MINISTRY OF PUBLIC WORKS & TRANSPORT
LAO PEOPLE'S DEMOCRATIC REPUBLIC

PREPARATORY SURVEY
ON
THE PROJECT
FOR
IMPROVEMENT OF NATIONAL ROAD NO. 9
AS
EAST-WEST ECONOMIC CORRIDOR
IN
THE LAO PEOPLE'S DEMOCRATIC REPUBLIC

REPORT

July 2011

JAPAN INTERNATIONAL COOPERATION AGENCY

ORIENTAL CONSULTANTS CO., LTD.

INTERNATIONAL DEVELOPMENT CENTER OF JAPAN INC.

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PREFACE

Japan International Cooperation Agency (JICA) decided to conduct the preparatory survey on the Project for Improvement of National Road No. 9 as East-West Economic Corridor in Lao People's Democratic Republic (Lao PDR), and organized a survey team headed by Keigo KONNO of the consultant (and consist of Oriental Consultants Co., Ltd. and International Development Center of Japan Inc.) between October, 2010 to June, 2011.

The survey team held a series of discussions with the officials concerned of the Government of Lao PDR, and conducted field investigations. As a result of further studies in Japan, the present report was finalized.

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

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of Lao PDR for their close cooperation extended to the survey team.

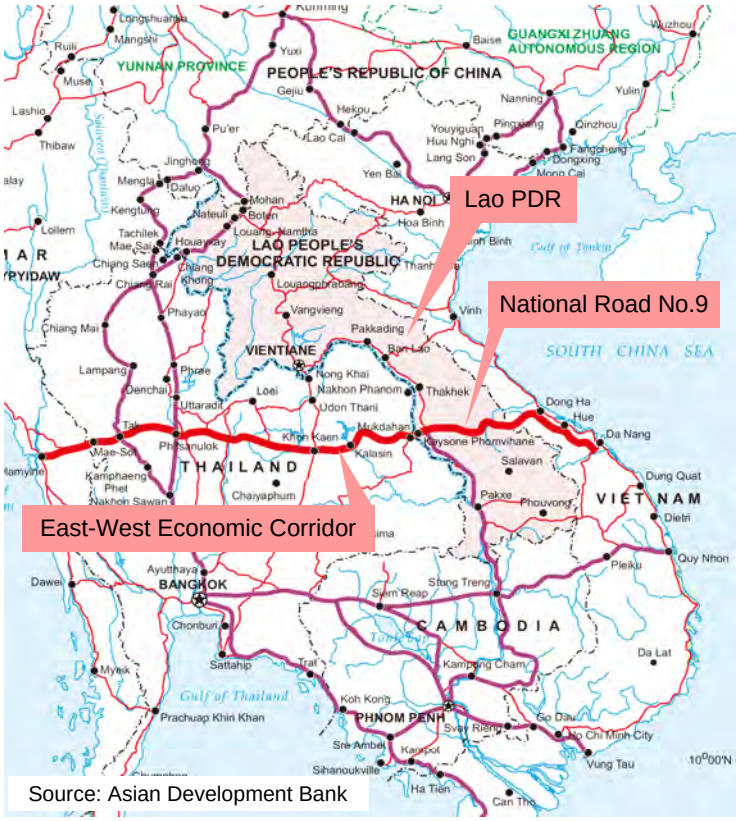
July, 2011

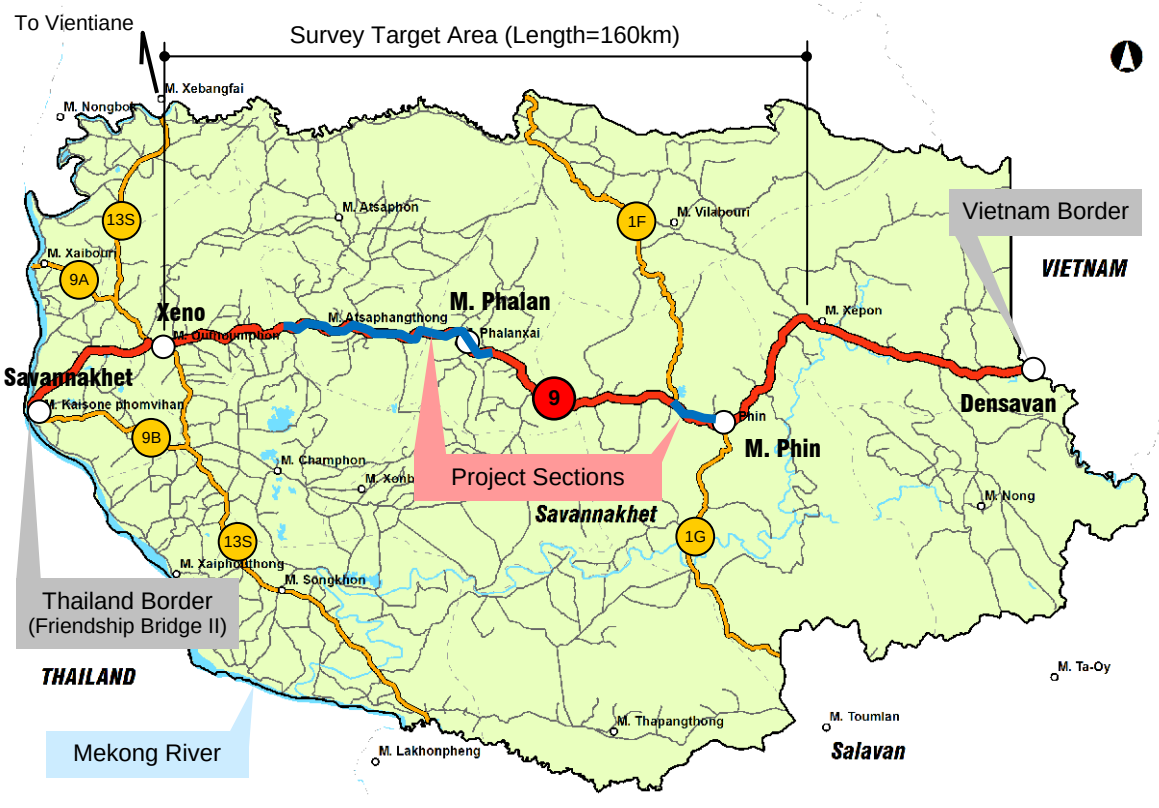
KONISHI Kiyofumi

Director General,

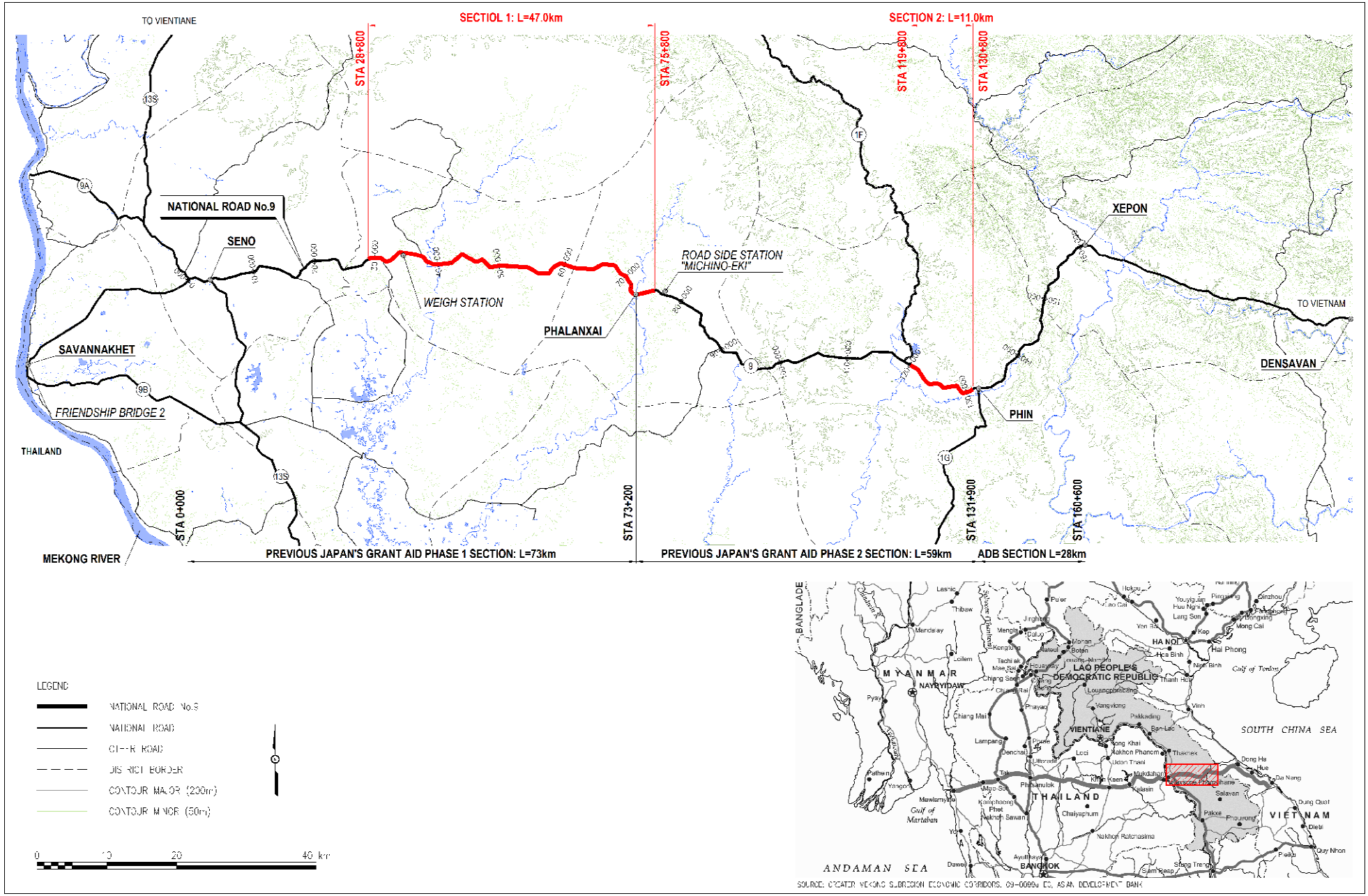
Economic Infrastructure Department

Japan International Cooperation Agency

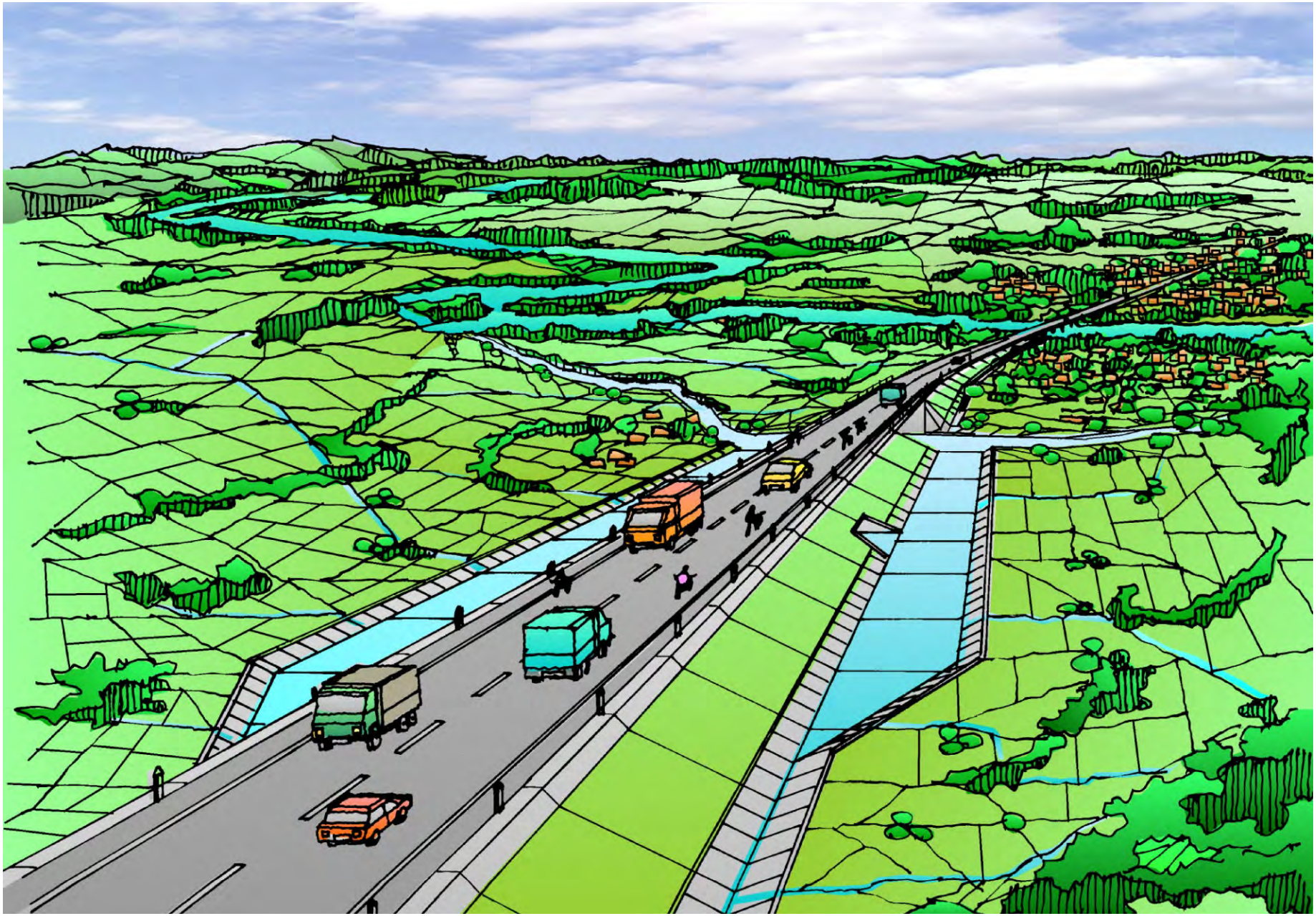




Survey Location Map



Project Location Map



Perspective of the Project

SUMMARY

1. Overview of the Lao People's Democratic Republic

Lao People's Democratic Republic (Lao PDR) is a landlocked country situated on the Indochina Peninsula stretching from north to south (north-south 1,000 km, east-west 100 to 450 km) bordered on the east by Vietnam, the west by Thailand, the south by Cambodia and the north by China and Myanmar. The country's total land area is 236,800 sq. km, which is almost the same as Japan's main island, Honshu. Its population is estimated to be approximately 6.83 million.

The climate of Lao PDR is influenced by tropical monsoons and divided into two seasons. Roughly from May until October is the rainy season, and from November until March, the dry season. Topography of the area within which National Road No. 9 is situated is flat between Savannakhet and Muang Phin, and mountainous terrain from Muang Phin to Densavan on the border with Vietnam. Average rainfall, during the 30 years between 1971 and 2000 measured in the level terrain in Savannakhet Province, was highest in August at approximately 350 mm per month; average annual rainfall was 1,452 mm and days with rainfall numbered 106. Hardly any rain falls during the dry season, when rainfall is less than 50 mm per month. The temperature is highest at the beginning of the rainy season in April, when the monthly average reaches 35 ^{0}C. The lowest temperatures are in December and January at around 15 ^{0}C.

Accounting for 33% of GDP, agriculture is the core industry in Lao PDR, centering on rice growing in which approximately 80% of the population engage. From 1988 and until recent years, Lao PDR has accomplished rapid economic growth averaging approximately 7.6% of GDP annually. This is high, even among Southeast Asian states.

Nevertheless, domestic communications, infrastructure, etc. still lag behind, and making improvements has become imperative. Many road and hydraulic power dam concessionary projects utilizing funds made available by foreign firms and donors have been formulated in recent years. Many of these are now in progress. These projects not only support the economy, but clearly indicate that Lao PDR's economic constitution is becoming more reliant on foreign capital.

The country's GDP is US$5.598 billion (2009 IMF estimate), and per capita GDP is US$885. Primary industries, agriculture, forestry and mining, account for 32.8% of GDP; this is followed by 25.2% accounted for by secondary industries (manufacturing sector) and 42.0% by tertiary industries (service sector). Approximately 45% of the population or 3 million are considered to be in the labour force, and approximately one-third of the population still lives below the poverty line. Exports amounted to US$1,005 million in 2009. The main exports are textile goods, coffee beans, electric power, gold and wood products. Thailand, its leading export market, accounts for 29.0% of this total, followed by Vietnam (15.0%) and China (15.0%). Imports, mainly of vehicles, sundry goods, machinery and fuel

(gas, oils and fats), were US$1.414 billion in 2009. The main partners importing from Lao PDR are Thailand (66.1%), China (11.5%) and Vietnam (5.3%), for fuel (gas, oils), industrial production materials, cars, life goods and machineries.

2. Backdrop, circumstances and outlines of requested project

Road traffic plays a significant role in transportation in Lao PDR, shouldering 80% of freight transportation and 85% of passenger transportation. The Government of Lao PDR is putting a great deal of effort into the development of its road network, but only about 5,300 km or 14% of the entire road length is paved. Even in the case of national roads, as of 2009, only about 55% of the total length was paved.

National Road No. 9 is a 240-km long arterial road extending from Savannakhet, which fronts on the Mekong River on the border with Thailand to Densavan on the Vietnamese border. It constitutes a key part of the East-West Economic Corridor traversing the Indochina Peninsula and is positioned as a vital route to secure access to the South China Sea.

Since Lao PDR is a landlocked country, National Road No. 9 has extreme significance from the viewpoint of reinforcing its economic and social ties with neighbouring countries. It is also important from the viewpoint of rectifying regional economic disparities, which is needed in order to move towards ASEAN unification

Improvements for the road have been implemented with the support of Japan's grant aid from 1999 to 2004 (for sections 1 and 2) and ADB's loan (for section 3). However, development of the Xepon Mine and other factors have changed road conditions. The road has suffered large-scale and extensive damage due to heavy use by large vehicles, relaxation of axle load regulations (from 9.1 to 11 tons), and an increase in large-sized trailer traffic volume. The damage has reached the extent that traffic on the road has been obstructed.

Under such circumstances, the project is being positioned as part of the development policy in the transport and traffic sectors in Lao PDR under the National Socio-Economic Development Plan (2006-2010, NSEDP), which states that improving infrastructure for socio-economic development is an important task and that focusing on developing international arterial roads linked to neighbouring countries has extremely high relevance to economic progress. Improving National Road No. 9 is positioned as a first-priority issue in the Government's 2000-2015 road development strategic plan.

Approximately 80% of the expenses required for operating and maintaining roads in Lao PDR is being covered by the Road Maintenance Fund established in 2001 with the support of the World Bank. In view of the role of National Road No. 9 as the East-West Economic Corridor, Lao PDR is making its best efforts, allocating 25% of its national road operation and maintenance budget for this purpose. However, large scale rehabilitation of the damaged road has become difficult to handle within its own securable

and implementable budget. Aid for structural reinforcement, which means to improve to the strength requested the heavy damaged pavement sections and to complete drainage facilities, of the road is indispensable to recovering smooth traffic on National Road No. 9, an international arterial highway. The fact that timely maintenance and repairs were not possible led to the large-scale damages, and further road maintenance operations on the part of the Government of Lao PDR is deemed to be required.

3. Outline of survey results and substance of the project

This survey was performed over a period of ten months, from October 2010 through August 2011 during which a preparatory survey team of seven members was dispatched from October 15 to December 22, 2010 as the first field survey. A second group of four members was dispatched from February 1 to 10, 2011 as the second field survey for explanation of the design concept. Finally, a team of three, a preparatory survey outline explanatory survey team, was dispatched from May 29 to June 3, 2011.

To implement this project, a request from the Government of Lao PDR was that the entire section between Savannakhet and Densavan (244km) be paved with cement concrete pavement (hereinafter referred to as “concrete pavement”) and that bridges be improved and repaired. However, field surveys and a series of discussions led to the conclusion that the section subject to the survey should be the 160 km section between Seno and Xepone. This was determined based on the fact that surveys will be performed on road sections where damage is significant, and that objectives should be to improve the road structure of National Road No. 9, to shorten the time required for passage, and to further upgrade traffic safety and comfort of passage vehicles.

It was recommended that the pavement method to be adopted asphalt concrete pavement (hereinafter referred to as “asphalt pavement”), in consideration of the pavement specification of the existing construction sections and of the other improved roads, and from the viewpoint of cost curtailment and environmental consideration, an existing in-situ recycling of base course method should be adopted for a part of the sections. This would make it possible to reuse existing road surfaces.

Since asphalt pavement, which has not been employed very much in the country as yet, will be adopted, upgrading execution and management capacity by soft components utilizing execution sites in this project will be implemented to secure appropriate execution of future large-scale repairs and maintenance by the Government of Lao PDR, namely Ministry of Public Works and Transportation (MPWT) and Department of Public Works and Transportation (DPWT) of Savannakhet Province. Specifications of roads to be improved in this project are as indicated in the following table:

Facility		Substance	Remarks
Road Pavement	Section 1 & 2	Replacing with new material of sub-base/base course: 47.6 km Replacing with in-situ recycled material: 10.2 km Total 57.8 km	Asphalt pavement
	The section near the entrance of the vehicle weigh station	Concrete pavement: 215m	
Road earth works	Cutting Filling works	13,100 cu. m 48,100 cu. m	
Box culvert		1 unit	
Drainage	Road gutter	53.4km (V type, U type w/cover, three-face armoured ditch)	Concrete
	Crossing drainage	11 culverts (φ 800mm, φ1000mm)	
Miscellaneous works		Guard rail, lighting and etc.	

4. Project Completion Time and Rough Estimate of Project Cost

Time for completion is scheduled to be 44.5 months, including time required for the detailed design (4 months); tender procedures (4.5 months); and construction work (36 months). Project cost by Lao government will be roughly estimated at 3.01 million US dollars.

5. Project Evaluation

(1) Adequacy

This project involves a vital route linking neighbouring Thailand to Vietnam. Improving and repairing the pavement structure and road structure of damaged sections of National Road No. 9 is vital to facilitating economic activity in Lao PDR, and it will provide smoother access to the East-West Economic Corridor.

- National Road No. 9 forms a part of the East-West Economic Corridor traversing the Indochina Peninsula and is positioned as a vital infrastructure contributing to AESAN economic unification.
- Owing to no detours instead of National Road No. 9 heavy damaged road sections and parts must improve urgently.
- In order to secure the certain qualities of improvement sections and parts and to manage the construction schedule, Japanese high technology shall be requested.
- Those who benefit from this project will not only be limited to the direct beneficiaries (the 240 thousand residents along National Road No. 9) but also indirect beneficiaries including impoverished residents will amount the 830 thousand residents of Savannakhet Province.

In view of the considerations outline above, it is judged that adequacy to implement the project is high.

(2) Effectiveness

Quantitative effect

- Maximum axle load increases from 9.1 t to 11.0 t
- Average travel speed increases from 44.8 km/h to 56.3 km/h

Qualitative effect

- Smoothness of road surface will be kept after improving and repairing the road, vehicle passage safety and comfort will be upgraded.
- Trade and investment will be facilitated in the central region of Lao PDR as an international arterial highway
- Taking agricultural products of the hinterlands to on arterial highways and planning the vitalization of distribution will contribute for development of the regional economy with agricultural and commercial activities.

From the above-mentioned facts, adequacy of the project is deemed to be high and judged that effectiveness can be expected.

(3) Recommendations

Daily maintenance is vital to keep asphalt paved roads in a good condition. Furthermore, heavily loaded vehicles greatly inflicts damage to asphalt paved roads. Based on the aforementioned, the following recommendations are made:

- Poor maintenance of drainage facilities, such as ditches and culverts, causes damage to the road structure due to water penetrating into the subgrade, sub base course and base course. Therefore, thorough cleaning of drainage facilities prior to and during the rainy season is recommended.
- To prevent damage to the pavement structure, not only imposing fines on overloaded vehicles, but also taking measures such as offloading cargo until the specific weight is reached is recommended.

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Abbreviations

A/P	Authorization to Pay
AASHTO	American Association of State Highway and Transportation Officials
ADB	Asian Development Bank
ASEAN	Association of Southeast Asian Nations
B/A	Banking Arrangement
C/S	Construction Supervision
CBR	California Bearing Ratio
D/D	Detailed Design
DBST	Double Bituminous Surface Treatment
DF	Damage Factor
DOR	Department of Roads
EIA	Environmental Impact Assessment
GDP	Gross Domestic Product
IEE	Initial Environmental Examination
JICA	Japan International Cooperation Agency
LAK	Lao Kip
Lao PDR	Lao People's Democratic Republic
MPWT	Ministry of Public Works and Transport
ODA	Official Development Assistance
PC	Prestressed Concrete
PTI	Public Works and Transport Institute
RAP	Resettlement Action Plan
ROW	Right of Way
US	United States of America
USSR	Union of Soviet Socialist Republics
VAT	Value Added Tax
WREA	Water Resources and Environment Agency

1. Background of the Project

1.1 Background of the Project

1.1.1 Substance of request

National Road No. 9 (extension 244km) was improved and became a two-lane asphalt paved road with support from Japan's grant aid and a loan from the Asian Development Bank (ADB). Following the completion of this work, maintenance and repairs were carried out by Lao PDR, but because the countermeasures and other elements were inadequate at the early stage of damages, deterioration progressed and the budget required to carry out repairs on National Road No. 9 alone accounted for more than 20% of the total governmental budget for maintenance of roads and the economic burden has become immense. In addition, circumstances are that such damages are obstructing smooth through traffic. This is the result of increased traffic volume due to the Friendship Bridge II being put into service, axle load relaxation (from 9.1 to 11 tons in 2007) based on an international agreement with Thailand and Vietnam, and the fact that the road is positioned higher as an international trunk road.

In regard to the pavement of National Road No. 9, it has been confirmed that the strength of the subgrade and sub base course has deteriorated, and base course strength deterioration has also been detected in some sections. There are sections where damages are significant. Overall refurbishment (repaving) of the existing asphalt pavement is required. However, low-cost road pavement by Double Bituminous Surface Treatment (DBST) is the general practice to surface roads in Lao PDR, and there are a limited number of engineers and constructors experienced in asphalt paving. Under these circumstances, the Government of Lao PDR requested grant aid from Japan as follows:

(1) Repaving National Road No. 9 with concrete

(2) Refurbishing highway ancillary facilities

(3) Bridge replacement (PC bridge: Length: 25 to 60m)

1.1.2 Change in contents requested

(1) From sophisticated standard (cement concrete pavement) to asphalt pavement

Cement concrete pavement (hereinafter referred to as "concrete pavement") projects actually done in Lao PDR are limited. National roads now being constructed are mostly done using DBST or asphalt pavement. Even for maintenance of national roads, refurbishments and repairs are either DBST or asphalt pavement. However, DBST and asphalt pavements are more economical (lower construction cost), work efficiency rises (shorter construction period) and

better running performance (no joints and less noise) are also advantages. Therefore, changing mainly to asphalt pavement was proposed to the Government of Lao PDR, to which they gave their consent.

(2) Bridge reconstruction not subject to grant aid

Fifty-one bridges exist along National Road No. 9, and damages to and deterioration of all of them are progressing. In December of 2009, the shoe seats of the main girder on the Houay Cheng Bridge (concrete beam) at a distance of 200 km from Savannakhet (Xepon to Densavan) collapsed and a large difference in elevation at the expansion joints (connection between bridge and earth works) was created. As a result, vehicle traffic became impossible and the Government of Lao PDR dealt with the situation by taking emergency measures to replace all main girders of the superstructure with Prestressed Concrete (hereinafter referred to as "PC") girders. Regarding the existing condition of bridges along National Road No. 9, it was proposed to the Government of Lao PDR that it is not subject to cooperation under this survey to which it gave its consent.

(3) Change in sections to be improved

In response to a request to improve the entire length of National Road No. 9 (244km), it was proposed to the Government of Lao PDR to separate the necessary sections that Japan improves as a Japan's grant aid and the sections which the Government of Lao PDR is to repair and maintain to which it gave its consent.

Definition of Improvement by Japan's grant aid means a large scale work by replacing new materials due to the sub base and base course of extremely damaged sections or parts. Repair and maintenance by Lao PDR defines a small scale work by sealing to the cracks and patching to the potholes.

The sections subject to improvement and sections subject to repairs and maintenance are shown in Table 1.1.1 below.

Table 1.1.1 Improvement Sections and Maintenance & Repair Sections

Category	Station (Length)	Outline of Road Condition
Improvement-1	Sta.29 - 76 (47km)	・ Pavement structure deteriorated in the whole length. ・ High roughness of road surface. ・ Strength of subgrade, sub base course and base course degraded. ・ Quite high percentage of crack & repair ratio. ・ Immediate improvement is required.
Improvement-2	Sta.120 - 131 (11km)	・ Pavement deterioration in progress. ・ High roughness of road surface. ・ Strength of subgrade and sub base course degraded. ・ High percentage of crack & repair ratio. ・ Immediate improvement required.
Maintenance & Repair-1	Sta.0 - 29 (29km)	・ Currently pavement structure is stable. ・ Base course partially deteriorated. ・ Routine/periodic maintenance required to prevent further deterioration of subgrade, sub base & base course and road surface.
Maintenance & Repair-2	Sta.76 - 120 (44km)	・ Strength of pavement structure partially degraded. ・ Low roughness of road surface. ・ Strength degradation of base course in the former segment in progress. ・ Routine/periodic maintenance required to prevent further deterioration of subgrade, sub base & base course and road surface.
Maintenance & Repair 3	Sta.131 - 160 (29km)	・ Strength of pavement structure partially degraded. ・ High roughness of road surface. ・ Strength degradation of base course in progress. ・ Routine/periodic maintenance required to prevent further deterioration of subgrade, sub base & base course and road surface.

1.2 Natural Conditions

(1) Geographic and Climate Conditions

1) Topographic Condition

Laos is a landlocked country and it borders five (5) countries, namely China, Myanmar, Thailand, Cambodia and Vietnam. The area of Laos is 236,800 sq. km, 70 % of it is categorized as mountainous terrain with the flatland spread along Mekong River, which is the border with Thailand. The highest peak in Laos is Mt. Bia (2,820 m height above sea level).

