	• As needed; After condition inspection
		Piers	• Repair/Seal cracks	• As needed; After condition inspection
4.0	Replacement of scupper and drain pipes	Deck Drainage	• Replace worn-out/damaged scupper and drain pipes	• As needed; After condition inspection
5.0	Repair slope protection	Abutment and Revetment	• Repair slope protection works in front of abutment and bank revetment	• As needed; After condition inspection
6.0	Repair of Pier Protection	Piers	• Repair of pier protection due to scour, etc.	• As needed; After condition inspection

(4) Major Bridge Improvement Works

The results of bridge inspections will determine the type of intervention necessary to restore the bridge function. Repair works, as part of the routine and periodic maintenance activities, will refer to remedial work activities to restore the bridge elements to their original condition. The "scope" and "cost" is much smaller than for rehabilitation.

Major improvement works on bridges include:

1) Rehabilitation

Rehabilitation is repair work of significant nature that consists of restoring the bridge to the service level it once had and has now lost. In some cases, this consists of giving the bridge the service level that was originally intended, but was never achieved, because of deficiencies in the design or construction.

Rehabilitation is thus intended to extend the service life of an existing bridge and may take the form of any one of several restoration procedures that requires engineering design.

The work can include:

- Deck repair or replacement,
- Procedures for correcting settlement problems,
- Strengthening or replacing critical members,
- Replacing bridge bearings,
- Bridge widening, and
- Correcting bridge deck alignment.

2) Strengthening

Strengthening aims to increase the load-carrying capacity of an existing structure by providing the structure with a service level higher than the structure originally had or was initially planned for the structure.

In a strict sense, strengthening normally refers to "structural strengthening" to improve the structural load carrying capacity of a bridge member or the whole bridge. However, in a broader sense, strengthening is sometimes referred to as "upgrading" or "improvement" when the work activities serve to raise the service level other than the load-carrying capacity. Such improvement may include geometric changes to the bridge such as widening or raising the deck to improve its road traffic capacity and navigational capacity.

3) Reconstruction

Reconstruction of the whole bridge is resorted to when the cost and extent of rehabilitation and strengthening is beyond the acceptable economic or technical limit.

(5) Maintenance Plan for Urgent Bridge Rehabilitation

The maintenance plan and responsibilities for "Urgent Bridge Rehabilitation" bridges follows the system shown in **Figure 4.3.2**. However, since these bridges are replacements of existing bridges, the bridge construction record will be the baseline of maintenance planning.

- Ordinary routine maintenance works shall be carried-out by the DPWT for these bridges including cleaning, sweeping, scupper and drain pipe maintenance, minor repairs, etc. on a regular basis, preferably monthly or quarterly depending on the available resources.
- Regular inspection shall be carried-out by the MPWT with the assistance of the DPWT to assess the bridge condition and determine additional maintenance requirements. *Routine Inspection* is normally done on a monthly or quarterly basis on the deck surface while *Condition Inspection* is normally done on an annual basis on the deck and from under the bridge. This will determine the overall bridge condition and identify necessary maintenance or improvement works. Additional *Engineering or Detailed Inspection* may be necessary after a condition inspection if critical damage or defect is found. *Emergency Inspection* is carried-out after an accident or natural phenomena including a flood has occurred.
- Decisions on maintenance or improvement works are made after the inspection results are assessed. Periodic maintenance and improvement work shall be the responsibility of the MPWT.
- All maintenance and inspections done for the bridge shall be recorded and kept in each bridge's file or folder. This will be maintained by the MPWT and used as a basis for the next inspection, maintenance or improvement work.

Figure 4.3.2 below illustrates the proposed maintenance system and responsibilities for the Urgent Bridge Rehabilitation.

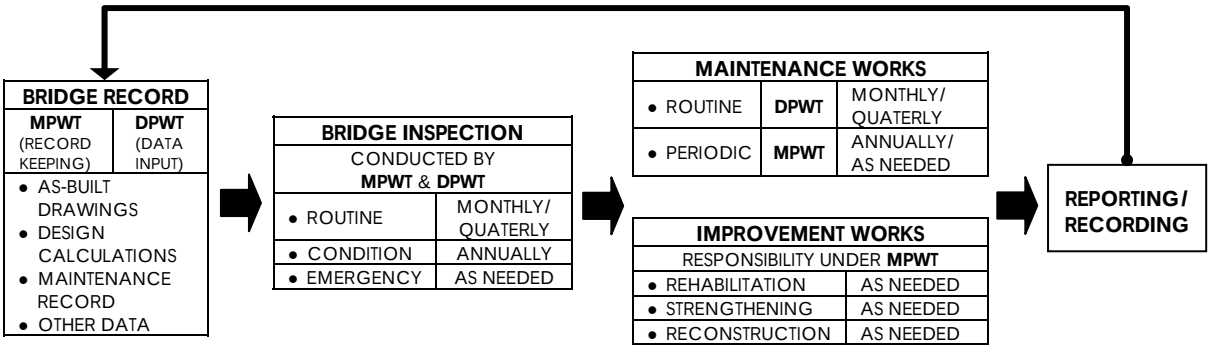


Figure 4.3.2 Urgent Bridge Maintenance

4.3.2 Maintenance Operation Plan

Maintenance of the proposed rehabilitation of bridges will be undertaken by the MPWT and the following provincial DPWTs where these priority projects are located:

- Rehabilitation of Bridges: 1 Bridge in Kandal Province
  2 Bridges in Kampot Province
  4 Bridges in Prey Veng Province
  1 Bridge in Kratie Province

(1) Organization and Operation

Without appropriate maintenance works, bridges deteriorate and become traffic bottlenecks which hinder smooth road transportation. Firstly, the MPWT/DPWT prepares a comprehensive and sustainable bridge inspection program to provide timely information to maintenance personnel for all bridges.

Demarcation of maintenance and inspection between the MPWT and DPWT is shown in **Table 4.3.3**.

Table 4.3.3 Bridge Management

Inspection	Frequency	Purpose	Responsibility
Inventory	Annual	To obtain/update bridge inventory data	MPWT (PWRC) /DPWT
Routine	Monthly/ Quarterly	Scheduling of routine maintenance, check of bridge condition	DPWT (PWRC) /DPWT
Condition	Annual	To obtain condition data on and periodic maintenance needs	MPWT (PWRC) /DPWT
Emergency	As required	To determine emergency work to bridges following a calamity	MPWT (PWRC)

Activity	MPWT	DPWT
Routine Maintenance Works	1. Inspection results assessment by PWRC. 2. Assessment of DPWT's budget request by DOR. 3. Preparation of project estimation by DOR. 4. Bidding and preparation of contract, force account or contract out by bidding committee. 5. Supervising of project by DOR. 6. Inspection of project by DOR.	1. Preparing of routine maintenance plan based on routine inspection record for requesting budget to MPWT (DOR). 2. Implementation or supervising of project. 3. Routine progress & final report

Activity	MPWT	DPWT
Periodic Maintenance Works	1. Preparation of project estimations, designs & spec. (by PWRC). 2. Inspection results assessment by PWRC. 3. Bidding and preparation of contract by bidding committee. 4. Supervising and reporting of project by PWRC. 5. Hand over of management to DOR.	1. Inspection sheet shall record the conducting of condition inspection. 2. Transfer management from PWRC.
Major Bridge Improvement Works	1. Conducting inspection with bridge expert, PWRC & DPWT. 2. Inspection results assessment by PWRC. 3. Preparation of project estimations, designs & spec. by PWRC. 4. Bidding and preparation of contract by PWRC. 5. Supervising and reporting of project by PWRC. 6. Hand over to management to DOR.	1. Conducting inspection with bridge expert, PWRC & DPWT. 2. Transfer management from PWRC.

(2) Financial Plan

(a) Required Maintenance Cost

Total maintenance costs for the bridges in the Urgent Bridges Rehabilitation is estimated to be about $0.078 million per annum as shown in **Table 4.3.4**, applying unit maintenance cost per square meter under the assumption of bridge maintenance activities as shown in **Table 4.3.5** and **Table 4.3.6.**

Table 4.3.4 Daily Maintenance Work Costs (1/2)

Bridge No.	Route	Length (m)	Width (m)	Area (m^2)	Patrol / Clean up		Rubber Joint (US$/year) **		Painting (US$/year) **		Total (US$ mil /year)
					Unit Cost (US$/m)	Maint. Cost (US$)*	Unit Cost (US$/m)	Maint. Cost (US$)	Unit Cost (US$/m)	Maint. Cost (US$)	
Bridge 1	NR.3	60.6	12.5	757.5	0.03	23.27	150.0	3,750	7.0	5,320.5	0.0091
Bridge 2	NR.3	54.6	12.5	682.5	0.03	20.97	150.0	3,750	7.0	4,777.5	0.0085
Bridge 3	NR.7	140.8	12.5	1,760.0	0.03	54.07	150.0	3,750	7.0	12,320.0	0.0161
Bridge 4	NR.11	42.6	12.5	532.5	0.03	16.36	150.0	3,750	7.0	3,727.5	0.0075
Bridge 5	NR.11	92.6	12.5	1,157.5	0.03	35.56	150.0	3,750	7.0	8,102.5	0.0119
Bridge 6	NR.11	69.6	12.5	870.0	0.03	26.73	150.0	3,750	7.0	6,090.0	0.0099
Bridge 7	NR.11	54.6	12.5	682.5	0.03	20.97	150.0	3,750	7.0	4,777.5	0.0085
Bridge 8	NR.33	30.6	12.5	382.5	0.03	11.75	150.0	3,750	7.0	2,677.5	0.0064
Total											0.0780

Note: Frequency: * : 1 time/month
** : 1 time/10 years

Table 4.3.5 Daily Maintenance Work Cost (2/2)

Road Class	Patrol (US$/ km)	Cleaning (US$/km)	Total (US$/km)
1-Digit	15.4	16.6	32
2-Digit	15.4	16.6	32
3,4-Digit	15.4	16.6	32

Table 4.3.6 Periodic Maintenance Costs

	Rubber Joint	Paint
Frequency	Once in 10 Years	Once in 10 Years
Unit Cost	$1500 per meter	$70 per square meter
Width	12.5m	
Quantity	2 for one bridge	12.5 x Bridge Length

(b) Financial Plan

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

Alt.1. Financing by Road Maintenance Added Tax

The forecast of the expected revenue from added tax or the road maintenance special fund in 2010 is about $30 million. This is based on the expected imports of the oil. Of this about $22 million is scheduled for the maintenance of the existing roads in the nation. The balance of $2.5 million is sufficient enough to be appropriated for the maintenance of the captioned bridge rehabilitation project.

Table 4.3.7 Expected Revenue from the Project

		Total Vehicle		Vehicle with 4 Wheel		Revenue from M/C($ Per day)		Revenue from 4 – wheel($ Per day)		Expected Revenue ($ mil. Per year)		Expected Revenue ($ mil. /year)
Project	Section	YR 2005	YR 2010	YR 2005	YR 2010	YR 2005	YR 2010	YR 2005	YR 2010	YR 2005	YR 2010	YR 2010
Bridge 1	NR-3	7,432	8,998	2230	2699	943	1,142	1,616	1,957	0.934	1.131	0.566
Bridge 2	NR-3	5,097	6,114	1529	1834	647	776	1,109	1,330	0.641	0.769	0.384
Bridge 3	NR-7	1,039	1,363	312	409	132	173	226	296	0.131	0.171	0.017
Bridge 4	NR-11	569	834	171	250	72	106	124	181	0.072	0.105	0.026
Bridge 5	NR-11	3,060	6,022	918	1807	388	764	666	1,310	0.385	0.757	0.189
Bridge 6	NR-11	3,060	6,022	918	1807	388	764	666	1,310	0.385	0.757	0.189
Bridge 7	NR-11	2,095	4,932	629	1480	266	626	456	1,073	0.263	0.620	0.155
Bridge 8	NR-33	2,213	3,843	664	1153	281	488	481	836	0.278	0.483	0.483
Bridge Total											4.793	2.010

Note:Road User Charge
- M/C : US$. 0.181/one time
- 4 wheel and over : US$. 0.725/one time

Assumption
1. Charge on M/C is 1/4 of 4 wheel vehicle.
2. Maintenance fee is charged not on a bridge base but a route basis.

