MINISTRY OF COMMUNICATION, TRANSPORT,
POST AND CONSTRUCTION
LAO PEOPLE'S DEMOCRATIC REPUBLIC

STUDY REPORT
ON
THE PROJECT FOR CONSTRUCTION OF PAKSE BRIDGE
IN
THE LAO PEOPLE'S DEMOCRATIC REPUBLIC

SEPTEMBER 1996

JAPAN INTERNATIONAL COOPERATION AGENCY
NIPPON KOEI CO., LTD.
CONSTRUCTION PROJECT CONSULTANTS, INC.

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PREFACE

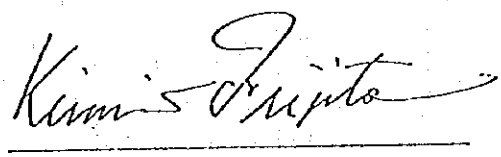
In response to a request from the Government of the Lao People's Democratic Republic, the Government of Japan decided to conduct a study on the Project for Construction of Pakse Bridge in the Lao People's Democratic Republic and entrusted the study to the Japan International Cooperation Agency (JICA).

The study was carried out by the study team organized by JICA and the team conducted the study in Japan. Then, a mission was sent to Laos in order to discuss a draft basic design, and as this result, 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 counties.

I wish to express my sincere appreciation to the officials concerned of the Government of the Lao People's Democratic Republic for their close cooperation extended to the team.

September 1996



Kimio Fujita

President

Japan International Cooperation Agency

September, 1996

Letter of Transmittal

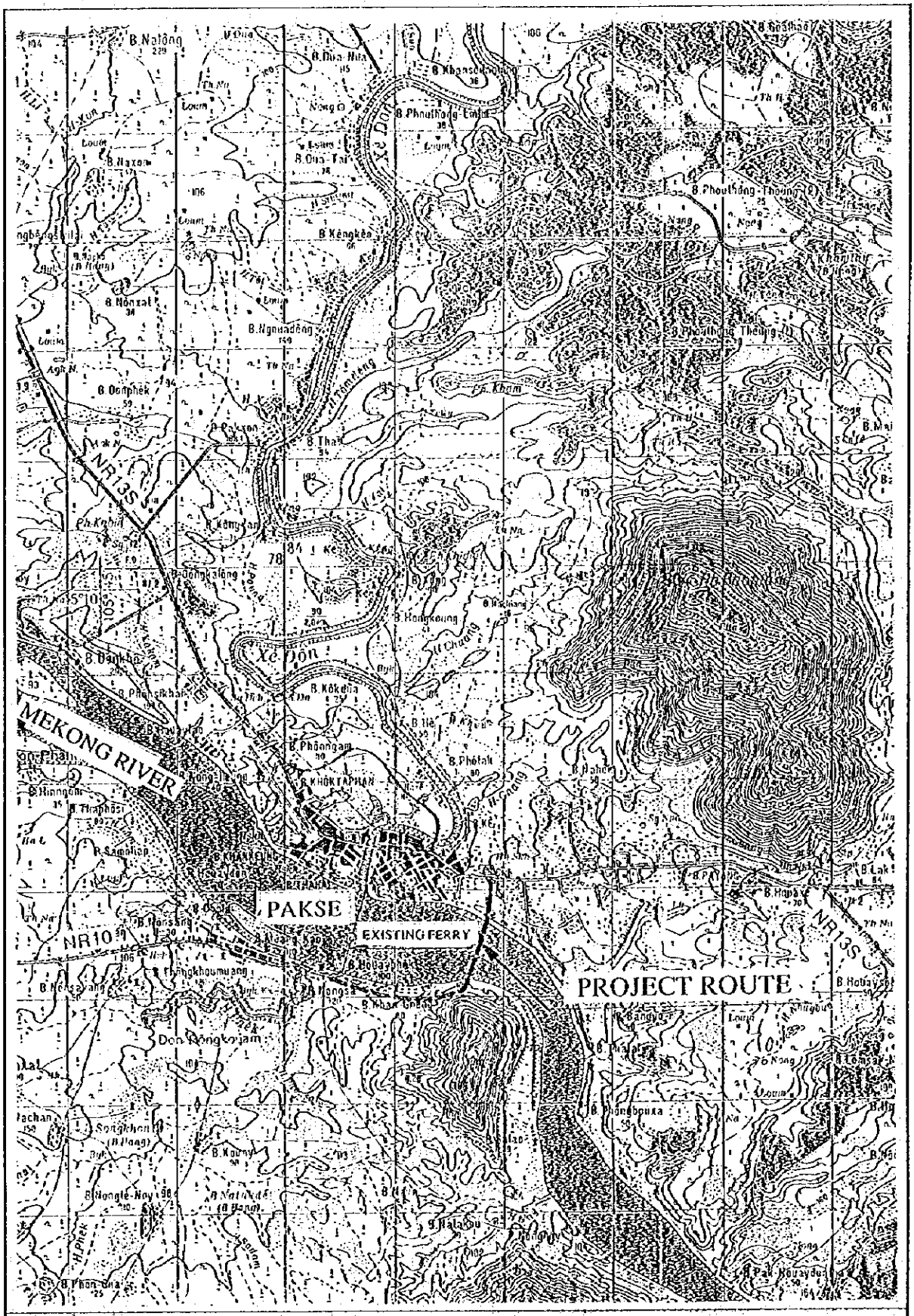
We are pleased to submit to you the study report on The Project for Construction of Pakse Bridge in the Lao People's Democratic Republic.

This study was conducted by Nippon Koei CO., LTD. and Construction Project Consultants, INC., under a contract to JICA, during the period from April 30, 1996 to September 9, 1996. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Laos and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

Finally, we hope that this report will contribute to further promotion of the project.