Savannakhet Province, where National Road No. 9 is located, is the biggest province in Laos. The area of the province is 21,774 sq. km, which accounts about 9.2 % of the country, with more or less rectangular area 180 km east-west by 100 km north-south. The terrain of the province inclines from the eastern part to the western part. The chain of mountains in the eastern part, with average height of 1,200 meter above sea level, is called the "Annamite chain", running from the northwest to the southeast along the border with Vietnam. The western part of the province is flatland terrain along Mekong River.

National Road No. 9 runs from the flat terrain, where the section from Seno to Muang Phin lies 170-200 m above sea level, to rolling terrain in the section from Muang Phin to Xepon.

Source: JICA Survey Team, compiled from the GIS data from National Geographic Department

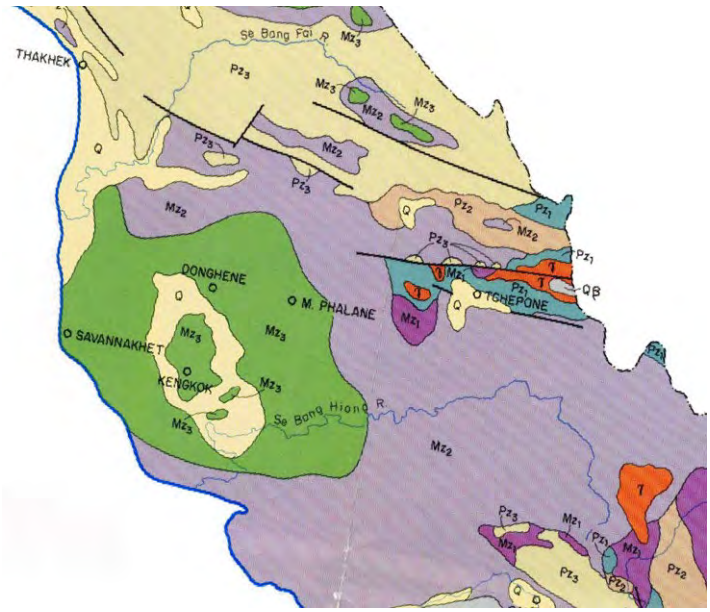
Figure 1.2.1 Topographic Map

2) Geological Condition

Savannakhet province is embedded with a widespread cover of relatively small 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 Savannakhet 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.

During the survey, it was observed that clayey sand was deposited over a layer of sandstone, which lies below 5-10 m from the ground surface, along National Road No. 9.



LEGEND

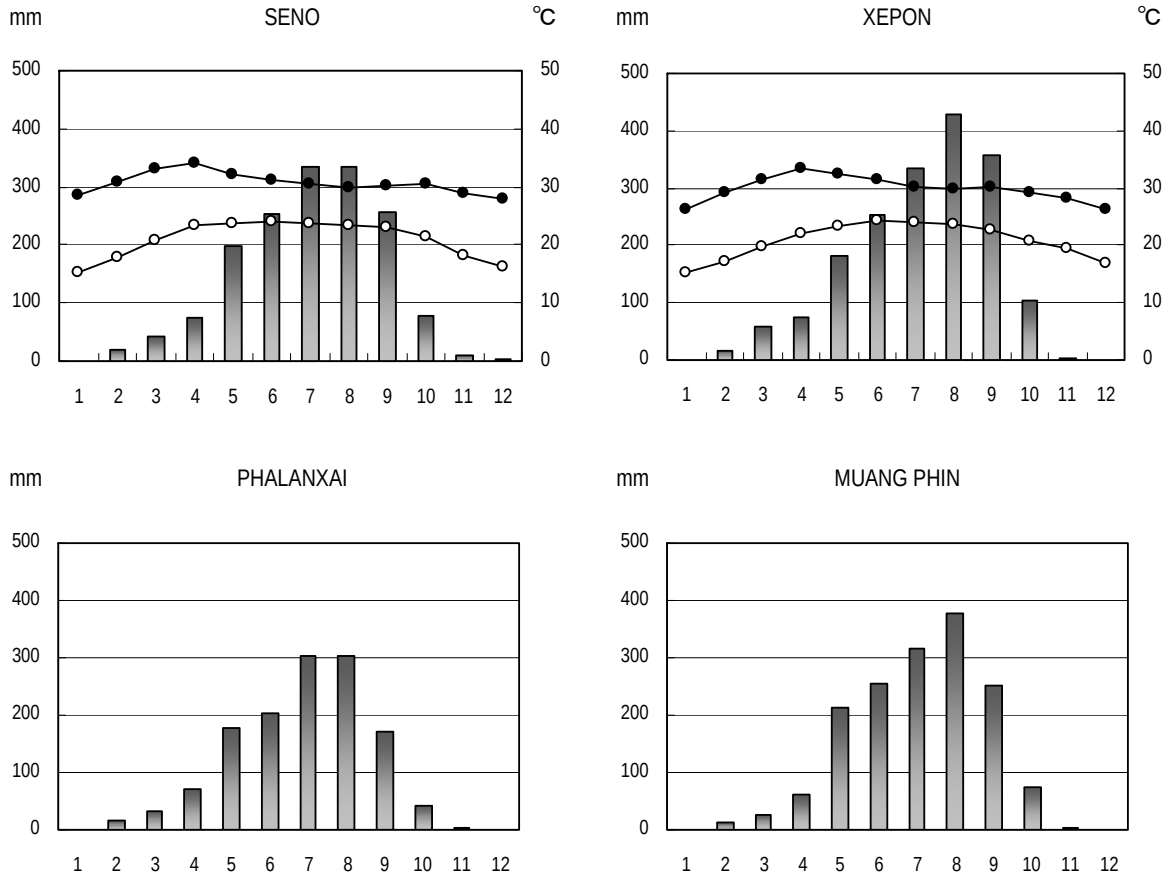
Q	Quaternary. Alluvial deposits of the Mekong river and its tributaries.
QB	Quaternary (possibly also Neogene in part) basalt, including alkaline varieties (basanite, limburgite etc.)
Mz_3	Late Mesozoiic, mainly Mid-Late Cretaceous, lower part mainly sandstones, predominantly fine-grained towards the top, with thick evaporates, especially rock salt and gypsum.
Mz_2	Mid-Mesozonic, mainly Late Triassic to Early Cretaceous, predominantly terrestrial sediments, mainly sandstones. Thin coats in places. Marine Late Triassic occurs in the NE and the NW. Marine Liassic is found in the SE.
Mz_1	Early Meaozoic, mainly Early-Mid Triassic. Mainly marine; terrestrial in certain areas. Mostly clastic sediments, some limestones. Volcanic rocks, mainly acidic (rhyolite, decite, tuff) widespread in N and SE.
Pz_3	Late Paleozoic (mainly Middle Carboniferous-Permian, some undifferentiated Early Triassic in the NW). Mainly marine; terrestrial in certain areas with coal. In the east, limestones are the dominant rocks of the marine facies, in the west and south clastic dominate, with subsidiary limestones. Volcanic rocks, mainly intermediate (andesite-decite), are widespread and of various ages, especially Permian.
Pz_2	Mid – Paleozoic (mainly Devonian-Early Carboniferous, some Silurian), mainly marine rocks, in places weakly metamorphosed. Limestones commonly occur, and may be more or less recrystalized to marble.
Pz_1	Early Palezoic (Cambrian-Silurian) with probable Proterozoic. Some undifferentiated Lower Devonian in NE, less generally metamorphosed to phyllites and schists, and marble. Some basic meta-volcanics. Ultrabasic lenses occur in a narrow belt in the NE.

Source: Atlas of Mineral Resources of the ESCAP Region, United Nations (1990)

Figure 1.2.2 Geological Map

3) Climate

Savannakhet Province is located in a tropical climate region where the south-west monsoon is dominant. The monsoon brings rainfall from the Indian Ocean during mid-May through mid-October. The north-east monsoon brings cold air from China during November and February. The 10-year observation records (2000-2009) of four (4) stations along National Road No. 9 shows that although tendencies of rainfall differ from the east and the west, rainfall excels in the rainy season during May through September. Rain falls more than 100 mm per day in a few days a year. Temperature is about 30 degree Celsius on an average during a year and that in Xepon, which are relatively high lands, is lower than the others.



Source：Department of Meteorology and Hydrology, Water Resources and Environment Administration

Figure 1.2.3 Monthly Average Rainfall, Max/Min Temperature (2000-2009)

(2) Drainage Condition

1) General

The terrain along National Road No. 9 is mainly flat and rolling. No springs were found in this survey but shallow wells were observed in some villages. The west part of the road near Seno is a gently hilly area and some 10-20 m wide rivers flow across the road from north to south. There are paddy fields in valleys and hillsides. Villages, forests and dry fields are located on the top of the hills.

In the western side from Muan Phalan, major rivers (e.g. Xe Xamxoy, Xe Thamouak and Xe Banghiang rivers) flow across or in parallel with National Road No. 9. Flood plains and swamps were found along these rivers and the terrain is relatively flatter than the east.

As a whole, the area drains along the road and flows into the rivers and swamps through minor drainage ditches and culverts. Currently, the major roadside drainage facilities are natural/artificial ditches, and box/pipe culverts.

2) Roadside drainage facilities

A total of 163 box/pipe culverts were found along National Road No. 9 from Seno to Xepon. These culverts were installed connecting to the natural water channels, which existed before the previous improvement project.

Drainage ditches were found in the village sections only (e.g. Seno, Muang Phin). Although, many longitudinal pipe culverts have been installed with housing developments, drainage capacities of these culverts are not adequate and this causes clogging and poor drainage. Except for the village sections, there is no artificial drainage ditch along the road and much of the rainfall flows into the rivers through natural water channels or percolates through the ground surface. For this reason, puddles due to poor drainage and erosion of ditches were found.

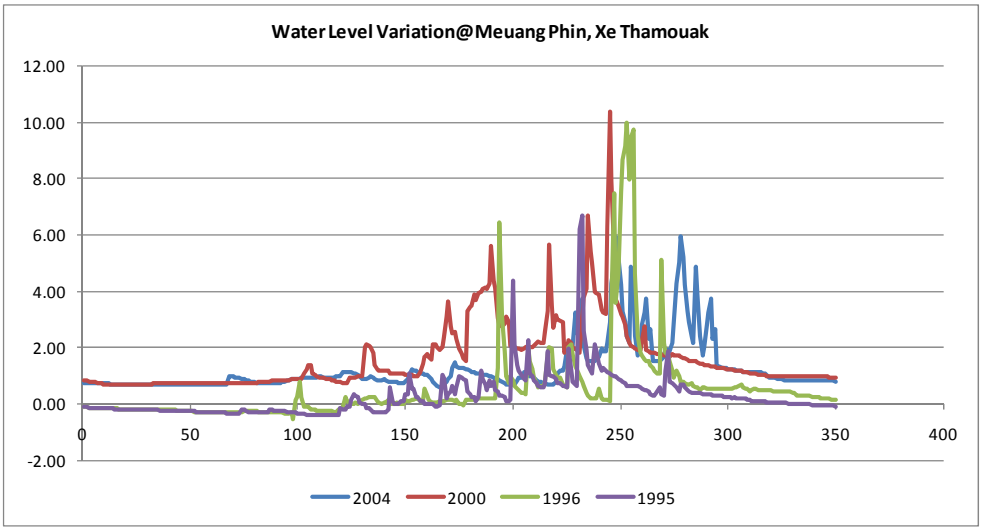
Poor drainage at Muang Phin

Erosion of ditch

Figure 1.2.4 Poor Drainage and Erosion

3) Rivers/Discharge Points

There are 33 bridges along National Road No. 9. The length of these bridges ranges from less than 10 m to more than 100 m. Banks of major rivers are eroded and stones rolling from upstream were found. Figure 1.2.5 shows the water level record of Xe Thamouak River at the crossing point with National Road No. 9. The water level rose up to 10 m height during the rainy season.



Note: The horizontal axis shows observational days and it starts from January 1st. The vertical axis shows water level, but the bench mark is unknown.

Figure 1.2.5 Water Level Record at Xe Thamouak River

(3) Flood Records along National Road No. 9

In an interview survey, floods were reported around the following rivers in past years.

- Xe Champhone River in M. Atsaphangthong;
- Xe Xamxoy and Xe Kumkam Rivers in M. Phalansay;
- Xe Thamouak and Xe Chon Rivers in M. Phin, and;
- Xe Banghiang River and its tributaries in M. Sepon.

Floods of Xe Banghiang River in 1987 and 2010 overflowed around its tributes and a part of the surface of National Road No. 9. Except for those floods, no other floods flowed over the surface of the road.

1) Overflow in Phalansay

Paddy fields spreading in Phalan Kang and Phosai villages near Xe Xamxoy experience small-scale floods almost every year. Xe Xamxoy River has a sharp curve north of the paddy fields and river water often overflows at this point. Spilled water flowed over paddy fields from north to south via the bridge and culvert along National Road No. 9. The culvert, which is installed at the lowest point of the area, is too small to drain the water and causes wide inundation in paddy fields in the north.

Figure 1.2.6 Overflow in Phalanxay

The culvert, which is installed at the lowest point of the area.

Paddy fields near Xe Xamxoy

Figure 1.2.7 Poor Drainage at Phalanxay

2) Overflow in Xepon Flood Plain

Xe Banghiang River and its tributaries area experienced the severest floods in 1978 and 2010. Both floods were caused by swollen river water from Xe Banghiang River and its tributaries such as Xe

Kok and Houay Kok. Water increased from these river and tributaries from south to north. Small-scale floods occur almost every year and some floods are caused by the swollen river flowing from the east and the inundation period is relatively long. But others were caused by heavy rain and slow drainage, and floodwater flows from west to east in relatively short period of time.

1.3 Environmental and Social Considerations

1.3.1 Environmental approval and license formalities

Acquiring prior environmental approval cum license from the Water Resources and Environment Agency (WREA) in Laos in compliance with the New Environmental Impact Assessment (New EIA) Law promulgated in 2010 is mandatory for the implementation of an infrastructure development program. Environmental inspection for approval cum license acquisition is divided into the Initial Environmental Examination (IEE) and the aforesaid EIA. These classifications are determined through deliberations with the WREA according to the scale and degree of environmental impact incidental to project implementation. The supervisory authority within the MPWT in respect of environmental survey is the DOR.

1.3.2 Confirmation of Initial Environmental Examination (IEE)

(1) Preliminary Environmental Survey

A preliminary environmental survey (scoping) in connection with this road improvement project was conducted in November 2010. The 30 items described in JICA's Guidelines for Environmental and Social Considerations were sorted out, and the environmental impacts assumed vital when implementing the project were extracted. At this stage, scoping was performed for two cases, (1) non-implementation of the project and (2) implementation of the project. Furthermore, negative impacts during project implementation whilst road improvement is being executed were analysed and also for the period after being put into service. Table 1.3.1 summarizes the results of scoping relative to the improvement project for National Road No. 9 as proposed by this study. Based on these results, an environmental checklist has been prepared (refer to Appendix).

(2) IEE Schedule

It is mandatory that a WREA registered contractor be engaged in its execution when an IEE is to be implemented. Again, the said road improvement project requires convening stakeholder discussion sessions at least twice in accordance with the schedule described below.

- First session: When substance of repair program is finalized
- Second session: Subsequent to initiation of repair work

A detailed schedule will be appended to the documents prepared by DOR as indicated in Figure 1.3.1. That two stakeholder sessions would be convened is evident from the figure.

Table 1.3.1 Results of Preliminary Environmental Survey Relative to National Road No. 9 Improvement Project

Environmental factor				Rating	
				With project	Without project
Social environment	1	Involuntary relocation	Land expropriation incidental to setting up construction yard, relocating shops illegally encroaching roadside	D	B
	2	Regional economy elements such as employment, means of living, etc.	Impact on regional tourism incidental to aggravated road condition, additional vehicle maintenance expenses as a consequence of aggravated road condition	B	D
			Impact on regional economy from temporary traffic jams caused by ongoing construction work.	D	B
	3	Land utilization, making use of regional facilities and resources	Land use as is or in competition with development program.	D	D
	4	Social structures such as social infrastructure, regional decision making bodies, etc.	Impact on regional society such as regional decision making body, etc.	D	D
	5	Existing social infrastructure, social services	Competition with current traffic systems as they are, energy, communication and public water supply systems.	D	D
	6	The poor, ethnic minorities and the indigenous	Impact on minority settlements residing in periphery of planned route.	D	D
	7	Mal-distribution of suffering and advantages	Concentration・localization, mal-distribution of suffering and advantages.	D	D
	8	Cultural heritage	Competition with rival roadside historical and cultural heritage	D	D
	9	Regional conflict of interest	Regional environmental preservation and development movement confrontation.	D	D
	10	Water usage	Impact on agricultural (rice paddy) irrigation.	D	B
	11	Public hygiene	Work environment (malaria, dengue hemorrhagic fever, etc) Disposing of construction yard domestic garbage.	D	B
	12	Illness, communicable disease (e.g. HIV, AIDS.)		D	B
	13	Accidents	Deterioration of safe passage by aggravated (e.g. pot holes) road surface	B	D
			Anxiety over frequently occurring traffic accidents incidental to temporary increase in traffic volume during construction period.	D	B
			UXO	D	B
Natural environment	14	Topographical features・Terrestrial Formation	Extensive change in topographical features incidental to construction work.	D	D
	15	Soil erosion	Soil erosion aggravation; sand deposition, etc. in lower reaches.	B	B
	16	Subterranean water	Temporary deterioration of water quality during construction period.	D	B
	17	Hydrology	Alteration and aggravation of regional drainage system incidental to large-scale work.	D	B
	18	Coastal ecology		D	D
	19	Flora and fauna, biological diversity	Destruction of roadside vegetation and ecological system.	D	D
			Impact on adjacent national parks and regenerated forestry areas.	D	B
	20	Weather conditions	Impact on localized weather conditions.	D	D
	21	Landscape	Impact on regional street scenery and landscape.	D	D
	22	Global warming	Increased regional CO2 emission.	B	B
Environmental pollution	23	Atmospheric condition	Temporary deterioration of roadside atmospheric condition during period of construction work.	D	B
			Roadside atmospheric condition to deteriorate from increased traffic when put into service.	B	B
	24	Water quality	Quality of surface water flow and underflow to temporarily become aggravated during construction period.	D	B
	25	Ground pollution	Ground polluted by accidental outflow of construction solvents, etc.	D	B
	26	Waste matter	Disposal of construction waste material during construction period.	D	B
	27	Noise・Oscillation	Aggravated noise caused by road surface pavement deterioration (pot holes.)	B	D
			Temporary aggravated roadside noise and oscillation construction period.	D	B
			Aggravated noise and oscillation to increased regional traffic volume whilst in service.	B	D
	28	Ground settlement	Occurrence of ground settlement from extensive earth works.	D	D
	29	Foul odors	Outbreak of foul odors.	D	D
	30	River bed・Benthic	River bed disturbance by construction work.	D	D

Note) A: Serious impact expected, B: Some impact expected, C: Minor impact expected, D: Almost nil impact, U: Unknown

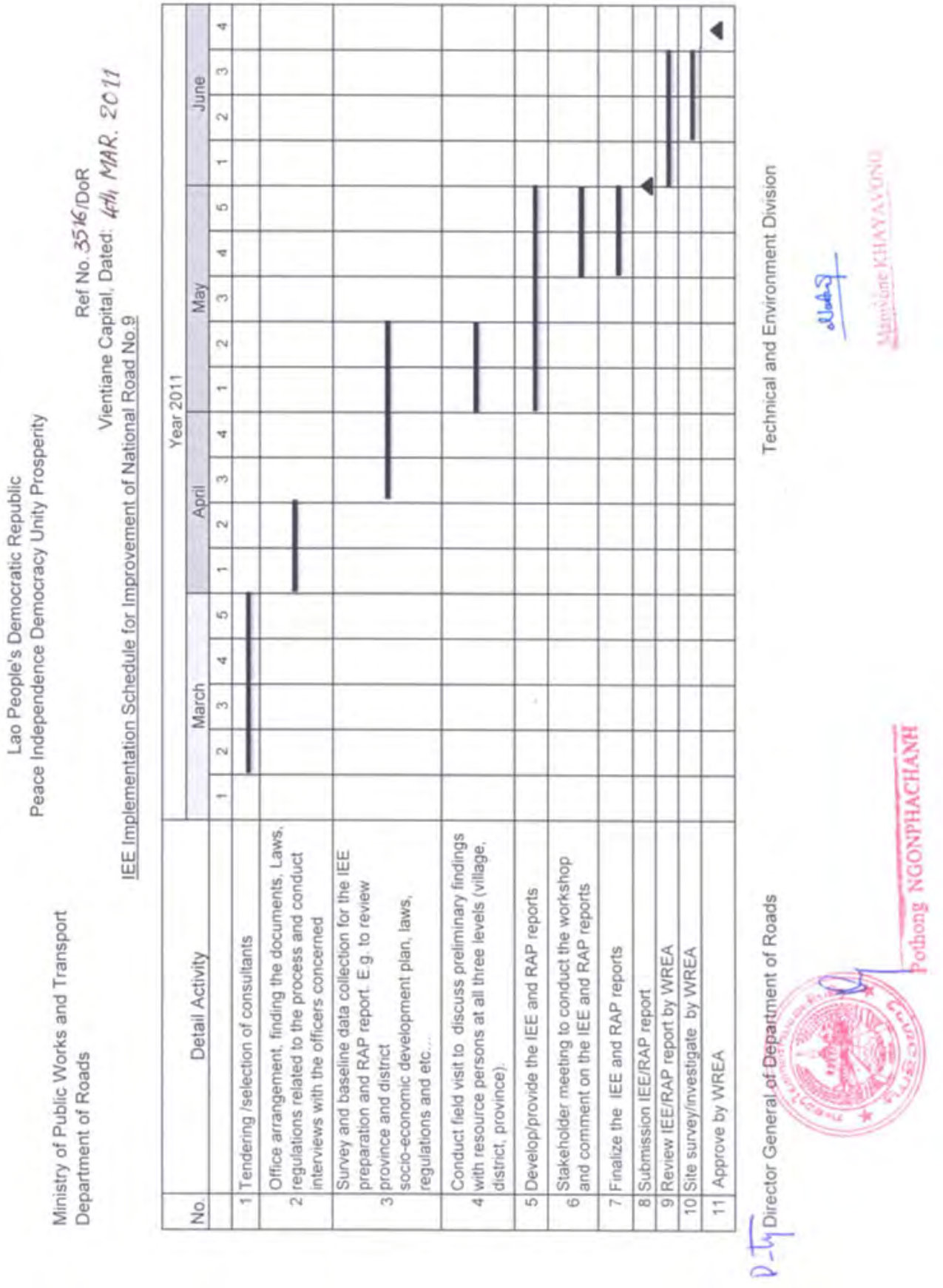


Figure 1.3.1 IEE Schedule (DOR)

2. Contents of the Project

2.1 Basic Concept of the Project

2.1.1 Overall Goal and Target of the Project

Lao PDR is a landlocked country and its transportation network with neighbouring countries, particularly in view of the importance of physical distribution by road, is extremely important. National Road No. 9 constitutes a part of the east-west economic corridor, which traverses Indochina. This arterial road connects eastern Thailand and central Vietnam and is positioned as vital infrastructure contributing to economic integration of ASEAN. Trade, investment and economic development in the central regions of Lao PDR are being advanced by making use of this East-West Economic Corridor.

The national development plan in Lao PDR, namely the Sixth Socio-Economic Five Year Plan (2006 - 2010), positioned reducing poverty and economic growth as the nation's vital issues. It also targets a mean economic growth rate of 8% per annum and per ca pita GDP of US$800 by 2010. The plan shows many development strategies in the roads and transportation sector of Savannakhet Province focused on National Road No. 9.

In such circumstances, National Road No. 9 was improved over the entire 244 km as 2 lanes of asphalt concrete road with funds by Japan's Grant Aid and the Asian Development Bank (ADB). Subsequent to completion of improvement works, necessary maintenance and repairs have been carried out by the Lao PDR side. However, initial measurements, taken to the deterioration of road surface, were not quite sufficient and for other reasons, the degree of damage became conspicuous. The funds required to carry out repairs on National Road No. 9 take up more than 20% of the country's road maintenance and repair budget. This economic burden has become increasingly problematic. Furthermore, the Second Mekong International Bridge and other factors have led to intensified traffic density. Now that National Road No. 9 is positioned as an international arterial highway, its axle load limit has been relaxed from 9.1 to 11 tons based on an international agreement with Thailand and Vietnam, the situation is that smooth traffic is being hampered by damaged road surfaces.

Based on the above mentioned, the Project was targeted by the Lao PDR government to promote trade and investment in the central area of Lao PDR. National Road No. 9 was targeted to be improved to a standard sufficient to be an asphalt concrete road that serves as the international trunk road to handle the traffic situation.

2.1.2 Outline of the Project

This project will carry out refurbishment by repaving road sections which have been significantly damaged to achieve the aforesaid objective, and it will provide guidance on the importance of road pavement methods and road maintenance throughout the entire construction period. Investment outline of this project is as follows;

- Construction Period: 36 months,
- Improvement of the road for 58 km in length with asphalt pavement,
- Installation of drainage facilities and subsidiary facilities on the improvement of the road section, and
- Installation of a box culvert.

2.2 Outline Design of the Japanese Assistance

2.2.1 Design Policy

2.2.1.1 Determination of Improvement Section

(1) Prioritization of the Section

This survey was conducted at seriously damaged road sections with a total length of 160km, namely Xeno - Palanxai (73km), Palanxai - Phin (59km) and Phin - Xepon (28km) in National Road No.9 (total length: 244km). Based on the analysis of the topographic survey, geological survey, hydrological survey and road surface condition survey, the priority of the sections was determined. Evaluation items and their scores for prioritization are shown in Table 2.2.1. Then the prioritization result of the sections is shown in Table 2.2.2.

Table 2.2.1 Evaluation Item & Score

Evaluation Item	Description	Score
A：Strength of subgrade	CBR less than 10	1
	CBR more than 10	-1
B：Strength of sub base course	CBR less than 30	1
	CBR more than 30	-1
C：Strength of base course	CBR less than 80	1
	CBR approx. 80	0
	CBR more than 80	-1
D：Crack & repair ratio	High	1
	Moderate	0
	Low	-1
E：Daily traffic volume	More than 5,000	1
	2,500 to 5,000	0
	Less than 2,500	-1
FR：Flood impact	Existing	1
	Non-existing	-1

Table 2.2.2 Prioritization Result of Road Sections

Section	Japan's grant (Phase-1) (73km)		Japan's grant (Phase-2) (59km)		ADB Section (28km)
Length (*)	**Sta.0 - 29**	**Sta.29 -76**	**Sta.76-103**	**Sta.103-132**	**Sta.132-160**
A : Subgrade strength	-1	1	-1	1	-1
B : Sub base course strength	-1	1	-1	1	-1
C : Base course strength	-1	1	-1	-1	0
D : Crack/Repair ratio	-1	1	0	1	1
E : Traffic volume	1	0	0	0	-1
F : Flood impact	-1	1	1	-1	1
Total Score	**-4**	**5**	**-2**	**1**	**-1**
Priority Rank	**5**	**1**	**4**	**2**	**3**

(*) Seno (Beginning point of Japan's grant section (Phase-1)) is defined as Sta.0.

(2) Determination of Improvement Sections and Maintenance & Repair Sections

Subgrade, sub base course and base course are known as the principal layers of pavement structure. However, it was observed that all of the layers have seriously deteriorated in the sections ranked 1 and 2 (total 76km length) in Table 2.1.2. Desirable road serviceability will not be attainable without implementation of large scale construction works in these sections. Therefore, road improvement work for these sections will be conducted under a Japan grant aid cooperation project with sustainable technology and quality control. The degree of pavement deterioration, the whole length of the rank 1 sections (47km) and the latter sections (11km between Sta.120 and Sta.131) of the rank 2 section, which deterioration is limited and other sections of the rank 2 still keep the original durability, are determined as the improvement sections (total 58km). Remained sections of the rank 2, which are between Sta.103 and Sta.120 and between Sta.131 and Sta.312, will be conducted by Lao PDR.

As a result of the above analysis and discussion, Improvement sections and Maintenance & Repair sections are determined as shown in Table 2.2.3. Further, the survey results and location map of these sections are summarized in Figure 2.2.1.

Table 2.2.3 Improvement Sections and Maintenance & Repair Sections

Category	Station (Length)	Rank	Outline of Road Condition
Improvement-1	Sta.29 - 76 (47km)	1st	・ Pavement structure deteriorated in the whole length. ・ High roughness of road surface. ・ Strength of subgrade, sub base course and base course degraded. ・ Quite high percentage of crack & repair ratio. ・ Immediate improvement is required.
Improvement-2	Sta.120 - 131 (11km)	The middle segment of the 2nd	・ Pavement deterioration in progress. ・ High roughness of road surface. ・ Strength of subgrade and sub base course degraded. ・ High percentage of crack & repair ratio. ・ Immediate improvement required.
Maintenance & Repair-1	Sta.0 - 29 (29km)	5th	・ Currently pavement structure is stable. ・ Base course partially deteriorated. ・ Routine/periodic maintenance required to prevent further deterioration of subgrade, sub base & base course and road surface.
Maintenance & Repair-2	Sta.76 - 120 (44km)	4th + the initial segment of the 2nd	・ Strength of pavement structure partially degraded. ・ Low roughness of road surface. ・ Strength degradation of base course in the former segment in progress. ・ Routine/periodic maintenance required to prevent further deterioration of subgrade, sub base & base course and road surface.
Maintenance & Repair 3	Sta.131 - 160 (29km)	The last segment (1km) of the 2nd + the 3rd	・ Strength of pavement structure partially degraded. ・ High roughness of road surface. ・ Strength degradation of base course in progress. ・ Routine/periodic maintenance required to prevent further deterioration of subgrade, sub base & base course and road surface.