Alt.2 Financing by charging maintenance charge against road users

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

Simple analysis suggests that the revenue from this method of levying is sufficient enough to cover the maintenance cost of the bridges in the urgent bridge rehabilitation project. Assuming a level of charge equivalent to that presently charged on NR.4 the figures are as calculated in **Table 4.3.8**.

Table 4.3.8 Comparison of Maintenance Expenditure and Revenue from Road-user Charge

Year 2010

Bridge No.	Route	Maintenance Cost ($ mil./year)	Expected Revenue from Road User Charge($ mil./year)
No. 1	NR.3	0.008	0.566
No. 2	NR.3	0.007	0.384
No. 3	NR.7	0.018	0.017
No. 4	NR.11	0.005	0.026
No. 5	NR.11	0.012	0.189
No. 6	NR.11	0.009	0.189
No. 7	NR.11	0.007	0.155
No. 8	NR.33	0.004	0.483
Total		0.068	2.009

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

4.4 Implementation Plan

4.4.1 Project Components

The Urgent Bridge Rehabilitation involves the bridges given in **Table 4.4.1**, which are to be replaced on the same horizontal alignment and raised vertically to secure adequate free board:

Table 4.4.1 Urgent Bridges

Bridge. No.	Road No.	PK	Bridge Type	Length (m)
No.1	NR.3	25+927	PCDG	60.6
No.2	NR.3	105+985	RCDG	54.6
No.3	NR.7	277+200	PCDG	140.8
No.4	NR.11	84+900	PCDG	42.6
No.5	NR.11	88+094	PCDG	92.6
No.6	NR.11	89+060	PCDG	69.6
No.7	NR.11	103+475	PCDG	54.6
No.8	NR.33	36+540	RCS	30.6

4.4.2 Procurement Source

The sources for material procurement for the bridges and pavement are given in **Table 4.4.2**.

Large crane, reverse circulation drill, vibration hammer etc. are not locally available. If required, these can be procured from other countries. The procurement plan for the major equipment is shown in the **Table 4.4.3**.

Table 4.4.2 Material Procurement Sources

Material Source	Source Country	
	Cambodia	Others
Structural Materials		
Crushed stone (foundation, sub-base)	○	
Cement	○	
Sand	○	
Crushed stone (Aggregate)	○	
Rebar：D 6～D32	○	
Admixture for Concrete		○
Pre-stressing tendon		○
Shoe		○
Non-shrink cement	○	
Pre-stressing device for PC		○
Crushed stone for masonry	○	
Steel Concrete Tube	○	
Bitumen	○	
Gabion		○
Corner Stone	○	
Concrete Peg	○	
Wooden Peg	○	
Steel sheet pile	○	
Sealing strip	○	
Timber	○	
Expansion Joint		○
Guard Rail		○

Table 4.4.3 Sources of Major Construction Equipment

Equipment	Spec.	Phnom Penh	RCC	Third Country
Backhoe	0.2m^2	○		
Backhoe	0.6m^2	○	○	
Bulldozer	21t	○	○	
Bulldozer	15t	○		
Motor Grader	3.1m	○	○	
Road roller	8t	○	○	
Tyreroller	8-20t	○		
Concrete Mixer	0.1m^3	○		
Concrete Mixer	0.5m^3	○		
Concrete Plant	Weigh Mix			○
Road Sprinkler	4.kl	○	○	
Dumptruck	6t		○	
Dumptruck	10t	○		
Truckcrane	11t	○		
Crawler Crane	40t	○		
Crawler Crane	50t		○	
Crawler Crane	100t			○
Crawler Crane	150t			○
Diesel Hammer	2.5t	○		
Vibro-Hammer	40kw			○
Reverse Driller				○
Water Tank	50m^3			○
Girder Erection Facilities				○
Power Generator	250KVA	○		
Power Generator	100KVA	○		
Power Generator	45KVA			
Power Generator	15KVA	○		
Submersible Pump	150mm			○
Submersible Pump	100mm			○
Compressor	5m^3	○		
Truck	2t	○		
Truck	4t	○		

4.4.3 Implementation Schedule

The following schedule has been prepared on the assumption that the consultant will carry out the detailed design, preparation of the tender document and evaluation, and also the construction supervision.

(1) Detailed Design

Main scope of work for the detailed design includes the review of the preliminary design, including preliminary design drawings, construction planning, procurement planning and cost estimation. The overall detailed design shall be carried out at the beginning of Stage-1, including the Stage-2 detailed design.

The period required for the detailed design is estimated to be 6 months, including the preparation of tender documents.

(2) Tendering

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

- Preparation of tender documents

The following process will be undertaken at the start of Stage-2.

- Public announcement
- Pre-Qualification of bidders
- Tendering
- Tender evaluation
- Promotion of contract establishment

(3) Construction Supervising

The consultant is to carry out the supervision of the construction work, which is stipulated in the contract made between the client and the contractor. 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

Required period for construction is estimated at 17 months for each stage.

(4) Construction Equipment

All construction equipment that 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. It has been observed that there are two sets of reverse circulation drilling machines and ancillary equipment being used in on-going bridge projects, but if required, equipment can be arranged from other countries.

(5) Implementation Schedule

The target bridges are scattered; two on NR.3, one on NR.33, four on NR.11 one on NR.7 and only four bridges on NR.11 are grouped. Under such conditions, the project has been divided into two stages, based upon accessibility and importance, similarity of work components etc. Stage-1 includes Bridge No.1, No.2 and No.3 on 1-Digit roads, and Bridge No.8 which should be included in with nearby NR.2, though it is located on a 2-Digit road. Stage-2 comprises Bridge No.4, No.5, No.6 and No.7 located nearby each other. The types of foundation and girder are also the same for these bridges as the soil and topographical conditions are similar.

The commencement of the project is planned for November, just after the rainy season is over, with the idea that foundation work be completed as much as possible during the dry season in order to avoid interference by high water and poor accessibility.

The Project Implementation Schedule is given in **Figure 4.4.1**.

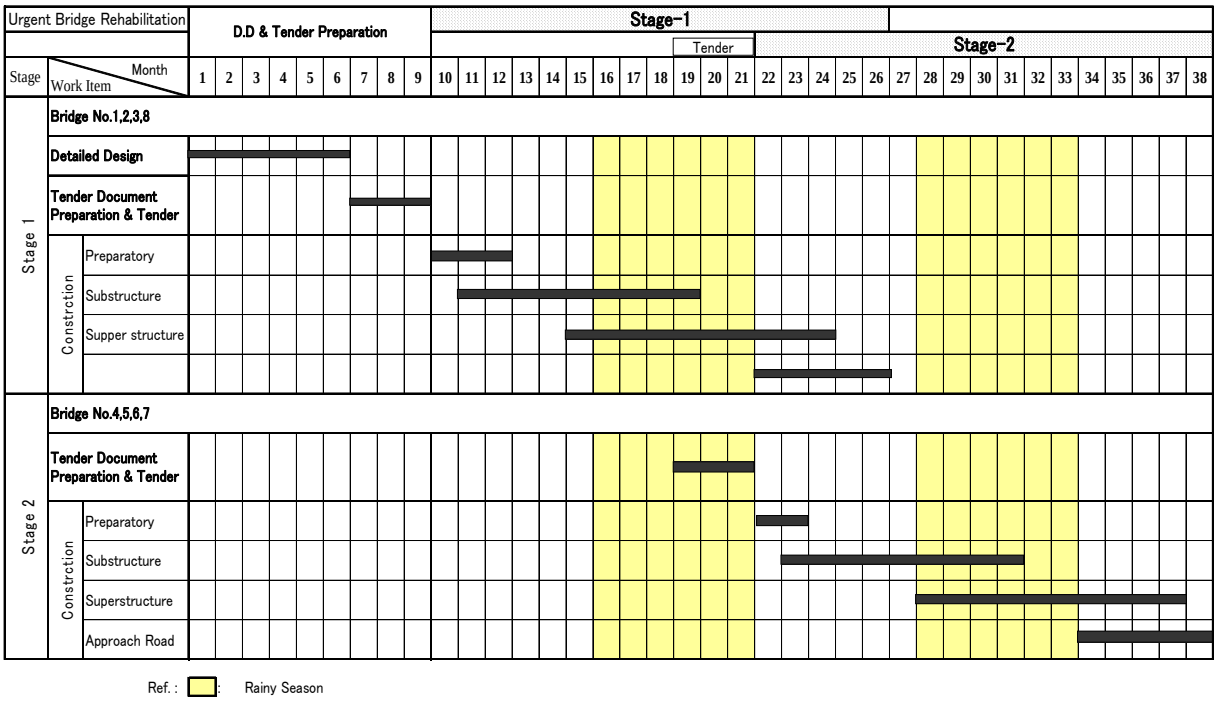


Figure 4.4.1 Implementation Schedule

CHAPTER B-5 ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

5.1 Introduction

5.1.1 Background

This chapter has been prepared to provide reference material for the IEIA for the urgent bridge rehabilitation program, which should be finalized and submitted to MOE for the approval of the project once the government has decided to proceed with the project. Because the project implementation has not yet been decided; and there is a constraint that an interview survey for the residents could not be conducted due to the insufficient capabilities of the government officers in law enforcement for land management especially in ROW. This IEIA follows the laws and regulations in Cambodia as well as the "Guidelines for Environmental and Social Considerations, April 2004, JICA".

5.1.2 Objectives

The objectives of this chapter are to:

- Prepare the draft IEIA as a basis for the final IEIA that is required for the submission;
- Prepare the basic data to enable decision making in relation to the project implementation;
- Predict social and environmental impacts that may be caused by the project; and
- Consider the necessary improvement measures and an environmental management plan.

5.2 Project Description

An outline of the project is given in the following table:

Table 5.2.1 Project Description

Item	Description
Name of Project	Urgent Bridge Rehabilitation Program in Cambodia (Phase I: Southeast Block)
Project Proponent	Ministry of Public Works and Transport (MPWT), The Royal Government of Cambodia
Objectives	- Improvement of Accessibility - Improvement of Serviceability - Enhance structural safety - Enhance traffic safety
Location	See the following table
Population of Beneficiaries	843,629 (2005) 1,119,128 (2020)

The program consists of eight (8) bridge-projects. The location of the bridges is shown in the table below. The projects are located in four (4) provinces and on four (4) national roads in the southeast block of Cambodia.

Table 5.2.2 Location of Bridges

Bridge No.	Road No.	Province	District	Commune	Village
No.1	NR.3	Kandal	Kandal Stung	Anlong Romiet	Daeum Trang
No.2		Kampot	Chhuk	Krang Sonay	Damnak Toap Khang Tboung
No.3	NR.7	Kratie	Snoul	Snoul	Preak Kdei
No.4	NR.11	Prey Veng	Peam Ro	Peam Ro	Peam Kaoh
No.5			Kamong Leav	Prey Kandieng	Prey Kandieng
No.6			Kamong Leav	Baray	Baray Lech
No.7			Prey Veng	Me Bon	Me Bon
No.8	NR.33	Kampot	Kampong Trach	Kampong Trach Khang Kaeut	Boeng Thum Khang Lech

The program involves the reconstruction of the existing temporary bridges because they are in poor structural condition, are not complying with the Cambodian standards and are at risk of collapse.

The project length for each bridge is 100 m, including both access roads (in total 200 m) and the bridge length. The main project components are the bridge construction, which includes the substructure, superstructure and foundation works, and the construction of both access roads, which includes AC pavements and embankments.

A detailed description of the engineering design is given in Chapter B-3.

5.3 Social and Environmental Impacts

5.3.1 General

The project impacts can be divided into two (2) types. The first impacts are those occurring during the project implementation, including the design and construction period, and the second impacts are those occurring after the project has been completed. The impacts during the project implementation are mainly caused by land acquisitions and construction works, such as earthworks, construction machines and equipment.

