Ministry of Public Works and Transport
Lao People's Democratic Republic

PREPARATORY STUDY FOR IMPROVEMENT OF ROADS AND BRIDGES IN THE SOUTHERN REGION IN LAO PDR

FINAL REPORT

November 2010

JAPAN INTERNATIONAL COOPERATION AGENCY

INTERNATIONAL DEVELOPMENT CENTER OF JAPAN
ORIENTAL CONSULTANTS CO., LTD.

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PREFACE

The location of Lao PDR offers strategic prospects, transforming itself from "land-locked" to "land-linked" country particularly due to globalization in trade and transport and regional economic integration in GMS and ASEAN region. In this respect, road links, in particular, are of vital importance.

The Government of Lao PDR has made intensive efforts to improve the trunk road network in Southern Lao. These efforts include road improvements along NR-13 (South), NR-9 and construction of the Second Mekong Bridge, under the support of both bilateral and multilateral donors, such as ADB, World Bank and JICA. In spite of the afore-mentioned, there is still need for significant injection of funds into road rehabilitation/development in Southern Lao. Unpaved roads and un-rehabilitated bridges, frequently observed in the Southern Lao, all contribute to deteriorating the road network and hence hindering trade of both goods and people. As such, the economic development in Southern Lao lags behind the other regions in Lao PDR.

In this regards, the Japan International Cooperation Agency (JICA) decided to conduct the Preparatory Study for Improvement of Roads and Bridges in the Southern Region in Lao PDR. JICA selected and dispatched the Study Team between February 2010 and September 2010.

The Study Team held discussions with the officials concerned of the Government of Lao PDR and conducted field surveys at the study area. Upon returning to Japan, the Study Team conducted further studies and prepared this final report.

It is my hope that this report will contribute to realization of the road improvement projects and hence to development in the Southern Region of Lao PDR. Finally, I wish to express my sincere appreciation to all the people for their generous cooperation extended to the Study Team.

November 2010

Kiyofumi KONISHI,
Director General
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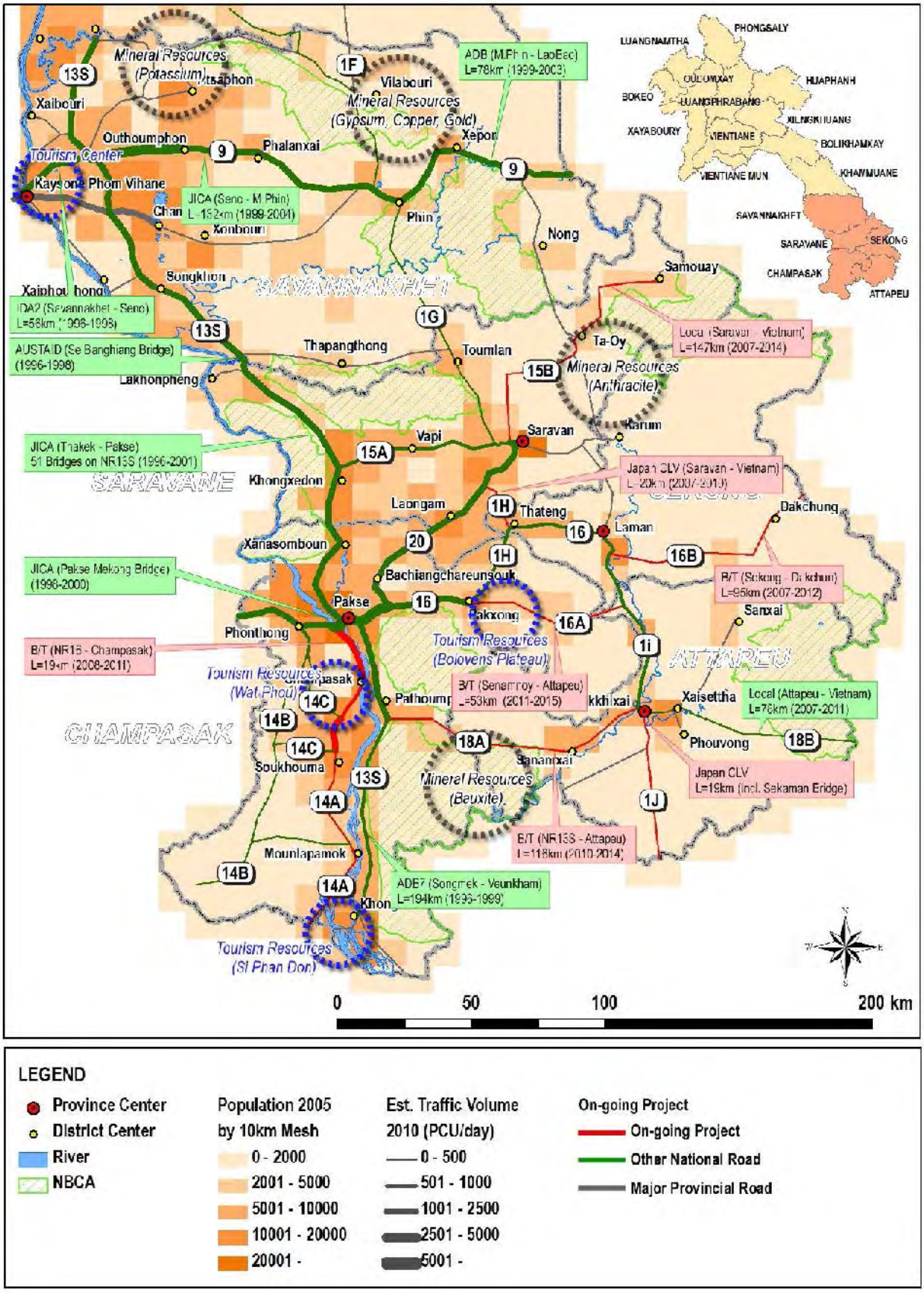

PHONGSALY
LUANGNAMTHA
OUDOMXAY
HUAPHANH
BOKEO
LUANGPHRABANG
XIENGKHUANG
XAYABOURY
VIENTIANE
BOLIKHAMXAY
VIENTIANE MUN
KHAMMUANE
SAVANNAKHET
SEKONG
SARAVANE
CHAMPASAK
ATTAPEU
Mineral Resources (Potassium)
Vilabouri
Mineral Resources (Gypsum, Copper, Gold)
ADB (M.Phin - LaoBao) L=78km (1999-2003)
Xaibouri
Outhoumphon
Phalanxai
Xepon
Tourism Center
Kaysone Phom Vihane
JICA (Seno - M.Phin) L=152km (1999-2004)
Phin
Nong
Samouay
Songkhon
Xaiphoulthong
JICA (Savannakhet - Seno) L=58km (1998-1999)
AUSTAID (Se Banghiang Bridge) (1996-1998)
Thapangthong
Toumlan
Ta-Oy
Local (Saravan - Vietnam) L=147km (2007-2014)
Mineral Resources (Anthracite)
Lakhonpheng
Vapi
Saravan
Karum
JICA (Thakek - Pakse) 51 Bridges on NR13S (1996-2001)
Khongxedon
Japan GLV (Saravan - Vietnam) L=20km (2007-2013)
Laongam
Thateng
Laman
Dakchung
Xanasomboun
JICA (Pakse Mekong Bridge) (1996-2000)
Bachiangchareunsouk
B/T (Sekong - Dakchung) L=95km (2007-2012)
Pakse
Pakxong
Sanxai
Phonthong
Tourism Resources (Bolovens Plateau)
B/T (NR13 - Champasak) L=19km (2008-2011)
Tourism Resources (Wat Phou)
B/T (Senamnoy - Attapeu) L=53km (2011-2015)
Xaisettha
Local (Attapeu - Vietnam) L=76km (2007-2011)
Phourvong
Soukhouma
Mineral Resources (Bauxite)
Japan GLV L=19km (incl. Sekaman Bridge)
B/T (NR13S - Attapeu) L=118km (2010-2014)
Mounlapamok
ADB? (Songmek - Veunkham) L=194km (1998-1999)
Khong
Tourism Resources (Si Phan Don)
0
50
100
200 km
LEGEND
Province Center
District Center
River
NBCA
Population 2005 by 10km Mesh
0 - 2000
2001 - 5000
5001 - 10000
10001 - 20000
20001 -
Est. Traffic Volume 2010 (PCU/day)
0 - 500
501 - 1000
1001 - 2500
2501 - 5000
5001 -
On-going Project
On-going Project
Other National Road
Major Provincial Road

Study Area

SUMMARY

1. INTRODUCTION

1.1 Background of the Study

The Government of Lao PDR has made intensive efforts to improve the trunk road network in Southern Lao. These efforts include road improvements along NR-13 (South), NR-9 and construction of the Second Mekong Bridge, under the support of both bilateral and multilateral donors, such as ADB, World Bank and JICA. In spite of the afore-mentioned, there is still need for significant injection of funds into road rehabilitation/development in Southern Lao. Unpaved roads and un-rehabilitated bridges, frequently observed in the Southern Lao, all contribute to deteriorating the road network and hence hindering trade of both goods and people. As such, the economic development in Southern Lao lags behind the other regions in Lao PDR.

In light of this, the Government of Lao PDR acknowledges road improvement in Southern Lao should be given the highest priority and has officially requested the Government of Japan for grant aid for the road and bridge improvement projects. In response to this request, the Japan International Cooperation Agency (JICA) carried out the study in 2003, namely the Study on Improvement of Roads in the southern region in Lao PDR, and conducted the feasibility study on two priority projects (NR-14A and NR-16A). However, none of the projects has been implemented yet, since reasoning behind these projects pointing out the appropriateness, necessity and urgency of the projects, and impact of the project on poverty alleviation need to be clearly identified as requirement for Japanese grant aid.

1.2 Objectives of the Study

This Study aims at revising the previous JICA study, i.e. the Study on Improvement of Roads in the southern region in Lao PDR, conducted in 2003, through updating the current road and bridge conditions and socio-economic conditions and testing the feasibility of the road improvement projects requested by the Government of Lao PDR for Japanese grant aid. Through this revision work of the previous study, the current study also aims at providing recommendations to narrow down the scope of road and bridge improvement projects in the southern region under the Japanese grant aid.

1.3 Study Area

The study area covers five provinces in the southern region in Lao PDR; Savannhakhet, Saravan, Sekong, Champasack and Attapu.

2. GENERAL UNDERSTANDING OF SOUTHERN REGION

2.1 Population and GDP

Table 2.1.1 illustrates the change in population in the 5 provinces from 1995 to 2005. The total population of the 5 provinces increased from 1.6 million in 1995 to 2.0 million in 2005. The percentage of the population in 5 provinces as a fraction of the national population has remained consistent at around 35%.

Table 2.1.1 Change in Population from 1995 to 2005

	Population (000 persons)		Share (%)		Growth rate from 1995 to 2005 (%)
	1995	2005	1995	2005	
Lao PDR	4,575	5,615	100	100	2.1
Savannakhet	672	826	14.7	14.7	2.1
Saravane	256	324	5.6	5.8	2.4
Sekong	64	85	1.4	1.5	2.9
Champasak	501	607	11.0	10.8	1.9
Attapeu	87	112	1.9	2.0	2.5
Total of the Study Area	1,581	1,955	34.6	34.8	2.1

Source: Census 1995 and 2005, DoS

Table 2.1.2 indicates estimated GRDP of the 5 provinces in 2008. It is calculated from the national GDP in 2008, household consumption by province and the number of business establishments by province. The study area contributes to 28.2% of the national GDP.

Table 2.1.2 Estimated GRDP of 5 Provinces in 2008

	GDP/GRDP (million Kip)	Share (%)	GDP/GRDP per Capita (USD)
Lao PDR	46,215	100.0	891
Savannakhet	5,499	11.9	720
Saravane	1,607	3.5	549
Sekong	450	1.0	552
Champasak	4,736	10.2	828
Attapeu	736	1.6	751
Total of the Study Area	13,028	28.2	721

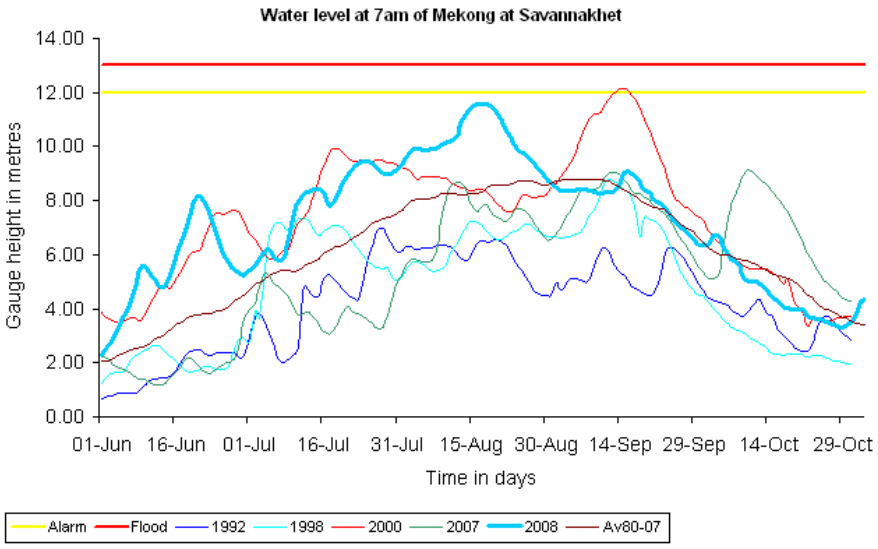
Source: Calculation by JICA Survey Team from Statistical Yearbook, LECS 3 and Economic Census 2006

2.2 Natural Condition

The southern region of Lao PDR is embedded with variable terrains from flat to mountainous. The altitude ranges from 120 to 150 meter above sea level in the Savannakhet plain. The chain of

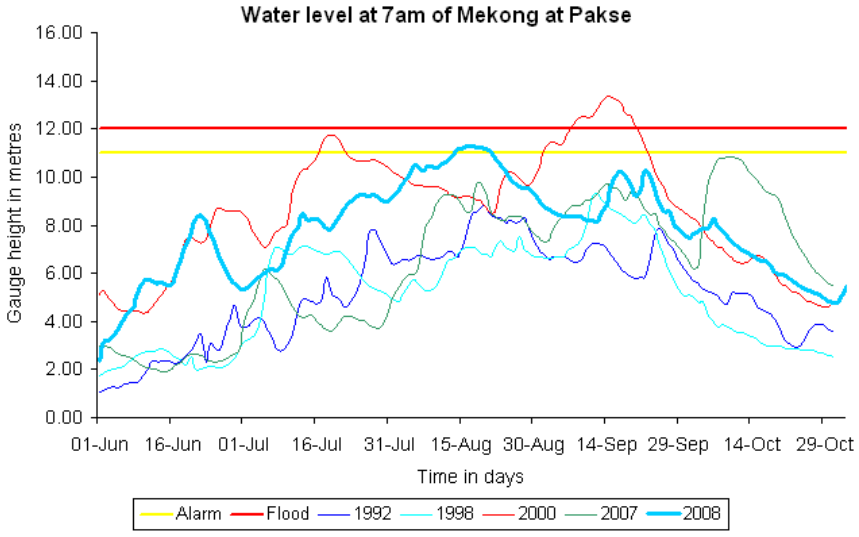
mountains, with average height of 1,200 meter above sea level, is called “Annamite chain“, running from northwest to southeast. The Bolovens Plateau, of which altitude ranges from 500 to 1,500 meter above sea level, is located in the middle of the southern region.

In the southern region, all rivers and tributaries such as Sebanhiang, Sedone, Sekong and Sekaman Rivers, originating from the western mountain side of the Annamite Chain, merge into the Mekong River, running through the western side of entire southern region. Vast rain forests exist around the Bolevan Plateau and Annamite Chain. Water level of the Mekong River fluctuates considerably throughout the year (see figures 2.2.1 and 2.2.2), so that, due to the backwater effect of the Mekong River on the regional river system, water levels of major tributaries in the southern region tend to have similar variation pattern.



Source: http://ffw.mrcmekong.org/historical_rec.htm

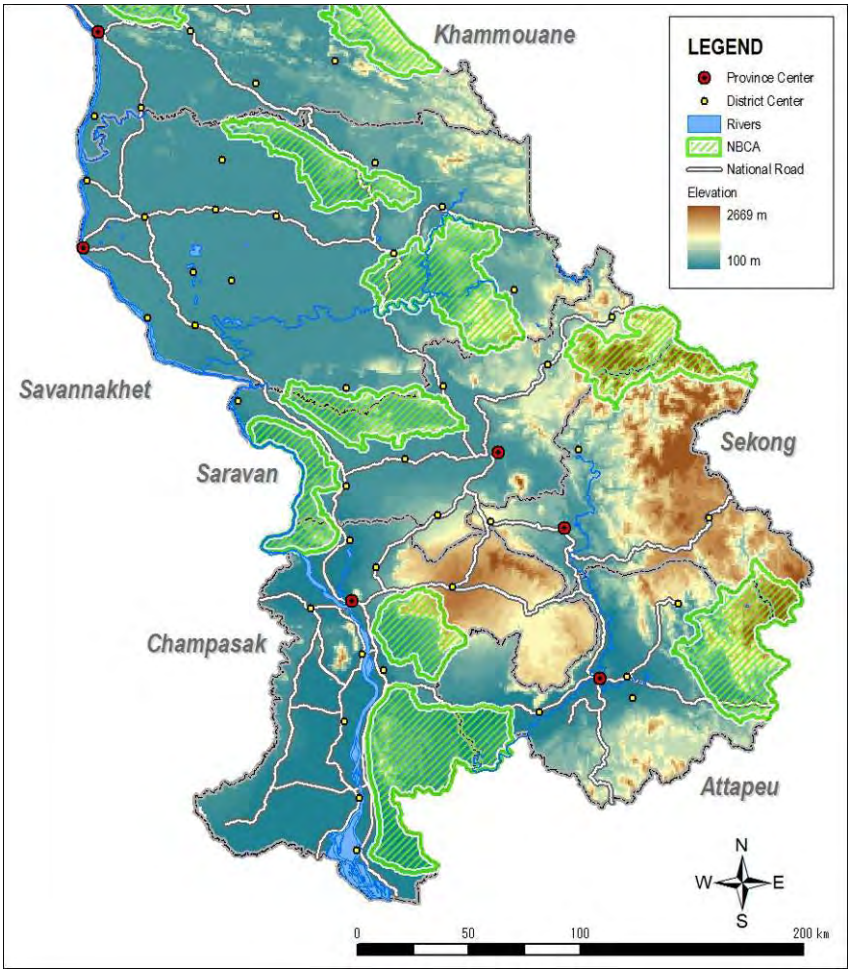
Figure 2.2.1 Temporal Variation (Flood Season) of Water Level of Mekong River at Savannakhet



Source: http://ffw.mrcmekong.org/historical_rec.htm

Figure 2.2.2 Temporal Variation (Flood Season) of Water Level of Mekong River at Pakse

The study area spans from the Mekong floodplain to Bolevan Plateau, and rich tropical floral and faunal biodiversities exist therein. The largest national protected areas exist in the southern region of Laos. There are eight National Protected Areas (see Figure 2.2.3) across this region. Beside those National Protected Areas, there are several Important Bird Area across the southern region (see Figure 2.2.4).



Source: Prepared by JICA Study Team based on the GIS Database

Figure 2.2.3 National Protected Areas

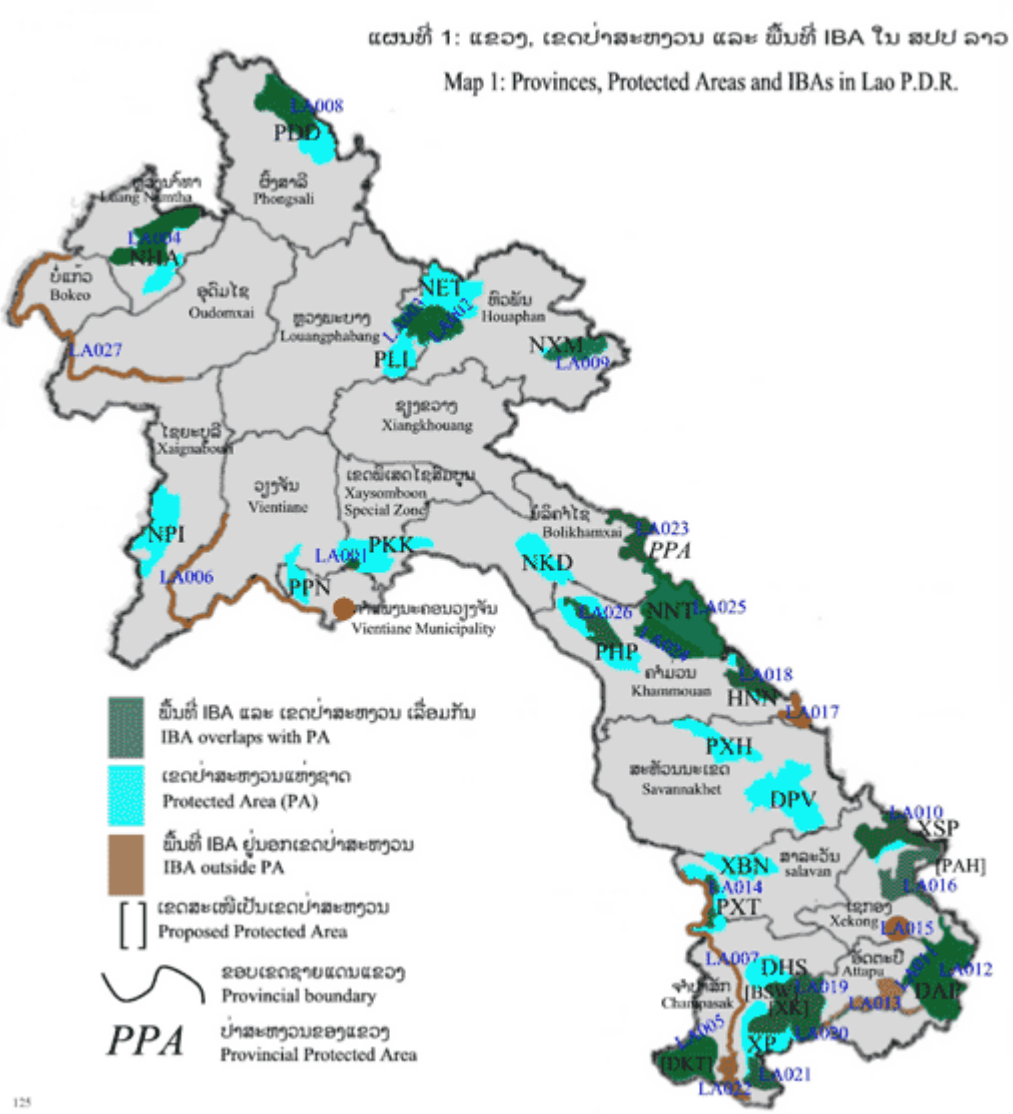
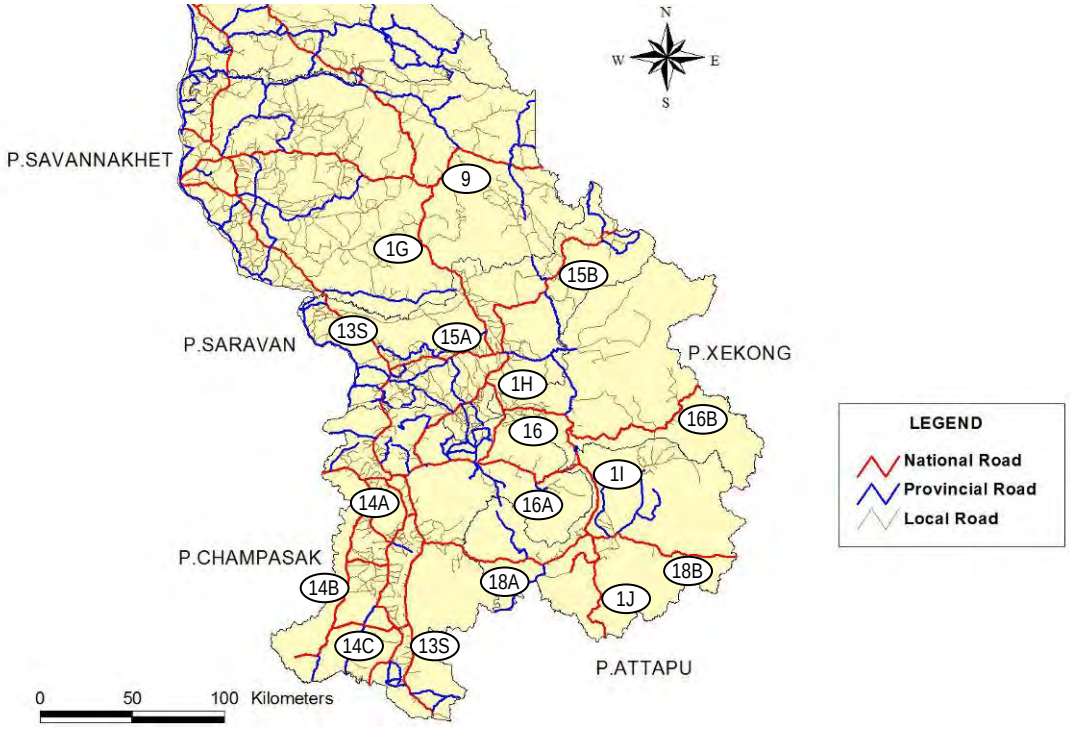


Figure 2.2.4 Important Bird Area

2.3 Road Network and Traffic Condition

(1) Road Network and Condition

The road network in the southern region of Laos stretches to a length of 12,250km, accounting for 33% of the total length of roads in Laos. 1,026 km of the road network in the southern region, mainly the national roads, is paved. Considering the national roads, about 49% of the national roads are paved. The remaining road network of length 1,131 km is either earth or gravel surfaced: these are left unpaved and 110km of these unpaved roads are reported currently impassable. Some 347km of the road network, mainly along NR-9 and NR-18B in the southern region, is paved with AC, which accounts for 34% of the total paved road length of national roads.



Source: JICA Study Team

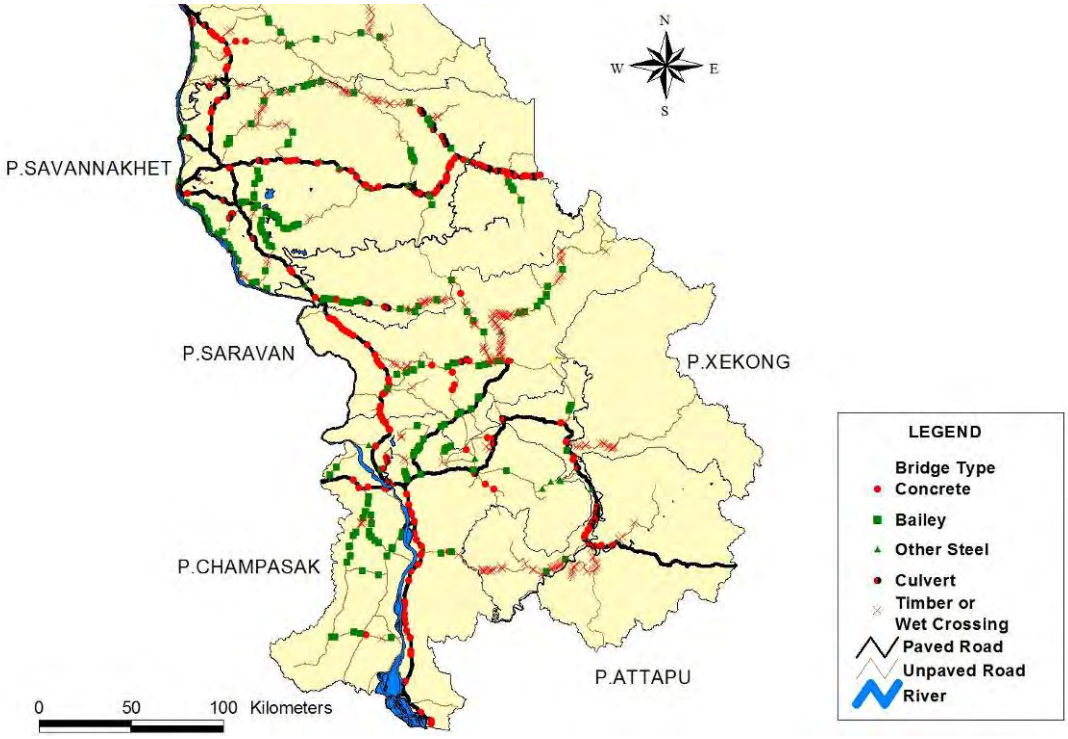
Figure 2.3.1 Road Network by Road Class

(2) Bridge Type and Condition

397 bridges in total were observed along the national roads in the southern region. Amongst them, only 60% of the bridges are maintained in a passable condition throughout the year. The rest of the bridges are without crossing structures due to destruction or damage by flooding or past conflicts.

Along the paved roads, almost all bridges are constructed by concrete, though the condition of these concrete bridges varies significantly. For instance, most of the bridges along NR-9 were constructed in the mid 1980s with the former Soviet Union's assistance but are now in deteriorated condition.

Besides the concrete bridges along the paved roads, most of the bridges are either bailey or timber bridges along the unpaved roads. At the crossing point of the major rivers, a small ferryboat usually operates to carry people and vehicles throughout the year or during rainy seasons. These include Sedone River (NR-15, during the rainy season), Sekong River (NR-16B) and Sekaman River (NR-1J).

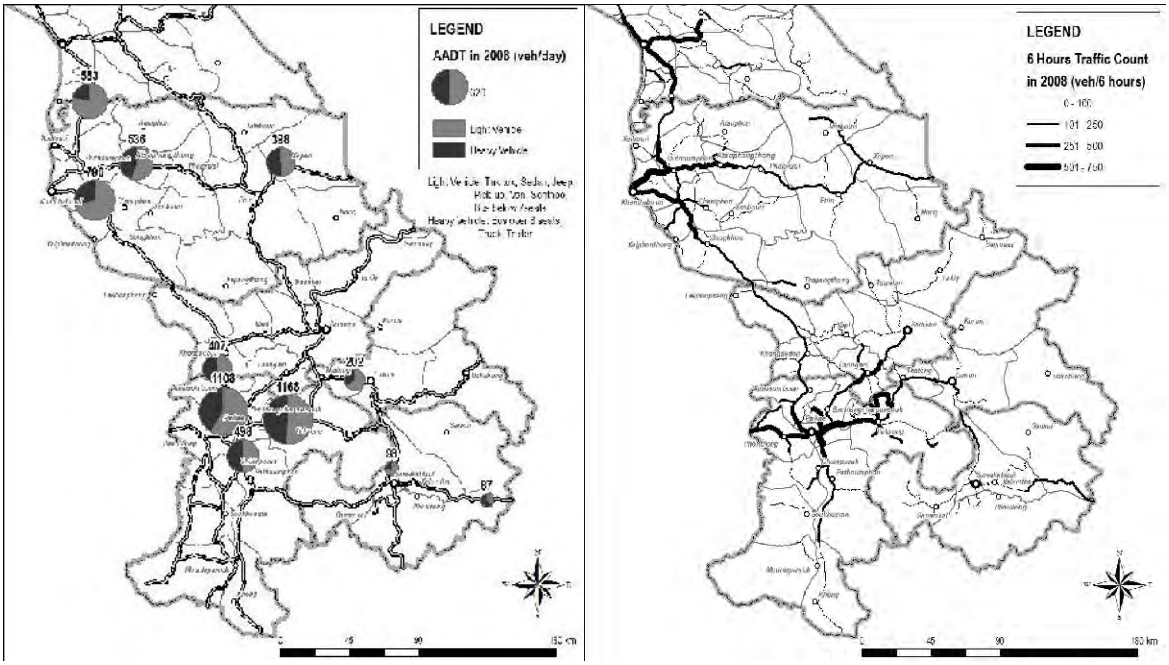


Source: JICA Study Team

Figure 2.3.2 Existing Bridges by Bridge Type

(3) Traffic Condition

Figure 2.3.3 shows the existing traffic volume based on the toll collection data in 2008 and 6 hours traffic volume complied into Road Management System in 2008. In the southern region, large traffic volumes were observed on national roads connecting province centers such as NR-13S, NR-9, NR-16, NR-18 and NR-20. The traffic volumes in the southern region were, however, observed to be less than a maximum of 2000 pcu/day, with the exception of congested streets in the urban areas.