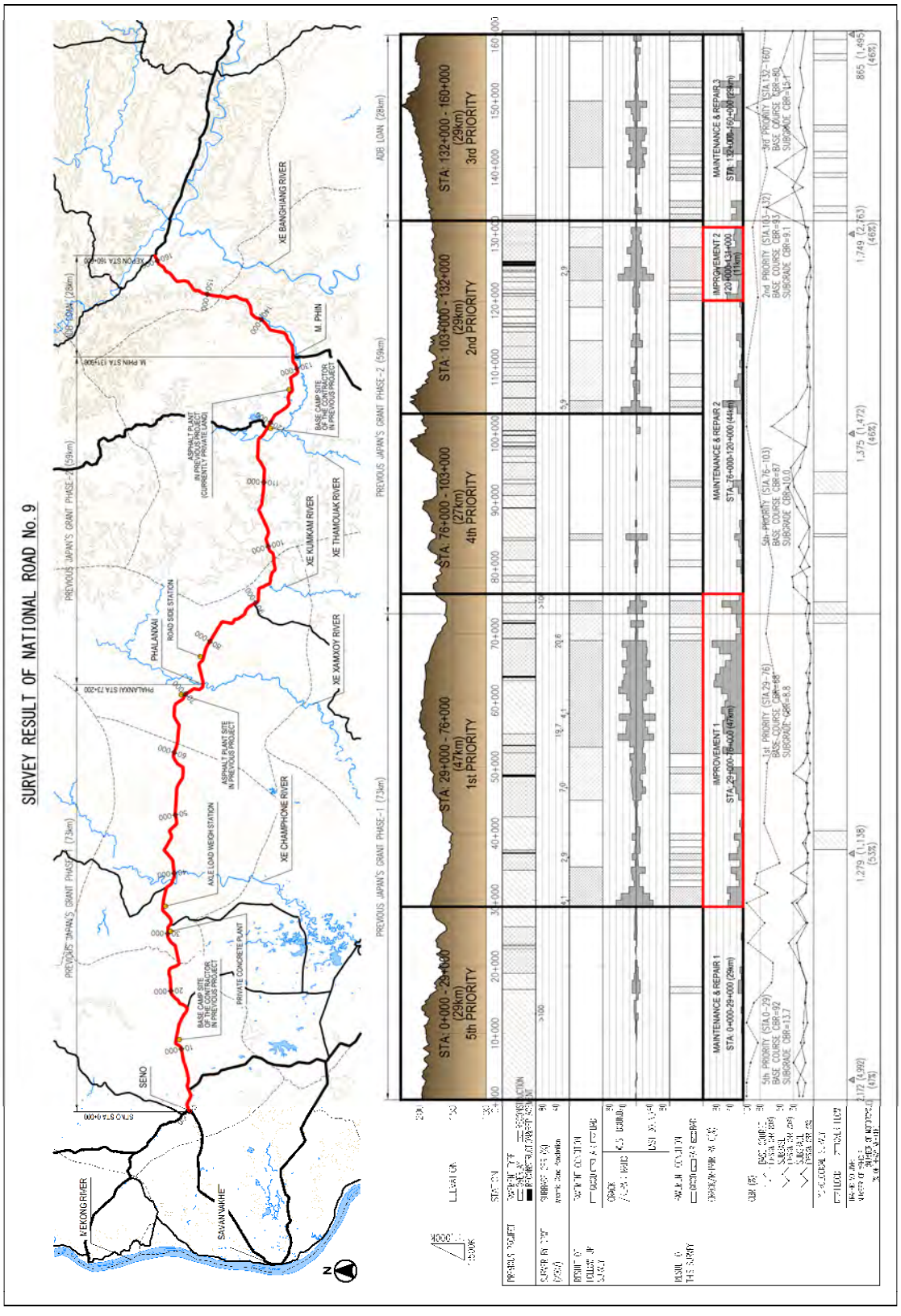


Figure 2.2.1 Survey Result and Improvement and Maintenance & Repair Section Location Map

2.2.1.2 Design Policy

The major project component is road improvement by replacing the asphalt pavement in improvement section-1 (47km) and improvement section-2 (11km). Road safety facilities and drainage works will also be improved in the sections. Note that the 200m-long section, near the entrance of the vehicle weigh station at STA. 34+500, will be improved with the concrete pavement to protect the road surface from the impact of the braking and accelerating load of heavy vehicles.

(1) Geometrical Structure

This Project improves the asphalt pavement structure following the existing road alignment, which was improved by the previous projects. The geometry of the road should follow the design concept of the previous projects. Geometrical structures for the Project are summarized in Table 2.2.4.

Table 2.2.4 Road Geometrical Structure of the Project

		Improvement-1 (Grant Phase 1)			Improvement-2 (Grant Phase 2)	
		Flat	Rolling	Village	Rolling	Village
Road class		Class II (3,000 - 8,000 vehicles per day)				
Number of lanes		2				
Carriageway width (m)		3.5				
Shoulder width (m)		1.5 (rural), 2.5 (village)				
Cross fall		3% (carriageway), 5% (shoulder)				
Max. super elevation		10%				
Max. vertical gradient		5%	6%	7%	6%	7%
Design speed (km/h)		100	80	50	70	50
Min. radius of horizontal curve (m)		400	250	80	175	80
Min. radius without super elevation (m)		7,000	4,000	4,000	4,000	4,000
Min. radius of vertical curve (m)	Crest	10,000	5,000	2,500	5,000	2,500
	Sag	3,000	2,000	1,500	2,000	1,500
Length of vertical curve (m) *		85	70	40	70	40
Right of way (m)		60			70	

Source: Road Design Manual (Lao PDR, 1996) and Japanese standard (marked by *)

(2) Pavement Design

Improvement of the existing pavement structure is the principal construction item of the Project. The design will be undertaken according to the following processes and conditions.

1) Improvement Method

Pavement damage causes deterioration not only to the wearing course but also to the lower layers such as the base course, sub base course and subgrade on the road. Therefore, full reconstruction of the pavement structure will be applied in the Project. Note that the existing sub base course (in-situ cement stabilized soil: 28cm) will remain to be used as the new subgrade, sub base and base course for reduction of disposal material and improvement of the drainage capability of the pavement structure. New pavement structure will be constructed above the new subgrade. This method is applicable in rural sections in which there is low impact from raising the elevation of the road surface in relation to the road

side area. On the other hand, the existing pavement structure will be wholly removed prior to new pavement construction in village sections because a drastic raise of the road surface is impossible considering the road side environment (e.g. houses, drainage facilities, etc.). Furthermore, 2 types of pavement materials will be proposed in rural sections namely "new material of new subgrade, sub base and base course" and "in-situ recycled material". Criterion for material selection is according to the current road surface condition. The latter material is available from asphalt pavement and base course of stone material. Therefore, the total figure of crack ratio and repair has to be low to obtain a sufficient quantity of the material. The sections with less than 15% of crack ratio + repair ratio are chosen to apply the latter material in the Project. The selection flow of construction method and model drawings of each construction method are shown in Figure 2.2.2 and Figures 2.2.3 – 2.2.5 respectively.

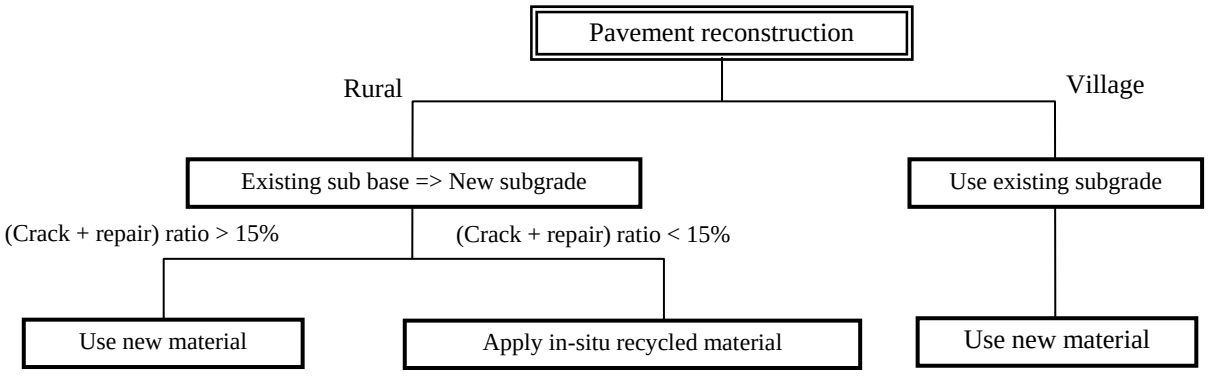
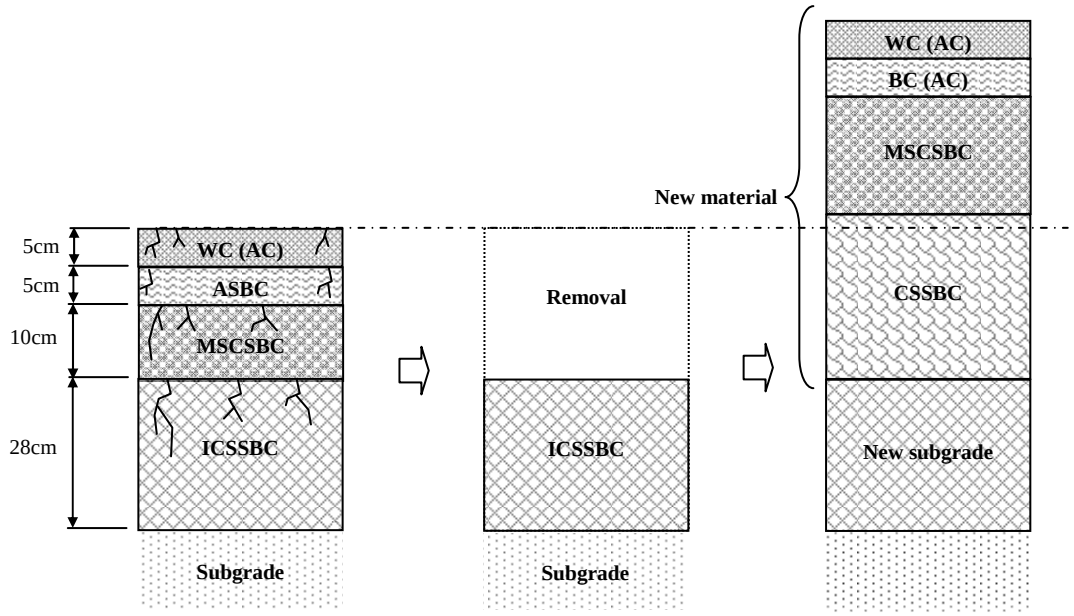
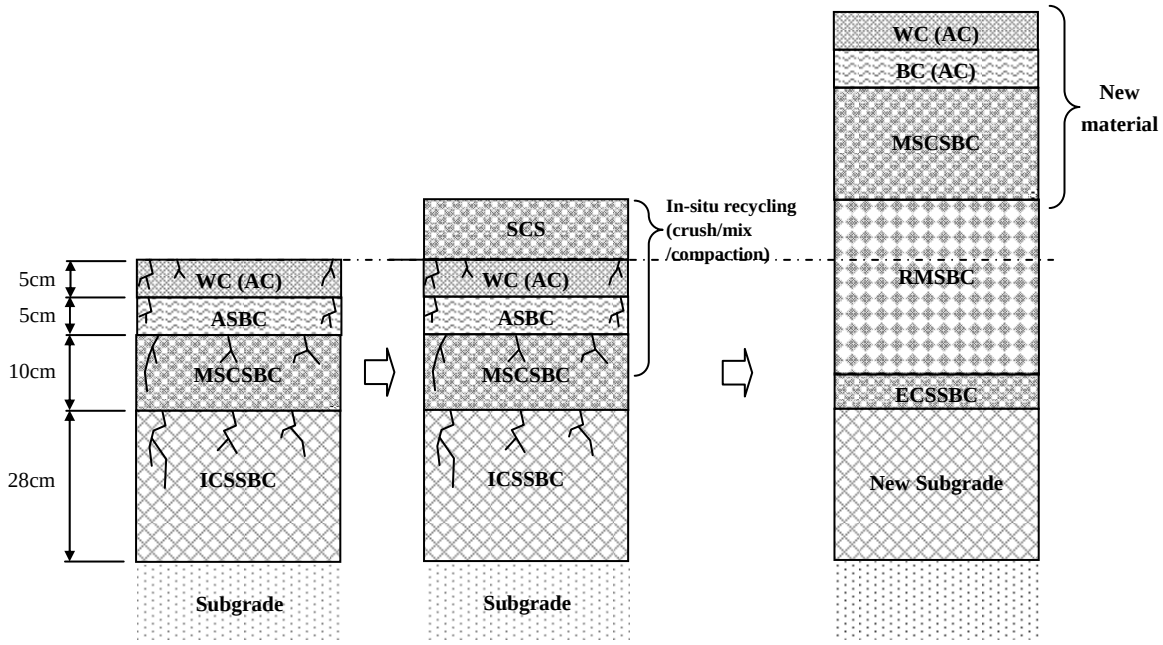


Figure 2.2.2 Selection Flow of Construction Method



Abbreviations
AC: Asphalt Concrete, ASBC: Asphalt Stabilised Base Course, BC: Binder Course,
CSSBC: Crushed Stone Sub Base Course, ICSSBC: In-situ Cement Stabilized Sub Base Course,
MSCSBC: Mechanical Stabilized Crushed Stone Base Course, WC: Wearing Course

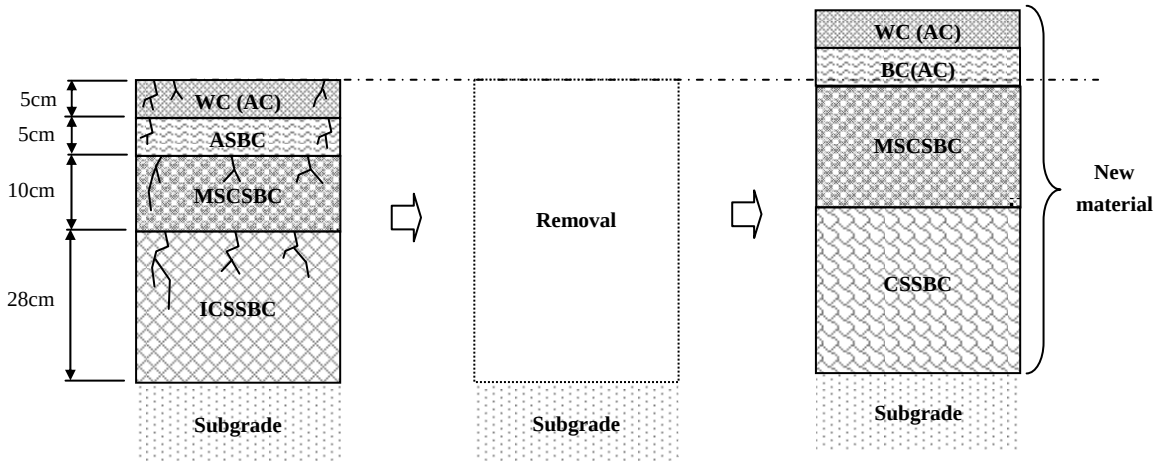
Figure 2.2.3 Full Reconstruction Work in Rural Sections (Crack Ratio + Repair Ratio > 15%, New material)



Abbreviations

AC: Asphalt Concrete, ASBC: Asphalt Stabilised Base Course, BC: Binder Course,
ECSSBC: Existing Crushed Stone Sub Base Course, ICSSBC: In-situ Cement Stabilized Sub Base Course,
MSCSBC: Mechanical Stabilized Crushed Stone Base Course, RMSBC: Recycled Material Sub Base Course,
SCS: Supplemental Crushed Stone, WC: Wearing Course, WC: Wearing Course

Figure 2.2.4 Full Reconstruction Work in Rural Sections (Crack Ratio + Repair Ratio < 15%, Recycled material)



Abbreviations

AC: Asphalt Concrete, ASBC: Asphalt Stabilised Base Course, BC: Binder Course,
CSSBC: Crushed Stone Sub Base Course, ICSSBC: In-situ Cement Stabilized Sub Base Course,
MSCSBC: Mechanical Stabilized Crushed Stone Base Course, WC: Wearing Course

Figure 2.2.5 Full Reconstruction Work in Village Sections (New material)

2) Design Standards

The following standards are applied for pavement design.

- Pavement Design Manual (AASHTO, 1993): Asphalt pavement
- Cement Concrete Pavement Design Manual (Japan Road Association, 1984) : Concrete pavement
- Guideline for Recycling of Pavement Material (Japan Road Association, 2004) : Recycling method

3) Design Method

Asphalt Pavement

Design for asphalt pavement is conducted by applying AASHTO which was applied in many of Japan's grant aid projects including previous projects on this road. Required pavement strength, which is called the Structure Number (SN), will be calculated by the following formula in this method. Estimated accumulative axle loads of heavy vehicles (i.e. damage to pavement: W18) in the design/analysis period and bearing capacity of subgrade (M_R) are principal factors to determine SN.

$$\log_{10}(W18) = Z_R \times S_0 + 9.36 \times \log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left(\frac{\Delta PSI}{4.2-1.5}\right)}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32 \times \log_{10}(M_R) - 8.07$$

W18: Accumulative axle loads (Number of single axles passing with 18kip (= 8.16ton) weight in design/analysis period)

M_R: Resilient coefficient of subgrade (CBR × 1500)

SN: Structure Number (Required strength of whole pavement structure)

Z_R: Reliability coefficient

S_0: Standard deviation (Asphalt pavement = 0.45)

⊿PSI: Difference between initial serviceability index and terminal serviceability index of pavement (initial: P0=4.2, terminal: Pt=2.5, P0 - Pt = 1.7)

Pavement structure with strength more than computed SN will be determined by applying the following formula.

$$SN_p = a_1 \times D_1 + a_2 \times D_2 + a_3 \times D_3 \times m_3 + a_4 \times D_4 \times m_4$$

SN_p Structure Number of determined pavement structure

a_n Material coefficient of each layer (wearing course −sub base course)

D_n Thickness of each layer (inch)

m_n Drainage coefficient of each layer

Concrete Pavement

Concrete pavement is designed by applying the Cement Concrete Pavement Design Manual (Japan Road Association, 1984). The thickness of each pavement layer will be determined on the basis of estimated traffic volume of heavy vehicles after 5 years from opening and the bearing capacity of the subgrade (CBR) in this manual. Design traffic volume is classified as shown in Table 2.2.5.

Table 2.2.5 Classification of Design Traffic Volume (No./day･direction)

Classification	Traffic Volume
L-traffic	Less than 100
A-traffic	100 – 250
B-traffic	250 – 1000
C-traffic	1000 – 3000
D-traffic	over 3000

Source: Cement Concrete Pavement Design Manual (1984)

4) Design Condition

(a) Asphalt Pavement

Design conditions were partially revised according to change of surroundings of the road since completion of previous projects. Comparisons of the conditions between previous projects and this project are shown in Table 2.2.6. Then discussions of revised conditions are described in the following clauses.

Table 2.2.6 Comparison of Pavement Design Conditions

Item		Previous	This Project	Remarks
1. Design variable	Design period	8 years	10 years	Described in (a)
	Analysis period	20 years	20 years	1 time overlay work in the period
	Reliability (R)	50%	85%	Described in (b)
	Standard deviation (Z0)	0.45	0.45	
2. Serviceability	Initial serviceability (P0)	4.2	4.2	
	Terminal serviceability (Pt)	2.5	2.5	
3. Damage factor of design vehicle	Large bus (2-axles)	0.383	1.005	Described in (c)
	Truck	0.383	0.113	
	Large truck (2-axles/4 wheels)	2.598	0.899	
	Large truck (2-axles/6 wheels)			
	Large truck (3-axles or more/6 wheels or more)		2.558	
	Large truck (3-axles or more/10 wheels or more)			
	Trailer (3-axles or more/18 wheels or more)	4.008	3.955	
	Trailer (3-axles or more/22 wheels or more)			
	Double trailer	-	6.469	
4. Accumulative axle load in design period (W18)		1.72×10^6	2.88×10^6	Described in (d)
5. Characteristics of material	Design CBR of subgrade	5	5-6	Described in (e)
	Coefficient of wearing course (AC)	0.39	0.42	Described in (f)
	Coefficient of binding course (AC)	-	0.42	
	Coefficient of asphalt stabilized base course	0.30	-	
	Coefficient of base course (mechanically stabilized crushed stone)	0.135	0.135	
	Coefficient of sub base course (recycled material)	-	0.140	
	Coefficient of sub base course (crushed stone)	0.115	0.108	
	Coefficient of sub base course (in-situ cement stabilized)	0.115	-	
6. Drainage coefficient	Base course	1.00	1.00	Described in (g)
	Sub base course	0.95	0.95-1.00	

Design Period

Design period is revised from 8 years to 10 years because pavement design manuals such as AASHTO, Japan and Lao PDR designate 10 years in principle.

Reliability

Reliability (R) is the probability that the pavement structure will fulfill the desired performance under the estimated traffic volume and environment in the design period. R is classified according to required function (i.e. importance) of the road in the AASHTO method. Table 2.2.7 shows recommended values of R. Further, Reliability coefficient (Z_R) is determined according to classified R as shown in Table 2.2.8.

Table 2.2.7 Recommended R by Road Function

Function	Recommended R (%)	
	Urban	Rural
Inter-state road & express way	85 – 99.9	80 – 99.9
Arterial road	80 – 99	**75 – 95**
Collector road	80 – 95	75 – 95
Rural road	50 – 80	50 – 80

Source: AASHTO pavement design manual

Table 2.2.8 Reliability Coefficient (Z_R) by Determined R

R (%)	Z_R
50	0.000
60	-0.253
70	-0.524
75	-0.674
80	-0.841
85	**-1.037**
90	-1.282
95	-1.645
99.9	-3.090

Source: AASHTO pavement design manual

R=50% (i.e. rural road level) was applied for previous projects because the 2nd Mekong Bridge had not been completed at that time. However, currently, the road is a part of an international road network called the East-West Economic Corridor because of the opening of the 2nd Mekong Bridge in 2006. Traffic volume 10 years after completion of the Project is estimated to be more than double the current volume. Therefore, it is reasonable to revise R from 50% to 85% (i.e. arterial road in rural area level) considering the above mentioned change.

Damage Factor of Design Vehicle

Damage factor (DF) for each design vehicle is determined to estimate accumulative axle loads (W18) in the design period. DF was computed by the AASHTO method on the basis of the axle load survey result at the weigh station owned by DPWT Savannakhet along the road. Comparison of DF by vehicle type between previous projects and this project is shown in Table 2.2.9.

Table 2.2.9 Comparison of DF by Vehicle Type

Vehicle Type	Previous	This Project
Large bus (2-axles)	0.383	1.005
Truck	0.383	0.113
Large truck (2-axles/4 wheels)	2.598	0.899
Large truck (2-axles/6 wheels)		
Large truck (3-axles or more/6 wheels or more)		2.558
Large truck (3-axles or more/10 wheels or more)		
Trailer (3-axles or more/18 wheels or more)	4.008	3.955
Trailer (3-axles or more/22 wheels or more)		
Double trailer	-	6.469

Accumulative Axle Loads in Design Period

Accumulative axle loads (W18) in the design period are estimated by DF and traffic volume forecast on the road. The result is shown in Table 2.2.10.

Table 2.2.10 AADT of Design Vehicle (number/day･2 directions) & Accumulative Axle Loads (W18) (2 directions)

Vehicle Type	Large bus	Truck	Large truck (2-axles)	Large truck (3-axles or more)	Trailer	Double trailer	Total W18 Annual	Analysis/ Design Period Total W18
DF	1.005	0.113	0.899	2.558	3.955	6.469		
2015	54	634	61	41	100	82	442,229	
2016	57	669	64	43	106	87	467,521	
2017	61	706	68	46	112	92	494,260	
2018	65	745	72	48	118	97	522,529	
2019	69	786	76	51	125	102	552,416	
2020	73	830	80	54	132	108	584,013	
2021	78	876	84	57	140	114	617,419	
2022	83	924	89	61	148	121	652,737	
2023	88	975	94	64	156	128	690,076	
2024	94	1,029	99	68	165	135	729,552	**5,752,752**
2025	100	1,086	105	72	174	143	771,289	
2026	106	1,147	110	76	184	151	815,414	
2027	113	1,210	116	80	195	160	862,065	
2028	120	1,277	123	85	206	169	911,387	
2029	127	1,348	130	89	218	178	963,532	
2030	135	1,422	137	94	230	189	1,018,663	
2031	144	1,501	144	100	243	199	1,076,950	
2032	153	1,584	152	106	257	211	1,138,574	
2033	162	1,672	161	112	272	223	1,203,727	
2034	173	1,764	170	118	287	235	1,272,611	**15,786,963**

(Note) Annual W18 = AADT × 365days × DF

W18 of 1 direction is applied for pavement design. Therefore, W18s of analysis period and design period are as shown below.

W18 of design period = 5,752,752 ÷ 2 = **2,876,376**

W18 of analysis period = 15,786,963 ÷ 2 = **7,893,481**

Design CBR of Subgrade

Existing subgrade and sub base course will be utilized as new subgrade for the Project as shown in Figure 2.1.3 to 2.1.5. Materials testing (sampling and laboratory testing) for existing subgrade and sub base course were conducted at intervals of 1.5km to determine design CBR of the new subgrade. The following formula is applied to determine design CBR for the Project based on the result of laboratory testing. Design CBR of each section is shown in Table 2.2.11.

Design CBR = (Average of testing result) －(Standard deviation of testing result)

Table 2.2.11 Design CBR

Section	Rural/Village	Design CBR	New subgrade
1	Rural	6	Use existing sub base
	Village	6	Use existing subgrade
2	Rural	5	Use existing sub base
	Village	6	Use existing subgrade

Material Coefficients of Pavement Layers

Each pavement layer has its own material coefficient depending on characteristics and strength of applied material. Each coefficient is determined by nomograph to convert the physical characteristics (e.g. elastic modulus, CBR) into the material coefficient in the AASHTO manual. Each material coefficient to apply for the Project is shown in Table 2.2.12.

Table 2.2.12 Material Coefficient of Each Layer

Layer	Material	Coefficient
Wearing course	Asphalt mixture	0.420
Binding course	Asphalt mixture	0.420
Base course	Mechanically stabilized crushed stone	0.135
Sub base course	Recycled material (cement stabilized)	0.140
Sub base course	Crushed stone	0.108

Drainage Coefficient of Pavement Layer

Existing sub base course (thickness = 28cm) will remain to be used as the new subgrade in the reconstruction sections (rural sections). It is forecast that drainage condition of the pavement structure will be improved in the above sections. Therefore, drainage coefficients of each layer will be revised as shown in Table 2.2.13.

Table 2.2.13 Comparison of Drainage Coefficient

Layer	Previous	This Project	
		Rural	Urban
Wearing	-	-	-
Binding	-	-	-
Base	1.00	1.00	1.00
Sub base	0.95	1.00	0.95

(b) Concrete Pavement

Design Traffic Volume

Traffic volume of heavy vehicles in 2019 (i.e. 5 years after opening of the road) is estimated as shown in Table 2.2.14. This volume is equivalent to B-traffic according to Table 2.2.5. Furthermore, the existing traffic volume is shown in the next page.

Table 2.2.14 Design Traffic Volume (number/day･direction)

Large bus	Truck	Large truck (2-axles)	Large truck (3-axles or more)	Trailer	Double trailer	Total
34	393	38	26	65	53	**603**

Design CBR of Subgrade

Design CBR = 6 is applied because the pavement structure consists of a concrete slab and base course that will be constructed on existing subgrade in Improvement Section-1.

(3) Drainage Facilities

1) General

Drainage facilities are required with proper dimensions and locations to sustain good condition of the road structure such as the subgrade and base/sub base course. It was reported that the existing drainage facilities currently malfunction. Therefore, reasonable drainage facilities shall be designed for the Project.

The JICA Survey Team conducted the following surveys to collect fundamental data/information for the design.

- Visual inspection of existing drainage facilities including their terminal flow point
- Interview with residents regarding flood history
- Meteorological data collection at survey station near the road

Major land uses around the road are green fields, paddy fields, farm land and pasture on gentle terrain. Alignment of the road is generally located on a ridgeline. Therefore, there are only limited segments where surface water collects on the road. Further, it was confirmed that there was no record of inundation above the road surface during floods where the road crosses the river according to the survey. Moreover, even partial inundation caused by the inadequate capacity of existing drainage facilities was only observed at Palanxai. Drainage facilities will be designed to accommodate only surface water within the road area of the Project based on the above survey.

The design for drainage facilities such as side ditches, pipe culverts and box culverts will be conducted by applying the Road Design Manual (Lao PDR, 1996).

Traffic Volume (1 day: 14 hours)

Location	Direction	Vehicle Type									
		Motor Cycle	Car	Small Bus	Large Bus	Small Truck	Large Truck (2-axle)	Large Truck (3 of more-axle)	Trailer	Double Trailer	Special Vehicle
L1. Lao-Thai border	East	0	217	84	38	3	0	16	35	22	0
	West	0	233	94	40	3	3	13	42	17	0
Total		0	450	178	78	6	3	29	77	39	0
L2. Seno	East	2,444	422	15	13	411	32	22	10	27	127
	West	2,549	440	21	15	393	45	21	12	20	130
Total		4,993	862	36	28	804	77	43	22	47	257
L3. Ban Donpalai	East	550	183	75	17	209	27	18	31	29	47
	West	588	173	82	26	216	29	24	35	21	42
Total		1,138	356	157	43	425	56	42	66	50	89
L4. Ban PhalanTai	East	661	205	109	23	201	22	20	28	29	57
	West	811	185	131	25	204	14	13	34	22	57
Total		1,472	390	240	48	405	36	33	62	51	114
L5. Ban Pasomxai	East	1,416	279	107	25	310	19	18	8	41	61
	West	1,347	275	132	37	238	17	16	3	68	99
Total		2,763	554	239	62	548	36	34	11	109	160
L6. Sepone Toll Gate	East	767	170	19	11	103	22	7	26	18	28
	West	728	207	22	18	89	16	22	34	35	23
Total		1,495	377	41	29	192	38	29	60	53	51
L7. Lao-Vietnamese border	East	1,191	123	11	21	23	29	17	13	35	28
	West	1,309	130	5	18	28	13	13	14	60	39
Total		2,500	253	16	39	51	42	30	27	95	67

2) The Embankment Section in Palanxai

There are plain paddy fields 3 to 4m lower than the road surface along the road embankment section in Palanxai. Xe Xome Xoy River which splits construction sections between Phase 1 and Phase 2 of the previous projects, and its tributary called Houay Koa River are located in this area. There were frequent inundations by overflow water from these rivers in the northern area of the road during the rainy season. It was also reported that the water reached around the slope of the road embankment. The embankment itself caused these inundations to block water flow. Therefore, improvement of the drainage function will be required to solve this issue. However, it is very difficult to compute water volume of overflow water from the northern area quantitatively due to lack of data.

