Ⅲ. MASTER PLAN

CHAPTER 5
MAINTENANCE & IMPROVEMENT PLAN FOR ROAD & BRIDGE

CHAPTER 5 MAINTENANCE AND IMPROVEMENT PLAN FOR ROAD AND BRIDGE

5.1 Introduction

The purpose of this chapter is to establish the maintenance and improvement plan for roads links and bridges to be improved in the southern region. This is to assist the economist of the Study in the Master Plan i.e., prioritization and recommendation of road improvement projects for the Study Area.

5.2 Maintenance Activities for Roads and Bridges

5.2.1 Road Maintenance Plan

The inspection for routine maintenance of all national roads should be carried out according to the intervention level indicated in Table 5.2.1.

Table 5.2.1 Frequency of Inspection for Routine Maintenance

Items	Frequency		Remarks
	Minimum	Designable	
Carriageway Shoulder	Every 2 months	Every week	
Slope Embankment	Every 4 months	Every month	Include after rainy season
Drainage	Every 4 months	Every month	Include before rainy season
Roadside Structures	Every 4 months	Every month	
Road Furniture	Every 4 months	Every week	

As routine maintenance, the cleaning or repair works should be executed according to the evaluation results on the basis of found defects by the inspection.

The road maintenance for gravel and earth surfaces should be executed in accordance with the intervention level indicated in Table 5.2.2.

Table 5.2.2 Maintenance Intervention Level for Gravel/Earth Roads

Road Type	Routine Maintenance	Periodic Maintenance
Gravel Roads	Grading : 2 times per year (including after rainy season) Other structures : when necessary	Re-gravelling: 5 years interval Other structures : when necessary
Earth Roads	Grading : 2 times per year (including after rainy season) Other structures : when necessary	None

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On the other hand, routine maintenance for surface treatment with asphalt concrete or DBST as improved road could be executed based on the evaluation results on the basis of found defects during the inspection.

The periodic maintenance for paved roads should be executed at least one (1) time within ten (10) years.

5.2.2 Bridge Maintenance Plan

Maintenance activities and intervention level can be referred to Tables 5.2.3 and 5.2.4.

Table 5.2.3 Routine Maintenance Requirements for Bridges

Bridge Type	Work Activities	Intervention level
Timber	-Cleaning of surface -Minor repair of slabs, piers and members -Removal of debris built-up against pillars	Every year After rainy season
Bailey (Wooden slab)	-Cleaning of surface -Minor repair of wooden slabs and structural steel members -Removal of debris built-up against piers -Repair to scour damage around substructures	Every year
Bailey (Steel slab)	-Cleaning of surface -Minor repair of wooden slabs and structural steel members -Removal of debris built-up against piers -Repair to scour damage around substructures and protection works - Painting of minor peeling	Every year
Concrete-slab	-Cleaning of surface and drainage facility -Minor repair of accessories (railing etc.) and surface -Removal of debris built-up against piers -Repair to scour damage around substructures and protection works	Every year

Steel-I Girder	-Cleaning of accessories and surfaces -Minor repair of accessories (railing etc.) and surface -Removal of debris built-up against piers -Repair to scour damage around substructures and protection works	Every year

Table 5.2.4 Periodic Maintenance Requirements for Bridges

Bridge Type	Work Items	Interval
Timber	Reconstruction of the whole structure	3-5 years
Bailey (Wooden slab)	Replacement of wooden slab Replacement of some structural panel Repair of protection work	3-5 years when necessary ditto
Bailey (Steel slab)	Replacement of steel slab Replacement of some structural panel Repair of protection work	10 years when necessary ditto
Concrete-slab	Resurfacing Repair of sever cracks Repair of protection work	5 years when necessary ditto
Steel-I Girder	Resurfacing Repainting of girders Replacement of expansion joints Repair of protection work	5 years 10 years 10 years when necessary

5.2.3 Maintenance Program by Each Candidate Road in the Region

The maintenance program by each candidate road is established based on the above mentioned maintenance plan and existing conditions which have been examined by the road inventory survey. Those maintenance works will be undertaken with the contracting-out system using a private contractor, which is a current MCTPC policy. The basic maintenance program for first 5 years for each candidate road is recommended in Table 5.2.5. This plan can be repeated at 5 years intervals.

Table 5.2.5 Basic Maintenance Program

Route	Length	Year				
		2003	2004	2005	2006	2007
1G	65.0	◎	○	○	○	○
1H	22.5	○	○	◎	○	○
1J	16.0	○	◎	○	○	○
14A(i)	54.0	○	○	◎	○	○
14A(ii)	51.5	◎	○	○	○	○
14A(iii)	32.0	○	◎	○	○	○
14A1	32.0	○	○	◎	○	○

14B	149.0	◎	○	○	○	○
14C	42.0	○	◎	○	○	○
14C1	23.0	○	○	◎	○	○
14C2	6.0	○	◎	○	○	○
15	73.0	○	○	○	◎	○
16A	71.0	○	○	○	◎	○
18A(i)	30.6	◎	○	○	○	○
18A(ii)	39.7	◎	○	○	○	○
18A(iii)	42.2	○	◎	○	○	○

Note : ◎ Periodic maintenance
○ Routine maintenance

5.2.4 Maintenance Cost for Road and Bridge

The "Summary of Unit Cost for Road Maintenance FY 2000 – 2001", estimating the unit costs of each work item by each DCTPC, indicates a large difference in each unit cost of road maintenance work item. This may be result from a different in work contents and its grade. Therefore, the Study examined several data and applied the following figures to the unit cost of the road maintenance including bridge for the Master Plan. Table 5.2.6 and 5.2.7 indicates the unit cost for existing road and improved road respectively.

- Routine Maintenance Program FY 2001 – 2005 in Lao PDR
- Road Maintenance Program : MP1 (2001 – 2002) in Lao PDR
- some ADB reports

Table 5.2.6 Maintenance Unit Cost for Existing Road (Gravel/Earth)

Routine Maintenance (US$/km/year)	Periodic Maintenance (US$/km/time)
300	11,000

Table 5.2.7 Maintenance Unit Cost for Improved Road (DBST)

Routine Maintenance (US$/km/year)	Periodic Maintenance (US$/km/time)
694	20,000

5.3 Improvement Plan for Road and Bridge

The following aspects and local conditions should be counted in the Master Plan to establish an improvement policy for roads and bridges.

- To perform a function as a part of a national road
- To ensure traffic safety for drivers and pedestrians
- To minimize the life-cycle cost
- To ease maintenance burden on the road administrator
- To maximize the use of local resources and materials for construction

5.3.1 Road Improvement Plan

(1) Road Design Class

The road design class should be basically determined in accordance with the road design criteria and the traffic volume forecasted. However in this process, the Study team developed the all candidate road as a national road class for the Master Plan, even though the some candidate roads have lower traffic volume than figures indicated in the road design criteria. Table 5.3.1 shows the road improvement plan for each candidate roads.

(2) Design Speed

The design speed by each road design class and terrain conditions recommended as the design criteria by the Study Team, is applied to all candidate roads.

(3) Typical Cross Section

The typical cross section by each candidate road is determined according to the road design class and terrain conditions. The results are shown in Table 5.3.1.

(4) Pavement Design

In the Master Plan, DBST is applied to all candidate roads to evaluate equally by economic

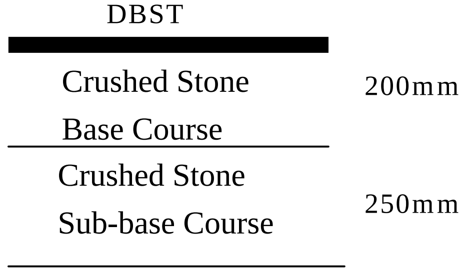

Figure 5.3.1 Pavement Structure for Road Design

analysis. Since the soil investigation is not executed in this master plan stage, the basic pavement structure is assumed as Figure 6.2.1 based on various projects of the road design..

5.3.2 Bridge Improvement Plan

The following improvement policy is applied for this master plan study.

- All existing bridges should be the subjects to be improved.
- A concrete bridge including a reinforced and pre-stressed concrete bridge should be applied as a basic bridge type. Those types should be utilized according to its economic span.
- The bridge width should be secured 2-lane carriageway with the minimum shoulders
- The footpath should be added to the carriageway and shoulder in the populated area or for a large-scale bridge with more than 100m in the total bridge length.

5.3.3 Summary of Improvement Plan for Candidate Roads and Bridges

The improvement plan for candidate roads and bridges are summarized in Table 5.3.1.

5.3.4 Improvement Cost for Roads and Bridges

The cost is composed by the following components:

- Construction Cost
- Compensation Cost
- UXO Clearing Cost

(1) Construction Cost

The construction const includes:

- Physical contingency
- Construction Facilities
- Engineering and construction supervision fee

1) Road Improvement Costs

The construction cost for the master plan includes the following site works, and those unit costs are determined based on the previous projects by ADB, World Bank and others:

- Earth work : filling work
- Pavement work : base and sub-base course and surfacing (DBST)

Table 5.3.1 Improvement Plan in 2020 for Roads and Bridges (1/2)

Route & Bridge	Length (km)	Traffic Volume (veh/day)	Road Design Class	Road Width (Excluding Soft Shoulder) (m)	Pavement Structure	Bridge		
						Nos.	Width (m)	Total Length (m)
1G	130	289	IV	F : 1 + 7 + 1 R : 1 + 6 + 1	DBST + Base (18cm) + Subbase (22.5cm)	42	8 or 10	1,310
1H	22.5	761	IV	F : 1 + 7 + 1	DBST + Base (18cm) + Subbase (22.5cm)	0	-	0
1J	81	126	IV	F : 1 + 7 + 1 R : 1 + 6 + 1 M :0.5 + 6 + 0.5	DBST + Base (18cm) + Subbase (22.5cm)	14	8 or 10	550
14A	25	1124	III	F : 1 + 7 + 1	DBST + Base (20cm) + Subbase (25cm)	4	8	165
	112.5	572	IV	F : 1 + 7 + 1	DBST + Base (18cm) + Subbase (22.5cm)	28	8 or 10	940
14A1	32	< 100	IV	F : 1 + 7 +	DBST + Base (18cm) + Subbase (22.5cm)	8	8 or 10	140
14B	149	< 100	IV	F : 1 + 7 + 1	DBST + Base (18cm) + Subbase (22.5cm)	30	8 or 10	800
14C	42	< 100	IV	F : 1 + 7 + 1	DBST + Base (18cm) + Subbase (22.5cm)	8	8	135
14C1	23	< 100	IV	F : 1 + 7 + 1	DBST + Base (18cm) + Subbase (22.5cm)	2	8	125
14C2	6	< 100	IV	F : 1 + 7 + 1	DBST + Base (18cm) + Subbase (22.5cm)	1	8	25
15	73	834	IV	F * 1 + 7 + 1	DBST + Base (18cm) + Subbase (22.5cm)	19	8 or 10	565