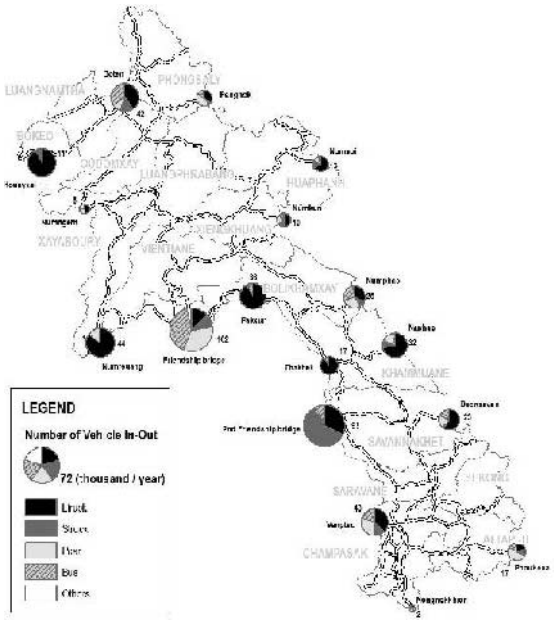


Note: 6 hours Traffic Volume is based on the Traffic Count in Road Management System (RMS)

Source: Annual Average Daily Traffic Volume at Toll Gate is based on the Toll Fee Collection Data in 2008

Figure 2.3.3 AADT at Toll Gate in 2008 (left) and 6 Hours Traffic Volume in 2008 (right)

Figure 2.3.4 shows the number of vehicles passing through the cross border points in 2009. The number of vehicles through the Second Friendship Bridge was about 93,000 vehicles per year, with the trucks dominant, accounting for 91% of the vehicles. The share of trucks at other major cross border points in the study area is also high, accounting for 61% of the vehicles at Densavan and 51% at Vantao.



Source: Summary of Immigration Statistics, Immigration Police Department, Ministry of Public Security

Figure 2.3.4 Number of Vehicles Entering and Leaving Lao PDR in 2009

3. REVISION OF MASTER PLAN

3.1 Review of the Previous Master Plan

The previous study proposed the road improvement master plan in the southern region to provide (i) international/ regional corridor, developing a trunk road network and (ii) basic access, ensuring reliable all-weather access to social infrastructures to reduce poverty. A multi-criteria analysis was applied to the previous study, which incorporated economic evaluation of road investments, together with socio-economic impacts and environmental impacts. Based on the result of project evaluation, the grade and corresponding score of the impact of each candidate road and bridge projects were determined (see Table 3.1.1).

Table 3.1.1 Overall Evaluation Result in Previous Study

Route	Cost-benefit Impacts	Socio-economic Impacts	Environment Impacts	Total Score
Weight	35%	45%	20%	
NR-1G	D 65	A- 92	D+ 68	77.8
NR-1H	B 85	C+ 78	A+ 98	84.5
NR-1J	E 55	B+ 88	C+ 78	74.5
NR-14A (i)	A 95	B 85	B+ 88	89.1
NR-14A (ii)	D 55	B 85	B+ 88	75.1
NR-14A (iii)	E 55	B 85	B+ 88	75.1
NR-14A1	C 75	C+ 78	A+ 98	81.0
NR-14B	E 55	C- 72	A+ 98	71.3
NR-14C	E 55	C- 72	A 95	70.7
NR-14C1	E 55	D+ 68	A 95	68.9
NR-14C2	E 55	D+ 68	A+ 98	69.5
NR-15	B 85	C 75	A+ 98	83.1
NR-16A	A 95	B 85	C 75	86.5
NR-18A (i)	D 65	A+ 98	C 75	81.9
NR-18A (ii)	E 55	A+ 98	C 75	78.4
NR-18A (iii)	C 75	A+ 98	C 75	85.4
Bridge (NR-1I)	D 65			65.0
Bridge (NR-16)	D 65			65.0
Bridge (NR-16)	E 55			55.0
Bridge (NR-20)	D 65			65.0

Source: Improvement of Roads in the Southern Region in Lao PDR (JICA, 2003)

3.2 Approach and Methodology Applied to this Study

This Study revised the previous master plan and formulated the road improvement master plan in the southern region by the following steps.

- At the initial stage of the Study, a long list of both road and bridge improvement projects was prepared. This long list of road projects was limited to unpaved national roads, including on-going road improvement projects. The long list of bridge projects included new long-span bridge projects, such as Sekong Bridge and Sedone Bridge, and deteriorated and narrow bridges, observed along NR-9 and NR-20. (Step 1)
- Future socio-economic framework was prepared with the target year of 2025 by reviewing and updating information such as population and GDP. Industrial and agricultural

development projects were listed for a further study to estimate the traffic generated from these projects. (Step 2)

- Future traffic demand in the study area was estimated based on existing and future road network and origin-destination matrices, built in the ongoing JICA Study on the Comprehensive Logistics System in Lao PDR. (Step 3)
- Initial environmental examination was carried out to identify major adverse environmental impacts caused by the project. (Step 4)
- Road and bridge improvement projects were evaluated by a multi criteria analysis, scoring evaluation indicators such as cost-benefit, future traffic volume, development potential, and environmental impacts. (Step 5)
- Economic feasibility of the project was tested, analyzing project benefits generated through reduction of vehicle operating costs and travel time versus the construction and maintenance cost of the project. (Step 6)
- Priority projects were selected based on the revised master plan and the scope of the projects by the Japanese grant aid was narrowed down through the evaluation of the appropriateness, necessity and urgency of the projects. (Step 7)

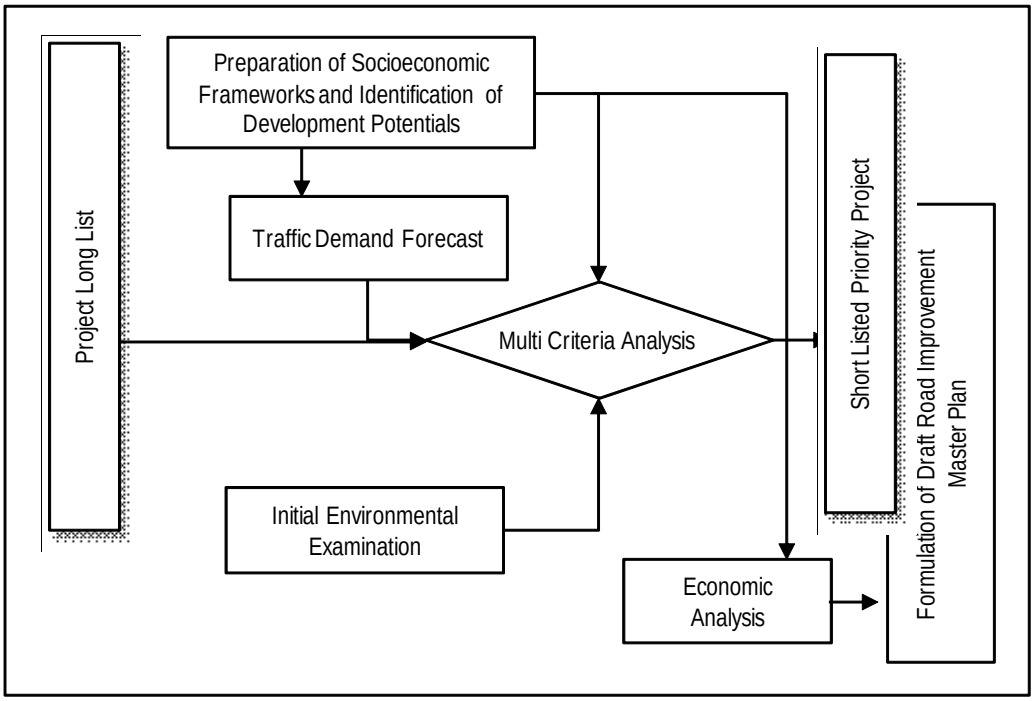


Figure 3.2.1 Overall Approach for Formulation of Draft Road Improvement Master Plan

3.3 Socio-economic Framework

Table 3.3.1 indicates the population forecasts in 5 provinces (Savannakhet, Saravane, Sekong, Champasak and Attapeu). Total population was projected to increase from 1.9 million in 2005 to 2.7 million in 2025 with annual population growth rate of 2.2%.

Table 3.3.1 Population Projection in 5 provinces

(Unit: 000 persons)

Province	1995	2005	2015	2025
Savannakhet	672	826	983	1,134
Saravane	256	324	358	394
Sekong	64	85	112	126
Champasak	501	607	760	913
Attapeu	87	112	112	126
Southern Region	1,580	1,954	2,325	2,693
Lao Total	4,575	5,615	6,696	7,874

Source: JICA Study Team

In regard to the national economic development, an average growth scenario, as indicated in Table 3.3.2 was prepared through analysis of different development alternatives. After the recession in 2010, GDP growth rate will recover to the level before the Global Financial Crisis, and a 7.5% average growth rate is assumed until 2020. After that the average growth rate will decrease gradually in accordance with maturity of economy and decrease of population growth rate.

Table 3.3.2 GDP Growth Scenarios until 2030

(Unit: percent)

	2010	2011-20	2021-25	2025-30
Average GDP Growth Rate	6.0	7.5	7.0	6.5

Source: JICA Study Team (Industrial Development Study, Logistics Network Study and Study on Regional Core Cities)

3.4 Traffic Demand Forecast

For the traffic demand forecast in this Study, road networks and OD matrices prepared in the Comprehensive Study on Logistics System in Lao PDR (JICA, ongoing) are utilized though road network updating and OD matrices division. Future traffic demand in the study area was forecasted by the procedure shown in Figure 3.4.1.

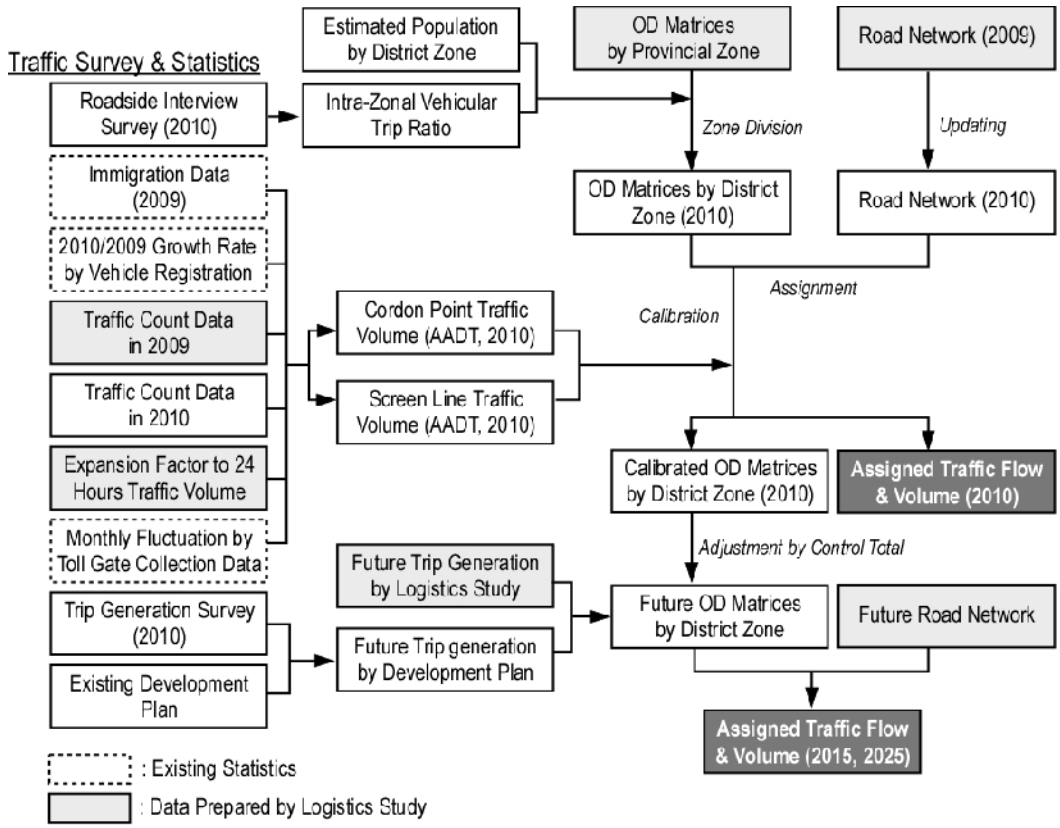
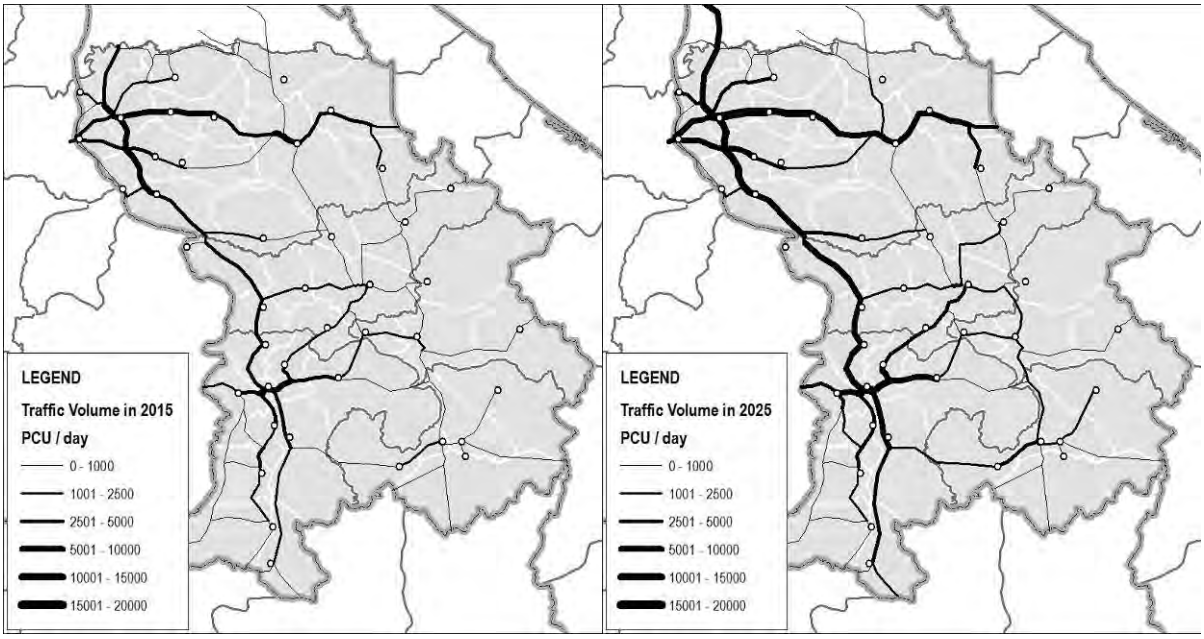


Figure 3.4.1 Traffic Demand Forecast Flow

Figure 3.4.2 shows the results of traffic assignment in 2010 and 2025. Large traffic volumes are observed along NR-9, NR-13S and NR-16. In 2025, the largest traffic volume, exceeding 18,000 pcu/day in both directions, will be observed at NR-13S (Pakse - Houaysae).



Source: JICA Study Team

Figure 3.4.2 Forecasted Traffic Volume

Table 3.4.1 shows forecasted traffic volumes and volume capacity ratios at major roads and bridges in the study area.

Table 3.4.1 Assigned Traffic Volume at Major National Roads

Road		2010		2015		2025	
		Ave. PCU/day	Ave. VCR	Ave. PCU/day	Ave. VCR	Ave. PCU/day	Ave. VCR
NR-9		1,768	(0.13)	4,725	(0.31)	7,511	(0.56)
NR-1G		99	(0.05)	463	(0.10)	892	(0.19)
	Bridge	0	(0.00)	375	(0.09)	673	(0.16)
NR-15A		619	(0.25)	1,772	(0.29)	4,187	(0.68)
	Sedone Bridge	519	(0.19)	1,705	(0.24)	4,010	(0.57)
NR-15B		251	(0.13)	621	(0.13)	1,382	(0.25)
NR-16A		39	(0.02)	23	(0.00)	141	(0.03)
NR-16B		112	(0.07)	184	(0.04)	383	(0.09)
	Sekong Bridge	147	(0.09)	240	(0.06)	500	(0.12)
NR-18A		43	(0.02)	959	(0.17)	2,007	(0.36)
NR-1J		9	(0.00)	60	(0.02)	132	(0.04)
	Sekaman Bridge	42	(0.01)	291	(0.04)	646	(0.09)
NR-14A		604	(0.22)	1,527	(0.22)	2,853	(0.41)
NR-14B		45	(0.02)	0	(0.00)	397	(0.06)
NR-14C		47	(0.02)	0	(0.00)	256	(0.03)
NR-20		1,374	(0.25)	2,383	(0.43)	4,773	(0.80)
NR-1F		59	(0.03)	633	(0.11)	1,066	(0.19)

Source: JICA Study Team

3.5 Revision of Master Plan

(1) Project Long List

In consideration of the existing conditions of roads and bridges as well as projects vying for Japanese grant aid[1], a long list of both road and bridge improvement projects was prepared. This long list of road projects was limited to unpaved national roads, including on-going road improvement projects. The long list of bridge projects included new long-span bridge projects, such as Sekong Bridge and Sedone Bridge, as well as deteriorated and narrow bridges, observed along NR-9 and NR-20. Table 3.5.1 provides details of road and bridge improvement projects studied in this master plan.

[1] Projects requested for Japanese grant aid include Improvement of NR-16A, Improvement of NR 1J, Upgrade of NR 9, Bridge construction along NR-1G, Construction of Sedone Bridge (NR-15A), Construction of Sekong Bridge (NR-16B).

Table 3.5.1 Project Long List

Project Road	Road Length (km)	Type of Project	Summary of Project
NR-9	244.0	Road Upgrade	Adopting the maximum axle load of 11 tons per axle, the whole stretch of the road will be upgraded to ASIAN Highway class III standard.
NR-1F	157.0	Road Improvement	The whole road section, currently with earth/gravel surface at some sections, will be improved to paved surface.
NR-1G	130.0	Road Development	Including 32 km missing link, the whole section of road will be developed/ improved to paved surface. Construction of 300 m long Sebang Hieng and 200 m long Sedone Bridge is part of this project.
NR-1J	81.0	Road Development	Including 65 km missing link, the whole section of road will be developed/ improved to paved surface.
NR-14A	137.5	Road Improvement	25 km road section from the junction of NR-16 is now under implementation. The rest of road section will be improved and paved.
NR-14B	149.0	Road Improvement	The whole road section, currently with gravel surface at some sections, will be improved to paved surface.
NR-14C	42.0	Road Improvement	The whole road section, currently with gravel surface at some sections, will be improved.
NR-15A	73.0	Road Improvement	The whole road section, currently with gravel surface at most sections, will be improved.
NR-15B	165.0	Road Improvement	Around 30 km length of road section is paved while road section of 76 km total length is under construction. The rest of the road section will also be paved.
NR-16A	71.0	Road Improvement	The whole road section will be paved and the survey and design work are currently ongoing.
NR-16B	123.0	Road Improvement	94 km road section is now under construction. The rest of the road section will be improved to paved surface.
NR-18A	112.5	Road Improvement	The whole section, including two over 150 m length bridges, is now under construction and will be paved.
NR-9		Bridge Replacement	All the bridges, constructed in mid 1980's, to be replaced. The total length of the bridge along NR-9 is 2,397m.
NR-1J	Sekaman	Bridge Construction	Around 200 m long Sekaman Bridge is currently at stage of preparation of construction work.
NR-15A	Sedone	Bridge Construction	Around 230 m long Sedone Bridge will be newly constructed.
NR-16B	Sekong	Bridge Construction	Around 280 m long Sekong Bridge will be newly constructed.
NR-20		Bridge Replacement	All the bridges, currently with bridge width of 4 m, to be replaced and widened. The total length of the bridge along NR-20 is 474m.
Total	1,485.0		

Source: JICA Study Team

Table 3.5.2 Project Construction Cost

Project Road	Type of Project	Road Length (km)	Construction Cost (Million USD)		
			Road	Bridge	Total
NR-9	Road Upgrade	244	99.3		99.3
NR-1F	Road Improvement	157	94.0	7.0	101.0
NR-1G	Road Development	130	65.0	41.1	106.1
NR-1J	Road Development	81	51.0	3.3	54.4
NR-14A	Road Improvement	138	49.0	22.2	71.2
NR-14B	Road Improvement	149	53.0	19.1	72.1
NR-14C	Road Improvement	42	15.0	3.2	18.2
NR-15A	Road Improvement	73	28.0	11.4	39.4
NR-15B	Road Improvement	165	107.0	47.2	154.2
NR-16A	Road Improvement	71	38.0	4.5	42.5
NR-16B	Road Improvement	123	91.0	12.9	103.9
NR-18A	Road Improvement	113	45.0	32.7	77.7
NR-9	Bridge Replacement			60.2	60.2
NR-1J	Sekaman Bridge Construction			7.7	7.7
NR-15A	Sedone Bridge Construction			8.8	8.8
NR-16B	Sekong Bridge Construction			8.6	8.6
NR-20	Bridge Replacement			9.8	9.8

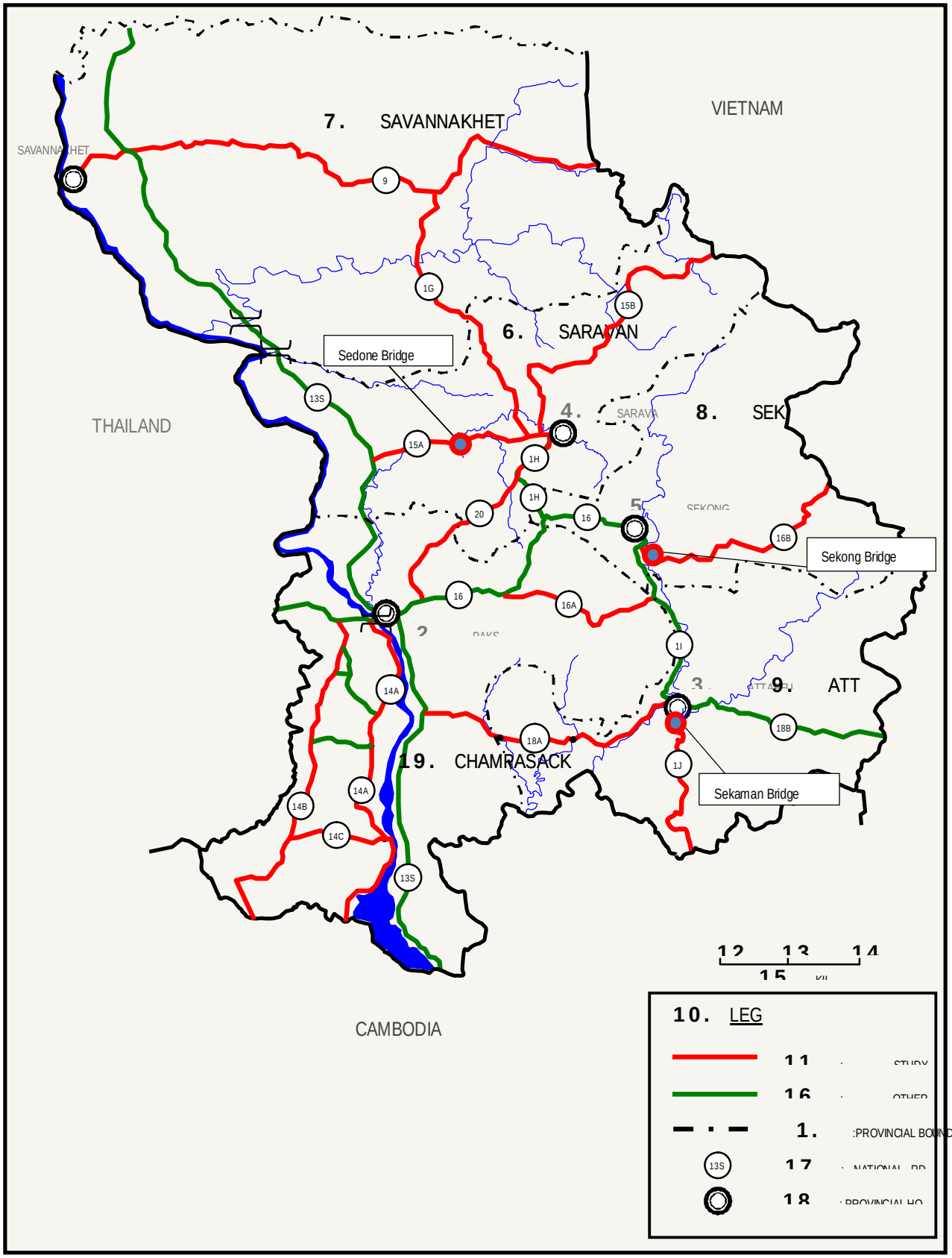


Figure 3.5.1 Location of Long Listed Projects

(2) Evaluation Method and Criteria Applied

Like the previous master plan study, the multi-criteria analysis was employed to determine the priority projects from amongst the project long list. This multi-criteria analysis had to involve all the stakeholders who assisted in identification of the criteria, allocation of weights and quantitative assessment of the projects. To accomplish this, the long listed projects were first evaluated via a quantitative appreciation by which the projects were appreciated and evaluated against a set of decision criteria: (i) Economic and technical criteria, (ii) Environmental criteria and (iii) Basic need criteria.

Table 3.5.3 Evaluation Criteria for Selection of Priority Project

1st level criteria	2nd level criteria	3rd level criteria	Evaluation items
Economic and technical criteria	Workability	Project size	Project cost
		Construction method	Locally available technique
	Sustainability	Maintenance	Maintenance cost
		Reliable traffic service	Year round traffic
	Economy	Traffic demand	Daily traffic volume
			Volume capacity ratio
		Cost effectiveness	Cost/ traffic volume
		Regional development and logistics network	External trip rate
			International trunk road
Environmental criteria	Pollution	Noise and vibration	Heavy vehicular traffic volume
		Air quality	Traffic volume and travel speed
		Water quality	Impact on river
	Natural Environment	Environmental reserve	Impact on national reservation area
		Fauna and flora	Impact on flood plain and mountain
		Erosion and sedimentation	Land cut and fill volume
	Social Environment	Involuntary resettlement	Resettlement and land acquisition
		Traffic accidents	Vehicle kilometre
Basic need criteria	Poverty Reduction	Impact on the regional economy	Size of population in project site
		Impact on impoverished people	Size of population below poverty line in project site
		Accessibility to social infrastructure	Size of population without schools in village
			Size of population without hospitals /clinics in village

(3) Evaluation of Road and Bridge Projects

The evaluation criteria were assigned ratings of A, B and C for the various projects. The final evaluation results were obtained by weighting the ratings of the evaluation criteria. Three sets of weights to be allocated to the different evaluation criteria were prepared to aid the decision making process: economy oriented weights (43% for economic and technical criteria, 34% for environmental criteria, and 23% for basic need criteria), Balanced (33%, 33% and 33%) and Basic needs oriented (23%, 34% and 43%).

Table 3.5.4 Weights for Evaluation Criteria

Evaluation Criteria	Economy Oriented	Balanced	Basic Needs Oriented
Economic and technical criteria	43%	33%	23%
Environmental criteria	34%	33%	34%
Basic needs criteria	23%	33%	43%

Using the above mentioned weighting system, the total scores for each project were derived from the sum of the products of the weight of each decision parameter and its rating: A (+1), B (0) and C (-1).

Considering the budgetary constraints (assuming the total investment of 150 million USD up to 2015 can be utilized for transport infrastructure projects), the following priority projects up to 2015 are suggested. Some of the ongoing projects score low marks in the multi criteria analysis but are selected as priority projects. The reasons for selecting the priority projects are summarized below.

(i) Upgrade of NR-9 (Project No.1): this project scores the highest marks for balanced and basic needs oriented weighting of decision parameters and the second highest mark for economy oriented weighting; suggesting it will contribute to expansion of regional economy and poverty alleviation and it would have less adverse impact on environment in spite of its scale.

(ii) Construction of Sedone Bridge (Project No.14): this project scores the highest marks for economy oriented weighting of decision parameters and the second and third highest marks for balanced weighting and basic needs oriented weighting respectively; suggesting it will contribute to the expansion of the regional economy and would have less adverse impact on the environment.

(iii) Replacement of Bridge along NR-9 (Project No.12): this project scores the third highest marks for all weighting systems of decision parameters. Together with the Upgrade of NR-9 (Project No.1), it may generate multiple impacts on economic growth and social development in the region.

4. PROJECT FORMULATION AND EVALUATION

4.1 Project Formulation of Priority Projects

(1) Preliminary Road Design

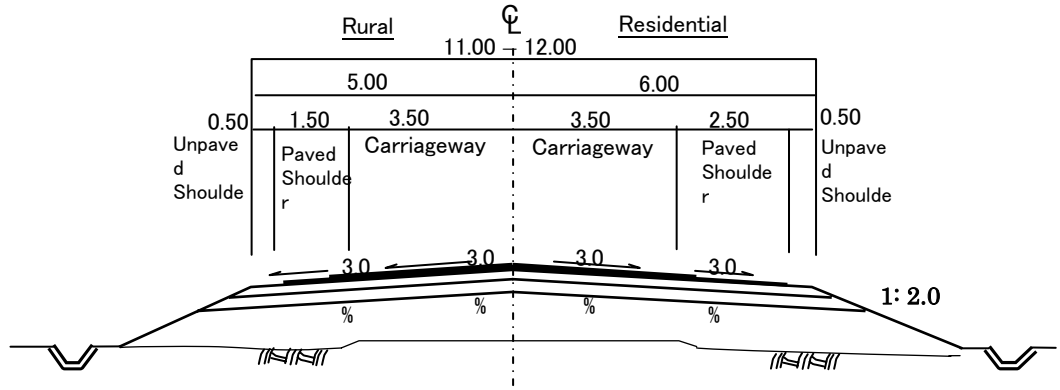
The road in Lao PDR is classified into seven classes, depending its functional classification and traffic volume as defined by the Road Design Manual. The NR-9 was upgraded under Japan's Grant Aid and ADB's assistance with specifications of Class II, determined by the future traffic demand with the target year of 2020. The improvement of NR-15A will be undertaken by ADB and the road class of NR-15A will be defined by the forthcoming engineering study by the ADB. Assuming the same classification applied to NR-13S, the road class of NR-15A is assumed with specifications of Class-III in this study. As a result, the design criteria of both NR-9 and NR-15A are summarized below.

Table 4.1.1 Design Criteria for Priority Project Road

Road	NR-9	NR-15A
Road Class	Class II	Class III
Traffic Volume （PCU）	3,000~8,000	1,000~3,000
Design Speed （Km/h）	100 (Flat), 70 (Hilly)	80 (Flat)
	50 (Residential)	50 (Resident)
Traffic Lane(m)	3.5	3.5
Shoulder (m)	1.5 (Rural)	1.5 (Rural)
	2.5 (Residential)	1.5 (Residential)

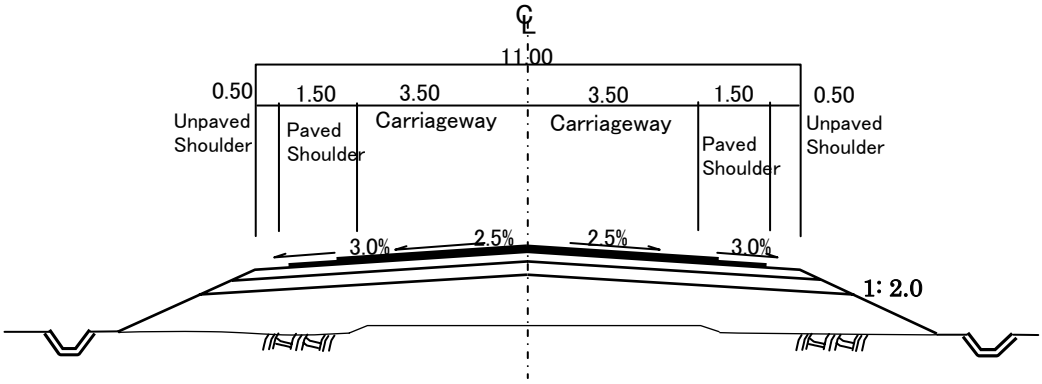
Source: Prepared by JICA Study Team based on Road Design Manual

The structures of the cross sections of both NR-9 and NR-15A are illustrated in the following figures.



Source: Prepared by JICA Study Team

Figure 4.1.1 Typical Cross Section of NR-9 (Class II)



Source: Prepared by JICA Study Team

Figure 4.1.2 Typical Cross Section of NR-15A (Class III)

(2) Preliminary Bridge Design

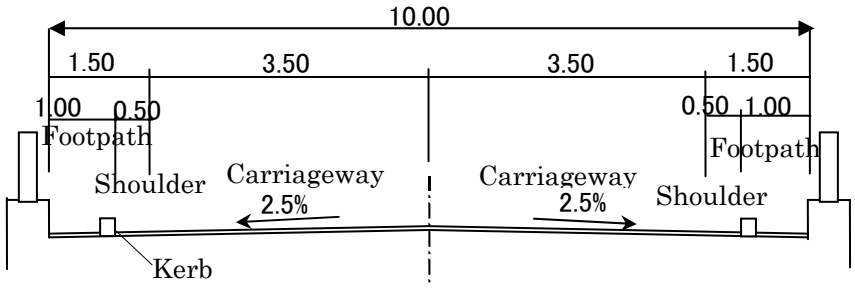
The Japanese standards or other international standards, in this study, are applied for design of the bridge structure. Table 4.1.2 summarizes the major design conditions for the project bridge.

