PART C

CAPACITY DEVELOPMENT

CHAPTER C-1 CAPACITY DEVELOPMENT PROGRAM OF THE MASTER PLAN STUDY

1.1 Introduction

The JICA Study Team gave priority to knowledge and technology transfer throughout the one-year implementation of the Study (See **Figure 1.1.1**). The technology transfer was aimed at the capacity development of counterpart members in the related Ministries, primarily in the Ministry of Public Works and Transportation, in researching, planning, designing, and presenting skills as governmental officers. The program also targets agencies, which are MEF, MOE and the MRD, associated with the road network administration.

The Study Team has worked together with nominated counterparts to transfer skills and has encouraged them to be forward thinking. The counterparts are expected to become leaders in the Ministries and to carry out the long term Master Plan in the future.

At the same time, the Study Team conducted lively discussions on the contents of the Proposed Master Plan with the Steering Committee consisting of senior officers who are the present decision-makers on the road network policy. Through the discussions, the conceptual and detailed plans have gradually been appreciated and a consensus has been achieved on the above-mentioned Master Plan. The decision makers in the ministries have been introduced to a decision making process that is logical and fair.

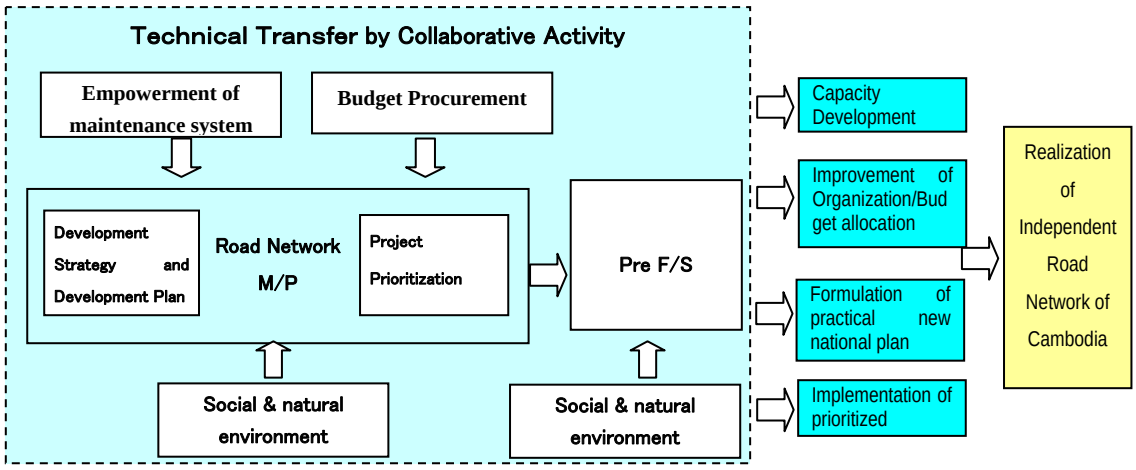


Figure 1.1.1 Capacity Developments Throughout the Master Plan Study

The overall goal of the capacity development could be called the "Enhancement of the Administrative Capabilities of the Governments." The capacity development program of the Master Plan was based on OJT (on-the-job training) but the Study Team expects that the experiences of the Master Plan Study will be the first step of a comprehensive, consistent program for effective road network administration in the future.

1.2 Target of Capacity Development

1.2.1 Structure of Capacity Development

Figure 1.2.1 below illustrates the structure of capacity development for enhancing the administrative capability of governments.

The target level of the capacity development is separated into two (2) stages. One is consultancy services to the top management in building consensus and decision making. The second stage is the technical transfer and training of the potential officers in how to make the appropriate plans and persuade stakeholders through presentations and reports. The Study Team established four (4) Taskforce Teams in accordance with areas of management.

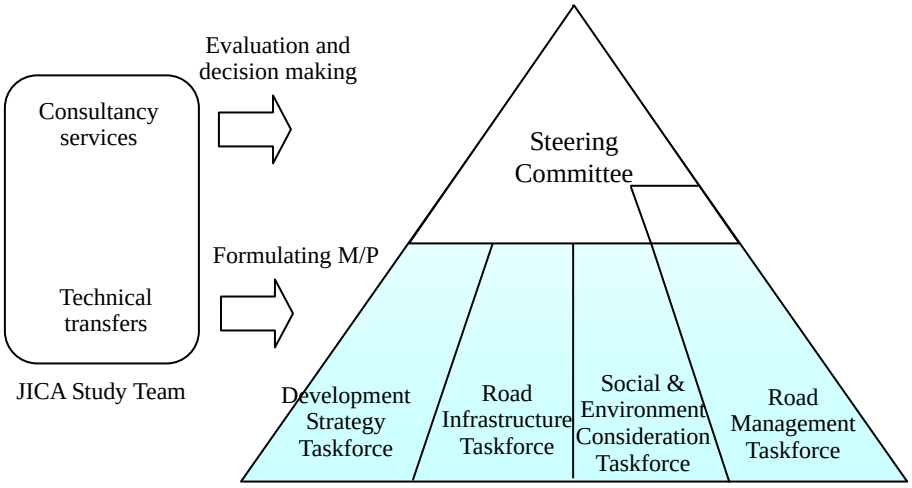


Figure 1.2.1 Enhancement of the Administrative Capabilities of Governments

Since the purpose of the technical transfer has not been to improve specific skills of individual people but rather to enhance the administrative capability of the government, the counterparts work together and share information through crosscutting workshops. The management and operation skills learned through the M/P Study are indicated in **Table 1.2.1**.

The "Crosscutting" mentioned below in the Table indicates the comprehensive targets which a mixture of individual taskforce teams must reach. Therefore, "Individual" refers to the target of the four individual taskforce teams. By working in parallel and exchanging opinions, the counterparts in each taskforce are aware of the issues in other fields.

Table 1.2.1 Major Targets of the Capacity Development

	Steering Committee	Taskforce Teams	
		Crosscutting	Individual
(1) Planning and supervising of the entire Study process	Main target		
(2) Information gathering		Target	Main target
(3) Conducting necessary surveys		Target	Main target
(4) Assessment of the present condition	Main target	Target	Target
(5) Presentation of survey results		Target	Main target
(6) Creation of the Master Plan framework		Main target	Target
(7) Prioritization and planning of Road Network	Target	Main target	Target
(8) Formulation of maintenance policy and plan	Main target	Target	
(9) Pre F/S formulation		Target	Main target
(10) Evaluation of Pre F/S and drafted M/P	Main target	Target	Target
(11) Updating of the Master Plan	Target	Main target	Target
(12) Preparation of the Final Report	Target	Main target	Target
(13) Taking action to realize M/P	Main target	Target	Target

1.2.2 Participation in the Master Plan Study

Members or participants in the Master Plan Study are responsible persons from related agencies. The members of the Steering Committee and Taskforce Teams are listed below.