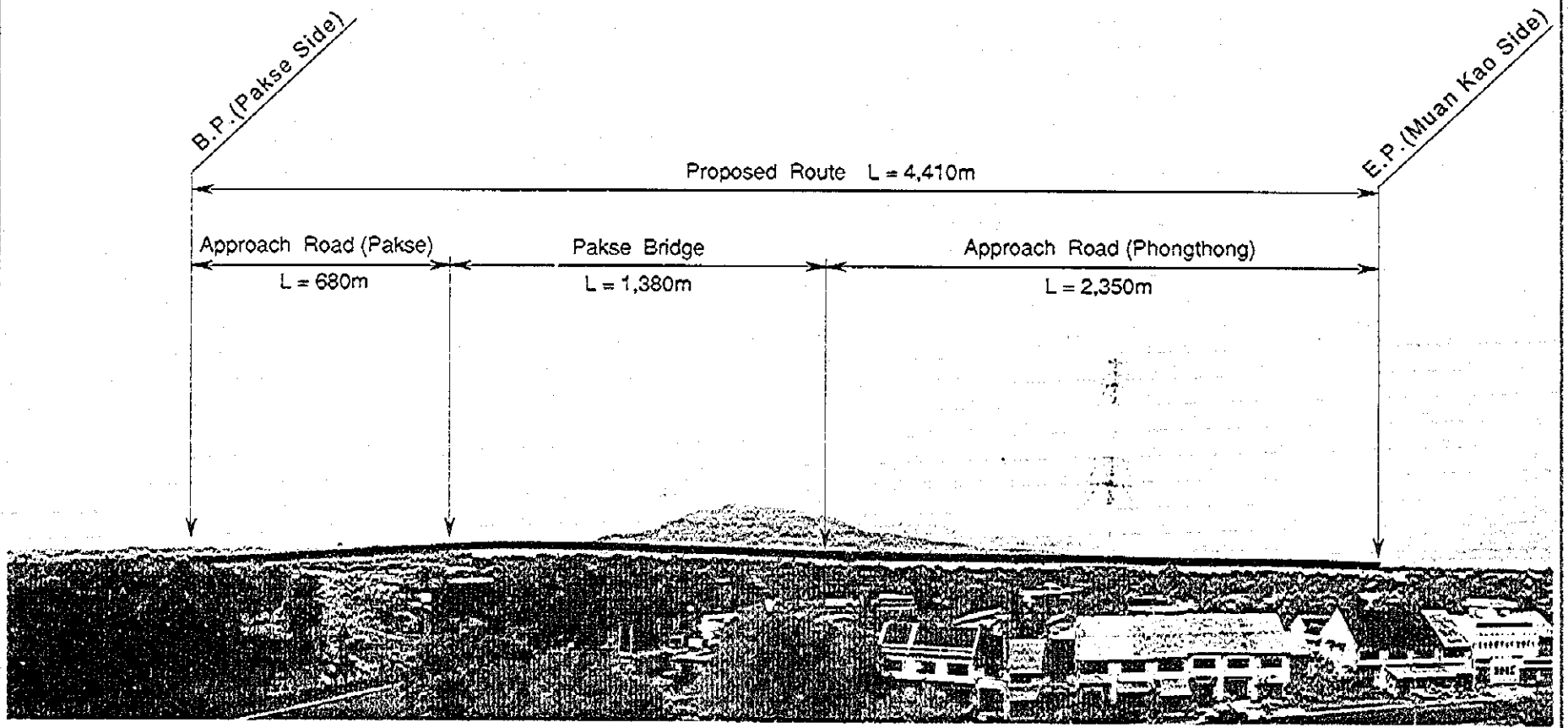
Very truly yours,

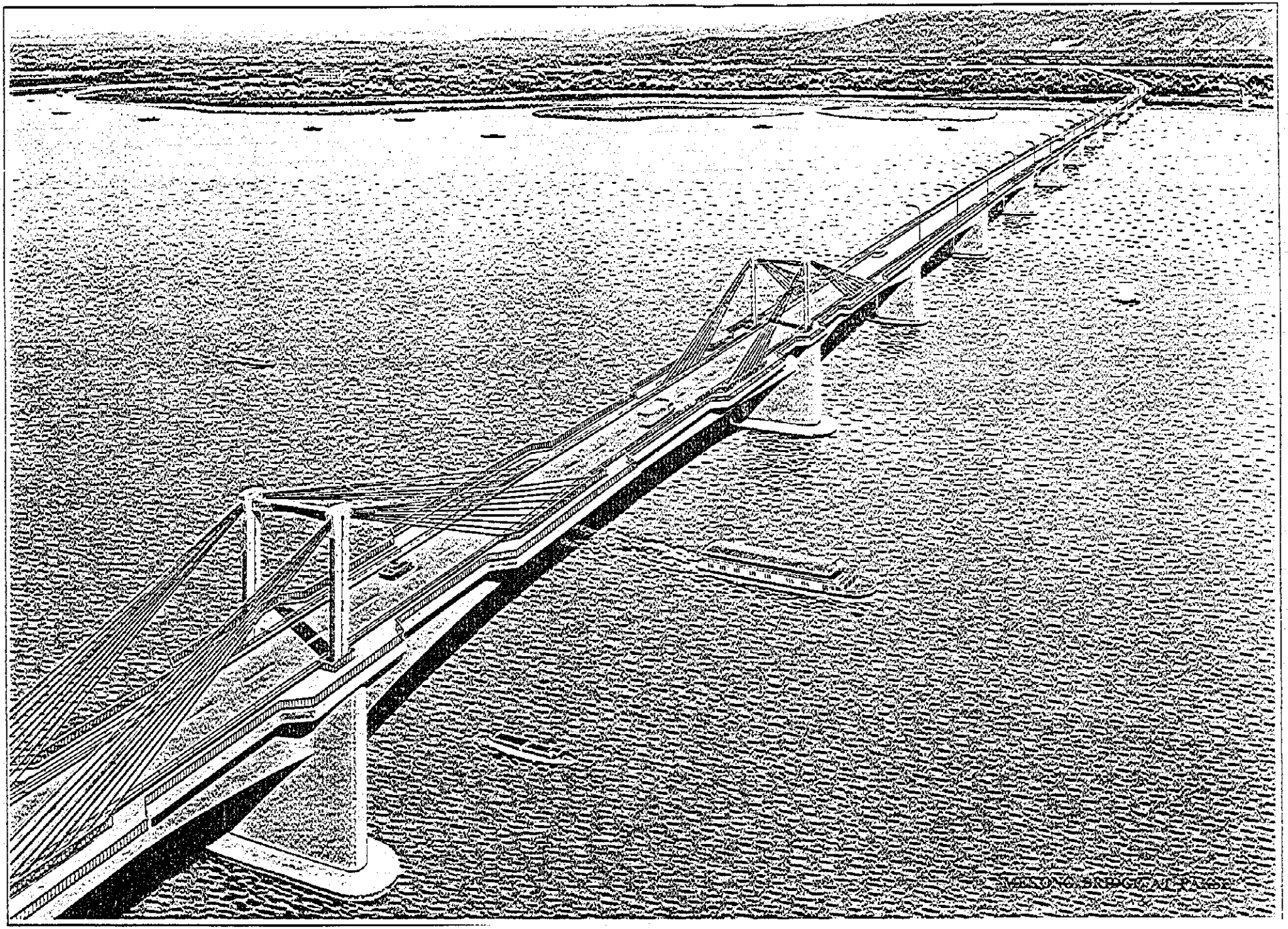
Junji Mashiba
Project manager,
Study team on
the project for construction of Pakse bridge
in the Lao People's Democratic Republic
Nippon Koei CO., LTD.

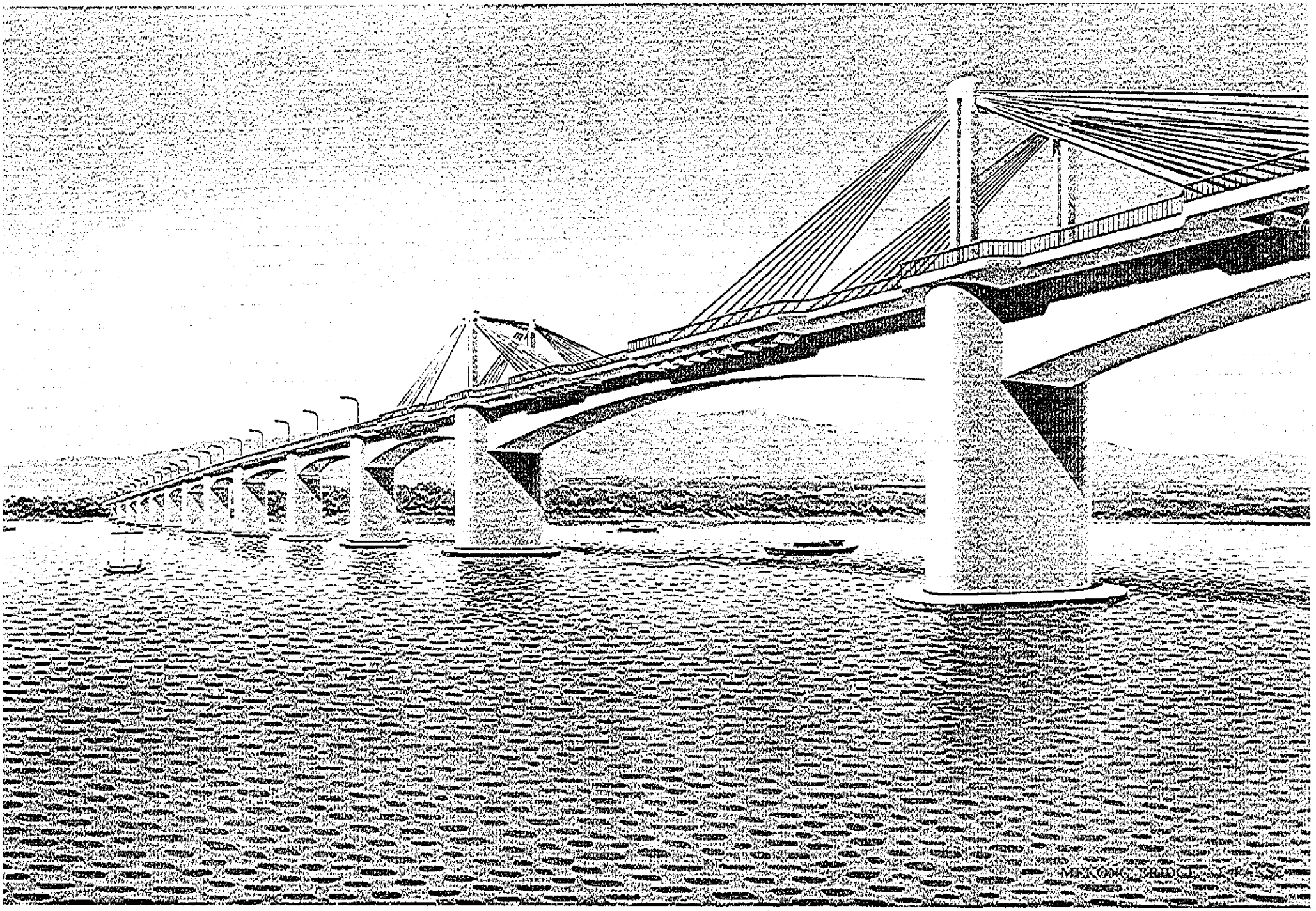


LOCATION OF THE PROJECT

PROJECT ROUTE







ABBREVIATIONS

AASHTO	American Association of State Highway and Transportation Officials
ADB	Asian Development Bank
ADT	Average (Annual) Daily Traffic
AP	Authorization to Pay
BHN	Basic Human Needs
CPC	Committee for Planning and Cooperation
DBST	Double Bitumen Surface Treatment
DCTPC	Department of Communication, Transport, Post and Construction (province or district)
EIRR	Economic Internal Rate of Return
F/S	Feasibility Study
FWL	Flood Water Level
GDP	Gross Domestic Product
HWL	High Water Level
JICA	Japan International Cooperation Agency
LWL	Low Water Level
MCTPC	Ministry of Communication, Transport, Post and Construction (Lao PDR)
NEM	New Economic Mechanism
NR	National Road
O-D	Origin and Destination
PC	Prestressed Concrete
PIP	Public Investment Program
P/Q	Prequalification

CONTENTS

CHAPTER 1. BACKGROUND OF THE PROJECT

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As the Lao PDR is a landlocked country, it is important to secure accesses to the sea and to maintain trade with neighboring countries for economic development. The relations between Laos and Thailand and Vietnam are particularly important for the Lao economy because the both countries have sea ports and construction of road network for the accesses to these sea ports is essential.

With the introduction of the New Economic Mechanism (NEM) in 1986, the Government of the Lao PDR started to move toward a market determined resource allocation system which adopted new policies such as promotion of foreign investment and privatization. The Third Five Year Plan was prepared in 1991 based on the NEM and put up its one of targets to secure the access routes in the both direction of Thailand and Vietnam. The Public Investment Program (PIP) which was announced in 1994 has also put high priority on the formation of the international road network including accesses to Thailand, Vietnam, China and Cambodia.

Formation of the international road network is, however, facing same physical barriers. The development of accesses to Vietnam has to pass the eastern mountainous areas and accesses to Thailand is prevented by the Mekong river. Since the introduction of NEM, Lao economy achieved fairly steady growth and opportunities of interactions of human resources and commodities are expected to increase in the future. The bottleneck of the Mekong river, however, may suppress such a development trend.

Pakse and Boloven Plateau in the southern provinces of Lao PDR are rich in agricultural resources such as rice, coffee, fruit, cash crops and timber product. This area almost monopolizes coffee production for export. At present, agriculture developments projects by the World Bank, Swedish government and Japanese government are ongoing. At the same time, 6 th and 7th road development projects under the program by the Asian Development Bank (ADB) are also progressing. The improvements of trunk road network by ADB are scheduled to be completed by the year 2000. If only the bottleneck of crossing over the Mekong river remains to be solved in the improved road network, the effects of road network will be reduced and accordingly other development projects such as agricultural and industrial development will not be promoted efficiently, as a result, the targets of the government of Laos such as promotion of trade with neighboring countries and realization of continuous economic development may not be achieved.