Table 4.1.2 Major Design Conditions for Project Bridge

Items	Specifications
(1) Width Formation	10.00=1.50+2@3.50 +1.50
(2) Cross-fall	2.5%
(3) Pavement	Asphalt Pavement t=50mm
(5) Ancillary Facilities	Railing, Expansion Joint, Lighting
(6) Design Return Period for Flood	50 years
(7) Freeboard	1.2m

Source: Prepared by JICA Study Team

The Figure 4.1.3 shows the typical cross section of the bridges on the national roads.



Source: Prepared by JICA Study Team

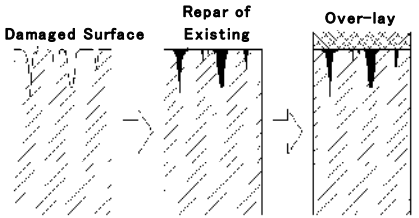
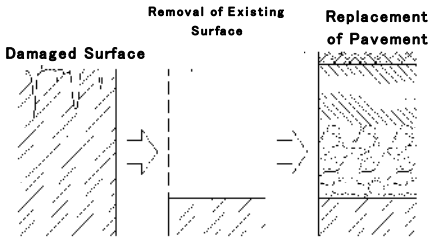
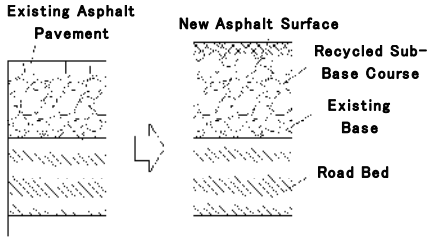
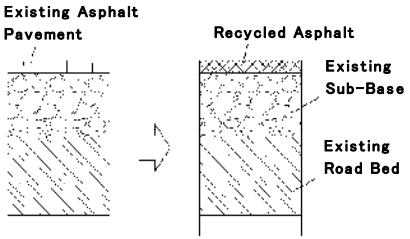
Figure 4.1.3 Typical Cross Section of Bridge on National Roads

(3) Project Formulation of Upgrade of NR-9

1) Pavement Type

The following table compares the structure of the pavement to upgrade the NR-9. As a result, overlay and replacement of the pavement are both recommended for upgrade of the NR-9.

Table 4.1.3 Comparison of Rehabilitation Methods of Pavement

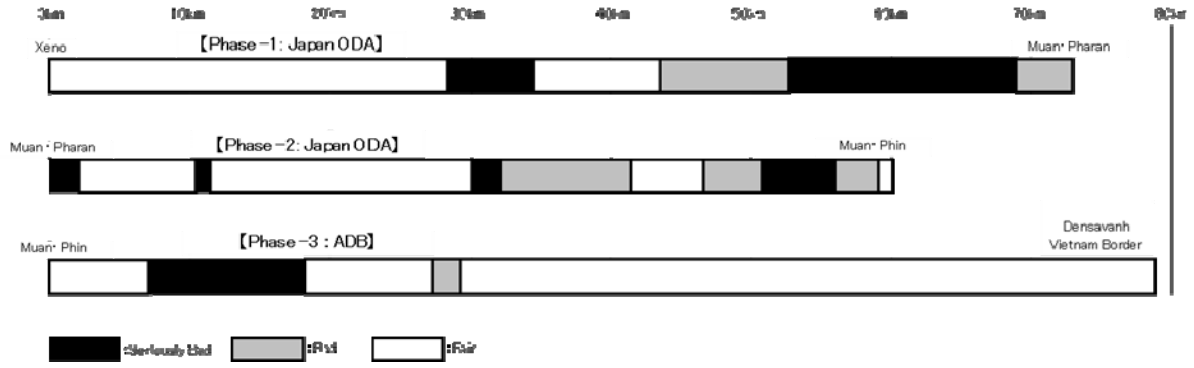
	Overlay	Pavement Replacement	Recycled Base Course	Recycled Asphalt Surface
				
Construction Method	After repairing existing surface, over-lay new asphalt concrete on the existing surface.	After existing surface and sub base course removed, replace to new material.	Remove the existing surface and sub base and base course, mixed stabilizer, reuse for sub base course.	Remove the existing surface, mixed stabilizer, reuse for sub base course.
Recommended Section	Damage is comparatively limited and does not affect the sub base and base course.	Crack reaches and affects sub base and base course.	Crack reaches and affects sub base and base course.	Damage is comparatively limited and does not affect the sub base and base course, and pavement design will not be changed. (in case of pavement design will be changed, asphalt overlay is needed.)
Construction efficiency	Standard road construction method, and comparatively easy to employ. Good	Transportation and depository of waste material (asphalt concrete and gravel) are required. Fair	Stabilizer (automotive) to remove the existing surface and sub base course, and motor grader to maintain flat surface are required. Quantity of material, construction schedule and cost can be reduced. Fair	Asphalt recycle plant should be developed. Material of asphalt concrete can be reduced. Fair

Economical efficiency	Asphalt concrete and tuck coat. Fair	Removal, transportation, disposal cost of existing material are additionally required. Worst	Cost of material and schedule can be reduced, however, other construction machinery is required. Bad	Cost of material and schedule can be reduced, however, other construction machinery is required. Good
Maintenance efficiency	Standard road maintenance. Good	Standard road maintenance. Good	Standard road maintenance. Good	Standard road maintenance. Good
Environmental Aspect	Mountain clashed-stone for material of asphalt concrete is required. Bad	Mountain clashed-stone for material of asphalt concrete and depository of waste material is required. Worst	Crashed stone pit and depository of waste material can be minimized. Good	Crashed stone pit and depository of waste material can be minimized. Good
Others	Thickness of over lay asphalt concrete should be decided after careful analysis of existing surface condition.	Detailed evaluation of CBR at design stage is necessary.	Quality control of recycled material	Quality control of recycled material
Evaluation	Construction and maintenance method is locally applicable. Good	Construction and maintenance method is locally applicable. Good	Ideal construction method for environmental aspect, however quality control is difficult. Bad	Ideal construction method for environmental aspect, however quality control is difficult. Worst

Source: JICA Study Team

2) Road Section to be Upgraded/Rehabilitated

The scope of the Upgrade of NR-9, following the results of the Follow-up Study, is proposed to replace pavement of 43-km seriously deteriorated road ('seriously bad' in the following figure) and to overlay 31-km bad road surfaces ('bad' in the following figure).



Source: Prepared by JICA Study Team based on Follow-up Study on NR-9

Figure 4.1.4 Pavement Condition of NR-9

Table 4.1.4 Pavement Condition of NR-9

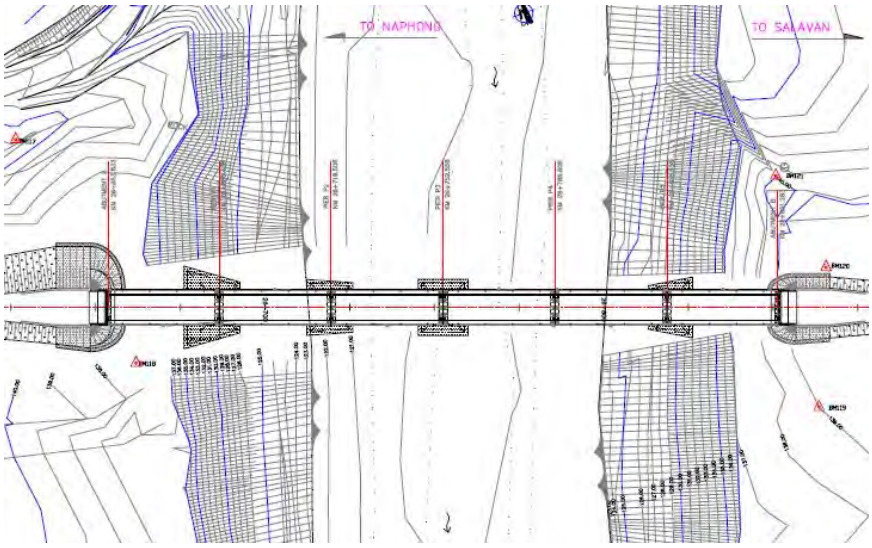
Phase	Phase-1		Phase -2		Phase -3		Total	
	Xeno- MuanPharan		Muan Pharan- Muan Phin		MuanPhin- Densavanh			
Donor	Japan				ADB			
	km	%	km	%	km	%	km	%
Serious	22	30.14	10	16.95	11	13.92	43	20.38
Bad	13	17.81	16	27.12	2	2.53	31	14.69
Fair	38	52.05	33	55.93	66	83.54	137	64.93
Total	73	100.00	59	100.00	79	100.00	211	100.00

Source: Prepared by JICA Study Team based on Follow-up Study on NR-9

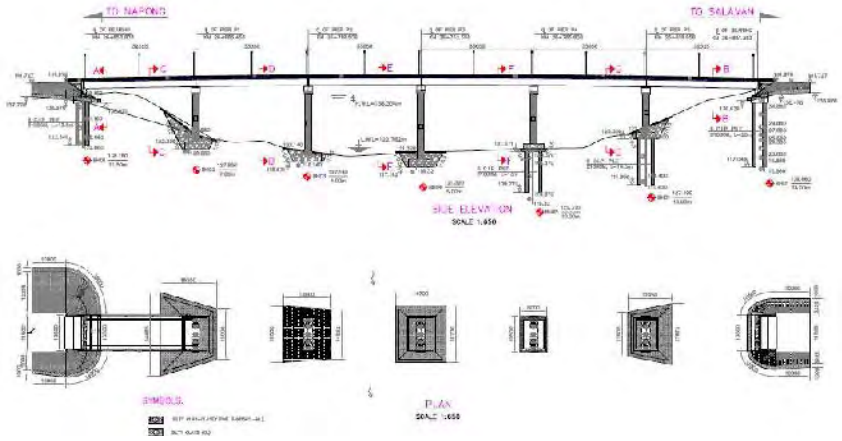
(4) Project Formulation of Construction of Sedone Bridge

1) Review of Existing Design of Sedone Bridge

The study of design of the Sedone Bridge was conducted by the local consultant in 2008. The bridge type, recommended in the said study, was PC post-tension six (6) span simple girder bridge. The design of PC girder was simply applied to the available local standard girder, which limits to the maximum length of 33m.



General View



Side View and Plan

Bridge Type: Six(6) spans PC simple girder bridge (Length :198m =32.6+4x33.05m+32.6)

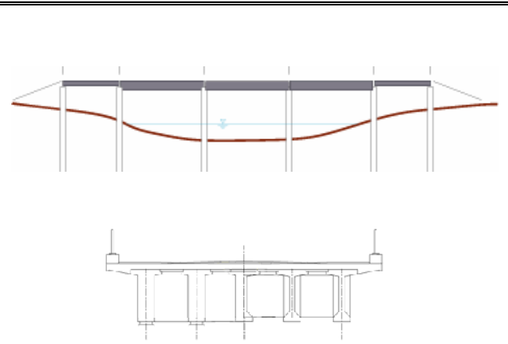
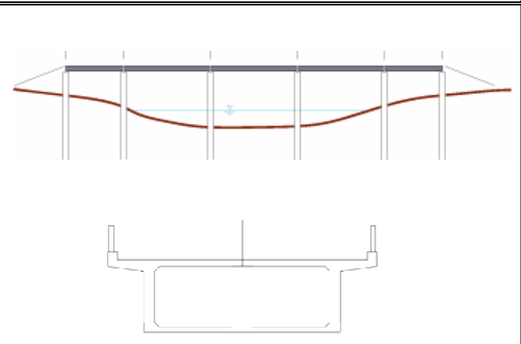
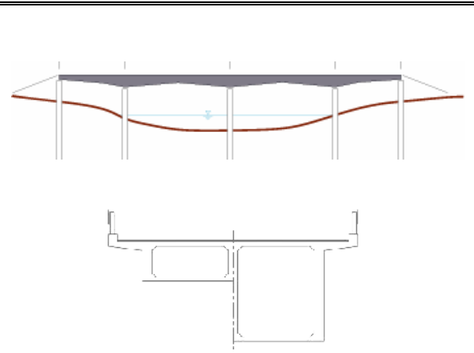
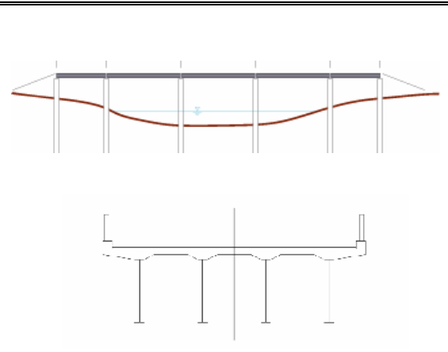
Figure 4.1.5 Sedone Bridge (designed by local consultant in 2008)

2) Revision of Design of Sedone Bridge

The river width during the flood ranges from 180 to 200m at upstream and downstream of the bridge site. At the crossing point of the new bridge, although the river width at the design HWL is approximately 240m, around 200 - 230m of the bridge length can be appropriate considering existence of the lower part of the river bank at the left bank including the clearance underneath of the girder. Considering the bridge length and span arrangement, the recommended design of the Sedone Bridge is five (5) span bridge (35m + 3X50m + 35m) with the total bridge length of 220m.

Table 4.1.5 proposes alternative superstructures and compares them in terms of (1) structural stability, (2) constructability, (3) cost effectiveness, and (4) easiness of maintenance. As a result, PC Box Girder with equal girder depth (Alternative-II) is recommended as an optimum bridge design for the Sedone Bridge.

Table 4.1.5 Comparison of Superstructure Type for Sedone Bridge

		Alt.-I:PC T-shaped Girder Type	Alt.-II: PC Box Girder Type with Equal Girder Depth	Alt.-III PC Box Girder with Variable Girder Depth	Alt.-IV: Steel I-Shaped Girder Type
Sketch					
Features of Alternatives	Br. L/Span	220m＝42.5+45+45+45+42.5	220m＝35+50+50+50+35	220m＝40+70+70+40	220m=35+50+50+50+35
	Br. Type	5 span continuous PC T-shaped girder Type	5 span continuous PC box girder with equal depth	4 span continuous PC box girder with variable depth	5 span continuous steel I-shaped girder
	Erection	Erection girder method	Incremental Lunching erection method	Canti-lever erection method	Erection by crane
	Structural Features	■ Applicable span length: 25-45m(max.45m) ■ Girder depth: 2.8m (depth/span ratio: 1/16).	■ Applicable span length: 30-60m(max.65m) ■ Girder depth: 2.8m (depth/span ratio: 1/16).	■ Applicable span length: 15-120m(max.150m) ■ Girder depth: 3.3m (depth/span ratio: 1/18-1/35).	■ Applicable span length: 25-60m ■ Girder depth: 2.5m (depth/span ratio: 1/18).
Constructability		■ Large-scale erection girder with portal frame crane shall be used for erection due to heavier girders. ■ Longest 45m girder length is less experience. ■ Possible erection continued during rainy season because of no supply the materials from river. ■ Need the fabrication space at the backside of abutment.	■ Erection nose girder is required in order to incrementally launch the girders. This span length is most suitable for this method. ■ Construction yard for this method shall be available at the left bank. ■ Possible erection continued during rainy season because of no supply the materials from river. ■ Need the fabrication yard at the backside of abutment.	■ Girder is launched from pier heads by each 2-4m at both sides by using form traveler ■ Many practical experiences ■ Supply the materials to the pier head is required during the erection of girder be concerned with cost increase for using temporary platform during higher water season.	■ Erection by using crane with 80-100 ton lifting capacity from the riverbed or temporary platform ■ Shortest erection time among other alternatives. ■ Erection girder method is possible during the rainy season. ■ Pre-fabricated girder will be transported to the site from the third country.
Construction time for superstructure)		Approximately 14 months	Approximately 14 months	Approximately 18 months	Approximately 14 months （including order process, fabrication and transportation）
Cost for superstructure		1.00 (Higher cost shall be required due to its applicable limit)	1.00	1.17	1.67 Procurement from a foreign country requires high cost
Maintenance		● Less maintenance cost than the steel girder ● Expansion joint requiring 4 places	● Less maintenance cost than steel girder ● Expansion joint requiring 2 places.	● Less maintenance cost than girder ● Expansion joint requiring 2 places.	● Periodic paining requires the highest cost of maintenance. ● Expansion joint requiring 2 places.
Aesthetics		● The girder depth difference gives inferior impression	● Equal girder depth and span balance between the center and the end gives good impression.	● Variable girder depth gives rhythmical impression and good balance between the center and the edge also gives good impression.	● Equal girder depth and span balance between the center and the end gives good impression.
Comprehensive Evaluation		**Not recommended** due to maximum length for PC-T girder requiring higher facility cost.	**Recommended** due to most economy and rational in structure. Possible year round erection despite of changing season and water level at the incremental launching method less affects constructability, construction time and maintenance	**Not recommended** since the girder depth nearby pier is high so that the elevation of profile needs to be lifted up to keep the clearance of high water level. Also, the supply of the materials to pier head during flood water season is complex.	**Not recommended** in terms of maintenance requiring more technique and cost than that of concrete girder.

Source: Prepared by JICA Study Team

(5) Project Formulation of Replacement of Bridges along NR-9

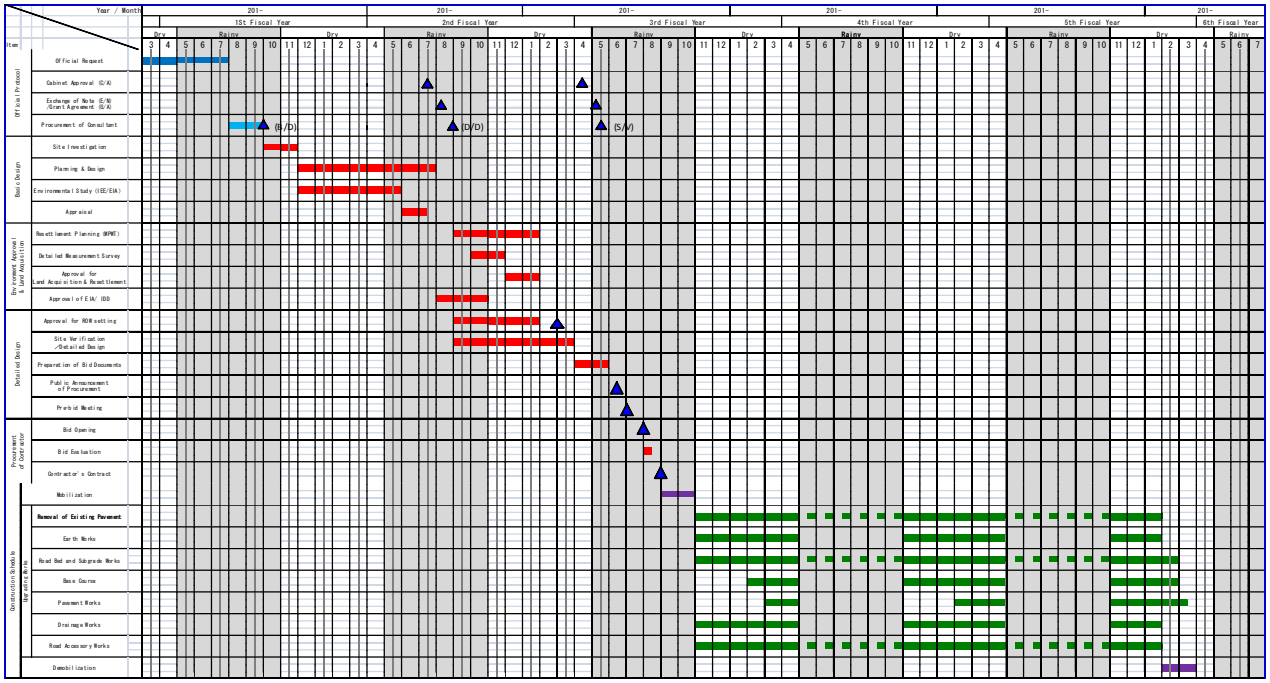
As a result of preliminary structural analysis, observatory survey and bridge inventory survey, two Steel Truss Girder (STG) bridges (No.13 and 17) are evaluated by class-III and it is confirmed that both bridges are required for urgent replacement or rehabilitation. The following bullet points details the priority of the bridges along the NR-9.

- 2 STG bridges of No.13 (Xe Kumkam Bridge) and No.17 (Xe Tha Mouak Bridge), like other steel bridges, have engineering deficiencies, including corrosion of strengthening girder, exposure of steel at both concrete slab and abutment. These 2 bridges are finally put the highest priority since there is higher potential risk for traffic accident due to abrupt profile of bridge.
- Reinforced Concrete Truss Girder (RCTG) bridges are more critically damaged and are required for urgent rehabilitation. These bridges are currently under minor repair works by DPWT Savannakhet and conditions of these bridges are expected to be improved. Having said that, the preliminary structural analysis confirms that RCTG bridges, especially those build by the former Soviet Union, have insufficient capacity against the standard load and major repair works or replacement for these bridges should be well considered.
- Some steel girder bridges have been maintained under the financial assistance by the World Bank. Amongst them, the condition of No.6, 7 and 34 (except RC girder located at side-span of bridge) are relatively better-off than other steel bridges. Scouring around the abutment during the flood is found at steel girder bridges of No.6 and 7. Steel truss supports are additionally installed to the existing steel bridges by Sepone Mining Company. These additional steel truss should be carefully verified in terms of disturbance of the river flows.

4.2 Project Implementation and Maintenance Plan

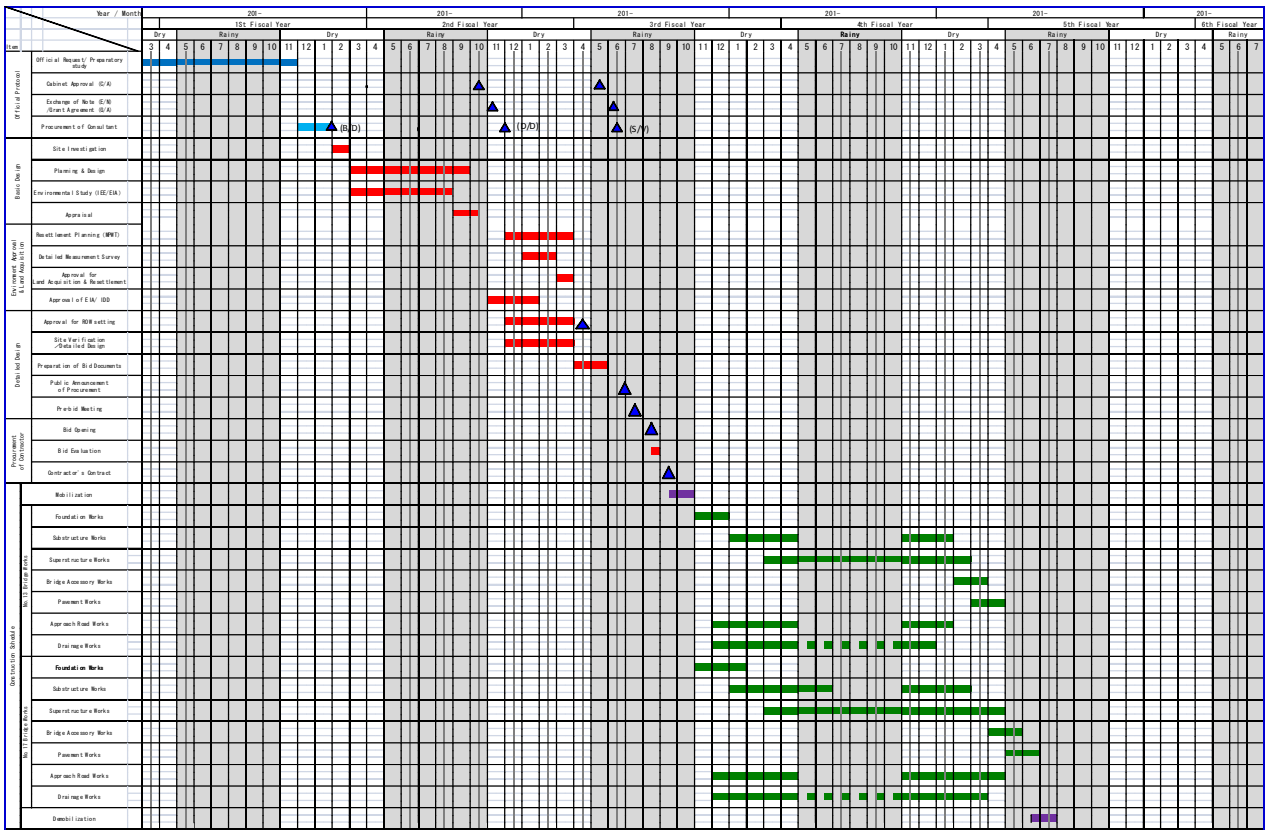
(1) Project Implementation Plan

Figures 4.2.1 - 4.2.3 show the tentative implementation schedule of each priority project. Each schedule was planed based on the aforementioned preconditions and construction works assumed in this study. It should be noted that the proposed implementation schedule is subject to the progress of undertakings by the Lao Government, and for instance, Japan's Grant Aid Project cannot be commenced without completion of resettlement and approval of environmental licensing when necessary.



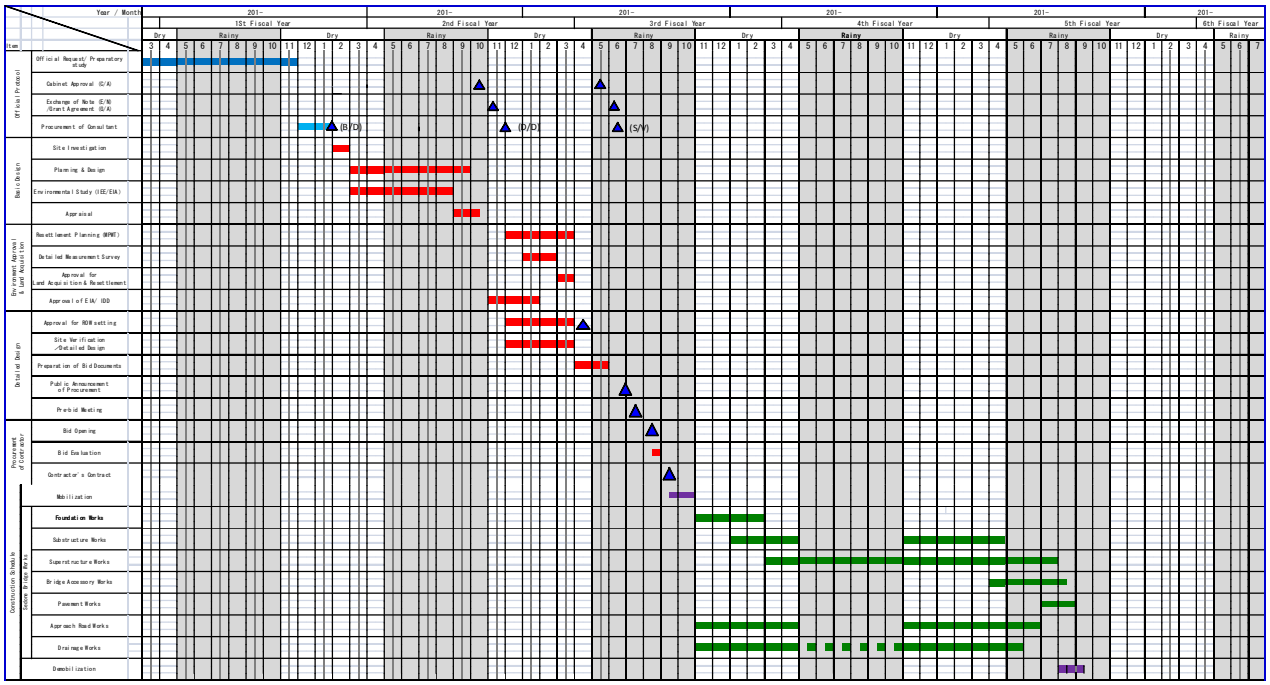
Source: Prepared by JICA Study Team

Figure 4.2.1 Implementation Schedule for Upgrading of NR-9



Source: Prepared by JICA Study Team

Figure 4.2.2 Implementation Schedule for Replacement of Bridges along NR-9



Source: Prepared by JICA Study Team

Figure 4.2.3 Implementation Schedule for Construction of Sedone Bridge on NR-15A

4.3 Preliminary Cost Estimate

(1) Project Cost

Assuming that the priority projects are implemented under the Japan's Grant Aid Assistance, the total cost of each priority project is summarized in Table 4.3.1. This project cost estimated is still provisional and will be finalized through the basic design study of each project.

Table 4.3.1 Preliminary Cost Estimate of Priority Projects (Unit: Million Japanese Yen)

Project Costs	Upgrading of NR-9	Two Bridge (NR-9)	Sedone Bridge (NR-15A)
Construction	3,305	1,245	1,029
Tendering Support & Supervision (6%)	198	75	62
Administration (2%)	66	25	21
Total Cost (Million Yen)	3,569	1,345	1,112

Source: Prepared by JICA Study Team

(2) Operation and Maintenance Cost

The following table summarizes operation and maintenance costs of the priority projects. The total operation and maintenance cost of all three priority projects is estimated at US$ 1.67 million/year and accounts for 20.4% of the maintenance budget (US$ 8.19 million) in 2008/09. These

maintenance cost are also borne by the government of Lao PDR after commencement of its operation.

Table 4.3.2 Operation and Maintenance Cost (Upgrade of NR-9)

Period	Works	Unit	Unit Price	Unit	Quantity	Frequency per 10 years	Total (x1000 Yen)
Routine Maintenance (Road) - Every Year	**Road (AC)**						
	Repair of pave. (sealing, filling pothole, patching	1.0% of total area / year	360	m2	5,281	8	15,209
	Slope repair (earth works)	0.5% of total area / year	200	m2	2,641	8	4,225
	Bridge (N/A)						
	Repair of deck (sealing)	1.0% of total area / year	360	m2	0	8	0
	Operation cost	20% of above					3,887
	Sub-total (i) for Routine Maintenance (for cumulate over 10 years)						23,321
Periodic Maintenance (Road & Bridge) - 5th & 10th year	**Road (AC)**						
	Repair of pave. (overlay: t=3cm)	100% of total area	2,295	m2	528,100	1	1,211,990
	Slope repair (earth works)	5% of total area	200	m2	26,405	2	10,562
	Bridge (N/A)						
	Repair of deck (overlay: t=3cm)	area	2,295	m2	0	1	0
	Repair of railing & curbs, lighting facility	5% of total bridge area	950	m2	0	1	0
	Miscellaneous						
	Retaining wall, gabion, etc	5% of total area	1,800	m2	26,405	2	95,058
	Sub-total (ii) for Periodic Maintenance (per time : 10 y)						1,317,610
Operation Cost (10% of Sub-total-(i)+(ii))							134,093
Operation & Maintenance Cost (for cumulate over 10 years)							1,475,023

Source: Prepared by JICA Study Team

Table 4.3.3 Operation and Maintenance Cost (Construction of Sedone Bridge)

Period	Works	Unit	Unit Price	Unit	Quantity	Frequency	Total (x1000 Yen)
Routine Maintenance (Road) - Every Year	**Road (DBST)**						
	Repair of pave. (sealing, filling pothole, patching	1.0% of total area / year	360	m2	40	8	115
	Slope repair (earth works)	0.5% of total area / year	200	m2	20	8	32
	Bridge						
	Repair of deck (sealing)	1.0% of total area / year	360	m2	40	8	115
	Operation cost	20% of above					52
	Sub-total (i) for Routine Maintenance (for cumulate over 10 years)						315
Periodic Maintenance (Road & Bridge) - 5th & 10th year	**Road (DBST)**						
	Repair of pave. (Repave: t=12.5cm)	100% of total area	809	m2	4,000	2	6,468
	Slope repair (earth works)	5% of total area	200	m2	200	2	80
	Bridge						
	Repair of deck (overlay: t=3cm)	area	2,295	m2	2,200	1	5,049
	Repair of railing & curbs, lighting facility	5% of total bridge area	950	m2	110	1	105
	Miscellaneous						
	Retaining wall, gabion, etc	5% of total area	1,800	m2	200	2	720
	Sub-total (ii) for Periodic Maintenance (per time : 10 y)						12,422
Operation Cost (10% of Sub-total-(i)+(ii))							1,274
Operation & Maintenance Cost (for cumulate over 10 years)							14,010

Source: Prepared by JICA Study Team

Table 4.3.4 Operation and Maintenance Cost (Replacement of Bridges along NR-9)

Period	Works	Unit	Unit Price	Unit	Quantity	Frequency	Total (x1000 Yen)
Routine Maintenance (Road) - Every Year	**Road (AC)**						
	Repair of pave. (sealing, filling pothole, patching	1.0% of total area / year	360	m2	60	8	173
	Slope repair (earth works)	0.5% of total area / year	200	m2	30	8	48
	Bridge (AC)						
	Repair of deck (sealing)	1.0% of total area / year	360	m2	60	8	173
	Operation cost	20% of above					79
	Sub-total (i) for Routine Maintenance (for cumulate over 10 years)						472
Periodic Maintenance (Road & Bridge) - 5th & 10th year	**Road (AC)**						
	Repair of pave. (overlay: t=3cm)	100% of total area	2,295	m2	6,000	1	13,770
	Slope repair (earth works)	5% of total area	200	m2	300	2	120
	Bridge (AC)						
	Repair of deck (overlay: t=3cm)	area	2,295	m2	2,600	1	5,967
	Repair of railing & curbs, lighting facility	5% of total bridge area	950	m2	130	1	124
	Miscellaneous						
	Retaining wall, gabion, etc	5% of total area	1,800	m2	300	2	1,080
	Sub-total (ii) for Periodic Maintenance (per time : 10 y)						21,061
Operation Cost (10% of Sub-total-(i)+(ii))							2,153
Operation & Maintenance Cost (for cumulate over 10 years)							23,686

Source: Prepared by JICA Study Team

4.4 Initial Environmental Examination

Preliminary environmental site inspection for the priority projects was carried out in March and August 2010. Based on empirical study reports and major findings obtained from this site inspection, the initial environmental examination (IEE) of those project sites is carried out separately, using 30 environmental factors, listed in JICA Guideline of Environmental and Social Considerations. Throughout this IEE study, potential environmental issues are summarized. Basically, the examination is carried out for following two scenarios: i.e., (i) Do - Nothing scenario, and (ii) Do – Project scenario. Under Do – Project scenario, possible negative environmental impacts to be caused during and/after the road and bridge improvement works are of concern. It is noted that the IEE of the NR-9 is separated into following two parts; i.e., (i) road section (Upgrade of NR-9) and (ii) bridge portion (Replacement of 2 Bridges along NR-9) for the simplification.