This embankment was constructed earlier than the previous Japanese projects with the Soviet Union's assistance. A bridge (L=15m) was at the same location as the existing pipe culvert (Sta.74+570) before that construction. It was reported that no malfunction of drainage occurred because the discharge capacity of the bridge was sufficient to accommodate the water flow at that time. Currently, the water will accumulate at this culvert due to the land configuration (i.e. the culvert is lower than its surrounding area) and its small diameter (600mm).

The riverbed of Hoyay Koa river which is located close to the culvert (Sta.73+800) is higher than the culvert. Therefore, drainage capacity will be improved by construction of drainage facilities with adequate capacity on both sides of the embankment.

3) Discharge volume of rain water

Required discharge volume of rain water of the drainage facility is estimated by the following formula (rational equation method).

$$Q = \frac{1}{3.6} C \cdot I \cdot A$$

where Q: Discharge volume（m3/sec）
C: Run-off coefficient
I: Rainfall intensity for the duration corresponding to the time of concentration (Tc) of the catchment area (mm/h)
A: Catchment area (km2)

Rainfall Intensity (I)

Rainfall intensity is calculated by the logarithmic normal distribution method on the basis of data from meteorological survey stations near the Project sections (Palanxai, Phin). Daily and hourly rainfall intensities are shown in Table 2.2.15 and Table 2.2.16. Applied intensity for the side ditch is for a storm with a 5 year return period and for the crossing structure it is 20 years.

Table 2.2.15 Daily Rainfall Intensity (mm/day)

	Palanxai	Phin
5 years	153	167
10 years	184	195
20 years	214	222
50 years	254	257

Table 2.2.16 Hourly Rainfall Intensity (mm/hr)

	Palanxai	Phin	Remarks
5 years	53	58	Design for side ditch
10 years	64	68	
20 years	74	77	Design for crossing structure
50 years	88	89	

Run-off Coefficient

Applied coefficients are as shown in Table 2.2.17.

Table 2.2.17 Run-off Coefficient

Type of ground surface	Coefficient
Asphalt pavement	0.95
Slope (turf)	0.65
Plain (gradient 0-5%)	0.01

Source：Road Design Manual (Lao PDR, 1996)

Dimensions of Drainage Facility

Discharge capacity of the facility is calculated by the following formula.

$$Q_c = A \cdot v$$

where, Q: Discharge capacity (m^3/sec)
A: Discharge section (m^2)
v: Average velocity (m/sec)

$$v = \frac{1}{n} R^{2/3} \cdot i^{1/2}$$

where, n: Roughness coefficient
R: Hydraulic radius (m)
i: Gradient in channel

2.2.2 Basic Plan of Road Improvement

The basic plan road improvement is drawn up according to the design policy in section 2.1.1. Contents of the plan are as follows.

2.2.2.1 Classification of Construction Method

Construction methods are classified according to Figure 2.1.2 in Improvement sections-1 and 2. Total construction length by method is as follows. Further, its breakdown is shown in Table 2.2.1. Note, (Crack + Repair) ratio (=13.55%) is currently under 15% (i.e. borderline between "new material" and "recycled material") between sta. 122 and 123 in the Section-2. However, it is forecast that the ratio will increase up to commencement of the Project (April 2012). Further, using recycled material is considered to be inefficient construction performance because the segment length of "recycled material" is only 1km in Section-2. Therefore, "new material" will be applied for this segment the same as in front and behind.

(Section-1) Sta. 28+800 – Sta. 75+800 (47.0km)

- Reconstruction by new material: 36.625km
- Reconstruction by recycled material: 10.175km
- Concrete pavement: 0.200km

Total: 47.000km

(Section-2) Sta. 119+800 – Sta. 130+800 (11.0km)

- Reconstruction by new material: 11.000km
- Reconstruction by recycled material: 0.000km
- Concrete pavement: 0.000km

Total: 11.000km

(Total)

- Reconstruction by new material: 47.625km
- Reconstruction by recycled material: 10.175km
- Concrete pavement: 0.200km

Total: 58.000km

Table 2.2.18 Classification of Construction Method

Improvement section-1 Length= 47.000 km

Station		(Crack+Repair)ratio(%)			Method	Rural/ Village	Length (km)			Surface increment (cm)
		Crack	Repair	Total			Concrete	New	Recycle	
28+800	29+000	0.72	2.18	2.90	New	Rural		0.200		35
29+000	30+000	0.70	45.38	46.08	New	Rural		1.000		35
30+000	31+000	6.69	32.56	39.25	New	Rural		1.000		35
31+000	32+000	3.47	43.90	47.37	New	Village		1.000		35
32+000	32+300	3.75	8.67	12.42	Recycle	Village			0.300	30
32+300	33+000	3.75	8.67	12.42	Recycle	Rural			0.700	30
33+000	34+000	6.26	15.37	21.63	New	Rural		1.000		35
34+000	34+400	9.02	26.73	35.75	New	Rural		0.400		35
34+400	34+600	9.02	26.73	35.75	Concrete	Rural	0.200			2
34+600	35+000	9.02	26.73	35.75	New	Rural		0.400		35
35+000	35+500	5.50	4.00	9.50	Recycle	Rural			0.500	30
35+500	36+000	5.50	4.00	9.50	Recycle	Village			0.500	7
36+000	37+000	3.51	39.19	42.70	New	Village		1.000		7
37+000	38+000	3.47	13.42	16.89	New	Village		1.000		7
38+000	39+000	4.15	8.18	12.33	Recycle	Village			1.000	7
39+000	39+825	3.77	22.77	26.54	New	Village		0.825		7
39+825	40+000	3.77	22.77	26.54	Recycle	Rural			0.175	30
40+000	41+000	2.35	3.32	5.67	Recycle	Rural			1.000	30
41+000	42+000	7.33	3.60	10.93	Recycle	Rural			1.000	30
42+000	43+000	1.84	2.86	4.70	Recycle	Rural			1.000	30
43+000	44+000	1.01	2.87	3.88	Recycle	Rural			1.000	30
44+000	45+000	2.54	1.70	4.24	Recycle	Rural			1.000	30
45+000	46+000	2.04	11.92	13.96	Recycle	Rural			1.000	30
46+000	47+000	4.61	18.40	23.01	New	Rural		1.000		35
47+000	48+000	8.10	21.46	29.56	New	Rural		1.000		35
48+000	49+000	8.95	11.59	20.54	New	Rural		1.000		35
49+000	50+000	12.59	21.12	33.71	New	Rural		1.000		35
50+000	51+000	6.81	23.57	30.38	New	Rural		1.000		35
51+000	52+000	2.59	30.22	32.81	New	Rural		1.000		35
52+000	53+000	5.01	56.70	61.71	New	Rural		1.000		35
53+000	54+000	4.10	30.79	34.89	New	Rural		1.000		35
54+000	55+000	5.33	28.72	34.05	New	Rural		1.000		35
55+000	56+000	5.61	53.79	59.40	New	Rural		1.000		35
56+000	57+000	6.19	55.51	61.70	New	Rural		1.000		35
57+000	58+000	2.63	51.69	54.32	New	Rural		1.000		35
58+000	59+000	2.57	62.56	65.13	New	Rural		1.000		35
59+000	60+000	2.51	51.97	54.48	New	Rural		1.000		35
60+000	61+000	3.60	42.90	46.50	New	Rural		1.000		35
61+000	62+000	4.23	60.79	65.02	New	Rural		1.000		35
62+000	63+000	1.14	85.97	87.11	New	Rural		1.000		35
63+000	64+000	0.40	82.79	83.19	New	Rural		1.000		35
64+000	65+000	0.49	68.84	69.33	New	Rural		1.000		35
65+000	66+000	2.03	51.20	53.23	New	Rural		1.000		35
66+000	67+000	3.42	32.58	36.00	New	Rural		1.000		35
67+000	68+000	4.17	66.91	71.08	New	Rural		1.000		35
68+000	69+000	2.38	90.72	93.10	New	Rural		1.000		35
69+000	70+000	0.87	21.15	22.02	New	Rural		1.000		35
70+000	71+000	0.05	8.50	8.55	Recycle	Rural			1.000	30
71+000	72+000	0.76	18.84	19.60	New	Rural		1.000		35
72+000	72+400	4.91	16.00	20.91	New	Rural		0.400		35
72+400	72+950	4.91	16.00	20.91	New	Village		0.550		7
72+950	73+000	4.91	16.00	20.91	New	Rural		0.050		35
73+000	74+000	20.37	14.49	34.86	New	Rural		1.000		35
74+000	75+000	17.97	45.96	63.93	New	Rural		1.000		35
75+000	75+800	4.42	7.94	12.36	New	Rural		0.800		35
					Total (km)		**0.200**	**36.625**	**10.175**	

(Table 2.2.18 continued)

Improvement section-2 Length= 11.000 km

Station		(Crack+Repair)ratio(%)			Method	Rural/ Village	Length (km)			Surface increment (cm)
		Crack	Repair	Total			Concrete	New	Recycle	
119+800	120+000		10.52	10.52	New	Rural		0.200		
120+000	121+000	0.21	48.70	48.91	New	Rural		1.000		40
121+000	122+000	1.19	14.72	15.91	New	Rural		1.000		40
122+000	123+000	12.01	1.55	13.55	New	Rural		1.000		40
123+000	124+000	5.66	57.03	62.69	New	Rural		1.000		40
124+000	125+000	4.67	74.03	78.70	New	Rural		1.000		40
125+000	126+000	0.06	48.06	48.13	New	Rural		1.000		40
126+000	127+000	3.16	35.30	38.46	New	Rural		1.000		40
127+000	128+000	3.48	41.57	45.05	New	Rural		1.000		40
128+000	129+000	1.12	22.32	23.43	New	Rural		1.000		40
129+000	130+000		28.80	28.80	New	Rural		1.000		40
130+000	130+800		25.44	25.44	New	Rural		0.800		40
Total (km)								**11.000**		

2.2.2.2 Pavement Component

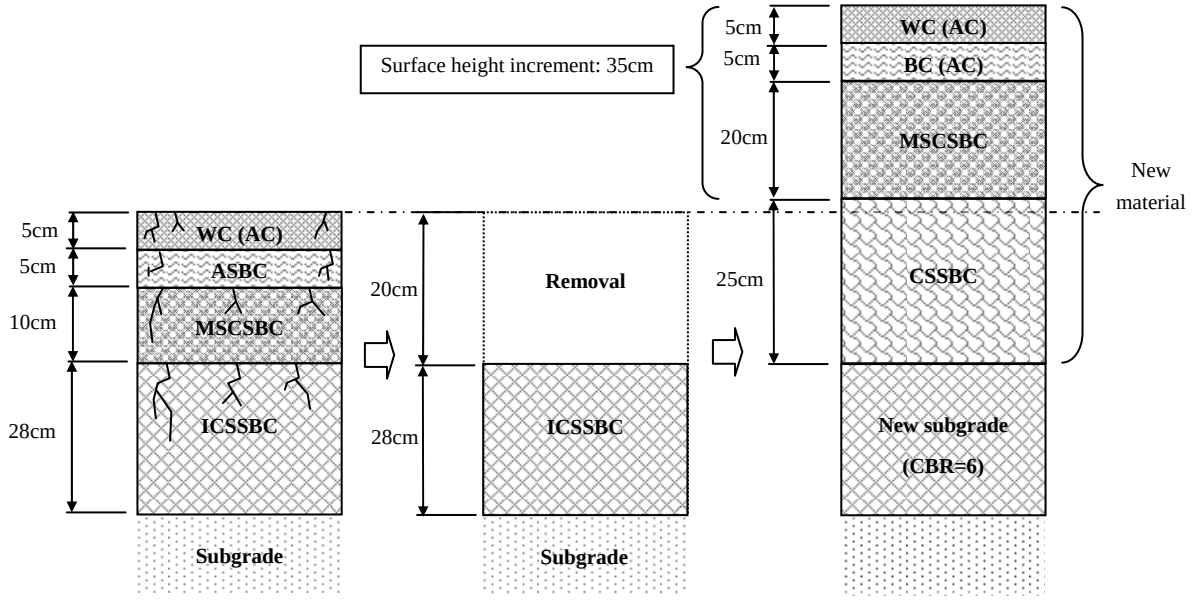
(1) Asphalt pavement

The result of pavement design based on the above discussion is shown in Table 2.2.19 and dimensions of pavement components by section are shown in Figures 2.2.6 to 2.2.10.

Table 2.2.19 Designed Pavement Component

(Unit : cm)

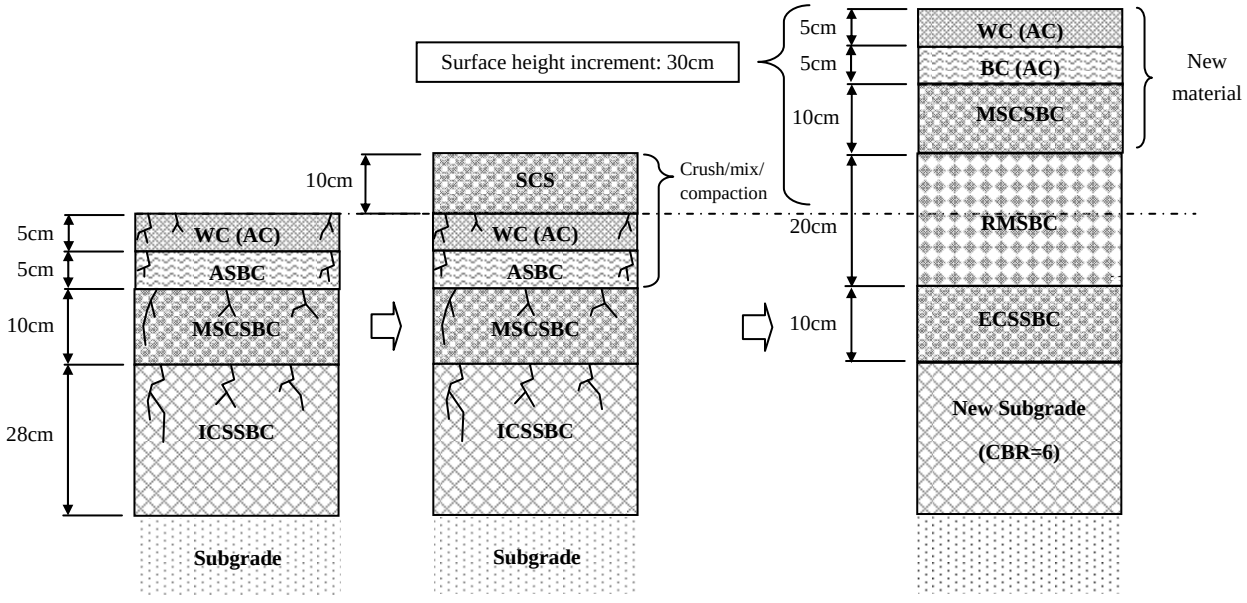
Improvement Section		1			2	
Layer	Material	Rural		Urban	Rural	Urban
		New	Recycle	New	New	New
Wearing	Dense graded asphalt	5	5	5	5	5
Binding	Coarse graded asphalt	5	5	5	5	5
Base	Mechanically stabilized crushed stone	20	10	20	25	20
Sub base-1	Recycled material	-	20	-	-	-
Sub base-2	Crushed stone	25	10	25	25	25
	Total (cm)	55	50	55	60	55
	Surface height increment (cm)	+35	+30	+7	+40	+7



Abbreviations

AC: Asphalt Concrete, ASBC: Asphalt Stabilised Base Course, BC: Binder Course,
CSSBC: Crushed Stone Sub Base Course, ICSSBC: In-situ Cement Stabilized Sub Base Course,
MSCSBC: Mechanical Stabilized Crushed Stone Base Course, WC: Wearing Course

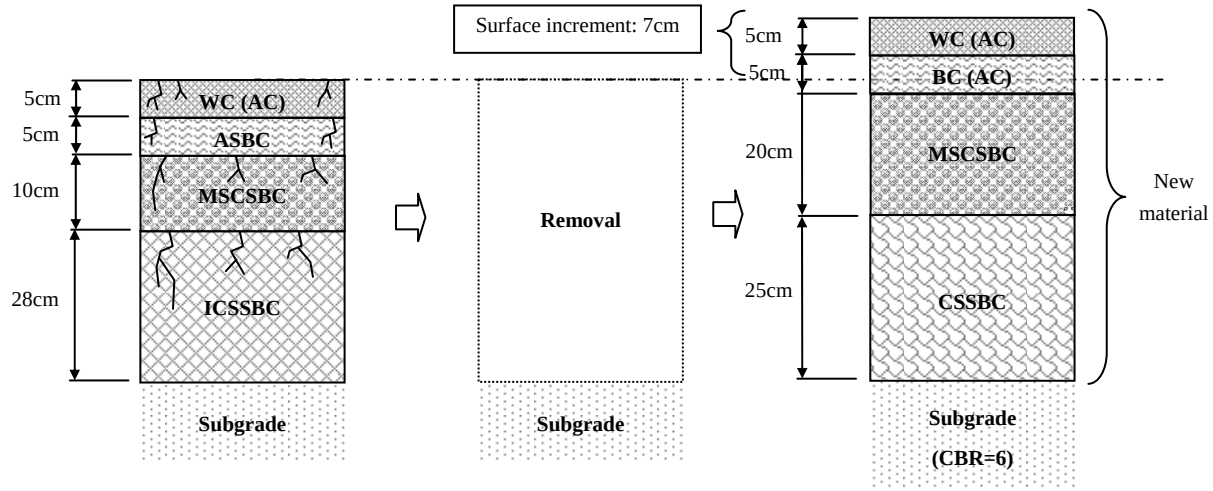
Figure 2.2.6 Full Reconstruction Work in Rural Section in Section-1 (Crack Ratio + Repair Ratio > 15%, New material)



Abbreviations

AC: Asphalt Concrete, ASBC: Asphalt Stabilised Base Course, BC: Binder Course,
ECSSBC: Existing Crushed Stone Sub Base Course, ICSSBC: In-situ Cement Stabilized Sub Base Course,
MSCSBC: Mechanical Stabilized Crushed Stone Base Course, RMSBC: Recycled Material Sub Base Course,
SCS: Supplemental Crushed Stone, WC: Wearing Course, WC: Wearing Course

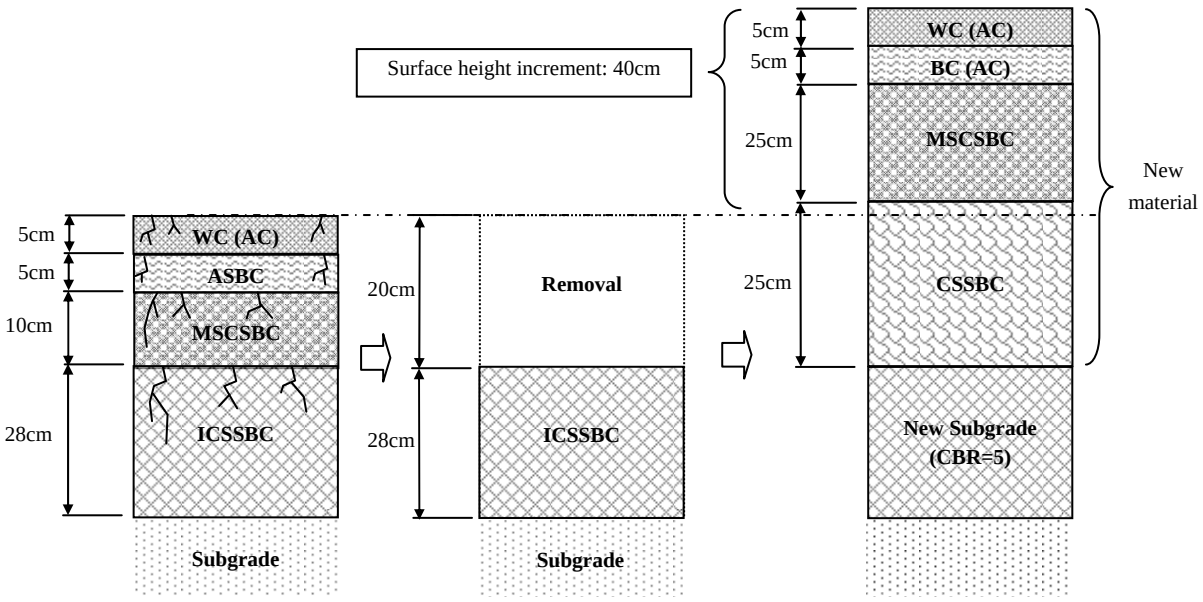
Figure 2.2.7 Full Reconstruction Work in Rural Section in Section-1 (Crack Ratio + Repair Ratio < 15%, Recycled material)



Abbreviations

AC: Asphalt Concrete, ASBC: Asphalt Stabilised Base Course, BC: Binder Course,
CSSBC: Crushed Stone Sub Base Course, ICSSBC: In-situ Cement Stabilized Sub Base Course,
MSCSBC: Mechanical Stabilized Crushed Stone Base Course, WC: Wearing Course

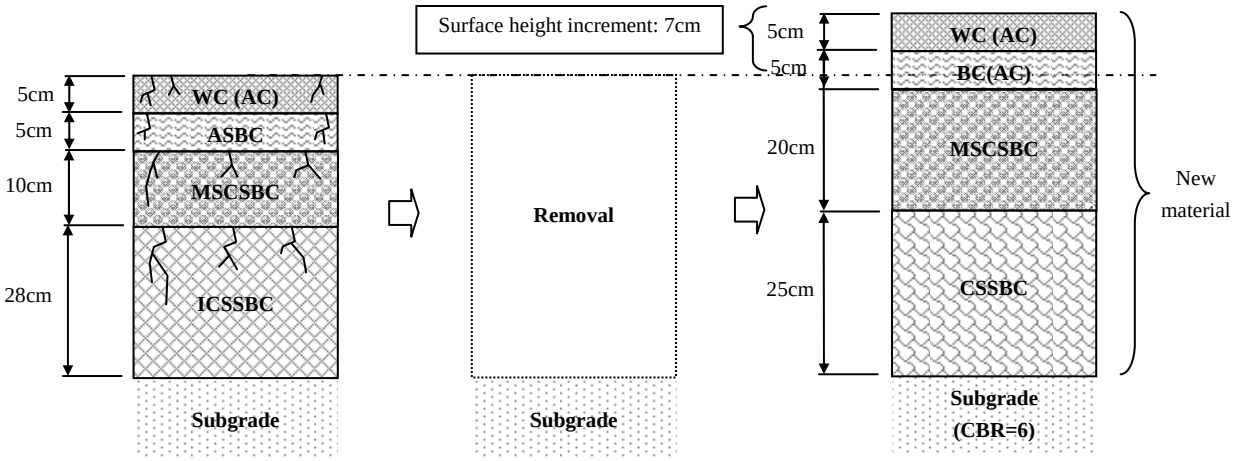
Figure 2.2.8 Full Reconstruction Work in Urban Section in Section-1 (New material)



Abbreviations

AC: Asphalt Concrete, ASBC: Asphalt Stabilised Base Course, BC: Binder Course,
CSSBC: Crushed Stone Sub Base Course, ICSSBC: In-situ Cement Stabilized Sub Base Course,
MSCSBC: Mechanical Stabilized Crushed Stone Base Course, WC: Wearing Course

Figure 2.2.9 Full Reconstruction Work in Rural Section in Section-2 (Crack Ratio + Repair Ratio > 15%, New material)



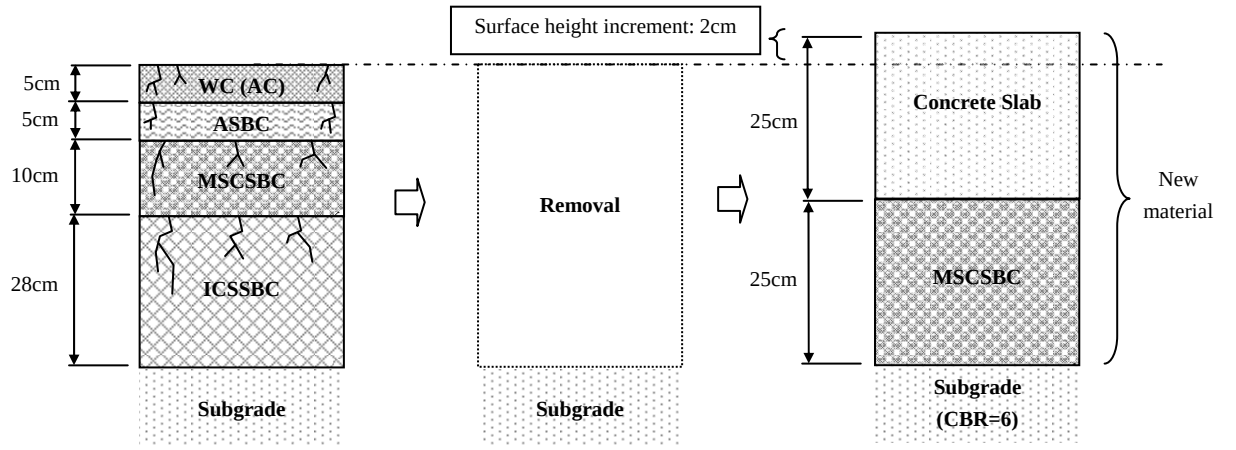
Abbreviations
AC: Asphalt Concrete, ASBC: Asphalt Stabilised Base Course, BC: Binder Course,
CSSBC: Crushed Stone Sub Base Course, ICSSBC: In-situ Cement Stabilized Sub Base Course,
MSCSBC: Mechanical Stabilized Crushed Stone Base Course, WC: Wearing Course

Figure 2.2.10 Full Reconstruction Work in Urban Section in Section-2 (New material)

(2) Concrete Pavement

Pavement components based on given conditions (i.e. B-traffic, CBR=6) are shown below according to the Cement Concrete Pavement Design Manual (1984). The dimensions are also shown in Figure 2.2.11.

Layer	Material	Thickness (cm)
Concrete slab	Reinforced, Flexural strength = 4.5N/mm2	25
Base course	Mechanical stabilized crushed stone (CBR>80)	25
	Total (cm)	50



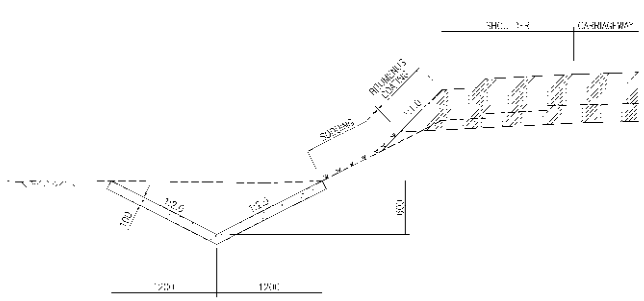
Abbreviations
AC: Asphalt Concrete, ASBC: Asphalt Stabilised Base Course, BC: Binder Course,
CSSBC: Crushed Stone Sub Base Course, ICSSBC: In-situ Cement Stabilized Sub Base Course,
MSCSBC: Mechanical Stabilized Crushed Stone Base Course, WC: Wearing Course

Figure 2.2.11 Concrete Pavement Work (Approach Road for Weigh Station)

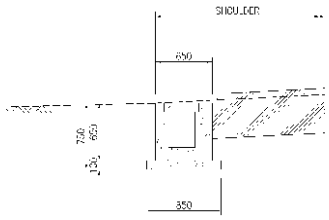
2.2.2.3 Drainage Facilities

(1) Road Side Ditches

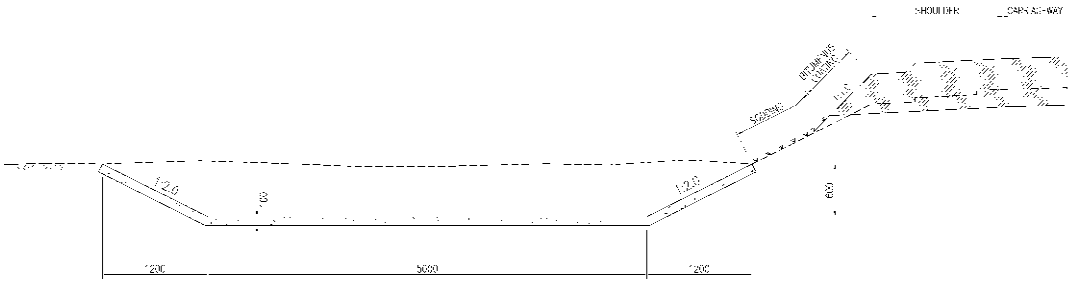
A V-shaped side ditch, which is called the standard type-1 in the Road Design Manual (Lao PDR, 1996) will be installed in the Project section excluding the north side of the embankment section in Palanxai as a result of the design. A waterway with a slab (W=5m) will be installed in the north side of the embankment section in Palanxai. Further, a U-shaped side ditch with cover and pipe culvert (vertical direction) will be installed in the village section to allow vehicles to pass over it. Those dimensions are shown in Figure 2.2.12. Further, list of side ditches is shown in Table 2.2.20.