(1) The 28 Members of the Steering Committee

The members of the Steering Committee are nominated from the related agencies of the road network policy: MPWT, MEF, MOE, MOWRAM and MRD. The main function of the Steering Committee has been supervising the Master Plan Study. At the same time, the Study Team expected and encouraged them to exchange the opinions of each Ministry and to reach a consistent standard of policy making throughout the Master Plan Study.

Names of the Steering Committee members are listed in **Table 1.2.2**.

Table 1.2.2 Members of the Steering Committee

Name	**Organization**	**Position and Title**
H.E. Tram Iv Tek	MPWT	Secretary of State
H.E. Sim Souleng	MPWT	Under Secretary of State
H.E. Touch Chan Kosal	MPWT	Under Secretary of State
H.E. Chhin Kong Hean	MPWT	Director General of Public Works
H.E. Leng hunyuthea	MPWT	Director General of Transport
H.E. Slot Sambo	MPWT	Director General of Administration
H.E. Kem Reat Viseth	CM	Advisor to H.E. Sok An
H.E. Keo Khemara	MLMUPC	Secretary of State
H.E. Ngor Pin	MOWRAM	Secretary of State
H.E. Don Sammoun	MRD	Secretary of State
H.E. Hou Taing Eng	MOP	Under Secretary of State
H.E. Tea Chup	MOE	Under Secretary of State
H.E. Leap Van Den	CDC	Deputy Secretary General

Name	Organization	Position and Title
H.E. Vongssey Vissoth	MEF	Deputy Secretary General
H.E. Chan Sothy	MEF	Director of Investment
Mr. Yoeun Sophal	MRD	Director of Rural Road Department
Mr. Mour Kimsan	MRD	Director of Technical Department
Mr. Vong Pisith	MPWT	Deputy Director General of PW
Mr. Pheng Sovecheano	MPWT	Deputy Director General of PW
Mr. Hong Sinara	MPWT	Deputy Director General PW
Mr. Phy Sophoat	MPWT	Deputy Director General PW
Mr. Yit Bunna	MPWT	Director of Public Works Research Centre
Mr. Vasim Sorya	MPWT	Director of Planning
Mr. Phy Lyda	MPWT	Director of Heavy Equipment Centre
Mr. Prum Chansonanary	MPWT	Director of Airway
Mr. Phing Katry	MPWT	Director of Waterway
Mr. Kem Borey	MPWT	Director of Road Infrastructure
Mr. Khun Sokha	MPWT	Deputy Director, PWRC

(2) The 10 Members of the Taskforce Teams

After holding the first Steering Committee Meeting on the contents of the Master Plan Study written in the Inception Report, the Steering Committee members nominated potential staff, as counterparts, to support the Study Team. The Committee expected all to learn the methodology used for formulating the M/P and to provide necessary information as required. The counterparts have commuted in general every day to the office of the JICA Study Team and they participated in field surveys as occasions arose.

Although other office tasks sometimes prevented them from attending the meetings, all members were able to get involved in the whole process of the Master Study.

Table 1.2.3 Members of the Taskforce Teams

	Name	Organization	Position and Title
Development Strategy	Mr. Cheam Sovanny	MPWT	Deputy Director of Planning Department
	Mr. San Piset	MRD	Staff of Financial Department
Road Infrastructure	Mr. You Dara	MPWT	Staff of Road infrastructure Department
	Mr. Nop Kilarith	MPWT	Staff of Road infrastructure Department
	Mr. Yim Borin	MPWT	Staff of Road infrastructure Department
	Mr. Tan Thira	MPWT	Staff of Research Center Department
Social and Environment Consideration	Mr. Mao Phannarith	MPWT	Staff of Research Center Department
	Mr. Yim Cham Nan	MOE	Chief of Monitory office
	Mr. San Virayouth	MPWT	Staff of Road infrastructure Department
Road Management	Mr. Phat Kong	MEF	Deputy Officer of Domestic Public Investment Division 3

The consultants of the Study Team in charge of the respective taskforce teams were assigned according to their expertise as shown in **Figure 1.2.2**.

The consultants provided proper guidance to the counterparts in each field through the process of study and planning. Cambodian members of the taskforce team spent the most time in collecting the necessary data/information and compiling it for the Master Plan according to the instructions of the Japanese consultants. This process was regarded as practical "on-the-job training" (OJT). Both Japanese and Cambodian members of the taskforce teams used workshops and seminars to review the degree of knowledge learned by the counterparts through the OJT.

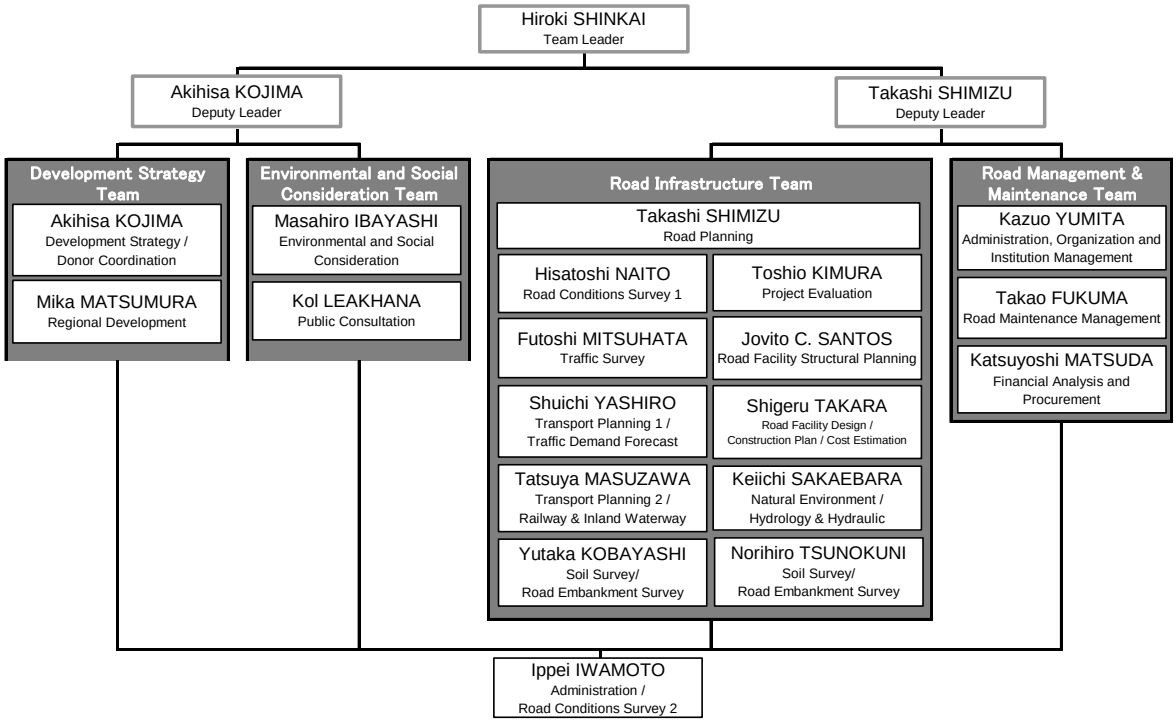


Figure 1.2.2 Operation Structure of the Technical Transfer

1.3 Flow Chart for the Capacity Development

The Capacity Development program was carried out as shown in the flow chart of **Figure 1.3.1**.