The impacts occurring after the project has been completed are caused by increased traffic volumes and the increased speed of vehicles. One of the project features is the reconstruction of the existing temporary bridges. Therefore, the traffic and infrastructure systems will be basically the same as they are now. The major changes resulting from the construction will relate to the safety, stability, width of bridges, and water flow capacity of the relevant section of river. The reconstruction will enhance the structural safety of the bridge and reduce the risk of collapse. Because of this the stability of the bridge and road network will be strengthened. The widening of the bridges will increase the traffic capacity to two (2) lanes and enhance the traffic safety in terms of reducing the risk of traffic moving in the opposite direction even though some vehicles may travel at excessive speeds.

Table 5.3.1 Bridge Width

Bridge No.	Width (m)	
	Existing	Designed
No.1	4.5	12.5
No.2	4.2	12.5
No.3	4.5	12.5
No.4	5.4	12.5
No.5	5.4	12.5
No.6	4.9	12.5
No.7	4.9	12.5
No.8	4.2	12.5

After the construction works have been completed, traffic volumes are expected to increase. This increase will not be caused directly by the new infrastructure but will be the result of future population increases and economic development. As there are no alternatives to the existing bridge roads, the traffic volumes with or without the construction works will remain the same. The daily traffic volume in 2005 and the estimated volume in 2020 are shown in the table below. The traffic volume at each bridge will have increased several times by 2020.

Table 5.3.2 Daily Traffic Volume (PCU)

Bridge No.	2005	2020
No.1	5,169	19,426
No.2	3,090	8,400
No.3	2,099	3,372
No.4	2,087	17,325
No.5	2,087	17,325
No.6	2,087	17,325
No.7	1,765	16,700
No.8	713	3,744

The reconstruction of the bridges will increase the bridge lengths as shown in the following table. Thus, the cross-sectional area of the rivers will increase and the water flow capacity of the rivers will be enhanced. As a result the speed of the river flow will reduce as a result of the construction works and consequently less soil erosion will occur.

Table 5.3.3 Bridge Length

Bridge No.	Bridge Length (m)	
	Existing	Designed
No.1	37	60.6
No.2	48	54.6
No.3	130	140.8
No.4	42	42.6
No.5	84	92.6
No.6	45	69.6
No.7	48	54.6
No.8	30	30.6

5.3.2 Scoping

The following table is a checklist for scoping based on the JICA guideline.

Table 5.3.4 Checklist for Scoping

No	Impacts	Bridge No.								Total	Description
		1	2	3	4	5	6	7	8		
Social Environment: *Regarding the impacts on "Gender" and "Children's Right", might be related to all criteria of Social Environment.											
1	Involuntary Resettlement	B	B	B	no	B	no	B	B	B	Several involuntary resettlements will be caused by land acquisition.
	Affected Property in ROW	25	5	1	0	15	0	2	23	71	
	Affected Property in PRW	6	1	1	0	14	0	2	5	29	
	Affected Property to be compensated in PRW	3	1	0	0	6	0	0	4	14	
2	Local economy such as employment and livelihood, etc.	B	B	No	no	no	no	B	B	B	Several shops/restaurants will be relocated caused by land acquisition.
3	Land use and utilization of local resources	no	no	No	no	no	no	B	no	B	Some part of cultivate land in PRW will be affected by land acquisition.
4	Social institutions such as social infrastructure and local decision-making institutions	no	no	No	no	no	no	no	no	no	
5	Existing social infrastructures and services	B	B	no	no	no	no	B	no	B	There are some pagodas.
6	The poor, indigenous and ethnic people	C	C	C	C	C	C	C	C	C	Social survey must be conducted before the finalization of IEIA.
7	Misdistribution of benefit and damage	no	no	no	no	no	no	no	no	no	
8	Cultural heritage	B	B	no	no	no	no	B	no	B	There are some pagodas.
9	Local conflict of interests	C	C	C	C	C	C	C	C	C	Social survey must be conducted before the finalization of IEIA.
10	Water Usage or Water Rights and Rights of Common	B	B	B	B	B	B	B	B	B	Usage of river water might be affected during construction period.
11	Sanitation	no	no	no	no	no	no	no	no	no	
12	Hazards (Risk) Infectious diseases such as HIV/AIDS	B	B	B	B	B	B	B	B	B	Infection diseases might be increased by construction workers during construction period.
Natural Environment											
13	Topography and Geographical features	no	no	no	no	no	no	no	no	no	
14	Soil Erosion	no	no	no	no	no	no	no	no	no	
15	Groundwater	no	no	no	no	no	no	no	no	no	
16	Hydrological Situation	B	B	B	B	B	B	B	B	B	Difficulty of water flow of river during construction period
17	Coastal Zone	no	no	no	no	no	no	no	no	no	
18	Flora, Fauna and Biodiversity	B	B	B	B	B	B	B	B	B	Wildlife, birds, fish and other aquatic animal might be disturbed during construction period.
19	Meteorology	no	no	no	no	no	no	no	no	no	
20	Landscape	no	no	no	no	no	no	no	no	no	
21	Global Warming	no	no	no	no	no	no	no	no	no	

Table 5.3.4 Checklist for Scoping

No	Impacts	Bridge No.								Total	Description
		1	2	3	4	5	6	7	8		
Pollution											
22	Air Pollution	B	B	B	B	B	B	B	B	B	- Dust during construction period - Air pollution after construction with increase of future traffic volume
23	Water Pollution	B	B	B	B	B	B	B	B	B	Risk of water pollution during construction
24	Soil Contamination	no	no	no	no	no	no	no	no	no	
25	Waste	B	B	B	B	B	B	B	B	B	- Construction and demolition waste of existing bridge - Wastes from construction yard
26	Noise and Vibration	B	B	B	B	B	B	B	B	B	- Noise and vibration during construction period - Noise and vibration after construction with increase of future traffic volume
27	Ground Subsidence	no	no	no	no	no	no	no	no	no	
28	Offensive Odor	no	no	no	no	no	no	no	no	no	
29	Bottom sediment	B	B	B	B	B	B	B	B	B	Benthos might be disturbed during construction period.
30	Accidents	B	B	B	B	B	B	B	B	B	- Traffic accidents might occur by over speed vehicles after construction. - Traffic accidents during the construction period might occur due to the detour road.
31	Others	B	B	B	B	B	B	B	B	B	- UXOs - Landmines

Rating:
A: Serious impact is expected.
B: Some impact is expected.
C: Extent of impact is unknown (Examination is needed. Impacts may become clear as study progresses.)
No Mark: No impact is expected. IEE/EIA is not necessary.

The above items are categorized as B, C and no mark in terms of the total program for all of the eight (8) bridges. As a result, the overall program is considered to be category B in accordance with the JICA guidelines. Therefore, the program does not require a full scale environmental impact assessment (EIA).

5.3.3 Social Impacts

Based on the above table, the details of the situation and impacts are described in the following sections.

(1) Involuntary Resettlement

ROW

The ROW area for NR.3, 7, 11 and 33 is stipulated as being 25 m from the centerline. Several properties were confirmed to be located within the ROW area for six (6) of the bridges, excluding Bridge No. 4 and 6.

PRW

The Provisional Road Width (PRW) has been set at 2 m from the edge of the embankment to provide adequate construction space and safety. This 2 m width is necessary for the construction activities such as construction machines and trucks.

Therefore, the properties located within the PRW will need to be removed for the construction works to be undertaken. In total 29 properties were confirmed to be located within the PRW at six (6) bridge sites, excluding Bridge No. 4 and 6.

Compensation

Basically, the affected property owners will be paid compensation. However, if the property, such as a cottage, can be easily moved, compensation will not be paid. As a result, compensation will be required for a total of 14 properties at four (4) bridge sites. These are located at Bridge No. 1, 2, 5 and 8.

PAPs

The number of Project Affected Persons (PAPs) for this program is not clear at the moment because a household survey has not yet been conducted.

Table 5.3.5 Affected Properties

Bridge No.	(a) Affected Property in ROW	(b) Affected Property in PRW	(c) Affected Property to be compensated in PRW
1	25	6	3
2	5	1	1
3	1	1	0
4	0	0	0
5	15	14	6
6	0	0	0
7	2	2	0
8	23	5	4
Total	71	29	14

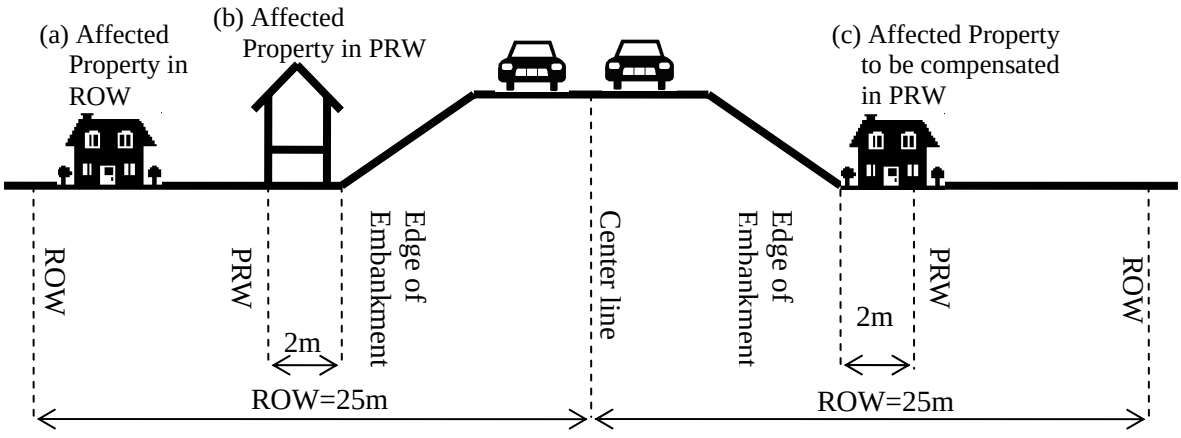


Figure 5.3.1 Affected Property

Involuntary resettlements are one of the most serious problems caused by the project. Even though a large number of resettlements will not occur, the necessary actions relating to the resettlements need to be undertaken in an effective and careful manner.

The necessary actions relating to the resettlements need to be considered and formulated in a Resettlement Action Plan (RAP), which will include the number of PAPs, compensation, a detailed measurement survey (DMS), support for compensation, resettlement and livelihood recovery, grievance procedures, relocation sites if required and monitoring.

(2) Local Economy, Land Use and Local Resources

Some shops/restaurants and some areas of cultivated land will be affected by the project. The necessary compensation should be paid for these properties.

(3) Social Infrastructure and Cultural Heritage

There are pagodas within the areas of Bridge No. 1, 2 and 7. The gates of the pagodas in the areas of Bridge No. 1 and 7 are within the PRW and will be affected by the construction works. The wall of the pagoda in the area of Bridge No. 2 is in the PRW and will be affected as well. However, it will be possible to mitigate the affects by constructing a retaining wall. It will be necessary to discuss the necessary measures with the monks and community people before implementation.

Consultation with monks and village people will be necessary before construction. The construction works required to avoid these gates and the wall could be considerable, such as the construction of a retaining wall.

(4) Water Usage

Water usage of the rivers for daily life, such as laundry and bathing, might be affected by the construction works. The construction method adopted should minimize changes to the water flow and usage. The substructure and foundation works for the bridges should be constructed during the dry season.

(5) Infectious Diseases

The number of cases of infectious diseases, such as HIV/AIDS, might increase in the construction workers during the construction period. Many construction workers will travel to the project sites from outside of the project areas.

Educational training on HIV/AIDS and other infectious diseases should be conducted for the construction workers. For this purpose, the NGOs who are involved in these activities should be considered for conducting the training.

5.3.4 Natural Impacts

(1) Hydrological Situation

The hydrological conditions may be affected during the construction of the substructure and foundation works. The hydrological situation itself will be unchanged after construction as riverbed protection works will be carried out and the new bridges will be longer than the existing temporary bridges. Basically, the substructure and foundation works should be constructed during the dry season, and construction methods which may significantly affect the river flows should be avoided.

(2) Flora, Fauna and Biodiversity

Wildlife, birds, fish and other aquatic animals might be disturbed during the construction of the substructure and foundation works. Basically, the substructure and foundation works should be constructed during the dry season, and treatments for polluted water, to minimize the affects on the river, should be undertaken during the construction period.