V-shaped side ditch



U-shaped side ditch



Waterway in north side of embankment section in Palanxai

Figure 2.2.12 Typical Cross Section of Side Ditch

Table 2.2.20 List of Road Side Ditches

STA	Length (m)	Type	STA	Length (m)	Type
28+800 – 36+725	7,925	Concrete V-shaped	119+800 – 123+375	3,575	Concrete V-shaped
37+525 – 37+800	275	Concrete V-shaped	123+400 – 124+900	1,500	Concrete V-shaped
37+800 – 38+275	475	Concrete U-shaped with cover	124+925 – 125+225	300	Concrete V-shaped
39+100 – 40+900	1,800	Concrete V-shaped	125+300 – 129+675	4,375	Concrete V-shaped
41+250 – 43+125	1,875	Concrete V-shaped	129+750 – 130+575	825	Concrete V-shaped
43+400 – 61+075	17,675	Concrete V-shaped			
61+175 – 72+300	11,125	Concrete V-shaped			
73+800 – 74+565	765	Concrete waterway			
74+565 – 75+525	960	Concrete V-shaped			

(2) Crossing Drainage

Pipe culverts (D=1,000mm) will be additionally installed if the design result requires it. List of pipe culverts is shown in Table 2.2.21.

Table 2.2.21 List of Pipe Culverts

STA	Diameter & length	STA	Diameter & length
30+384	φ800mm、L=20m	49+000	φ1,000mm、L=20m
32+725	φ800mm、L=20m	55+187	φ800mm、L=20m
33+575	φ800mm、L=20m	64+150	φ800mm、L=20m
34+960	φ800mm、L=20m	64+350	φ800mm、L=20m
42+425	φ800mm、L=20m	72+300	φ800mm、L=20m
48-100	φ600mm、L=20m		

2.2.2.4 Road Facilities

(1) Lighting Facilities

Lighting facilities will be installed to prevent traffic accidents during the night time in densely populated areas namely Atsapahangthong and Phalanxai. Both areas are located in Improvement section-1. The components are summarized as follows.

- Type of lamp: High pressure sodium vapor lamp
- Average luminance: 0.5cd per sq.m
- Installation interval: every 25m on both sides
- Total quantities: 204 poles
- Installation: See the table below

Table 2.2.22 The Sections for Lighting Installation

Area	Section	Length
Atsapahangthong	Sta.37+300 – Sta.38+400	1,100m
	Sta.39+050 – Sta.39+825	775m
Phalanxai	Sta.72+400 – Sta.72+950	550m
	TOTAL	2,425m

(2) Traffic Safety Facilities

Currently, guide posts are installed at short radius curves (radii shorter than 1,000 meters), and also at bridge approaches and high embankment sections. This Project should follow the concept of the guide post installation in the previous project and current operations.

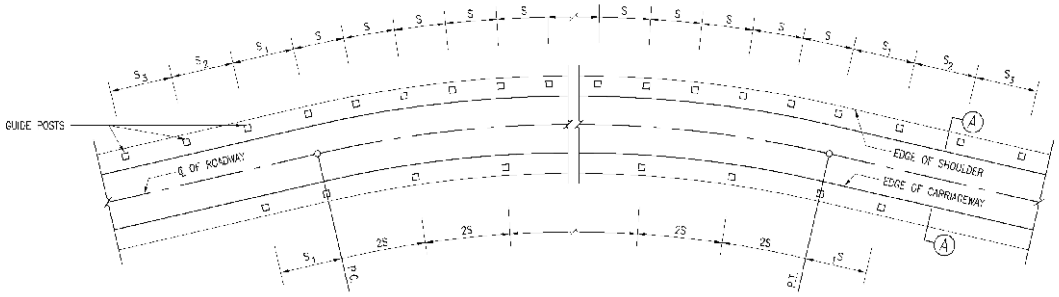
However, considering greater safety for vehicles and motorcycle traffic, guardrails should be installed instead of guide posts only at the sections where embankment height is 4 meters or more higher than the surrounding area.

Guide Posts

Guide posts should be installed at the following sections:

- Short radius curves
- Bridge approaches
- The locations where drainage installations cross the road

The layout and the spacing of the guide posts should be based on the figures and tables below. Although there are no defined standards for installation of guide posts in Laos, the standards of Thailand are often used in other projects in Laos. The project also applies Thailand standards as a basic rule as well as the principle of Japanese standards for installation of guardrails for safety reasons.



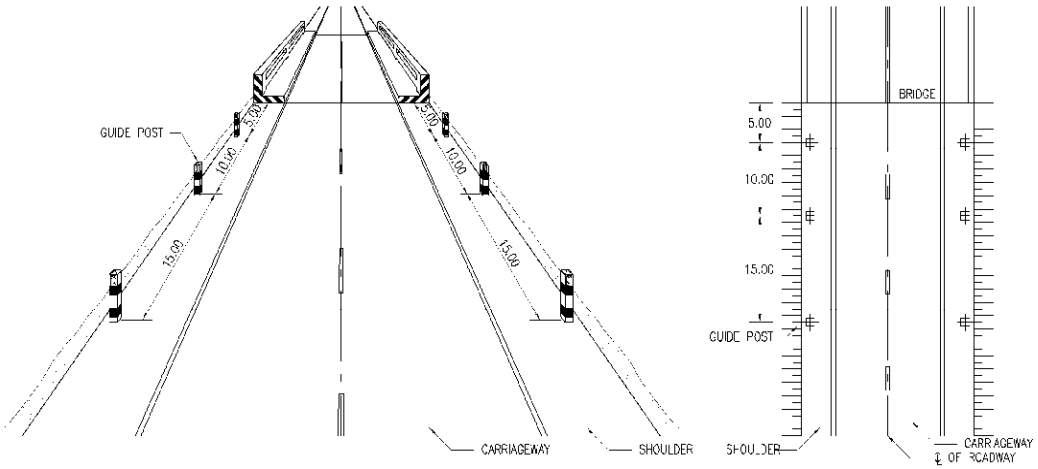
Source: Based on the standard drawing in Thailand, the survey team set the layout of guide posts.

Figure 2.2.13 Guide Post Installation in Curve Sections

Table 2.2.23 Spacing of Guide Posts

Radius of Curve (m)	Spacing of Guide Post (m)			
	S	S1	S2	S3
15-74	4	7	12	24
75-99	6	11	18	36
100-149	7	13	21	42
150-199	8	14	24	48
200-299	9	16	27	54
300-499	10	18	30	60
500-999	15	27	45	60
1000-1500	21	38	60	60

Source: Standard drawing in Thailand



Source: Standard drawing in Thailand

Figure 2.2.14 Guide Post Installation at Bridge Approach

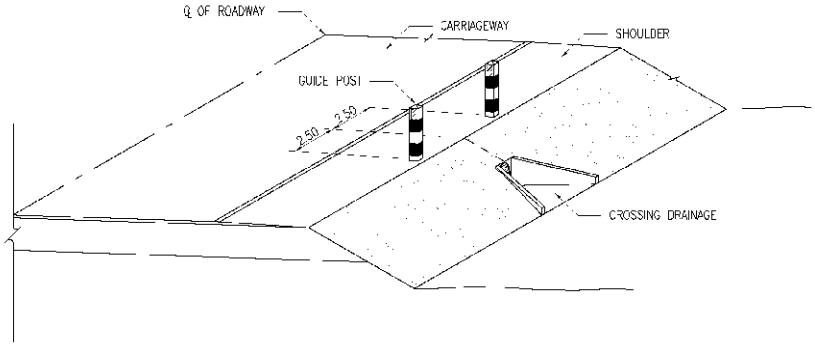


Figure 2.2.15 Guide Post Installation at Drainage Crossing

Guardrails

Guardrails should be installed at following sections

- Embankment height is 4 meters higher than surrounding area
- The locations where drainage crossings are installed and the embankment height is 2 meters or more higher than surrounding area

Table 2.2.24 shows the list of guardrail installations.

Table 2.2.24 List of Guardrail Installations

Improvement Section-1

Station		Left	Right
BP	EP	(m)	(m)
36+912	36+932	20	20
36+974	36+994	20	20
38+348	38+763	415	
38+298	38+763		465
38+891	39+036	145	145
39+850	40+075	225	
39+850	40+325		475
40+925	41+200	275	275
45+125	45+195	70	70
72+955	73+040	85	
72+990	73+040		50
73+140	73+235	95	
73+140	73+240		100
73+400	73+787	387	387
73+805	74+100	295	
73+805	74+200		395
74+560	74+580	20	20
Total		**2,052**	**2,422**
Total in Section-1			**4,474**

Improvement Section-2

Station		Left	Right
BP	EP	(m)	(m)
120+350	120+400	50	50
121+920	122+020	100	
122+000	122+020		20
123+332	123+382	50	
123+282	123+382		100
123+400	123+480	80	80
124+875	124+895	20	20
124+925	124+945	20	20
125+199	125+234	35	35
125+282	125+357	75	75
125+780	125+800	20	20
126+940	126+960	20	20
127+380	127+400	20	20
128+700	128+875	175	
128+700	128+800		100
129+302	129+517		215
129+675	129+715		40
129+680	129+700	20	
129+925	130+025	100	100
130+125	130+350		225
130+225	130+350	125	
Total		**910**	**1,140**
Total in Section-2			**2,050**

Total in Project (m)	**6,524**

2.2.2.5 Design for Repair Work in the Maintenance & Repair Section

Currently, repair work on damaged pavement has been undertaken by local contractors based on the contracts with DPWT in the road. The work contents are as follows.

- Replace existing pavement (Wearing course to sub base course)
- Refill/Compact soil and gravel material
- Seal surface with DBST

The damage suffered due to the pavement deterioration affected entire layers, not only the wearing course but also down to the sub base course in the road as stated in the above discussion. Therefore, it can be said that the above method is conceptually appropriate. However, applying inferior materials such as gravel and DBST instead of crushed stone and asphalt mixture for repair is obviously inappropriate. New damage occurred on the repaired part and the projected growth of heavy vehicle traffic in the future also indicates its inappropriateness. It is said that partial reconstruction of pavement structure by applying hot mix asphalt mixture is required in the road. The details are described below.

(1) Construction Area and Design Thickness

Construction area will be a rectangle parallel with the centreline of the road. Minimum width of the area required is 2.5m considering workability of the equipment. Area of each layer is as follows.

- Sub base course: 0.5m beyond edge of damage
- Base course, Binding course, Wearing course: 0.3m beyond the construction area of the sub base course [*1]

In addition, finished surface height shall be designed 0.5 to 1.0cm higher than the existing surface because the repaired surface is liable to subside after it is opened to the public. A model of the construction area is shown in Figure 2.2.13.

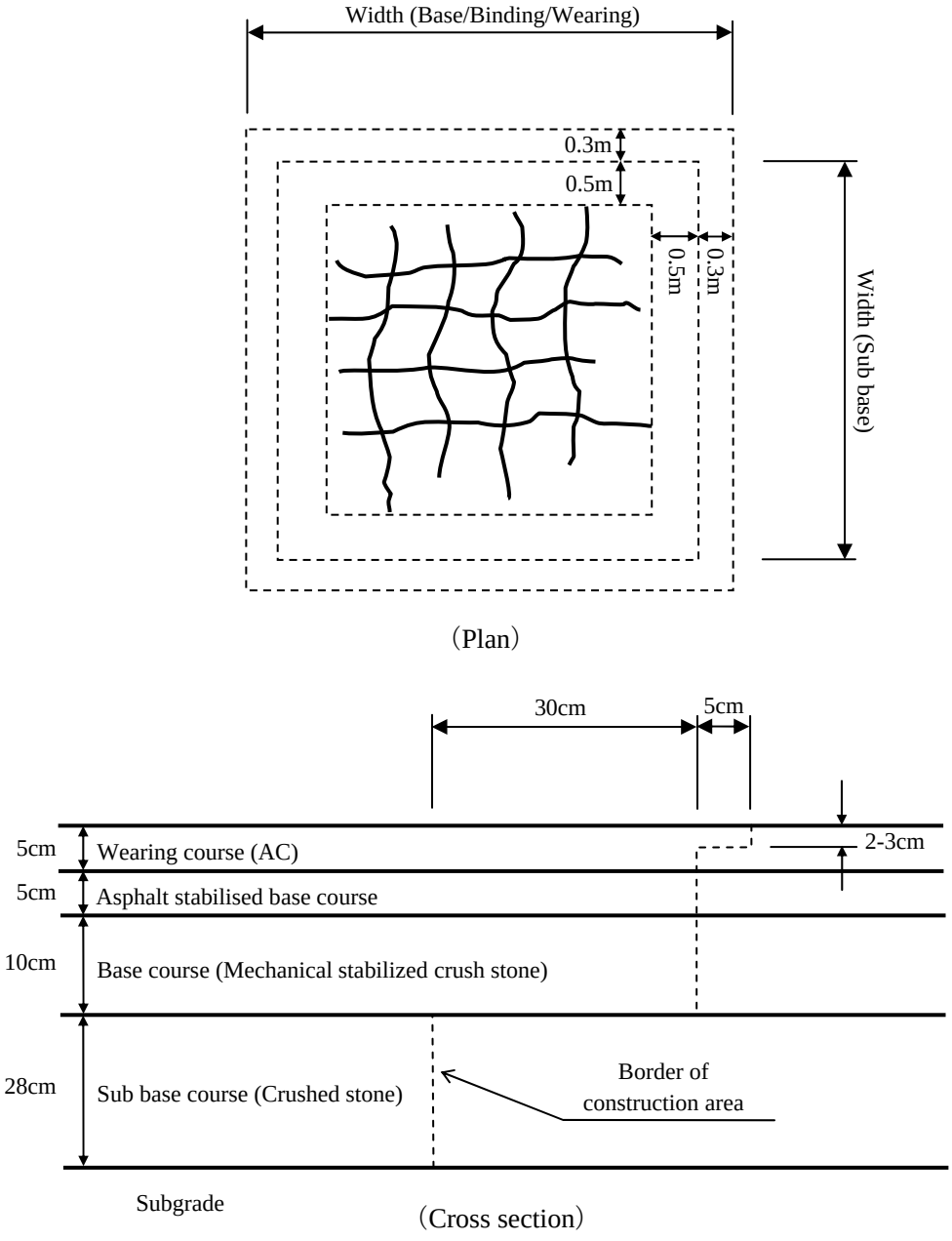


Figure 2.2.16 Model of Partial Reconstruction of Pavement Structure

[*1] Margin width is decided according to characteristics of applying material for the sub base as follows.
Loose material: Thickness of sub base × 1.7
Dense material: Thickness of sub base × 1.0
Crushed stone will be applied for the Project. Therefore, 28cm × 1.0 = 28cm ≒ 30cm

(2) Construction Method

Repair work of limited damage parts will be executed according to the following process.

- Cut and shape existing asphalt layer(s) vertically with a concrete cutter. Note cut area shall be rectangular.
- Demolish existing asphalt layer(s) with a rock drill and excavate down to the surface of the subgrade using a backhoe.
- Trim surface of subgrade, and compact with a road roller and compactor.
- Spread base/sub base course material, and compact with a road roller and compactor appropriately. Note: conscientious compaction shall be required at corners and edges of the area because these parts are difficult to compact properly and tend to result in areas of low density and/or loose material.
- Spray prime coat on the surface of the base/sub base course after removing dust and mud from cut section of asphalt layer.
- Spread binder course material on the surface of the base/sub base course, and compact with a road roller and compacter.
- Spray asphalt emulsion as tack coat all over the surface of the binder course, while painting on cut section of asphalt layer(s) appropriately with a brush.
- Spread and level wearing course material on the surface of the binder course with an asphalt finisher and manpower. Note finished surface height shall be designed 0.5 to 1.0cm higher than the existing surface because the repaired surface is liable to subside after it is opened to the public.
- Compact appropriately with a road roller, pneumatic roller and vibrating roller.
- Open to the public after the surface becomes cool to the touch.

(3) Quantity Volume of Maintenance Parts

Quantity volume of maintenance parts is shown in Table 2.2.25.

Table 2.2.25 Quantity Volume of Maintenance Parts

Section	Km	(Crack+Repair)Rate (%) Crack	Repair	Total	Rut (mm)
	0-1	0.1	0.3	0.4	3
I Phase	1-2	0.0	0.0	0.0	19
	2-3	0.0	1.2	1.2	8
	3-4	0.1	2.5	2.6	8
	4-5	0.0	0.0	0.0	8
	5-6	0.0	0.0	0.0	8
	6-7	0.0	0.0	0.0	8.5
	7-8	0.1	0.0	0.1	62
	8-9	0.5	1.2	1.6	8
	9-10	0.1	1.3	1.4	4
	10-11	0.5	4.6	5.1	14
	11-12	2.8	2.0	4.8	8
	12-13	1.3	3.1	4.4	20
	13-14	1.7	4.6	6.3	13
	14-15	0.0	0.0	0.0	8
	15-16	0.4	1.9	2.3	20
	16-17	2.1	13.1	15.2	14
	17-18	1.1	13.2	14.3	13
	18-19	0.5	4.8	5.3	18
	19-20	1.0	8.6	9.7	15
	20-21	0.7	2.4	3.2	7
	21-22	0.0	0.0	0.0	7
	22-23	0.0	0.0	0.0	6
	23-24	0.0	1.0	1.0	6
	24-25	0.5	6.0	6.4	6
	25-26	0.2	2.1	2.2	8
	26-27	0.7	0.8	1.5	12
	27-28	1.0	1.9	3.0	10
	28-29	0.7	2.2	2.9	7
	76-77	2.2	0.0	2.2	4
II Phase	77-78	0.0	0.0	0.0	6
	78-79	2.2	0.0	2.2	8
	79-80	5.6	2.0	7.6	14
	80-81	9.3	10.2	19.5	12
	81-82	1.7	2.5	4.1	14
	82-83	0.9	7.7	8.6	25
	83-84	1.9	11.1	13.1	8
	84-85	3.4	22.2	25.5	10
	85-86	8.4	0.0	8.4	7
	86-87	11.0	0.3	11.4	9
	87-88	2.3	0.0	2.3	7
	88-89	0.6	0.0	0.6	8
	89-90	0.0	0.0	0.0	6
	90-91	5.2	0.0	5.2	10
	91-92	14.6	0.0	14.6	6
	92-93	31.0	0.0	31.0	8
	93-94	3.7	1.5	5.3	5
	94-95	0.1	0.0	0.1	6
	95-96	0.1	0.0	0.1	3
	96-97	0.1	0.0	0.1	12
	97-98	0.1	0.0	0.1	7
	98-99	0.0	0.0	0.0	5
	99-100	0.0	0.2	0.2	9
	100-101	0.1	2.1	2.2	8
	101-102	0.1	3.5	3.6	9
	102-103	2.9	1.5	4.4	12
	103-104	3.7	14.6	18.3	14
	104-105	6.9	55.5	62.4	8
	105-106	2.6	3.5	6.2	8
	106-107	5.9	4.1	10.0	7
	107-108	10.7	15.1	25.8	9
	108-109	3.3	12.6	15.9	15
	109-110	0.6	3.6	4.2	3
	110-111	0.6	10.4	11.0	3
	111-112	1.3	4.4	5.8	21
	112-113	1.6	0.8	2.4	7
	113-114	0.8	10.8	11.5	21
	114-115	4.4	15.9	20.2	7
	115-116	0.0	2.4	2.4	6
	116-117	0.0	0.5	0.5	4
	117-118	0.0	2.0	2.0	18
	118-119	0.2	5.8	6.0	9
	119-120	0.0	10.5	10.5	10
	131-132	0.0	2.2	2.2	8
	132-133	0.3	34.3	34.5	15
	133-134	0.0	21.2	21.2	15
	134-135	0.3	35.1	35.3	8
	135-136	0.0	0.2	0.2	2
	136-137	0.0	0.9	0.9	5
	137-138	0.7	1.4	2.1	4
	138-139	5.9	16.5	22.4	4
	139-140	1.0	46.3	47.2	5
	140-141	1.8	17.8	19.6	10
	141-142	0.2	0.0	0.2	12
	142-143	1.4	59.2	60.6	10
ADB	143-144	0.7	32.5	33.2	8
Phase	144-145	0.0	49.2	49.2	8
	145-146	2.2	33.3	35.4	6
	146-147	3.4	4.8	8.2	10
	147-148	10.7	16.8	27.5	16
	148-149	11.1	8.1	19.2	7
	149-150	26.8	38.8	65.6	10
	150-151	4.5	41.8	46.3	25
	151-152	0.3	9.4	9.7	16
	152-153	25.7	44.8	70.5	16
	153-154	6.8	4.3	11.2	22
	154-155	1.0	0.3	1.3	4
	155-156	0.0	0.3	0.3	4
	156-157	0.0	10.7	10.7	8
	157-158	0.1	9.5	9.6	4
	158-159	2.3	9.3	11.7	14
	159-160	3.8	11.9	15.7	6
	160-161	0.4	4.4	4.8	7

2.2.3 Outline Design Drawings

The following drawings are attached in the appendix.

No.	Drawing Title	No.	Drawing Title
A-01	Project Location Map	C-144	Plan & Profile STA..58+400 - 59+100
A-02	Guide Map	C-145	Plan & Profile STA..59+100 - 59+800
A-03	Typical Cross Section	C-146	Plan & Profile STA..59+800 - 60+500
A-04	Pavement Details	C-147	Plan & Profile STA..60+500 - 61+200
		C-148	Plan & Profile STA..61+200 - 61+900
C-101	Plan & Profile STA..28+300 - 29+000	C-149	Plan & Profile STA..61+900 - 62+600
C-102	Plan & Profile STA..29+000 - 29+700	C-150	Plan & Profile STA..62+600 - 63+300
C-103	Plan & Profile STA..29+700 - 30+400	C-151	Plan & Profile STA..63+300 - 64+000
C-104	Plan & Profile STA..30+400 - 31+100	C-152	Plan & Profile STA..64+000 - 64+700
C-105	Plan & Profile STA..31+100 - 31+800	C-153	Plan & Profile STA..64+700 - 65+400
C-106	Plan & Profile STA..31+800 - 32+500	C-154	Plan & Profile STA..65+400 - 66+100
C-107	Plan & Profile STA..32+500 - 33+200	C-155	Plan & Profile STA..66+100 - 66+800
C-108	Plan & Profile STA..33+200 - 33+900	C-156	Plan & Profile STA..66+800 - 67+500
C-109	Plan & Profile STA..33+900 - 34+600	C-157	Plan & Profile STA..67+500 - 68+200
C-110	Plan & Profile STA..34+600 - 35+300	C-158	Plan & Profile STA..68+200 - 68+900
C-111	Plan & Profile STA..35+300 - 36+000	C-159	Plan & Profile STA..68+900 - 69+600
C-112	Plan & Profile STA..36+000 - 36+700	C-160	Plan & Profile STA..69+600 - 70+300
C-113	Plan & Profile STA..36+700 - 37+400	C-161	Plan & Profile STA..70+300 - 71+000
C-114	Plan & Profile STA..37+400 - 38+100	C-162	Plan & Profile STA..71+000 - 71+700
C-115	Plan & Profile STA..38+100 - 38+800	C-163	Plan & Profile STA..71+700 - 72+400
C-116	Plan & Profile STA..38+800 - 39+500	C-164	Plan & Profile STA..72+400 - 73+100
C-117	Plan & Profile STA..39+500 - 40+200	C-165	Plan & Profile STA..73+100 - 73+800
C-118	Plan & Profile STA..40+200 - 40+900	C-166	Plan & Profile STA..73+800 - 74+500
C-119	Plan & Profile STA..40+900 - 41+600	C-167	Plan & Profile STA..74+500 - 75+200
C-120	Plan & Profile STA..41+600 - 42+300	C-168	Plan & Profile STA..75+200 - 75+900
C-121	Plan & Profile STA..42+300 - 43+000	C-201	Plan & Profile STA..119+300 - 120+000
C-122	Plan & Profile STA..43+000 - 43+700	C-202	Plan & Profile STA..120+000 - 120+700
C-123	Plan & Profile STA..43+700 - 44+400	C-203	Plan & Profile STA..120+700 - 121+400
C-124	Plan & Profile STA..44+400 - 45+100	C-204	Plan & Profile STA..121+400 - 122+100
C-125	Plan & Profile STA..45+100 - 45+800	C-205	Plan & Profile STA..122+100 - 122+800
C-126	Plan & Profile STA..45+800 - 46+500	C-206	Plan & Profile STA..122+800 - 123+500
C-127	Plan & Profile STA..46+500 - 47+200	C-207	Plan & Profile STA..123+500 - 124+200
C-128	Plan & Profile STA..47+200 - 47+900	C-208	Plan & Profile STA..124+200 - 124+900
C-129	Plan & Profile STA..47+900 - 48+600	C-209	Plan & Profile STA..124+900 - 125+600
C-130	Plan & Profile STA..48+600 - 49+300	C-210	Plan & Profile STA..125+600 - 126+300
C-131	Plan & Profile STA..49+300 - 50+000	C-211	Plan & Profile STA..126+300 - 127+000
C-132	Plan & Profile STA..50+000 - 50+700	C-212	Plan & Profile STA..127+000 - 127+700
C-133	Plan & Profile STA..50+700 - 51+400	C-213	Plan & Profile STA..127+700 - 128+400
C-134	Plan & Profile STA..51+400 - 52+100	C-214	Plan & Profile STA..128+400 - 129+100
C-135	Plan & Profile STA..52+100 - 52+800	C-215	Plan & Profile STA..129+100 - 129+800
C-136	Plan & Profile STA..52+800 - 53+500	C-216	Plan & Profile STA..129+800 - 130+500
C-137	Plan & Profile STA..53+500 - 54+200	C-217	Plan & Profile STA..130+500 - 131+000
C-138	Plan & Profile STA..54+200 - 54+900		
C-139	Plan & Profile STA..54+900 - 55+600	D-01	Details of Drainage Ditch
C-140	Plan & Profile STA..55+600 - 56+300	D-02	Details of Box Culvert
C-141	Plan & Profile STA..56+300 - 57+000		
C-142	Plan & Profile STA..57+000 - 57+700		
C-143	Plan & Profile STA..57+700 - 58+400		

2.2.4 Implementation Plan

2.2.4.1 Implementation Policy

(1) Direct Works

1) Repaving Work

The major work of this project is the repaving work as a premise for improvement of the existing pavement. The work execution flow of repaving works is shown in Figure 2.2.17.

The earth works and pavement works are to be implemented during the six months of dry season (November to April). Other structural and stone crushing works will be implemented both in dry and wet seasons.

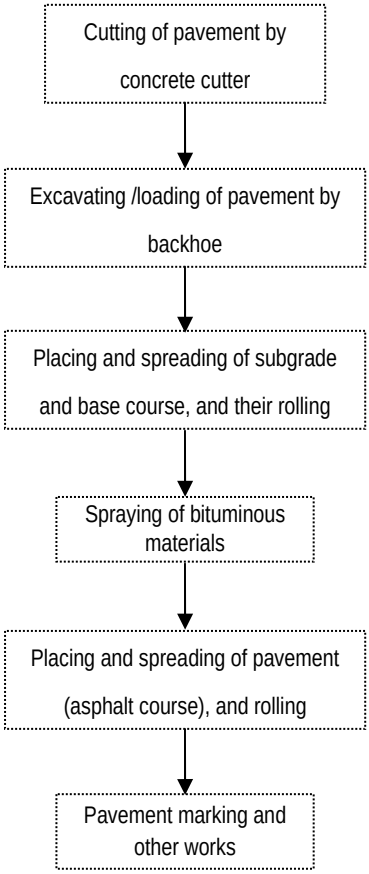


Figure 2.2.17 Flow of road repaving works

2) In-place Base Course Recycling Method

The in-place base course recycling method will be applied for the applicable sections so as to recycle existing wearing course (AC) and base course materials (base course; crushed stones). For the section repaired by the Lao side, the mixed material (crushed stone and sand mixture) has been used for the base course material below DBST. When implementing in-place recycling of the section repaired or patched by DBST by the Lao counterpart, recycling work tests should be made to determine the necessary amount of cement to ensure the strength of the base course material. The work flow is shown below.

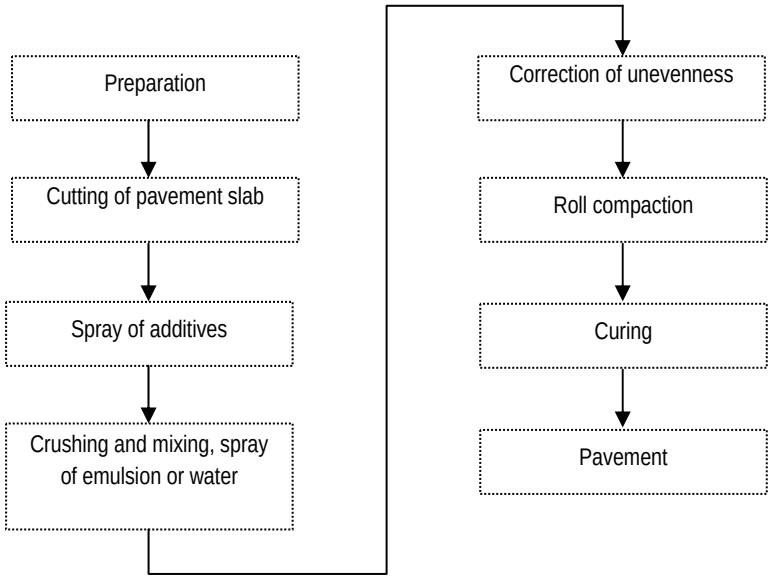


Figure 2.2.18 Flow of the in-place base course recycling method

In this project, the number of parties in charge of full reconstruction works and those in charge of in-place base course recycling method will be planned respectively to establish the work section and arrangement ensuring implementation of efficient road work.

3) Work procedure, and traffic regulation during the work period

Basically, the road works will be executed on one side of the road, and a temporary by-pass road will be provided as much as possible in the town areas. If such temporary by-pass road cannot be provided, the flagman will be arranged to secure traffic safety during execution of the work. (See Table 2.2.26)

(a) Work execution procedure

The works will be executed as follows by taking into account the safety the work being done on one side of the road while opening the space for traffic, efficiency of the machinery used, and its workload.