The blue boxes indicate the Steering Committee Meetings, and the white boxes show the activity flow of the four taskforce teams that were training technical skills. The arrows flow from left to right on horizontal lines. The pink boxes indicate that there are vertical lines of capacity development such as documentation skills, presentation skills and methodology of prioritization for every taskforce team. The orange color shows opportunities for presentation and information exchange by the counterparts.

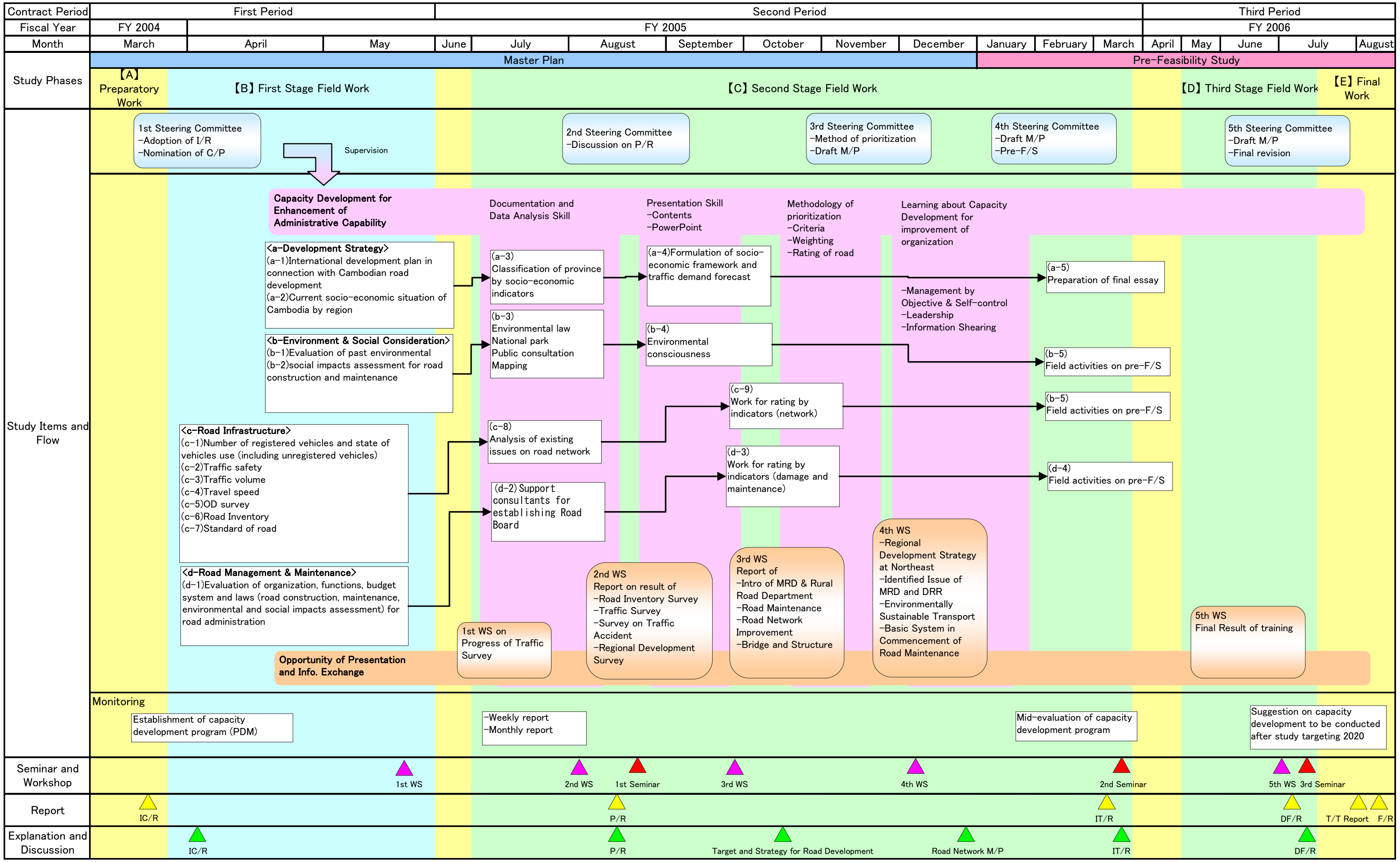


Figure 1.3.1 Flow for the Capacity Development

CHAPTER C-2 STEERING COMMITTEE

2.1 Importance of Information Sharing

The Steering Committee consists of the top government officials involved in road administration as shown in **Table 1.2.2**, "Members of the Steering Committee."

Recently, international donors have been introduced to the bottom-up system of planning which has the advantage of informing them of the real conditions at the implementation stages of the sites. However, top management (above General Director) and middle management (Director Class) is still very important. Even if field staff and middle management identify the problems and try to make improvements, it is hard to achieve effective change unless the top management adapts the plans offered by subordinate officers. The bottom-up system cannot work well without the appreciation and support of the top management.

According to the Study Team's observations, the role and function of middle management leaders is crucial for a smooth implementation. The Study Team expects them to exchange and share information at the Steering Committee Meeting. Information sharing is the starting point to enhance the administrative capabilities of government. By encouraging the leaders on the Steering Committee of the Master Plan Study to get involved on the process, the ownership of the Master Plan will be transferred to the Cambodian Government.

The significant roles of the Steering Committee are as follows:

- To enhance **ownership** of the Master Plan of the Road Network
- To ensure **transparency** of the process for the formulation of the Master Plan
- To achieve **accountability** of the Master Plan from the Study Team to the members and from the members to their boss, colleagues and subordinates

As shown in **Figure 2.1.1** below, the process of "Report," "Discussion," and "Feedback" through the Committee is effective in expanding the information.