Table 5.3.1 Improvement Plan in 2020 for Roads and Bridges (2/2)

Route & Bridge	Length (km)	Traffic Volume (veh/day)	Road Design Class	Road Width (Excluding Soft Shoulder) (m)	Pavement Structure	Bridge		
						Nos.	Width (m)	Total Length (m)
16A	71	750	IV	F : 1 + 7 + 1 R : 1 + 6 + 1 M :0.5 + 6 + 0.5	DBST + Base (18cm) + Subbase (22.5cm)	6	8	210
18A	112.5	792	IV	F : 1 + 7 + 1 R : 1 + 7 + 1	DBST + Base (18cm) + Subbase (22.5cm)	38	8 or 10	1285
Bridge (Route 20) 19 Nos						19	8 or 10	575
Bridge (Route 1I) H-Lamphan						1	8	60
Bridge (Route 16) H- Phakkud						1	8	25
Bridge (Route 16) Xe-Kong						1	10	230

Note: *1: 8m bridge width comprises 7m carriageway with 0.5m shoulders at both sides.

*2: 10m-bridge width comprises above width plus 1m foot path at both sides.

- Drainage work (pipe culverts) : pipe culvert (D1.0m)

  Pipe culverts of 1m diameter are estimated to install at every 1 km. The length of a pipe culvert is average 12 m.

- Miscellaneous work : slope protection, safety facilities, clearing, temporary roads, side ditches, walls and box culverts, etc.

The basic unit cost is calculated approximately US$210,000 per km according to the assumptions mentioned the above. The detailed information is shown in ANNEX M-8.

The basic unit costs are estimated based on the following assumptions referring to road inventory survey results and traffic volume forecasted:

- Typical cross section : Road Design Class III
- Terrain condition : flat.
- Existing road condition : Rank 1

Since the existing road condition will significantly affect the improvement cost, the existing road condition is classified into 3 ranks as follows:

Rank 1: the sufficient road width has already been ensured, and it keeps relatively good condition. Accordingly, it is easy to undertake the improvement with reasonable cost

Rank 2 : Better condition than Rank 3 but not better than Rank 1

Rank 3 : Missing link or roads with narrow width less than 2m, accordingly, much work effort such as widening, cut and filling works are needed, and the improvement cost will be higher.

The cost should be developed depending on the road class also such as ClassⅢ and Class Ⅳ.

Table 5.3.2(1) Basic Unit Road Improvement Costs(Road Design Class III)

Terrain	Existing Road Conditions (US$/km)		
	Rank 1	Rank2	Rank 3
Flat/Rolling	210,000	220,500	231,000
Mountainous	199,500	231,000	241,500

Table 5.3.2(2) Basic Unit Road Improvement Costs(Road Design Class IV)

Terrain	Existing Road Conditions (US$/km)		
	Rank 1	Rank 2	Rank 3
Flat	189,000	198,450	207,900
Rolling	170,100	179,550	189,000
Mountainous	160,650	189,000	198,450

Each project cost for roads is estimated based on the unit costs shown in Table 5.3.2.

The physical contingency is estimated 10 % of the construction cost.
Construction facility cost such as camp facilities are estimated 2.5 % of the total of construction cost and physical contingency.
The detailed engineering and construction supervision fee are estimated 8 % of the total of above costs.

2) Bridge Improvement Costs

The unit bridge construction cost is determined on the basis of the bridge costs in previous projects in Laos and neighboring countries. The results of the unit bridge cost analysis of the previous projects in Laos are summarized in ANNEX M-8. The unit bridge costs are provided for three categories; namely, small-scale one, medium-scale bridge and large-scale one, and those also includes physical contingency, construction facilities and detailed design and construction supervision fee as the road unit cost included. The assumption and unit bridge cost by each bridge type are shown in Table 5.3.3.

Table 5.3.3 Unit Bridge Improvement Costs and Assumption

Bridge Type	Unit Cost (US$/m2)	Assumptions
Small scale	1,200	RC beam or slab type with less than 15m in span and spread foundation
Medium scale	1,530	PC beam type up to 33m in span with spread foundation
Large scale	1,840	PC beam type up to 33m in span and more than 100m in the total length with pile foundation

Notes: *1: the total bridge cost will be calculated based on the deck area.
*2: the shallow bearing strata are assumed from the previous project experience except for a bridge crossing over a large-scale river.
*3: a large span more than 33m is assumed not to be required to a bridge crossing over the large-scale rivers in the study area

(2) House Compensation Cost and UXO Clearing Costs

Compensation costs by each project are estimated based on the road inventory survey results and those are summarized in shown in ANNEX M-8. In addition, UXO clearance costs are also estimated according to analysis results in Chapter 2 and it summarized in ANNEX M-8.

(3) Total Project Costs

The total project cost by each project is summarized in Table 5.3.4. The project cost mainly comprises the road improvement cost, bridge improvement cost, house compensation cost and UXO clearing cost.

Table 5.3.4 Total Project Cost for Each Candidate Roads

Route and Bridge	Road Class	Origin	Destination	Road Length (km)	Project Cost (1000US$)				
					Road Cost	Bridge Cost	Compenzation	UXO Clearing	Total
1G	IV	JCT. of Route 9	JCT. Of Route 16	130.0	25,403.5	18,700.5	24.0	390.0	44,518.0
1H	IV	Junction of Route 20	Junction of Route 16	22.5	4,252.5	0.0	0.0	22.5	4,275.0
1J	IV	Junction of Route 18B	Border of Cambodia	81.0	15,784.0	8,888.0	16.0	81.0	24,769.0
14A-1	III,IV	Phone Thong Dist. (16)	Ban Sam Kha (14C1)	54.0	11,256.0	3,724.4	128.0	0.0	15,108.4
14A-2	IV	Ban Sam Kha (14C1)	Junction of 14C	51.5	10,584.7	830.4	0.0	0.0	11,415.1
14A-3	IV	M. Moonlapamok	Border of Cambodia	32.0	6,352.0	9,129.2	16.0	0.0	15,497.2
Total				137.5	28,192.7	13,684.0	144.0	0.0	42,020.7
14A1	IV	Ban Ang Kham (14B)	Ban Don Talath (14A)	32.0	6,048.0	1,638.8	5.0	0.0	7,691.8
14B	IV	Junction of Route 16	Border of Cambodia	149.0	29,914.7	10,144.1	24.0	0.0	40,082.8
14C	IV	Ban Nong Nga (14B)	M. Moonlapamok	42.0	7,938.0	1,561.1	0.0	0.0	9,499.1
14C1	IV	Ban Hieng (14B)	Ban Sam Kha (14A)	23.0	4,347.0	2,173.5	0.0	0.0	6,520.5
14C2	IV	Ban Phong Photh (14B)	Ban Nong Te (14A)	6.0	1,134.0	306.0	0.0	0.0	1,440.0
15	IV	Junction of Route 13S	Junction of Route 1H	73.0	14,490.5	7,007.8	40.0	219.0	21,757.3
16A	IV	Junction of Route 16	Junction of Route 1I	71.0	13,250.7	1,585.2	7.5	71.0	14,914.4
18A-1	IV	Junction of Route 13S	Border of Province	30.0	5,868.1	1,585.3	8.0	0.0	7,461.4
18A-2	IV	Border of Province	Se Piane River	40.0	7,503.3	10,193.9	5.0	0.0	17,702.2
18A-3	IV	Se Piane River	Junction of Route 18B	42.5	8,376.7	5,452.3	8.0	52.5	13,889.5
Total				112.5	21,748.1	17,231.5	21.0		39,000.6
Bridge (Route 20) 19Nos					0.0	6966.5	0.0	0.0	6,966.5
Bridge (Route 1I) H-Lamphan					0.0	747.6	0.0	0.0	747.6
Bridge (Route 16) Xe-Kong					0.0	3680.0	0.0	0.0	3,680.0
Bridge (Route 16) H-Phakkud					0.0	299.0	0.0	0.0	299.0

CHAPTER 6

ECONOMIC ANALYSIS

CHAPTER 6 ECONOMIC ANALYSIS

6.1 Introduction

The economic priorities of projects that would achieve the objectives are considered in this section.

Vehicle operating cost and travel time savings typically represent the major element of economic benefits for both road improvements and the restoration of missing links, where diverted traffic is the main beneficiary. The economic analysis evaluates these benefits. The three components of benefits are:

- benefits to *normal traffic*: traffic which is already using the road in its existing condition and the natural growth in this traffic;
- benefits to *generated (induced) traffic*: additional trips made solely as a result of the project improvement to the condition of the road. These trips are assigned a benefit half that of normal traffic trips and such traffic is assumed to grow in line with the growth of normal traffic; and
- benefits to *diverted traffic*: traffic which before the improvement used other routes. These benefits are valued as the difference in cost between the old and new routes. Diverted traffic is also assumed to grow at the same rate as normal traffic.

Three road sections are at present virtually impassable: 32km of Route 1G, 65km of Route 1J and 25km of Route 14A. All other sections are passable during the dry season, albeit some only with varying degrees of difficulty by 4-wheel drive vehicles. A number of sections are impassable for varying lengths of time during the wet season. For these sections, the benefits of providing 12-month accessibility may be considerable. Such benefits have been quantified by assuming that they are represented by the full cost of trips that would have been made were the road open in its existing condition. Clearly, the value of a trip will be at least equal to this cost, otherwise the trip would not be worth making.