(3) Air Pollution

Dust will be caused during the construction period due to the earthworks and detour roads. Periodic sprinkling and covering the detour roads with gravel will be necessary, especially in the areas of Bridge No. 1, 2, 5 and 8, where there are many houses. Air pollution may occur after the construction period due to the increase in the future traffic volumes. This is, however, considered to be an indirect impact as the reconstruction of the existing bridges does not contribute directly to the increase in traffic volumes. The bridge widening may contribute towards smoothing the traffic flows as vehicles will not need to stop and wait for the vehicles traveling from the opposite direction to pass. This smoothing of traffic flows may contribute towards a decrease in emissions.

(4) Water Pollution

Water pollution might occur during the construction period if waste water is discharged to the river directly during the mixing and laying of concrete. The construction waste water should be treated before it is discharged. Therefore monitoring of water quality is necessary, including a baseline survey before construction. The necessary measures will need to be undertaken when the results of the monitoring exceed the standard level.

(5) Waste

There will be several types of waste as a result of the construction works: general construction waste, such as surplus soil; existing pavements and concrete; and waste produced by the construction workers. The MPWT, which maintain the bridges, should collect the superstructure of the existing bridges as they are recyclable. The general construction waste and waste from the construction workers should be disposed of to the designated sites.

(6) Noise and Vibrations

During the construction period noise and vibrations will occur mainly as a result of the machines and earthworks. They may also occur due to the increased traffic volumes after the completion of the construction works. There are many houses around Bridge No.'s 1, 2, 5 and 8. For these areas, special considerations are required. During construction, low-noise construction equipment and low-vibration machines should be used. After the completion of construction, the vibration levels may vary due to the future traffic volumes, however, these will not be directly caused by the project. The noise levels after completion of the project will be reduced from the current level of noise that is caused by the steal deck plates.

Monitoring during the construction period is necessary, including a baseline survey before construction. The necessary mitigation measures should be undertaken when the results of the monitoring exceed the standard level.

(7) Bottom Sediment

A part of bottom sediment will be changed by the construction works due to the riverbed protection works. The ecological system, however, will not be affected (even though benthos might be disturbed during the construction period) because the affected area is only the area of the riverbed protection works and this is only a small area.

(8) Accidents

The number of traffic accidents might increase during and after the construction works. Therefore, during the construction period, traffic safety measures should be undertaken such as using flag men and traffic sign boards. After the completion of the construction works, traffic safety sign boards and directional arrows will be necessary, to avoid traffic accidents occurring due to speeding vehicles and increased traffic volumes.

(9) Other Issues

There may be UXOs and landmines around the construction areas. To avoid accidents occurring due to the UXOs and landmines, these should be cleared in cooperation with the Cambodian Mine Action Centre (CMAC).

5.4 Environmental Management Plan

An Environmental Management Plan (EMP) is required for the monitoring before, during and after the construction works and the necessary measures. The items that must be included in the EMP, which the contractor will need to implement, should be included in the tender documents. A baseline survey will be necessary during the basic design (B/D) stage to allow for comparisons against the situation before construction. The items that need to be monitored include air pollution, water pollution, noise, vibrations, accidents and the resettlement process, which includes the negotiation process and assessing livelihood recovery after the resettlement.

5.5 Necessary Actions to be taken

When the government approves the project, the following actions should be promptly undertaken.

5.5.1 Public Consultation

Public consultation should be conducted with the people around the project sites for the purpose of disclosing the project information so that they can understand both the positive and negative impacts of the project.

Public consultation is required to explain the procedure of the project, the legal framework and grievance mechanisms as most of the people will not know the aspects relating to land acquisition and resettlement.

Public consultation should be conducted several times as necessary, such as before the public awareness survey and the DMS.

5.5.2 Public Awareness Survey

A public awareness survey is necessary for the people around the project sites for the purpose of confirming their basic agreement to the project. If many people oppose the project, the project should be reconsidered. In addition to their basic agreement to the project, their needs and social situations should be clarified through the survey. The survey should be conducted at the same date as the cut-off date.

5.5.3 Cut-off Date

The cut-off date must be declared when the project implementation is decided so as to protect the ROW against illegal squatters aiming to get compensation.

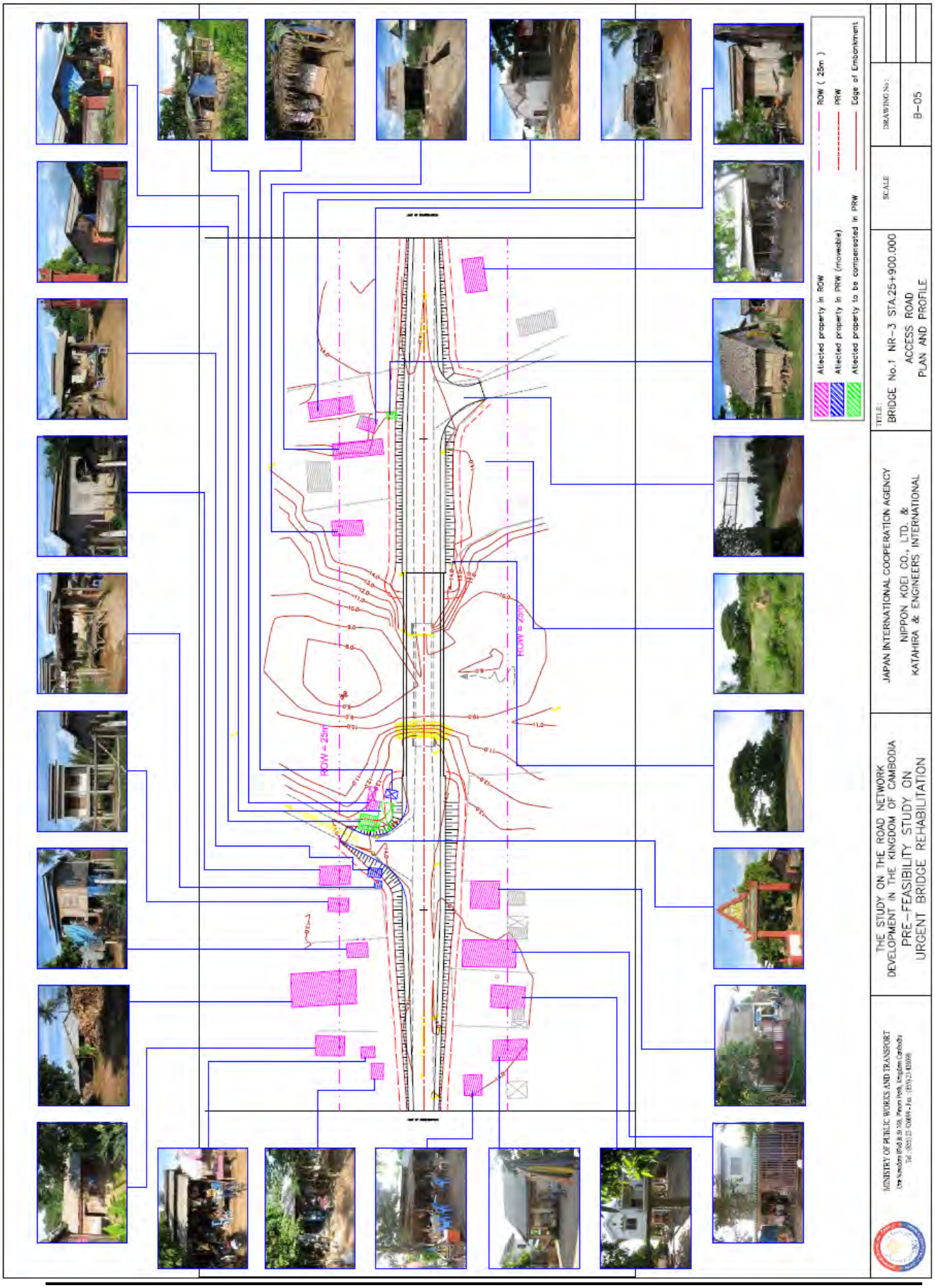
5.5.4 Formulation of the Resettlement Action Plan (RAP)

The formulation of a Resettlement Action Plan (RAP) is crucial after the project implementation date has been decided. The purpose of the RAP is to protect the livelihood of the PAPs and to maintain the same standard of living as before the project. In this sense, the necessary measures should be planned in the RAP and the monitoring plan (for after the resettlement) should be formulated in RAP.

5.5.5 Finalization and Submission of IEIA

The MPWT, as the project owner, has to finalize the IEIA and submit it to MOE for the project approval. The necessary additional surveys, such as the household survey (forming part of the public awareness survey), should be conducted in an effective and prompt manner.

The properties within the ROW for every construction site are shown in the figures starting from the next page.


ROW (25m)
PRW
Edge of Embankment
Affected property in ROW
Affected property in PRW (movable)
Affected property to be compensated in PRW
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ROW = 25m
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ACCESS ROAD
PLAN AND PROFILE
SCALE
DRAWING No.:
B-05
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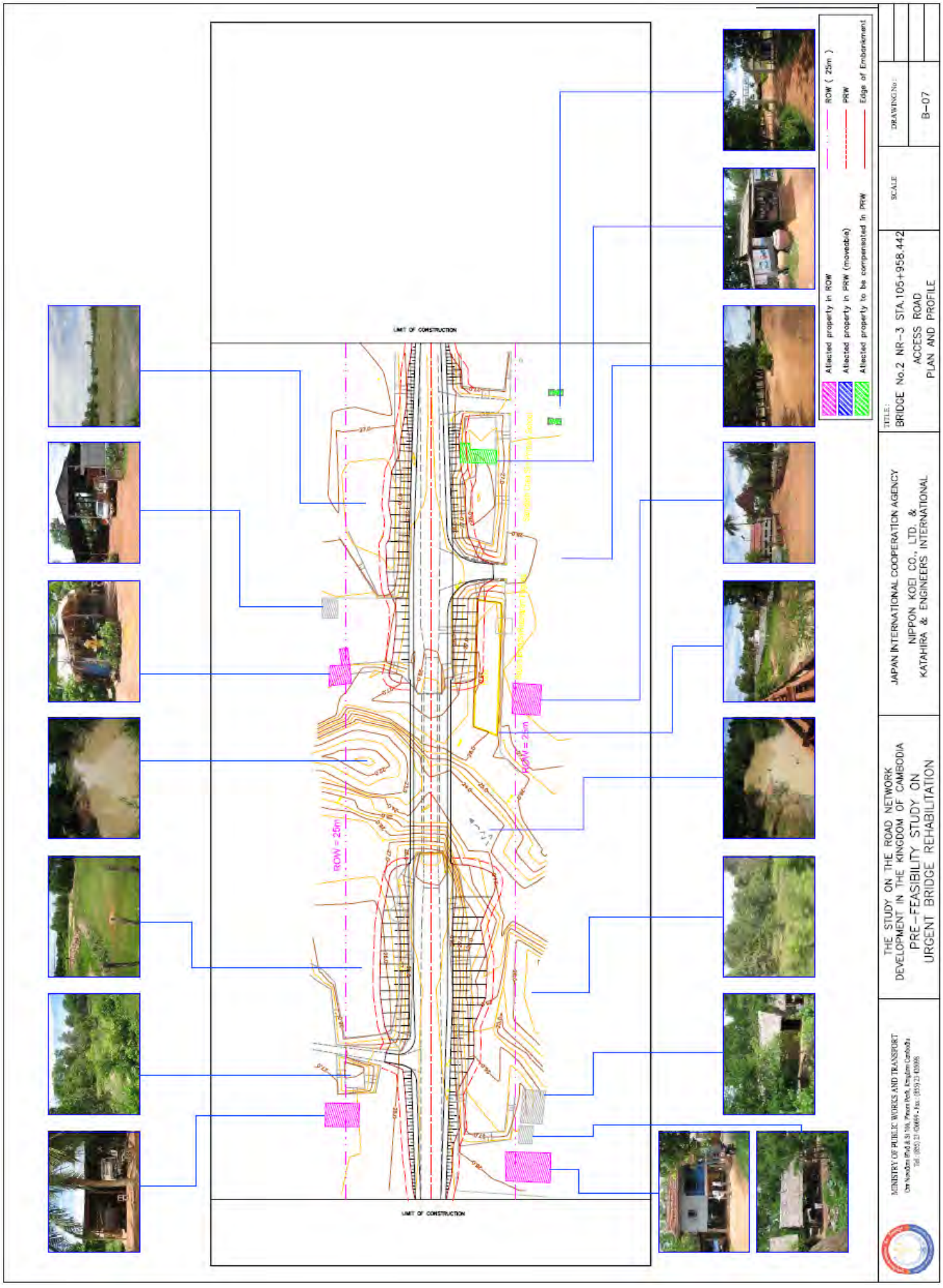
MINISTRY OF PUBLIC WORKS AND TRANSPORT