Table 4.4.1 Preliminary Environmental Scoping Results (Upgrade of NR-9)

Environmental Factor				Evaluation	
				Do-Nothing	Do-Project
Socio-Cultural Environment	1	Involuntary Resettlement	Land expropriation due to construction yard	D	B
			Demolition of roadside houses.	D	D
	2	Local Economy	Impact on regional tourism industry due to worsened road condition	B	D
			Increased vehicle maintenance cost due to worsened traffic condition	B	D
			Impacts on local economy, caused by temporal traffic congestion during construction period.	D	B
	3	Land use and Utilization of Local Resources	Conflict with current local land use/or development plans	D	D
	4	Social Institutions	Possible Impact on social infrastructure and local decision-making institutions	D	D

Environmental Factor				Evaluation	
				Do-Nothing	Do-Project
	5	Existing social infrastructures and services	Conflict with current local transport system. Conflict with current local energy/ communication/water supply system.	D	D
	6	The poor, indigenous of ethnic group	Existence of ethnic minority around the site.	D	D
	7	Misdistribution of benefit and damage	Risk of possible damages/or negative impacts concentration/or localization.	D	D
	8	Cultural Heritage	Conflict with the setting of historical, cultural or monumental sites.	D	D
	9	Local Conflict of interests	Conflicts between regional environmental conservation and development.	D	D
	10	Water use/or water right	Impacts on irrigation for agricultural lands (e.g., rice paddy fields)	D	B
	11	Public Heath	Working Environment (Malaria, Dengue and others). Household waste treatment at construction camp	D	B
	12	Infectious Disease (e.g., HIV.AIDS)		D	B
	13	Accidents	Worsened traffic safety due to discontinuity of vehicle lane	B	D
			Worsened traffic safety due to degraded road surface (e.g., pot hole)	B	D
			Worsened traffic safety due to temporal increase of traffic volume during construction period.	D	B
			UXO	D	D
Bio-Physical Environment	14	Topography and Geology	Significant topographical change due to construction	D	D
	15	Soil Erosion	Potential for soil erosion. Occurrence of new sedimentation at downstream side.	B	B
	16	Groundwater	Temporal water quality degradation during construction period	D	B
	17	Hydrological condition	Disruption of regional drainage pattern due to large-scale earthwork	D	B
	18	Coastal condition		D	D
	19	Flora/fauna and biodiversity	Destruction of roadside vegetation./habitat	D	D
			Disturbance to aquatic ecosystem/or habitats.	D	B
	20	Meteorology	Impact on local meteorological condition	D	D
	21	Landscape	Disruption of local townscape/or landscape	D	D
	22	Global warming	Increased regional CO2 emission	B	B
Pollution	23	Air Quality	Temporal roadside air quality degradation during construction period	D	B
			Roadside air quality degradation due to traffic volume increase during operation period.	B	B
	24	Water Quality	Temporal water quality degradation of nearby surface/sub-surface water during construction period.	D	B
	25	Soil Contamination	Risk of soil contamination due to accidental spill of construction chemical.	D	B
	26	Waste	Treatment of construction waste during construction period.	D	B
	27	Noise/Vibration	Worsened roadside noise due to degraded road surface (e.g., pot hole)	B	D

Environmental Factor				Evaluation	
				Do-Nothing	Do-Project
			Temporally worsened roadside noise/vibration during construction period.	D	B
			Worsened roadside noise/or vibration during operation period.	B	D
	28	Ground subsidence	Potential of large-scale consolidation due to earthwork	D	D
	29	Obnoxious smell	Potential of newly created bad smell	D	D
	30	River bed	Disturbance to river bed condition.	D	D

Note A: significant, B: major, C: minor, D: less significant, U: Unknown

Source: Prepared by JICA Study Team

Table 4.4.2 Preliminary Environmental Scoping Results (Replacement of Bridges along NR-9)

Environmental Factor				Evaluation	
				Do-Nothing	Do-Project
Socio-Cultural Environment	1	Involuntary Resettlement	Land expropriation due to construction yard	D	B
			Demolition of roadside houses.	D	D
	2	Local Economy	Impact on regional tourism industry due to worsened road condition	B	D
			Increased vehicle maintenance cost due to worsened traffic condition	D	D
			Impacts on local economy, caused by temporal traffic congestion during construction period.	D	B
	3	Land use and Utilization of Local Resources	Conflict with current local land use /or development plans	D	D
	4	Social Institutions	Possible Impact on social infrastructure and local decision-making institutions	D	D
	5	Existing social infrastructures and services	Conflict with current local transport system. Conflict with current local energy/ communication/water supply system.	D	D
	6	The poor, indigenous of ethnic group	Existence of ethnic minority around the site.	D	D
	7	Misdistribution of benefit and damage	Risk of possible damages/or negative impacts concentration/or localization.	D	D
	8	Cultural Heritage	Conflict with the setting of historical, cultural or monumental sites.	D	B
	9	Local Conflict of interests	Conflicts between regional environmental conservation and development.	D	D
	10	Water use/or water right	Impacts on irrigation for agricultural lands (e.g., rice paddy fields)	D	B
	11	Public Heath	Working Environment (Malaria, Dengue and others). Household waste treatment at construction camp	D	B
	12	Infectious Disease (e.g., HIV.AIDS)		D	B
	13	Accidents	Worsened traffic safety due to discontinuity of vehicle lane	B	D
			Worsened traffic safety due to degraded bridge condition	B	D
			Worsened traffic safety due to temporal increase of traffic volume during construction period.	D	B
			UXO	D	U
ysical Environ	14	Topography and Geology	Significant topographical change due to construction.	D	D

Environmental Factor				Evaluation	
				Do-Nothing	Do-Project
	15	Soil Erosion	Potential for soil erosion. Occurrence of new sedimentation at downstream side.	B	B
	16	Groundwater	Temporal water quality degradation during construction period	D	B
	17	Hydrological condition	Disruption of regional drainage pattern due to large-scale earthwork	D	B
	18	Coastal condition		D	D
	19	Flora/fauna and biodiversity	Destruction of roadside vegetation/habitat.	D	D
			Disturbance to aquatic ecosystem/or habitats.	D	B
	20	Meteorology	Impact on local meteorological condition	D	D
	21	Landscape	Disruption of local townscape/or landscape	D	D
	22	Global warming	Increased regional CO2 emission	B	B
Pollution	23	Air Quality	Temporal roadside air quality degradation during construction period	D	B
			Roadside air quality degradation due to traffic volume increase during operation period.	B	B
	24	Water Quality	Temporal water quality degradation of nearby surface/sub-surface water during construction period.	D	B
	25	Soil Contamination	Risk of soil contamination due to accidental spill of construction chemical.	D	B
	26	Waste	Treatment of construction waste during construction period.	D	B
	27	Noise/Vibration	Worsened roadside noise due to degraded road surface (e.g., pot hole)	B	D
			Temporally worsened roadside noise/vibration during construction period.	D	B
			Worsened roadside noise/or vibration during operation period.	B	D
	28	Ground subsidence	Potential of large-scale consolidation due to earthwork	D	D
	29	Obnoxious smell	Potential of newly created bad smell	D	D
	30	River bed	Disturbance to river bed condition.	D	B

Note A: significant, B: major, C: minor, D: less significant, U: Unknown

Source: Prepared by JICA Study Team

Table 4.4.3 Preliminary Environmental Scoping Results (Construction of Sedone Bridge)

Environmental Factor				Evaluation	
				Do-Nothing	Do-Project
Socio-Cultural Environment	1	Involuntary Resettlement	Land expropriation due to construction yard	D	B
			Demolition of roadside houses.	D	B
	2	Local Economy	Impact on regional tourism industry due to worsened road condition	B	D
			Increased vehicle maintenance cost due to worsened traffic condition	D	D
			Impacts on local economy, caused by temporal traffic congestion during construction period.	D	B
	3	Land use and Utilization of Local Resources	Conflict with current local land use/or development plans	D	D

Environmental Factor				Evaluation	
				Do-Nothing	Do-Project
	4	Social Institutions	Possible Impact on social infrastructure and local decision-making institutions	D	D
	5	Existing social infrastructures and services	Conflict with current local transport system. Conflict with current local energy/ communication/water supply system.	D	D
	6	The poor, indigenous of ethnic group	Existence of ethnic minority around the site.	D	D
	7	Misdistribution of benefit and damage	Risk of possible damages/or negative impacts concentration/or localization.	D	D
	8	Cultural Heritage	Conflict with the setting of historical, cultural or monumental sites.	D	D
	9	Local Conflict of interests	Conflicts between regional environmental conservation and development.	D	D
	10	Water use/or water right	Impacts on irrigation for agricultural lands (e.g., rice paddy fields)	D	B
	11	Public Heath	Working Environment (Malaria, Dengue and others). Household waste treatment at construction camp	D	B
	12	Infectious Disease (e.g., HIV.AIDS)		D	B
	13	Accidents	Worsened traffic safety due to degraded bridge condition	B	D
			Worsened traffic safety due to temporal increase of traffic volume during construction period.	D	B
			UXO	D	U
Bio-Physical Environment	14	Topography and Geology	Significant topographical changes due to construction	D	U
	15	Soil Erosion	Potential for soil erosion. Occurrence of new sedimentation at downstream side.	B	B
	16	Groundwater	Temporal water quality degradation during construction period	D	D
	17	Hydrological condition	Disruption of regional drainage pattern due to large-scale earthwork.	D	U
	18	Coastal condition		D	D
	19	Flora/fauna and biodiversity	Destruction of roadside vegetation/habitat.	D	D
			Disturbance to aquatic ecosystem/or habitats.	D	B
	20	Meteorology	Impact on local meteorological condition	D	D
	21	Landscape	Disruption of local townscape/or landscape	D	D
	22	Global warming	Increased regional CO2 emission	B	B
Pollution	23	Air Quality	Temporal roadside air quality degradation during construction period	D	B
			Roadside air quality degradation due to traffic volume increase during operation period.	B	B
	24	Water Quality	Temporal water quality degradation of nearby surface/sub-surface water during construction period.	D	B
	25	Soil Contamination	Risk of soil contamination due to accidental spill of construction chemical.	D	B
	26	Waste	Treatment of construction waste during construction period.	D	B
	27	Noise/Vibration	Temporally worsened roadside noise/vibration during construction period.	D	B

Environmental Factor			Evaluation	
			Do-Nothing	Do-Project
		Worsened roadside noise/or vibration during operation period.	B	D
28	Ground subsidence	Potential of large-scale consolidation due to earthwork	D	D
29	Obnoxious smell	Potential of newly created bad smell	D	D
30	River bed	Disturbance to river bed condition.	D	B

Note A: significant, B: major, C: minor, D: less significant, U: Unknown

Source: Prepared by JICA Study Team

4.5 Project Evaluation

(1) Economic Evaluation

1) Basic Assumption

Economic feasibility of the 3 priority projects is evaluated separately in this section. The following basic assumptions are employed for the analysis:

- Indicator to evaluate economic feasibility: In order to evaluate economic feasibility, Economic Internal Rate of Return (EIRR) of each project is calculated and employed.
- With-project case and without-project case: a with-project case is a situation that the priority project will be conducted. On the other hand, a without-project case is a situation that the priority project will not be conducted, and existing road and bridges will be utilized.
- Project implementation schedule: Project implementation schedule consists of two years of engineering service, two years of construction and 30 years of operation.
- Lifetime: Lifetime of civil works in the projects is assumed 50 years. Residual value which is 40% of project cost (20 years of residual lifetime divided by 50 years) is calculated in the final year of operation.
- Physical contingency, tax, consultant service and administration cost: Physical contingency and tax are not included in the economic analysis. Cost for consultant service which is six percent of the cost of the projects and administration cost which is two percent of the cost of the projects will be added.

Economic effects of the upgrade of NR9 project are reduction of Vehicle Operating Cost, reduction of vehicle travel time and reduction of traffic accident. Out of the three economic effects, the reduction of traffic accident is not included in the economic benefit due to difficulty of calculation, and the economic benefit is calculated from the other factors. The reduction of Vehicle Operating Cost and vehicle travel time is calculated from the Traffic Demand Forecast described in the section 3.4, unit VOC, time value per labor and time value of vehicle and cargo. On the other hand, project cost presented in the Chapter 4 is converted to economic cost, and distributed to annual investment amount. In addition to that, annual operation and maintenance cost is listed to calculate annual net cash flow. Calculated EIRR is 11.9%.

In the same manner, EIRRs of the other 2 projects are calculated. The rates are 12.9% for the replacement of bridges at NR9, 13.2% for construction of Sedong Bridge,

In two bridge projects (replacement of bridges along NR9 and construction of Sedone Bridge at NR15), Figures of EIRR is higher than 12%, which is substitution cost of capital. Therefore, These

projects are feasible from the viewpoint of national economy of Lao PDR.

On the other hand, EIRR of upgrading NR9 is lower than 12%. The figure would be over 12% if other economic effects such as reduction of traffic accident were included. Level of the figure is meaningful enough to consider project implementation.

(2) Impact on Poverty Reduction

Comparing household expenditure (nearly equal to household income) and estimated benefits by saving travel time, contributions to poverty reduction by each proposed project can be summarized below (see Table 4.5.1).

- Upgrade of NR-9 will contribute to generating economic benefits on 132 thousand households in Savannakhet Province.
- Construction of Sedone Bridge is expected to generate benefits on 73 thousand households in Saravan Province.
- To lesser extent, Replacement of Bridges along NR-9 contributes to increase benefit on 19 thousand households in Savannakhet Province.

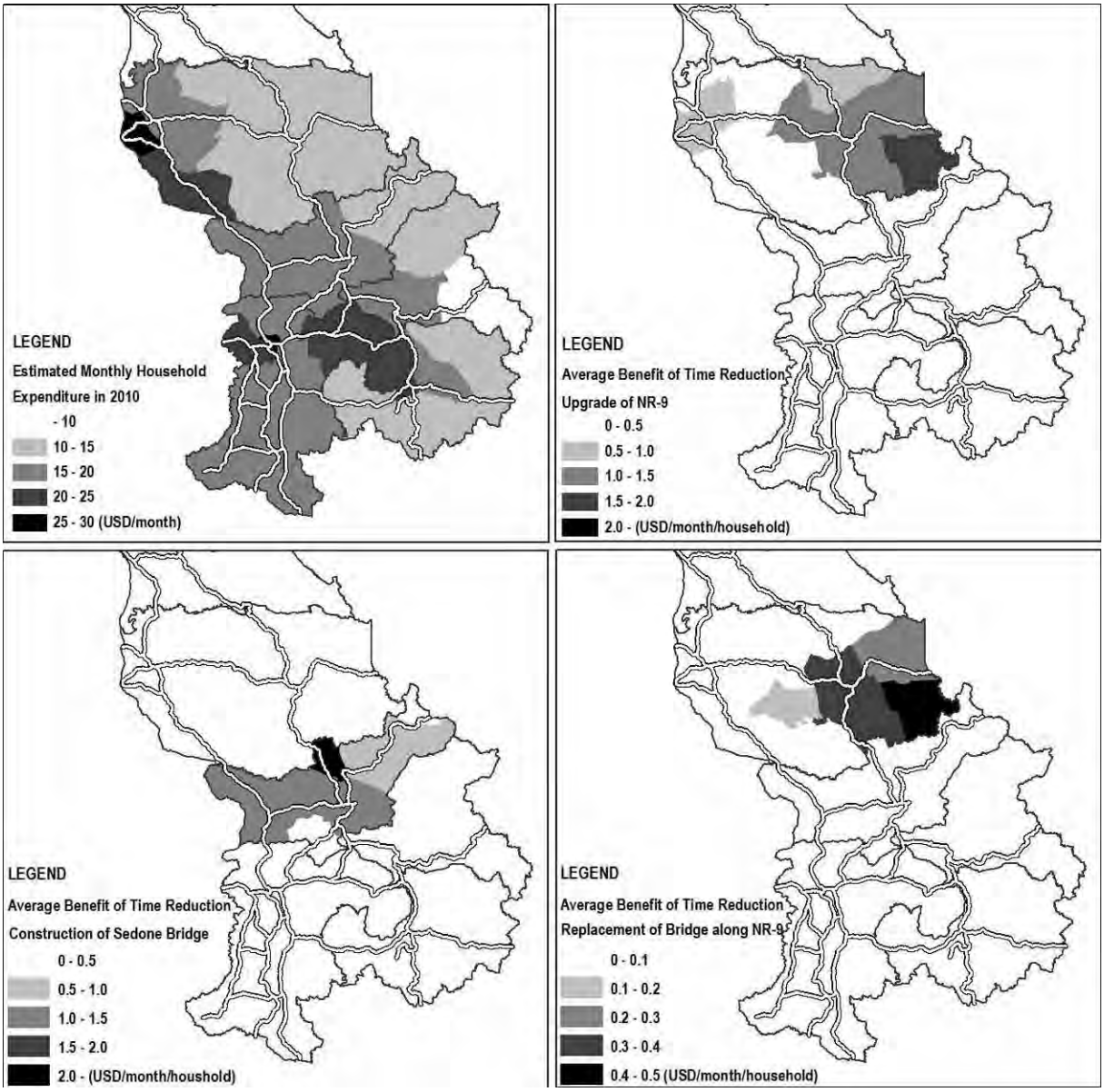
Table 4.5.1 Number of Households and Average Household Expenditure by Percentage Band of Benefit/Household Expenditure

	Increase by 1-5%	5-10%	Over 10%
Upgrade of NR-9	101,876 (18.6)	13,093 (12.3)	16,730 (13.1)
Construction of Sedone Bridge	29,851 (21.4)	40,359 (16.4)	2,696 (17.8)
Replacement of Bridge along NR-9	19,489 (12.7)	0 (N/A)	0 (N/A)

Source: JICA Study Team

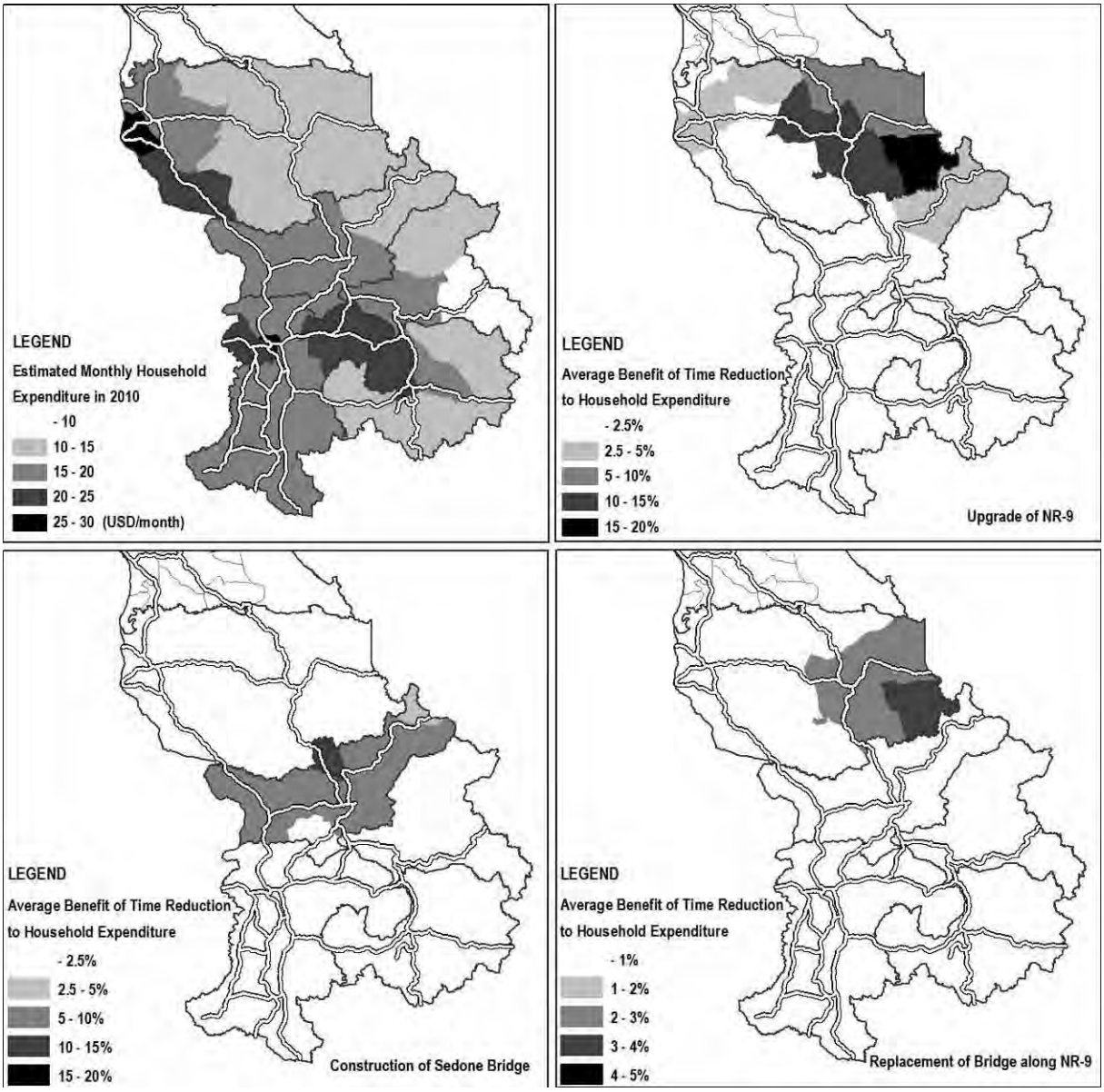
Figure 4.5.1 and 4.5.2 shows district-wise household expenditure and forecasted benefit by travel time saving. Contributions to poverty reduction by each proposed project can be summarized below.

- Households benefited by Upgrade of NR-9 mainly spread in the east side of Savannakhet Province, where most districts are defined as poor and poorest districts.
- Construction of Sedone Bridge along NR-15A benefits to the households thoughout Saravan Province. Ta-Oy District (poorest district) and Toumlan District (poor) are among beneficiaries of this project.
- Like Upgrade of NR-9, Replacement of Bridges along NR-9 benefits to the household in eastern area of Savannakhet Province.



Source: JICA Study Team

Figure 4.5.1 Estimated Household Expenditure and Forecasted Benefit by Priority Projects in 2010



Source: JICA Study Team

Figure 4.5.2 Percentage of Average Benefit by Priority Project to Household Expenditure

4.6 Project Profiling

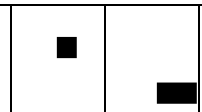
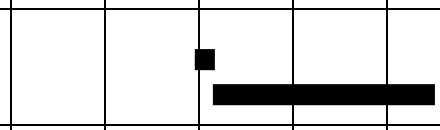
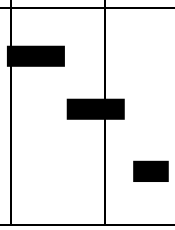
As discussed above, three priority projects are selected through the revision work of the previous master plan. The next question is how these projects would be realized for its implementation. In order to answer this question, the preliminary study on these priority projects were carried out to identify the appropriate scope of the project, the preliminary project cost, the implementation and maintenance plan for these projects. The overall result of this study is compiled into the project profile of the priority project.

Table 4.6.1 Project Profile (Upgrade of NR-9)

Project Name	Upgrade of NR-9	SN	N-1-NR9
Project Background	The location of Lao PDR offers strategic prospects, transforming itself from "land-locked" to "land-linked" country particularly by developing international infrastructure networks. In this respect, road links, in particular, are of vital importance. The transport system in Laos significantly depends on the road network, and is critical for national integration, and is also highly valued for improving accessibility to surrounding countries. Especially the East – West Corridor between Vietnam and Thailand is essential in securing access to the sea ports. In addition, the improvement of the road network is domestically important for improving accessibility of the rural communities to the livelihood assets e.g. goods, services and opportunities; and for realizing the potentials of economic growth. The Government of Lao PDR has made intensive efforts to improve the trunk road network in Southern Lao. These efforts include road improvements along NR-13 (South), NR-9 and construction of the Second Mekong Bridge, under the support of both bilateral and multilateral donors, such as ADB, World Bank and JICA. In spite of the afore-mentioned, there is still need for significant injection of funds into road rehabilitation/development in Southern Lao. Unpaved roads and un-rehabilitated bridges, frequently observed in the Southern Lao, all contribute to deteriorating the road network and hence hindering trade of both goods and people. As such, the economic development in Southern Lao lags behind the other regions in Lao PDR.		
Overall Goal and Project Purpose	Overall Goal: ・ To promote international/domestic traffic along the East-West Corridor and to generate economic growth in the GMS/Laos. Project Purpose: ・ To reduce travel time and transport costs along the NR-9 and to establish a safe and reliable road network and hence to promote trade of goods and passengers along the East-West Corridor. ・ To improve accessibility to social infrastructures, markets and public transport services and to enhance income and employment opportunities and hence to reduce poverty along the NR-9.		
Justification of the Project	Consistency with Upper Plan	・ Previous National Socio-economic Development Plan (2006-10) set major goals and targets, including strengthening socio-economic infrastructures as fundamentals for development and draft National Socio-economic Development Plan (2011-15) sets development directions, including strengthening international cooperation and integrating the economy into the regional and global organizations. ・ In the Provincial Socio-economic Plan of Savannakhet, improvement of roads and bridges in the rural area (2006-10) and elimination of poverty and development of the local economy (2011-15) are set as focal targets of the province. ・ There are development potentials, industrial development in especial, along the NR-9. For instance, Savan-Seno SEZ develops 4 SEZs along the NR-9. Gold and copper mining at Sepon, which significantly contributes to national economic growth, expands its production. ・ In this study, the road section of this project is selected as one of three priority projects from among 16 long listed road and bridge improvement projects.	

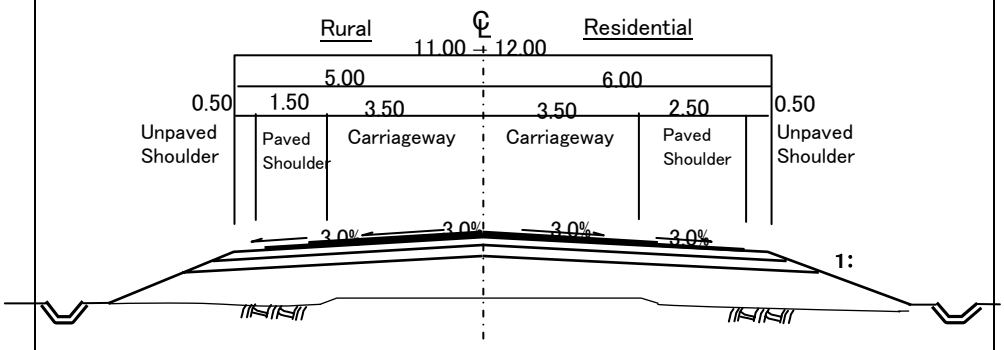
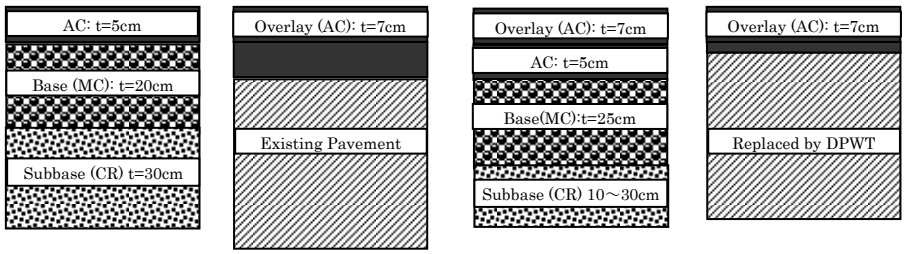
	Urgency of the Project	• An inventory survey by JICA's Follow-up Study on NR-9 found that the road section of this project is considerably deteriorated and is in a bad/poor surface condition. Due to the insufficient amount of maintenance funds, the deteriorated road section cannot be properly maintained and contributes to increasing travel time and transport costs and high occurrence of traffic accidents. • A socio-economic survey was carried out at the sampled villages along the NR-9. It suggests that there is an urgent demand for road improvement to improve accessibility to social infrastructure and markets and sustain the livelihood of the villagers.
	Necessity of the Project	• The road section of this project partly composed of the Asian Highway No. 16 and GMS Economic Corridor (East-West Corridor). The design standards of the Asian Highway (Class II) suggests this road section to be upgraded to AC surfaced roads to allow maximum load of 11.0 ton. • The international traffic observed along the NR-9, estimated by the traffic demand forecast, will increase to 58% of the traffic and the NR-9 is expected to function as the important international corridor. • Based on comprehensive analysis by this study, the traffic volume of this road section is estimated to increase to 8,500 vehicles (PCU) per day by 2025. The volume capacity ratio along the NR-9 reaches 0.55 by 2025, showing the highest ratio among those of the long-listed projects.
	Adverse Impact of the Project	• IEE study suggests that there would be no significant adverse impact during the construction and after the operation of the project. Some critical environmental factors to be carefully studied are (i) impact on regional drainage system including irrigation for agricultural land, (ii) potential for soil erosion along road bank, (iii) temporal water quality degradation during construction period, (iv) roadside air quality and noise during construction period, (v) worsened traffic safety during construction period, and (vi) risk of soil contamination due to accidental spill of construction chemicals.
	Beneficiaries and Benefits generated from the Project	• The road users along the NR-9 are direct beneficiary. 239,000 persons, including 82,000 persons under poverty, who stayed near the project site (within 5 km buffer) are indirect beneficiaries. Amongst these people, there are 77,000 persons living in the village without schools and 217,000 persons without hospital/clinics. • The result of the economic analysis on this particular project is summarized below: EIRR= 11.9%. Thus, the economical validity of this project is justified. • Economic benefits derived from the project will contribute to poverty reduction. This project contributes to generating income on 132,000 households in east part of Savannakehet Province, where most severe poverty is observed.
Scope of Project	Replacement of pavement of 43km and overlay of 31km road along NR-9. The scope of the project is detailed in the separate table.	
Implementing Agency	Ministry of Public Works and Transport	
Other Stakeholders	Savannakhet Province, WREA, Traffic Police, Roadside Communities, Regional Tourism Industry (long-distance bus company, hotel, restaurants and others), Cargo Company	

Implementation Schedule		1st	2nd	3rd	4th	5th	6th	7th	8th - Year
	Design Works - B/D - D/D								

	Tendering - E/N - Tender		
	Construction - Preparation - Works		
	EIA - EIA/EMP/RAP - License - (Land Acquisition)		
Project Cost	Construction cost: 3,305 million yen Design and supervision work: 198 million yen Administration cost: 66 million yen Total cost: 3,569 million yen		
Possible Financial Source	The Government of Japan		
Related Activities	JICA is to conduct the basic design for the project and the scope of the project will be finalized, including the project cost.		
Requirement	Planning Requirement	・ The following surveys may be required: Topographic survey, Pavement condition survey, Geotechnical survey (boring), Hydrological survey and Traffic survey.	
	Technical Requirement	・ N/A	
	Environmental Requirement	・ Environmental approval shall be obtained prior to construction, by conducting either of IEE or EIA. Type of environmental study for official environmental approval is determined at Project Screening Process with WREA. ・ It is recommended to have discussions with WREA about Project Screening Process to determine ToR of relevant environmental study after upgrading outline of NR-9 is finalized.	