Basic conditions

The work section of one party will be divided into eight blocks. The length of each block will be set to 250 m considering the standard daily workload of base course and pavement works. (Correction of unevenness: 1580m^2/day, base course work: 1150m^2/day/course, wearing course (AC):2300m^2/day (when the wheel type is used)

Rationale

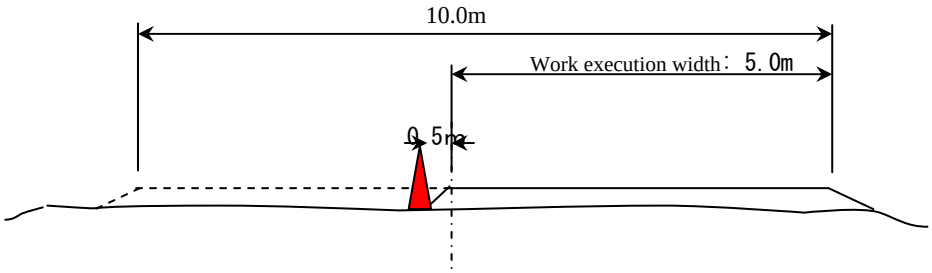
- Base course work: 5m×250m=1250m^2>1150m^2 (1250/1150=1.08)
- Pavement work: 3.5m×250m =875m2x2= 1750m^3 < 2300m^2 (1750/2300=0.76)
  (1.08+0.76) /2 =0.92≈1.00
- The maximum length over which traffic control can cover is considered to be the length of one-side work, that is, 1km.

- Considering the amount of works execution as a whole, pavement structure, and the efficiency of machinery used, the work unit for each subgrade correction, subbase course, and base course in each work section, the wearing course work will be executed by the party/machine arrangement while using one to two units.
- Work execution procedure：See Table 2.2.27
- Work execution section of one-side work
- To ensure sufficient rolling compaction of the end portions, the work execution section of BLK1-4 and BLK5-8 will be as follows.

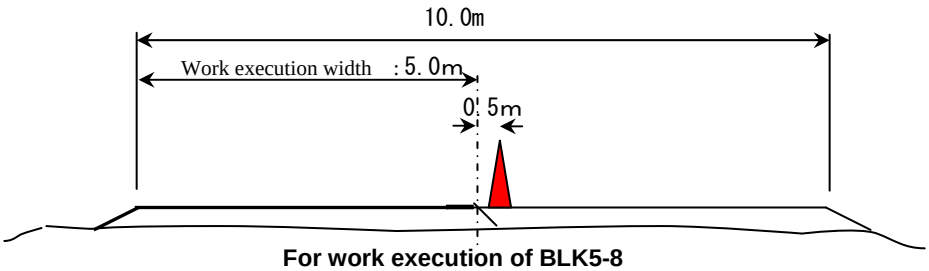
(b) Machine arrangement

Table 2.2.26 Layout plan of principal machines

Type of work	Machine set to be used	
	Name of machine	Specifications
1. Road replacement (1) Removal of pavement slabs, excavation (2) Correction of subgrade	Backhoe Bulldozer (Motor grader)	0.45m^3 (0.35m^3 when piled flat) Normal 3t class 3.1m
(3) Subbase course	Road roller	Tandem 10ton
(4) Base course	Tyre roller Dump truck	8-20ton
(5) Wearing course AC)	Dump truck Asphalt finisher Road roller Tyre roller Dump truck	 Wheel type 2.4-4.5m Tandem 10t 8-20t 10t
2. In-place base course recycling	Stabilizer Motor grader Road roller Tyre roller Vibrating roller Tyre roller	For base course recycling; recycling width 2.0m Blade width 3.1m Macadam 10 - 12t 8 - 20t 6 - 7.5t 8 - 20t



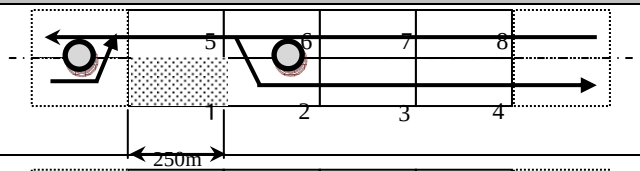
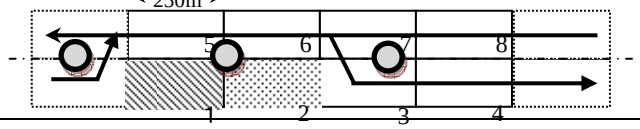
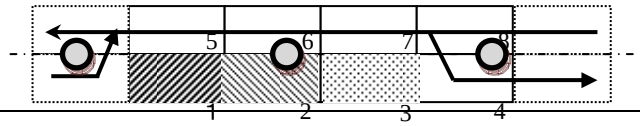
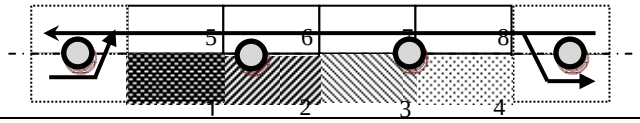
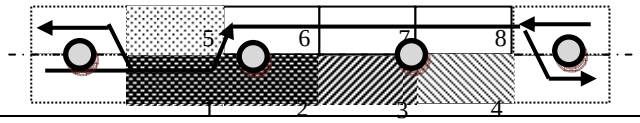
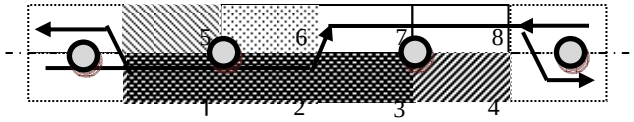
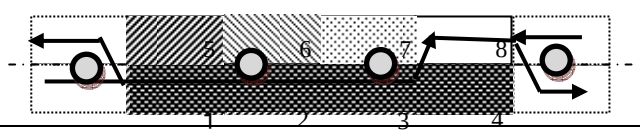
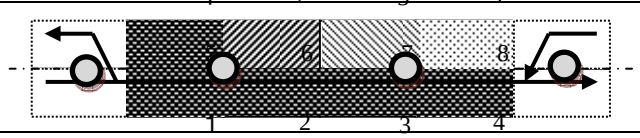
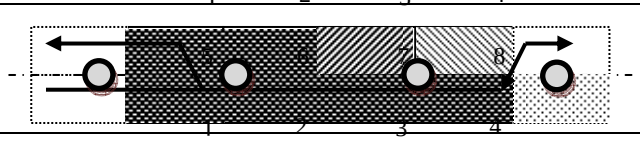
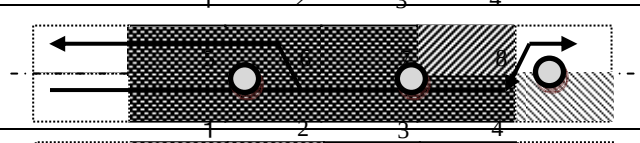
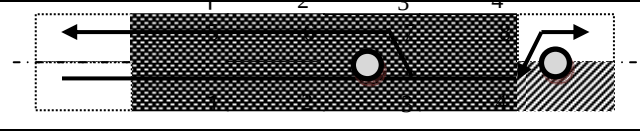
For work execution of BLK1-4



For work execution of BLK5-8

Figure 2.2.19 One-side work execution (conceptual view)

Table 2.2.27 Work execution steps of each section

Step	Description		Conceptual view
Step 1 (the 1st day)	・BLK1	Subbase course (1st)	
Step 2 (the 2nd day)	・BLK1 ・BLK2	Subbase course (2nd) Subbase course (1st)	
Step 3 (the 3rd day)	・BLK1 ・BLK2 ・BLK3	Base course (1st) Subbase course (2nd) Subbase course (1st)	
Step 4 (the 4th day)	・BLK1 ・BLK2 ・BLK3 ・BLK4	Base course (2nd) Base course (1st) Subbase course 2nd) Subbase course (1st)	
Step 5 (the 5th day)	・BLK2 ・BLK3 ・BLK4 ・BLK5	Base course (2nd) Base course (1st) Subbase course (2nd) Subbase course (1st)	
Step 6 (the 6th day)	・BLK3 ・BLK4 ・BLK5 ・BLK6	Base course (2nd) Base course (1st) Subbase course (2nd) Subbase course (1st)	
Step 7 (the 7th day)	・BLK4 ・BLK5 ・BLK6 ・BLK7	Base course (2nd) Base course (1st) Subbase course (2nd) Subbase course (1st)	
Step 8 (the 8th day)	・BLK5 ・BLK6 ・BLK7 ・BLK8	Base course (2nd) Base course (1st) Subbase course (2nd) Subbase course (1st)	
Step 9 (the 9th day)	・BLK6 ・BLK7 ・BLK8	Base course (2nd) Base course (1st) Subbase course (2nd)	
Step 10 (the 10th day)	・BLK7 ・BLK8	Base course (2nd) Base course (1st)	
Step 11 (the 11th day)	・BLK8	Base course (2nd)	

Legend

: Subbase course (1st)

: Subbase course (2nd)

: Base course (1st)

: Base course (2nd)

: Managing traffic during work

: Deployment of flagman

4) Box culvert

The Xesamsoi River flows from north to south while meandering near National Road No.9, then crossing it. During the rainy season, the water level of this river rises, causing overflow around its bend section (as shown in the upper portion of the figure). Overflowing water is about to flow toward the south along the topographical gradient and cause inundation of paddy fields on the north side of the road (white blank portion of the figure) because of insufficient flow capacity of the pipe culvert (see the figure below) located halfway along the route of the overflowing water.

To secure the required flow capacity, an additional box culvert shall be installed on the route. During the construction period, a by-pass road will be provided by the side of the existing road.

(2) Subcontracted works

None

(3) Common temporary facilities

1) Base Camp

Before commencement of the work, it is necessary to secure the site necessary for the work and to clear or move any obstructions to the work as soon as possible.

2) Temporary site for facilities for the work

During the works period, a temporary site will be secured for installation of temporary buildings and equipment and for storage of equipment. Principal candidate sites and their areas are summarized in Table 2.2.28.

Table 2.2.28 Temporary site for the work

Intended use	Candidate sites
Base camp (office, accommodation quarters, equipment/material storage yard, workshop)	M. Phalanxai (15,000m^2) M. Phalanxai (4,000m^2)
Asphalt plant	M. Phalanxai (10,000m^2)
Crusher plant	M. Phalanxai (1,500m^2)
Concrete plant Equipment/material storage yard	Around each site (100m^2 each)

The camp facilities layout plan and the plant layout plan are shown in Figures 2.2.20 and 2.2.21 respectively.

Acquisition of a site necessary for the work and transfer/removal of obstructions are included in the scope of responsibility of the Lao side counterpart. Since this project site is located in the province of Savannakhet, it is necessary to notify and to obtain approval for acquisition of the temporary yard from the DPWT Savannakhet in advance.

For transfer and installation of the electricity and telephone systems, negotiation with competent agencies is necessary, so that the procedure must be taken via DPWT in advance.

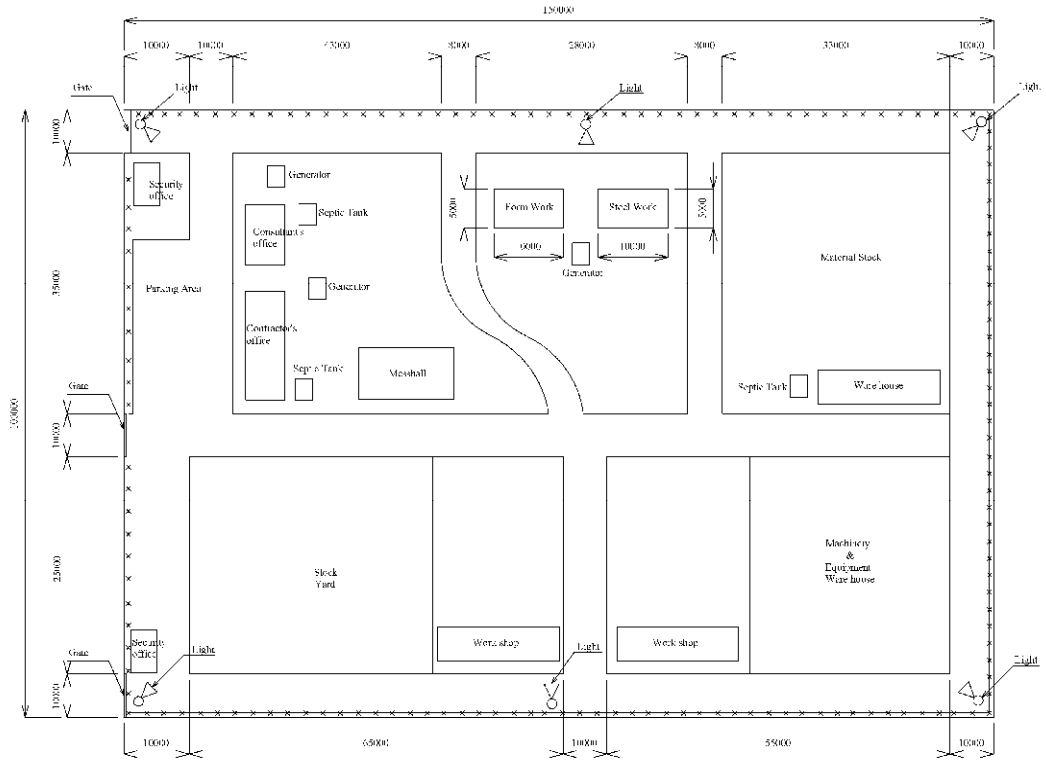


Figure 2.2.20 Camp facilities layout plan

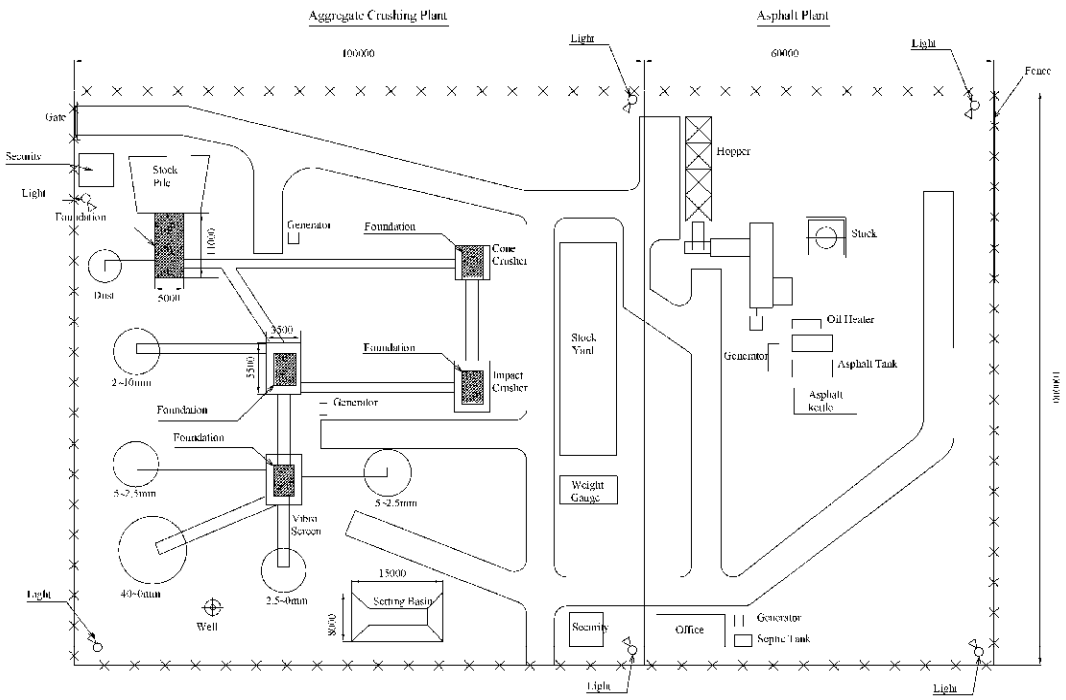


Figure 2.2.21 Plant layout plan

3) Temporary yard site (candidate)

The wayside land is almost flat along the whole section of the project road. Houses are dotted along the wayside and there are almost no houses beyond those immediately adjacent to the road. Access roads (local roads) are observed, which run to the land farther from the road that is used for agricultural purposes. Considering the road construction plan, it is advisable to provide a temporary yard near the center of the whole upgrade section. Therefore, it is planned to provide the temporary yard to the west of the Phalanxai urban area (about Sta. 60 – 80 km from Savannakhet). The main temporary yard will be for the office site and for storage of heavy machinery/material and equipment. The site for installation of aggregate and asphalt plants will also be planned. If the site is to be used for a temporary yard, it is necessary to clear the thicket as shown in Figures 2.2.22 to 2.2.23 and to develop the land with embankments. Note that the request to secure the temporary yard has been delivered to the DPWT Savannakhet side.

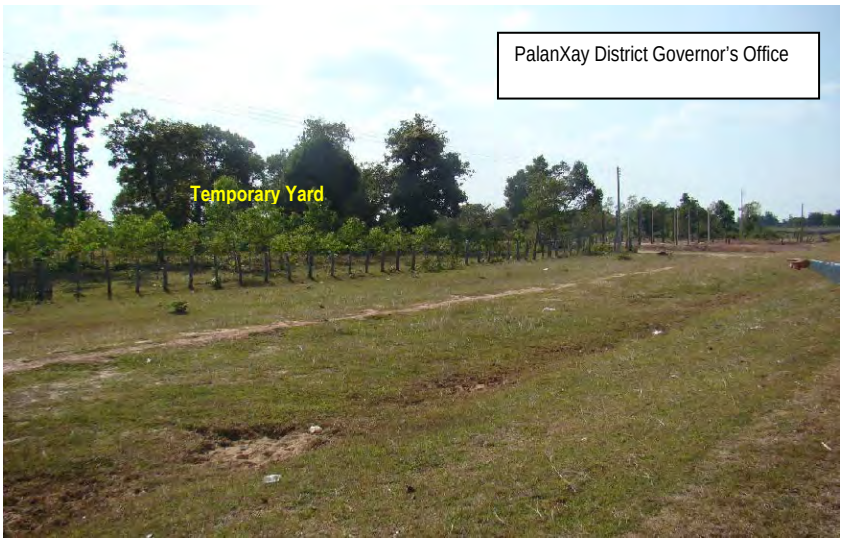


Figure 2.2.22 Phalanxai temporary yard candidate site for work (at around Km130 point)

Figure 2.2.23 Condition of the temporary yard candidate site (at around KM70 point)

4) Land lease procedure

For the temporary yard, the currently assumed size of temporary facilities is illustrated as reference, and the request is being made to DPWT for searching of the public land around Phalanxai to secure the yard. After establishment of the basic design and implementation schedule, the drawings will be officially submitted to MPWT and the request will be made to undertake the land lease procedure.

5) Supply of electricity, telephone, and water

Electricity

Electricite du Laos (EDL) is distributing and supplying electricity to general houses along NR-9 at 220V and 50Hz. Since the capacity is not known, electricity necessary for the work will be supplied from a generator.

Telephone

Both fixed line and cell phones can have connection services from Lao Telecom or Enterprise of Telecommunications Lao (ETL). Connection to Internet is also possible via cell phones (GPRS, EDGE, partially 3G).

Water supply

Along the road, there is no wide-area public water supply service, except in Savannakhet and Xeno. In certain local cities, such as Muan Palan, M. Phin, and Xephon, deep wells have been excavated for the public water supply system. Most of sections use ordinary wells to supply water. The choice of concrete mixing water will be made after testing the adequacy of the water quality. Since neighbouring residents use the wells, taking underground water for the works shall not affect the surrounding areas.

Optical fiber cable

Fiber optic cables have recently been laid in the right-of-way along R13 and NR-9 under cooperation from China. The cables are laid under an earth covering of around 1 to 1.5 m, but not protected with protective tubes, etc., so that they may be damaged with loading or scraping by the heavy machinery during the excavation work. Since the cable position is indicated with concrete piles, necessary measures, such as confirmation of the cable position and protection with temporary protective tubes, must be taken in the presence of an authorised person before proceeding with excavation of the surrounding area.

6) Necessity of providing the diversion road

NR-9 is a wide-area trunk road connecting three countries and there is no by-passing alternative road. In principle, the road will be opened for one-way traffic during upgrading of the road. If necessary, a diversion road will be provided in locations where the work may hinder transport on the existing road.

7) Necessity of traffic blockage

As aforementioned, the road works will be implemented while closing the traffic on one side of the road. The length of works section will be planned to avoid offensive disturbance to the existing traffic as much as possible. A complete closure of the road, if necessary, will be implemented after approval of the concerned agencies while taking the following points into account:

As far as the situation allows, the closure of the road will be planned to be in the night time when the traffic volume is less.

Thorough safety measures will be planned, such as provision of information signs and protection equipment, arrangement of the flagmen, etc.

8) Transfer and removal of obstructive materials

Removal and transfer of utilities (electricity, telephone, etc.) will require negotiation with pertinent agencies, so that the necessary procedures must be taken beforehand through MPWT. The condition of obstructive materials may be summarized as shown in Table 2.2.29.

Table 2.2.29 Result of study on obstructive materials

Transfer, removal/adjustment of expected obstructive materials		
Item	Pertinent agencies	Description
Houses	WREA and MPWT, DPWT	■ Part of houses occupying ROW (right-of-way) to be removed (predicted)
Electricity	Electricity du Lao PDR: EDL	■ High-voltage wire：22kv, Low-voltage wire 220V to be transferred⇒Transfer of poles and raising/changeover of wire necessary (predicted) ■ Transfer of electric lamps
Telephone	Lao Telecom, ETL	■ Transfer of telephone lines (overhead) (along the road) ■ Wiring, etc. to temporary yard, field office ■ Protection of optical fiber cable
Water supply	Nampapa	■ Transfer of part of piping of local public water supply system in urban areas; Xeno, PalanXai, Phin, Xephon
Others	DPWT	■ Agreement and approval concerning installation of culvert crossing the embanked section ■ Addition of the drainage facilities ■ Development of bus stops, and pavement inside the vehicle weight weighing facilities

9) Disposal Area

For disposal of excess soil, a request will be made to MPWT or DPWT to establish a spoil bank in the neighbourhood (within 5 km distance from Phalanxai). Concurrently, the design and implementation plan will be established to minimize generation of excess soil.

10) Transport packing plan

Transport of equipment/materials to the project site will be made by land. Equipment/materials not procurable in Lao PDR or those to be imported by sea from Japan will be transferred from neighboring Vietnam and Thailand. Transfer from Vietnam will be made from Da Nang port or Hanoi at the east end of the East-West Economic Corridor, via Lao Bao – Den Savan on the border, to the site.

Transport from Thailand will be made by land in Thailand, crossing the Second Mekong International Bridge between Mukdahan and Savannakhet and passing through Xeno, to the site. Specific routes are shown below.

Transportation Route

Laem Chabang Port, Thailand		747km
R212 ↓ 660km		
Mukdahan		
R212 ↓ 7km		
Savannakhet (Friendship Bridge-2)		
the road ↓ 80km		
the road Project Site (Km80+00)		Phalanxay
the road ↑ 164km		754km (324km)
Densavanh/ LaoBao		
the road ↑ 90km(160km)		
DongHa／(DaNang)		
↑ 500km		
Da nang Port, Vietnam		

Figure 2.2.24 Access to the construction material site

Transportation by road

The principal trunk road, which is used for land transport from Bangkok and/or Laem Chabang Port in Thailand, is a complete four-lane road over its entire length, and thus no concerns will be expected to transport the materials and equipment. On the other hand, National Road No. 9 in Lao PDR is a two-lane two-way traffic road having the standard lane width of 3.5 m. The wayside terrain is flat to the west of Muang Pin, but mountainous from the suburb of Xepon to the east up to the Den Savan near the border with Vietnam, including hill roads in certain locations. In addition, the bridges constructed on the route under aid from the former USSR and Vietnam are narrow in width. It is considered necessary before actually transporting large and special equipment and materials to carry out a preliminary study covering the loading capacity.

Around Xeno
Route passing the lowland and flat land. Almost no cut slope or embankment, with gentle alignment

Around Den Savan
Route passing through mountainous areas. Road with many cut slopes. Alignment including many curves along the land features

Figure 2.2.25 Road condition

Transportation by sea

For equipment/materials to be imported from Japan or a third country by sea, the equipment/materials will be unloaded in Laem Chabang Port dedicated to Lao PDR or Bangkok Port to be transported via Thailand to the site as shown below:

Neighbouring countries/ Japan —(by sea)→ Laem Chabang Port (Bangkok) —(by land within Thailand)→ Mukdahan (Thailand)/Savannakhet (Lao PDR) —(through Friendship Bridge-2/customs)→ —(by land within Lao PDR)→ Site (near Palanxay)

The time required for transport is estimated at about 1.0 to 1.5 months including totally the procurement, packing, transport by sea, customs clearance, and inland transport.

Transportation by air

For transport by air from overseas, either the equipment/materials will be received at the Vientiane International Airport or received at the nearest airport in Thailand (Ubon Ratchathani or Udon Thani) or at Da Nang airport in Vietnam, so as to be transported by land to the site.

2.2.4.2 Implementation Conditions

(1) Securing safety during work execution

Although there is no problem in terms of security, due attention must be paid to prevent theft or missing equipment/materials to execute the work. Patrolling of the site by a guard and establishment of a 24-hour security system for the base camp and plant are considered necessary.

(2) Considerations in terms of procurement

In addition to the dedicated Laem Chabang Port of the neighboring country, Thailand, the Bangkok Port as well as Hanoi and Da Nang Ports of Vietnam are available to land the procured imported equipment and materials for execution of the work in Lao PDR. As far as this scale of road improvement project is concerned, on the other hand, most of equipment/materials are available in the Vietnam or Thailand market, so that transport by land will be the major transport means. In this case, the duty exemption procedure is necessary when crossing the border, so that it is necessary to request the Lao Government to prepare the master list of import equipment and materials to be subject to duty exemption and to complete the duty exemption approval procedure beforehand. Since VAT (value added tax) was introduced in the year 2008 in Lao PDR, it is also essential to gain understanding of the VAT exemption procedure in addition to duties.

2.2.4.3 Scope of the work

For the grant aid of Japan for this project, the burden of the project will be shared between Japan and Lao PDR as follows:

(1) Burden share of Japan

i) Transport of equipment and materials from Japan or a third country to the port of discharge (Bangkok or Laem Chabang)
ii) Transport by land from the port of discharge of Lao PDR or the source of equipment and materials procurement
iii) Construction of road facilities (pavement, box culverts, drainage, traffic safety) as shown in the design
iv) Construction and removal of the temporary yard, temporary road, diversion and camp site necessary to the works
v) Procurement of the equipment, materials, and labor necessary for the works
vi) Management services necessary for the construction work
vii) Consulting services necessary for implementation of the project

(2) Burden share of Lao PDR

i) Acquisition and compensation for the ROW, removal of public facilities within the ROW and the arrangement of temporary yard with the local authority,
ii) Authorization to Pay (A/P) notification to the Japanese bank according to the Banking

Arrangement (B/A), bearing the miscellaneous charge for payment

iii) Exemption of custom and duties on imported materials and equipment unloaded at the port in Lao PDR

iv) Provision of privilege to the Japanese involved in the project concerning the imported goods and services provided within the scope of authentication agreement

v) Necessary arrangement for the Japanese to be exempted from payment of duties, internal tax, value-added tax imposed on the provision of goods and services within the scope of authentication agreement

vi) Necessary arrangement and coordination for the relocation of electricity, water supply, and other auxiliary facilities within the area related to the Works, and supply electricity to the lighting facilities installed in the project

vii) Implementation of road maintenance for the sections specified as compulsory by Lao PDR

viii) Continue sustainable road maintenance after completion of the Works by the Japanese side

ix) Appropriate use and maintenance of facilities constructed by the Japan grant aid scheme

x) Bearing of the expenses necessary for the construction of facilities, other than the expenses accommodated by the grant aid scheme

2.2.4.4 Consultant Supervisions

(1) Detailed Design Service

On the basis of the preparatory survey for the grant aid, a field study will be conducted to review the contents of the design and confirm the appropriateness of the facilities and specifications. After the field survey, the detailed design, including the quantitative calculations and preparation of tender documents, will also be carried out.

(2) Supervision Service

1) Approval of the work plan and shop drawings

The consultant supervisor will give approval for the work plan, schedule, and shop drawings which are submitted by the Contractor if they comply with the agreement, contract drawings, and specifications.

2) Progress Control

The consultant supervisor will receive the report on the progress of works from the contractor and will give instructions to the contractor regarding the necessary measure for the work to be completed within the contract period.

3) Quality Inspection

The consultant supervisor will check the materials and quality of works to determine if they comply with the contract drawings and specifications, and will give approval if appropriate.

4) Actual measurement inspection

The consultant supervisor will check the completed product to determine if the actual measurement complies with the drawings and quantities as well as satisfies the specifications.

5) Issuing of certificates

The consultant supervisor will issue the necessary certificates on the completed amount, the work completion and the acceptance of inspection.

6) Submitting reports

The consultant supervisor will check the contents of the monthly reports, the completion drawings, and the completion photos submitted by the contractor before submitting them to MPWT. At completion of the work, the consultant supervisor will also prepare a completion report and submit it to the Client and other concerned parties.

(3) Work Supervision System

The consultant office will be constructed in the vicinity of the contractor's office. Additionally, to submit the monthly report once a month, the consultant should go to Savannakhet (which is about 450 km from the Capital city of Vientiane) where the DPWT Savannakhet, a branch office of the project implementing agency, MPWT is situated. It will take about two hours by car from the site to Savannakhet so that no liaison office will be located in Savannakeht since it will be completed within half a day even when the round-trip is taken into account. The place of accommodation will be in Vientiane when reporting to the implementing agency (MPWT).

2.2.4.5 Quality Control Plan

The quality control of works will follow the Road Design Manual (1996) since the manual provides the standard technical specifications and the quality control methods. However, for the items not contained in this manual, AASHTO or the Japanese standards or other international test method will apply.

For the job mix design of pavement, all possible mix options shall be attempted and the final mixing of pavement shall be determined after the trial. The quality control methods are shown in Table 2.2.30.