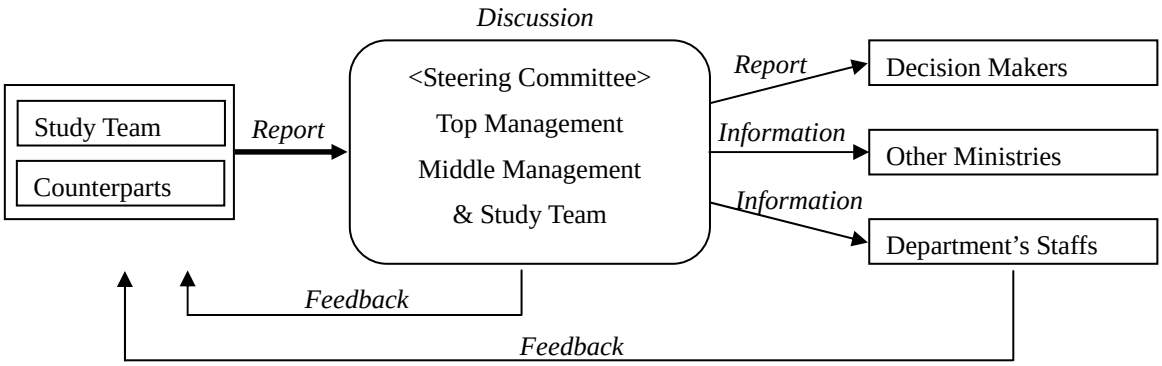


Figure 2.1.1 Operation Structure of Technical Transfer

2.2 Steering Committee Meetings

2.2.1 Actual Achievement of Steering Committee

Steering Committee meetings have been held six times, since February 2005 until the end of July 2006 according to the initial schedule. The Steering Committee meetings are aimed at confirming the direction of the Master Plan and to get approvals from the decision-makers at the inception, as the work progresses and for the draft final report. Through the meetings, the Study Team fine-tuned the process and the outcomes of the Study in line with discussions.

The titles, dates and contents of the steering committee meetings are as follows. The minutes of the meetings are attached in the Volume IV, Data Book. The members of the Steering Committee have agreed on most of the reports without critical objections.

March 25th, 2005 1st Steering Committee Meeting (Inception Report)

The Study Team explained the contents of the M/P Study and proposed the establishment of four Taskforce Teams according to the activities. After acceptance of the Inception Report, the Steering Committee members nominated the counterparts.

<Contents of the meeting>

1. Introduction
   - 1.1 Background of the Study
   - 1.2 Objective of the Study
   - 1.3 Study Area

2. Study Implementation
   - 2.1 Work Schedule
   - 2.2 Organization of Study Team
   - 2.3 Reporting and Seminars
   - 2.4 Undertakings by the Cambodian Government

3. Basic Concept
   - 3.1 Formulation of the Master Plan
   - 3.2 Road Construction and Road Maintenance Management
   - 3.3 Traffic Demand Forecast
   - 3.4 Social and Environmental Considerations

4. Outline of the Study
   1. Work Flow
   2. Technical Transfer

September 1st, 2005 2nd Steering Committee Meeting (Progress Report)

The results of the study conducted by the four Taskforce Teams were presented at the 2nd Steering Committee meeting. The purpose of this meeting was to achieve a consensus of the present situation of the road network and its operation.

The Steering Committee accepted the contents of the Progress Report and engaged in a lively discussion on Development Strategies. Agreement was reached on the direction of the development of the road network. With regard to the road maintenance system in particular, a Road Board for management of the maintenance budget was established to continue discussion on this issue among the related agencies and donors.

<Contents of the meeting>

A: Master Plan Study for Infrastructure Development of the Road Network
B: Master Plan Study for Institutional Development of Road Maintenance

November 8th, 2005 3rd Steering Committee Meeting (Concept of the Master Plan)

By the 3rd Steering Committee meeting, the Study Team had come up with the development concept in compliance with the agreed direction of the road development strategy and here presented it to the members of the Steering Committee. The methodology of the prioritization was also discussed among the participants.

In addition, the Study Team proposed the method for road maintenance improvement. The issue of the budget was still under discussion but it was observed that there was a stronger recognition of the importance of a common organization.

<Contents of the meeting>

A: Road Development Master Plan 1. Strategy Development 2. Road Network Development 3. Concept for Road Development and Methodology for Selection of Priority Roads
B: Road Maintenance Improvement 1. Goal and Strategy 2. National Road Maintenance

January 16th, 2006 4th Steering Committee Meeting (Prioritization of the Network)

The Study Team reviewed the comprehensive methodology of prioritization of the road network at the 4th Steering Committee meeting. The members of the Steering Committee accepted the clarified criteria and the degree of importance as a fair and clear way for prioritizing the road network.

The tentative results of the calculations based on the method were shown at the same time. The members of the Steering Committee agreed with the results for the prioritized 2-Digit and 3-Digit roads.

The Study Team recommended a basic financial system including financial resources for road

maintenance improvement, which was accepted by the Steering Committee.

<Contents of the meeting>

A: Road Development Master Plan
1. Additional Study Results on the Development Strategy and Future Traffic Demand Forecast
2. Revised Road Development Plan based on the Development Strategy
3. Initial Environmental Assessment
4. Improvement Measures to be Applied for Each Road
5. Priority Order of the Proposed Road Based on the Ranking Method
6. Financing Plan and Mechanism for Road Investment
7. Implementation Program and Project for Pre-Feasibility Study

B: Road Maintenance Improvement
1. Summary of Findings of Road Maintenance / Management

March 10th, 2006 5th Steering Committee Meeting (Interim Report)

The 5th Steering Committee meeting to explain the Interim Report was held on March 10th, 2006.

The major topics of this meeting were i) reporting the results of the prioritization of the road network projects, ii) recommending a road maintenance system and iii) selecting sites for the pre-feasibility studies during the Master Plan Study.

As a result of the calculation of the prioritization according to the criteria, a) the pre-feasibility study on the upgrade project of NR57 (BatamBang – Pailin – Thai Border) and b) the Urgent Bridge Rehabilitation Program for eight bridges were proposed. The members of the Steering Committee accepted it with great expectations.

July 24th, 2006 6th Steering Committee Meeting (Draft Final Report)

The 6th Steering Committee meeting to explain the Draft Final Report was held on July 24th, 2006.

The Study Team made a presentation of the Draft Final Report to the members of Steering Committee. The members of the Steering Committee agreed and accepted in principle the contents of the Draft Final Report and expressed gratitude to the Japanese government for the efforts made in the Study.

2.2.2 Findings

The Steering Committee has been functioning well in general. The meetings were held at each suitable juncture and the discussions highlighted significant issues in the Master Plan.