Under such situation, the Government of Lao PDR recognized that the construction of the Mekong bridge at Pakse would be a key project in the southern Laos and requested to the Government of Japan for the feasibility study on the project in April 1994. In response to the request, the Government of Japan has decided to conduct the feasibility study and entrusted the study to the Japan International Cooperation Agency (JICA). The feasibility study has commenced from July 1995 and completed in June 1996. During the course of the feasibility study, the Government of Laos requested the Government of Japan to implement the project under the Japanese grant aid facility. In response to this request, the Government of Japan has decided to conduct a further study in order to formulate the most appropriate design for the project under Japan's grant aid scheme.

CHAPTER 2. CONTENTS OF THE PROJECT

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2.1 Objectives of the Project

The Government of Lao PDR has introduced new economic policies since 1986 and put the highest priority on the development of infrastructures, especially on the improvements of road network in order to accomplish the policy targets and these strategies are reflected in the "Third Five Year Plan" and "Public Investment Program 1994 - 2000".

The above national development plan and program aimed at promoting the development of agricultural and industrial sector and to realize the continuous economic growth of the country through the formation of road network and construction of international links to neighboring countries.

The Project aims at constructing a bridge over the Mekong river at Pakse in order to facilitate efficient road transport to the connecting section between NR 10 and NR 13S where river crossing is being ensured by ferries. It is expected that this construction project will contribute to socio-economic development not only in the southern region of Laos, but also in Indochina as a whole because NR 10 and NR 13S are international roads leading directly to Thailand and Cambodia respectively.

2.2 Basic Concept of the Project

The basic concept of the Project is to construct the bridge at Pakse with approach roads replacing the existing ferry facilities in order to improve the road transport network in and around Pakse.

The fundamental dimensions on the Project were established in the latest study, "Feasibility Study on the Mekong Bridge at Pakse" hereinafter referred to as F/S, implemented by JICA, for the whole road route of 4,410 m long composed of the 1,380 m long river crossing bridge and the 3,030 m long approach roads.

The scale and quality of the design of the above facilities have been reviewed and determined taking the following into consideration in this study;

a. To provide permanent facilities capable of meeting the traffic demand forecast in the long term; and

b. To implement the project in conformity with the Japan's Grant Aid Scheme and its procedure.

2.3 Basic Design

2.3.1 Design Concept

1) Design concept

The basic design concept applied for the proposed bridge and roads is as follows:

(1) Natural Conditions

The climate at the Project site is distinctly divided into two seasons, rainy season and dry season, and the water level of the Mekong river varies more than 10 m in a year. These meteo-hydrologic conditions restrict the selection of the structural type of foundation of the bridge and the construction method in the river. Under these conditions, it is judged that adoption of the small scale foundation structure type is appropriate, although the construction of all of the foundation and most part of the substructure could not be excuted in the rainy season.

The annual mean air temperature at Pakse is around 27°C and the recorded extreme highest air temperature is 40°C. Therefore special emphasis should be paid to material design and concrete works as well as structural design for thermal effect.

The river bed deposit consists of alternately layered sand and gravel sediments with a thickness of 10 m - 15 m and mud stone and/or basalt lay under the river deposit . Considering these subsoil conditions, pile structure would be appropriate as a foundation type.

Although no earthquake effect has been recorded in and around the Project site and no epicenter observed in the past within 300 km from the Project site, a seismic coefficient of 0.05 for earthquake resistance design would be adopted as a minimum requirement for the design horizontal force.

Other natural conditions, such as humidity, wind force, and river flow velocity are also considered for their eventual physical effects in the

structural design, even though they might not severely affect the structure.

(2) Social Conditions

There is no special regards paid to the social conditions in LAO PDR on design principle of the Project.

(3) Construction Circumstances

Laos has technical experience in prestressed concrete engineering for small scale bridge structures. However, mechanized construction methods are not exercised. Not only equipment but also skilled labor and engineers for road and bridge construction are limited in Laos. For the prompt execution of the Project, some mechanical equipment and construction staff are required to be mobilized from outside of the country.

Raw materials for concrete aggregate and road pavement can be procured from licensed local suppliers.

Most of all construction equipment and other materials such as cement and steel can be easily procured from Thailand. However, special parts and materials for the bridge structure should be imported from Japan.

The embankment materials for subgrade of roads will be procured from the borrow area near the construction site.

(4) Local Contractors

There are 4 major construction companies being engaged in road and bridge construction. Each company currently manages some 300 staff. Although they have no experience in big scale bridge construction, they can participate in the Project implementation as subcontractors to Japanese construction firms.

(5) Capacity of Road and Bridge Maintenance

Most of the projects in the transportation sector which are currently implemented by the Communication Department, MCTPC, concern road betterment and are called "road maintenance projects". These projects are assisted by foreign aid agencies, since most of existing roads have been too deteriorated to be maintained by routine maintenance works. National

budgets also are allotted mainly to these road betterment projects and the budgets for routine inspection and maintenance are insufficient to meet the requirements. Therefore the facilities of the Project shall be maintenance free structure as much as possible. In this aspect, concrete structures are mainly proposed for the Project.

(6) Facilities of the Project

The facilities of the Project are composed of a river crossing bridge and approach roads connected with NR 10 and NR 13S. The general plans adopted in the feasibility study should be reviewed taking the above design principles into consideration.

The facilities of the Project as well as NR 10 and NR 13S shall have a national road transport of the dual single lane (2 lanes) facilitating traffic demand in the long term.

The river crossing bridge should be consist of a prestressed concrete superstructure and a cast-in-situ pile foundation of extrusion type as proposed in the Feasibility Study and conforming to the above design principles.

The approach roads should be constructed at the same grade as ADB 7th Projects for NR 10 and NR 13S as proposed in the Feasibility Study.

2) Future Traffic Demand

- Future Socio-Economic Framework

The Government of the Lao PDR has announced the "Public Investment Program 1994-2000" in June 1994 which indicated that GDP growth would be maintained at 7% per year to 1995/96 and then at 8% to the year 2000. The same growth rate was adopted in the traffic forecast in the Feasibility Study. It seems, at present, that the Government has no intention to change the above target rate. Actually, the Lao economy has achieved fairly steady growth averaging 6.2% per year over the past four years (1991-1994). Especially in 1994, actual GDP has recorded a high growth rate of 8%. Considering penetration of market economy and progress of improvement of infrastructure such as road development, the target rate of 8% up to 2000 is considered to be reasonable. Therefore,

there are no reasons to change the socio-economic framework established in the Feasibility Study.

- Present River Crossing Traffic at Pakse

Present traffic volumes crossing the Mekong river at Pakse were surveyed in the Feasibility Study in August 1995. On the other hand, the same kind of traffic survey was carried out by ADB for the "East-West Transport Corridor Study" in the same month. The two survey results are compared and summarized below:

Vehicle Type	JICA (F/S)	ADB*
Motorcycles	388 /day	320 /day
Car, Pickup	80	80
Bus	14	8
Samlor	15	26
Truck	99	113
(Total)	(596)	(547)

Source * : "East-West Transport Corridor Study : Traffic Study at Champasak, Savannakhet and Khammouan Provinces", CDRI, 1995

Considering variations of daily traffic, the results of both surveys shown above are quite similar. Therefore, the basic data of the present traffic obtained in the Feasibility Study are considered to be correct and need not to be updated.

- Process of Future Traffic Forecast

Future traffic demands on the Project bridge were forecast based on the following:

The present O-D matrix of traffic on the Mekong bridge at Pakse was established based on the results of traffic count survey conducted by the JICA Study Team and applying the O-D pattern at Km12 of NR10 surveyed under the "ADB 7th Road Improvement Project".

Future population was forecast on the basis of past trend and projection under the "ADB 7th Road Improvement Project". The expected macro economic growth rates for the Lao PDR and other surrounding countries were set based on the National Development Plans and related studies

such as "Sub Regional Transport Sector Study, ADB" and "ADB 7th Road Improvement Study". The estimated figures are shown below :

	1994-2000	2000-2010	2010-2020
Population Growth (Champasak province)	2.0%p.a.	1.7%p.a	1.2%p.a.
GDP Growth Rate	8.0%	6.5%	5.0%

A traffic growth model was established based on the historical traffic data and applying population of the Champasak province and GDP. The traffic growth rates were calculated by inputting future socio-economic indices as shown below :

	1995-2000	2000-2010	2010-2020
Light Vehicles (Car, Pickup, etc.)	13.3%p.a.	8.7%p.a.	5.5%p.a.
Truck	7.5%	6.1%	4.1%

The future O-D matrix for the normal traffic was obtained applying the above overall growth rates and growth rates by traffic zone to the present O-D matrix. Furthermore, induced traffic (newly generated traffic by the bridge)) was estimated from an induced traffic model which includes travel time as an explanatory variable. In addition, the following two kinds of traffic were forecast and incorporated into the O-D matrix of normal traffic :

- Development traffic that will be generated from the agricultural development projects in the Boloven Plateau.
- International trips between northern Thailand and southern Vietnam applying future goods transportation.

- Results of Future Traffic Forecast

The results of traffic forecast are as shown below:

Vehicles / day (ADT)			Growth rate per year	
2000	2010	2020	2000-10	2010-20
1,460	3,451	5,737	9.0%	5.2%

The present traffic volume of 596 vehicles (including motorcycles) will grow to about 5,700 vehicles in 2020, i.e. about 9.6 times the present traffic.

2.3.2 Design Criteria and Standards to be Applied

1) Bridge Design

a. According to the Road Design Mannual compiled by MCTPC in 1994, the live load of HS-25-44 specified by AASHTO will be applied for the bridge design.

b Other design conditions and calculation method should be based on the bridge specifications compiled by the Japan Road Association in 1992.

c. Meteo-hydrologic effects will be considered according to the data surveyed in the Feasibility Study. The varying range of design temperature should be reduced to 10°C. A basic seismic coefficient of 0.05 for static horizontal analysis of the bridge structure should be employed as a minimum requirement for horizontal force design.

d. Navigation clearances under the bridge should be secured as follows according to the discussion with MCTPC as described in the Feasibility Study.