For the impassable sections of Routes 1G and 14A, the major benefit of opening them would be distance savings for diverting traffic. Secondary benefits from accessibility are by comparison minor and can be disregarded for master planning purposes. The main benefit of completing the missing section of Route 1J would be to open up a new route to Cambodia. This benefit cannot be quantified on the basis of VOC savings without traffic surveys in Cambodia, beyond the scope of the current study. However, experience after improvement of Route 13S to the Cambodian border, where access from the south remains inadequate, suggests that cross-border traffic initially would be light.

6.2 Vehicle Operating Costs

The quantification of VOC and time benefits is discussed in this section .A detailed study of vehicle operating costs in Lao PDR was undertaken in 1999, under the ADB's *Road Infrastructure for Rural Development Project* (Final Report, April 2000). The World Bank's Highway Design and Maintenance Standards Model (HDM) version III was recalibrated to reflect local conditions. Equations were then determined by multiple regression analysis to relate VOCs to the International Roughness Index (IRI) and the vehicle's operating speed.

The equation is in the form:

$$VOC = a + b\ IRI + c\ IRI^2 + d\ V + e\ V^2 + f/V$$

Where: VOC is the vehicle operating cost (in US cents per km)

The a is a constant

b,c,d,e and f are coefficients

IRI is the International Roughness Index (in m/km)

V is the vehicle speed (in kph).

The equation was calibrated for the following 12 vehicle types:

- motorcycle, car, jeep and pick-up;
- pick-up (passenger variant), light truck (passenger), medium bus and heavy bus; and
- light, medium, heavy and articulated trucks.

Table 6.2.1 presents the VOCs and passenger time values (see section 6.3) for seven of the vehicle types, for a range of road conditions from an IRI of 3 (representing a new paved road) to an IRI of 30 (representing a deteriorated earth road). The operating speeds used in the equation are also given in the table. These speeds are based on the Study team's assessment during field inspection and on the results of the vehicle speed surveys.

Table 6.2.1 VOC and Passenger Time Values (in US Cents/km)

IRI	Vehicle Operating Costs							Passenger Time			
m/km	M/C	Car	Pick-Up	Med Truck	Hvy Truck	Articulated	Bus	M/C	Car	Pick-Up	Bus
3	3.73	17.8	17.3	22.2	40.8	52.5	29.7	0.60	0.9	1.0	6.0
7	3.99	19.6	20.0	25.6	47.1	60.2	33.1	0.65	1.0	1.2	6.5
11	4.32	22.4	23.8	29.6	55.1	68.6	36.8	0.72	1.2	1.4	7.2
15	4.85	26.2	29.0	35.0	65.7	82.0	42.6	0.90	1.4	1.8	9.0
20	5.71	32.1	35.4	40.3	76.3	95.1	48.1	1.20	1.8	2.1	10.3
25	7.06	40.0	45.7	51.2	89.1	111.0	58.4	1.80	2.4	2.9	14.4
30	10.09	55.5	62.1	61.8	106.0	131.8	77.0	3.60	4.8	4.8	24.0
	Operating Speed kph							VOC + Passenger Time			
3	60	80	70	70	60	50	60	4.33	18.7	18.3	35.7
7	55	70	60	55	50	45	55	4.65	20.7	21.2	39.6
11	50	60	50	45	40	40	50	5.04	23.6	25.3	44.0
15	40	50	40	35	30	30	40	5.75	27.6	30.8	51.6
20	30	40	35	30	25	25	35	6.91	33.9	37.5	58.4
25	20	30	25	20	20	20	25	8.86	42.4	48.6	72.8
30	10	15	15	15	15	15	15	13.69	60.3	66.9	101.0

The *Rural Access Roads Improvement Project* Economic Report, February 2001 re-evaluated the feasibility of three roads in the project area: Attapeu-Xe Namnoy (National Road 1I), Xaisetha-Sanxai (Provincial Road 970) and Sekong-Dakchung (National Road 16). The latest version of HDM, VOC-IV was used. The IRI values before and after improvement are given in the Report and it is therefore possible to compare the results with those from applying the above equation. The comparative benefits obtained by the two methodologies are shown in Table 6.2.2 for three vehicle types: cars, medium trucks and heavy trucks. The comparison demonstrates that the equation produces a reasonable approximation to the results obtained from a full feasibility study, using detailed knowledge of characteristics of the road section. The equation is therefore appropriate for use in Master Planning.

Table 6.2.2 Comparison of HDM III/IV VOC Benefits

Road Section/Method	**Car**	**Med. Tr.**	**Heavy Truck**
	(Benefit/Vehicle Km US cents)		
***Attapeu-Xe Namnoy*:**			
Economic Report (HDM IV)	17.7	24.7	33.0
Equation (HDM III)	16.4	19.3	37.9
***Xaisetha-Sanxai*:**			
Economic Report	32.1	40.2	53.3
Equation	37.4	39.0	64.1
***Sekong-Dakchung*:**			
Economic Report	27.6	35.2	46.3
Equation	24.4	29.6	49.7

6.3 Value of Time

The low operating speeds possible on the project roads in their current condition result in substantial travel time savings after improvement. The economic benefits of these savings have been included in the analysis by relating the time saved to average GDP per hour of work in the study area..

Average GDP per capita in Saravan, Sekong, Champasack and Attapeu provinces in 2000 was US$410. The proportion of the population in the labor force was 51 per cent, with GDP per gainfully active person of US$804. GDP per hour of work, based on annual working hours of 1920, was US$0.42. The Study team’s OD survey indicated that 58 per cent of passenger trips were work-related. Only time saved on such trips is considered to be of economic value and passenger time in 2000 is accordingly valued at **US$0.24 per hour**. For comparison, the *Road Infrastructure for Rural Development Project* estimated a time value of US$0.18 per hour for 1999 and the *Feasibility Study on the Construction of the Mekong Bridge at Pakse* a value of US$0.25 for 1995.

Travel time will increase in economic worth in line with the growth of GDP per capita. This is forecast to be 3.5 per cent per annum 2000-2020. The hourly value of passenger time increases as follows: 2005 US$0.28; 2010 US$0.34; 2015 US$0.40 and 2020 US$0.48.

Average occupancy, based on the Study team's field surveys was: motorcycle 1.5; car/pick-up 3; and bus 15. The value of time per vehicle hour (for 2000) is: motorcycle US$0.36; car/pick-up US$0.72; and bus US$3.60.

6.4 Cost Benefit Analysis

The cost benefit analysis compares each project's construction and maintenance costs with the resulting road user benefits. For maintenance, the difference in cost between maintaining the road in its existing condition and in its condition after improvement is the net benefit. Both periodic and routine maintenance costs have been included for the project, but for the without project condition annual maintenance costs have been assumed to be minimal, US$300 per km. In order to determine economic priorities, all projects have been evaluated on the same basis, with the start of construction in 2004 and with benefits assessed over a 20-year period after project completion.

The derivation of the construction and maintenance cost estimates is discussed in the previous chapter. Construction costs have been allocated 50 per cent to 2004 and 2005 for 2-year projects and 20, 40 and 40 per cent respectively 2004 – 2006 for 3-year projects. A residual value of 30 per cent of the construction cost has been included as a terminal benefit in the final analysis year.

The *Road Infrastructure for Rural Development Project* reviewed the relationship between the financial price and the economic cost of road projects. It found that for international competitive bidding (ICB) contracts the economic cost was on average 92 per cent of the financial price, while for local competitive bidding contracts the average was 85 per cent. The former percentage is higher because on ICB contracts duties have generally been waived on imported materials and equipment. Financial costs have been converted to economic costs, assuming that the projects would be ICB contracts, by applying a factor of 0.92.

The road improvement and bridge components of project financial costs are summarized in Table 6.4.1.

Table 6.4.1 Financial Improvement Costs

Route	Road	Bdge.	Total	Road	Bdge.	Total
				Cost per km		
	(in US$ mill.)			(in US$'000)		
1G	25.8	18.7	44.5	199	144	342
1H	4.3	0.0	4.3	190	0	190
1J	15.9	8.9	24.8	196	110	306
14A(i)	11.4	3.7	15.1	211	69	280
14A(ii)	10.6	0.8	11.4	206	16	222
14A(iii)	6.4	9.1	15.5	199	285	484
14A1	6.0	1.6	7.7	189	51	240
14B	29.9	10.1	40.1	201	68	269
14C	7.9	1.6	9.5	189	37	226
14C1	4.3	2.2	6.5	189	94	283
14C2	1.1	0.3	1.4	189	51	240
15	14.7	7.0	21.8	202	96	298
16A	13.3	1.6	14.9	188	22	210
18A	21.8	17.2	39.0	194	153	347

6.5 Economic Analysis of Road Improvements

6.5.1 Overview

The road projects analyzed comprise all remaining unpaved/impassable national roads in the study area, excluding those with improvement funding either committed or sourced. The projects vary enormously in importance, from major routes viable for immediate upgrading to paved standard, to tracks and trails.

In addition to the existing designated national roads, new links that might be considered at a later stage when resources permit include:

- the short link south from Route 1G to Route 1H, to avoid the dog-leg through Saravan for through traffic; and
- new links to the Thai border, one between Savannakhet and Pakse, serving traffic from Route 15 and one westwards from Route 14C or 14C1.

The results of the economic evaluation are discussed below. An example of the cost benefit analysis spreadsheet is presented in Table 6.5.1, showing the results for Route 1H. The other spreadsheets are included in ANNEX M-6.