Findings and issues to be addressed related to the Steering Committee are as follows:

(1) Interest in the Master Plan

The members of the Steering Committee have been participating with great interest. The discussions were lively and many issues had been solved. However, the counterparts do not seem to be taking ownership of the report as much as expected. It would be beneficial if the members would recognize that the Master Plan was developed by, not only the Japanese Study Team but also the Cambodian counterparts.

(2) Contradiction between Logic and Politics

The quantitative data and logic were emphasized in the process of formulating the Master Plan. However, the importance of politics was always raised at the meetings. Decision-making is influenced by both domestic and international politics and the road network administration is no exception. It is expected that the Master Plan will be carried out based on logic with some exceptions caused by politics.

(3) Lack of Appreciation for Capacity Development

The meetings of the Steering Committee mostly focused on the Master Plan of Road Network and budget allocation for maintenance but not on the enhancement of administrative capability. The MPWT may have to be aware of the future importance of key staff that will contribute to the development and sustainability of the independent road network administration.

CHAPTER C-3 PROGRAM OF EACH TASKFORCE TEAM

3.1 Program Design of Capacity Development

The formulated four (4) Taskforce Teams consist of the members of the JICA Study Team and nominated counterparts. The counterparts as government officials are expected not only to learn the modern technology of engineering but also the skills of documentation and presentation. Furthermore, they are required to be cooperative and have a sense of responsibility and wider general knowledge of road network administration as potential future managers. During the period of participation in the Taskforce Teams, they have been expected to act as self-starters based on the instructions of the JICA Study Team. Positive intent to take part in planning and policymaking is an important part of the capacity development.

The Study Team introduced the methodology of Management by Objectives and Self-control (so-called MBO)[1], which is widely known as a method of business administration. Although MBO has a lot of theories and tools, the Study Team simplified it into four stages for the purpose of training the counterparts.

1) Progression stage: to steer the progression of activities for a holistic overall synergy
2) Challenging stage: to accomplish new projects and/or the master plan
3) Empowerment stage: to encourage him/herself to develop his/her capacity
4) Responsible stage: to achieve the tasks and duties as groups and even individuals

The third and fourth stages are rather regular activities of the counterparts. It is expected that counterparts complete their tasks as requested by the consultants. Moreover, it is strongly emphasized that working with a positive attitude is the base of capacity development.

The challenging stage is aimed at accomplishing the master plan and projects, which is a more concrete practical target than progressive achievement.

The progression stage is aimed toward a comprehensive result for the management of the whole organization and the agencies related to road administration. The ideal is that individual improvement activities link to each other to generate a synergistic effect.

The Study Team indicated “logical frameworks of Taskforce Teams" (See Appendix C-1) and utilized them in order to manage activities and to promote the motivation of counterparts. Self-motivation could not be generated unless the members were shown the target goal. In the challenging stage, the Study Team provided presentation opportunities to counterparts at the **workshops**, where they exchanged information and gained wider knowledge. Other than logical frameworks, the Study Team has requested counterparts to submit **monthly reports** and **weekly reports**. The program of capacity development was designed according to the concept of MBO as mentioned above.

[1] Reference Book Title: The Practice of Management. Contributors: Peter F. Drucker - author. Publisher: Harper & Row. Place of Publication: New York. Publication Year: 1954

In summary, the tools for the capacity development of counterparts are shown as follows:

Long term goal	Log Frame	<=Progression stage
Mid term goal	Workshops	<=Challenging stage
Monthly goal	Monthly report	<=Empowerment stage
Weekly goal	Weekly report	<=Responsible stage

The summarized logical framework of Capacity Development is shown in **Table 3.1.1** below.

Table 3.1.1 Target of Capacity Development

Objectives and Tasks	Indicators
Overall goal Smooth implementation of M/P until 2020 Independent administration of the road network	 Realization of M/P Maintenance of roads
Goal Effective public road administration by fostering potential leaders	Future promotion
Expected Result 1. Positive attitude to improve situation 2. Managerial skills and leadership to the followers 3. Presentation skills 4. Documentation/Reporting skills 5. PC skills	 1. Final evaluation 2. Final evaluation 3. Workshops 4. Monthly/weekly report and memos 5. All above
Activities 1. Regular activity of Taskforce Teams 2. Meeting among staff, visiting the local offices, participation in Japanese training courses 3. Workshops 4. Reporting the field surveys 5. Input data and create figures by PC	<Input> Cambodia Counterparts Japan Consultants

3.1.1 Development Strategy for Taskforce Teams

(1) Objective of the Technical Transfer for Development Strategy

Overall goal:

Contribute to the national socio-economic development by improving the road infrastructure in synergy with other infrastructures and the potential of the respective areas.

Objective of the Development Strategy Taskforce Team:

- Establish a master plan for road construction, particularly for 1-Digit National Roads, that effectively enhances and contributes to the national development plan and clarifies the functions of categorized roads.
- For 2-Digit National Roads and Provincial Roads establish a rural road network plan that contributes to the regional development plans.

A detailed plan of the activities of the development strategy taskforce team is shown in Appendix C-1.

(2) Output of the Technical Transfer

The consultants of the Study Team have emphasized logical thinking for formulating the Master Plan. In principle, there are two parallel ways to analyze information in the period of the study, qualitative and quantitative. Counterparts learned how to get the information and compile it for reference in decision-making.

Major topics to be learned are as follows:

- Socio-economic index to formulate the development strategy
- Basic theory and process for designing regional development
- Study procedure and classification of the regional economy

Their major outputs so far are as follows:

- Discussion memos of interviews
- Report on field survey
- Analysis of socio-economic survey by district (poverty map, etc.)
- Presentations at the workshops

3.1.2 Road Infrastructure Taskforce Team

(1) Objective of the Technical Transfer on Road Infrastructure

Overall goal:

Contribute to the efficiency of domestic transportation and distribution by improving the road network consistent with regional development, tourism, inland water transportation and railway.

Objective of Road Infrastructure Taskforce Team:

Design an optimal proposal for the M/P and Pre-F/S that will be adopted and implemented as a national plan by the MPWT or other related organizations.

(2) Output of the Technical Transportation

The Study Team, with counterparts in charge of a local research company as a sub-contractor, conducted benchmark studies on i) Road Inventory, ii) Traffic count survey, iii) OD (Origin and Destination) survey, iv) Travel time survey and v) Road accident survey. Through the processes of the studies, the counterparts learned the importance of that data, the method of survey design and the process of surveys. The Study Team recommended that the MPWT continue conducting periodic surveys of the traffic condition in order to monitor the result of the M/P.