LIMIT OF CONSTRUCTION
LIMIT OF CONSTRUCTION
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ROW = 25m
ROW (25m)
PRW
Edge of Embankment
Affected property in ROW
Affected property in PRW (moveable)
Affected property to be compensated in PRW
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ACCESS ROAD
PLAN AND PROFILE
SCALE
DRAWING No.
B-07
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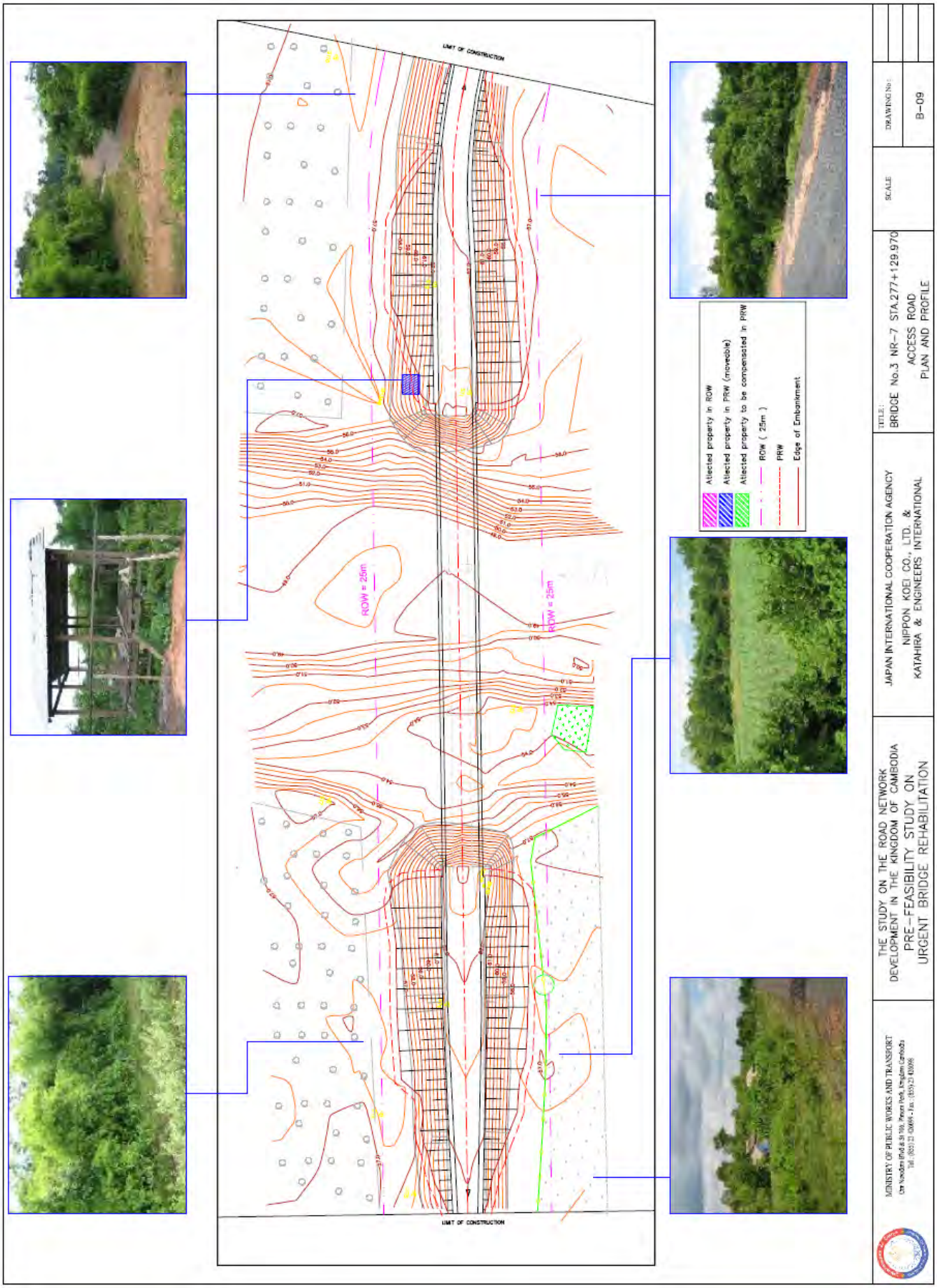
MINISTRY OF PUBLIC WORKS AND TRANSPORT