Source: Prepared by JICA Study Team

Table 4.6.1 Scope of Project (Upgrade of NR-9)

Scope of Works	Improvement of Pavement Structure and Rehabilitation
(1) Length	Replacement of pavement of 43km and overlay of 31km road along NR-9
(2)Design Conditions	Road class:Class II (3000～8000PCU/day), Design speed:100km/h(Flat), 70km (Rolling) ,50km(Residential)
(3)Cross-section	 Total width:11-12m＝0.5m(Un-paved shoulder)+1.5m(Paved shoulder)+3.5m x 2（Carriageway）+2.5m （Paved shoulder: Residential） +0.5m （Unpaved shoulder）
(4)Geometric Standards	Cross-fall Min horizontal curve applied:R=200m, Max. Grade:5.0 - 7.0%
(5)Pavement Structure	 Carriageway:AC, Shoulder: BTB Design Life:20 year for accounting traffic demand
(6)Drainage Facility	Type:side ditch, transverse pipe culvert, Design method:Rational formula, Design rainfall intensity:120mm/h （5year return period）
(7) Reference Index	Crack Ratio including DBST patching by Section (Follow-up Study)

Ph se	Phase-1		Phase -2		Phase -3		Total	
	Xeno-M anPharan		Muan Pharan-Muan Phin		MuanPhin-Densavanh			
Donor	Japan				ADB			
	km	%	km	%	km	%	km	%
Serious	22	30.14	10	16.95	11	13.92	43	20.38
Bad	13	17.81	16	27.12	2	2 53	31	14.69
Fair	38	52.05	33	55.93	66	83.54	137	64.93
Total	73	100.00	5	10 .00	79	100.00	211	100.00

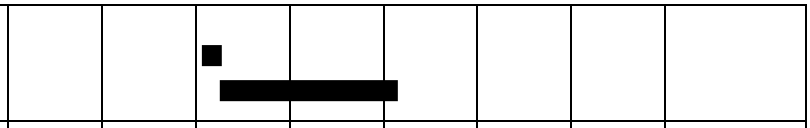
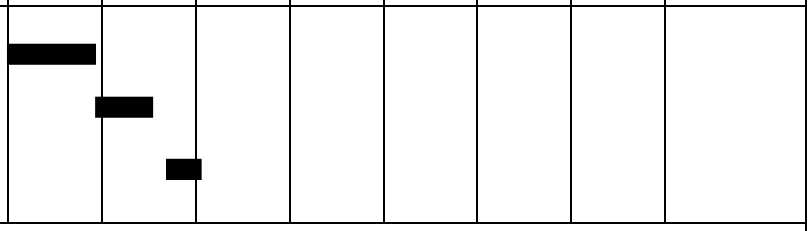
Source: Prepared by JICA Study Team

Table 4.6.2 Project Profile (Construction of Sedone Bridge)

Project Name	Construction of Sedone Bridge	SN	N-2-NR15A
Project Background	The location of Lao PDR offers strategic prospects, transforming itself from "land-locked" to "land-linked" country particularly by developing international infrastructure networks. In this respect, road links, in particular, are of vital importance. The transport system in Laos significantly depends on the road network, and is critical for national integration, and is also highly valued for improving accessibility to surrounding countries. Especially the East – West Corridor between Vietnam and Thailand is essential in securing access to the sea ports. In addition, the improvement of the road network is domestically important for improving accessibility of the rural communities to the livelihood assets e.g. goods, services and opportunities; and for realizing the potentials of economic growth. The Government of Lao PDR has made intensive efforts to improve the trunk road network in Southern Lao. These efforts include road improvements along NR-13 (South), NR-9 and construction of the Second Mekong Bridge, under the support of both bilateral and multilateral donors, such as ADB, World Bank and JICA. In spite of the afore-mentioned, there is still need for significant injection of funds into road rehabilitation/development in Southern Lao. Unpaved roads and un-rehabilitated bridges, frequently observed in the Southern Lao, all contribute to deteriorating the road network and hence hindering trade of both goods and people. As such, the economic development in Southern Lao lags behind the other regions in Lao PDR.		
Overall Goal and Project Purpose	Overall Goal: ・ To promote regional economic growth, especially that in Saravan Province, and alleviate poverty in Saravan Province, one of the poorest provinces in Laos. Project Purpose: ・ To reduce travel time and transport costs along the NR-15A and to establish a safe and reliable road network and hence to promote trade of goods and passengers to/from Saravan Province. ・ To improve accessibility to social infrastructures, markets and public transport services and to enhance income and employment opportunities and hence to reduce poverty in Saravan Province.		
Justification of the Project	Consistency with Upper Plan	・ Previous National Socio-economic Development Plan (2006-10) set major goals and targets, including strengthening socio-economic infrastructures as fundamentals for development and draft National Socio-economic Development Plan (2011-15) sets development directions, including socio-economic development of the country, by balancing economic growth and socio-cultural development. ・ In the Provincial Socio-economic Plan of Saravan, improvement of roads and bridges and promotion of export of local products (2006-10) and development of tourism and service industries (2011-15) are set as focal targets of the province. ・ There is also a potential of the industrial development. Saravan, has existing and prospective mines of coals and ironstones. ・ In this study, the road section of this project is selected as one of three priority projects from among 16 long listed road and bridge improvement projects.	

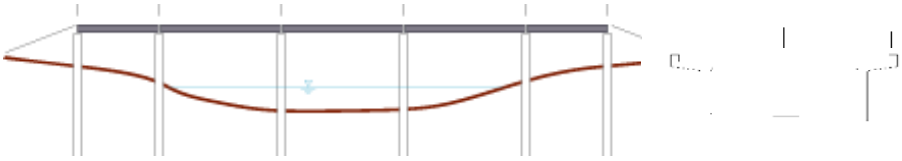
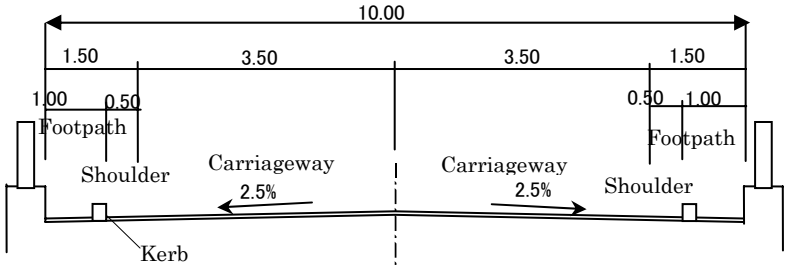
	Urgency of the Project	• A preliminary hydrological survey found that a water level of Sedone River fluctuates between 10-12 meters throughout the year. A rapid increase of water level and flow rate is frequently observed during the rainy season. Several causalities are reported at the project site. In August 2010, one passenger was washed away by the flood and drowned to death. • The existing bridge is a sunk bridge and is not passable during the rainy season, totaling between 1-3 months in a year. A ferry boat operates when the bridge is not passable. • A socio-economic survey was carried out at the sampled villages along the NR-15. It suggests that there is an urgent demand for road and bridge improvement to improve accessibility to social infrastructure and markets and sustain the livelihood of the villagers.
	Necessity of the Project	• Together with NR-15A (to be implemented by ADB/13) and 15B (undergoing by local funding), the project bridge consists of an alternative international corridor, connecting among Thai-Lao-Vietnam. • Based on comprehensive analysis by this study, the traffic volume of this road section is estimated to increase to 4,000 vehicles (PCU) per day by 2025. The volume capacity ratio along the NR-15A reaches 0.6 by 2025, showing the highest ratio among those of the long-listed projects.
	Adverse Impact of the Project	• IEE study suggests that both hydrological and hydrodynamic factors, considering local river morphology, would be critical for proper design of bridge and approach road. Other critical environmental factors to be carefully studied are (i) potential for soil erosion, (ii) temporal water quality degradation during construction period, (iii) roadside noise and air quality during construction phase, (iv) worsened traffic safety during construction period and (v) risk of soil contamination due to accidental spill of construction chemicals. • Therefore, a future study is required to minimize the environmental impact caused by the project by proposing mitigation measures.
	Beneficiaries and Benefits generated from the Project	• The road users along the NR-15A are direct beneficiary. 71,000 persons, who stayed near the project site (within 5 km buffer) are indirect beneficiaries. Amongst these people, there are 7,000 persons living in the village without schools and 61,000 persons without hospital/clinics. • The result of the economic analysis on this particular project is summarized below: EIRR= 13.2%. Thus, the economical validity of this project is justified. • Economic benefits derived from the project will contribute to poverty reduction. This project contributes to generating income on 73,000 households in Saravane Province.
Scope of Project	Construction of 220 m bridge with approach road. The scope of the project is detailed in the separate table.	
Implementing Agency	Ministry of Public Works and Transport	
Other Stakeholders	Saravane Province, WREA, Traffic Police, ADB (possibly, donor for 15A improvement), Roadside Communities, Cargo Company	

Implementation Schedule		1st	2nd	3rd	4th	5th	6th	7th	8th - Year
	Design Works - B/D - D/D								
	Tendering - E/N - Tender								

	Construction - Preparation - Works		
	EIA - EIA/EMP/RAP - License - Land Acquisition		
Project Cost	Construction cost: 1,029 million yen Design and supervision work: 62 million yen Administration cost: 21 million yen Total cost:1,112 million yen		
Possible Financial Source	Multi-lateral and bi-lateral donors		
Related Activities	The whole road section of NR-15A will be improved under ADB/13. ADB is going to conduct the project preparatory study to narrow down the scope of the project. The construction of Sedone Bridge will be excluded from the scope of the project, due to the limited budget allocated by ADB.		
Requirement	Planning Requirement	・ The following surveys may be required: Topographic survey, Geotechnical survey (boring), Hydrological survey, Environmental survey and Traffic survey.	
	Technical Requirement	・ N/A	
	Environmental Requirement	・ Environmental approval shall be obtained prior to construction, by conducting either of IEE or EIA. Type of environmental study for official environmental approval is determined at Project Screening Process with WREA. ・ It is recommended to have discussion with WREA about Project Screening Process to determine ToR of relevant environmental study after design of Sedone Bridge is finalized.	

Source: Prepared by JICA Study Team

Table 4.6.1 Scope of Project (Construction of Sedone Bridge)

Scope of Works	Construction of Bridge with Approach Roads
(1)Bridge length /Span	 220m=35m+50m+50m+50m+35m PC-Box Girder
(2)Width formation	 Effective width:10m=1.0m(footpath)+ 0.5m(shoulder)+3.5m x 2(carriageway) +0.5m(shoulder)+1.0m(footpath)
(3)Design Loads	Live Load: HS20-44 x 1.25
(4)Superstructure	
- Structural type	5span continuous PC box girder type
- Erection method	Incremental launching method
(5)Substructure	Two (2) abutments and 4 piers
(6)Foundation	Sperad foundation / Pile foundation
(7) Ancillary Facility	Lighting, Newel post, Drainage facility
(8)Others	Loading water supply pipe, electric pipe and telephone pipe for future extension
Approach Roads	
(1) Length	Right bank:200m, Left bank:200m
(2)Design Conditions	Road class:Class III Design speed:60km/h Design traffic volume(1000～3000PCU/day), Terrain:Flat,
(3)Cross-section	Total width:11m＝0.5m(Un-paved shoulder)+1.5m(Paved shoulder)+3.5m x 2 （Carriageway） +1.5m （Paved shoulder） +0.5m （Unpaved shoulder）
(4)Geometric Standards	Geometric standards according to the design speed of 60km/h Min horizontal curve applied:R=200ｍ, Max. longitudinal gradient applied:4.0%
(5)Pavement Structure	Carriageway:DBST, Shoulder: SBST Design Spec.:Road Note 31, Design Life:10 year, Design traffic volume:assume based on the traffic count survey
(6)Drainage Facility	Type:side ditch, transverse pipe culvert, box culvert, etc.

Source: Prepared by JICA Study Team

Table 4.6.2 Project Profile (Replacement of Bridges along NR-9)

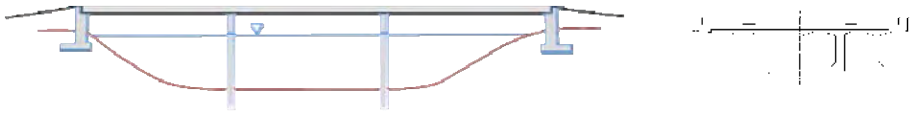
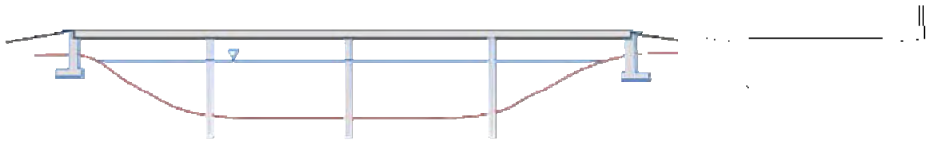
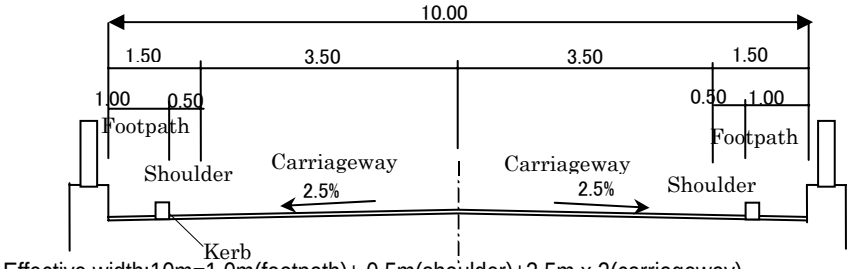
Project Name	Replacement of Bridge along NR-9	SN	N-3-NR9
Project Background	The location of Lao PDR offers strategic prospects, transforming itself from "land-locked" to "land-linked" country particularly by developing international infrastructure networks. In this respect, road links, in particular, are of vital importance. The transport system in Laos significantly depends on the road network, and is critical for national integration, and is also highly valued for improving accessibility to surrounding countries. Especially the East – West Corridor between Vietnam and Thailand is essential in securing access to the sea ports. In addition, the improvement of the road network is domestically important for improving accessibility of the rural communities to the livelihood assets e.g. goods, services and opportunities; and for realizing the potentials of economic growth. The Government of Lao PDR has made intensive efforts to improve the trunk road network in Southern Lao. These efforts include road improvements along NR-13 (South), NR-9 and construction of the Second Mekong Bridge, under the support of both bilateral and multilateral donors, such as ADB, World Bank and JICA. In spite of the afore-mentioned, there is still need for significant injection of funds into road rehabilitation/development in Southern Lao. Unpaved roads and un-rehabilitated bridges, frequently observed in the Southern Lao, all contribute to deteriorating the road network and hence hindering trade of both goods and people. As such, the economic development in Southern Lao lags behind the other regions in Lao PDR.		
Overall Goal and Project Purpose	Overall Goal: ・ To promote international/domestic traffic along the East-West Corridor and to generate economic growth in the GMS/Laos. Project Purpose: ・ To establish a safe and reliable road network and hence to promote trade of goods and passengers along the East-West Corridor. ・ To ensure accessibility to social infrastructures, markets and public transport services and to enhance income and employment opportunities and hence to reduce poverty along the NR-9.		
Justification of the Project	Consistency with Upper Plan	・ Previous National Socio-economic Development Plan (2006-10) set major goals and targets, including strengthening socio-economic infrastructures as fundamentals for development and draft National Socio-economic Development Plan (2011-15) sets development directions, including strengthening international cooperation and integrating the economy into the regional and global organizations. ・ In the Provincial Socio-economic Plan of Savannakhet, improvement of roads and bridges in the rural area (2006-10) and elimination of poverty and development of the local economy (2011-15) are set as focal targets of the province. ・ There are development potentials, industrial development in especial, along the NR-9. For instance, Savan-Seno SEZ develops 4 SEZs along the NR-9. Gold and copper mining at Sepon, which significantly contributes to national economic growth, expands its production. ・ In this study, the road section of this project is selected as one of three priority projects from among 16 long listed road and bridge improvement projects.	

	Urgency of the Project	• There are 51 concrete and steel bridges along the NR-9, mostly constructed in mid 1980s. One of the concrete bridges along the NR-9 was collapsed due to the heavy loaded truck and is replaced by the local funding in 2010. • An inventory survey on the bridges along the NR-9 found structural cracks caused by shearing force and bending moments, inadequate concrete filling, damaged expansion joint, absence of bearing shoe (concrete bridges) and damaged reinforcement post, residual deflection, and no appropriate gap between abutment and steel girder (steel bridges). • Due to the insufficient amount of maintenance funds, the deteriorated bridges cannot be properly maintained and high risk of bridge collapse. • A socio-economic survey was carried out at the sampled villages along the NR-9. It suggests that there is an urgent demand for road improvement to improve accessibility to social infrastructure and markets and sustain the livelihood of the villagers.
	Necessity of the Project	• The road section of this project partly composed of the Asian Highway No. 16 and GMS Economic Corridor (East-West Corridor). The design standards of the Asian Highway (Class II) suggests this road section to be upgraded to AC surfaced roads to allow maximum load of 11.0 ton. • The international traffic observed along the NR-9, estimated by the traffic demand forecast, will increase to 58% of the traffic and the NR-9 is expected to function as the important international corridor. • Based on comprehensive analysis by this study, the traffic volume of this road section is estimated to increase to 8,500 vehicles (PCU) per day by 2025. The volume capacity ratio along the NR-9 reaches 0.55 by 2025, showing the highest ratio among those of the long-listed projects.
	Adverse Impact of the Project	• IEE study suggests that both hydrological, hydrodynamic factors, considering local river morphology, would be critical for proper design of bridge and approach road. Other critical environmental factors to be carefully studied are (i) potential for soil erosion of riverbank, (ii) temporal water quality degradation during construction period, (iii) roadside noise and air quality during construction phase, (iv) worsened traffic safety during construction period and (v) risk of soil contamination due to accidental spill of construction chemicals.
	Beneficiaries and Benefits generated from the Project	• The road users along the NR-9 are direct beneficiary. 239,000 persons, including 82,000 persons under poverty, who stayed near the project site (within 5 km buffer) are indirect beneficiaries. Amongst these people, there are 77,000 persons living in the village without schools and 217,000 persons without hospital/clinics. • The result of the economic analysis on this particular project is summarized below: EIRR= 12.8%. Thus, the economical validity of this project is justified. • Economic benefits derived from the project will contribute to poverty reduction. This project contributes to generating income on 1,000 households in east part of Savannakehet Province, where most severe poverty is observed.
Scope of Project	Replacement of 2 bridges with construction of approach road along NR-9. The scope of the project is detailed in the separate table.	

Implementing Agency	Ministry of Public Works and Transport								
Other Stakeholders	Savannakhet Province, WREA, Traffic Police, Roadside Communities, Regional Tourism Industry (long-distance bus company, hotel, restaurants and others), Cargo Company								
Implementation Schedule		1st	2nd	3rd	4th	5th	6th	7th	8th - Year
	Design Works - B/D - D/D								
	Tendering - E/N - Tender								
	Construction - Preparation - Works								
	EIA - EIA/EMP/RAP - License - Land Acquisition								
Project Cost	Construction cost: 1,245 million yen Design and supervision work: 75 million yen Administration cost: 25 million yen Total cost: 1,345 million yen								
Possible Financial Source	Multi-lateral and bi-lateral donors								
Related Activities	Curerntly, the DPWT of Savannakhet Province works to maintain the existing concrete bridges along the NR-9.								
Requirement	Planning Requirement	• The following surveys may be required: Topographic survey, Geotechnical survey (boring), Hydrological survey and Traffic survey.							
	Technical Requirement	• N/A							
	Environmental Requirement	• Environmental approval shall be obtained prior to construction, by conducting either of IEE or EIA. Type of environmental study for official environmental approval is determined at Project Screening Process with WREA. • It is recommended to have discussion with WREA about Project Screening Process to determine ToR of relevant environmental study after replacement outline of all bridges along NR-9 is finalized.							

Source: Prepared by JICA Study Team

Table 4.6.1 Scope of Project (Replacement of Bridges along NR-9)

Scope of Works	Replacement of Two Bridges with approach road	
(1) Bridge length /Span	 No.13 No. 13 95m=35m+50m+35m PC-I Girder	
	 No.17_168m=42m+42m+42m+42m+42m PC-Box Girder	
(2)Width formation	 Effective width:10m=1.0m(footpath)+ 0.5m(shoulder)+3.5m x 2(carriageway) +0.5m(shoulder)+1.0m(footpath)	
(3)Design Loads	Live Load: HS20-44 x 1.25	
(4)Superstructure	No.13	No.17
- Structural type	PC post-tension 3 span simple girder	PC post-tension 4span continuous PC box girder type
- Erection method	Crane erection	All staging method
(5)Substructure	Two (2) abutments and 2 piers	Two (2) abutments and 3 piers
(6)Foundation	Spread foundation / Pile foundation	
(7) Ancillary Facility	Lighting, Newel post, Drainage facility	
(8)Others	Loading water supply pipe, electric pipe and telephone pipe for future extension	
2..Approach Roads		
(1) Length	Right bank:200m, Left bank:200m	
(2)Design Conditions	Road class:Class II Design speed:100km/h Design traffic volume(3000～8000PCU/day), Terrain:Flat,	
(3)Cross-section	Total width:11m＝0.5m(Un-paved shoulder)+1.5m(Paved shoulder)+3.5m x 2 （Carriageway） +1.5m （Paved shoulder） +0.5m （Unpaved shoulder）	
(4)Geometric Standards	Cross-fall 2.5% Min horizontal curve applied:R=200m, Max. gradient applied:4.0%	
(5)Pavement Structure	Carriageway:Asphalt Design Spec.:Road Note AASHTO, Design Life:10 year, Design traffic volume:assume based on the traffic count survey	
(6)Drainage Facility	Type:side ditch, transverse pipe culvert, box culvert, etc.	

Source: Prepared by JICA Study Team

5. CONCLUSION AND RECOMMENDATION

5.1 Conclusion

At the initial stage of the Study, current socio-economic and road/traffic conditions in the southern region were overviewed, reviewing and analyzing statistics and empirical studies. Based on the data analysis of these conditions, the previous master plan was reviewed and revised and the priority projects are identified by the following steps.

- A long list of both road and bridge improvement projects was prepared. This long list of road projects limits to unpaved national roads, including on-going road improvement projects. The long list of bridge projects includes new long-span bridge projects over major rivers, such as Sekong Bridge and Sedone Bridge, and deteriorated and narrow bridges, observed along NR-9 and NR-20.
- Future socio-economic framework was prepared with the target year of 2025 by reviewing and updating such information as population and GDP. Industrial and agricultural development projects were also listed for further study to estimate the traffic volume generated from these projects.
- Future traffic demand in the study area was estimated based on existing and future road network and origin-destination matrices, built in the ongoing JICA Study on the Comprehensive Logistics System in Lao PDR.
- Road and bridge improvement projects were evaluated by a multi criteria analysis, scoring indicators such as cost-benefit, future traffic volume, development potential, and environmental impacts. The priority projects are selected from among the long list of road and bridge improvement projects.

As a result of sophisticated analytical works, Upgrade of NR-9, Construction of Sedone Bridge and Replacement of Bridges along NR-9, scores the highest marks by the multi criteria analysis and are selected as the priority project proposed to be implemented up to 2015.

5.2 Recommendation

Through the preliminary engineering study on the priority project, alternatives of the structural design of the priority projects were tested and optimum scope of the priority projects was determined. As a consequence, this study recommended that;

- For Upgrade of NR-9, the alternative structures of the pavement were tested and both overlay and replacement of the pavement are selected as the optimum pavement structure applied to this project. In order to maximize the cost effectiveness of the project, the scope of the Upgrade of NR-9 is proposed to replace pavement of 43-km seriously deteriorated road and to overlay 31-km partially damaged road surfaces. Total construction cost was estimated at 36.5 million USD (3,305 million JPY).
- The study of design of the Sedone Bridge was conducted in 2008 and recommended 198-meter PC post-tension six (6) span simple girder bridge. Considering discharge volume of the Sedone River, current direction, and the variable topography of river bed at the river crossing point, the Sedone Bridge is recommended to have five (5) span PC box girder bridge (35m + 3X50m + 35m) with the total bridge length of 220 meter. The construction cost for the Sedone Bridge is estimated at 11.3 million USD (1,029 million JPY).

- In a course of the study, the durability of the bridges along the NR-9 was tested through the preliminary structural analysis and observatory analysis during the site visit. The bridge inventory survey was also conducted to access the condition of the bridges along the NR-9 and confirmed that two STG bridges (No.13 and 17) are required for urgent replacement or rehabilitation. The construction cost for these 2 bridges is estimated at 13.7 million USD (1,245 million JPY).

Finally, the initial environmental examination was carried out to identify major adverse environmental impacts caused by the project. Economic feasibility of the project was tested, analyzing project benefits generated through reduction of vehicle operating cost and travel time and construction and maintenance cost of the project.

- Thought some environmental impacts are unknown and need to be further studied, IEE study suggests that there would be no significant adverse impact during the construction and after the operation of the project. Having said that, detailed hydrological and hydrodynamic studies, considering local river morphology, are recommended for proper design of bridge and approach road.
- For all priority projects, figures of EIRR are nearly equal to or higher than 12%, which is substitution cost of capital. Therefore, these projects are justified feasible from the viewpoint of national economy of Lao PDR.

Preparatory Study for Improvement of Roads and Bridges in the Southern Region in Lao PDR

Final Report

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Abbreviations

4WD	4 Wheel Drive
AADT	Annual Average Daily Traffic
AASHTO	American Association of State-Highway and Transportation Officials
ADB	Asian Development Bank
ADT	Average Daily Traffic
AFTA	ASEAN Free Trade Area
ASEAN	Association of South-East Asian Nations
AusAID	Australian Agency for International Development
B/D	Basic Design
CBR	California Bearing Ratio
D/D	Detailed Design
DBST	Double Bitumen Surface Treatment
DCTPC	Department of Communication, Transport, Post and Construction
DoMH	Department of Meteorology and Hydrology
DOR	Department of Roads (of MPWT)
DoS	Department of Statistics, Ministry of Planning and Investment
DOT	Department of Transport
DP	Development Partners
DPWT	Department of Public Works and Transport
DRP	Detailed Resettlement Plan
EA	Environmental Assessment
EDL	Electricite du Laos
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
EMP	Environmental Management Plan
ESD	Environmental Social Division (of MPWT/DOR)
FAO	Food and Agriculture Organization of the United Nations
FDI	Foreign Direct Investment
GDP	Gross Domestic Products
GMS	The Greater Mekong Subregion
GRDP	Gross Regional Domestic Products
GTS	Global Telecommunication System
IBA	Important Bird Area
IDA	International Development Association (World Bank)
IEE	Initial Environmental Examination
ISIC	International Standard Industrial Classification
JAIF	Japan-ASEAN Integration Fund
JICA	Japan International Cooperation Agency
JPHRD	Japan Policy and Human Resource Development Fund
JSDF	Japan Social Development Fund
LCR	Land Acquisition and Compensation Report
LDC	Least Developed Country
LECS3	Expenditure and Consumption Household 2002/2003
LECS4	Expenditure and Consumption Household 2007/2008
LHSE	Lao Holding State Enterprise

LRD	Local Road Division
LTEC	Lao Transport Engineering Consultant
MDGs	Millennium Development Goals
MPI	Ministry of Planning and Investment
MPWT	Ministry of Public Works and Transport
MRC	Mekong River Commission
NDF	Nordic Development Fund
NGPES	National Growth and Poverty Eradication Strategy
NOAA	National Oceanic and Atmospheric Administration
NPA	National Protected Area
OCTPC	Office of Communications, Transport, Post and Construction
OD	Origin-Destination
OPWT	Office of Public Works and Transport
PDR	People's Democratic Republic
PC	Prestressed Concrete
PCU	Passenger Car Unit
PDA	Project Development Agreement
PMD	Project Monitoring Division (of MPWT/DOR)
RMP	Road Maintenance Program
PRF	Poverty Reduction Fund
PRoMMS	Provincial Road Maintenance Management System
PRSP	Poverty Reduction Strategy Paper
PTI	Public Works and Transport Institute
RAD	Road Administration Division
RC	Reinforced Concrete
RDO	Regional Development Office
RMF	Road Maintenance Fund
RMP	Road Maintenance Program
RMS	Road Maintenance System
ROW	Right of Way
SBST	Single Bitumen Surface Treatment
SEZ	Special Economic Zone
SIDA	Swedish International Development Agency
SSL	Standard Span Length
STEA	Science, Technology and Environment Agency
TEC	Thai Engineering Company
TED	Technical and Environment Division
TEDI	Transport Engineering Design Incorporated
TFR	Total Fertility Rate
TOR	Terms of References
TRRL	Transport and Road Research Laboratory
UDA	Urban Development Administration Authority
UXO	Unexploded Ordnance
VCR	Volume Capacity Ratio
VOC	Vehicle Operating Cost
WTO	World Trade Organization

CHAPTER 1 INTRODUCTION

1.1 Background of the Study

The location of Lao PDR offers strategic prospects, transforming itself from "land-locked" to "land-linked" country particularly by developing international infrastructure networks. In this respect, road links, in particular, are of vital importance. The transport system in Laos significantly depends on the road network, and is critical for national integration, and is also highly valued for improving accessibility to surrounding countries. Especially the East – West Corridor between Vietnam and Thailand is essential in securing access to the sea ports. In addition, the improvement of the road network is domestically important for improving accessibility of the rural communities to the livelihood assets e.g. goods, services and opportunities; and for realizing the potentials of economic growth.

The Government of Lao PDR has made intensive efforts to improve the trunk road network in Southern Lao. These efforts include road improvements along NR-13 (South), NR-9 and construction of the Second Mekong Bridge, under the support of both bilateral and multilateral donors, such as ADB, World Bank and JICA. In recent years, the private investors are actively involved in the road improvement projects such as NR-14A, 15B and 16A, mainly on build and transfer contract basis. In spite of the afore-mentioned, there is still need for significant injection of funds into road rehabilitation/development in Southern Lao. Unpaved roads and un-rehabilitated bridges, frequently observed in the Southern Lao, all contribute to deteriorating the road network and hence hindering trade of both goods and people. As such, the economic development in Southern Lao lags behind the other regions in Lao PDR.

In light of this, the Government of Lao PDR acknowledges road improvement in Southern Lao should be given the highest priority and has officially requested the Government of Japan for grant aid for the road and bridge improvement projects. In response to this request, the Japan International Cooperation Agency (JICA) carried out the study in 2003, namely the Study on Improvement of Roads in the Southern Region in Lao PDR, and conducted the feasibility study on two priority projects (NR-14A and NR-16A). Following this study, the JICA carried out the Preliminary Study for Construction of Bridges in the Southern Region in Lao PDR for Poverty Reduction in 2008 to narrow down the scope of bridge rehabilitation projects along NR-1G. However, none of the projects has been implemented yet, since reasoning behind these projects pointing out the appropriateness, necessity and urgency of the projects, and impact of the project on poverty alleviation need to be clearly identified as requirement for Japanese grant aid.

The Government of Lao PDR recognizes that there is still need for significant effort in road improvement projects in the southern region and thus requests donors, including ADB and JICA, to support the road improvement projects. Accordingly, this Study will revise and update the previous JICA study on the road improvement master plan and select priority projects, identifying

appropriateness, necessity and urgency of the projects as required by Japanese grant aid.

1.2 Objectives of the Study

This Study aims at revising the previous JICA study, i.e. the Study on Improvement of Roads in the Southern Region in Lao PDR, conducted in 2003, through updating the current road and bridge conditions and socio-economic conditions and testing the feasibility of the road improvement projects requested by the Government of Lao PDR for Japanese grant aid. Through this revision work of the previous study, the current study also aims at providing recommendations to narrow down the scope of road and bridge improvement projects in the southern region under the Japanese grant aid.