Table 6.5.1 Economic Cost Benefit Analysis (in US$'000)

Route:	**1H**	**Section:**	**Junction Rt. 20 - Junction Rt.16.**				
Distance:	**22.5**	**Cost/km:**	**189**	**Bridges:**	**0**	**Generated %**	**20**
Existing:	**IRI 15**	**Improved:**	**IRI 3**			**IRR:**	**10.5%**

Year	Improvement Cost		Normal Traffic Vehs/Day					Economic Benefits		
	Construction	Maintenance	M/C	Car/Pick-Up	Medium Trck	Heavy Truck	Bus	VOC	Time Savings	Total Benefit
2001			82	47	10	29	21			
2002			93	53	11	31	23			
2003			106	59	12	34	25			
2004	1956		120	66	13	36	28			
2005	1956		136	74	14	39	31			
2006		9	154	82	15	42	34	249	22	271
2007		9	175	92	16	45	37	273	25	298
2008		9	189	101	18	48	39	295	28	323
2009		9	205	111	19	52	42	320	31	350
2010		9	222	122	21	55	45	346	34	380
2011		9	240	134	23	59	48	374	39	413
2012		9	260	148	25	64	51	405	43	448
2013		9	281	163	28	68	54	438	48	487
2014		9	305	179	30	73	58	475	54	528
2015		414	330	197	33	78	61	514	60	574
2016		9	357	216	37	84	65	557	67	624
2017		9	386	238	40	90	70	603	75	678
2018		9	418	261	44	97	74	654	84	738
2019		9	453	287	48	104	79	708	94	802
2020		9	490	316	53	111	84	768	105	873
2021		9	524	335	56	117	87	809	115	924
2022		9	561	355	58	122	91	853	125	978
2023		9	600	376	61	128	94	899	136	1035
2024		9	642	399	64	135	98	947	149	1096
2025	-1276	9	687	423	68	142	102	998	162	1161

6.5.2 Restoring/Improving Route 1

Route 1 is the only designated north-south through route, other than Route 13S. Heavily damaged in the war, it no longer serves its original purpose. The upgraded sections, parts of Route 1H and 1I, primarily provide for local or east-west traffic. Restoring the road from Route 9 to Attapeu and on to Cambodia would open up a second north-south development corridor.

1G: Junction Rt.9 – Junction Rt.15 130.0km

Route 1G is impassable over its central 32km and is not functioning as a trunk route. Improvement and reconstruction would provide a much shorter route for traffic from Vietnam and areas of eastern/central Lao PDR along Route 9 to central southern areas. The existing circuitous route is via Routes 13S and Routes 15/16. The planned construction of Route 15(east) Saravan-Vietnam Border will, however, also cater for the Vietnamese traffic. Route 1G also serves local traffic on the southernmost 32km.

This route is most difficult to analyze at master planning level. Until the traffic pattern stabilizes after completion of Routes 9 and 15A, it is not possible to accurately assess the extent of diversion to 1G. It is recommended that a detailed study be undertaken two years after opening of Route 15(east). No improvement to paved standard is likely to be warranted in the interim.

From Saravan to the Vietnamese border it will be 147km via the new Route 15(east). It is 214km via Routes 9 and 1G. Traffic to/from Vietnam would therefore only divert from Route 15(east) to central and northern sections of a reconstructed Route 1G. On the basis of the traffic model forecasts for 2007 and 2020, the EIRR for paving/bridge construction commencing in 2004 is 0.4 per cent. The project may not be feasible for opening before 2020, achieving an opening year benefit of 8 per cent only in 2022. The analysis worksheet is given in ANNEX M-6. Improvement of the southernmost and the northernmost sections should be considered earlier as a first stage, to cater for local traffic needs.

1H: Junction Rt.20 – Junction Rt.16 22.5km

This will be the last unpaved section on the Saravan-Sekong-Attapeu route, after the planned improvement under ADB9 of the remaining 32.2km Xe Namnoy-Attapeu unpaved section of Route 1I, south of the junction with Route 16A. It has a relatively high EIRR of 10 per cent and is feasible for construction beginning in 2006.

1J: Junction Rt.18 – Cambodian Border 81.0km

This route from Attapeu south to the Cambodian border is currently impassable over the southern 65km. It would provide a third border crossing east of the Mekong, avoiding long detours to Route 13S or to Route 18B for traffic from central southern areas. It would also complete Route 1 south of Route 9, in conjunction with construction of Route 1G. A connection to Cambodia is planned from Route 18B and the paved connection via Route 13S is new. Cross-border traffic potential appears to be limited at this stage. The need for a third route is not therefore urgent and further consideration to this project should await experience with the other routes, once fully functioning.

The first 15km south from Attapeu serves local traffic and connects to a provincial road to the west. This section should be reviewed for improvement as a local project.

6.5.3 Improving West Bank Access to Champasack and the South

The study roads in this area were recently re-designated from provincial to national roads. Apart from a short stretch of Route 14A between Champasack ferry and the access road to Wat Phou, there are no paved roads on the west bank of the Mekong other than Route 16, from Pakse to the Thai border. The west bank is heavily populated along the river, but otherwise more lightly populated. The Champasack area is an important tourist destination, with Wat Phou the primary attraction. This is to be designated a World Heritage Site. The far south of the area is adjacent to the major tourist attractions of the Mekong falls and the thousand islands region but being remained undeveloped for a long time.

14A: Junction Rt.16 – Cambodian Border 137.5km

With the opening of Pakse bridge, improvement of Route 14A has become of increased importance. The bridge is proving very successful, with higher than forecast traffic volume. The route, for analysis purposes, comprises four distinct sections:

- Junction Route 16 to Champasack (missing link) 25.0km;
- Champasack to Junction with Route 14C1 29.0km;
- Route 14C1 to Route 14C 51.5km; and
- Route 14C to Cambodian border 32.0km.

Section 1 runs south close to the west bank of the Mekong. It is virtually impassable from the junction with Route 16 adjacent to Pakse Bridge throughout to Champasack. Construction of this section would provide a much shorter route from Pakse to the Champasack area and the south. The existing alternatives are a circuitous journey via Routes 14B/14A1/14A or Route 13S and the Mekong vehicle ferry at Champasack, with a waiting period of up to 30 minutes.

Section 2 forms the main road through the town of Champasack and is paved from the Champasack ferry to the junction to Wat Phou. The road is unpaved in fair condition south to the junction with Route 14C1.

Construction of the first section in 2004 produces an EIRR of 31 per cent, the highest of any section analyzed. Paving of the second section in 2004 is close to the viability threshold, with an EIRR of 10 per cent. It achieves the threshold for opening in 2008. The combined 54km of sections 1 and 2 yields an EIRR of 22 per cent and it is recommended that this be treated as a single project for immediate construction.

Section 3 runs inland from the Mekong. It is a dry-season track on a poor alignment through sparsely-populated woodland. This section is passable only by 4-wheel drive vehicles and currently has very little traffic. Improvement of this section is a long term project and requires initially an alignment study, followed by the provision of a good dry season route, then upgrading to an all-weather link, with finally paving once traffic volume justifies it. Improvement of this section needs to be evaluated together with improvement of the parallel section of Route 14B to determine priorities.

Section 4 runs close to the Mekong south to the Cambodian border. This is the most expensive section to improve per km of all sections analyzed, due to the large amount of bridge work that would be necessary. There is little traffic, although the population served along the Mekong is substantial, river now being the preferred means of transport. As with section 3, this is a long term project requiring a program of phased improvements.

ADB is believed to be considering upgrading sections 3 and 4 to all-weather gravel standard as part of its forthcoming Smallholder Development Project, currently at the feasibility study stage. This would complement the paving of sections 1 and 2, improving access to all areas of the west bank adjacent to the Mekong. ADB may also propose improvements to Mekong ferry services in the area.

14A1: Junction Rt.14B – Junction Rt.14A 32.0km

This route is part of the existing west bank route to Champasack/Wat Phou from Pakse and the east or Thailand. In the absence of section 1 of Route 14A, it would be viable for construction in 2004, with an EIRR of 16 per cent. However, Route 14A provides much greater benefit and is preferred to 14A1. With 14A available, most of the traffic would divert from Route 14A1. The residual mostly local traffic would not justify early improvement to paved standard. If 70 per cent of through traffic diverted, paving would not be viable until after 2015, but growth in local traffic will make it feasible earlier than this.

14B: Junction Rt.16 – Cambodian Border 149.0km

The first 11km of the route from Route 16 to the junction with Route 14A1 form part of the existing west bank route to Champasack. This section would be economically viable for paving in 2004 (together with Route 14A1), as an alternative to section 1 of Route 14. However, if the more beneficial 14A is built, the residual traffic would not justify improvement until after 2010, depending on how quickly traffic develops on southern sections of the route.

From the Route 14A1 junction southwards, road condition deteriorates markedly to dry season only. This serves a relatively undeveloped area of low population density for the whole 138km south to the border. The section has very little existing traffic and should be improved in stages as development justifies to good dry season gravel road; good all season gravel road, and finally to paved road.

14C: Junction Rt.14A – Junction Rt.14B 42.0km

14C1: Junction Rt.14A – Junction Rt.14B 23.0km

14C2: Junction Rt.14A1 – Junction Rt.14B 6.0km

These three relatively new gravel roads each provide connections between Routes 14A and 14B, through largely undeveloped areas. Currently traffic is minimal on all three. Improvement to paved standard is unlikely to be appropriate for many years, with timing dependent on the speed of development in the area. Should, as recommended, Route 14A be paved as far as the junction with Route 14C1, this route should have priority for upgrading, to open a paved route to the western area.

6.5.4 Improving East-West Links

Dramatic improvements in east-west connectivity in the study area are in progress, with the paving of Route 9 and the construction of Route 18B. Routes 15A and 16 are also planned, which will result in four paved routes to Vietnam. With the Savannakhet Mekong Bridge, there will also be two paved routes to Thailand. The study area is likely to become increasingly east-west oriented. Further improvements in the Route13S/Route1 corridor will accordingly be of increasing importance.

There are two possibilities: improvement of Route 15 and of either Route 16A or Route 18A.

15: Junction Rt.13S – Saravan 73.0km

This route provides a much shorter connection from central areas to Savannakhet and the north than the existing paved route via Pakse. The route is subject to closure during periods of heavy rain. Improvement of Route 15 to paved standard and the provision of missing bridges to give all-weather access yield an EIRR of 8 per cent and is viable for opening in 2011. The project could be staged, with paving in advance of the bridge construction.