The analysis of the data was a valuable experience for the counterparts. By using the opportunities for presentation at the workshops, they reviewed the results of surveys by themselves and reported them to their colleagues to share information.

Major topics to be learned are as follows:

- Method for carrying out traffic surveys
- Multiple viewpoints on traffic demand forecasting
- Awareness of the reality of road accidents in comparison with other countries

Their major outputs so far are as follows:

- Analysis of road damage and causes of damage (flood disaster)
- Analysis of road accidents
- Records of the road classification
- Review of road inventory
- OD matrix from the traffic survey
- Traffic demand forecast

The logical framework of the road infrastructure taskforce team is shown in Appendix C-1.

3.1.3 Social Environment Consideration Taskforce Team

(1) Objective of the Technical Transfer on Social Environment Consideration

Overall goal:

The smooth implementation of the road project without negative impact to the environment and society.

Objective of Social Environment Taskforce Team:

To reduce any negative impact to environment and society of the formulated road M/P.

(2) Output of the Technical Transportation

Major topics to be learned are as follows:

- Working process to approach the Strategic Environmental Assessment (SEA)
- Preparation of Environmental Impact Assessment (EIA) report
- Process for obtaining public consensus
- Procedure for preparation of the resettlement action plan

Their major outputs so far are as follows:

- Review of Environmental Law
- Explanation workshop on environmental impact of road construction

3.1.4 Road Management Taskforce Team

(1) Objective of the Technical Transfer on Road Infrastructure

Overall goal:

For local development in Cambodia, the national road network requires periodic maintenance and

improvement of arterial roads from the nationwide trunk line network.

Objective of Road Management Taskforce Team:

Periodic road maintenance will be operated by an optimal maintenance system.

(2) Output of the Technical Transportation

Major topics to be learned are as follows:

- Work routine for road maintenance (site checking diagnosis and evaluation, budgeting of operation)
- Establishing technical requirements of road maintenance as per road classification
- Preparation of maintenance implementation plan
- Budget allocation planning for road development plan (construction, rehabilitation and maintenance)
- Scenario formulation and satisfaction of maintenance budget including specific funds such as fuel tax
- Process for toll setting for charge roads
- Procurement process and contractual conditions for private sector funds for the project
- Formulation of the action plan for reforming the organization, procurement process and construction management (short, medium and long term targets)

Their major outputs so far are as follows:

- Estimation of the tax revenue
- Simulation of tax revenue according to conditions

3.2 Logical Framework of the Taskforce Teams

The logical frameworks and planned schedules of the respective Taskforce Teams are attached in Appendix C-1 at the end of Part C as mentioned before. The consultants in charge have always referred to the Logical Frameworks to check the position or progress of the Study.

3.3 Workshops and Seminars

3.3.1 Schedule of Events

According to the initial plan written in the Inception Report, several workshops and seminars had been planned as programs for the technical transfer. The purpose and outline of the workshops and seminars are as follows:

Workshops are presented by the counterparts of the taskforce teams, aiming to:

- Provide practice at giving presentations,
- Help with the understanding of the process of the master plan by making the presentation by themselves,

- Exchange information of each taskforce team by listening to the other members' presentations,
- Clarify unclear points by answering questions from the audience and
- Acquire skills from core-trainers and/or leaders to instruct other staff.

Seminars are presented by the Japanese consultants, aiming to:

- Show the process of formulation of the Master Plan,
- Open the information of the Master Plan Study to the related agencies besides the Steering Committee members, and
- Get comments from the audience.

The programs and the names of attendants of the seminars/workshops are attached in the Volume IV, Data Book, therefore only the key points of the lessons learned at each event are highlighted here.

May 30th, 2005 1st Workshop on "Traffic Survey"

The Study Team held a first workshop concerning the Traffic Survey on May 30th, 2005. The number of attendants was 15 in total, 4 from JICA and 11 from the MPWT. Japanese consultants made the presentations regarding the traffic survey. Although the outline of the traffic survey was explained well, the participants did not positively join the discussion. Participants listened to the presentation as authors.

Realizing the situation the Study Team spent time reflecting on the design and operation of the first workshop. The definition, purpose and even organizing process was clarified as part of the Capacity Development Program. The Study Team then redesigned and formulated the workshops and seminars as a whole.

August 12th, 2005 2nd Workshop

The main topics of the 2nd workshop were "Progress of the Activities by Teams," which was presented by the counterparts in charge, and "Brainstorming/Mental Exercise," which was a group discussion on designated questions such as criteria of prioritization and weighting of the criteria.

Program of Presentation (30min/person)

(1) Result of the Road Inventory Survey by Mr. Thira (MPWT)

(2) Result of the Traffic Survey by Mr. Yin Borin (MPWT)

(3) Result of the Survey on Traffic Accidents by Mr. Kilarith (MPWT)

(4) Result of the Regional Development Survey by Mr. Sovanny (MPWT)

The Study Team explained to the counterparts how to organize PowerPoint slides. The Study Team showed them the basic rules and components of the presentations and the counterparts developed their presentations on their own in accordance with the advice.

Presentation Contents

1) Introduction
- Survey Objectives (survey needs, purpose and relation to the Study)
- Survey Scope (survey limitation, scope and coverage)

2) Survey Methodology
- Schedule/Logistics/Procedure

3) Survey Results
- Data Collected
- Data Analysis/Summary
- Data Utilization for the Study

4) Comments/Closing Remarks
- Lessons Learned
- Difficulties/Problems encountered
- Next Steps for the Master Plan

This occasion was used to hold a group discussion as an internal brainstorming session on designated issues. The designated issue was criteria for the prioritization of road rehabilitation.

September 5th, 2005 1st Seminar

The Study Team used this seminar as an opportunity to report and lecture. The progress and future direction of the Study was explained in the 1st Seminar.

Based on the results of the survey for grasping the current situation, the Concept and Strategy of the road network was shown and the method of prioritization of the road network projects was presented as well. The Seminar consisted of two (2) sessions, the first half entitled "Current Situation of the Road Network and Living Conditions" and "Concept, Strategy and Action Plans" in the second half. There were 46 attendants in total including the staff from provincial offices and Japanese consultants. The program of the Seminar is as below.

Program of Presentation (30min/person)

(1) Traffic Survey Result by Mr. Yashiro

(2) Existing Road Network by Mr. Santos

(3) Socio-Economic Condition by Ms. Matsumura

(4) Development Strategy by Mr. Kojima

(5) Concept of Road Development Plan by Mr. Shinkai

(6) Improvement Plan of Road Maintenance Mechanism by Mr. Fukuma

Most attendants could understand the presentations in English, however some of the attendants from other provinces could not participate well in the discussions because of their English ability. Although the counterparts and their colleagues helped each other to understand at points, the Study

Team should have asked for professional translators of "English and Cambodian" or "Japanese and Cambodian."