Table 2.2.30 Quality control methods

Type of work concerned	Control items	Quality control test, inspection, etc.	Test frequency and timing
1) Earth works, asphalt pavement, subgrade, base course, backfilling of structures	Material control	CBR test, soil test (specific gravity, grain size, liquid limit・plastic limit, density), aggregate test (specific gravity, grain size distribution, strength, water absorption), bituminous material (quality certificate, component analysis table)	Before execution of work
	Daily control	Compaction density test, bituminous material (stability, flow value, porosity, Marshall test, temperature)	During execution of the work, at the time of mixing
2) Concrete	Batcher plant performance inspection	Weighing instrument, mixing performance test	Before execution of work and once a month
	Material control	Cement・admixture (quality certificate, component analysis table), aggregate test (specific gravity, grain size, strength, water absorption, alkali-aggregate reaction)	Before execution of the work, at change of material
	Concrete mixing test (test mixing)	Slump, air content, temperature, test piece strength	Before execution of the work
	Daily control	Fresh concrete (air content, slump, temperature)	During execution of the work
		Witness test (compaction, curing, removal of laitance)	During execution of the work
		Concrete specimen (strength test, preparation of control chart)	At seven and 28 days after placement
3) Reinforcing bars	Material control	Quality certificate (mill sheet), tensile test result	Before execution of the work
	Daily control	Witness inspection (cover, arrangement, wrap length)	During execution of the work

2.2.4.6 Procurement plan

(1) Labour

1) General

In the course of the recent rapid economic growth of Lao PDR, private investment has become active for development of infrastructures and the demand for workers in the construction field is increasing. However, Lao PDR has only 6.5 million population so the ratio of workforce is extremely small, and thus cannot meet the demand. In this situation, overseas workers, especially those of China are flowing into the construction market. Investment in the road sector is also quite active, and upgrading of several principal trunk roads is in progress concurrently and that also pushes up the demand for workers. In the local sites, however, only unskilled workers are available. Therefore, skilled workers, such carpenters, plasterers, electricians, and heavy machine operators, should be procured from the Vientiane. However, skilled workers and operators who are experienced in asphalt pavement are limited, therefore the employment of those from a third country or Japanese workers is indispensable for large-scale projects.

2) Construction Engineers

Conventionally, the engineer-level construction workers were mostly students who have gone abroad to study in overseas universities. Currently, engineers graduated from Lao PDR National University are increasing. Immediately after the end of the US – USSR Cold War, engineers were mostly

graduates from Russia and East Europe under sponsorship of the USSR. Currently increasing are the number of engineers who have gone abroad to study in universities of Thailand, AIT (Asian Institute Technology), and Australia, US, and Japan and who have taken a degree above the master's course.

3) Labour from a Third Country

In Lao PDR, it is relatively easy for the workers from a third country to get a working visa in connection with ODA. In particular, enterprises of Thailand, Vietnam, Malaysia, Japan, Europe as well as China are advancing into Lao PDR increasingly. However, it is difficult for common labours to work in Lao PDR.

4) State of Labour-related Laws

When employing the local workers, the enterprises are governed by the employment act, the "LABOUR LAW OF LAO PEOPLE'S DEMOCRATIC REPUBLIC." This was adopted by the National Congress on March 14, 1994 and promulgated in April 21, the same year, by the Executive Order No.24.

Important requirements related to this project are summarized in Table 2.2.31.

Table 2.2.31 Outline of the labor law of Lao PDR

Item	Description
1) Payroll system	● The wage・payroll system need not be a uniform system, but should be easy to understand and simple. The labour or labour union representatives have the right to negotiate with the employer concerning wages and salaries. The government or the agency concerned regularly establishes the minimum wage of each area. The employer must not set the minimum wage lower than the level stipulated regularly by the government. ● The minimum wage and payroll system established regularly for each office is subject to inspection and control of the government.
Minimum wage	● **LAK 290,000 (dated April 1, 2005)** Note however that this is stipulated as applying to the eight-hour workday and does not include the overtime work, assistance for dining, insurance, and other subsidies. This minimum wage is not applicable to the payment to the government employees or contract staffs, party members, etc.
2) Working hours	● 48 hours a week
3) weekly day-off and public holidays	● The workers have the right to take one whole day of every week as a day-off for refreshment. The day-off is set on Sunday or other day of the week according to the agreement between workers and the employer. The public holidays are stipulated by the government.
4) Annual holidays	● For workers working under an indefinite employment agreement or under an agreement exceeding one year, 15-day annual holidays must be granted after working for one year. For workers engaged in hard work or work possibly hazardous to the health, as stipulated in Article 25 of this Law, an 18-day paid leave must be granted. Weekly days-off and public holidays are not counted in the annual holidays.
5) Sick leave	● The worker on a salary system is granted fully-paid sick leave for the annual limit of 30 days by submitting a medical certificate from a doctor. This is applicable similarly to workers working for 90 days or more, regardless of whether they are hourly-rated, daily paid, piecework payment, or contract-based workers. When the sick leave period exceeds 30 days, the worker concerned accepts compensation on the basis of the social security program. The stipulation of this article does not apply to on-the-job injuries/sickness.
6) Compensation for on-the-job injuries	On-the-job injuries mean an accident that caused injury to a worker, making him/her crippled or physically handicapped, and in certain cases, caused death, as follows: (Ⅰ) While the worker is executing his job duty on the job site or other location under instruction of the employer or supervisor. (Ⅱ) Entertainment facilities, dining halls, and other locations under the responsibility of the operator. Occupational diseases of all kinds are also considered to be on-the-job injuries. The labour management agency must cooperate with the health management agency and the labour union to specify the kind of occupational diseases. Injuries occurring in the course of a job executed without instructions from the employer or representatives and for personal purposes are not handled as on-the-job injuries.
	The employer must provide rapid and adequate assistance to the workers suffering on-the-job injuries. In addition, the actual doctor's bill verified by a doctor's certificate must be born by the employer or the social security funds for: (Ⅰ) Medical treatment fees and the doctor's bill inside and outside the hospital, including the surgical costs (Ⅱ) Hospital charges and costs for other clinics (Ⅲ) Cost of treatment made by the doctor, assistant doctor, and dedicated practitioner. Expenses for complementary medicine included When the worker is killed as a result of on-the-job injuries, the employer must pay the condolence money of the amount equivalent to the wage or salary for six months at least. In addition, the bereaved family has the right to receive a given amount of benefit. When the worker was killed working under instruction of the employer, the cost to transport the body to the bereaved family must be born by the employer.
	The compensation for an on-the-job injury is determined as follows: The worker suffering an on-the-job injury is eligible for receiving the regular wage or salary for a maximum of six months throughout treatment and rehabilitation by the doctor. When the period exceeds 6 months to reach 18 months, the worker is eligible for receiving only 50% of the regular wage or salary. When the period exceeds 18 months, the beneficiary will be provided from the social security foundation. When, as a result of an on-the-job injury, the worker has a part of his body mutilated or the worker is crippled or killed, the employer must pay the specified compensation to the worker or his/her bereaved family. When the employer has reserved the compensation fund or social security fund according to Clause 48 or when the employer takes out insurance from an insurance company for the worker, the above beneficiary must be paid as specified at the responsibility of the compensation fund or the insurance company.
7) Allowance for overtime work	• For the overtime work in the daytime of a normal workday, extra wages at 150% of the normal hourly rate will be paid. • For the overtime work in the night time of a normal workday, extra wages at 200% of the normal hourly rate will be paid. • For the overtime work in the daytime of a weekly holiday or public holiday, extra wages at 250% of the normal hourly rate will be paid. For that in the night time, extra wages at 300% will be paid. • Workers working in the night shift from ten o'clock in the afternoon to five o'clock in the morning the next day will have an extra wage of at least 15% of the normal hourly rate.

Item	Description
8) Retirement・dismissal	• Termination of the employment agreement The employment agreement can be terminated on the basis of agreement of both parties regardless of whether the agreement is limited or infinite. When an infinite employment agreement is to be terminated by one party, the advance notice must be made no later than 45 days for professional engineers and no later than 15 days for the blue-collar workers. In the case of parties of the employment agreement with a limited period, the wish for continuation/termination must be mutually noticed not later than 15 days before the date of termination. When continuation of the agreement is wished, both parties must conclude a new employment agreement. The employment agreement for the task whose amount has been specified(注 2)is terminated by the completion of the task. The employment agreement is terminated by the death of the worker.
	• Termination of the employment agreement by dismissal When the worker does not have the required expertise or capability or the worker is not in a healthy state and thus cannot continue the work or when the employer thinks it necessary to reduce the number of workers to improve the operation environment, the employer can terminate the employment agreement by dismissal. When the worker does not have the required expertise or capability or is not in a healthy state, the employer can order the worker to stop working. The employer can also terminate the agreement. In such a case, the employer must explain the reason to terminate the agreement and give at least a 45-day advance notice. In the advance notice period, the employer must grant the worker one workday per week as a paid day-off to search another job. However, before termination of the employment agreement, the employer must consider adequate relocation appropriate to the capacity and health of the worker concerned. The agreement can be terminated only when a job appropriate to the worker is not available. When the office thinks it necessary to reduce the number of workers to improve the operation environment, the employer must prepare the list of affected workers through negotiation with the labour union or labour representatives and must notify the competent labour management agency. Concurrently, the employer must provide the 45-day advance notice of dismissal and the explanation. If the employment agreement is to be terminated for either one of the above reasons, the employer must pay compensation appropriate to the working period of the worker. The amount of compensation must be equivalent to 10% of the monthly wage for the number of employment months and must be paid at the time of dismissal. For workers working for three years or more, the compensation must be equivalent to 15% of the same monthly wage for each month worked. For the worker whose salary is not fixed and who works in the piece work system, the compensation is calculated on the basis of the average of wage/salary received for the three months before termination.
9) Pension system	• There are two types: Employees Provident Fund (EPF) and Employees Trust Fund (EPF). • Allotment for the employer and employee is as follows: (A) EPF : Share of employer＝12% of the total sum of salary, Share of employee＝8% of the total sum of salary (B) ETF : Share of employer＝3% of the total sum of aid

Source: Labour Law of Lao PDR, Ministry of Health and Labour, 2004

In the National Assembly held in December, 2008, the amended labour law was adopted and promulgated by Executive Order in January 16, 2007. This amendment was made after 13 years of promulgation of the original one through addition and alteration to a considerable degree, with the number of Clauses increasing from 62 to 77. Alterations related to this project implementation are shown below:

The overtime hours were increased from the original 30 hours a month to 45 hours (Clause 18).

Regarding the workers, the advance notification to terminate the agreement with the blue-collar workers was changed from the 15-day advance notice to the 30-day advance notice (Clause 28).

The employment percentage of foreign workers must be 10% or less of the total number of workers for blue-collar workers and 20% or less of the total number of workers for white-collar workers (Clause 25).

5) Tax System

The principal tax system of Lao PDR is outlined in Table 2.2.32.

Table 2.2.32 Principal Taxes of Lao PDR

Kind of tax	Tax rate
1. Value-added tax (VAT)	・Officially introduced in January 2009 at the tax rate of 10% applied uniformly to articles and services. (With the introduction of VAT, the conventional sales tax was abolished.) ・10% applied apart from custom duty at the time of import and 0% applied for export ・Tax amount clearly described in the receipt ・Entity with the sales of 5.0 billion Kip or more to be subject to tax ・Entity to file VAT registration (for tax exemption) ・Lease and services to be subject to tax ・VAT for foreign aid projects to be exempted
2. Individual income tax	Income tax rate of 10% uniformly applied to foreign residents
3. Import tax	The foreign investors can remit the following to the home country or a third country after payment of tax (royalties, original investment, interest payable, funds after pull-out of business, remittance of salary of foreign employees, financial transfer based on agreement concluded among foreign countries)
4. Remittance of profits	Tax exemption for import of the equipment, machinery and transport equipment by foreign investment enterprises. Exemption of the transport equipment import tax directly related to the investment projects The transport equipment import tax rate directly related to an investment project is 1%. Note that the transport equipment is deemed to be a temporary input vehicle and the amount of equipment depends on the scale of the investment project. For raw materials and intermediate properties that are to be worked and re-exported, the import duties are exempted.
5. Others	For raw materials and intermediate properties to be imported for the purpose of import replacement, the import duties may be exempted after negotiation.

6) Considerations for Implementation of the Project

In principle, according to the bilateral agreement between Japan and Lao PDR, equipment and materials to be procured for this project are not subject to tax. For import duties, the exemption procedure must be taken on the basis of a master list of import/export equipment and materials, which the contractor has prepared beforehand. For this purpose, such master list related to import/export must be prepared before commencement of the project and submitted to MPWT to report properties to be taxed to the tax authorities. On the other hand, the tax exemption procedure for VAT introduced in the beginning of 2009 as shown in the table above has never been put into practice after introduction because there has been no Japan grand-aid project. Though MPWT refers to application of the exemption procedure concerning ODA from Japan during negotiation, specific official procedure is not known. Since the VAT exemption has been alleged by DOR of MPWT, it is necessary to confirm it again through the concerned agencies before implementation of this project.

7) Number of Holidays

Table 2.2.33 shows the Lao national holidays that are the basis for calculation of the number of working days.

Table 2.2.33 National holidays of Lao PDR (2010)

Month/day	National holidays
January 1	New Year's Day
March 8	Women's Day
April 13 - 15	Lao New Year
May 1 (Monday)	Labour Day
July 26	Boun Khao Phansa Day
October 23	Boun Oak Phansa Day
October 24	Boat Racing Festival Day
November 21	That Luang Festival Day
December 2 (Saturday)	National Day

Source: ASEAN Center・Lao PDR country data

(2) Construction Materials

This project will use the construction materials produced or procurable within Lao PDR as much as possible. The study results on the quality and suppliers are shown below. The material suppliers are shown.

1) Asphalt (bituminous material)

The major asphalt producer supplying asphalt to Lao PDR is “TIPCO” with a base in Thailand, whose supply can cover about 70% of the asphalt demand of Lao PDR. Apart from “TIPCO”, Thai corporate global enterprises, such as “Shell” and “Esso”, are providing asphalt to the Lao market. Since the pavement specification of Lao PDR remains DBST, the share competition among suppliers may heat up in line with the future growth of the asphalt market. “TIPCO” is a manufacturer growing as a Thai domestic company while enjoying technical assistance from France, and has an asphalt refinery plant in Malaysia. From this base plant, asphalt is delivered to the storage bases dotted throughout Southeast Asia. The Ubon Ratchathani storage base of Thailand is the nearest one available for the project site. The Lao agent of “TIPCO” has several tank lorries specialized for transport of asphalt and may be the most favourable for supplying asphalt for this project.

2) Bituminous Mixture (plant)

There is only one bituminous mixture plant in the suburb of Savannakhet. Asphalt is imported from a third country (Thailand or Vietnam) while crushed stones of river gravel taken from Mekong River are used for aggregates. The plant is of a portable type with small capacity, and is considered not capable of supplying enough asphalt for a large-scale road upgrade project. Accordingly, this project will have a dedicated asphalt plant installed this time. The list of asphalt plants (four plants) existing currently in Lao PDR is shown in the next page.

3) Cement

There is a cement plant constructed with investment from China about 80 km along the road northward from Xeno. Initially, this plant supplied cement mainly to construct infrastructure in Lao PDR under assistance from China. In line with recent demand growth in the market, the product of this cement plant is marketed along with Lao-cement. On the other hand, there is also the cement refining

plant invested by Thailand at the Km59 point along NR-9. Cement produced in Thailand is transported in the state of clinker and refined to cement in this plant for shipment after bagging.

4) Ready-Mixed Concrete

There are several ready-mixed concrete plants in the suburb of Savannakhet. The average distance to the site is about 80 km and will take about one hour and a half by car. Since this project consists of major road improvement, only a small amount of concrete will be used for the facilities, such as gutters, culverts, etc. Job mixing is considered practical by using a portable mixer for concrete supply.

Table 2.2.34 Survey Result of Asphalt Plants

		SURVEY OF ASPHALT PLANT		
DESCRIPTION	**Asphalt Plant -1 Savannakhet**	**Asphalt Plant-2 Pakse**	**Asphalt Plant-3 Vientiane**	**Asphalt Plant-4 Vientiane**
CONTACT PERSON	R8CE, Mr. Phoukhong	SERA 20, Mr. Phonpana	KSC	R8CE, Mr. Phoukong
ADDRESS	BAN. THAHOURXANG	BAN. NONGHOY	BAN. DONGXIENDY	BAN. SALADENG
	KAISONEPHOMVIHAN DC	PHONTHONG DC	XAITHANY DC	HARDXAIPHONG DC
	SAVANNAKHET LAO P.D.R	CHAMPASAK LAO PDR	VIENTIANE LAO P.D.R	VIENTIANE LAO P.D.R
TELEPHONE / FAX	TEL : (856-21) 263143	TEL : (856-31) 212487	TEL : (856-21) 711019	TEL : (856-21) 263143
	FAX : (856-21) 562023	FAX : (856-31) 212487	FAX : (856-21) 710829	FAX : (856-21) 562023
	MOBILE : (856-20) 55542118	MOBILE : (856-20) 2337373	MOBILE : (856-20) 55512263	MOBILE : (856-20) 55542118
SUPPLY GRADES				
PRODUCTION	10 -20 ton/h	40 ton/h	50 ton/h	120 ton/h
(CAPACITY TON/ HOUR)				
NUMBER OF DUMP TRUCK	4 TRUCKS	4 TRUCKS	5 TRUCKS	6 TRUCKS
CURRENT SUPPLY (No. & TON /DAY)	80 - 160 ton/day	320 ton/day	400 ton/day	480 ton/day
SOURCE OF MATERIAL				
ASPHALT & BITUMEN	SENEOUDOM TRADING CO., LTD	SENEOUDOM TRADING CO., LTD	SENEOUDOM TRADING CO., LTD	SENEOUDOM TRADING CO., LTD
	AC 60/70	AC 60/70	AC 60/70	AC 60/70
	SAVANNAKHET LAO P.D.R	CHAMPASAK LAO PDR	VIENTIANE LAO P.D.R	VIENTIANE LAO P.D.R
COURSE AGGREGATE	MEKONG RIVER GRAVEL	MEKONG RIVER GRAVEL	COURSE AGGREGATE FROM BAN SAKAI	COURSE AGGREGATE FROM BAN SAKAI
			VIENTIANE DC	VIENTIANE DC
FINE AGGREGATE	MEKONG RIVER GRAVEL	MEKONG RIVER GRAVEL	COURSE AGGREGATE FROM BAN SAKAI	COURSE AGGREGATE FROM BAN SAKAI
FILLER	MEKONG RIVER GRAVEL	MEKONG RIVER GRAVEL	COURSE AGGREGATE FROM BAN SAKAI	COURSE AGGREGATE FROM BAN SAKAI
TEST LABORATORY				
ITEM OF TEST				
UNIT PRICE READ-MIX AC	60/70 - USD695/TON	60/70 - USD695/TON	60/70 - USD695/TON	60/70 - USD695/TON
(SUUPLY AT PLANT BY GRADE)				
TRANSPORTATION COST	N/A	N/A	N/A	N/A
(SUPPLY TO M. PHARANXAY)				

5) Raw Materials (aggregates, borrow materials, river sand and gravel)

As a source of procurement of raw materials, the quarry sites around the road were studied. In the study, samples were taken from each site by the local subcontractor, and laboratory tests were made. On the basis of the test results, the appropriateness for this project was determined. Table 2.2.35 shows the values required for each construction material as specified in the Road Design Manual of Lao PDR and Figure 2.2.26 shows the map of sites from which the samples were taken. Tables 2.2.36 to 2.2.39 show the laboratory sample test results and the appropriateness of each material.

Table 2.2.35 Required values of construction materials (Road Design Manual)

Material / Test	Subbase course	Base course	As stabilized base course	Wearing course		Subgrade	Concrete	
				Coarse aggregates (>2mm)	Fine aggregates (<2mm)		Coarse aggregates	Fine aggregates
LAA	< 40	< 30	< 35	< 30	-	-	< 50	-
ACV	< 30	< 25	< 28	< 25	-	-	-	-
SSS	< 20	< 12	< 12	< 12	< 12	-	< 12	< 10
FI	< 35	< 25	< 25	< 20	-	-	-	-
FM	-	-	-	-	-	-	-	2.3 – 3.1
4-day water immersed CBR	-	-	-	-	-	> 5		
4-day water expansion ratio	-	-	-	-	-	< 2		
PI	-	-	-	-	-	< 50	-	-
Organics content	-	-	-	-	-	< 3	< 3 (Co pavement) < 5 (others)	< 3

LAA: Los Angeles Abrasion, ACV: Aggregate Crushing Value: SSS: Sodium Sulphate Soundness, FI: Flakiness Index, FM: Fine Modules, PI: Plastic Index

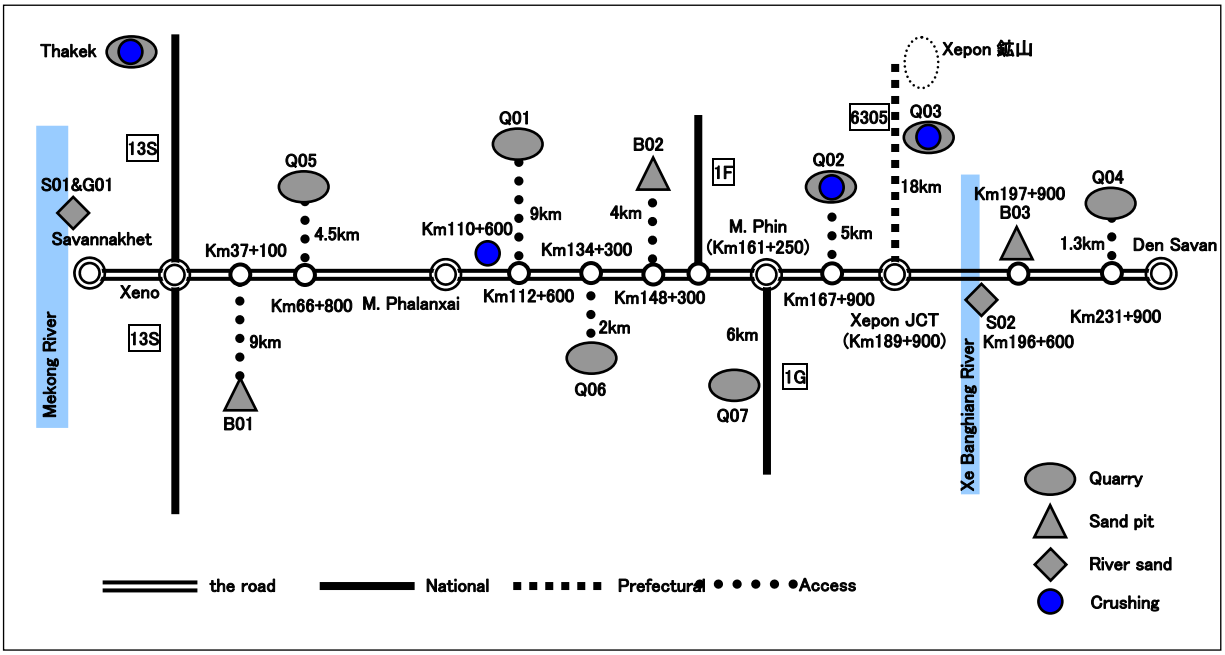


Figure 2.2.26 Map of location of suppliers of construction materials (aggregate, borrow material, river sand and gravel)

Table 2.2.36 Laboratory sample test results (1)

Site		Quarry Q01	Quarry Q02	Quarry Q03	Quarry Q04
Location		Km112+700/8km after turning left	Km167+900/5 km after turning left	JCT to Xepon mine (Km189+900)/18 km after turning left	Km231+900/1.3 km after turning left
Rock quality		Sand stone	Sand stone	Granite	Granite
Test result	LAA (%)	30.6	17.6	17.3	16.7
	ACV (%)	23.6	22.2	24.1	19.2
	SSS (%)	6.0	3.4	3.4	3.4
	FI (%)	22.7	20.2	22.0	27.0
Organic content (%)		1	1	1	1
Estimated reserves		400,000m3	1,300,000m3	7,500,000m3	8,000,000m3
Appropriateness		SBC, ABC, Co, (BC)	SBC, BC, ABC, Co, (WC)	SBC, BC, ABC, Co, (WC)	SBC, (BC), (ABC), Co
Remarks		Material supplied to the existing plant (Km110+600)	Existing plant in the neighbourhood (currently not operating). Flat index (FI) slightly undershooting the required value	Existing plant operating. Flat index (FI) slightly undershooting the required value for the wearing course	Distanced from the project section. Sufficient strength, but high flat index (FI)

SBC: Sub base course, BC: Base course
ABC: Asphalt stabilized base course, WC: Wearing course, Co: Concrete (pavement/structures)

Table 2.2.37 Laboratory sample test results (2)

Site		Quarry Q05	Quarry Q06	Quarry Q07	Quarry Q08
Location		Km66+800/4.5 km after turning right	Km134+300/2 km after turning right	JCT with Route 1G (Km161+250)/6 km after turning right	R13S Km319+300/5 km after turning right (Thakek)
Rock quality		Sandstone	Sandstone	Sandstone	Limestone
Test results	LAA (%)	58.2	53.0	62.7	25.3
	ACV (%)	27.3	30.2	32.5	20.0
	SSS (%)	11.6	10.4	12.6	5.0
	FI (%)	24.2	27.0	27.4	23.0
Organic content (%)		1	1	1	1
Estimated reserves		90,000m^3	390,000m^3	200,000ms	1,000,000m^3
Appropriateness		None	None		SBC, BC, ABC, Co, (WC)
Remarks		High percentage of wear (LAA). Small reserves	High percentage of wear (LAA)	Development difficult because of its location within the forest reserve. Strength not enough	Remotest from the project section. Sufficient strength, but the flat index (FI) slightly undershoots the required value for the wearing course

SBC: Sub base course, BC: Base course
ABC: Asphalt stabilized base course, WC: Wearing course,
Co: Concrete (pavement/structures)

Table 2.2.38 Laboratory sample test results (3)

Site		Soil pit	Soil pit	Soil pit
		B01	B02	B03
Location		Km37+100/9 km after turning right	Km148 +300/4 km after turning left	Km197+900
Soil quality		Clayey laterite	Clayey laterite mixed with gravel	Clayey laterite
Test results	CBR (%)	20	26	12
	Expansion ratio (%)	1.7	1.4	1.6
PI (%)		20.7	21.7	19.5
Estimated reserves		78,000m3	24,000m3	24,000m3
Appropriateness		Fill, subgrade	Fill, subgrade	Fill, subgrade
Remarks		Remote from the road. Narrow access road. Passing through the village inevitable		Remote from the project section

Table 2.2.39 Laboratory sample test results (4)

Site		River sane	River gravel	River sand
		S01	G01	S02
Location		Mekong river (Savannakhet)	Mekong river (Savannakhet)	Km196+600 (Xe-Banghiang川)
Test results	LAA (%)		25.4	
	SSS (%)	5.8	5.0	6.1
	FM (%)	2.0		1.8
Organic content (%)		2	1	2
Estimated reserves		28,800m^3	12,000m^3	
Appropriateness		WC (fine aggregates), (Co)	Co	WC (fine aggregates), (Co)
Remarks		Grain size adjustment necessary by screening		Grain size adjustment necessary by screening

6) Coarse Aggregates (for concrete and asphalt)

The existing crusher plant nearest to the project site is the one belonging to Khunxay Phatana, which is currently undertaking maintenance of National Road No. 9. This is in the vicinity of the construction equipment workshop, and both are located in the backside of the temporary yard of the company. Sandstone quarried from the surrounding bedrock is used for aggregates.

In Thakek about 80-100km to the north of the road, high-quality hard limestone can be quarried. The cement refining plant of Lao Cement is situated there and produces cement from the limestone available at the site. This is applicable as aggregate for pavement. If this is to be used, it is assumed to transport raw stones to the crusher plant provided in the temporary yard to produce crushed stones.

1) Crusher plant (of Khunxay Phatana Co., Ltd) (Quarry at Km180 point along the road)	2) Same as left (sandstone)
	
3) Application to DBST (sandstone)	4) same as left (DBST placement state)
	
5) Xepon quarry	6) Same as left (granite)
	

Figure 2.2.27 State of the crusher plant and quarry

7) Fine Aggregate (for concrete and asphalt)

For the fine aggregate, river sand obtained from Mekong River can be used. Depending on the quarry site, the grain size distribution may not meet with the specifications. It is necessary to confirm the quality as fine aggregate for concrete and asphalt by laboratory test before use.

8) Embankment Materials

Soil for embankment and backfill is available from the borrow pits near the project site. The laboratory test proved that these are thoroughly applicable as embankment material. These soil pits are all located in the state-owned land, so that no special procedure for permission is required to take the soil.

9) Steels (reinforcing bars, steel materials)

Similarly to the cement, the domestic product of Lao PDR (Vientiane Steel) is available for small-sized reinforcing bars (φ<20mm) and the use is limited to small structures, such as the drain structures, etc. Accordingly, consideration should be given to using the Thailand products (TIS products) for reinforcing bars necessary for the major structures because of their reliability. In addition, steel materials for temporary facilities, special steels, and large steels are also to be imported from Thailand.

10) Lumber

In Lao PDR, lumber is available and applicable as necessary material for form works. The plywood products shall be imported from Thailand.

11) Other Construction Materials

Ashlars, bricks, and roof materials are procurable in Lao PDR. The table below shows the suppliers of major materials.

Table 2.2.40 List of suppliers of major materials

Name of construction materials	Local procurement	Procurement in the third country	Remarks
Bituminous material		✓	Import (Thailand、Vietnam)
Cement	✓		Import (Thailand)
Concrete admixture	✓		Import (Thailand)
Reinforcing bar	✓		Large size : Import (Thailand)
Crushed stone・sand	✓		Lao PDR
Form material	✓		Import (Thailand)
Support /scaffold		✓	Thailand
Concrete pipe	✓		Lao PDR (secondary product)

(3) Construction Machines

The need for construction machines is increasing due to the recent rapid development of road infrastructures. Accordingly, the general construction machines (bulldozers, dump trucks, and backhoes) necessary for ordinary civil works are procurable in the domestic market of Lao PDR. However, crane vehicles exceeding the capacity of 50 tons, equipment used for special pavement (in-place recycling method), etc. are to be imported from Japan or the neighbouring country, Thailand. State enterprises and private contractors generally use their own machines for the works. Some of them are in charge of leasing the machinery. The details are provided below.

1) State Enterprises

In Lao PDR, there are major state enterprises such as No.3, 8, 12 and 20 that contract for the works directly under the control of MPWT. As the state enterprises under control of MPWT, they used to depend on the projects ordered by MPWT. At present, they are trying to enter the private market, and the difference in competitiveness among the many state enterprises begins to become remarkable.