15 (east): Saravan – Vietnamese Border 147.0km

This route runs north-eastwards from Saravan to the Vietnamese border at Lalay. It is currently not passable. A contract between MCTPC and Truong Phou International Trade, Production, Construction Investment Corporation Ltd. of Vietnam was signed in early 2002 for its construction as a class IV paved road. Site mobilization commenced in 2002. The contract value is US$46.9 million, wholly financed by the Vietnamese side. Of this, US$26.1 million is the road component, US$12.5 million for bridges and US$8.4 million is for design, supervision, contingency (10 per cent) and general items. The construction period is four years, with completion expected in early-2006. Construction is being undertaken simultaneously from the Saravan and Larly ends.

Route 15(east) will provide Saravan and other southern provinces with convenient access to Da Nang, Hue and central areas of Vietnam. The route has been treated for modeling purposes as a committed project in the 2007 network.

Route 16: Sekong-Dakchung 101.8km

This route runs east then north-east from Sekong to Dakchung and would likely be extended a further 20km to the Vietnamese border. The starting point is the Sekong ferry. Construction of a bridge at this site is discussed in section 6.6.2. The Sekong-Dakchung section of the road project (excluding the bridge) was evaluated for inclusion in either the ADB9 or ADB10 packages, but was withdrawn from the final list of projects for consideration by ADB, as it achieved the lowest economic return of the 10 projects studied. Detailed engineering was completed in June 2001. The project cost estimate was US$16.3 million.

The link would, together with Routes 9, 15(east) and 18B, provide a fourth paved connection to Vietnam, giving Sekong province its own direct route, as an alternative to Routes 15(east) or 18B. The route would also provide access to central Lao PDR for the Dakchung area and for hill tribes in the border areas, whose main connections at present are cross-border. Social considerations would have to be a main factor to justify developing the route The EIRR in the February 2001 feasibility study, 8.2 per cent, was based on an economic cost of US$8.7 million, less than 60 per cent of the detailed engineering cost estimate.

Currently, the route is dry season only and has very little traffic. The 1999 traffic count showed 7 vehicles and 15 motorcycles. The Dakchung-Border section is currently a track, constructed in 2000 and passable for only two months a year.

A Malaysian group (Malaysian-Lao Timber Company) has expressed interest in constructing the route and an MOU has been signed with MCTPC. Whether financing is in place is not clear.

16A: Junction Rt.16 – Junction Rt.1I 71.0km

18A: Junction Rt.13S – Attapeu 112.5km

Saravan and Sekong have direct paved routes to Pakse. Attapeu will have a paved link on completion of the improvement to Route 1I. The Attapeu-Pakse route is however circuitous via Sekong. A more direct paved route is desirable. The two alternatives are paving of Route 16A and paving of the currently virtually impassable Route 18A. The latter would provide a slightly shorter route and avoid the climb over the Boloven Plateau. Improvement of Route 18A is however costed at US$39.0 million, 160 per cent more than the cost of improving

Route 16A. The improvement section is 54 per cent longer and all bridges are missing or require replacing, whereas concrete bridges are in place on Route 16A, apart from a single Bailey bridge. Improvement of Route 16A would also serve significant local traffic over the initial 35km from Paksong. Route 18A has little local traffic potential, apart from the section immediately west of Attapeu, which could be improved as a local project.

Paving Route 16A, with Route 18A unimproved, yields an EIRR of 15 per cent. The project is feasible for construction in 2004. Reconstruction of Route 18A, with Route 16A unimproved, results in an EIRR of 5 per cent. Route 16A provides many of the benefits of Route 18A for 38 per cent of the cost. Once Route 16A is improved, the incremental benefits from improving Route 18A are secondary and the project as a through route has a low economic priority. Improvement of short sections at both ends to serve local traffic needs should, however, be considered.

18B: Attapeu-Vietnamese Border 113.0km

Construction of this route as a Class III paved road commenced in December 2001, financed by the Socialist Republic of Vietnam. Completion is scheduled for December 2004 and the project has been treated as a committed project in the 2007 network.

6.5.5 Sensitivity Tests

The sensitivity of the economic analysis results to changes in traffic volume and in construction costs is illustrated by tests on Route 1H, given in Table 6.5.2. An increase of 20 per cent in construction cost would delay feasibility two years. An increase in the construction cost together with a 20 per cent decrease in traffic would delay feasibility by five years. An increase in traffic of 20 per cent would bring forwards feasibility by one year.

Table 6.5.2 Cost Benefit Sensitivity Tests Route 1H

Test	**EIRR (in %)**	**Feasibility Year**	**NPV (in US$mill.)**
Base case	10.5	2008	-0.45
Cost +20%	8.8	2010	-1.09
Ct +20/Tr-20%	6.8	2013	-1.66
Traffic +20%	12.4	2007	0.12

6.6 Economic Analysis of Bridges

6.6.1 Bailey Bridges

There are single-lane Bailey bridges (3.8-4.3m wide) on paved sections of Route 1H (5 bridges of total length 102m); Route 1I (1); Route 16 (1); and Route 20 (14 bridges of total length 312m). The longest of the Route 1H/20 bridges is 69m. The bridges are in generally good condition. They provide 12-month accessibility, but will at some stage need to be improved for reasons of traffic safety (with provision of lighting and traffic signals) and at a later date to be replaced on capacity grounds. Replacement cost is estimated at US$1500/sq.m. – a total for the 21 bridges of US$8.0 million.

Intervention timing should be based on future traffic volumes. The traffic model forecast volumes (number of vehicles, excluding motorcycles) for each route are given in Table 6.6.1.

Table 6.6.1 Traffic Volumes on Bailey Bridges

Year	1H	1I	16	20
2001	410	170	770	370
2007	660	420	1240	620
2020	1720	870	2530	1350

Vehicle operating cost savings from avoiding a sharp speed change cycle at each bridge will become significant, with an increasing proportion of vehicles having to stop and wait for opposing traffic to clear the bridge. Time savings will also increase. The peak hour volumes in 2020 could be accommodated without additional bridge capacity, but earlier replacement might be justified based on road user benefits. As a first step, signalisation should be considered. Driver behavior is the critical factor determining accident rates. It is recommended that bridge-related accidents be monitored and that interventions be programmed accordingly.

6.6.2 Route 16: Sekong Bridge

Improvement of the 102km Sekong-Dakchung section of Route 16 was evaluated under the *Rural Access Roads Improvement Project.* The feasibility study's *Economic Report* (February 2001) showed an EIRR for the road improvement alone of 8.2 per cent. Construction of the

Sekong Bridge was not included under the project. The 200m bridge, estimated financial construction cost US$3.68 million, would replace an existing single pontoon ferry, which currently operates between 07:00 and 18:00 daily. The fee for a car/jeep is Kip22,000 per single crossing.

The feasibility study expected that the road improvement would result in generated traffic of 100 per cent normal traffic. The study's traffic forecast is given in Table 6.6.2. Motorcycles were not included in the evaluation. In a 1999 traffic count, motorcycle volume was twice that of vehicles.

Table 6.6.2 Sekong Crossing Daily Vehicles

Year	Normal	Generated	Total
2005	20	20	40
2010	35	35	70
2015	48	48	96
2020	72	72	144

This forecast excludes cross-border traffic from Vietnam, possible once the short Dakchung-border section is constructed. This would increase traffic by possibly 20 per cent. By 2020 motorcycle volume might be four times domestic traffic volume. The total number of passengers crossing per day in 2020, based on the vehicle composition given in the Feasibility Study, would be some 1900. The annual time savings would be 116,000 hours, with two ferries in operation and an average waiting time of 10 minutes. The economic value of passenger time in 2020 is US$0.48, giving a time benefit of US$56,000 for the year. The ferry operating costs would also be saved by a bridge.

In order to justify construction of the bridge, the first year benefits should be at least 8 per cent of the economic construction cost of US$3.39 million, US$271,000. The bridge is therefore not expected to be a candidate for construction before 2020, based on economic feasibility alone.

An economic analysis of increasing the capacity of Xe-Don Bridge Pakse is given in ANNEX M-7.

6.7 Project Priorities

The earliest economically feasible project opening year is that in which the EIRR achieves the set minimum level. In Lao PDR, the threshold is currently 12 per cent. This is equivalent to the year in which project benefits reach 8 per cent of the total economic construction cost. Clearly, resource constraints may not allow projects to be constructed on the basis of achieving the threshold. The criterion is, however, appropriate for setting programme priorities. The resulting programme can then be adjusted as necessary to give a reasonably constant workload, consistent with anticipated funding.

Table 6.7.1 presents an indicative development program for the study area to 2020.

Table 6.7.1 Cost Benefit Indicative Program for Candidate Projects (financial cost US$ million)

Route	2004	2005	2006	2007	2008	2009	2010	2011	2012
1G									
1H			2.1	2.2					
1J									
14A(I)	3.0	6.0	6.1						
14A(ii)									
14A(iii)									
14A1/14B*						2.4	4.8	4.9	
14B									
14C									
14C1								3.2	3.3
14C2								0.7	0.7
15					4.3	8.7	8.7		
16A	3.0	5.9	6.0						
18A									
Total	**6.0**	**11.9**	**14.2**	**2.2**	**4.3**	**11.1**	**13.5**	**8.8**	**4.0**

Route	2013	2014	2015	2016	2017	2018	2019	2020
1G						8.8	17.7	17.7
1H								
1J						5.0	10.1	10.1
14A(I)								
14A(ii)	2.3	4.5	4.6					
14A(iii)			3.1	6.2	6.2			
14A1/14B*								
14B			7.5	15.0	15.0			
14C	4.7	4.7						
14C1								
14C2								
15								
16A								
18A						6.9	17.7	17.9
Total	**7.0**	**9.2**	**15.2**	**21.2**	**21.2**	**20.7**	**45.5**	**45.7**

Note:* 11km from Rt.16-Junct. Rt.14A1

6.8 Cost Benefit Project Ranking

Each project has been given an economic ranking on a 5-point scale, taking into consideration three factors. These are based on evaluating project improvement to paved standard, together with bridge construction, beginning in 2004. The factors are: EIRR; year in which benefits first reach 8 per cent of the economic project cost; and net present value (at a 12 per cent discount rate) per US$1 million economic cost. Where paving is not justified as the initial stage of improvement, indicative years for opening as a paved road are shown, taken from Table 6.7.1. For such projects, an EIRR for paving cannot be determined at this stage. The results of the ranking are presented in Table 6.8.1.