1.3 Study Area

The Study area covers five provinces in the southern region in Lao PDR; Savannakhet, Saravane, Sekong, Champasack and Attapeu (see Figure 1.3.1).

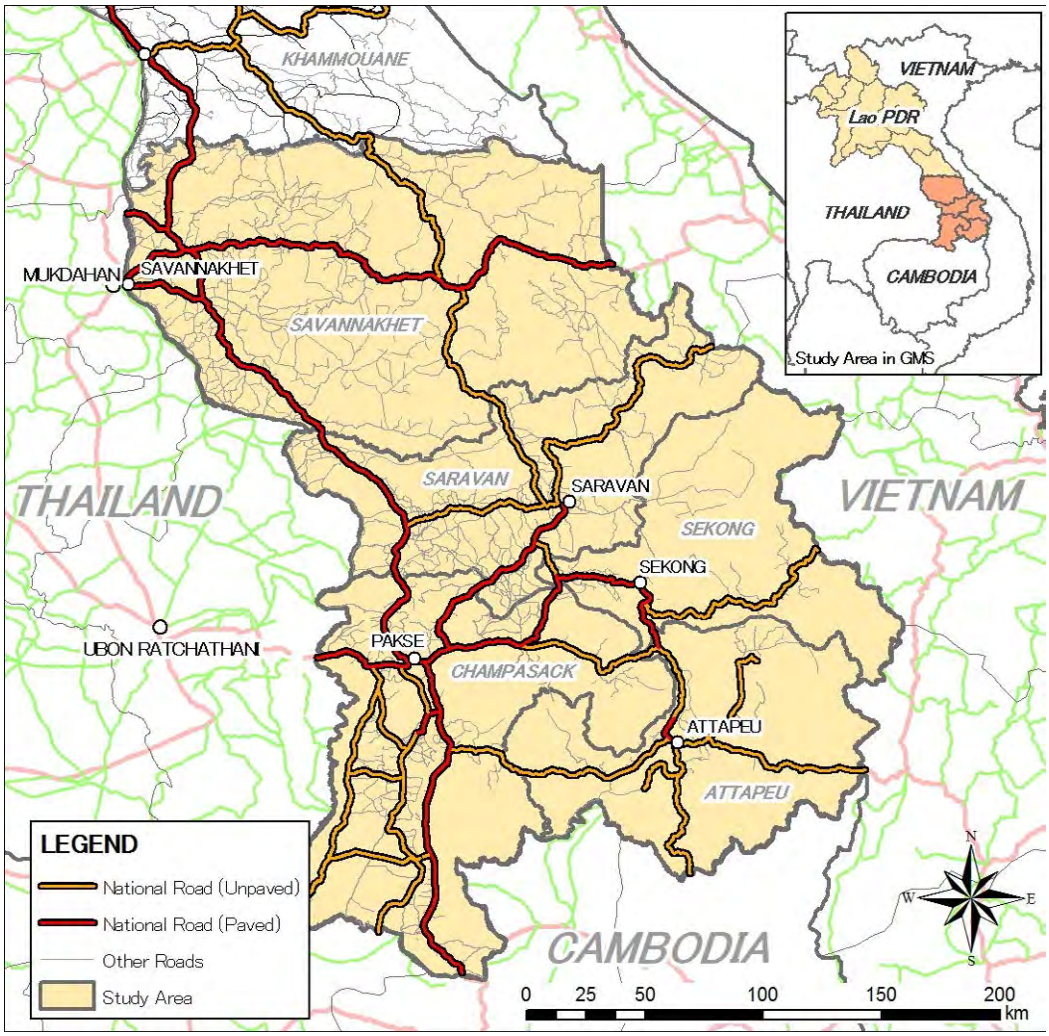


Figure 1.3.1 Study Area

1.4 Target Year

This Study formulates the road improvement master plan with the target year of 2025 and selects priority projects with the intermediate target year of 2015.

1.5 Structure of this Report

This Final Report consists of five chapters: General Understanding (Chapter 2), Revision of Master Plan (Chapter 3) and Preliminary Study of Priority Projects (Chapter 4) and Conclusion and Recommendation (Chapter 5). Chapter 2 demonstrates current socio-economic conditions, natural conditions and road network and traffic conditions, which provide inputs for revision of the previous master plan. Chapter 3 explores revision of the master plan, updating socio-economic framework and traffic demand forecast and proposes road development and improvement master plan and policy implications for road and bridge operation and maintenance. Chapter 4 carries out a preliminary study on priority projects, identifying an optimum scope of each priority project and testing economic and environmental viability of these priority projects. Chapter 5 provides conclusions and recommendations for realization of the priority projects by Japanese grant aid.

CHAPTER 2 GENERAL UNDERSTANDING

2.1 Socio-economic Conditions

2.1.1 Population and GDP

(1) National Socio-economic Development

Table 2.1.1 summarizes the population and its annual average growth rates in the census years. The population of Lao PDR had doubled from 2.9 million in 1976 to 5.6 million in 2005, showing a growth rate higher than the average in the East Asia and Pacific region. However, the growth rate is gradually getting lower, from 2.5% in the decade between 1976 and 1985 to 2.0% between 1995 and 2005. According to the Statistical Yearbook 2008, population passed the 6 million mark in 2008.

Table 2.1.1 Population and Annual Average Growth Rate in Census Years

Year	1976	1985	1995	2005
Total Population (000 persons)	2,886	3,618	4,605	5,622
Annual Average Growth Rate (%)	-	2.5	2.4	2.0

Source: Statistical Yearbook 1975-2005, 2007, DoS

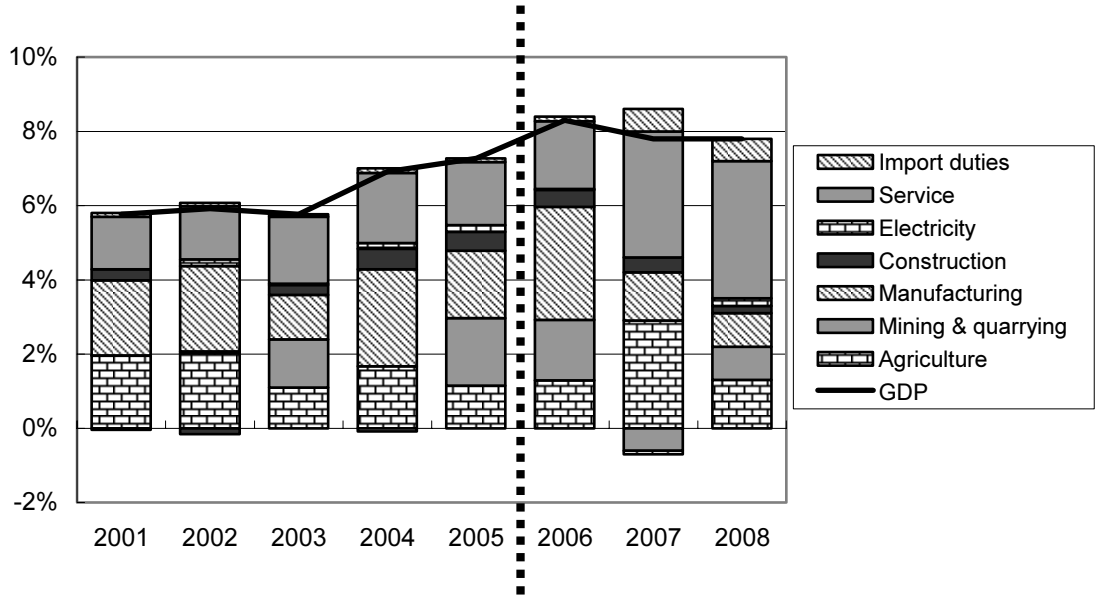
In the Census 2005 report, all villages in Lao PDR are classified into three categories: “urban” village, “rural with road” village and “rural without road” village. The urban village is defined based on the following characteristics:

- The village must lie in municipal vicinity where the district or provincial authority is located, and there should be more than 600 residents or more than 100 households.
- There should be a road for motor vehicle access to the village.
- The majority of households in the village should be electrified.
- The majority of households should have access to tap-water supply.
- There should be a market in the village.

Population of urban villages in 2005 was 1,523,000, which comprised 27% of the total population. The percentage of urban population has increased by 10% since 1995.

Figure 2.1.1 shows the GDP growth and the contribution of industries to GDP growth. GDP data before and after 2006 are not consistent because the Department of Statistics under the Ministry of Planning and Investment changed the methodology by which GDP is calculated. The graph

shows that manufacturing and mining & quarrying are major contributors to the recent rapid growth until 2006. Out of 8.3% growth, the sum of manufacturing and the mining & quarrying occupied 4.6% in 2006. Since 2007, service sector has become a major contributor to GDP growth. According to "Lao PDR Economic Monitor 2009 End-year Update" published by the World Bank, the GDP growth rate was 6.4% in 2009. This figure was the second highest in Asia and Pacific region following China.

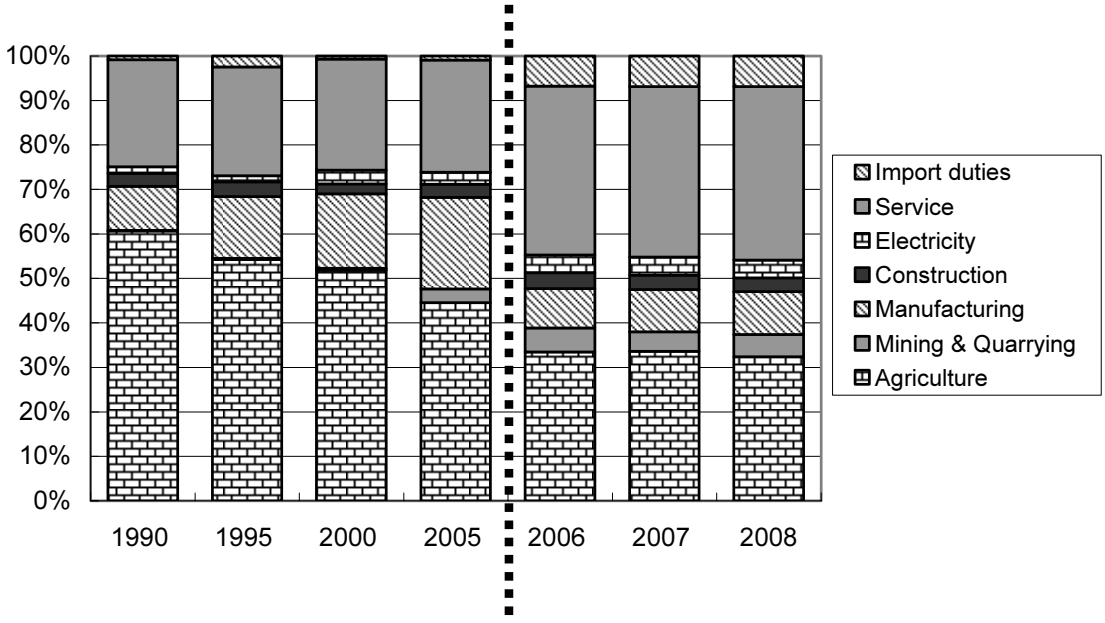


Source: Statistical Yearbook 1975-2005, 2007, DoS

Figure 2.1.1 GDP Growth Rate and Contribution of Industries

Figure 2.1.2 illustrates the composition of industry from 1990 to 2008. As is the case with GDP growth rates by industrial sector, the industrial share also changed in an anomalous manner after 2006 due to alteration of the calculation method. The primary sector claimed a share of 60% in 1990, but it has dropped gradually and was recorded at 32% in 2007. On the other hand, manufacturing, mining & quarrying, electricity have increased their share during the same period.

The share of the tertiary industry has increased gradually from 37.9% in 2006 to 39.0% in 2009 while the share of the manufacturing industry has also increased from 8.9% in 2006 to 9.6% in 2008. In general, the trend of decrease in the share of the primary sector coupled with an increase in the shares of the secondary and tertiary sectors has continued throughout the survey period from 1990 to 2008.



Source: Statistical Yearbook 1975-2005, 2007, DoS

Figure 2.1.2 Change of Industrial Composition

(2) Socio-economic Development in the Study Area

Table 2.1.2 illustrates the change in population in the 5 provinces from 1995 to 2005. The total population of the 5 provinces increased from 1.6 million in 1995 to 2.0 million in 2005. The percentage of the population in 5 provinces as a fraction of the national population has remained consistent at around 35%.

The population in Savannakhet Province contributes 14.7% of the national population, which is the highest among the 17 provinces in Lao PDR. The population was recorded at 826,000 in 2005. The population in Champasak Province was recorded at 607,000 which was 10.8% of the national population in 2005. Population in Saravane Province was 324,000 in 2005, about 5.8% of the national population. The Population of the other two provinces was relatively little: 112,000 persons (2.0%) in Attapeu Province and 85,000 persons (1.5%) in Sekong Province in 2005.

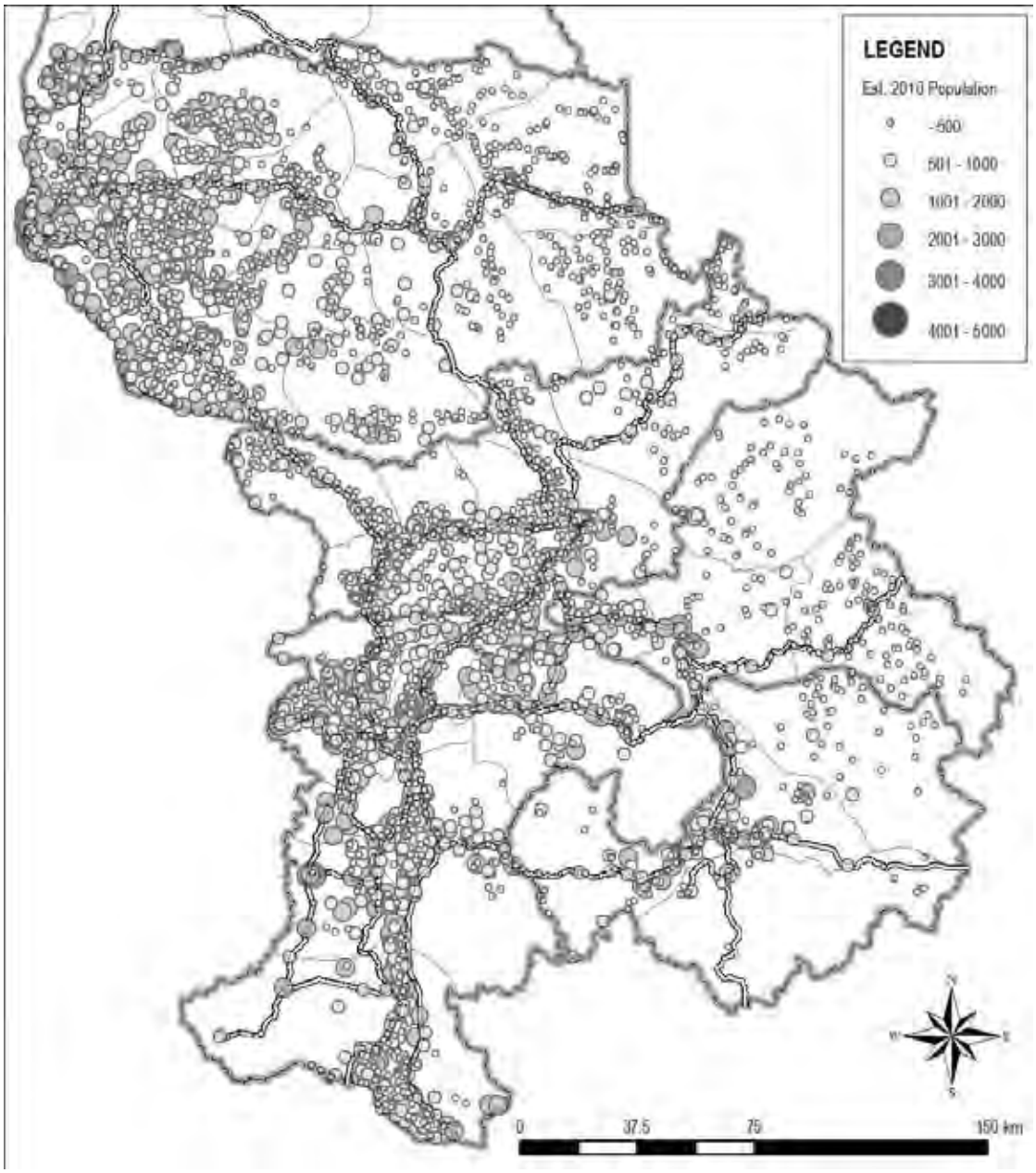
Table 2.1.2 Change in Population from 1995 to 2005

	Population (000 persons)		Share (%)		Growth rate from 1995 to 2005 (%)
	1995	2005	1995	2005	
Lao PDR	4,575	5,615	100	100	2.1
Savannakhet	672	826	14.7	14.7	2.1
Saravane	256	324	5.6	5.8	2.4
Sekong	64	85	1.4	1.5	2.9
Champasak	501	607	11.0	10.8	1.9
Attapeu	87	112	1.9	2.0	2.5
Total of the Study Area	1,581	1,955	34.6	34.8	2.1

Source: Census 1995 and 2005, DoS

As regards the annual average population growth rate in the 10 years running from 1995 to 2005, Savannakhet recorded the same level at 2.1% as the national average. The growth rate is a little lower in Champasak Province (1.9%). On the other hand, Sekong (2.9%), Attapeu (2.5%) and Saravane Province (2.4%) recorded higher growth rates than the national average.

Figure 2.1.3 shows estimated village population in 2010. Two clusters of population accumulation are observed in the figure: one is in the western part of Savannakhet Province and another is in the Saravane and Champasak Provinces along NR-13, NR-15, NR-16 and NR-20.



Source: Calculation by JICA Study Team from Census data in 1995 and 2005

Figure 2.1.3 Estimated Population by Village in 2010

Table 2.1.3 Estimated GRDP of 5 Provinces in 2008

	GDP/GRDP (million Kip)	Share (%)	GDP/GRDP per Capita (USD)
Lao PDR	46,215	100.0	891
Savannakhet	5,499	11.9	720
Saravane	1,607	3.5	549
Sekong	450	1.0	552
Champasak	4,736	10.2	828
Attapeu	736	1.6	751
Total of the Study Area	13,028	28.2	721

Source: Calculation by JICA Survey Team from Statistical Yearbook, LECS 3 and Economic Census 2006

Table 2.1.3 indicates estimated GRDP of the 5 provinces in 2008. It is calculated from the national GDP in 2008, household consumption by province[1] and the number of business establishments by province[2]. The study area contributes to 28.2% of the national GDP.

GRDP of Savannakhet Province was LAK5,499 million, 11.9% of the national GDP and is the second highest after Vientiane Capital (LAK10,574 million, 22.9%). GRDP of Champasak Province recorded LAK4,736 million, 10.2%. GRDPs of the other 3 provinces were small: LAK1,607 million (3.5%) for Saravane Province, LAK736 million (1.6%) for Attapeu Province and LAK450 million (1.0%) for Sekong Province.

In the same year, estimated GDP per capita was USD891 in Lao PDR. Champasak Province had the highest GDP per capita at USD828: however, this was lower than the national average. The GDP per capita of the other provinces were USD751 in Attapeu Province, USD720 in Savannakhet Province, USD552 in Sekong Province and USD549 in Saravane Province.

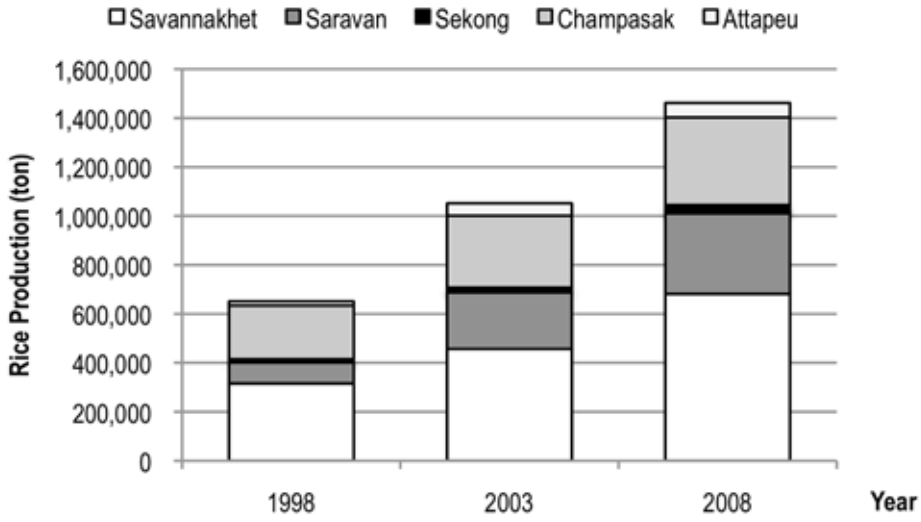
2.1.2 Industrial Development

(1) Agriculture

Figure 2.1.4 shows rice production in the 5 provinces. The production has more than doubled from 651,000 tons in 1998 to 1.5 million tons in 2008, and the proportion of production of these five provinces to the national production has also increased from 39% to 48%.

Around half of the production came from Savannakhet Province (47% in 2008). Champasak Province lost its share from 34% in 1998 to 24% in 2008. On the other hand, Saravane Province increased its share from 13% to 23% during the same period. Shares of the other provinces were relatively minimal i.e. 4% for Attapeu Province and 2% for Sekong Province in 2008.

[1] Data from Expenditure and Consumption of Household 2002/2003 (LECS 3)
[2] Data from the first Economic Census in 2006



Source: Statistical Yearbook 1975-2005 and 2008, DoS

Figure 2.1.4 Rice Production in 5 Provinces

Table 2.1.4 illustrates production of major commercial crops in 2008. The study area is rich in production of commercial crops. Productions of coffee and sugarcane in the study area contributed respectively to 99% and 82% of the national production in 2008. Productions of peanuts, vegetables and beans and soybeans from the provinces contributed respectively to 57%, 28% and 27%, of the national production. In contrast, the proportion of maize which is the popular commercial crop in Lao PDR was only 7%.

Champasak Province is dominant in production of coffee (75% of the national production), soybean (25%), peanuts (17%) and vegetables and beans (13%). Saravane Province has a higher share in peanut (32%) and coffee (17%) production. Savannakhet Province has a dominant position in sugarcane production (81% of the national production). Two sugar factories recently started operations in the province.

Table 2.1.4 Production of Major Commercial Crops in 2008

(Unit: ton)

	Vegetables and Beans	Maize	Peanuts	Soybeans	Sugarcane	Coffee
Savannakhet	34,620(7%)	3,580(2%)	1,850(6%)	15(0%)	609,415(81%)	NA
Saravane	34,010(7%)	1,955(1%)	10,510(32%)	335(2%)	NA	5,440(17%)
Sekong	7,540(1%)	845(1%)	840(3%)	NA	1,170(0%)	1,805(6%)
Champasak	69,010(13%)	4,055(3%)	5,570(17%)	3,335(25%)	5,415(1%)	23,410(75%)
Attapeu	2,475(0%)	185(0%)	NA	NA	NA	215(1%)
Total of 5 Provinces	147,655(28%)	10,620(7%)	18,770(57%)	3,685(27%)	616,000(82%)	30,870(99%)
Lao PDR	521,495	154,255	32,690	13,515	749,295	31,125

Note: NA not available

Source: Statistical Yearbook 2008

(2) Industry

Table 2.1.5 indicates the number of manufacturing factories[3] classified by number of employees in 2008 in the 5 provinces. 24% of manufacturing factories (total of Level I, Level II and Level III) of Lao PDR were located in the study area. 11% of the manufacturing companies were located in Savannakhet Province while 8% of them were located in Champasak Province.

Table 2.1.5 Number of Manufacturing Factories and Number of Employees in 2008

	Number of Factories				Number of employees
	Total	Level I	Level II	Level III	
Savannakhet	2,541	19	48	2,474	7,170
Saravane	760	9	12	739	4,344
Sekong	39	10	3	26	664
Champasak	1,875	34	23	1,818	7,483
Attapeu	464	8	5	451	2,351
Total for Study Area	5,679	80	91	5,508	22,012
Lao PDR	24,227	832	431	22,964	121,979

Note: Level I Factory: means a type of large-scale factory with a total labor force in excess of 200 people or mechanized power in excess of 200 horsepower or which has a high [level of] environmental impact. Level II Factory: means a type of medium-scale factory with a total labor force from 51 to 200 people or mechanized power from 51 to 200 horsepower or which has a medium [level of] environmental impact. Level III Factory: means a type of small-scale factory with a total labor force from 10 to 50 people or mechanized power from 5 to 50 horsepower or which has a low [level of] environmental impact.

Source: Ministry of Industry and Commerce, Department of Industry, Factory Division

34 of 80 Level I companies (large-scale companies) were located in Champasak Province while most of the middle-scale companies and small-scale companies were located in the Savannakhet province. Saravane Province followed these two provinces in terms of industrial prominence. The numbers of Level I companies in Sekong and Attapeu were similar to that in Saravane Province. However, the numbers of Level II and Level III companies in the 2 provinces were relatively low.

Manufacturing employees in the study area accounted for 18% of the total number of national manufacturing employees. 6.1% of the national figure was contributed by Champasak Province while 5.9% was contributed by Savannakhet Province. The proportions contributed by Attapeu and Sekong Provinces were only 1.9% and 0.5% respectively.

Table 2.1.6 illustrates the extent of foreign direct investment (FDI) by industry type and province. The number of FDI projects in the study area was 26, which is 11% of the total number of FDI projects in Lao PDR.

FDI industries in Champasak Province were in the same industry group. 6 out of 11 projects were in food & beverage manufacturing while 4 projects were for chemical products. On the other hand, FDI projects in Savannakhet Province were diversified. There was a food & beverage project in Saravane Province while there were no FDI projects in Sekong and Attapeu.

[3] Manufacturing factories consists of 15 to 41 of ISIC Rev 3.

Table 2.1.6 Number of Foreign Direct Investment Industries by Type of Industry and Provinces

ISIC	Industry	Savannakhet	Saravane	Sekong	Champasak	Attapeu	Total
15	Manufacture of food products & beverages	1	1		6		8
16	Manufacture of tobacco products	1					1
17	Manufacture of textiles	1					1
18	Manufacture of wearing apparel; dressing and dyeing of fur	1					1
19	Tanning & dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear				1		1
20	Manufacture of wood and of products of wood & cork, except furniture; of articles of straw and plaiting materials	2					2
24	Manufacture of chemicals and chemical products	2			4		6
25	Manufacture of rubber & plastics products	1					1
28	Manufacture of fabricated metal products, except machinery & equipment	1					1
29	Manufacture of machinery and equipment n.e.c.				1		1
34	Manufacture of motor vehicle, trailers and semi-trailers	1					1
40	Electricity, gas, steam & hot water supply				2		2
Total		11	1	0	14	0	26

Note: Logging factories were not included.

Source: Ministry of Industry and Commerce, Department of Industry, Factory Division

Savan-Seno SEZ has 4 development sites; Site A, Site B, Site C and Site D. Site A and Site C are being developed by private concessionaires while site B is being developed by Savan-Seno SEZ Authority. 13 private companies decided to invest in the Site C, and construction work has started. In the Site B designated for logistics industry, three logistics companies had invested but business activities there have not started as yet. Development of Site A intended to be utilized for commercial and leisure purposes is experiencing delays. Development of Site D which is designated as residential area and relocation site for residents of Site A is also experiencing delays.

Gold and copper mining at Xepone has contributed to the recent economic development. Production of gold and copper had started in 2003 and 2005, respectively. Figure 2.1.5 shows the production volume of gold and copper from 2003. Gold production, which started in 2003, is recorded between 6 to 12 tons per year. The estimated deposit amount of gold is 46.7 tons at Xepone Mine and 31.1 tons at Phu Bia Mine (Vientiane Province), and these mines are expected to continue to produce the same volume of gold for more than 10 years.

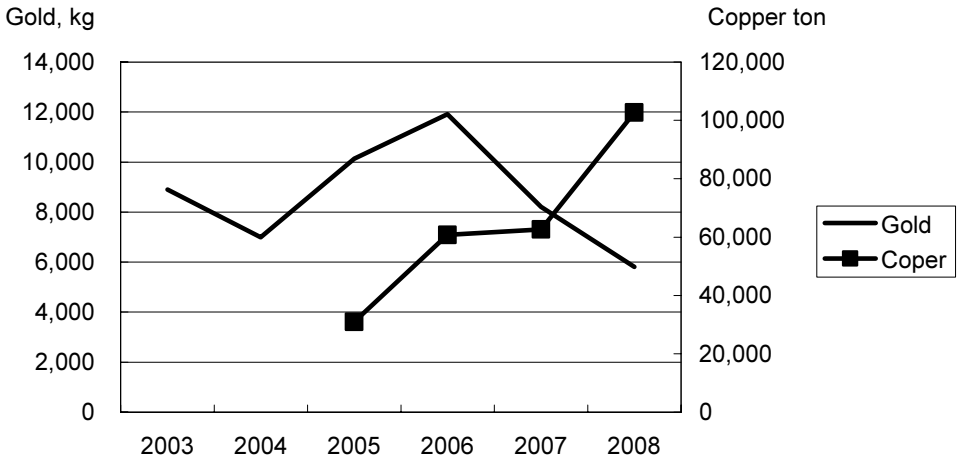


Figure 2.1.5 Production of Gold and Copper

Source: Statistical Yearbook various issues, DoS

Production of copper at Xepone Mine started in 2005, and the production amount has doubled in 2008. Together with gold, copper production in the two mines has contributed to the rapid economic growth in recent years. The deposit amount of copper is 1.7 million tons at Xepone Mine, and it is expected that production will continue at the same volume for 30 years.

(3) Service

Champasak and Savannakhet Provinces are the center of the tourism sector in the southern region. Table 2.1.7 indicates Visitor arrivals in the study area. Savannakhet Province recorded 373,000 visitors in 2007 and 421,000 in 2008. The province also undertook the opening of the 2nd Friendship Bridge in December 2006. Visitor arrivals to Champasak Province were recorded as 220,000 in 2007 and 258,000 in 2008. Most of the visitors visited international-level tourist sites such as Wat Phou and Si Phan Don.

Table 2.1.7 Visitor Arrival in the Study Area

	2007	2008
Savannakhet	323,700	420,809
Saravane	4,825	16,321
Sekong	NA	NA
Champasak	220,214	258,164
Attapeu	NA	NA
Lao PDR	1,623,943	1,736,787

Note: NA means not available.

Source: Statistical Yearbook of each province

Table 2.1.8 indicates the number of accommodations, restaurants and tourist sites. Proportion of accommodation in the study area to the total figure for Lao PDR was 21% in 2008. Most of the accommodations in the study area were located in Champasak Province (52% of the accommodations in the study area) and Savannakhet Province (28%).

Table 2.1.8 Number of Accommodations, Restaurants and Tourist Sites in 2008

	Hotel	Guesthouse, Resort	Restaurant	Tourist Sites
Savannakhet	15	68	19	4
Saravane	3	20	9	2
Sekong	3	15	20	0
Champasak	35	119	18	15
Attapeu	3	14	29	4
Total of 5 provinces	59	236	95	25
Lao PDR	265	1,120	742	164

Source: Statistical Yearbook 2008 of each province

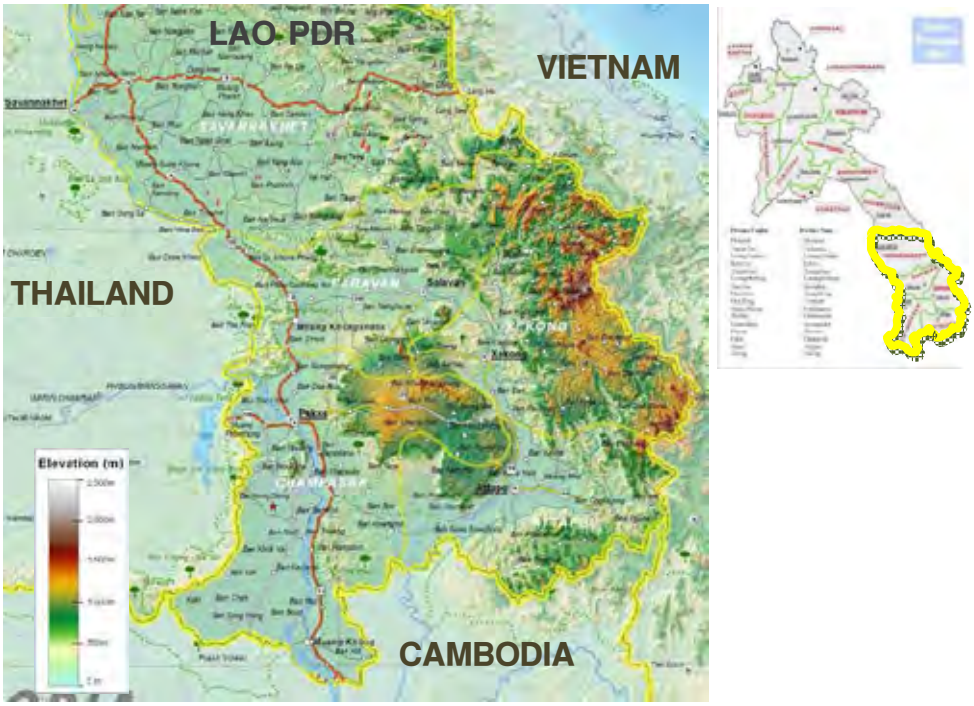
2.2 Natural Condition

2.2.1 Topography

The southern region of Lao PDR is embedded with variable terrains from flat to mountainous. The altitude ranges from 120 to 150 meter above sea level in the Savannakhet plain, which reaches the Se Bangfai and Se Banhieng rivers, and continues into the Champasak plain along the Mekong River. The alluvial plains and terraces of the Mekong and its tributaries cover only about 20 % of the country's land area, most of which lies in southern region.