LIMIT OF CONSTRUCTION
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ROW = 25m
LIMIT OF CONSTRUCTION
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Affected property to be compensated in PRW
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Edge of Embankment
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PLAN AND PROFILE
SCALE
DRAWING No.:
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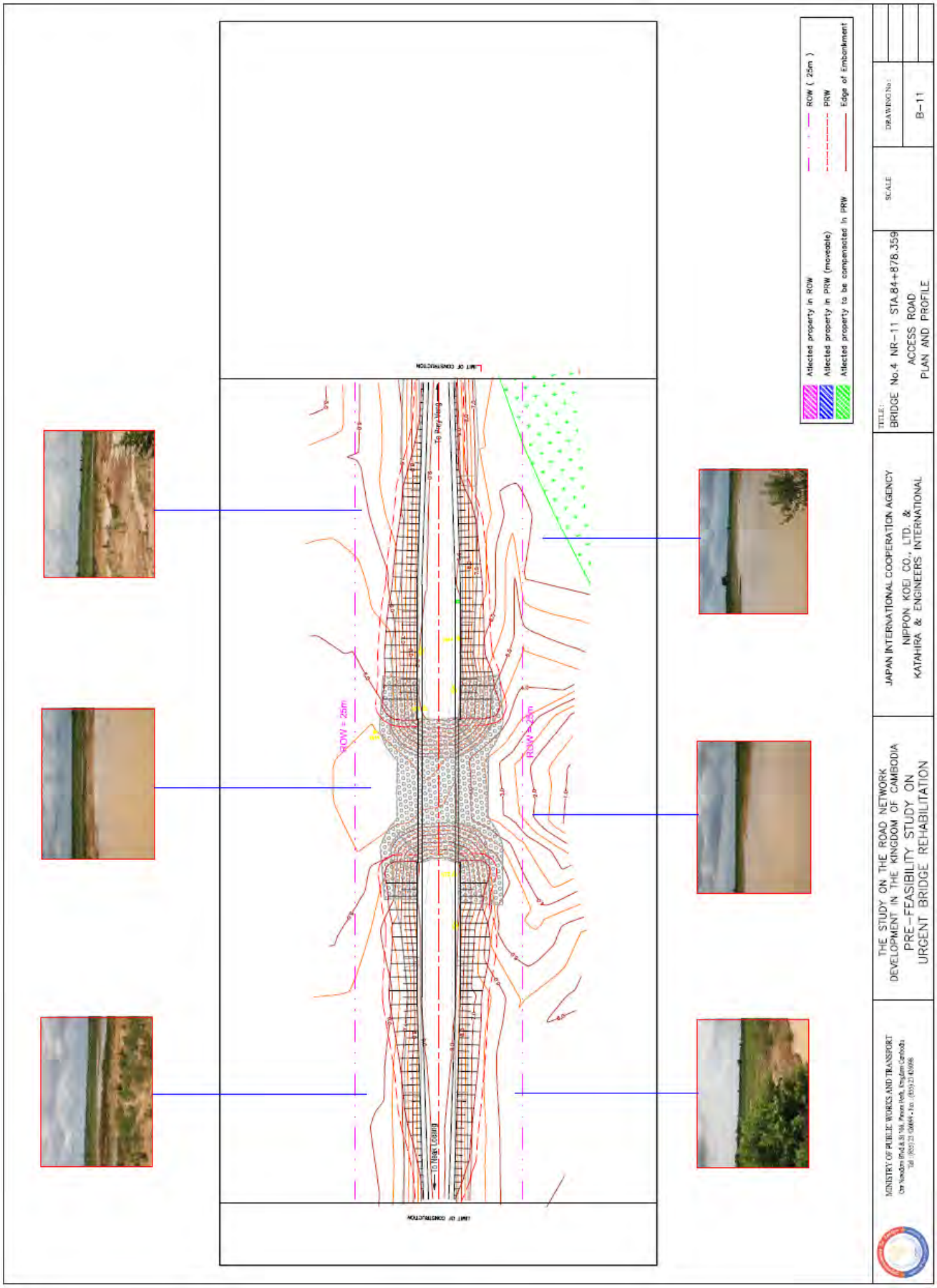
MINISTRY OF PUBLIC WORKS AND TRANSPORT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Affected property to be compensated in PRW
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Edge of Embankment
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To Phnom Penh
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ROW = 25m
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ACCESS ROAD
PLAN AND PROFILE
SCALE
DRAWING No.:
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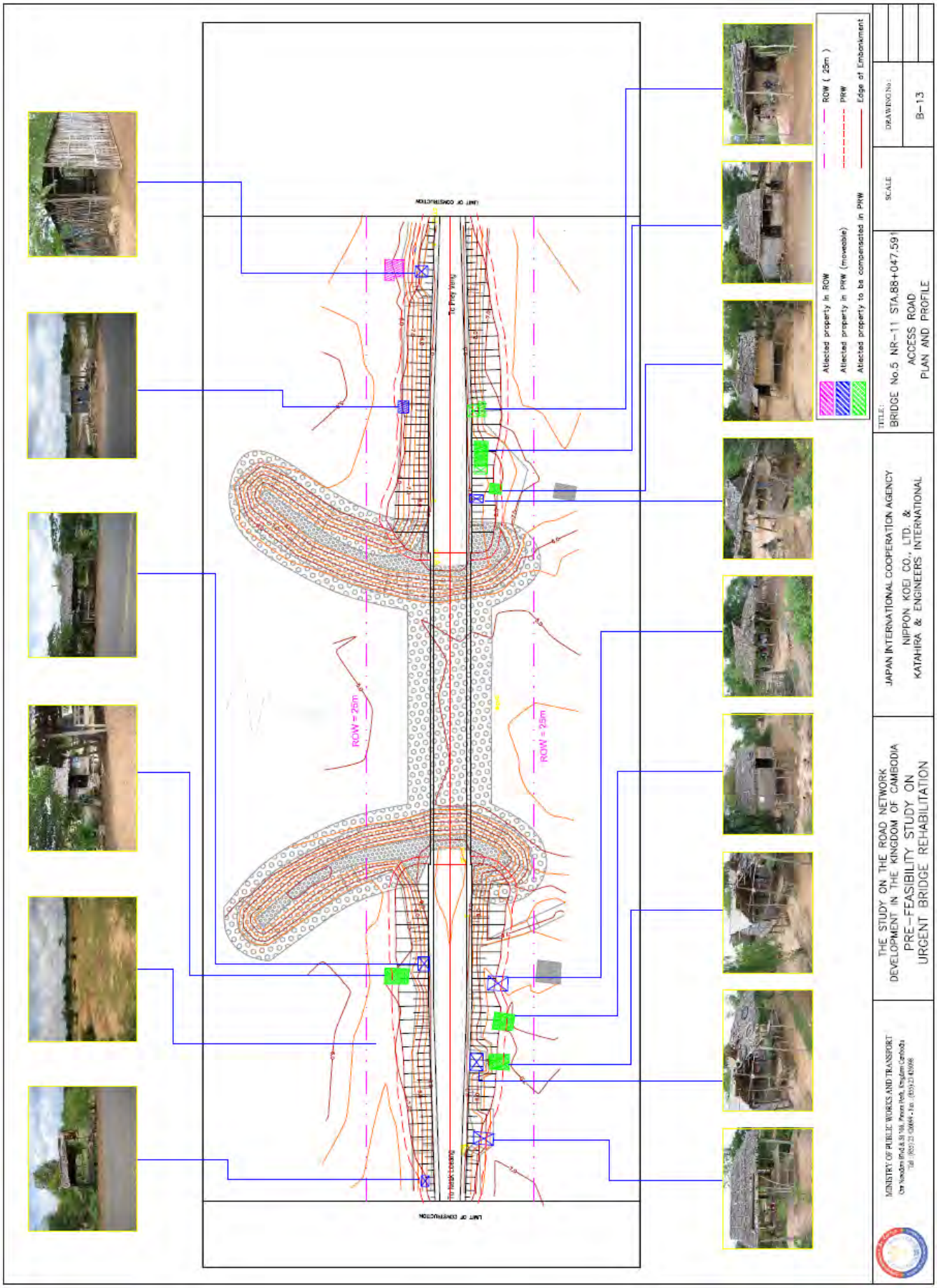
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Attected property to be compensated in PRW
ROW (25m)
PRW
Edge of Embankment
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ACCESS ROAD
PLAN AND PROFILE
SCALE
DRAWING No.
B-13
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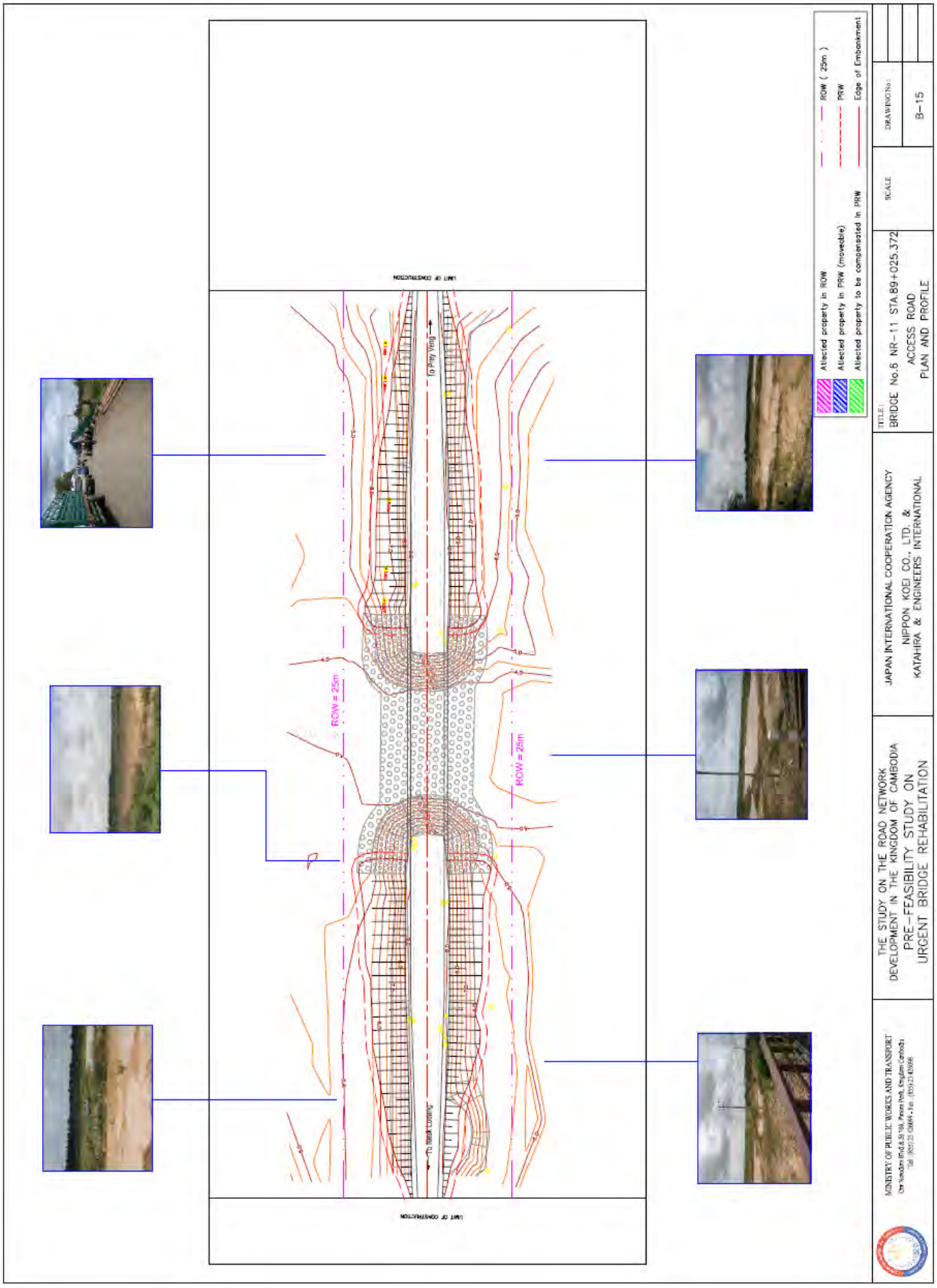
ROW = 25m
ROW = 25m
To Prey Veng
To Neak Loueng
Alleged property in ROW
Alleged property in PRW (moveable)
Alleged property to be compensated in PRW
ROW (25m)
PRW
Edge of Embankment
TITLE:
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ACCESS ROAD
PLAN AND PROFILE
SCALE
DRAWING No.:
B-15
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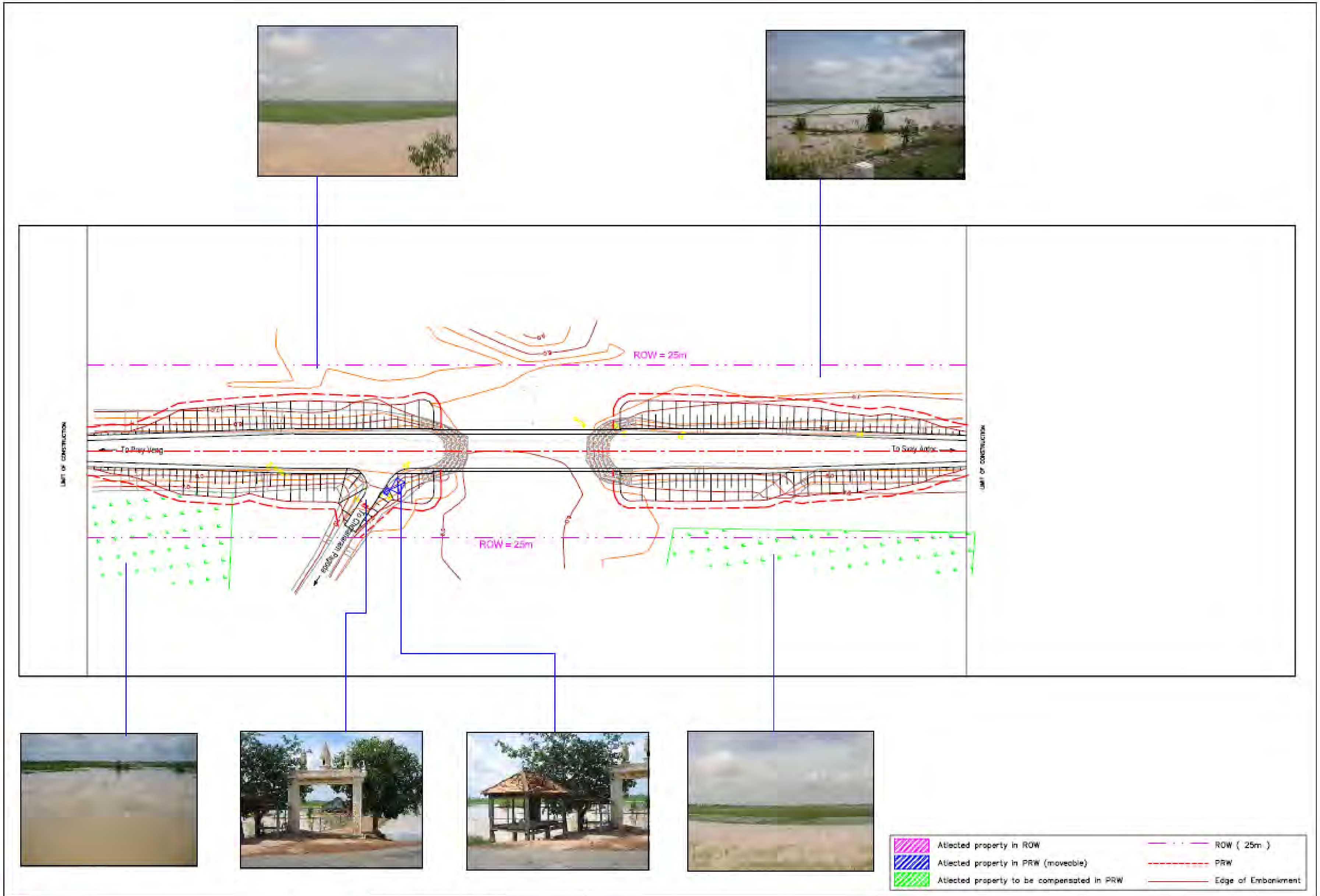
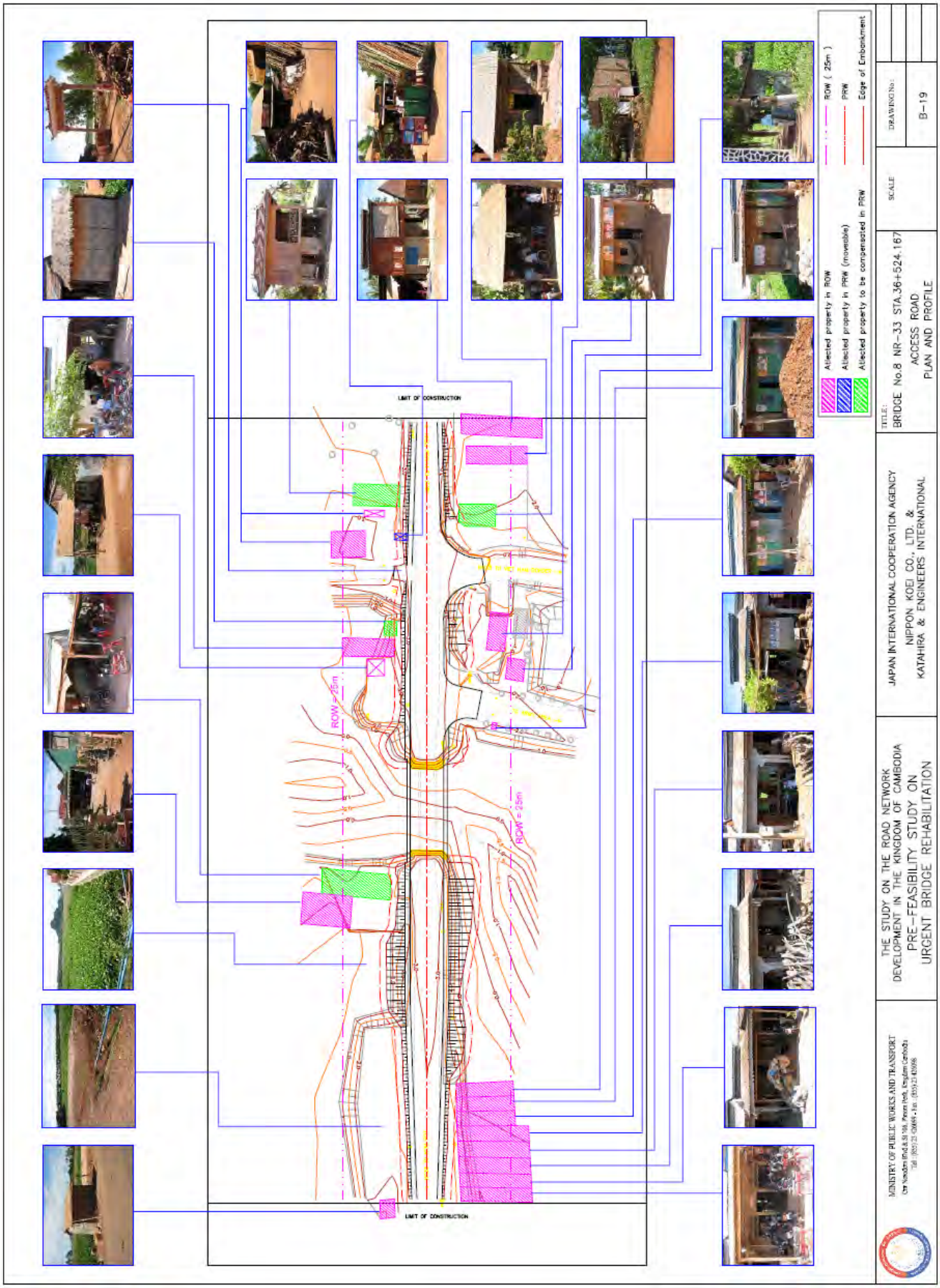