Table 6.8.1 Project Ranking: Cost Benefit Analysis

Route	EIRR %	Year	NPV/C (US$mill)	Rank
1G	0.4	2020	-0.57	4
1H	10.5	2008	-0.11	2
1J	-	2020	-	5
14A(i)	22.4	2007*	0.89	1
14A(ii)	-	2016	-	5
14A(iii)	-	2018	-	5
14A1**	15.6	2007*(2012)	0.28	1**(3)
14B	-	2018	-	5
14C	-	2015	-	5
14C1	-	2013	-	5
14C2	-	2013	-	5
15	7.8	2011	-0.24	2
16A	15.1	2007*	0.25	1
18A+	4.9	2015(2020)	-0.39	4
Bailey Bridges	-	2015	-	4
Sekong Bridge	-	2020	-	5

Notes : * earlier than.

** as alternative to 14A(i) otherwise (..)

+ as alternative to Route 16A, otherwise negative EIRR, so (2020).

CHAPTER 7

MASTER PLAN & MOST APPROPRIATE ROAD IMPROVEMENT PROJECTS FOR FEASIBILITY STUDY

CHAPTER 7 MASTER PLAN AND MOST APPROPRIATE ROAD IMPROVEMENT PROJECT FOR FEASIBILITY STUDY

7.1 Introduction

This chapter presents a Master Plan for road improvement in the southern region of Lao P.D.R., which prioritizes projects up to 2020 and selects the most appropriate road projects to be improved by the year 2007 for further consideration in the Feasibility Study. The Master Plan covers only national roads in the four southern provinces of Champasack, Saravan, Sekong, and Attapeu (together with Route 1G south of Route 9 in Savannakhet). It should be mentioned that the Government of Lao would have to consider the relative priority of projects in this area with roads in the central and northern areas of the country when allocating budget monies.

The 2025km national road network of the Study area connects all of the South’s provincial centers, and is potentially an efficient network. In conjunction with Route 9, this network is capable of adequately providing for likely future cross-border and transit movements between Lao, Thailand, Cambodia and Vietnam. That is no network deficiencies have been identified that would require the development of new routes in the area before 2020. The priority is therefore to upgrade existing roads and to complete missing road links and bridges to allow the network to function fully for 12 months a year. Network capacity, other than single-lane bridges at some locations, is not seen as a constraint before 2020.

The study area’s basic paved road network connecting provincial capitals and to the borders of the three neighboring countries is largely complete and will be completed by already committed projects. The three outstanding objectives for the network are:

- to restore Route 1 as a north-south route (233.5km of this route have been evaluated);
- to improve access for areas west of the Mekong (389.5km); and
- to further improve east-west links (256.5km).

Some 43 per cent of the national road network (880 km) in the Study area has been evaluated for improvement, together with specific bridges. Of this length, 122 km is currently impassable, while the remainder consists of earth and gravel roads of widely varying standards together with one short paved stretch. The remaining 1,145 km of network has either been paved, is being paved, or will be paved via a project with an identified funding source.

7.2 Preferred Road Links and Bridges

7.2.1 Priority Setting

The purpose of priority setting is to identify ‘priority projects’, which is the first step in the creation of a Master Plan. This has been carried out in the Study by taking into account the economic standing and socioeconomic potential of districts, communities, and road links (such as population distribution, education and literacy, and poverty and access) as well as the present road improvement program which have been already committed for implementation. In addition, adverse environmental and structural impacts have also been considered.

By applying the above process, the Study Team identified from both an economic and socioeconomic viewpoint roads and bridges in southern Lao P.D.R. that are most in need of improvement.

7.2.2 Ranking

Twelve (12) road projects and four (4) bridge projects were selected as potential road improvement projects. The costs and benefits of these projects are analyzed in the previous chapter. In consideration of the big disparities in economic viability, as well as to their large size, Route 14A and 18A are divided into 3 (three) sub-links for economic analysis.

Meanwhile, the projects (except for the four bridges) were evaluated via the application of conventional cost-benefit analysis. Furthermore, evaluation was carried out in the preceding chapters by applying a rating system based on the following factors:

- Socio-Economic (Regional Development) Impacts
- Environmental Impacts

The relative impacts for each road link are first evaluated using a non-metric grading system (i.e., A, B, C, etc.) in this chapter. The assigned grades for each of the factors are then converted into metric scores (see Table 7.2.1).

Table 7.2.1 Grade and Score

A^{+}	98	A	95	A^{-}	92
B^{+}	88	B	85	B^{-}	82
C^{+}	78	C	75	C^{-}	72
D^{+}	68	D	65	D^{-}	62
E^{+}	58	E	55	E^{-}	52

Based on the preceding data, the grade and corresponding score of the impact of each candidate road link and bridge are summarized in Table 7.2.2. The most appropriate project for implementation is selected based on the summation of these scores. The road links and/or bridges with the highest total number of points are considered to be the most appropriate projects for implementation. Notice that the table provides four weighting systems that reflect different orders of priority. The intent here is to provide sufficient information to decision-makers to make informed choices based on an understanding of the impacts that different sets of weights have on road and bridge prioritization.

Table 7.2.2 Overall Impacts

Route and Bridge	Cost-Benefit Impacts (C)	Socio-Economic Impacts (S)	Environ-mental Impacts (E)	Total Score: Weight (equally) Case 1	Weight (C:S:E) (40:40:20) Case 2	Weight (C:S:E) (45:35:20) Case 3	Weight (C:S:E) (35:45:20) Case 4
1G	D 65	A- 92	D+ 68	75.0	76.4	75.1	77.8
1H	B 85	C+ 78	A+ 98	87.0	84.8	85.2	84.5
1J	E 55	B+ 88	C+ 78	73.7	72.8	71.2	74.5
14A i	A 95	B 85	B+ 88	89.3	89.6	90.1	89.1
14A ii	D 55	B 85	B+ 88	76.0	73.6	72.1	75.1
14Aiii	E 55	B 85	B+ 88	76.0	73.6	72.1	75.1
14A1	C 75	C+ 78	A+ 98	83.7	80.8	80.7	81.0
14B	E 55	C- 72	A+ 98	75.0	70.4	69.6	71.3
14C	E 55	C- 72	A 95	74.0	69.8	69.0	70.7
14C1	E 55	D+ 68	A 95	72.7	68.2	67.6	68.9
14C2	E 55	D+ 68	A+ 98	73.7	68.8	68.2	69.5
15	B 85	C 75	A+ 98	86.0	83.6	84.1	83.1
16A	A 95	B 85	C 75	85.0	87.0	87.5	86.5
18A i	D 65	A+ 98	C 75	79.3	80.2	78.6	81.9
18A ii	E 55	A+ 98	C 75	76.0	76.2	74.1	78.4
18Aiii	C 75	A+ 98	C 75	82.7	84.2	83.1	85.4
Bridge (Route 1I) H-Lamphan	D 65			65.0			
Bridge (Route 16) H-Phakkud	D 65			65.0			
Bridge (Route 16) Xe-Kong,	E 55			55.0			
Bridge (Route 20) 19Nos	D 65			65.0			

The highest-ranking projects in terms of cost-benefit impacts are road link **14Ai** and road link **16A**. In terms of socio-economic impacts, road link 18Ai, ii and iii are evaluated the highest. As for environmental impacts, road links 1H, 14A1, 14B, 14C2 and 15 had the least impact and therefore are highly rated.

Determining weighting in some instances is a function of national priorities coupled with regional and local interests. The Study Team here recalls the following targets set forth in the 'Fifth Five-Year Socio-Economic Development Plan,' which indicate the strong set of positive socio-economic impacts that road improvement will have in southern Lao:

- to realize continued economic growth,
- to reduce current poverty levels by half,
- to achieve food security,
- to eliminate slash-and-burn cultivation,
- to pay serious attention to both state and private enterprise reform, and
- to develop human resources in various sectors.

The above priorities also involve a process of trade-offs where benefits and costs have to be balanced with the larger social need and concerns. For example, although road improvement projects will spur economic and socio-economic development, they will also cause damage to the natural/ecological environment. A balanced approach could perhaps minimize the impact on natural/ecological environments by ensuring sufficient human capacity to manage the environment in a sustainable manner via a responsible and transparent regulatory system.

The Planning and Technical Division of MCTPC has developed an approach for the prioritization of investment projects (PEP: Project Evaluation Procedure). The idea of the PEP is to analyze the government policy aspects of projects in addition to carrying out a strict economic analysis. Criteria are rated on a 0 to 10 scale and then combined linearly using criteria weights from 0 to 100 percent. Note that the criteria overlap to some extent. However, by introducing these as separate items, weight can be given to different road functions and geographic locations, without which a conventional economic analysis would result in the further concentration of investment in those parts of the network with already relatively high levels of traffic, population and rates of growth. The criteria and corresponding weights introduced in the PEP are illustrated in Table 7.2.3.

Table 7.2.3 Criteria and Weight (example)

Cost Benefit	**30**
Connect Provinces	**10**
Connect Districts	**5**
Poverty Reduction	**20**
Neighboring Countries	**10**
National Integration	**15**
Tourism	**5**
Environment	**5**

Source: Handbook of Road Investment Project Judgment Proposal 31 January 2000

Based on the above concept and reference, the Study Team recommends that Case 4 (C:S:E = 35:45:20) in Table 7.2.2 be applied as the criteria/weight composition for prioritizing projects. As the table indicates for this Case, road link **14Ai has the highest** and **16A has the second** total evaluation score and are therefore recommended as most appropriate project for early implementation.

7.3 Establishment of Road Improvement Master Plan to 2020

The selected road improvement projects, are prioritized in the Master Plan using the ranking and scoring system described in the previous section, as well as the following factors:

- ◆ Urgency and Necessity
- ◆ Funding
- ◆ Other Related Road Improvement Projects
- ◆ Level of Technology

It is important to note that not all road links, especially those with relatively low traffic volume, necessarily conform to national standards (i.e., road surface type). Therefore, the Study Team suggests that there be a range of alternatives regarding road surface criteria and its implementation schedule to meet the all-weather needs of residents, and that priority setting take into account staged improvement (e.g., surface dressing in the first stage and asphalt-concrete in the second stage). It is generally agreed that a road link would be upgraded from surface dressing to asphalt concrete pavement when motorized four-wheeled daily traffic exceeds 1500 vehicles per day.