The chain of mountains, with average height of 1,200 meter above sea level, is called "Annamite chain", running from northwest to southeast. Their eastern slopes rise abruptly from the South China Sea while more gradual slopes prevail toward the southern region of Laos in the west of the Mekong basin.

The Bolovens Plateau, of which altitude ranges from 500 to 1,500 meter above sea level, is located in the middle of the southern region. The Bolovens Plateau drains northwest through the Sedone River and other smaller tributaries of the Mekong.



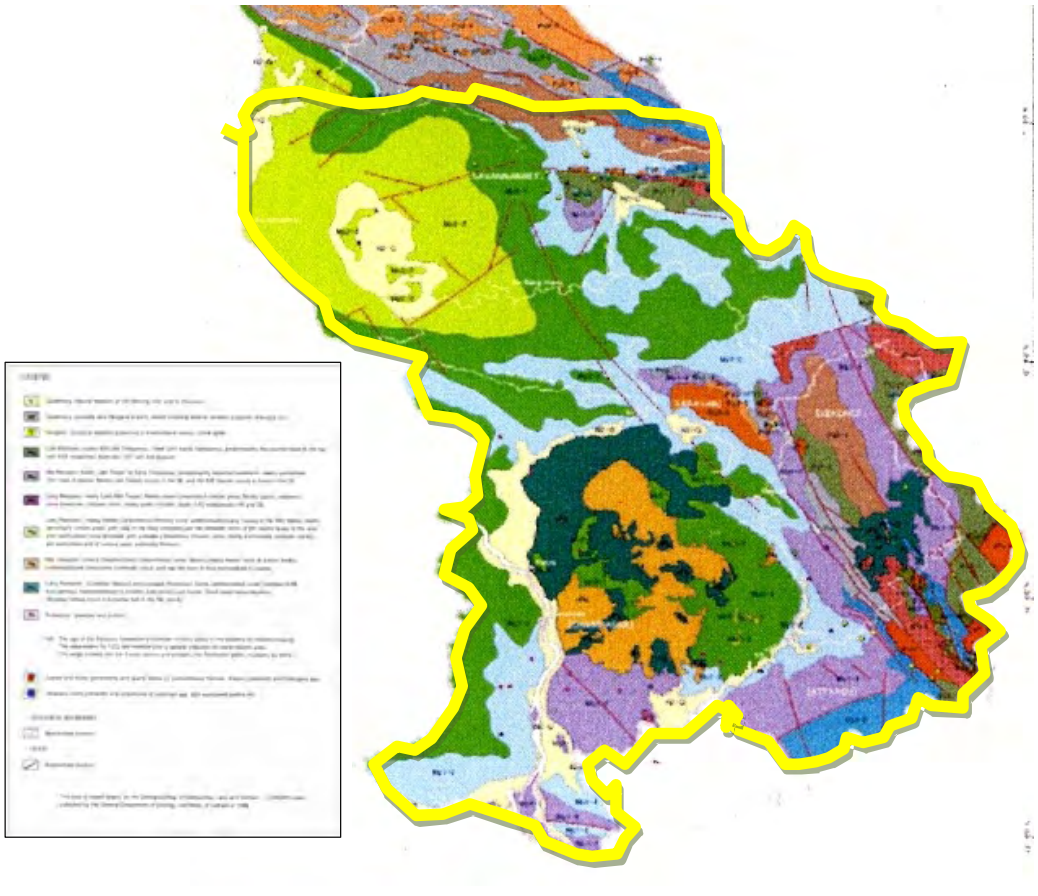
Source: UNOSAT Image (Base Map)

Figure 2.2.1 Topographic Map in Southern Region

2.2.2 Geology

The southern region is embedded with a widespread cover of relatively little deformed rocks, most of which are Mesozoic continental deposits. Earlier platform cover on the Mid-Paleozoic fold belt lies in the area east of Thakhek in the form of moderately folded Carboniferous and Permian limestone. The only area in the southern region where post-Lower Carboniferous rocks are observed is the eastern part of Saravane.

Folding of a late Carboniferous coal-bearing formation and Permian limestone in this area was pre-Jurassic and presumably Triassic, when there was considerable eruption of acidic volcanic rocks in the area. The Bolovens Plateau is composed of basaltic rock formed by great lava flows when tectonic movement stressed the Earth's crust. Post-orogenic deposition of continental sandstone and conglomerates in the Jurassic and early Cretaceous period are deposited in most parts of the country.



Source: Department of Geology and Mines

Figure 2.2.2 Geological Map in Southern Region

2.2.3 Hydrology

(1) General Descriptions

In general, all rivers and tributaries such as Sebanhiang, Sedone, Sekong and Sekaman Rivers, originating from the western mountain side of the Annamite Chain, merge into the Mekong River, running through the western side of entire southern region. Vast rain forests exist around the Bolevan Plateau and Annamite Chain (see figure 2.2.3). Besides, regional topographic gradients along the east-west direction are relatively steep. There is huge potential of water recharge around the upstream sides of major tributaries and abundant run-off waters flow into the nearby tributaries, and eventually reach the Mekong River. Also, these rainforests play an important role as the hydrological damper to stabilize the river flow of nearby tributaries i.e. they help prevent rapid changes in the flow rate of the nearby tributaries.

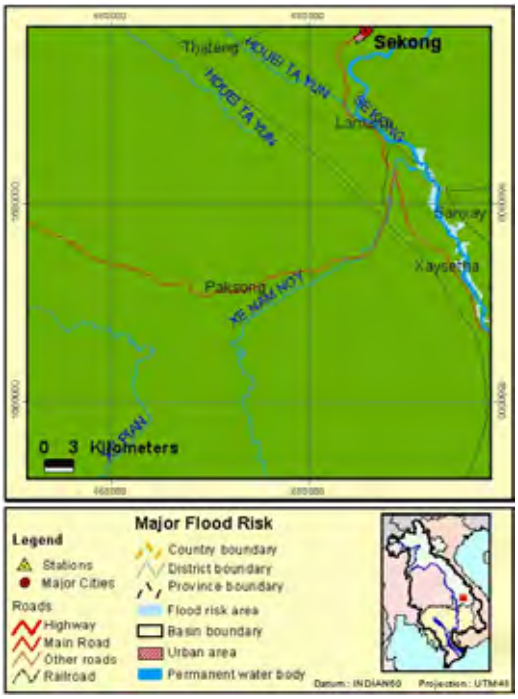
Rainforest (Water Recharge Area) around Bolevan Plateau (Attapeu Province)

Rainforest (Water Recharge Area, Upstream of Sekong River, inside of Dong Ampham NPA, Attapeu Province)

Source: Photos taken by the Study Team in March 2010.

Figure 2.2.3 Technical Site Visits in Southern Region

The lowland area of Attapeu is prone to flooding every rainy season, and regional flooding problems occur when the average river depth of the Sekong River is higher than 14.5 m (note that the exact survey point of this water level is unknown). In 2009, there was a severe flood/inundation across both Sekong and Attapeu Provinces and some parts of the provincial town were inundated (the maximum inundation depth was about 2.0m). Recently, large-scale deforestation due to several construction works around the upstream side of the southern region has become significant, while the implementation of slope stabilization measures for most of open-cut slopes, created by the mountainous road construction works is not good enough for protection against erosion and/or landslides as well as increased sedimentation loading into nearby tributaries. Without proper vegetation cover such as rain forests, most of the run-off water from the rainfall tends to run down these newly created slopes, flowing into nearby tributaries, accelerating the erosion of the slopes in the process. This regional deforestation (to be described in the environmental section of this report) is probably one of the key factors triggering the recent severe flooding around Attapeu Province. The following figure shows flood-prone areas across the southern region in Laos.

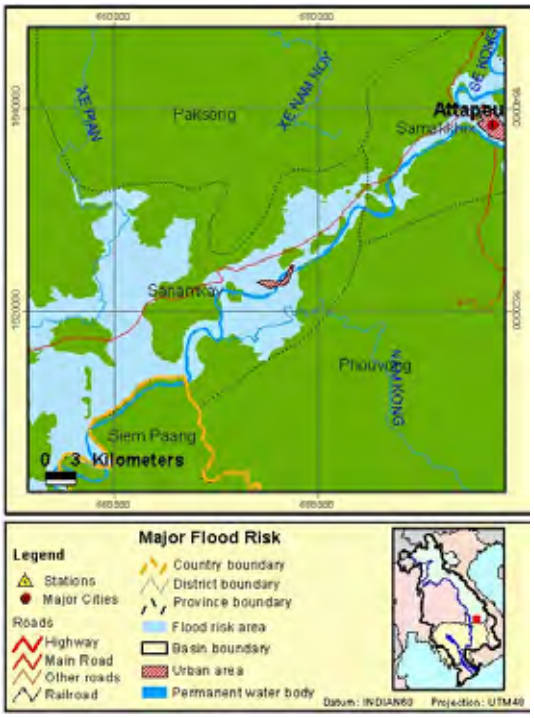


Area around Sekong Province (south of the provincial capital)

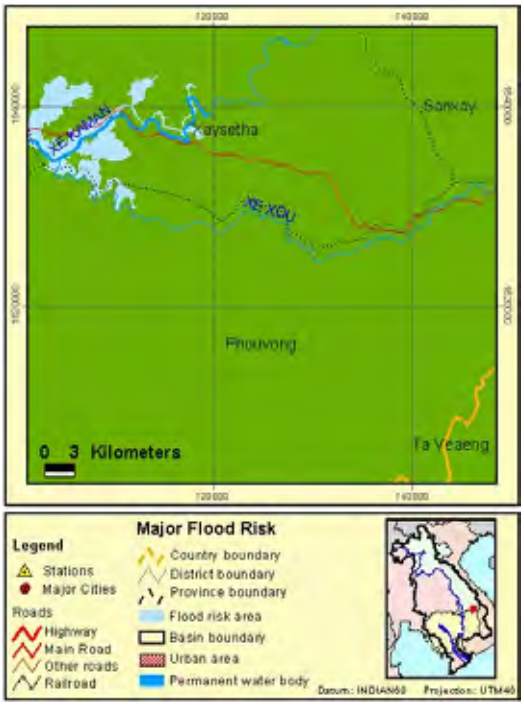
Note: These maps show flood-prone areas. These maps neither depict actual flood situations nor forecasted flood extents. The maps are based on the maximum historical flood extent of the combination of the Years 1995, 1996 and 2000 floods.
The following are average water depths of the Sekong River.

	Low (m)	High (m)
1996	1.42	16.85
1997	1.54	12.63
1998	1.26	10.48
1999	1.85	12.26
2000	1.93	14.29

Source: Danida, STEA, MoAF, WWF and UNDP, (2003) Biodiversity Profile for Attapeu Province



Area around Attapeu Province (western part of provincial capital)



Area around Attapeu Province (eastern part of provincial capital)

Source: http://ffw.mrcmekong.org/floodrisk.htm#here

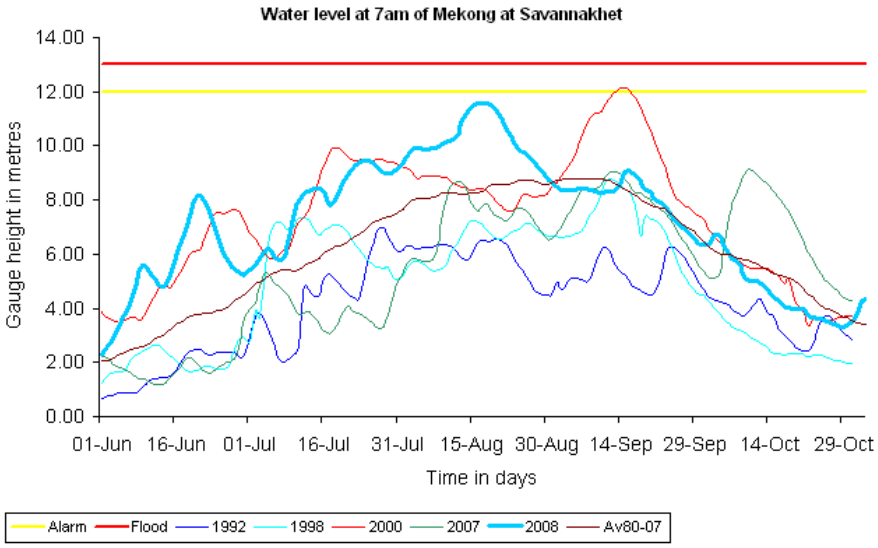
Figure 2.2.4 Maximum Flood Extent Areas

The flood events during the monsoon season are the driving force of the Mekong River ecosystem. As is the case for most tropical floodplain river systems, the seasonal habitats on the floodplains created by the monsoon floods are the main “fish production sites” of the Mekong Basin. Usually,

these areas are very rich in nutrients, food and shelter during the flood season, and most Mekong fishes depend on these resources for at least certain parts of their early life cycle (MRC, Fish Migrations of the Lower Mekong River Basin: Implications for Development, Planning and Environmental Management, MRC Technical Paper No.8, 2002). The more detailed descriptions of inland fish ecology across the southern region are summarized in the environmental section of this report.

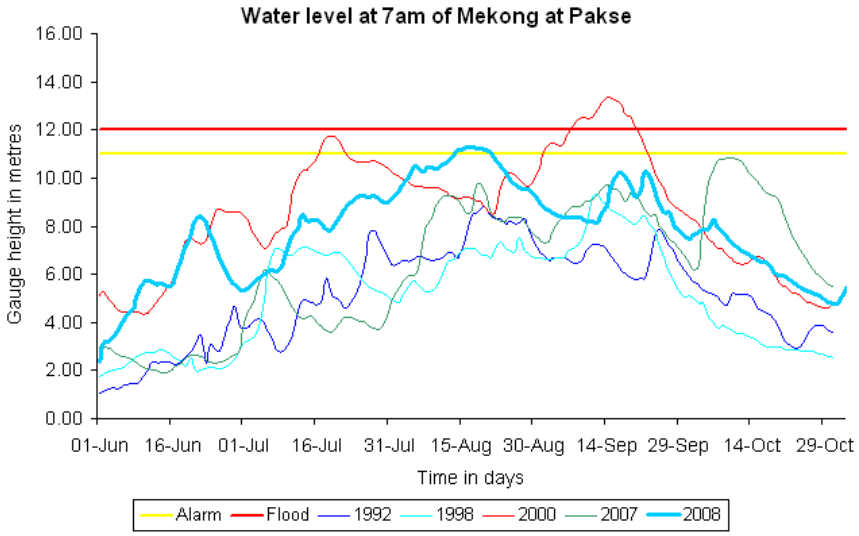
(2) Water Level Variations

Water level of the Mekong River fluctuates considerably throughout the year (see figures 2.2.5 and 2.2.6), so that, due to the backwater effect of the Mekong River on the regional river system, water levels of major tributaries in the southern region tend to have similar variation pattern.



Source: http://ffw.mrcmekong.org/historical_rec.htm

Figure 2.2.5 Temporal Variation (Flood Season) of Water Level of Mekong River at Savannakhet



Source: http://ffw.mrcmekong.org/historical_rec.htm

Figure 2.2.6 Temporal Variation (Flood Season) of Water Level of Mekong River at Pakse

The following figure shows snapshots taken during the site visit, conducted within the dry season, early March of 2010. In general, most of tributaries have rocky riverbeds, and there are many large boulders and gravels along river spaces. Traces of scouring, presumably caused by the rapid local currents during the rainy season, are observed at most riverbeds. Also, traces of past flood events, in particular, the maximum water level during past flood events, can be estimated by the elevation of drifted fallen trees and/or the location of drifters conveyed and trapped in tree branches of riverside woods. From these observations, the water level of these tributaries during every rainy season tends to increase by several meters, compared with those of dry seasons, while considerable velocity increases may also occur. Note that more than 10 meters water level variations between the dry and rainy seasons were recorded in past flood events such as the floods in the years from 1996 to 2000.

Water Gauge at Bridge Abutment, Route 9, Savannakhet Province

Scouring observed at Bridge Pier, Route 9, Savannakhet Province

Scouring observed at Sebanhiang River, Savannakhet Province

Trace of Past Flood (riverside wood, Sekong River, Sekong Province). Flood water levels can be estimated by the location of drifters trapped in tree branches.

Source: Photos taken by the Study Team in March 2010.

Figure 2.2.7 Technical Site Visits in Southern Region

Sedimentation of large volumes of sand can be observed at several points along rivers (see the figure 2.2.8), in particular, around the inner sides of the bends in the river courses where flows tend to be slowed down and/or stagnated. Also, vegetation across those sand beach regions is scarce and no large trees exist. These observations may indicate that sedimentation potential of these tributaries during every rainy season is significant. Sands bars and/or beaches, located along those tributaries are not topographically stabilized due to the impacts of every rainy

season's floods.

Sand sedimentation (Sedone River, Salavan Province)

Sand Sedimentation (Sekong River, Attapeu Province)

Source: Photos taken by the Study Team in March 2010.

Figure 2.2.8 Technical Site Visits in Southern Region

The following table summarizes key hydrological factors to be carefully approached within this regional road network improvement study.

Table 2.2.1 Key Hydrological Factors to be considered within the Study

Project	Erosion/landslide	Scouring	Regional flood/ inundation	Future Tasks
Road	Significant risk of erosion or landslide to construction of mountainous road.	N/A	Appropriate road drainage system shall be planned in order to establish integrated regional drainage network and to avoid regional inundation	1. Regional inundation study (e.g., T = 1/20 - 1/30). 2. Anti-erosion/landslide protection for mountainous roads.
Bridge	Significant risk of erosion or landslide along nearby river bank	Significant risk of scouring around bridge abutment/piers.	Same as above for design of approach roads.	1. Hydrodynamic Evaluation around Bridge Facilities. 2. Riverbank protection 3. Anti-scouring protection 4. Regional Inundation Study (e.g., T = 1/20 – 1/30) when approach road is long.

Note: T is the return periods

Source: JICA Study Team

2.2.4 Natural Environment

The Study Area spans from the Mekong floodplain to Bolevan Plateau, and rich tropical floral and faunal biodiversities exist therein. From the bio-geographical point of view, entire southern region is categorized as (i) the mountainous region belonging to Annamite Mountain Chain, spanning from the national border with Vietnam to Attapeu Province, and (ii) Central Indochina Tropical Lowland Plain (i.e., Mekong floodplain). Major soil type across the region is classified as the tropical red soil and the thickness of upper soil layers tend to be thin, in particular, in mountainous regions.

Annual rainfall, observed in Savannakhet, varies between 1,500 and 2,000 mm/year. During the rainy season (usually it starts in May and ends in September), there are frequent heavy torrential rains (the maximum daily rainfall is approximately 100 mm/day). Since vast tropical forests exist around the mountainous region of the Southern Laos, the water recharge around those mountainous regions is significant while playing an important role as the hydrological damper to stabilize the flow rate of nearby tributaries (see the hydrological section of this report for more detailed descriptions). The run-off waters flow into nearby tributaries such as Sebanhiang, Sekong, Sekaman and Sedone Rivers (see the figure 2.2.9), and then, eventually, reach the Mekong mainstream, running through the western side of the southern region.

Mekong River (Pakse, Champasak Province)

Sedone River (Saravane Province)

Sekong River (Sekong Province)

Sebanhiang River (Savannakhet Province)

Source: Photos taken by the Study Team in March 2010.

Figure 2.2.9 Snapshots of Major Tributaries in Southern Region

During every rainy season, vast run-off waters, generated from steep mountainous rainforest regions, also cause rapid increases in the water flows in local tributaries in areas where proper anti-flood measures have not been implemented. Also, as described in the previous hydrological section, the water level fluctuation of major tributaries across the southern region is significant (approximately 10 meters difference between the highest and the lowest levels). Several local riverside areas are prone to regional floods and/or inundations that may lead to regional disruptions in local road network while triggering natural disasters such as a large-scale erosion and/or landslide events. During the site visit, it was established that large-scale deforestation, caused by the construction of mountainous road such as NR-18B, connecting Attapeu and Vietnam border, was significant. During that road construction, large-scale earth-works were undertaken without any proper slope stabilization measures such as the re-vegetation and/or earth anchor methods. Currently, many traces of on-going erosions/gulleys and/or landslides are observable along the mountainous section of this road. The resultant increase in sedimentation

loading into nearby tributaries has also been considerable (see figure 2.2.10).

Erosion/gulleys found along Route 9 (Savannakhet Province)

Landslide occurred at riverbank of Sekong River (Sekong Province)

Large boulder fallen down (Route 18B, Attapeu Province)

Moutain Cutting without proper vegetation cover (Route 18B, Attapeu Province). Large-scale erosion is on-going.

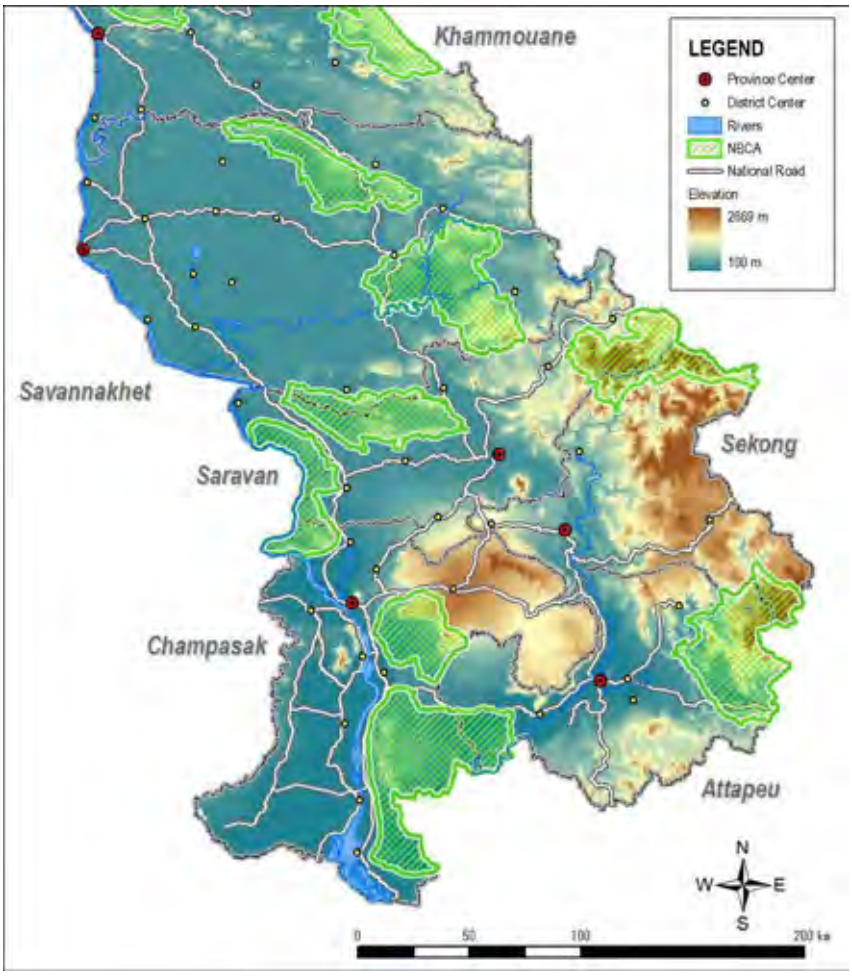
Source: Photos taken by the Study Team in March 2010.

Figure 2.2.10 Traces of Natural Disasters (Erosion, Gulleys and Landslides)

The largest national protected areas exist in the southern region of Laos. There are eight National Protected Areas (NPAs, see Table 2.2.2 and Figure 2.2.11) across this region.

Table 2.2.2 List of NPAs in Southern Region

No	NPAs	Area (km^2)	Location (province)	Nearby Roads
1	Phou Sang Hae	1,060	Khammuan, Savannakhet	N/A
2	Dong Phu Vieng	1,970	Savannakhet	NR-9, NR-1G
3	Se Ban Nuan	1,260	Savannakhet/Saravane	NR-1G, R6313
4	Se Xap	1,335	Saravane, Sekong	NR-15B
5	Phu Xieng Thong	1,200	Saravane, Champasak	N/A
6	Dong Hua Sao	1,100	Champasak	NR-18A
7	Se Pian	2,400	Champasak, Attapeu	NR-18A
8	Dong Ampham	1,975	Attapeu	NR-18B



Source: Prepared by JICA Study Team based on the GIS Database

Figure 2.2.11 National Protected Areas

Dong Phu Vieng NPA

Dong Hua Sao NPA

Dong Ampham NPA

Se Pian NPA

Source: Photos taken by the Study Team in March 2010

Figure 2.2.12 Snapshots of Major NPAs in Southern Region

Beside those NPAs, there are several important IBAs (Important Bird Area) across the southern region (see table 2.2.3). It should be noted that some of those IBAs geographically overlap with some NPAs mentioned above.

Table 2.2.3 List of IBAs in Southern Region

No	IBAs	Criteria	Area (ha)	Location (province)	Nearby Roads
1	Xe Sap	A1, A2	137,120	Saravane, Sekong	NR-15B
2	Upper Sekaman	A1, A2, A3	34,780	Attapeu	NR-18B
3	Dong Ampham	A1, A2, A3	180,220	Attapeu	NR-18B
4	Attapeu Plain	A1, A3	71,400	Attapeu	NR-18B
5	Houay Kok-Houay Phalaphang	A1, A2, A3	36,650	Champasak, Saravane	N/A
6	Dakchung Plateau	A1, A2	5,140	Sekong	NR-16B
7	Phou Ahyon	A1, A2	148,900	Sekong	NR-16B
8	Xe Khampho/Xe Pian	A1, A2, A3, A4i	197,280	Attapeu	NR-18A
9	Sekong Plains	A1, A2, A3, A4i	37,150	Champasak, Attapeu	NR-18A
10	Dong Kalo	A1, A2, A3, A4i	41,460	Champasak	N/A
11	Siphandon	A1, A2, A4i	37,320	Champasak	N/A

Note A1: Globally threatened species, A2: Restricted-range species, A3: Biome-restricted assemblages, A4i: Congregations

Source: World Bank (2003) , Birdlife, MoAF, WCS and Danida, Important Bird Area in Lao PDR

As mentioned earlier, all tributaries across the southern region merge into the Mekong River, such that the entire river system can be regarded as a regional, continuous aquatic habitat. For instance, the Mekong River Dolphin, popularly seen around the deep-pool areas around Kratie or some tributaries of Ratanakiri in Cambodia, was reportedly seen around the Sekong Province several years ago.

This Mekong River Dolphin, *Orcaella brevirostris,* is one of the most conspicuous animals in the Mekong, and at the same time, one of the most threatened species. Its ecology is deeply integrated with the ecology of Mekong fishes, and it is closely dependent on the existence of deep pool areas for its survival. The distribution of this dolphin in the Mekong is restricted to the area from Kratie in the south, to the Khone Falls in the north. They are also found in the lower stretches of the Sesan sub-catchment, Cambodia.

As described above, this area is also the most important in terms of deep pool fish habitats in the Mekong. This is not a coincidence since dolphins are known to spend most of their time in deep pools, from where they frequently undertake “hunting” migrations following groups of migratory fishes (MRC, 2002).

Currently, the total number of aquatic species recorded or expected from the Mekong River is approximately 1,200 species. Amongst them, about 590 species are found in Laos (FAO, Fishes of the Cambodian Mekong, FAO Species Identification Field Guide for Fishery Purposes, 1996). Across the southern region, small-scale inland fisheries are common at the Mekong mainstream as well as along major tributaries such as Sekaman and Sekong Rivers (see figure 2.2.13). Also, aquaculture is popular and several fish ponds are recognized along Sekaman River in Attapeu Province.

Inland fishing activity

Fish Catch

Source: Photos taken by the Study Team in March 2010

Figure 2.2.13 Inland Fisheries Activity in Laos

The fish migratory system of the Mekong consists of three sub-systems; i.e., (i) the lower Mekong migration system (LMS), (ii) the middle Mekong migration system (MMS), and (iii) the upper Mekong migration system (UMS). Basically, the migration system of the southern region of Laos is categorized under the MMS while some part of Sekong and Sekaman Rivers system is linked to LMS. The following are key features of the fish ecology across the MMS.

- **Dry season refuge habitats**: Deep pool stretches of the Mekong mainstream and within major tributaries.
- **Flood-season feeding and rearing habitats**: Floodplains of this system, mainly associated with major tributaries, are inundated during every rainy season.
- **Spawning habitats**: Rapids and deep pool systems in the Mekong mainstream. Floodplain spawning habitats associated with tributaries.
- **Migration routes**: Connections between the Mekong River (dry season habitats) and major tributaries (flood season habitats).
- **Hydrology**: The annual flood pattern that causes inundation of floodplain areas along major tributaries

Note that the two different migration systems (i.e., LMS and MMS) are not independent ecological systems isolated from each other, but are rather interconnected.

Across the southern region, the Khone Falls area has been the subject of several ecological and fisheries studies during the past decade, and thus, is one of the most well-researched sites within the Mekong in terms of fisheries ecology.

The following table summarizes key environmental factors to be carefully approached within this regional road network improvement study.

Table 2.2.4 Key Environmental Factors to be considered within the Study

Project	Flora/Fauna	Water Quality	Future Tasks
Road	Some of project routes may run through/or near NPAs/or IBA.	Risk of water quality degradation due to construction work.	1. Regional inundation study (e.g., T = 1/20 - 1/30). 2. Biological Environmental studies. 3. Water Quality Study
Bridge	Small scale inland fishery is active. Most of tributaries are important habitats for aquatic fauna.	Same as above.	1. Biological Environmental Studies (aquatic flora/fauna). 2. Water Quality Study 3. Regional Inundation Study (e.g., T = 1/20 – 1/30) when approach road is long.

Note: T is the return periods

Source:JICA Study Team

2.3 Road Network and Traffic Condition

2.3.1 Current Condition of Road

(1) Road Class in Laos

Lao PDR currently has a road network of total length of 37,323km with national roads accounting for 7,153km, which is 19% of the total road length. The national road network links major towns and provincial capitals and connects neighboring countries. The rest of the roads include provincial, district, urban, rural roads and special roads (i.e. forestry and mining roads). Road length by road class is shown in Table 2.3.1.