September 30th, 2005 3rd Workshop

The counterparts in the taskforce teams were now getting used to planning the workshops and they were able to review the knowledge learned through the process of the Study. It was observed that they were willing to participate in the workshop with ownership.

The PowerPoint presentation skills had been improved, as was the awareness of the audience.

Program of Presentation (30min/person)

(1) Introduction to the Ministry of Rural Development and Rural Road Department by Mr. San Piset (MRD)

(2) Road Maintenance by Mr. You Dara (MPWT)

(3) Road Network Improvement by Mr. Nop Kilarith (MPWT)

(4) Bridge and Structure by Mr. Yin Borin (MPWT), Result of the Road Inventory Survey by Mr. Thira (MPWT)

December 8th, 2005 4th Workshop

Since the workshop was scheduled during a busy time in December, the only participants were the presenters and the Japanese consultants.

It was really an internal workshop for the members of taskforce teams to exchange opinions. The counterparts clarified the unclear points by answering the consultants' questions.

Program of Presentation (30min/person)

(1) Regional Development Strategy in the Northeast of Cambodia by Mr. You Dara

(2) Identified Issue of MRD and DRR by Mr. San Piset (MRD)

(3) Environmentally Sustainable Transport by Mr. Than Thira (MPWT)

(4) Basic System for Commencement of Road Maintenance by Mr. Pheng Sovicheano (MPWT)

March 13th, 2006 2nd Seminar

Topics of the 2nd Seminar were summaries of the Interim Report of Master Plan as well as the Steering Committee meeting held two days earlier, though the contents were simplified since the audience members were invited from the local governments. The counterparts of the taskforce team translated the lectures from English to Cambodian in order to assist the audience in grasping the

details of the lectures.

The participants from local governments were interested in the road network projects because they influenced the socio-economic conditions of the provinces. The concept and the strategy of the Master Plan were new to them, but they understood them in general. The MPWT confirmed that they have to share the relevant information with the related agencies in order to promote understanding toward the road network administration.

Program of Presentation

(1) Development Strategy (20 min.)	Mr. Kojima
(2) Road Network Development Plan (30 min.)	Mr. Shimizu
(3) Road Improvement Measures (30 min.)	Mr. Santos
(4) Financial Issues (20 min.)	Mr. Matsuda
(5) Implementation Program (20 min.)	Mr. Shimizu
(6) Road Maintenance System (20 min.)	Mr. Yumita

July 6th, 2006 5th Workshop

The workshops held in the past were aimed at practicing presentation. For the conclusion of the workshops, the staff of the provincial offices was invited to participate in the audience. Since the levels of the audience members were taken into consideration, the lectures were given in the Cambodian language.

All the counterparts of taskforce members made presentations as lecturers. They selected a MC by themselves and helped each other in terms of PC operation, translation and other preparation works.

Program of Presentation (20min/person)

(1) Outline of the Road Network Master Plan Study by Mr. Cheam Sovanny (MPWT)

(2) Traffic Survey and Analysis by Mr. Nop (MPWT)

(3) Socio-economic Condition by Mr. San Piset (MRD)

(4) Environmental Sustainability for Road Network Development by Mr. Yim Cham Nan (MOE)

(5) Budget Distribution for Road Maintenance by Mr. Phat Kong (MEF)

(6) Road Maintenance by Mr. You Dara (MPWT)

(7) Methodology for ORTHO Map Profile and Road Map Presentation by Mr. Mao Phannarith (MPWT)

(8) Results of the Master Plan Study (Priority of the Roads) by Mr. Cheam Sovanny (MPWT)

Although the time was limited, there were many questions raised from the floor and lively discussion was held in the workshop. For example, questions about the rules for the traffic survey, demarcation between the MPWT and the MRD in terms of rural roads, environment during construction such as dust, procedure to get approval of the IEE assessment and the Inter-ministerial Committee were raised from floor and the counterparts in charge answered properly.

This was the first opportunity for the independent dissemination of the Master Plan Study by the trained counterparts to other staff. It is expected that the counterparts, as potential future leaders, will share their knowledge and contribute to the capacity development of the Ministries and promote implementation of the Master Plan.

Opening remark by H.E. Touch Chankosal


Workshop were facilitated by counterpart sitting the side table.


Counterparts made presentation in Cambodian language and translated into English for Japanese guests.


Discussion was active during the workshop.

Counterparts made presentation by showing the slides.

About 60 participants from 24 DPWT, MRD, MEF, MOE, MLM, attended the Workshop.

July 25th, 2006 3rd Seminar

Topics of the 3rd Seminar were summaries of the Draft Final Report of the Study as well as the Steering Committee meeting held one day earlier. The contents were simplified since the audience members were invited from the local governments. The counterparts of the taskforce team translated the lectures from English to Cambodian in order to assist the audience in grasping the details of the lectures.

In the 1st and 2nd seminars, the announcement of the study result was a main objective from the viewpoint of information disclosure. However, considering the necessity for the execution of the study for the M/P and the Pre-F/S by the Cambodian government, the principal objective was put on the methodology of the formulation of M/P and the execution of Pre-F/S in the 3rd seminar.

Program of Presentation

(1) Findings of Road Network Master Plan
(Road network system, Improvement measures and Implementation plan)
(40 min.) Mr. Matsuda

(2) Findings of Road Network Master Plan
(Guidelines and Capacity Development)
(30 min.) Mr. Fukuma

(3) Findings of Pre-Feasibility Study
(NR.57 Improvement Project and Urgent Bridge Rehabilitation Program)
(30 min.) Mr. Takara

3.3.2 Evaluation of the Workshops

Since the 2nd workshop, the Study Team has distributed simple questionnaires to the participants asking about their degree of understanding, degree of interest in the presentations and degree of enjoyment of the discussion.

(1) Degree of Understanding

Attendants rated respective presentations provided in each workshop. However, the Study Team summed up the scores of the four presentations together in order to avoid scoring individual presentations. Therefore, the results of the scoring are integrated as shown in **Table 3.3.1** and **Figure 3.3.1**. The number of respondents is linked with the number of presentations as well as the number of participants.

The characteristics of the audiences were not the same at each workshop where the questionnaires were collected. The attendants of the 4th Workshop were mainly internal taskforce members, and on the other hand, the respondents of 5th Workshop were from the DPWT, MOE, MOF and MLM who are not so familiar with the Master Plan Study and excluded the regular counterparts.