The Master Plan is driven by a series of imperatives, but clearly economic development and the alleviation of poverty must be seen as the main driving forces. In addition, preservation of the environment is also essential.

Outline of the 16 (sixteen) road links to be improved, is summarized in Table 7.3.1.

To establish the Mater Plan, the following conclusions from a traffic viewpoint also should be taken into account:

- **From the perspective of traffic demand and time savings, construction of the missing link on Rt. 14A is desirable. For example, vehicles that currently use the ferry to cross the Mekong River at Champasack would divert to this route for significant reductions in travel times. The construction of this link would also promote tourism and encourage agricultural activity by providing improved access.**
- **Routes 16A and 18A are similar in the role that they play in the network and therefore directly compete. Accordingly, scarce resources should only be used to**

improve one of these routes. Either of these routes would serve as an important east-west corridor connecting the province of Attapeu and Vietnam with the more populous and richer western part of southern Lao. According to the July 2000 "Study on the National Transport Development Strategy in the Socialist Republic of Vietnam," which was financed by JICA, this is becoming especially important as Vietnam puts more emphasis on its links with southern Lao via Attapeu.

Note that although distance via Rt. 16A is a little longer than via Rt. 18A in terms of length (*), its improvement would also provide better access to markets for the coffee-rich Boloven Plateau, while improving Rt. 18A would have little commercial value and could potentially be destructive environmentally.

- From the perspective of linking up central southern Laos with the north-south Rt. 13, the improvement of Rt. 15 can be said to be desirable. This would also provide better access between Savannakhet, Pakse and Saravan, which already form an important trip-making axis. In addition, the population density along this route is relatively high; thereby, ensuring sufficient demand.
- Even with the improvement of Rt. 1G and the construction of its missing link, there will be little traffic on this road. This is because most of the traffic on Rt. 9, which has a high proportion of goods vehicles and traffic from Vietnam, is headed for Savannakhet and the northern part of Laos. In addition, Rt. 1G competes with Rt. 15 East for traffic from Vietnam and careful consideration should be given to whether or not both require improvement.
- The improvement of the portion of Rt. 1H under study has merit in that it connects two of the most important routes in southern Lao (i.e., Rt. 16 and Rt. 20) and should be carried out in the near future.
- In terms of traffic flows and economic interconnectivity, improvements to the road network in southern Lao should focus more on east-west connections rather than north-south connections.
- Although these are not Study roads, seven of the 30 district capitals of the Study area do not have all-weather road (i.e., basic access) and this issue should be considered in a future study.

Combining the timetable given in 'Ⅲ6.Economic Analysis' with the above, a timetable for the improvement of the road links and bridges in the Master Plan to all-weather passable standard has been prepared, as shown in Figure 7.3.1.

(*) At feasibility study stage a shortcut section was included for Rt. 16A. With this section the distance via Rt. 16A is a little shorter than via Rt. 18A.

Table 7.3.1 Outline of Road Links to be Improved

Route	Origin	Destination	Length (km)	Road Conditions in early 2002	River Crossing Nos. & Length (m)	Project Cost * (M. US $) Pavement :DBST Bridges	Population Impact (within 5km from the Road)	Traffic Volume In 2020 (veh./day)	EIRR in year ()	Outline of the Road Link
1G	JCT. Rt. 9	JCT. Rt. 15	130.0	32 km is missing link. Bad conditions through the whole section. This route runs through the protected area, NBCA.	42 1,299m	44.5	32,510	289	0.4 (2020)	This area has little economic potential and significant need for social development. Improvement would provide a basic access and a much shouter route from Vietnam and areas along Route 9 to central southern areas.
1H	JCT. Rt. 20	JCT. Rt. 16	22.5	Well maintained with a gravel surface.	0 0m	4.3	6,384	761	10.5 (2008)	This is the section on Saravan-Sekong-Attapeau. It has relatively high EIRR and is feasible for improvement beginning in 2006.
1J	JCT. Rt. 18B	Cambodian Border	81.0	65 km is missing link.	13 548m	24.8	14,488	126	-	This area has little economic potential and significant need for social development. Improvement would provide a basic access. Cross-border traffic potential appears to be limited at this stage.
14A(i)	Phong Thoth Dist.	Ban Sam Kha	54.0	16 (25) km is missing link. Short stretch between Champasack ferry and access to Vat Phou is paved. Route It is about 25km from Route 16 to Champasack .	8 305m	15.1	72,000 (the greater part : in14Ai)	1,124	22.4 (2007)	This route would improve West Bank Access to Champasack and the south from Pakse which is a core city in the Southern Region. Agriculture sector will get direct profit to have shortest access to the market as well as tourism.

14A(ii)	Ban Sam Kha	JCT. of Rt. 14C	51.5	Vehicles can pass for only 2 months at Houay Kamouan River.	2 70m	11.4		572	-	This has rich potential on the agriculture as well as the area along road 14A(i). ADB is believed to be considering upgrading to all-weather gravel standard. This would complement the paving of 14A(i) improving access to all areas of the west bank adjacent to the Mekong.
14A(iii)	M. Moonlapamok	Cambodian Border	32.0	Many rivers cross the route.	22 730m	15.5		572	-	
14A1	Ban Ang Kham	Ban Don Talath	32.0	Fair condition through the route and well maintained.	8 148m	7.7	38,130	<100	15.6 (as alternative to 14Ai otherwise 2012)	This route would contribute to function as a basic access to the inland agriculture area. In the absence of Route 14A(i), it would be viable for construction of paved road.
14B	JCT. of Rt.16	Cambodian Border	149.0	The first 11.2 km of the road has been improved with gravel surface. From the Route 14A1 junction southward, road condition deteriorates markedly to dray season only.	30 789m	40.1	12,565	<100	-	This serves a relatively undeveloped area of low population density for the whole of 138km south to the Cambodian border.
14C	Ban Nong Nga	M. Moonlapamok	42.0	The road has been improved with gravel surface at some sections.	8 120m	9.5	6,194	<100	-	These three provide connections between Routes 14A and 14B, through largely undeveloped and low populated areas.
14C1	Ban Hieng	Ban Sam Kha	23.0	Well maintained with gravel surface at some sections.	2 125m	6.5	10.756	<100	-	
14C2	Ban Phone Photh	Ban Nong Te	6.0	Well maintained with gravel surface.	1 25m	1.4	3,765	<100	-	
15	JCT. Rt. 13S	JCT. Rt. 1H	73.0	Well maintained with gravel surface. During rainy season, it is difficult to pass through on two bridges.	19 564m	21.8	58,851	834	7.8 (2011)	This route provides a much shorter connection from Saravan to Savannakhet and the north than the route via Pakse.
16A	JCT. Rt. 16	JCT. Rt. 1I	71.0	The road passes through the Boloven Plateau and connects Route 16 at Paksong and Route 1I.	6 207m	14.9	13,363	750	15.1 (2007)	The route would contribute to both East-West Connectivity and development of cash crops

										agriculture in Boloven Plateau.
18A(i)	JCT. Rt. 13S	Provincial Border	30.6	Fair condition through the route.	5 135m	7.5	13,364	792	4.9 (as alternative to 16A, otherwise negative)	The route passes through NBCA. The route provide a slightly shorter route than the Route 16A from Pakse and Attapeau. Improvement of 18A however costs 160 per cent more the cost of improving Route 16A.
18A(ii)	Provincial Border	Xe Piane River	39.7	Two big rivers cross the route. Bad conditions through the whole section.	19 710m	17.7	3,179			
18A(iii)	Xe Piane River	JCT. of Rt. 18B	42.2	Fair condition through to Attapeau.	14 445m	13.9	29,028			

Remarks: * Project Cost indicates for purpose of the Study on Master Plan only (Pavement : DBST), not for the Feasibility and Implementation.