MINISTRY OF PUBLIC WORKS AND TRANSPORT	THE STUDY ON THE ROAD NETWORK DEVELOPMENT IN THE KINGDOM OF CAMBODIA PRE-FEASIBILITY STUDY ON URGENT BRIDGE REHABILITATION	JAPAN INTERNATIONAL COOPERATION AGENCY NIPPON KOEI CO., LTD. & KATAHIRA & ENGINEERS INTERNATIONAL	TITLE: BRIDGE No.7 NR-11 STA.103+448.058 ACCESS ROAD PLAN AND PROFILE	SCALE	DRAWING No: B-17


ROW (25m)
PRW
Edge of Embankment
Affected property in ROW
Affected property in PRW (moveable)
Affected property to be compensated in PRW
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LIMIT OF CONSTRUCTION
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ACCESS ROAD
PLAN AND PROFILE
SCALE
DRAWING No.:
B-19
JAPAN INTERNATIONAL COOPERATION AGENCY
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CHAPTER B-6 PROJECT EVALUATION

6.1 General

The evaluation of the proposed Urgent Bridge Rehabilitation Project considers traffic, economic, financial and regional development factors.

A traffic analysis will provide a useful indicator for road and bridge administrators to predict the level of service for each bridge, thereby helping them to make a rational decision on the necessity for each bridge rehabilitation from a traffic viewpoint.

An economic evaluation provides useful criteria for making a rational decision for the allocation of the limited budget from national economy to a certain project. For the economic evaluation, the various benefits said to arise from the project and costs for the operation and maintenance as well as implementation of the project are calculated, in economic terms, on an annual basis throughout the project life.

A financial analysis will predict the financial resources required for the investment, thereby helping the decision making on the investment of funds from the government's financial budget.

Other effects of the bridge rehabilitation project, which can be pointed out are: a) to make the road suitable for traffic throughout the year, b) improved bridge safety and c) promotion of regional development.

6.2 Traffic Analysis

The Master Plan Study included a forecast of future traffic demand in the years 2010, 2015 and 2020 in the form of an OD matrix. In this section, the traffic demand on the eight (8) urgent bridges is forecasted using a traffic assignment method on the road network integrated with these bridges. The forecast of traffic volume on the road "with" the project is summarized in **Table 6.2.1**.

Table 6.2.1 Assigned Traffic Volume on Urgent Bridges

Vehicle/Day

Bridge No.	Road No.	Year	MC	LV	HV	Vehicle Total	PCU
Bridge 1	NR.3	2005	4,832	2,194	406	7,432	5,169
		2010	5,404	2,956	638	8,998	6,960
		2015	7,916	4,512	1,099	13,527	10,916
		2020	14,012	8,010	1,970	23,992	19,426
Bridge 2	NR.3	2005	3,948	768	381	5,097	3,090
		2010	4,424	1,136	554	6,114	4,188
		2015	5,280	1,486	708	7,474	5,302
		2020	6,932	2,266	1,278	10,476	8,400
Bridge 3	NR.7	2005	4,156	507	142	4,805	2,099
		2010	4,772	715	180	5,667	2,627
		2015	5,232	781	211	6,224	2,917
		2020	5,648	994	239	6,881	3,372
Bridge 4	NR.11	2005	2,144	684	232	3,060	4,233
		2010	4,012	1,506	504	6,022	6,900

Table 6.2.1 Assigned Traffic Volume on Urgent Bridges

Vehicle/Day

Bridge No.	Road No.	Year	MC	LV	HV	Vehicle Total	PCU
Bridge 4	NR.11	2015	10,760	4,008	1,494	16,262	10,848
		2020	14,444	6,154	2,007	22,605	17,325
Bridge 5	NR.11	2005	2,144	684	232	3,060	2,087
		2010	4,012	1,506	504	6,022	4,398
		2015	10,760	4,008	1,494	16,262	12,182
		2020	14,444	6,154	2,007	22,605	17,325
Bridge 6	NR.11	2005	2,144	684	232	3,060	2,087
		2010	4,012	1,506	504	6,022	4,398
		2015	10,760	4,008	1,494	16,262	12,182
		2020	14,444	6,154	2,007	22,605	17,325
Bridge 7	NR.11	2005	1,228	653	214	2,095	1,765
		2010	2,984	1,463	485	4,932	4,030
		2015	5,468	3,950	1,468	10,886	11,709
		2020	8,848	6,055	1,973	16,876	16,700
Bridge 8	NR.33	2005	2,080	118	15	2,213	713
		2010	3,520	297	26	3,843	1,329
		2015	6,508	378	44	6,930	2,232
		2020	10,968	626	73	11,667	3,744

Based on the estimated traffic volume in terms of PCU the traffic volume/capacity ratio (VCR) and level of services (LOS) are calculated and shown in **Tables 6.2.2**. In this table, the capacity of a one (1) lane bridge section is assumed be 10,000 PCU/day. The LOS and VCR in the Highway Capacity Manual (HCM) are defined as follows:

- LOS A: Free flow traffic, VCR less than 0.15
- LOS B: Free flow traffic, VCR 0.16 -0.27
- LOS C: Moderate traffic, VCR 0.28- 0.43
- LOS D Moderate/heavy traffic, VCR 0.44- 0.64
- LOS E: Heavy traffic, VCR 0.65-1.00
- LOS F: Saturation volume, stop and go, VCR over 1.00

Table 6.2.2 Results of VCR on Urgent Bridges

Vehicle/Day

Bridge No.	Road No.	Year	Traffic Volume	VCR	LOS
Bridge 1	NR.3	2005	5,169	0.517	D
		2010	6,960	0.696	E
		2015	10,916	1.092	F
		2020	19,426	1.943	F
Bridge 2	NR.3	2005	3,090	0.309	C
		2010	4,188	0.419	C
		2015	5,302	0.530	D
		2020	8,400	0.840	E
Bridge 3	NR.7	2005	2,099	0.210	B
		2010	2,627	0.263	B
		2015	2,917	0.292	C
		2020	3,372	0.337	C

Table 6.2.2 Results of VCR on Urgent Bridges

Vehicle/Day

Bridge No.	Road No.	Year	Traffic Volume	VCR	LOS
Bridge 4	NR.11	2005	4,233	0.423	D
		2010	6,900	0.690	E
		2015	10,848	1.085	F
		2020	17,325	1.733	F
Bridge 5	NR.11	2005	2,087	0.209	D
		2010	4,398	0.440	E
		2015	12,182	1.218	F
		2020	17,325	1.733	F
Bridge 6	NR.11	2005	2,087	0.209	D
		2010	4,398	0.440	E
		2015	12,182	1.218	F
		2020	17,325	1.733	F
Bridge 7	NR.11	2005	1,765	0.177	D
		2010	4,030	0.403	E
		2015	11,709	1.171	F
		2020	16,700	1.670	F
Bridge 8	NR.33	2005	713	0.071	A
		2010	1,329	0.133	A
		2015	2,232	0.223	B
		2020	3,744	0.374	C

The results of the analysis on LOS indicated that:

a) Traffic demand on Bridge No.1, 4, 5, 6 and 7 is expected to exceed their capacity between 2010 and 2015. It thus is necessary to widen these bridges from one-lane bridges to two-lane bridges in order to meet the traffic demand.

b) Traffic demand on Bridge No.2, 3 and 8 will not exceed their capacity. However, taking into account of the desirable LOS and traffic safety, it is necessary to widen these bridges into two lane bridges.

6.3 Economic Evaluation

6.3.1 Presumptions of Economic Evaluation

(1) Evaluation Period

The evaluation period is assumed to be 25 years from 2011 to 2035 taking into account the service life of the bridge rehabilitation project.

(2) Implementation Schedule

The implementation schedule is assumed as follows:

- 2007 Detailed design
- 2007 Land acquisition
- 2008 - 2010 Construction
- 2011 Open to the public

(3) "With" and "Without" the Project

Economic benefits are calculated as the differences between the "With the Project" and "Without the Project" scenarios. For the calculation of economic benefits, the situation of "Without the Project" is defined as "Do Minimum or Do Nothing" on the existing eight (8) bridges, while "With the Project" is defined as the proposed implementation of the bridge rehabilitation project.

(4) Economic Benefits

Economic benefits in the economic analysis are assumed to be the following three (3): a) Saving in vehicle operating cost (SVOC), b) Saving in travel time cost (STTC) and c) Saving in detoured VOC and TTC caused by bridge collapse (SDC). The economic benefit can be calculated by following formula:

$$AB = ((SVOC^{Dry} + STTC^{Dry}) + (SVOC^{Rainy} + STTC^{Rainy})) + (SVOC^{Detour} + STTC^{Detour})$$

Where: AB: Annual benefits
$SVOC^{Dry}$: Saving in vehicle operating cost during dry season
$STTC^{Dry}$: Saving in travel time cost during dry season
$SVOC^{Rainy}$: Saving in vehicle operating cost during rainy season
$STTC^{Rainy}$: Saving in travel time cost during rainy season
$SVOC^{Detour}$: Saving in vehicle operating cost during bridge collapse period
$STTC^{Detour}$: Saving in travel time cost during bridge collapse period

These SVOC and STTC benefits are computed from total vehicle kilometers and hour time units. Yearly benefits during the evaluation period are calculated by interpolation and extrapolation for the projected years; 2010, 2015 and 2020.

(5) Economic Costs

For the economic analysis, costs in terms of financial prices are converted to be in terms of economic prices.

In this economic analysis, all the costs are classified into items of a) trade goods, b) non-trade goods and c) transfer items. It is assumed that trade goods are equivalent to the foreign currency portion, and the aggregate of non-trade goods is the local currency portion. Transfer items are the portions for taxes.

The economic prices for all non-trade goods are obtained by applying the standard conversion factor (SCF).

The SCF is estimated to be 0.893 according to the statistical data regarding foreign trade and government revenues in Cambodia.

(6) Price Indices and Project Life

For the economic and financial evaluation, the following assumptions are held.

- Pricing date: As of June 2006
- Foreign Exchange Rate 1US Dollar = 4,000 Riel

(7) Economic Indicators

The economic evaluation method principally employed is the benefit cost analysis. The economic indicators used in this study are as follows:

- Net Present Value (NPV)
- Benefit Cost Ratio, (BCR), and
- Economic Internal Rate of Return (EIRR)

6.3.2 Estimation of Benefit

(1) Basic Vehicle Operating Cost

The basic vehicle operating cost (BVOC) as shown in **Table 6.3.1** was estimated in the master plan stage. In the pre-feasibility study, the same BVOC is used for the benefit calculation.