- Vertical navigation clearance

  For the 2 middle spans: Not less than 10 m

  For side spans excluding extreme side spans: Not less than 5.5 m

  These clearances should be calculated from H.W.L of the river

- Horizontal navigation clearance:

  For all spans excluding extreme side spans: Not less than 60 m

e) Design water level and discharge

According to the result of analysis in the Feasibility Study, the relationship between water level and discharge is as follows:

F.W.L	EL 101.24 m	54,070 m3/sec
H.W.L	EL 97.78 m	36,291 m3/sec

L.W.L EL 87.10 m 1,692 m3/sec

Where, F.W.L: Flood water level with a 100-year return period
H.W.L: Annual mean high water level
L.W.L: Annual mean low water level

f) River erosion

The river erosion conditions were evaluated by a comparative analysis of river bank maps prepared in different years and a verbal information obtained at the site. Results of these investigations show that the river bank is eroded approximately 1.0 m per year, by the wearing action of water flow.

g) Scouring and sedimentation

The scouring and/or sedimentation phenomena were examined by the Lacey's theory, and it was judged that the river section along the project route will not be affected by scouring but sedimentation. However, a scouring depth of 5.0 m was considered in the design anticipating local scouring around piles.

2) Road Design

a. The Road Design Mannual of MCTPC could be used for the Project road design. The Project roads are classified as National Road, and graded as Road Standard III in the "Geometric Design Standards for Rural Roads" of the said Mannual.

b. Accordingly, the design speed of the Project roads should be 80 km/hr.

c. A 40-meter right of way is applied for this Project as well as NR10 and NR13S. The right of way of the Project should not invade the lands of traditional and/or religious facilities.

d. The formation heights of the approach roads should be so planned as the sub-base course of road pavement will not be submerged even at H.W.L.

e. Crossings should be constructed so that the communities around the Project roads are accessible to each other.

2.3.3 Basic Design

1) Bridge Location and Proposed Route

The bridge location and proposed route were determined in the Feasibility Study, based on the analysis results of comparative study of economic aspects, engineering consideration, and environmental evaluation.

The bridge site is located at around 2 km downstream of the existing ferry site. The approach road on Pakse side will be connected to NR13S at Km 2+100 and the approach road on Phonthong side will be connected to NR10 at the latter's terminal point. (Refer to Figure 2.3-1)

2) Elements of the Route

(1) Number of lanes

The dual single lane was employed for the Project route considering the future traffic demand forecast for 2020.

(2) Carriageway width

The width of the carriageway per lane was designed to be 3.5 m according to the Road Design Manual of MCTPC.

(3) Shoulder

The shoulder width of 2.0 m was adopted for the approach roads in conformity with the ADB 7th Project. For the bridge section, a narrower shoulder width of 0.5 m, which is minimum lateral clearance, was adopted.

(4) Standard cross sections

The standard cross sections of the bridge and roads composed of the above elements are shown in Figure 2.3-2.

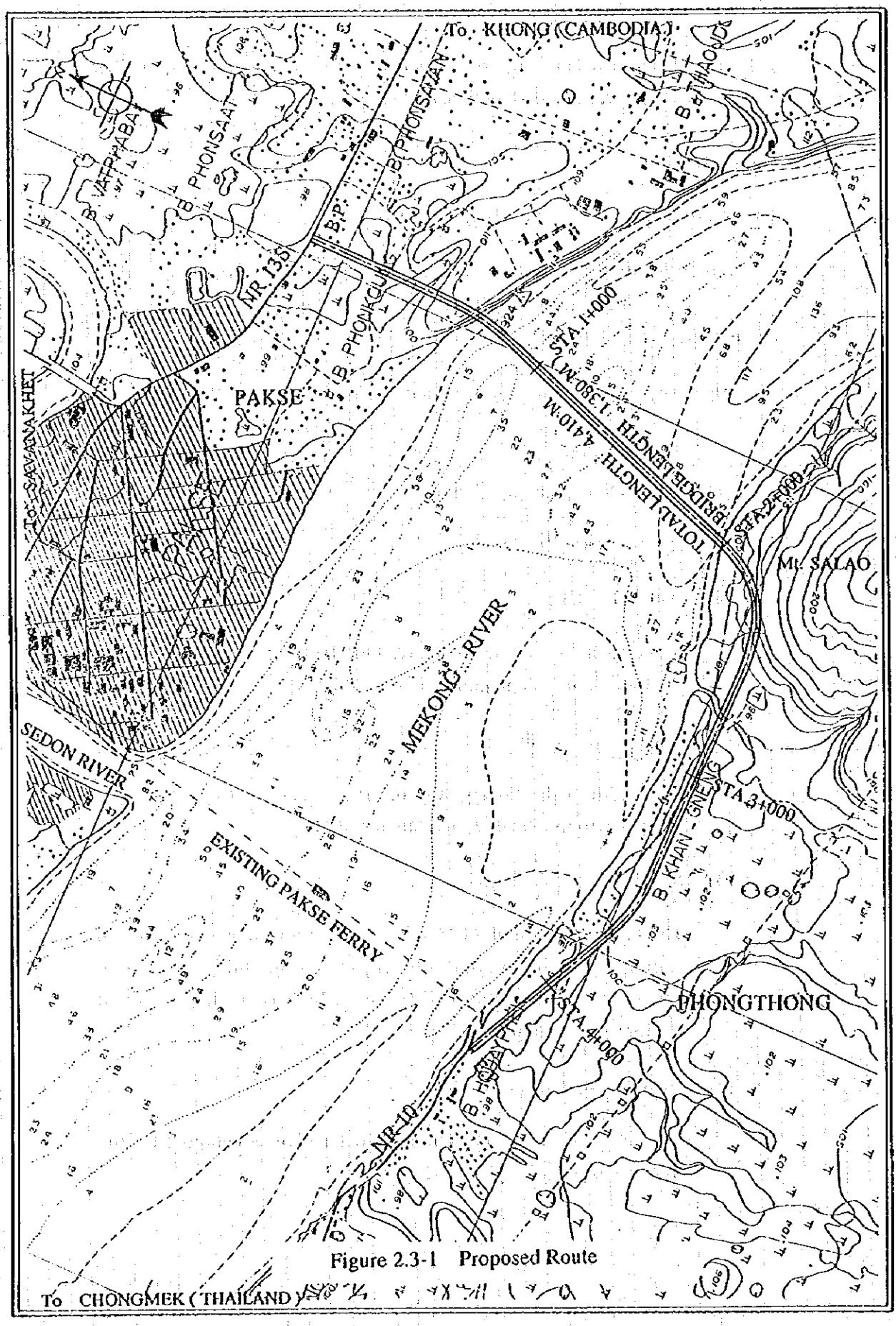
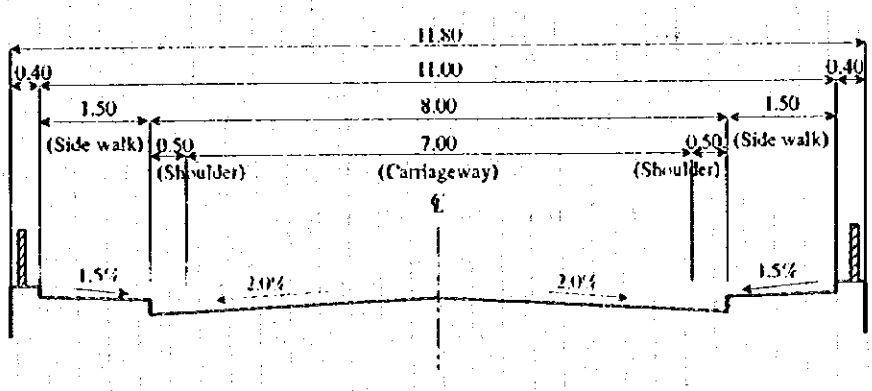
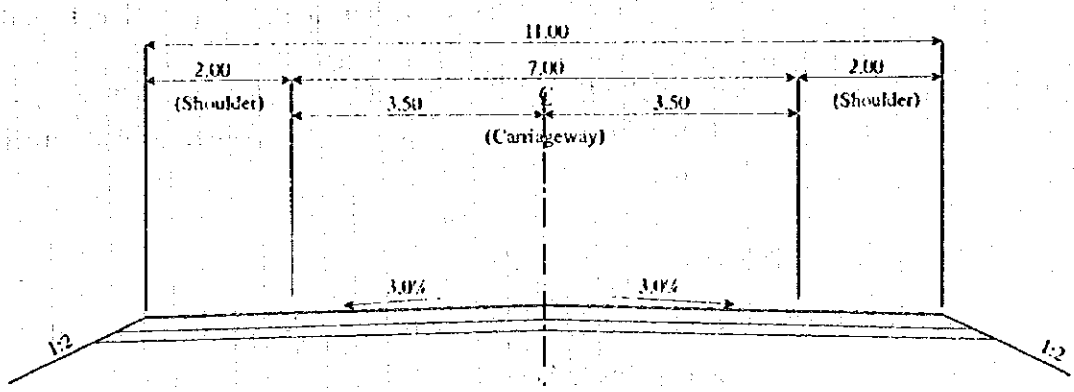


Figure 2.3-1 Proposed Route



a) Standard Cross Section of Bridge



b) Standared Cross Section of Approach Roads

Figure 2.3-2 Standard Cross Sections

3) Bridge

(1) Bridge length

The bridge length was determined to be 1,380 m taking into account the location of the abutments, which were set based on the following requirements and site conditions:

a) The abutment should be set back from the shoreline at F.W.L so as not to block the river flow;

b) River bank erosion on the left bank (Pakse side) should be considered. The design bank erosion extent was estimated at 50 m considering the design life of the bridge. This erosion extent should be measured from the shoreline at H.W.L; and

c) The stability of abutments and approach road embankments should be maintained even if the estimated bank erosion occurs.

(2) Foundation structure type

The foundation types applicable to the bridge considering the site conditions are as follows:

- Cast-in-situ pile foundation of extrusion type;
- Inter-locking steel pipe pile well; and
- Open caisson.