Table 2.3.1 Road Length (Km) by Road Class and Province

Province		National (km)	%	Provincial (km)	%	District (Km)	%	Urban (Km)	%	Rural (Km)	%	Special (Km)	%	Total (Km)	%
		%		%		%		%		%		%		%	
1	Vientiane	247.7	3.5	246.4	3.4	416.0	8.3	505.6	27.3	498.6	3.2	54.0	7.7	1,968.3	5.3
		12.6		12.5		21.1		25.7		25.3		2.7		100.0	
2	Phonsali	474.0	6.6	146.5	2.0	63.3	1.3	21.1	1.1	594.8	3.9	1.2	0.2	1,300.8	3.5
		36.4		11.3		4.9		1.6		45.7		0.1		100.0	
3	Luang Namtha	301.8	4.2	452.7	6.3	111.0	2.2	72.7	3.9	509.2	3.3	35.9	5.1	1,483.2	4.0
		20.3		30.5		7.5		4.9		34.3		2.4		100.0	
4	Oudmxay	314.0	4.4	303.3	4.2	441.6	8.9	51.8	2.8	470.3	3.1	8.8	1.3	1,589.8	4.3
		19.8		19.1		27.8		3.3		29.6		0.6		100.0	
5	Bokeo	169.5	2.4	264.9	3.7	153.0	3.1	59.9	3.2	395.0	2.6	13.8	2.0	1,056.2	2.8
		16.0		25.1		14.5		5.7		37.4		1.3		100.0	
6	Luang Phabang	610.0	8.5	479.2	6.6	275.8	5.5	64.7	3.5	1,021.2	6.6	40.3	5.7	2,491.2	6.7
		24.5		19.2		11.1		2.6		41.0		1.6		100.0	
7	Xayabury	540.0	7.5	785.5	10.9	323.6	6.5	160.9	8.7	535.0	3.5	61.1	8.7	2,406.1	6.4
		22.4		32.6		13.4		6.7		22.2		2.5		100.0	
8	Houaphanh	446.5	6.2	447.8	6.2	555.8	11.1	76.0	4.1	870.2	5.6	15.0	2.1	2,411.2	6.5
		18.5		18.6		23.1		3.1		36.1		0.6		100.0	
9	Xiengkhuang	464.0	6.5	357.4	5.0	75.0	1.5	36.1	1.9	1,213.2	7.9	70.9	10.1	2,216.6	5.9
		20.9		16.1		3.4		1.6		54.7		3.2		100.0	
10	Vientiane Province	650.3	9.1	937.8	13.0	468.5	9.4	175.6	9.5	823.0	5.3	131.1	18.6	3,186.3	8.5
		20.4		29.4		14.7		5.5		25.8		4.1		100.0	
11	Bolikhamxay	510.0	7.1	608.1	8.4	284.9	5.7	58.7	3.2	343.5	2.2	19.5	2.8	1,824.7	4.9
		28.0		33.3		15.6		3.2		18.8		1.1		100.0	
12	Khammuane	421.8	5.9	461.7	6.4	476.7	9.6	117.8	6.4	1,653.7	10.7	6.6	0.9	3,138.3	8.4
		13.4		14.7		15.2		3.8		52.7		0.2		100.0	
13	Savannakhet	558.0	7.8	850.3	11.8	430.4	8.6	96.5	5.2	3,265.6	21.2	47.0	6.7	5,247.8	14.1
		10.6		16.2		8.2		1.8		62.2		0.9		100.0	
14	Saravane	428.9	6.0	99.0	1.4	268.9	5.4	74.1	4.0	1,239.8	8.0	33.0	4.7	2,143.6	5.7
		20.0		4.6		12.5		3.5		57.8		1.5		100.0	
15	Champasak	457.1	6.4	520.2	7.2	355.7	7.1	140.2	7.6	1,473.0	9.6	121.9	17.3	3,068.1	8.2
		14.9		17.0		11.6		4.6		48.0		4.0		100.0	
16	Sekong	201.6	2.8	64.4	0.9	225.6	4.5	54.0	2.9	193.6	1.3	7.3	1.0	746.5	2.0
		27.0		8.6		30.2		7.2		25.9		1.0		100.0	
17	Attapeu	358.0	5.0	189.1	2.6	60.0	1.2	89.4	4.8	311.8	2.0	35.7	5.1	1,044.0	2.8
		34.3		18.1		5.7		8.6		29.9		3.4		100.0	
Total of Study Aria		2,003.6	28.0	1,723.0	23.9	1,340.6	26.9	454.1	24.5	6,483.9	42.1	244.9	34.8	12,250.0	32.8
		16.4		14.1		10.9		3.7		52.9		2.0		100.0	
Total		7,153.2	100.0	7,214.3	100.0	4,985.8	100.0	1,855.0	100.0	15,411.5	100.0	703.0	100.0	37,322.7	100.0
		19.2		19.3		13.4		5.0		41.3		1.9		100.0	

Source: JICA Study Team based on DoR Statistic Year Book, 2007

The road density of whole country is 0.16km/km^2 which is considerably lower than those of other Asian countries (see table 2.3.2). The road length per population in Laos is 6.2 m per capita which is a relatively higher rate in the region due to Laos' low-density population.

Table 2.3.2 Road Density by Road Class and Province

No.	Province	National (km)	km/km²	Provincial (km)	km/km²	District (Km)	km/km²	Urban (Km)	km/km²	Rural (Km)	km/km²	Special (Km)	km/km²	Total (Km)	km/km²	Aria(km²)	%
1	Vientiane	248	0.063	246	0.063	416	0.106	506	0.129	499	0.127	54	0.014	1,968	0.502	3,920	1.7
2	Phonsali	474	0.029	147	0.009	63	0.004	21	0.001	595	0.037	1	0.000	1,301	0.080	16,270	6.9
3	Luang Namtha	302	0.032	453	0.049	111	0.012	73	0.008	509	0.055	36	0.004	1,483	0.159	9,325	3.9
4	Oudmxay	314	0.020	303	0.020	442	0.029	52	0.003	470	0.031	9	0.001	1,590	0.103	15,370	6.5
5	Bokeo	170	0.027	265	0.043	153	0.025	60	0.010	395	0.064	14	0.002	1,056	0.170	6,196	2.6
6	Luang Phabang	610	0.036	479	0.028	276	0.016	65	0.004	1,021	0.061	40	0.002	2,491	0.148	16,875	7.1
7	Xayabury	540	0.033	786	0.048	324	0.020	161	0.010	535	0.033	61	0.004	2,406	0.147	16,389	6.9
8	Houaphanh	447	0.027	448	0.027	556	0.034	76	0.005	870	0.053	15	0.001	2,411	0.146	16,500	7.0
9	Xiengkhuang	464	0.028	357	0.022	75	0.005	36	0.002	1,213	0.074	71	0.004	2,217	0.136	16,358	6.9
10	Vientiane Province	650	0.029	938	0.042	468	0.021	176	0.008	823	0.036	131	0.006	3,186	0.141	22,554	9.5
11	Bolikhamxay	510	0.034	608	0.041	285	0.019	59	0.004	344	0.023	20	0.001	1,825	0.123	14,863	6.3
12	Khammuane	422	0.026	462	0.028	477	0.029	118	0.007	1,654	0.101	7	0.000	3,138	0.192	16,315	6.9
13	Savannakhet	558	0.026	850	0.039	430	0.020	96	0.004	3,266	0.150	47	0.002	5,248	0.241	21,774	9.2
14	Saravane	429	0.040	99	0.009	269	0.025	74	0.007	1,240	0.116	33	0.003	2,144	0.201	10,691	4.5
15	Champasak	457	0.030	520	0.034	356	0.023	140	0.009	1,473	0.096	122	0.008	3,068	0.199	15,415	6.5
16	Sekong	202	0.026	64	0.008	226	0.029	54	0.007	194	0.025	7	0.001	746	0.097	7,665	3.2
17	Attapeu	358	0.035	189	0.018	60	0.006	89	0.009	312	0.030	36	0.003	1,044	0.101	10,320	4.4
Total of Study Aria		2,004	0.030	1,723	0.026	1,341	0.020	454	0.007	6,484	0.098	245	0.004	12,250	0.186	65,865	27.8
Total		7,153	0.030	7,214	0.030	4,986	0.021	1,855	0.008	15,411	0.065	703	0.003	37,323	0.158	236,800	100.0

Source: JICA Study Team based on DoR Statistic Year Book, 2007

Table 2.3.3 Cross Country Comparison of Road Density by Road Type

Country	Year of Data	Road Length (km)	Primary Road (km)	Arterial Road (km)	Others (km)	Pavement Raaitio (%)	Road length per 1km2	Road length per population	Land area (km2)	Population
Japan	04	1,192,972	61,647	129,139	1,002,185	79.00	3.16	0.0094	364,500	127,078,679
India	02	3,383,344	58,112	863,136	2,462,096	47.40	1.03	0.0029	2,973,190	1,156,897,766
Indonesia	02	368,360	—	—	—	58.00	0.19	0.0015	1,811,570	240,271,522
Korea	05	102,293	17,192	85,101	—	76.82	1.03	0.0021	98,730	48,508,972
Singapore	05	3,234	744	454	2,036	100.00	4.63	0.0007	670	4,657,542
Thailand	00	57,403	—	—	—	98.50	0.11	0.0009	510,890	65,998,436
China	05	1,930,544	79,386	246,442	1,604,716	81.62	0.21	0.0014	9,327,470	1,338,612,968
Turkey	05	426,914	33,146	30,568	363,200	—	0.54	0.0056	769,630	76,805,524
Pakistan	04	258,340	9,031	101,409	147,900	64.70	0.34	0.0015	770,880	174,578,558
Philippine	03	200,037	28,266	49,782	121,989	9.90	0.67	0.0020	298,170	97,976,603
Malaysia	04	98,721	19,916	61,420	17,385	81.32	0.30	0.0038	328,550	25,715,819
Vietnam	06	251,787	17,295	23,138	211,354	32.20	0.76	0.0028	332,210	88,576,758
Laos P.D.R	07	37,323	7,153	7,214	22,956	14.20	0.16	0.0062	236,800	6,000,379

Source: JICA Study Team

(2) Road Surface Condition in Laos

At present, 5,303 km of the roads in Lao PDR, accounting for 14% of the total road length, are paved. 512 km of the roads are paved with asphalt concrete, accounting for only 1.4% of the total road length. Most of the asphalt concrete roads are observed along national roads and urban roads. The major pavement structure is DBST, functioning as surface treatment sealing the base course to stabilize the aggregates surface. Most of provincial and district roads still remain unpaved. Rough and deteriorated road condition leaves unpaved roads impassable especially during the rainy season. The pavement structure by road class is summarized in Table 2.3.4.

Table 2.3.4 Pavement Structure by Road Class

Road Category	Total Length		Asphalt Concrete		DBST		Gravel		Earth	
	km	%	km	%	km	%	km	%	km	%
National Road	7,153.2	19.2	431.8	6.0	3,498.1	49.0	2,489.6	34.1	733.6	10.8
Provincial Road	7,214.3	19.3	0.0	0.0	459.9	6.5	3,731.3	52.0	3,023.0	41.5
District Road	4,985.8	13.4	1.1	0.0	250.7	2.3	2,377.1	51.5	2,356.9	46.3
Urban Road	1,855.0	5.0	77.9	4.3	440.0	24.0	866.4	47.4	470.8	24.3
Rural Road	15,411.6	41.3	0.0	0.0	50.6	0.5	2,842.8	20.7	12,518.1	78.8
Special Road	702.9	1.9	1.0	0.1	91.4	12.3	264.7	37.5	345.8	50.0
Total	37,322.7	100.0	511.8	1.4	4,790.8	12.8	12,571.9	33.7	19,448.2	52.1

Source: Road Inventory in MPWT (NRAD)

(3) Road Class in Southern Region

The study area covers five provinces in the southern region of Laos. NR-9 and NR-13 form the backbone of transport in the southern region connecting the northern region of Laos and neighboring countries. Other roads function as regional trunk roads, connecting provincial centers, and stretching to cover the whole southern region. The road network in the southern region of Laos stretches to a length of 12,250km, accounting for 33% of the total length of roads in Laos.

Source: JICA Study Team

Figure 2.3.1 Road Network by Road Class

(4) Road Surface Condition in Southern Region

Road surface condition can be determined by surface type as well as the level of maintenance and upgraded condition of the road. As shown in table 2.3.4, 1,026 km of the road network, mainly the national roads, in the southern region is paved. Considering the national roads, about 49% of the national roads are paved. The remaining road network of length 1,131 km is either earth or gravel

surfaced: these are left unpaved and 110km of these unpaved roads are reported currently impassable.

Source: JICA Study Team

Figure 2.3.2 Road Network by Surface Condition

The road surface is categorized into three types; paved, gravel wearing, and earth. The paved road can be divided into two pavement types; Asphalt Concrete (AC) and Double Bituminous Surface Treatment (DBST).

Some 347km of the road network, mainly along NR-9 and NR-18B in the southern region, is paved with AC, which accounts for 34% of the total paved road length of national roads. This figure is much higher than the national average of 14%. The pavement type of road surface in the southern region is illustrated in the figure below:

Source: Study Team

Figure 2.3.3 Road Network by Pavement Type

2.3.2 Major Findings of Road Condition from Field Survey

The Study Team conducted field surveys in early March and early April to investigate the current road network and its condition. The Study Team also conducted a series of interviews with local officials to update information on road network. From the observations in the field survey, the major findings in investigation of road structures and facilities are described below:

Alignment and cross section:

- The flexible application of geometric standards of roads based on the Road Design Manual (RDM) leads to inconsistency of the alignment and cross sections of road that affects the traffic capacity and safety.
- Narrower shoulder widths than specified by design speed where particularly observed at sections of roads categorized as higher class. This affects the capacity of traffic. It also poses a concern for smooth traffic flows and increases the rate of accidents when the traffic volume increases.

Traffic control and safety facility:

- There is a difference between improved and unimproved roads as regards provision of road facilities. It was noticed that the unimproved roads lacked road safety facilities such as lane marking, guard railing and bus-bays.

Pavement:

- Three types of road surface were observed on national roads in the study area, viz: Asphalt Concrete (AC), DBST, and gravel and earth surface. The most prominent pavement type on national roads is DBST. This is because it saves on initial cost and the associated

maintenance costs are approximately half of those associated with the AC pavement type, especially on roads with less traffic.

Maintenance:

- Grading works have been undertaken in some sections of the study roads using gravel surfacing. The road surface in these sections is well maintained.
- Along NR-1H, the maintenance activities such as ditch clearing, grass cutting on shoulders and grading were undertaken. The quality of maintenance varies depending on the capacity of each province. The quality of maintenance works and the condition of the roads need to be maintained consistently.
- The budget allocation for the rehabilitation of NR-9 reaches approximately 10% of total revenue of RMF: this impedes the maintenance of other roads.

The typical observations made on the sampled roads are summarized in the following sections:

(1) NR-9 (Savannakhet – Densavan)

NR-9, 224 km of road from Savannakhet to Densavan, were upgraded to the AC surface type with financial assistance from Japan (between KM 30 and KM 162), ADB (between KM 162 and 224) and World Bank (KM 0 and 30, upgraded by ADB in 2005).

Table 2.3.5 NR-9 Characteristics of Road Structure by Section

Kilo-post	Km 30 - 103	Km 103 - 162	Km 162 - 224
Donor	Japan		ADB
	Phase I	Phase II	
Length (km)	73km	59km	62km
Period	1999 - 2002	2001 - 2004	2000-2004
Design Speed	Flat: 100km/h Semi-urban: 50-70km/h	Flat: 100km/h Roll: 70km/h Semi-urban: 50km/h	Flat: 100km/h(W. Xepone) Roll: 70km/h(E. Xepone) Semi-urban: 50-70km/h
Cross Section	Traffic Lane 3.5m Shoulder: 1.5 – 2.5m (Paved: 1.0 – 2.5m AC)	Traffic Lane 3.5m Shoulder: 1.5 – 2.5m (Paved: 1.0 – 2.5m AC)	Traffic Lane 3.5m Shoulder: 1.5 – 2.5m (Paved: 1.0 m SBST)
Pavement	AC	AC	AC
Life period	8 years	8 years	10 years
Surface course	AC: 5cm Bitumen Stabilized: 5cm	AC: 5cm Bitumen Stabilized: 5cm	AC: 5cm SBST: 1cm
Base course	Aggregate: 10cm Cement Stabilized: 28cm	Aggregate: 10cm Cement Stabilized: 28cm	Aggregate: 35cm Upper: 17.5cm Lower: 17.5cm
Sub-grade	Sub-grade: CBR =5	Sub-grade: CBR =5	Sub-grade: Upper CBR =15 Lower CBR=5

	Section	Road Conditions	Typical Observation	Remarks
World Bank/ ADB (Upgrading) Section	Start Savannakhet Km. 0 - Xeno Km. 30.0	 Km 6+000 Section upgraded by ADB	 Intersection (Roundabout) with approach road to Friendship II Bridge	Class III- Flat Semi-urban Area Flat - Junction with Friendship Bridge II - Savan-Xeno Special Economic Zone - Intersection with NR-13 South at Xeno
		 Km 20+000 Repaired by patching	 On-going industrial development in Savan-Xeno Special Economic Zone	
		Upgraded section by ADB in 2005 without any significant damage between Savannakhet and Xeno. Higher traffic volume up to the intersection with NR-13 South at Xeno due to a link to Friendship Bridge II.		
Japanese Section (Phase-I L=73km)	Seno Km. 30.0 - B Phalan Km. 103.0	 Km 30+000 intersection with NR-13 South at Xeno	 Typical alligator cracks observed on approach bank to the bridge	Class III-Flat Flat
		 Km 32+000 stable surface suburb of Xeno	 New cement plant entrance at NR-9	

		 Km 55+000 in front of new cement plant	 Logging truck running often observed	
		The section upgraded by Japanese Grant Aid (Phase-I: 1999-2002) is seriously damaged. Crack and distress of pavement spreads almost over the section. DPWT Savannakhet is involved in the rehabilitation replacing with DBST.		
Japanese Section (Phase II L=59km)	B Phalan Km. 103.0 - M Phin Km. 162.0	 Km107+000	 Pavement in some sections completely destroyed and replaced with DBST	Class III Flat
		 Km 139+000	 Logging trucks often observed	
		 Km 161+000 intersection with NR-1G at M. Phin	 Tandem trailers from Xepone mining	
		The section upgraded by Japanese Grant Aid (Phase-II 2001-04 L=59km). The serious damage to pavement is observed in Phase-I section. DPWT Savannakhet spent more than 6 million USD in the last 3 years on the maintenance of both Japanese sections.		

<table>
<tr><td rowspan="4">ADB Section (M Phin – Xepone)</td><td rowspan="3">M. Phin
Km. 162.0
-
At the junction with Xepone mining road
Km. 180.0</td><td> 
Km171+000</td><td> 
Additional 3cm thickness overlay done covering traffic lane after completion of defect liability period</td><td rowspan="3">Class III-
Flat - Rolling

- Intersection with Provincial road access to Xepone Mining</td></tr>
<tr><td> 
Km 172+000</td><td> 
On-going rehabilitation of pavement : patching with DBST</td></tr>
<tr><td colspan="3">Upgraded section by ADB in 2004 is also seriously damaged; similar to the Japanese section. On-going rehabilitation on site by DPWT: replacing the asphalt with DBST.</td></tr>
<tr><td rowspan="3">ADB Section (Xepone – Densavan)</td><td rowspan="2">At the junction with Xepone mining road
Km. 180.0
-
Densavan (Border with Vietnam)
Km. 241.0</td><td> 
Km192+000</td><td> 
Patching near the toll collection gate at km 190+000</td><td rowspan="2">Class III-
Rolling –Mount

- Densavan (Border with Vietnam)</td></tr>
<tr><td> 
Km 197+000</td><td> 
Heavy trailer travelling from Vietnam</td></tr>
<tr><td colspan="3">This section upgraded by ADB remains in a good surface condition compared with other sections. Almost no repair and rehabilitation works are required. The asphalt pavement properly works and is in a stable condition.</td></tr>
</table>

(2) NR-1G (NR-9 – Tat Hai Bridge – Tuoumlane – Saravane)

<table>
<tr><th></th><th>Section</th><th>Road Conditions</th><th>Typical Observation</th><th>Remarks</th></tr>
<tr><td rowspan="3">NR-1G North Section</td><td rowspan="3">Start
M Phin at
NR-13S
Km. 0
-
Tat Hai Bridge
Km. 35.0</td><td> 
Km 0+300 M. Phim</td><td> 
Security gate for N Dong Phouvieng National Protected Area</td><td rowspan="2">Class III- Flat Semi-urban Area

Junction with NR-9 at M Phin

Dong Phouvieng National Protected Area

Impassable condition beyond Se Banhiang</td></tr>
<tr><td> 
Km 6+000</td><td> 
Impassable due to the derelict Tathai bridge that was destroyed during the Indochina war.</td></tr>
<tr><td colspan="3">35km section from Muang Pin along NR-9 is a narrow earth road. The surface condition is well maintained and is in good condition. Few villages exist along the road near the Se Banhiang. Tat Hai Bridge is located at the end of section which was destroyed by air bombing during Indo-China War in 1964.</td></tr>
<tr><td rowspan="3">NR-1G South Section</td><td rowspan="3">Start
M Phin at
NR-13S
Km. 130.0
-
Toumlane
Km. 92.0
End</td><td> 
Km 130+000 Saravan</td><td> 
Impassable due to the derelict Sedone Bridge destroyed during the Indochina War</td><td rowspan="2">Class III- Flat Semi-urban Area

Junction with NR-15A Saravane

Road is in Impassable condition beyond Sedone

Toumlane Administration.</td></tr>
<tr><td> 
Km 127+000</td><td> 
Toumlane (District Administration) is located 40km from Saravane</td></tr>
<tr><td colspan="3">95km section from Saravan is narrow earth road. The surface condition is more distressed than the northern section of NR-1G. A number of villages exist along the road. Toumlan District is in a strategic position along NR-1G. However, it is impossible to access Toumlane from Saravane during the rainy season beyond the Sedone River.</td></tr>
</table>

(3) NR-15A (Naphone – Saravane)

<table>
<tr><th></th><th>Section</th><th>Road Conditions</th><th>Typical Observation</th><th>Remarks</th></tr>
<tr><td rowspan="5">NR-15A (NR-13S JCT to Saravane)</td><td rowspan="5">Start
Napone
Intersection
with NR-13S
Km. 0
-
Saravane
Km. 73.0
End</td><td> 
Km 0+000 intersection with NR-13S Napone</td><td> 
Under rehabilitation by DPWT Saravane to improve the road bed and grading surface</td><td rowspan="5">Class III- Flat Semi-urban Area

Junction with NR-13S

Paddy field along the NR-15A

Relatively densely -populated area

The road runs almost parallel to Sedone so that flood water affects the road structure.

Intersection with NR-1G Km 67.0</td></tr>
<tr><td> 
Km 5+500</td><td> 
A submerged crossing during low water season of Sedone and ferry is instead available during high water season</td></tr>
<tr><td> 
Km 35+500</td><td> 
Most of crossing facilities are bailey bridges. Some were submerged and damaged by the flood in 2009</td></tr>
<tr><td> 
Km 52+000</td><td> 
An old bridge damaged by overloading of trucks in 2009 is being replaced with a steel girder bridge</td></tr>
<tr><td colspan="3">76km unpaved road section stretches from Napon at the intersection with NR-13S to Saravane. The road runs through rich paddy field. Relatively high density residences are observed along the roadside. This section is supposed to be upgraded by forthcoming ADB13 based on the interviews with MPWT.</td></tr>
</table>

(4) NR-15B (Saravane – Vietnam Border)

	Section	Road Conditions	Typical Observation	Remarks
NR-15B (Saravane to Vietnam Border)	Start B. Phone Dou JCT with NR-15A Km. 0.3 - Vietnam Border Km. 140.0 End	 Km 0+000	 A five span PC simple girder crossing for Sedone recently constructed by local contractor	Class III- Flat Semi-urban Area Junction with NR-15A Saravane Passable condition to the North Saravane beyond Sedone River Possible connection with Toumlane via NR-15B
		 Km 15+000	 Ditto (5x L=33m PC simple girder)	
		 Km 31+000	 Chinese cement factory observed along the road	
		 Km 32+000	 Bridge width is 8m for two way traffic lanes and 1.0m for sidewalks on both sides.	
		Apprx.30km section from Saravane has been upgraded to DBST by local funds project transferred from concession project on March 2010. The section beyond Km 32 is still a narrow earth road which becomes impassable during the rainy season. The improvement works is on-going at the site and is scheduled for completion in 2012.		

(5) NR-16A (Paksong – JCT with NR-1I)

	Section	Road Conditions	Typical Observation	Remarks
NR-16A (JCT R1I – Paksong NR-16)	Start NR-16 Jct Km. 53.2 - R1I Jct. Km. 0.0 End	 Km 53+200 junction with NR-16 Paksong	 A bailey bridge along NR-16A has damaged girder.	Class III Rolling- Mountain Junction with NR-16 Paksong Passable throughout the year Mountainous terrain subject to realignment of existing road way Junction with R1I
		 Km 51+000 coffee plantation along NR-16A	 Five bridges are steel girder bridges built under the concession with hydro power station project	
		 Km 26+000 sharp bending curves continues	 Almost no traffic on the road but some tourists were travelling by motor cycle from Sekong to Pakson.	
		 Km 0+000 junction with R1I	 Security gate to control illegal logging at the junction with R1I	
		71km length of road runs through the flat (32.1 km), rolling (17.9 km) or mountainous (21.0 km) terrains. First 10km section is badly deteriorated due to remaining fragments of old DBST. Some villages exist along this section. Other sections have gravel surface type and few villages exist along these sections. The road width varies between 3 and 7m: widening is required to accommodate a 2 lane carriageway.		

(6) NR-1H (NR-20 JCT - Tateng)

<table>
<tr><th></th><th>Section</th><th>Road Conditions</th><th>Typical Observation</th><th>Remarks</th></tr>
<tr><td rowspan="4">NR-1H (NR-20 JCT to Tateng)</td><td rowspan="4">Start
JCT with No.20
Km. 22.0
-
JCT with NR-16
Km. 42.6
End</td><td> 
Km22+000 junction with NR-20</td><td> 
JAIF (CLV) funded USD 20 million for the improvement of 20km section link NR-16 in Tateng</td><td rowspan="3">Class III
Flat - Rolling

Junction with NR-20

A complete two lane road link to NR-16 via paved road

Junction with NR-16</td></tr>
<tr><td> 
Km 27+000 trenching the side ditch</td><td> 
Grading the surface with DBST by local contractor</td></tr>
<tr><td colspan="2">20km section of road runs through the flat (7.4 km) and rolling (15.1 km) terrain. The road has been upgraded and just substantially completed on March 2010. The remaining minor works still continue on site.</td></tr>
</table>

(7) NR-16B (Sekong – Dukchung – Vietnam Border)

<table>
<tr><th></th><th>Section</th><th>Road Conditions</th><th>Typical Observations</th><th>Remarks</th></tr>
<tr><td rowspan="3">R16B (Sekong-Dukchung-Vietnam Border)</td><td rowspan="3">Start
Sekong
Ferry
Km. 0.0
-
Vietnam
Border
Km. 122.6</td><td> 
Km 5+000 on-going works (private B/T)</td><td> 
Current ferry services operated by private company enable the heavy transport to cross the Sekong River.</td><td rowspan="2">Class III
Rolling - Mountainous

Start from NR-16 5km section approach to Sekong Bridge

Complete in 2012

UXO survey done on site.</td></tr>
<tr><td> 
Km 9+000 earth works is on-going</td><td> 
Contractor’s office and stock yards store the materials and machines</td></tr>
<tr><td colspan="3">114km length of R16B extends from Sekong to Vietnam border. Road construction is in progress by private finance (B/T) contract since March 2009. Progress of works is about 8% of 94km length section from Sekong and about 50% of 21km length section from Vietnam border respectively on February 2010. The target completion of project is scheduled in March 2013.</td></tr>
</table>

(8) NR-14A (NR-16 JCT – B. Phaphin- Soukhouma)

<table>
<tr><th></th><th>Section</th><th>Road Conditions</th><th>Typical Observations</th><th>Remarks</th></tr>
<tr><td rowspan="3">NR-14A (JCT with NR-16-Phaphin)</td><td rowspan="3">Start
B. Houay Phek JCT with NR-16
Km. 0.0
-
B. Phaphin
Km. 19.0</td><td> 
Km 4+000 ongoing works</td><td> 
Contractor’s office at about Km 5+000, stores the materials and equipment</td><td rowspan="2">Class III
Rolling - Mountainous

Start from NR-16 JCT

AC pavement adopted

20 km section up to Pha Pin</td></tr>
<tr><td> 
Km 9+000 earth works are on-going</td><td> 
The bridge with standard typed PC girder is under construction.</td></tr>
<tr><td colspan="3">62km length of NR-14A starts from NR-16 extending to the South region of Mekong enclave. Since NR-14A was a highest priority candidate in JICA master plan in 2003 the construction of phase 1 of 25km section from No.16 is now on going by private fund (B/T). Total cost is 19 million US$. The following 37km length of Phase 2 from Pha Pin to Soukhouma is being considered for implementation.</td></tr>
</table>

(9) NR-18A (NR-13S JCT – R1I JCT Attapeu)

	Section	Road Conditions	Typical Observations	Remarks
NR-18A (NR-13S JCT to Attapeu)	Start NR-13S JCT Km. 0 - R1I JCT Attapeu Km. 112.5 End	 Km 0+000 intersection with NR-13S	 Up to the Se Kham Pho River (Km 30.6) is passable throughout the year.	Class III- Flat Semi-urban Area Junction with NR-13S Paddy field along the NR-15A Relatively densely populated area The road runs almost parallel to Sedone so that flood water affects the road structure. Intersection with NR-1G Km 67.0
		 Km 5+500	 Poor remote area in the section between Se Khampho River and Se Piane River.	
		 Km 35+500	 Many streams flow down from Boloben Plateau crossing the Road without bridges.	
		 Km 111+000	 Se Piane River (Km 70.3) without any bridge becomes impassable by vehicle for almost 8 to 10 months in a year.	
		First 36km section of road runs through the flat section and 5 to 8m wide surface road conditions is relatively good condition up to Se Khampho River. The remaining section is a missing link and vehicles can pass for only 2 - 3 months a year. The road width is very narrow around 1.5m to 3.0m. The road surface is graded but still in a bad condition. The average running speed in this section is less than 10km/hour. The section between Se Piane River and KM post 74.9 km is in a bad condition with road width of around 4.0 m to 4.2 m. The end section between KM post 74.9 km and Junction of NR-18 B is in a fair condition with road width of around 4.0 m to 6.7 m.		

2.3.3 Current Condition of Bridge

(1) Bridge Length

Table 2.3.6 shows the number of bridges by bridge length along the national road in the southern region of Lao PDR. The crossing structures with less than 5m in length are not included in the table. 397 bridges in total were observed along the national roads and most of them require to be built or replaced with new structures. Amongst them, only 60% of the bridges are maintained in a passable condition throughout the year. The rest of the bridges are without crossing structures due to destruction or damage by flooding or past conflicts.

Table 2.3.6 Bridge Length by National Road in Southern Region

No.	Route	Road Length (km)	Small Bridge (RC) PL<25 (Nos)	Small-Middle Class Bridge (PC) 25≦PL<100 (Nos)	Middle Class Bridge (PC-Box) 100≦PL<300 (Nos)	Total Bridge Numbers (Nos)	Remarks
1	R1G	130.0	17	23	2	42	Tat Hai Br Sedone Br
2	R1H	44.5	3	2	0	5	
3	R1J	81.0	10	1	1	12	Sekaman Br
3	R9	210.0	11	36	4	51	
4	R14A	124.0	5	23	0	28	
5	R14A1	32.0	7	1	0	8	
6	R14B	149.0	14	16	0	30	
7	R14C	42.0	5	3	0	8	
8	R14C1	23.0	0	1	1	2	Huay Kangoune
9	R14C2	6.0	0	1	0	1	
10	R15A	73.0	9	9	1	19	Sedone Br
11	R15B	165.0	61	30	2	93	Sedone Br
12	R16A	129.0	0	6	0	6	
13	R16B	123.0	23	13	1	37	Sekong Br
14	R18A	112.5	12	18	2	32	Se Khampho Se Piane
15	R18B	123.0	9	1	0	10	
16	R20	69.0	5	8	0	13	
						0	
	Total	**1,636.0**	**191**	**192**	**14**	**397**	

(2) Bridge Width

Narrow bridges sometimes become bottlenecks along congested roads. Figure 2.3.4 illustrates width of the existing bridges in the southern region. Along the paved roads, almost all the bridges have more than 6m in width, except NR-20 where narrow bailey bridges were observed. On the other hand, the bridges along the unpaved roads remain narrow in width.

Source: JICA Study Team

Figure 2.3.4 Existing Bridges by Bridge Width

(3) Bridge Type

The types of bridges in the southern region are illustrated in the figure 2.3.5. Along the paved roads, almost all bridges are constructed by concrete, though the condition of these concrete bridges varies significantly. For instance, the bridges along NR-13S were replaced by concrete bridges by 2001 under the Japanese grant aid: these bridges are maintained in a good condition. Most of the bridges along NR-9 were constructed in the mid 1980s with the former Soviet Union's assistance but are now in deteriorated condition. The bridges along NR-20 are narrow bailey bridges that are less than 6 m wide.

Besides the concrete bridges along the paved roads, most of the bridges are either bailey or timber bridges along the unpaved roads. Considering the engineering features of the bridges, bailey bridges were frequently observed when river crossings required crossing structures of more than 10m in length. Timber bridges were, on the other hand, observed where crossing structures of less than 10m length were required.

At the crossing point of the major rivers, a small ferryboat usually operates to carry people and vehicles throughout the year or during rainy seasons. These include Sedone River (NR-15, during the rainy season), Sekong River (NR-16B) and Sekaman River (NR-1J).