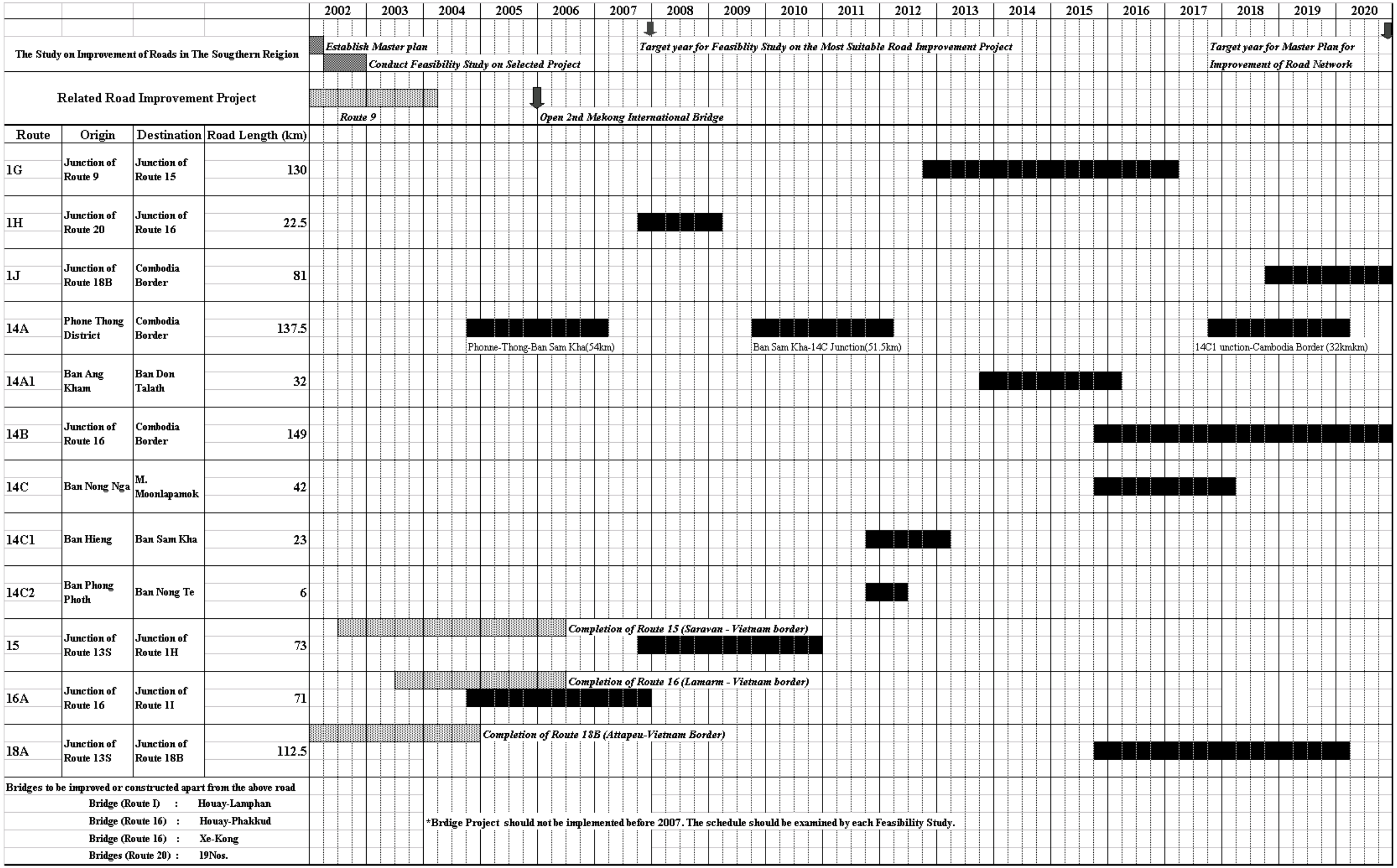

Figure 7.3.1 Road Improvement Master Plan to 2020

The implementation schedule of the most appropriate road improvement project has been examined and developed considering optimal commencement time and the completion date (the end of 2007). However, the Study Team would like to state that the project schedules in the timetable are purely indicative and should be carefully considered when deciding to proceed with a feasibility study for a particular project.

Each project (target year: 2020) is composed of several major work items as presented in Table 7.3.2. Based on the traffic forecast up to 2020, surface dressing is recommended for most of the roads.

Table 7.3.2 Work Items by Project

Study Routes & Bridges	New Construction	Upgrading of Geometric Design (Major Portion)	Pavement (1) Surface Dressing	Pavement (2) Asphalt Concrete	Other Work Structure, drainage, traffic signs, etc.
1G	○	○	○		○
1H			○	**	○
1J	○	○	○		○
14A	○	○	○	**	○
14A1		○	○		○
14B		○	○		○
14C			○		○
14C1			○		○
14C2			○		○
15			○	**	○
16A		○	○	**	○
18A		○	○	**	○
Bridge (Route 1I) Houay-Lamphan	○				
Bridge (Route 16) Houay Phakkud	○				
Bridge (Route 16) Xe-Kong, Lamarm	○				
Bridge (Route 20) 19Nos.	○				

** Possible on some sections

7.4 Selection of Priority Road Improvement Projects

Based on the analyses of the Master Plan, the priority road improvement projects to be completed by 2007, have been selected for detailed examination in the Feasibility Study.

The Study Team concluded that **Road Link 14A(i) (between Phon Thong Dist. And Ban Sam Kha) and Route 16A** are the most appropriate for implementing and completion by 2007. It was also suggested by the Lao Government that the Feasibility Study extend the recommended section of improvement for 14A(i) by about 4km down to the junction for the district capital of **Sukhuma**.

The future traffic assignment (year 2007,with 14A(i) and 16A improved) developed in the Master Plan, is illustrated in Figure 7.4.1.

Route 14A(i) will provide direct access to the west bank area of the Mekong as well as to the southern part of the west bank, which will fuel development of the Emerald Triangle Area.

- This route would be improved to all weather road to connect Pakse (core city center in the southern region) and major points in the west bank of the Mekong (i.e., Champasack town, B.Phonnggam, Wat Phou, B.Dontalat and B.Sukhuma etc.) in order to promote regional development and to stimulate international tourism.
- This route is located in one of the most rice-rich areas in the nation. The population has a high literacy rate, which may have a potential to facilitate industry and commercial activities.
- This route also promotes development of the far south area of the west bank which remains undeveloped.
- This route provides all weather access to ‘missing link section’ along the west side of the Mekong. Regional development and poverty reduction in this area will be promoted.
- Vehicles currently using the ferry to cross the Mekong at Champasack would divert to this route, with significant reduction in travel times.
- This route leads toward the south and the Cambodia border via Route 14 A(ii) and 14A(iii) and therefore will contribute to the development of the Emerald Triangle Area, Thai, Lao and Cambodia.

Route 16A will contribute to rural development in an area near the Champasack-Attapeu border and also improve East-West connectivity between Thailand, Lao and Vietnam.

- This route would be improved to all weather road between Paksong and Route 1H, in order to promote regional development.

- Improvement of this route provides better access to market for the coffee-rich Boloven Plateau.
- Improvement of this route contributes as an important east-west corridor connecting Thailand via Pakse (provincial and regional core city) and Vietnam via Attapeu (provincial capital).

The Feasibility Study in Ⅳ takes into consideration economic, financial, and technical viability in evaluating the feasibility of the above-mentioned projects.

The Feasibility Study, which includes detailed surveys and design work, estimates project economic benefits while carefully considering construction planning. An implementation plan is drawn up, taking into consideration the financial requirements of the project, its appropriate phasing, and the most cost-effective work packaging and work breakdown.

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In addition, the Study Team noted that Road Link 18A, which is the most highly evaluated link in terms of socioeconomic impact, should also be examined from the viewpoint of being upgraded to the level of providing "**Basic Access and Road for Regional Economic Activity**" with the aim of reducing current poverty levels. It is therefore recommended that a road improvement study be carried out that proposes a reliable methodology to upgrade existing roads (such as Route 18A) to the above sufficient level. The crucial benefit of this methodology is that it will enable the Government of Lao to execute such road improvements using its own economic and technical resources.

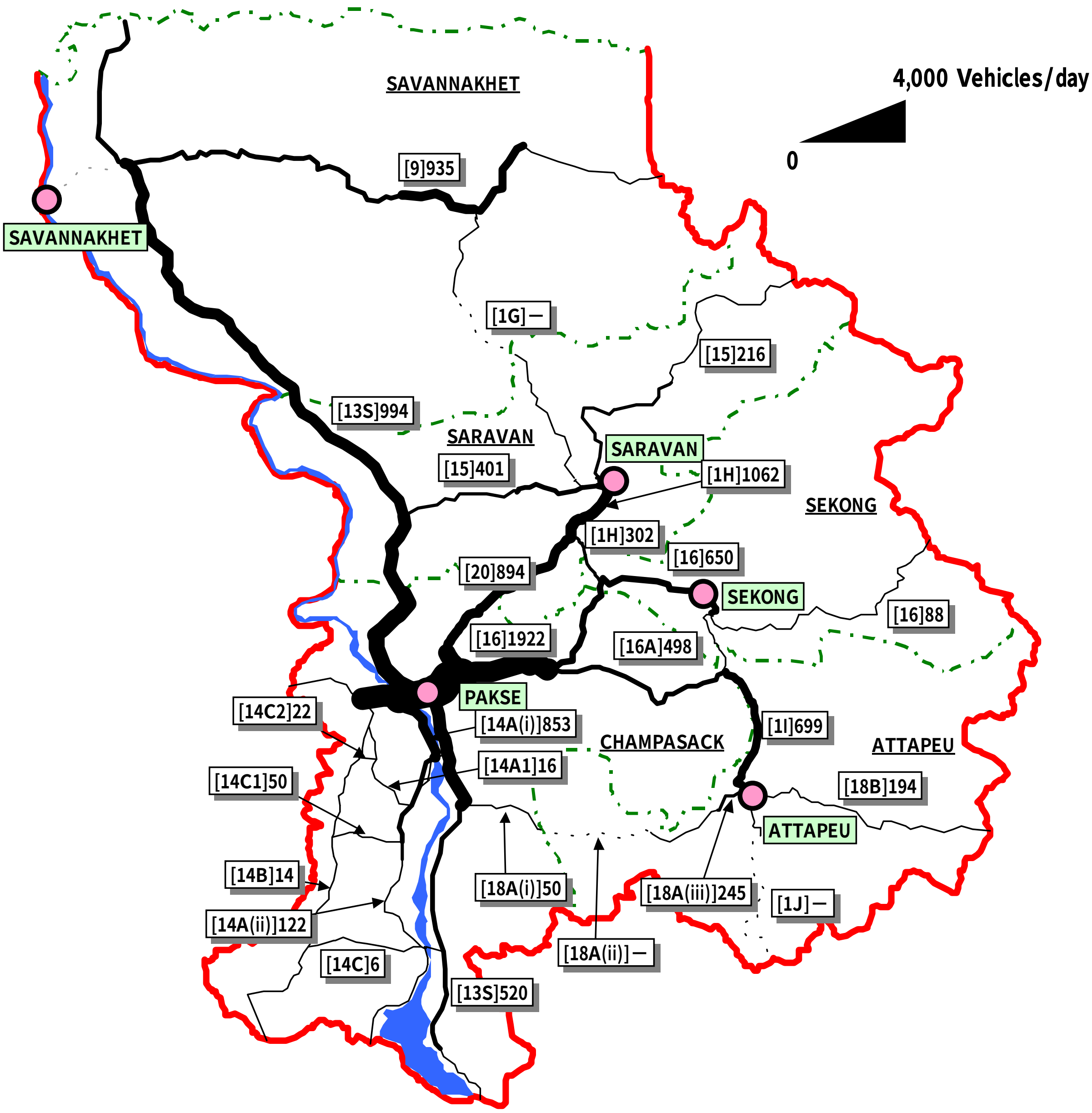

Figure 7.4.1 Future Traffic Assignment (Year 2007,with 14A &16A improved)