The cast-in-situ pile foundation of extrusion type with a pile diameter of 1.5 m, was selected in view of the construction cost and workability of foundation. The pile cap, which is a footing of pier shaft, was designed to be constructed above L.W.L. (Refer to Figure 2.3-3)

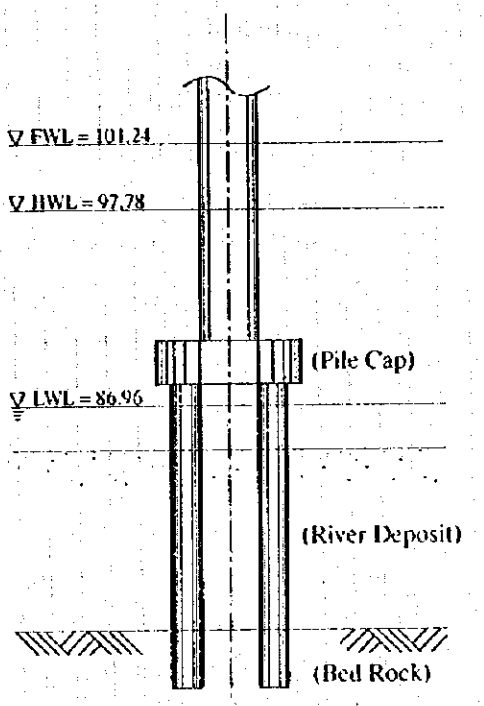


Figure 2.3-3 Pile Foundation

(3) Superstructure Type

In the selection of the superstructure type of the bridge, the following aspects were mainly considered besides the cost aspect:

- To be as much as possible free from maintenance after construction; and
- To use local materials as much as possible.

The superstructure types applicable to the Project considering the above aspects are the following:

- Multi-series of continuous PC box girder
- Continuous rigid frame PC box girder with center hinge
- Multi-series of cable-stayed PC box birder

A cost comparison of the above types was carried out and the continuous rigid frame PC box girder type with center hinge was selected.

(4) Span length and span composition

The span lengths of the bridge section were determined from an economical viewpoint and based on the result of analysis of the cost relationship between construction cost and span length. The economical span lengths were found to be around 100 m for the relatively shallow section and around 150 m for the deepest section of the river. Cosequently, the span arrangement throughout the bridge section was determined as shown below:

$$1,380\ m = 70\ m + (102\ m \times 10) + 150\ m + 102\ m + 38\ m$$

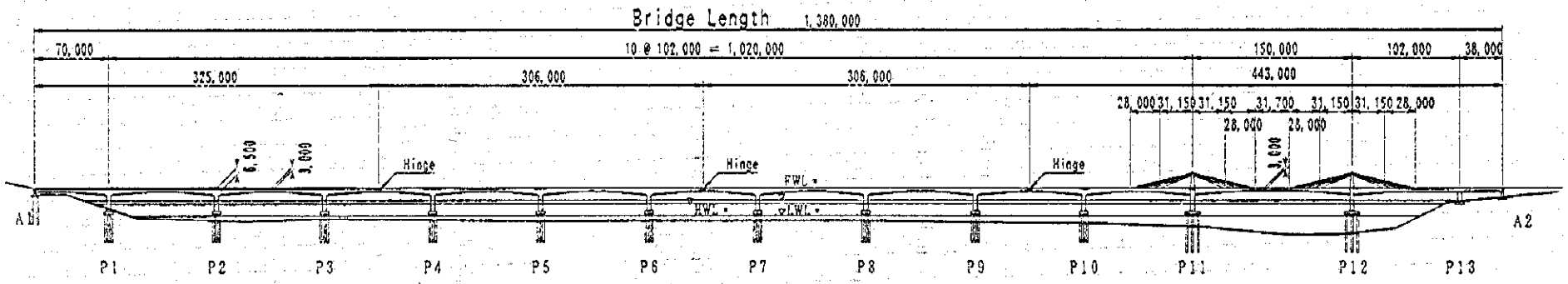
As the continuous rigid frame PC box girder type is applied for the long bridge section, non-continuous section such as center-hinged sections are required to be placed alternately along the spans to release the longitudinal force action due to elongation or contraction of the bridge girder. The number and positions of center hinges required for the bridge are as shown in Figure 2.3-4.

(5) Structural dimensions of superstructure

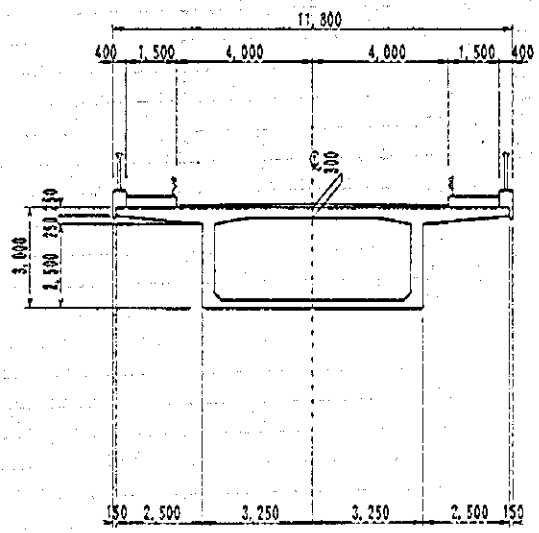
The geometric main dimensions of the box girder structure were determined for a span of 102 m in length. The girder cross section is of single box type with canti-lever slab decks since the bridge width is 11.8 m. The section with a 150 m long span is reinforced with extradosed cables so as not to vary the main dimensions of the box girder determined for the section with 102 m spans. The towers supporting extradosed cables at piers and the anchoring of extradose cables into main girder are installed in the area between the carriageway and the sidewalk. The bridge width is extended by 1.4 m on both sides to 14.8 m in the section were towers or anchors are installed.

The girder depth of 6.5 m at pier was employed aiming at 1/16 of span length. The depth of 3 m at span center was determined due to the minimum requirement for the space installing center hinge shoes. The structural dimensions are shown in Figure 2.3-4

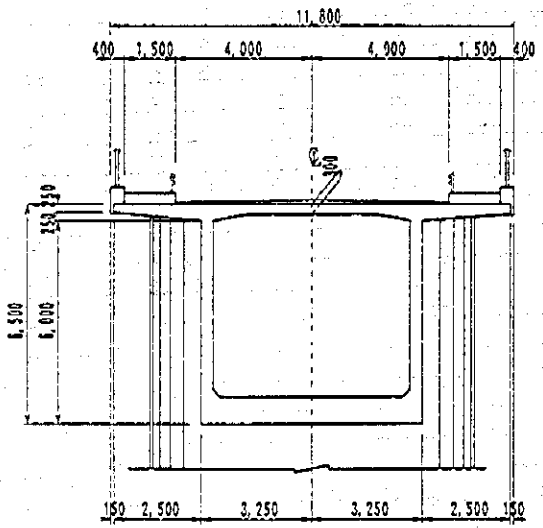
Side View S=1:4000



Cross Section of Span Center and Girder End S=1:150



Cross Section at Pier S=1:150



Cross Sections of Extradosed PC Girder S=1:150

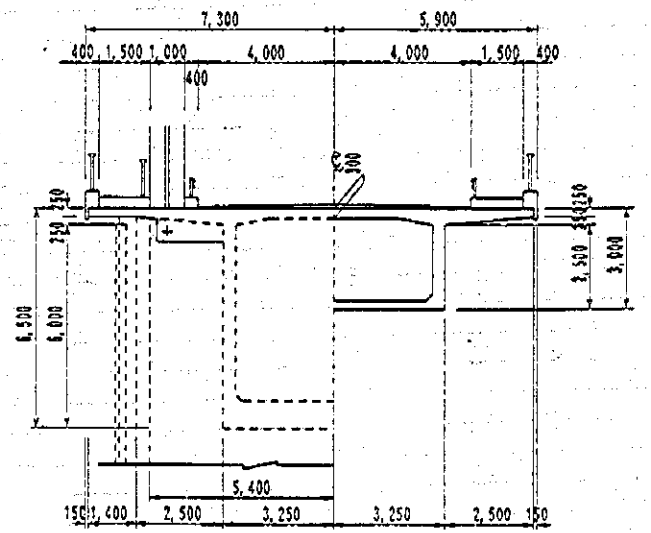


Figure 2.3-4 General View of Pakuse Bridge

4) Approach Roads

(1) Geometric Design

The approach roads were designed taking into consideration the following basic requirements.

- To maintain smooth traffic flow between the proposed roads and existing road network; and
- To minimize the environmental effect around the road sites.

a) Horizontal Alignment

The horizontal alignment of approach roads was determined taking into consideration the following factors for the whole route:

- To avoid curves in the bridge section as much as possible;
- To avoid small radius horizontal curves and short curve length; and
- To avoid sharp curves.

Accordingly, the minimum curve radius of the horizontal alignment is set at 400 meters and clothoidal transition curves were applied for smooth alignment.

b) Vertical Alignment

The vertical alignment along the center line was mainly based on the flood water level, the formation heights of the bridge section around the river banks and the designed elevations of NR13S and NR10 in the ADB 7th Project. (Refer to Figure 2.3-5) Other considered factors controlling the vertical alignment design are:

- To keep generous gradient (maximum 4.00%, minimum 0.30%);
- To select vertical curve lengths which match with coincidental horizontal curves; and

- To make formation between the proposed roads and the existing roads and/or otherwise planned roads which intersect each other.