These state enterprises under the control of MPWT operate and maintain their own construction machinery. They have the construction machinery, but maintenance of the heavy machinery is insufficient.

2) Contractors in Lao PDR (contractors and leasing companies)

General construction machinery is mostly procurable in Lao PDR. Since the road pavement works in Lao PDR primarily employs DBST, the percentage of contractors holding the asphalt finisher, stabilizer, and other construction machines is low and these machines are not available in the market. Accordingly, these machines will be procured by leasing from the limited available contractors or by bringing them in from neighbouring countries, either Thailand or Vietnam.

3) Procurement of Plants

There are several plants for asphalt, concrete, and aggregate crushing around Vientiane. There are also a few concrete batching plants around Savannakhet, but the available asphalt plant adjacent to the site that is owned by Road Company No.8 is the only portable plant. It is planned, therefore, that the asphalt plant for this project is to be procured from a third country or Japan.

4) Procurement of Principal Equipment

The construction machinery whose procurement in Lao PDR is difficult must be obtained from outside Lao PDR. Table 2.2.41 summarizes procurement of principal equipment. When the equipment is to be imported, it will be from Japan or a third country.

Table 2.2.41 Suppliers of principal equipment

No.	Item	Capacity Specification	No.	Procurement		Remarks
				Domestic	Import	
I.	Earth works					
1	Backhoe	Crawler type 0.28m3	2	○		
2	Backhoe	Crawler type 0.45m3	2	○		
3	Backhoe	Crawler type 0.80m3	2	○		
4	Bulldozer	Marsh type 7t	1	○		
5	Bulldozer	Normal type 15t	1	○		
6	Bulldozer	Normal type 21t	1	○		
7	Dump truck	2t	4	○		
8	Dump truck	Normal Diesel 4t	4	○		
9	Dump truck	Normal Diesel 10t	8	○		
10	Giant Breaker	1300kg	1	○		
11	Truck Crane	Oil pressurised jib 16t	1	○		
12	Truck Crane	Oil pressurised jib 25t	1	○		
13	Truck Crane	Oil pressurised jib 50t	1		○	
14	Truck Crane	Oil pressurised jib 100t	1		○	
15	Crawler Crane	Oil pressurised winch 40t	1	○		
16	Crawler Crane	Oil pressurised winch 50t	1	○		
17	Crawler Crane	Oil pressurised winch 60t	1		○	
18	Pile Driver by crawler	3.5t	1		○	
19	Electric Vibro-hammer	460.9-480.5kN	1	○		
20	Clawer loader	Clawler type 2.2-2.5m3	2	○		
21	Tractor shovel	Clawler type 1.5-1.7m3	2	○		
II.	Pavement Works					
22	Asphalt Finisher		2	○		
23	Asphalt Plant	Output 130kW	1	○		
24	Stabilizer	w=2.0m,d=0.4m	2		○	
25	Distributer	1000-1500l	2	○		
26	Cargo Truck	3-3.5t	4	○		
27	Tyre roller	8-20t	4	○		
28	Wheel loader	2.5-2.9m3	4	○		
29	Motor grader	3.1m	4	○		
30	Road roller	Makadam10-12t	4	○		
31	Vibration roller	Handguide 0.8-1.1t	4	○		
32	Tampa	60-100kg	8	○		
III.	Concrete and Plant					
33	Compressor	Variable screw 3.5～3.7m3/min	1	○		
34	Compressor	Variable screw 5.0m3/min	1	○		
35	Compressor	Variable screw 7.5～7.8m3/min	1	○		
36	Water pump	Diameter φ150mm	10	○		
37	Concrete mixer	Dram capacity 0.75×1	2	○		
38	Concrete mixer	Dram capacity 0.5m3	2	○		
39	Truck mixer	4.4-4.5m3	4	○		
40	Screw conveyor	20t/h 7m	1	○		
41	Bucket lift	20t/h 10m	1	○		
42	Cooling plant	772kW	1	○		
43	Generator	Diesel engine 25kVA	5	○		
44	Generator	Diesel engine 100kVA	2	○		
45	Generator	Diesel engine 200kVA	4	○		
46	Generator	Diesel engine 250 kVA	4	○		
47	Generator	Diesel engine 300 kVA	1	○		
48	Marker pot	200-350kg×2 pot	2	○		
49	Trailer	50t	1	○		

5) Considerations related to Maintenance of Construction Machinery

Lao PDR depends entirely on imports in terms of raw materials of fuels and oils/greases, but their supply is possible. Since special oils/greases may be necessary depending on the machine, it is necessary to take into account import of special oils/greases when the machines to be used are to be selected. For the machines requiring long-term maintenance and operation, it is recommended to stock the machine components on the site even when the machine concerned is leased.

(4) Local Enterprises

1) Contractor

DOR has recently introduced a registration system for contracting of the MPWT's projects, and 322 construction companies in Lao PDR have been registered (as of August 31, 2009). They are classified on the basis of annual amount of works and the ordering class is ranked into three phases according to the work scale. Class-III is for the actual achievement of less than $300,000, Class-II is for $300,000 - 600,000, and Class-I is for $600,000 or more. The number of contractors belonging to Class-I is the largest at 159, followed by 80 contractors of Class-II and 64 contractors of Class-III. (For details, refer to the reference.) On the other hand, the contractors with experience in the field of asphalt pavement are limited in number. According to reports from MPWT, only the local contractors shown in Table 2.2.42 have successful records.

Table 2.2.42 Local constructors experienced in asphalt pavement

Type	Name of constructors
State enterprises	Road Construction Enterprise No.8
	Road Construction Enterprise No.20
	Phoudoi Construction state enterprise
Lao PDR enterprises	Nong Hai Road & Bridge Construction, Co., Ltd.
	Khounxay Phatthana Construction Co.,Ltd.
	Douangdy Road & Bridge Co.Ltd
Japanese-affiliated enterprises	Shimizu Corporation, Vientiane Office
	Hazama Corporation, Vientiane Office

2) Engineering Consulting Companies

The local consultants having successful records for implementation of topographical and geological surveys and for management of road works are shown in Table 2.2.43.

Table 2.2.43 Local consultants

Name of consultants	Address
Lao Transport Engineering Consultant	Km-5 Thadeua Rd. Vientiane
Lao Consulting Group Ltd.	377 Lao-Thai Road, Ban Vatnak, PO Box 3097, Vientiane
Burapha BDC Co., Ltd	46 Phonekheng Road, Ban Phonesaat, Vientiane
MEK Consultants Co., Ltd.	067 Sidamdouane Road , Vientiane

2.2.4.7 Soft Component (Technical Assistance) Plan

Asphalt concrete roads require routine maintenance work (e.g. daily inspection, minor repair) and periodic maintenance work (e.g. overlay, reconstruction) by the road management administrations in order to sustain them in good condition. However, the capacities of both the Government of Lao PDR and the local contractors are still insufficient to satisfy this requirement. This is one of the causes of the deterioration and the escalation of pavement structure damage in National Road No. 9. Therefore, the soft component (technical assistance) plan will be conducted to solve the above issue. Note that a technical cooperation project for road maintenance will be commenced shortly by JICA. Therefore, activities will be classified between the "soft component" and the "technical cooperation" to prevent their duplication as shown below.

- Soft component: periodic maintenance work by applying hot mix asphalt mixture
- Technical cooperation: Routine maintenance work such as daily inspection, cleaning and minor repair

Counterparts dispatched from the Lao PDR side will be present at the main project sites (i.e. road improvement by applying hot mix asphalt mixture) to develop their capacities in this plan. The Activities are drafted as follows.

- Draw up implementation program of the activities
- Prepare manuals and guidelines to apply for the activities
- Conduct workshops
- Quality control at material production
- Control of construction schedule and as-built dimensions during construction period
- Design/Construction plan/Cost estimates for large scale road rehabilitation projects
- Prepare monitoring and evaluation reports

The following experts will be assigned from Japan for the plan.

- Pavement technology: D/D 2.5 months (Japan 1.0 month, Lao PDR 1.5 months)
- Pavement construction: C/S 4.0 months (Lao PDR 4.0 months)

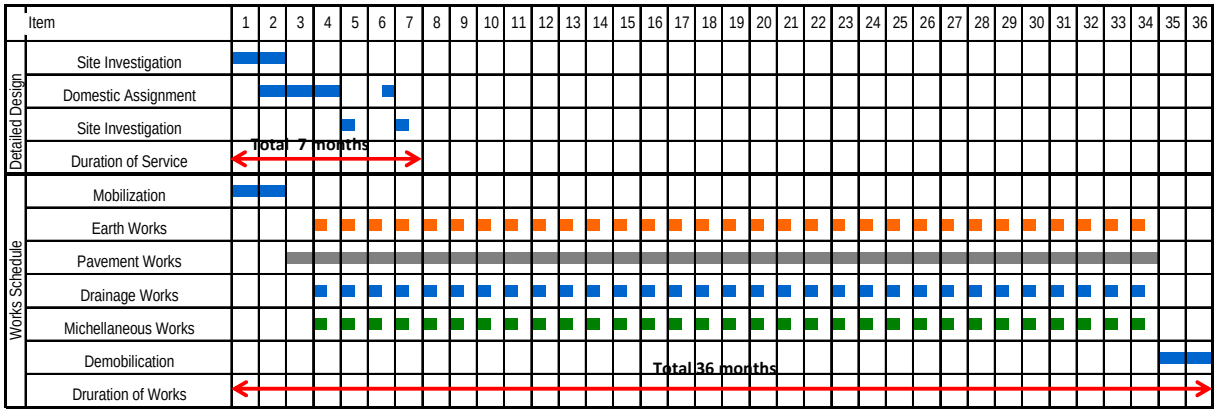
2.2.4.8 Implementation Schedule

Table 2.2.44 shows the implementation schedule prepared based on the result of the Survey. After the Survey, the project will be implemented upon conclusion of Exchange of Note and Grant Agreement. The preparation of tender documents, tender opening and the commencement of works will follow after the completion of the detailed design study.

The finalization of design, the preparation of tender documents, and assistance with the tender procedures will be made within the scope of works in Japan. The explanation of the detailed design to the Lao counterpart will be given subsequent to the completion of the detailed design. Assistance with bidding and activities related to the contract conclusion will be given, which will require a length of about seven months.

On the other hand, the work schedule will require a total of 36 months, including three wet seasons (six months/one wet season). The principal works will be pavement, road earth works, drainage, and road auxiliary works.

Table 2.2.44 The road improvement project implementation schedule



2.3 Obligations of Recipient country

The matters and items to be undertaken by Lao PDR under the Project are as described below.

(1) General

1) To complete Bank arrangements (B/A);
2) To advise commission of an Authorization to Pay (A/P) and make payment commissions paid to the Bank in Japan.

(2) Implementation Matters

1) To secure land for the project sites, to lease temporary yards, to compensate for resettlement, and to remove/relocate obstructive utilities;
2) To secure all the expenses and prompt execution of customs clearance at the port of disembarkation for unloading products purchased under the Grant Aid;
3) To afford Japanese nationals whose services may be required in connection with supply of the products and the services under the verified contracts;
4) To exempt Japanese nationals and the third country nationals entering Lao PDR to work on the project from customs duties, internal taxes and other fiscal levies which may normally be imposed in the recipient country with respect to the supply of the products and services under the verified contracts;
5) To provide electricity, water supply, drainage and other incidental facilities to the vicinities of the sites;
6) To maintain and use properly the facilities constructed under the Grant Aid;
7) To conduct the necessary maintenance works for the sections borne by Lao PDR;
8) To bear all the expenses, other than those to be borne by the Grant, necessary for construction of the facilities.

(3) Others

1) To secure the budget for land acquisition, temporary yard leasing, compensation for resettlement, and tax exemption covered by the recipient country;
2) To contract with a Japanese consulting firm for detailed design (D/D) and construction supervision;
3) To contract with a Japanese construction firm for construction work.

2.4 Project Operation Plan

2.4.1 Organization

The organizational structure of the MPWT, including the number of staff of each department, is illustrated in the following figure. As of March 2010, the number of staff is reported at 753 staff at the head quarters of the MPWT, including 114 staff at the DOR, 57 staff at the Public Works and Transport Institute (PTI), and 1,645 staff at the DPWT at the provincial level. In Savannakhet Province, the number of staff is reported at 96 staff at the DPWT and 69 staff at the district office.

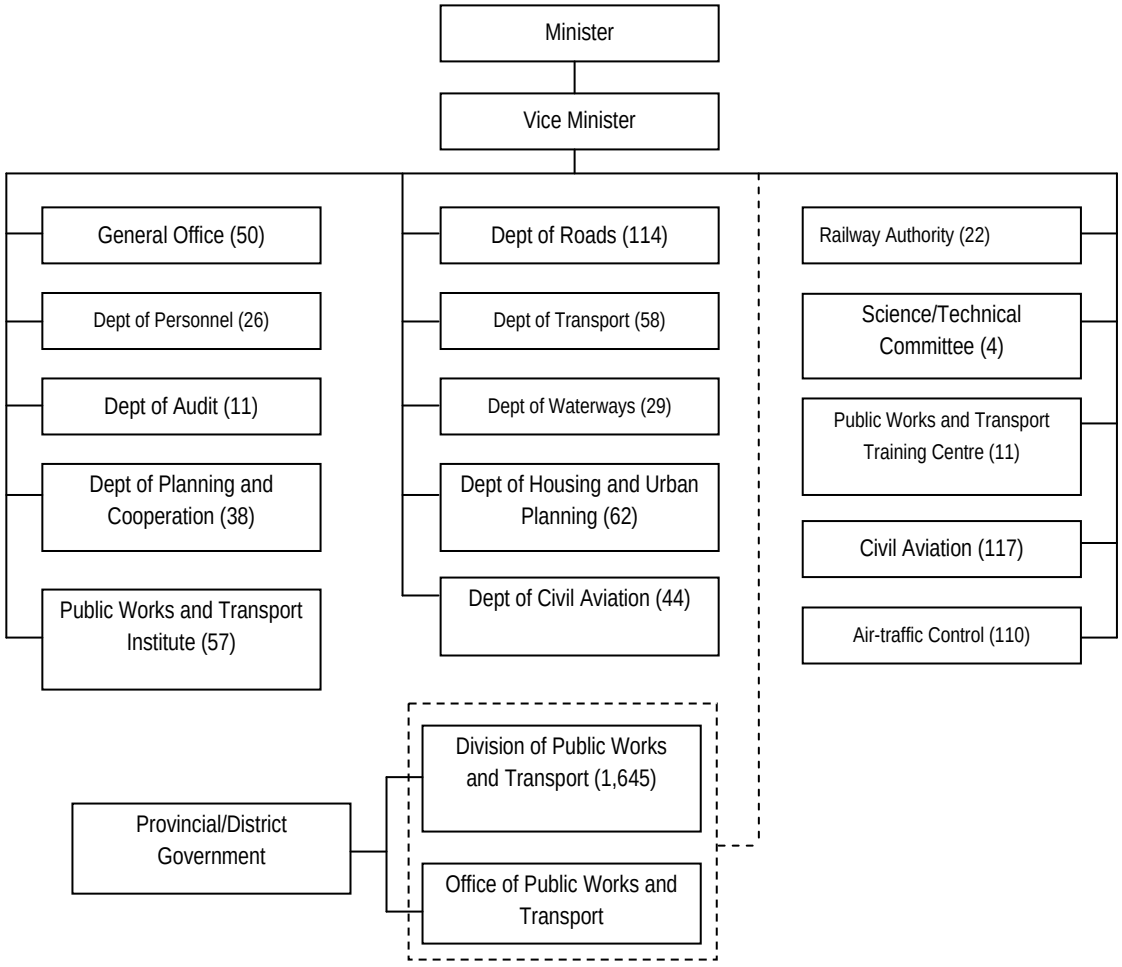


Figure 2.4.1 Organizational Structure of MPWT

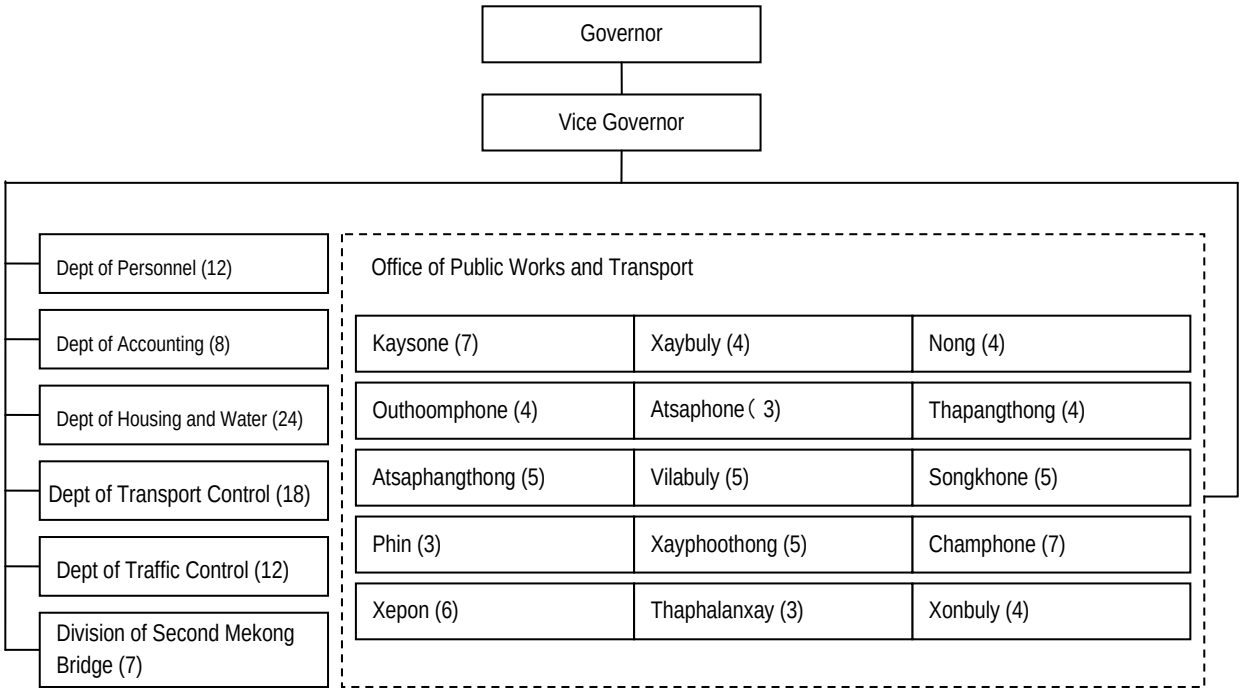


Figure 2.4.2 Organizational Structure of DPWT in Savannakhet Province

The following table compares existing and proposed road maintenance systems, indicating detailed work items of the road maintenance and responsible agencies of these works. The road maintenance system at the project road should be re-structured, considering the following bullet points.

- As mentioned earlier, no routine and periodic maintenance exercise is visible on National Road No. 9, and only major rehabilitation works are being carried out. Accordingly, any necessary arrangements should be immediately undertaken to provide the routine and periodic maintenance on National Road No. 9. To do so, the Japanese side should provide a technical transfer program on the maintenance of asphalt concrete pavement to both implementing agencies and local contractors since very few roads are paved with asphalt concrete in Lao PDR and the local knowledge and skills for maintenance of these asphalt concrete roads are still lacking.
- Through the workshop organized in this Study, it has been noted that the inspection planning, evaluation of the inspection result and audit, which are compulsory with the common maintenance works, are all missing in the actual maintenance exercise in Lao PDR. The existing road operation and maintenance system should be carefully reviewed in the course of the forthcoming technical assistance project, which is expected to contribute to preparation of the technical manuals, technical transfer by on-the-job training and technical seminars, and introduction of the audit system, when necessary.
- Through the interview survey conducted during this Study, some interviewees emphasized the importance of establishing maintenance workshops at the provincial level, mentioning that local contractors in Lao PDR have inadequate knowledge and skills to maintain asphalt concrete roads

and that the current contract-out system in road maintenance does not allow the contractors to conduct the emergent maintenance works in a timely and effective manner. It is recommended that this matter on the regional maintenance workshop should be continuously discussed among the stakeholders and the necessity and feasibility of establishing this workshop should be demonstrated in the course of the forthcoming JICA technical assistance project.

Table 2.4.1 Existing and Proposed Maintenance System for National Road No.9

Work Items	(Routine Maintenance)	(Periodic Maintenance)	Rehabilitation/ Emergency Maintenance
(Inspection Plan)	(MPWT)	(MPWT)	(MPWT)
Inspection	(DPWT)	(MPWT)	DPWT
(Evaluation)	(DPWT)	(MPWT)	(DPWT)
Database Management	(MPWT)	(MPWT)	MPWT
Maintenance Plan	(MPWT)	(MPWT)	MPWT/DPWT
Budget Plan/Disbursement	(MPWT)	(MPWT)	MPWT/ DPWT
Maintenance	(Contractor)	(Contractor)	Contractor
Post-evaluation	(DPWT)	(MPWT)	MPWT/ DPWT
(Audit)	(RMF)	(RMF)	(RMF)

Note: The tasks/agencies in parenthesis show the tasks are not properly implemented by the agencies/contractors. For instance, routine and periodic maintenance is not done along NR-9.

2.4.2 Operation and Maintenance Method

The road improvement project for National Road No. 9 is divided into two projects/sections, considering the necessity and urgency of the Project: i) the seriously deteriorated road sections to be improved by Japanese Grant Aid, where urgent and major repair works are required, and ii) the road sections to be repaired by the Lao side, where minor repair works are required. After the implementation of the Project, the whole of NR-9 needs to be maintained timely and effectively by the Lao side.

The following table proposes detailed undertakings by the Lao side and Japanese side for both improvement/rehabilitation sections and maintenance sections, indicating potential technical assistance by the Japanese side in implementation of these undertakings. The road maintenance of the whole of NR-9 needs to be proposed, considering the following bullet points.

- In order to appropriately maintain the project road, the Lao side is required to complete the following undertakings: preparation of the maintenance plan, estimation of the maintenance cost, budget planning and disbursement, implementation of the maintenance works, and project monitoring and evaluation.
- Amongst these undertakings by the Lao side, it is recommended that the Japanese side should provide technical assistance during implementation of the Project (as soft components of the Project) and in the course of the forthcoming JICA technical assistance project: inventory survey, update/maintenance of the road database, maintenance of the Road Management System (for preparation of the maintenance plan), revision of the unit maintenance cost (for estimation of the

maintenance cost), revision of the bidding procedures, revision of the maintenance manual, provision of technical seminars, implementation of the pilot project (for implementation of maintenance works), and revision of monitoring and evaluation manuals (for project monitoring and evaluation).

Table 2.4.2 Proposed Undertakings by the Lao/Japanese Sides at Improvement Sections and Maintenance Sections

	Improvement Section	Maintenance Section
Undertakings by the Lao Side	Rehabilitation Plan (Grant Aid) Pavement Design/ Construction Plan (Grant Aid) Rehabilitation Cost Estimation (Grant Aid) Budget Plan/ Disbursement Rehabilitation Work (Grant Aid) Project Monitoring/Evaluation (Grant Aid)	Maintenance Plan (Technical Assistance/ Grant Aid) Maintenance Cost Estimation (Technical Assistance) Budget Plan/ Disbursement Maintenance Work (Technical Assistance/ Grant Aid) Project Monitoring/ Evaluation (Technical Assistance)
Undertakings by the Japanese Side	Same above	Nil

Note: Grant Aid: Undertakings of these tasks by the Lao side can be technically supported in the course of this Grand Aid Project (e.g., Soft components of this Project), Technical Assistance: Undertakings of these tasks by the Lao side can be technically supported by the forthcoming technical assistance project.

2.5 Project Cost Estimation

2.5.1 Initial Cost Estimation

(1) Cost Estimate

The total cost of the Project by the Japanese Grant Aid is summarized in Table 2.5.1. This cost estimate is provisional and will be further examined by the Government of Japan for the approval of the Grant. In addition, these approximate project costs will not be quoted as the Maximum Amount of Japanese Grant Aid in the Exchange of Notes immediately just as they are.

Table 2.5.1 Approximate Project Costs

Items			Cost (Hundred Million JPY)
Construction Facilities	Road	Earthwork, Pavement work and other related works	CONFIDENTIAL
	Structure	Bridge, Culvert works	CONFIDENTIAL
	Ancillary work	Drainage, Traffic Safety facilities, Other related works	CONFIDENTIAL
	Subtotal		CONFIDENTIAL
Detailed Design and Construction Supervision			CONFIDENTIAL
Total			CONFIDENTIAL

Note: The cost estimates in the above table are provisional and will be further examined by the Government of Japan for the approval of the Grant.

(2) Condition of Estimation

1) Time of estimate: December 2010
2) Exchange rate: 1US$ =JPY 86.62 (at the above mentioned time)
   1US$= LAK 8,146 (at the above mentioned time)
3) Implementation period: Detailed design and construction period are shown in Table 2.2.41, Implementation schedule
4) Others: On Condition that the Project is implemented under Japan's Grant Aid Scheme, The above mentioned exchange rate is to be reviewed by the Japanese Government.

(3) Costs Borne by the Lao Government Side

Approximate costs required for the undertaking of the Lao Government side are shown in Table 2.5.2. This cost estimate is provisional.

Table 2.5.2 Approximate Costs to be Borne by Lao Government Side

Items	Description	Cost (USDx1000)	Remarks
Environmental Considerations	Environmental Monitoring and Dissemination	50.0	
	Resettlement, land acquisition, and monitoring	200.0	
Relocation of public utilities	Relocation of electric poles, telephone, water supply and optic fibber cables	150.0	
Construction yard	Camp, temporary yard	470.0	
Exemption of VAT(Reimbursable)/ Import duty and custom		2,100.0	6% of construction cost
Payment Commissions		40.0	
Total		3,010.0	

Note ; The costs tabulated in the table are preliminary.

2.5.2 Operation and Maintenance Cost

The periodical inspection, repair/maintenance shall be carried out under the directive of DPWT Savannakhet. The normal cost for operation and maintenance of the portion of National Road No. 9 covered by this project per year is estimated as shown below. The total cost for operation and maintenance per year after four years accounts for approximately 5.0 % of the road maintenance budget for DPWT Savannakhet in 2010 (USD 2.50 million). Accordingly the implementation of maintenance can be adequately carried out.

Table 2.5.3 Approximate Cost for Operation and Maintenance

Items	Frequency	Inspection Place	Work Contents	Approximate Cost (USDx1000)	Remarks
Length: 57.0km					
Drainage	2 times per year	Side Ditch Culvert	Cleaning deposit	33.0	
Road	1 time per year	Road Marking	Repaint	8.3	
Traffic Safety Facilities	2 times per year	Shoulder Side slope	Repair erosion, Weeding	2.0	
Annual operation and maintenance cost				**43.3**	
Pavement	Every year after 7 years	Pavement surface		58.2	
Drainage		Side ditch Culvert		23.0	
Total operation and maintenance cost per year up to 4 years after completion				**81.2**	
Total operation and maintenance cost per year after 4 years				**124.5**	

2.6 Other Relevant Issues

As multiple arterial road and bridge improvement projects have been executed in Lao PDR under Japan's Grant Aid, Lao PDR fully understand the systems and points of concern to implement Japan's Grant Aid project such as land acquisition, resettlement, relocation of public facilities and etc. Therefore, it is thought that problems will not be encountered in executing the project.

However, in addition to compensation payable to those subject to relocation when the project is carried out, changing of utilities, providing a camp site, construction yard and etc. become necessary. Securing these and the procedures involved will have a great impact on project start up. Therefore, these points shall be subject to reconfirmation with the implementing agency in Lao PDR in the detailed design (D/D) stage.

Furthermore, regarding Value Added Tax (VAT) introduced in 2008, a confirmation letter has already been obtained from the implementing agency that Japan's Grant Aid project will be tax-exempt. However, as definite means for tax-exemption procedures have not been indicated as yet, relevant confirmation shall be made in the D/D stage.

3. Project Evaluation

3.1 Recommendations

Daily maintenance is vital to keep asphalt paved roads in good condition. Furthermore, heavily loaded vehicles greatly inflict damage to asphalt paved roads. Based on the aforementioned, the following recommendations are made:

- Poor maintenance of drainage facilities, such as ditches and culverts, causes damage to the road structure due to water penetrating into the subgrade, sub base course and base course. Therefore, thorough cleaning of drainage facilities prior to and during the rainy season is recommended.
- To prevent damage to the pavement structure, not only imposing fines on overloaded vehicles, but also taking measures such as offloading cargo until the specific weight is reached is recommended.

3.2 Project Evaluation

3.2.1 Adequacy

This project involves a vital route linking neighbouring Thailand to Vietnam. Improving and repairing the pavement structure and road structure of damaged sections of National Road No.9 is vital to facilitating economic activity in Lao PDR, and it will provive smoother access to the East-West Economic Corridor.

- National Road No.9 forms a part of the East-West Economic Corridor traversing the Indochina Peninsula and is positioned as a vital infrastructure contributing to AESAN economic unification.
- Owing to no detours instead of National Road No. 9 heavy damaged road sections and parts must improve urgently.
- In order to secure the certain qualities of improvement sections and parts and to manage the construction schedule, Japanese high technology shall be requested.
- Those who benefit from this project will not only be limited to the direct beneficiaries (the 240 thousand residents along National Road No. 9) but also indirect beneficiaries including impoverished residents will amount the 830 thousand residents of Savannakhet Province.

In view of the considerations outline above, it is judged that adequacy to implement the project is high.

3.2.2 Effectiveness

Quantitative effect

- Maximum axle load increases from 9.1 t to 11.0 t
- Average travel speed increases from 44.8 km/h to 56.3 km/h

Qualitative effect

- Smoothness road surface will be kept after improving and repairing the road, vehicle passage safety and comfort will be upgraded.
- Trade and investment will be facilitated in the central region of Lao PDR as an international arterial highway
- Taking agricultural products of the hinterlands to on arterial highways and planning the vitalization of distribution will contribute for development of the regional economy with agricultural and commercial activities.

From the above-mentioned facts, adequacy of the project is deemed to be high and judged that effectiveness can be expected.