Table 6.3.1 Basic Vehicle Operating Cost (Excluding Tax)

Type	Item	Motor Cycle	Car	Pick-up	Mini Bus	Large Bus	Light Truck	Medium Truck	Heavy Truck
Distance related VOC	Fuel cost	145.3	2,543.5	3,052.1	3,270.2	11,973.8	3,877.2	14,710.6	14,710.6
	Lubricant cost	8.0	19.9	29.9	39.8	348.3	123.8	359.4	359.4
	Tire cost	6.9	63.1	75.7	97.8	1006.1	174.7	706.4	2060.2
	Maintenance cost	6.7	136.4	131.5	296.6	623.5	199.6	306.1	579.6
	Depreciation cost	0.4	8.5	9.8	18.3	38.5	10.3	16.3	30.8
	S-total	167.3	2,771.3	3,299.0	3,722.7	13,990.2	4,385.6	16,098.8	17,740.7
	Overhead cost	0.0	0.0	329.9	372.3	1,399.0	438.6	1,609.9	1,774.1
	Total	167.3	2,771.3	3,628.9	4,095.0	15,389.2	4,824.2	17,708.7	19,514.7
Time related VOC	Crew cost	75.0	275.0	412.5	1,344.0	2,170.0	1,488.0	2,542.0	2,542.0
	Maintenance cost	2.3	5.1	5.1	18.1	21.9	18.1	21.9	25.6
	Insurance cost	20.0	493.1	475.4	296.6	623.5	199.6	368.8	698.4
	Depreciation cost	0.2	4.6	5.3	9.9	20.7	5.5	8.8	16.6
	S-total	97.6	777.7	898.2	1,668.6	2,836.1	1,711.2	2,941.4	3,282.5
	Overhead cost	0.0	0.0	89.8	166.9	283.6	171.1	294.1	328.3
	Total	97.6	777.7	988.0	1,835.4	3,119.8	1,882.3	3,235.6	3,610.8
Total		264.9	3,549.0	4,616.9	5,930.4	18,509.0	6,706.5	20,944.3	23,125.5
VOC /1000 km		26.5	142.0	153.9	197.7	264.4	167.7	243.5	268.9

(2) "Without" and "With" Rehabilitation

1) "Without" and "With" Rehabilitation Cases

In order to estimate the benefits, the situations for "Without" and "With" rehabilitation are assumed to be as shown in **Table 6.3.2**.

Table 6.3.2 Assumptions of "Without" and "With" Rehabilitation Cases

	W/O Project (Do minimum case)	W/ Project
Bridges 1, 4, 5 and 7	・ These bridges will collapse every 10 years due to flooding or over-loaded trucks ・ When these bridges collapsed, traffic ought to detour for 3 months to reconstruct temporary bridges. ・ When VCR on these bridges will be over 1.00, additional one lane temporary bridge will be constructed.	・ Proposed bridge rehabilitation will be implemented.
Bridges 2, 3 & 8	・ These bridges will collapse every 10 years due to flooding or over-loaded trucks ・ When these bridges collapsed, traffic ought to detour for 3 months to reconstruct temporary bridges.	・ Proposed bridge rehabilitation will be implemented.

2) VOC and TTC "Without" and "With" Rehabilitation Cases

Prior to estimating the unit VOC, the travel speeds in the cases of "Without" and "With" Rehabilitation are assumed, on the basis of the field investigation, to be as shown **Table 6.3.3**.

Table 6.3.3 Travel Speed in cases of W/O Improvement and W/ Rehabilitation

	LOS			
	A,B,C	D	E	F
W/O Improvement	20 km/h	15 km/h	10 km/h	5 km/h
W/ Improvement	60 km/h			

Based on the relationship between travel speed and VOC estimated and described in Appendix 13.2.9, the unit VOC in the cases of with and without improvement is estimated in **Table 6.3.4.**

Table 6.3.4 VOC in cases of W/O Improvement and W/ Improvement

Unit: US $

	LOS			
	A,B,C	D	E	F
W/O Improvement	0.192	0.205	0.217	0.246
W/ Improvement	0.151			

Table 6.3.5 Forecast of Time Value per vehicle by Vehicle Type

Unit: US$/hour

	2005	2010	2015	2020
Motor Cycle	0.321	0.388	0.491	0.648
LV	2.394	2.897	3.663	4.836
Bus	3.166	3.831	4.844	6.395

(3) Estimation of Benefits

The savings in vehicle operating cost and travel time cost are estimated and shown in **Table 6.3.6**.

Table 6.3.6 Estimation of Benefits

Unit: US $ '000/Year

		SVOC	STTC	S-Total	SDC	Total
Bridge 1	2010	11.0	46.6	57.7	20.7	78.4
	2015	26.1	156.7	182.8	39.2	222.0
	2020	46.4	563.3	609.7	87.9	697.7
Bridge 2	2010	4.2	12.1	16.4	8.7	25.1
	2015	9.1	58.7	67.8	13.8	81.6
	2020	21.7	188.0	209.6	28.6	238.3
Bridge 3	2010	5.9	36.6	42.5	36.2	78.7
	2015	6.6	61.5	68.1	50.4	118.5
	2020	7.6	137.3	144.9	76.4	221.3
Bridge 4	2010	7.2	30.6	37.8	12.1	49.9
	2015	30.2	181.5	211.7	41.9	253.6
	2020	43.0	521.5	564.4	77.7	642.2
Bridge 5	2010	9.4	62.2	71.5	12.1	83.6
	2015	39.1	209.4	248.5	41.9	290.4
	2020	55.7	675.5	731.1	77.7	808.9
Bridge 6	2010	7.4	31.2	38.6	12.1	50.7
	2015	30.9	185.3	216.2	41.9	258.1
	2020	43.9	532.5	576.3	77.7	654.1
Bridge 7	2010	4.1	29.2	33.3	11.1	44.3
	2015	30.2	181.6	211.8	40.3	252.1
	2020	43.1	523.1	566.3	74.9	641.2
Bridge 8	2010	2.1	6.0	8.1	4.6	12.6
	2015	3.5	15.4	18.9	9.5	28.4
	2020	5.9	52.1	58.0	20.9	78.9

6.3.3 Estimation of Economic Costs

(1) Economic Costs

The project cost, which has already been calculated in the previous section, is expressed as the financial cost. It is therefore necessary to convert the financial cost to economic costs. In this study the economic cost was estimated by deducting from financial cost the government taxes and SCF labor as shown in **Table 6.3.7**.

Table 6.3.7 Economic Cost Estimate

(US $)

Bridge No.	Road No.	Financial Cost	Economic Cost
Bridge 1	NR.3	1,331,927	1,203,906
Bridge 2	NR.3	1,165,957	1,052,348
Bridge 3	NR.7	2,979,901	2,696,597
Bridge 4	NR.11	1,005,009	907,898
Bridge 5	NR.11	2,037,349	1,842,893
Bridge 6	NR.11	1,507,805	1,363,282
Bridge 7	NR.11	1,240,821	1,121,474
Bridge 8	NR.33	662,808	598,048
Total		11,931,577	10,786,446

(2) Maintenance Cost

The maintenance cost, which consists of routine maintenance and periodic maintenance, was estimated in Section 4.3.2. The maintenance cost is converted to the economic cost as follows:

Table 6.3.8 Annual Maintenance Cost Estimate

(US $)

Bridge No.	Road No.	Financial Cost	Economic Cost
Bridge 1	NR.3	9,100	8,130
Bridge 2	NR.3	8,500	7,590
Bridge 3	NR.7	16.100	14,380
Bridge 4	NR.11	7,500	6,700
Bridge 5	NR.11	11,900	10,590
Bridge 6	NR.11	9,900	8,840
Bridge 7	NR.11	8,500	7,590
Bridge 8	NR.33	7,800	6,970
Total		77,900	69,580

6.3.4 Economic Evaluation

The economic analysis of the Project is based on the above-mentioned estimates of costs and benefits. **Table 6.3.9** shows the cost - benefit analysis during the project life period of 25 years of urgent rehabilitation of 8 bridges.

Table 6.3.9 Economic Indications of Cost Benefit Analysis

Bridge No.	Road No.	NPV (US $'000)	BCR	EIRR
Bridge 1	NR.3	2,505.9	3.40	22.54
Bridge 2	NR.3	313.9	1.34	14.19
Bridge 3	NR.7	-1,005.9	0.57	7.60
Bridge 4	NR.11	2,769.2	4.50	24.34
Bridge 5	NR.11	2,576.9	2.62	24.34
Bridge 6	NR.11	2,386.1	3.02	20.46
Bridge 7	NR.11	2,641.7	3.72	22.07
Bridge 8	NR.33	-156.8	0.70	9.35

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

6.4 Financial Appraisal

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 6.4.1** of the Master Plan Study was recommended. This project is principally in accordance with the recommended implementation program and there are no foreseen problems for the implementation of the Urgent Bridge Rehabilitation project from a financial viewpoint.

Table .6.4.1 Financial Capability of the Project

US $ 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
(2) Maintenance	113
(3) Urgent Bridge Rehabilitation Program	(20)
Total	516
C. Amount of Balance	47

6.5 Other Effects

(1) Securing Traffic Throughout the Year

As mentioned in the engineering investigations of the urgent bridges, these bridges have suffered damage and collapsed due to heavy flooding and over-loaded trucks. When one of the bridges is damaged, it has to be closed to vehicles for several months forcing, if possible, detours to other routes. This badly affects industry and the activity of people along the route served by the bridge.

The bridge rehabilitation project can prevent damage such as the collapse of these bridges, so that traffic will be able to use these bridges throughout the year. As a result, it will encourage more agricultural, industrial and commercial activities and the activity of people along the roads with these bridges

(2) Traffic Safety Provision on Bridges,

Presently, the urgent bridges to be rehabilitated are one-lane temporary bridges allowing only one-way traffic. As a result, traffic accidents sometimes occur at these sections of bridges.

The bridge rehabilitation project can reduce traffic accidents and improve traffic safety on these bridges.

(3) Promotion of Regional Development

The project will provide an efficient transport facility around the area influenced by of the "urgent" bridges. Since economic activities within area influenced by the urgent bridges will be stimulated, the project will contribute to the economic growth around the urgent bridge sites and the regional development.

Table 6.5.1 Existing and Future Population in Direct Influence Area, 2005-2020

Bridge No.	Road No.	2005	2010	2015	2020
Bridge 1	NR.3	338,163	384,500	434,159	486,331
Bridge 2	NR.3	145,515	158,902	172,727	185,854
Bridge 3	NR.7	42,972	48,816	54,820	60,795
Bridge 4	NR.11	225,009	241,660	256,159	269,223
Bridge 5	NR.11				
Bridge 6	NR.11				
Bridge 7	NR.11				
Bridge 8	NR.33	89,965	98,242	106,789	114,905

CHAPTER B-7 CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

This Pre-Feasibility Study proved that this program is technically feasible but Bridge No.3 on NR.7 and Bridge No.8 on NR.33 have low economic viability with an economic internal rate of return less than 12% as shown in Chapter FS-B-6.

Although the rehabilitation of the two (2) bridges, Bridge No.3 and No.8 do not yield high economic internal rate of return, these bridges should also be rehabilitated in terms of safety and road importance. These bridges are bailey bridges with very low load carrying capacity. On the other hand, NR.7 (Bridge No.3) is part of the Asian Highway AH11, NR.33 (Bridge No.8) is part of the Asian Highway AH123, and NR.3 (Bridge No.2) is a major trunk highway in the southwest block of Cambodia. This program should be implemented as early as possible due to its importance as indicated in the implementation schedule proposed in Chapter FS-B-4.

7.2 Recommendations

It is recommended that the Royal Government of Cambodia takes the following action to ensure that this project is implemented successfully:

(1) Allocation of Budget for Project Preparation

The program cost do not include the cost of land acquisition, resettlement of residents, relocation of houses and public properties at construction areas including camp yards, stock yards, borrow pits and spoil areas. For the smooth implementation of this project the Royal Government of Cambodia needs to allocate a budget for the above preparatory works.

(2) Operation of the Maintenance

The project bridges proposed are to be constructed in concrete with asphalt concrete pavement. These structures deteriorate day by day if maintenance is neglected so maintenance shall be effectively conducted according to Chapter FS-B-4 to preserve the life span of the bridge and traffic safety.

(3) Recycle of the Existing Temporary Superstructure

The existing temporary superstructures (Bailey bridge structures) that are in good condition can be recycled for bridges in provincial roads or rural roads after this project.

(4) Education for Traffic Safety, Rules and User Behavior

After the completion of the project, it is predictable that the number of traffic and car running speed will be increased. It is therefore recommended that steps be taken to organize traffic safety education, improve the traffic rules and user behavior, and that there is strict observance of traffic regulations to decrease traffic accidents.