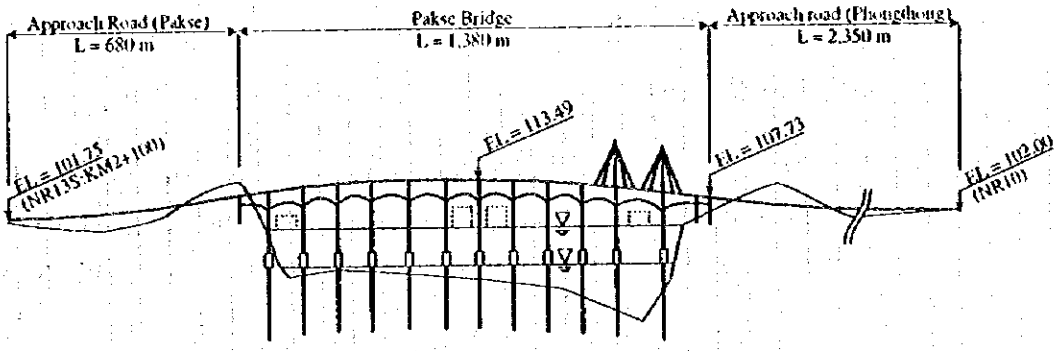


Figure 2.3-5 Vertical alignment

(2) Pavement Design

The pavement design was carried out in accordance with the "Pavement Design, Road Design Manual Part III, Lao PDR". The pavement consists of a subbase course, a base course and a surface course. The subbase course having a 15 cm thickness will be constructed with lateritic soil, while the base course, having a thickness of 20 cm, shall be a mixture of gravel with lateritic soil.

The road surface of the carriageway shall be paved by DBST (Double Bituminous Surface Treatment) method using screened gravel.

(3) Miscellaneous Road Structures and Facilities

- Guard Post

Guard posts for traffic safety were designed to be installed in the sections of high banking and outer curvature.

- Guardrail

Steel guardrails were designed to be installed in the sections of the approaches of 200 m long each to the main bridge.

(4) Intersection with NR13S

For the connection of the Approach Road with NR13S, a T-shape junction at grade was adopted.

It was considered that the traffic signal facilities would not installed for the time being.

(5) Box Culverts

The approach road of Phonthong side crosses two small rivers. The crossings were designed to be box culvert type in viewpoint of cost-effect and workability of the construction comparing with bridge type.

CHAPTER 3. IMPLEMENTATION PLAN

CHAPTER 3 IMPLEMENTATION PLAN

3.1 Implementation Plan

3.1.1 Implementation Concept

In case the Project is executed under a grant aid from the Japanese Government, the implementation concepts are as follows:

1) The Project will be implemented in 2 stages; the detailed design stage and the construction stage, considering the size of the Project.

2) The detailed design, which would require around 8 months for preparation of the required documents, should include detailed site investigations such as geological investigations and supplementary geographic surveys.

3) The construction will be commenced after selection of the contractor from Japanese firms through pre-qualification and competitive tender. The actual construction works following the preparatory works should be started at the beginning of the dry season. The construction period is proposed to be 35 months, and shall be executed within 4 fiscal years of Japan.

4) The construction works consist of 4 major components: bridge substructure, bridge superstructure and 2 approach roads. For the prompt execution of the Project, these construction works will be carried out in a single package.

5) Most of raw materials and labor for the construction will be procured in Laos in principle, and major processed materials and equipment will be transported from Thailand. NR 10 will be used as the main transport route for imported materials and equipment.

6) A precast segment erection method will be employed for the superstructure construction, therefore the substructure works and superstructure works will start at the same time. The mobilization schedule for plant and machinery should correspond to the method.

7) In each construction stage, especially the pile foundation construction stage and fabrication of girder segments and their erection stage, Japanese specialists should be dispatched for engineering supervision.

8) The Project will be executed paying most attention to the environment and ecology nearby the site.

9) The executing agency on the Lao side is the Communication Department, MCTPC. The administration office for the Project will be established on site for smooth implementation of the Project .

10) The major construction items are the following:

- Bridge construction

(Substructure)
Extrusion type cast-in-situ piles foundation socketted into rock
Concrete pile caps constructed above L.W.L
Concrete shafts for bridge piers

(Superstructure)
Fabrication of precast segments of PC box girder
Cast-in-situ pier top segments
Transportation and erection of precast segments
Installation of bridge accessories

- Approach roads construction

Soil embankment and slope cutting
Pavement with DBST
Slope protection with sodding
Concrete box culverts for underpasses

3.1.2 Implementation Conditions

To implement the Project, the following factors which concern coordination of the work areas, construction method, procurement of materials, relevant projects and so on must be considered:

1) The Project needs 300 - 500 staff and labors a day during the construction period, that might be composed of foreign nationals. A well organized coordination system to manage them should be required for smooth implementation.

2) A work yard of around 25,000 m^2 should be secured nearby the Project site in the earliest stage of the Project. The prospective site for the work yard is located on the Phonthong side along the project route. It needs to be reclaimed and developed to be used in all seasons throughout the whole construction term.

3) NR 10, which has 4 old Bailey bridges limiting heavy vehicle load, will be used as the major transport route for mobilization of materials and equipment to and from the Project site. NR 10 scheduled to be repaired under the ADB 7th Maintenance Project which starts in October 1996. Detailed information on the serviceability of NR 10 should be required for smooth implementation of the Project from the earliest stage to the completion of the Project.

4) The construction of pile foundations for all bridge piers will be a key issue to be executed in the first dry season after the commencement of the Project. To this end, a well studied construction method and schedule will be required.

5) Raw materials such as gravel and sand are available in the Mekong river around the site throughout the year except in the highest water season from July to September. Extraction of aggregates from the river is not carried out at present. Stocking of raw materials should be planned according to the construction schedule and above procurement conditions.

6) The intake tower of the Pakse water pump station is currently operated immediately downstream of the proposed bridge. During the construction of the Project, the location of the intake mouth should be shifted upstream of the Project bridge to prevent water pollution that might be caused by the bridge construction.

3.1.3 Scope of Works

The scope of the Project works as mutually agreed by the Japanese side and Lao side covers the following:

1) Works to be undertaken by the Japanese side

(1) Consulting Services

- To carry out detailed design
- To prepare tender documents for construction
- To assist in tendering for construction
- To supervise construction

(2) Construction

- To construct a 2-lane road bridge of 1,380 m long with sidewalks
- To construct two 2-lane approach roads of a total length of 3,030 m

(Pakse side: the 680 m section between the bridge end and NR 13S KM 2+100)
(Phonthong side: the 2,350 m section between the bridge end and the terminal point of NR 10)

2) Works to be undertaken by the Lao side

- To secure the right of way for the Project
- To clear the site
- To provide temporary necessary land space for the work yard and Project office

3.1.4 Construction Supervision

The services will cover assistance in tendering and construction supervision.

The required Japanese staff and their responsibilities are described below:

(i) Proejct Manager/Resident Engineer

Responsible for all the activities related to the consulting services during the tendering and construction supervision.

(ii) Superstructure Engineer

Responsible for the supervision of fabrication and erection of the bridge.

(iii) Substructure Engineer

Responsible for the supervision of construction of the foundation and substructure of the bridge.

(iv) Highway Engineer

Responsible for the supervision of construction of the approach roads and their ancillary structures.

(v) Soil/Material Engineer

Responsible for checking and advising on quality control of the materials for the bridge structure and approach roads.

3.1.5 Procurement Plan

The construction materials to be used for the Project are mostly available in Laos and Thailand. However, some of the materials are planned to be procured from Japan as shown in Table 3.1.2.

As for the construction machinery and equipment, a procurement plan is shown in Table 3.1.3.

Table 3.1.2 Procurement of Construction Materials

No.	Description	Specification	Procurement Sources		
			Laos	Japan	Others (Thailand)
1	Cement	Portland cement, 40 kg/bag			○
2	Concrete Admixture			○	
3	Gravel for Concrete Aggregate	under 50 mm	○		
4	Crusher run		○		
5	Asphalt Emulsion	Various sizes			○
6	Deformed Steel Bar	Each size			○
7	Timber	Each size	○		
8	Water-proof Plywood	12 mm*0.9 m*1.8 m			○
9	Fuel Oil	Gasoline & diesel oil	○		
10	Shaped Steel	Each size			○
11	Steel Pipe	150A - 50A			○
12	Steel Plate	12-16mm			○
13	Steel Pipe for Pile	ø1500 mm		○	
14	Metal Form	W/accessories			○
15	Pipe Support				○
16	Scaffolding				○
17	Concrete Pipe	Each size	○		
18	PVC Pipe	Each size			○
19	Guardrail	for Bridge			○
20	PC Bar	ø26mm		○	
21	PC Wire	12ø8 mm			○
22	PC Strand	12T12.7			○
23	PC Sheath	Each size		○	
24	PC Anchor	Each size		○	
25	Center Hinge Shoe	50 t		○	
26	Rubber Shoe	Each size		○	
27	Expansion Joint	Expansion=±80 mm		○	
28	Handrail	Stell, H=1 m		○	
29	Lighting Equipment	200 W w/accessories			○

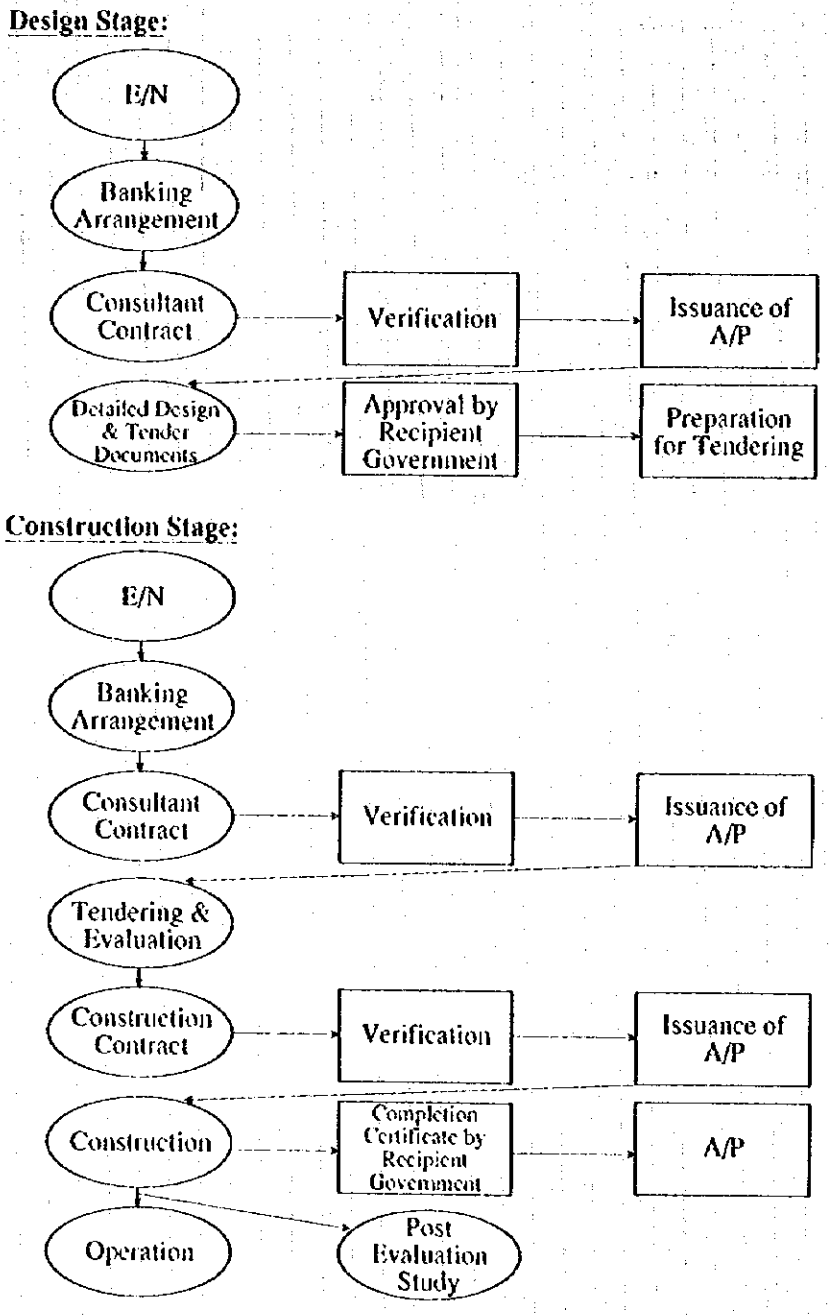
Table 3.1.3 Procurement of Construction Machinery

No.	Description	Specification	Procurement Source		
			Laos	Japan	Others (Thailand)
1	Bulldozer	21 t			O
2	Bulldozer	15 t			O
3	Hydraulic Backhoe	0.6 m3			O
4	Wheel Loader	2.1 m3			O
5	Dump Truck	11 t			O
6	Water Tanker	8 m3			O
7	Truck Mixer	4.5 m3			O
8	Concrete Pump Car	90 m3			O
9	Flatbed Truck	11 t			O
10	Truck with Crane	4 t w/2.9 t			O
11	Asphalt Distributor	4000 lit			O
12	Crawler Crane	80 t		O	
13	Crawler Crane	50 t			O
14	Truck Crane	35 t			O
15	Truck Crane	25 t			O
16	Truck Crane	15 t			O
17	Jib Crane	16 t-m			O
18	Motor Grader	3.7 m			O
19	Tire Roller	8-20 t			O
20	Road Roller	10/12 t			O
21	Vibration Roller	8-10 t			O
22	Vibrating Hammer	75 kW		O	
23	High Water Pressure Generator	130 PS		O	
24	Crawler Drill	150 kg drifter			O
25	Rock Breaker	600 kg			O
26	Portable Air Compressor	17 m3/min			O
27	Portable Air Compressor	5 m3/min			O
28	Diesel Generator	200 kVA		O	
29	Diesel Generator	150 kVA		O	
30	Diesel Generator	100 kVA			O
31	Diesel Generator	75 kVA			O
32	Diesel Generator	45 kVA			O
33	Diesel Generator	25 kVA			O
34	Submersible	ø150 mm * 20 m			O
35	Submersible	ø100 mm * 20 m			O
36	Aggregate Screening Plant	45t/hr, w/acc		O	
37	Concrete Mixing Plant	60m3/h, w/acc		O	
38	Grout Mixer	2.2 kW			O
39	Grout Pump	2.4 kW			O
40	Working Pontoon	700 t			O
41	Working Pontoon	500 t			O

42	Working Pontoon	300 t			○
43	Working Pontoon	200 t			○
44	Motor Boat	4.9 t			○
45	Tug Boat	10 t			○
46	Anchor Barge	5 ton hoist			○
47	All Casing Drilling Machine	ø1500 mm		○	
49	Concrete Spreader	3-7.5 m			○
50	Concrete Finisher	3-7.5 m			○
51	Center Hole Jack	50 t, 200 t			○
52	Segment Processing Plant			○	
53	Segment Erection Equipment			○	

3.1.6 Implementation Schedule

The implementation schedule will be set for 2 stages, Design Stage and Construction Stage, according to the Japanese Grant Aid Progam and considering the size of the Project as shown in Figure 3.1.6-1:



Note (1) E/N : Exchange of Note
(2) A/P : Authorization to Pay

Fig 3.1.6-1 Conceptual Procedure of Japanese Grant Aid Program

1) Contract with the Consultant and Detailed Design

After signing the contract with the selected Japanese consulting firm, the detailed design will be carried out by the Consultant including the preparation of the tender/contract documents, drawings and cost estimate. The direct contract system will be applied to the employment of the Consultant.

2) Prequalification, Tendering and Contract with the Contractor

After discussion with and approval by JICA of the items for prequalification (P/Q) of tenderers for the construction works, P/Q activities will be carried out in Japan by the Consultant on behalf of the Government of the Lao PDR to select qualified tenderers.

In the tendering process, the principle of general competitive bidding will be applied to select a Japanese contractor for the construction works. Evaluation of tenders and selection of the Contractor will be performed in Japan by representatives of the Government of the Lao PDR and the Consultant in the presence of JICA officials. Negotiation with the selected Contractor and signing of the Contract will be also be done in Japan.

In parallel with the Contract signing, the Government of the Lao PDR will conclude a banking arrangement with an authorized foreign exchange bank in Japan to open accounts for the purpose of receiving the funds granted by the Government of Japan, and making payments to the Japanese Consultant and Contractor. This banking arrangement will serve as the basis for the Government of the Lao PDR to issue the Authorization to Pay (A/P) that is indispensable for use by the Japanese Consultant as well as by the Japanese Contractor for obtaining export licenses for equipment and materials.

Such banking arrangement will also be used to receive payments as stipulated in the Contract terms and should be concluded within one month after the signing of the E/N. It is noted that the Japanese Consultant and Contractor will be able to carry out their responsibilities only after receiving the verified contract and A/P.

The next step is the contract verification by the Government of Japan. Verification means to examine whether the contents of the Contracts conform to the provisions of the E/N, which is a requisite for the Contracts to be effective.

3) Construction Works

The construction period of the Project will be 35 months, including such works as preparatory work, construction of temporary yard, bridge foundation and

substructure, bridge superstructure, approach roads and demobilization. The implementation schedule of each stage is shown in Table 3.1.6-2.

4) Implementation Schedule

The Implementation Schedule by stage for the Proejct is shown in Figure 3.1.6-2.

It takes 8 months for the detailed design work, and the construction period is estimated at 35 months for the Project.

To smooth implementation of the Project, the undertakings such as land acquisition and compensation to secure the Project site by Lao Government should be managed immediately after the completion of the detailed design.

3.1.7 Obligations of Recipient Country

For the implementation of the project, the Lao government will undertake the following:

1) Undertakings required for construction work

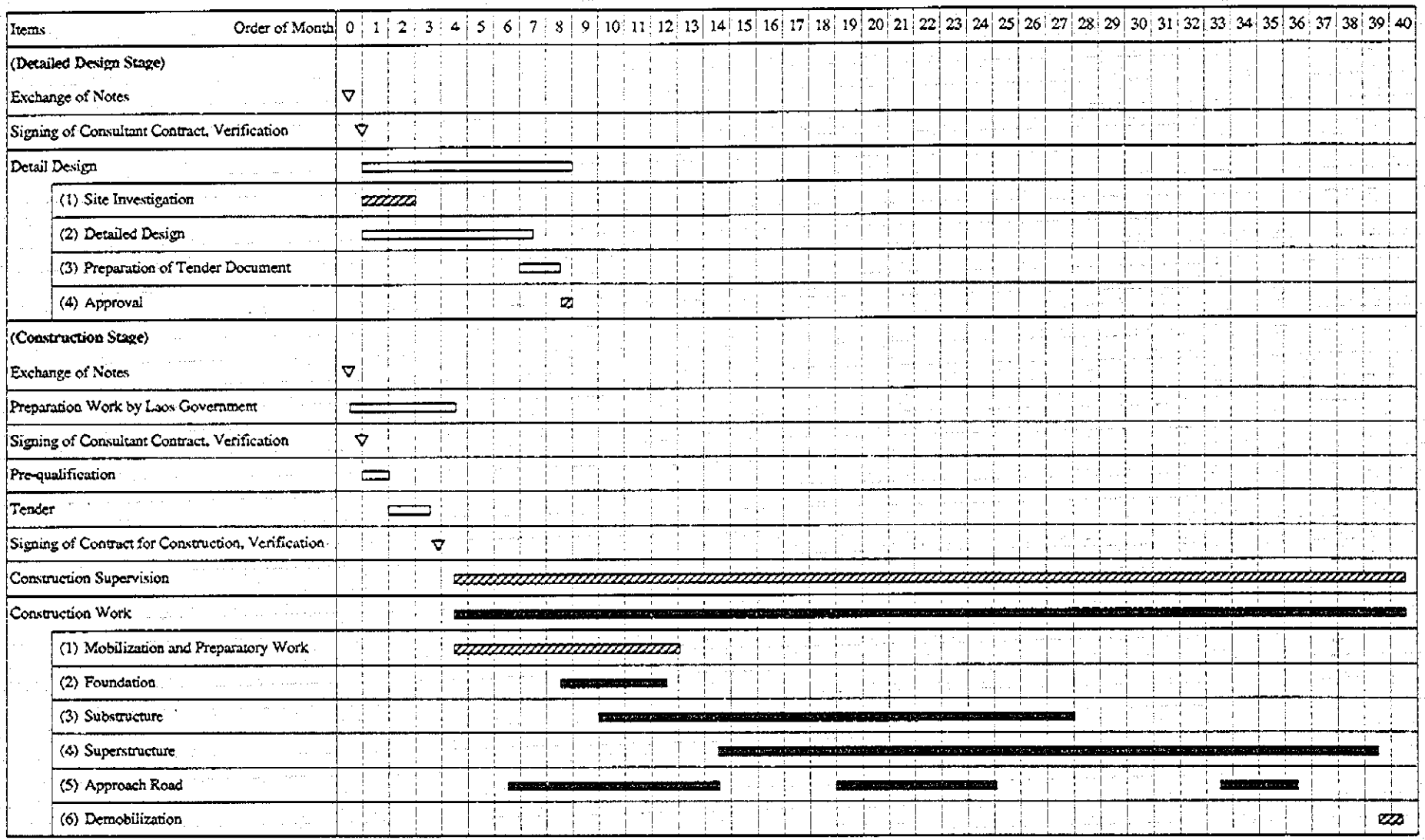
- Land acquisition,
- Land lease for temporary facilities,
- Clearing/grubbing of the site, and
- Connection of utility cables to the project site.

2) Administration work

- To furnish data necessary for the detailed design and construction supervision,
- To bear commission for the banking services based on the Banking Arrangement,
- To ensure prompt unloading and customs clearance at the port of disembarkation in Laos for the equipment, materials and machinery required for the Project,
- To ensure tax exemption for the consultant and the contractor engaged in the Project,

- To issue visa, traffic certificate and other certificates necessary for the execution of the Project to the consultant and the contractor,
- To ensure contractual payments to the consultant and the contractor,
- To bear expenses required for the proper and effective maintenance after completion of the Project, and
- To bear all the expenses necessary for the execution of the Project other than those to be borne by the Grant Aid.

Figure 3.1.6-2 Implementation Schedule



3.2 Operation and Maintenance Plan

3.2.1 Organization for Operation and Maintenance

The Ministry of Communication, Transport, Post and Construction (MCTPC) will be responsible for the maintenance of the bridge and approach roads.

The periodical inspection and maintenance work will be carried out by governmental officers and the rehabilitation work will be undertaken by specific contractors when required.

The organization for operation and maintenance should be established immediately after the completion of the Project, which is recommended as follows:

- Director * : One Civil Engineer
- Engineers * : Two for civil works, road and bridge, One for mechanical works
- Technicians : Two for civil works, One for mechanical works
- Administration staff : One staff

Note: Mark * means concurrent post in the DCTPC

3.2.2 Inspection Items and Expected Maintenance Work

Table 3.2.1 Inspection & Maintenance

	Inspection Items	Anticipated Maintenance Work
Bridges (Weekly inspection)	Expansion joint Railing Lighting Bearing PC cable	- Cleaning of drainage and road surface, - Checking miscellaneous facilities, handrail, lighting etc., - Temporary repair of damage due to accident
Roads (Daily inspection)	Pavement Slope protection Drainage River bank protection	- Patching pot hole, - Repairing shoulder, - Re-shaping slope

3.2.3 Maintenance Cost

The maintenance costs after the completion of the Project are estimated as follows:

1. Administration cost 2,400 US$/year
2. Inspection cost (Included in administration cost)
3. Routine maintenance costs per year 7,380 US$/year

1)	Cleaning work for bridge and roads	860 US$/year
2)	Road surface maintenance	4,400 US$/year
3)	Electricity charge	1,450 US$/year
4)	Others	670 US$/year
4.	Periodical maintenance costs for 5 years	28,070 US$/5 years
1)	Renewal of ancillary structures	3,680 US$/5 years
2)	Road maintenance	22,000 US$/5 years
3)	Others	2,390 US$/5 years

Accordingly, the annual maintenance cost for the Project was estimated at about 15,400US$ per year.

CHAPTER 4. PROJECT EVALUATION AND RECOMMENDATION

CHAPTER 4. PROJECT EVALUATION AND RECOMMENDATION

4.1 Project Effect

The Asian Development Bank prepared "A Compendium of Project Profiles" in 1995 for the Forum for Comprehensive Development of Indochina which was promoted by the Government of Japan and selected 9 corridors as high priority road improvement projects. Among these corridors, improvement of National Road 13 running from north to south in Laos via Pakse and connecting China, Laos and Cambodia is defined as "Southern Lao PDR - Sihanoukville Road Improvement Project". The objectives of the project are primarily to provide Lao PDR with an outlet to/inlet from the sea (Sihanoukville port) through a third country and in the long term to provide Cambodia with direct access to China through Lao PDR. This north - south corridor improvement project is expected to contribute to the economic development of three countries along the corridor.

The Pakse bridge will enhance the effects of the above-mentioned north - south corridor improvement project proposed in the "Forum" through forming an east - west corridor which connects Thailand, Lao PDR and Vietnam and thereby provides Indochina with an international road network.

The Pakse bridge project site is located in the southern provinces in Laos which have 20% of population of the whole country and are rich in agricultural resources. In addition, the project is at a strategic site connecting the north - south corridor with the east - west corridor. Considering the situations above, the project bridge is expected to generate the following effects :

1) Direct Effects

a. Traffic Demand

According to a traffic survey conducted in August 1995, present traffic volumes crossing over the Mekong river at Pakse were 596 vehicles per day (including 388 motorcycles). The Feasibility Study on Construction of the Mekong Bridge at Pakse conducted by JICA in 1995-96 has forecast future traffic demand on the project bridge at 1,460 vehicles in 2000 and at 5,700 vehicles in 2020 which are 2.4 times and 9.6 times of present traffic volumes respectively. These future increased traffic volumes may be difficult to be handled by the existing ferry services. On the other hand, planned Pakse bridge has enough capacity to handle future traffic volumes.

b. Beneficial Population

Number of beneficial population by this project is estimated about 1.0 million persons in the four provinces of southern Laos in 1995 and 1.5 million persons in 2020. As the project bridge is located in the east - west transport corridor connecting Thailand, Laos and Vietnam, the influence area of the project is considered to be wider than the southern provinces in Laos. The total beneficial population in the corridor is estimated about 11.0 million persons including Ubon Ratchathani in Thailand, four provinces in southern Laos and south Vietnam.

2) Indirect Effects

a. Betterment in Living Conditions

The present number of hospitals or health care centers in the Champasak province is 91 including one provincial management hospital. However, the fully-equipped hospital is located only in Pakse. Small dispensaries are located in most villages, but are not staffed with qualified doctors. It is, therefore, clear that all-weather and 24-hour operated bridge is very important for those living in western bank areas (about 40 % of provincial population : 180,000 persons) remote from Pakse particularly in the case of emergency and from the aspect of Basic Human Needs (BHN).

b. Industrial Development Effects

Although present manufacturing industry in the study area is dominated by small size factories, saved transport time and costs by the bridge will reduce the costs of raw materials, and on-time delivery of produced commodities will stimulate new locations of other industries.

c. Promotion of Tourism Development

There are notable tourist attractions in the Champasak province such as Wat Phu, Khon Phapheng Waterfalls, Khong Island and Boloven Plateau. The number of tourists visiting Champasak province by roads will be increased by the construction of the Pakse bridge.

d. Expansion of Employment Opportunities

The Pakse bridge project requires 250 - 300 labors per day during the construction period and a total of 260,000 persons will be employed for 35 months of construction period.

e. Formation of International Road Network

The Pakse bridge is located at a strategic site in southern Laos connecting north-south transport corridor with east-west corridor. The east-west corridor is strengthened by the Pakse bridge linking Thailand, Lao PDR and Vietnam and functions as an international road network in six countries of Indochina.

4.2 Recommendation

The proposed route will require the removal of about 40 buildings. Resettlement and compensation for lands and buildings need to be undertaken in accordance with lows in Laos. Furthermore, it is important to keep the adequate level of maintenance and management after construction of the project because the proposed route connects National Road 10 and 13. It is recommended in this study to establish a new organization for operation and maintenance of the project in MCTPC. Successful management and maintenance work should be undertaken through the capable new organization.

The effective and efficient implementation of the project will be realized if the following actions are surely taken by the Government of Laos:

1) Smooth land acquisition and compensation according to the schedule without delay.

2) Establishment of a new project team in Lao side in order to implement the project smoothly and,

3) Establish a capable organization for the maintenance and management as soon as the construction of the project is finished.

APPENDICES

1. Member List of the Survey Team

Leader	SUZUKI Haruo	Japan International Cooperation Agency
Coordinator	NAKAGAWA Atsushi	Japan International Cooperation Agency
Chief Consultant/ Bridge Planner	MASHIBA Junji	Nippon Koei Co., Ltd.

2. Survey Schedule

Description	1996					
	April	May	June	July	August	September
Study & Analysis in Japan						
Explanation of Draft Study Report in Laos			▲ Draft Report			
Submission of Study Report						▲ Study Report

3. List of Party Concerned in the Recipient Country

Ministry of Communication, Transport, Post and Construction (MCTPC)

Mr.Phao BOUNNAPHONE	Minister
Mr.Math SOUNMALA	Deputy Director, Cabinet
Mr.Sommad PHOLSENA	Director, Communication Dept.
Mr.Phetsamone VIRAPHANTH	Deputy Director, Cabinet
Mr.Khanngeun KHAMVONGSA	Director, International Relations
Mr.Oulay PHADOUANGDETH	Head of Technical Division, Communication Dept.
Mr.Houngla SENGMEUANG	Head of Administration Division, Communication Dept.

Committee for Planning and Cooperation (CPC)

Mr.Chanthavong SAYASITH	Director, Dept. of Public Investment Program
Mr.Somchith INTHAMITH	Deputy Director, International Economic Cooperation

Champasack Province

Mr.Chanthavong SAYASITH	Governor of Champasack Province
Dr.Koung SOUK ALOUN	Director of CTPC of Champasack Province

Embassy of Japan

Mr.Hiroomi SAKAI	Ambassador Extraordinary and Plenipotentiary
Mr.Saburo SATO	First Secretary
Mr.Yoshio ISHIZAKI	Second Secretary
Mr.Kenro TAURA	Special Assistant

JICA Laos Office

Mr.Tsuneo TAKAHATA	Resident Representative, Laos Office
Mr.Hiroyuki IMOTO	Assistant Resident Representative