Table 3.3.1 Result of the Questionnaire on Degree of Understanding

	Number of Responds				Ratio of Responds			
	2nd	3rd	4th	5th	2nd	3rd	4th	5th
Yes	39	31	45	152	65%	60%	94%	68%
More or Less	17	16	0	64	28%	31%	0%	29%
No	0	2	0	2	0%	4%	0%	1%
No Answer	4	3	3	6	7%	6%	6%	3%
Total	60	52	48	224	100%	100%	100%	100%
Respondents	15	13	12	28				

Source: JICA Study Team

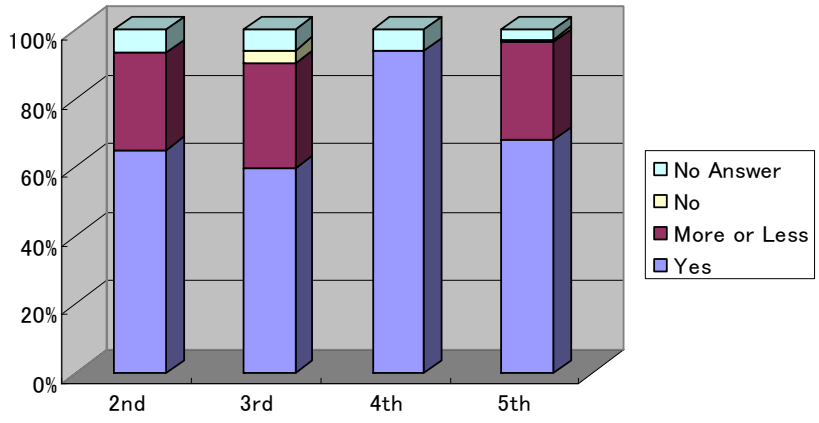


Figure 3.3.1 Degree of Understanding by Respective Workshops

(2) Degree of Curiosity about the Presentations

As well as the above question, the degrees of curiosity about the provided presentations were shown. **Table 3.3.2** shows the result of the analysis and **Figure 3.3.2** illustrates the ratios.

It seems that the respondents of the 4th workshop were more interested in the presentation than in the other 3 workshops. From the viewpoint of the Study Team, the skill of presentation is improving. However, 11% of the respondents of the 5th workshop from outside of the taskforce team answered that they were not interested in some topics, because the contents of Master Plan has many factors that they were not so familiar with.

Table 3.3.2 Result of the Questionnaire on Degree of Curiosity

	Number of Responds				Ratio of Responds			
	2nd	3rd	4th	5th	2nd	3rd	4th	5th
Yes	37	33	42	154	62%	63%	88%	69%
More or Less	19	12	2	36	32%	23%	4%	16%
No	1	1	0	24	2%	2%	0%	11%
No Answer	3	6	4	10	5%	12%	8%	4%
Total	60	52	48	224	100%	100%	100%	100%

Source: JICA Study Team

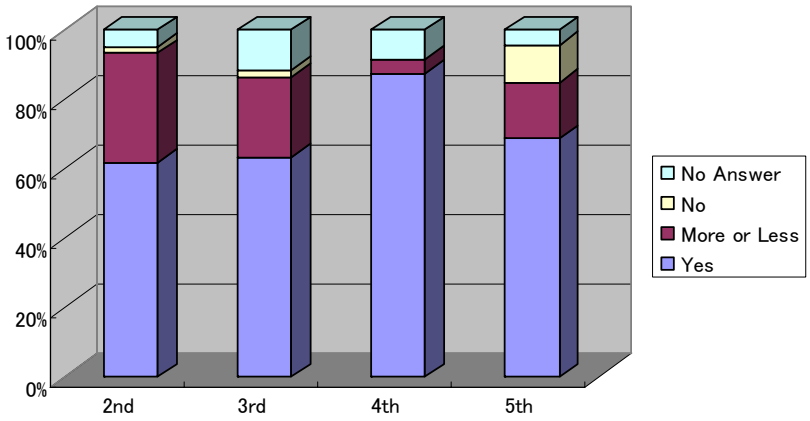


Figure 3.3.2 Degree of Curiosity by Respective Workshops

(3) Degree of Enjoyment of Discussion

The enjoyment of discussion was also queried in association with the above questions. If discussion is not lively, audiences cannot participate much in the workshop. It is hard to have a discussion if audiences do not understand the presentation and/or presenters do not understand the subject deeply. In accordance with observations by the Study Team the degree of understanding from regular counterparts, who gave presentations, is getting better so that the discussion with the floor in the 5th workshop was very active and enjoyed by participants.

Table 3.3.3 Result of the Questionnaire on Degree of Enjoyment

	Number of Responds				Ratio of Responds			
	2nd	3rd	4th	5th	2nd	3rd	4th	5th
Yes	11	9	10	20	73%	69%	83%	71%
More or Less	3	3	0	3	20%	23%	0%	11%
No	0	0	0	0	0%	0%	0%	0%
No Answer	1	1	2	5	7%	8%	17%	18%
Total	15	13	12	28	100%	100%	100%	100%

Source: JICA Study Team

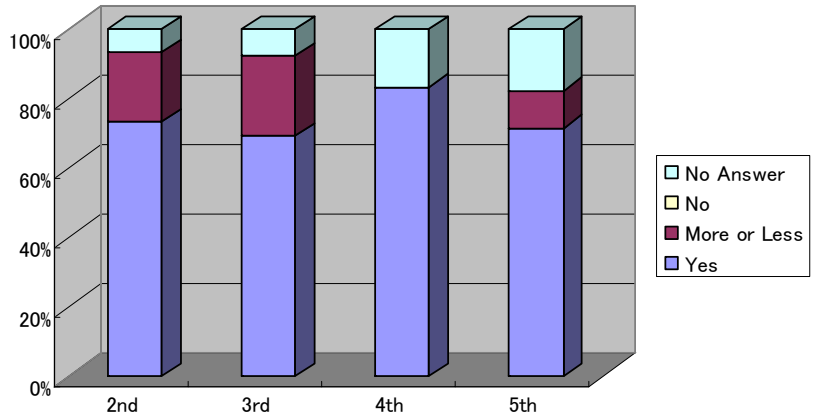


Figure 3.3.3 Degree of Enjoyment of Discussion

3.4 Counterpart Training in Japan

Two counterparts (MPWT) were accepted to attend group training courses provided by JICA.

(1) Group Training Course in Urban Environment and Transportation

Mr. Tan Thira, MPWT, who is on the staff of the Research Center Department, was approved to attend the group training course on "Urban Environment and Transportation" in Japan and attended it from 13 Oct 2005 until 15 Nov 2005. The course program is shown in **Figure 3.4.1**.

In the 4th workshop he explained the contents of the program and reported on what he learned from the course in Japan.

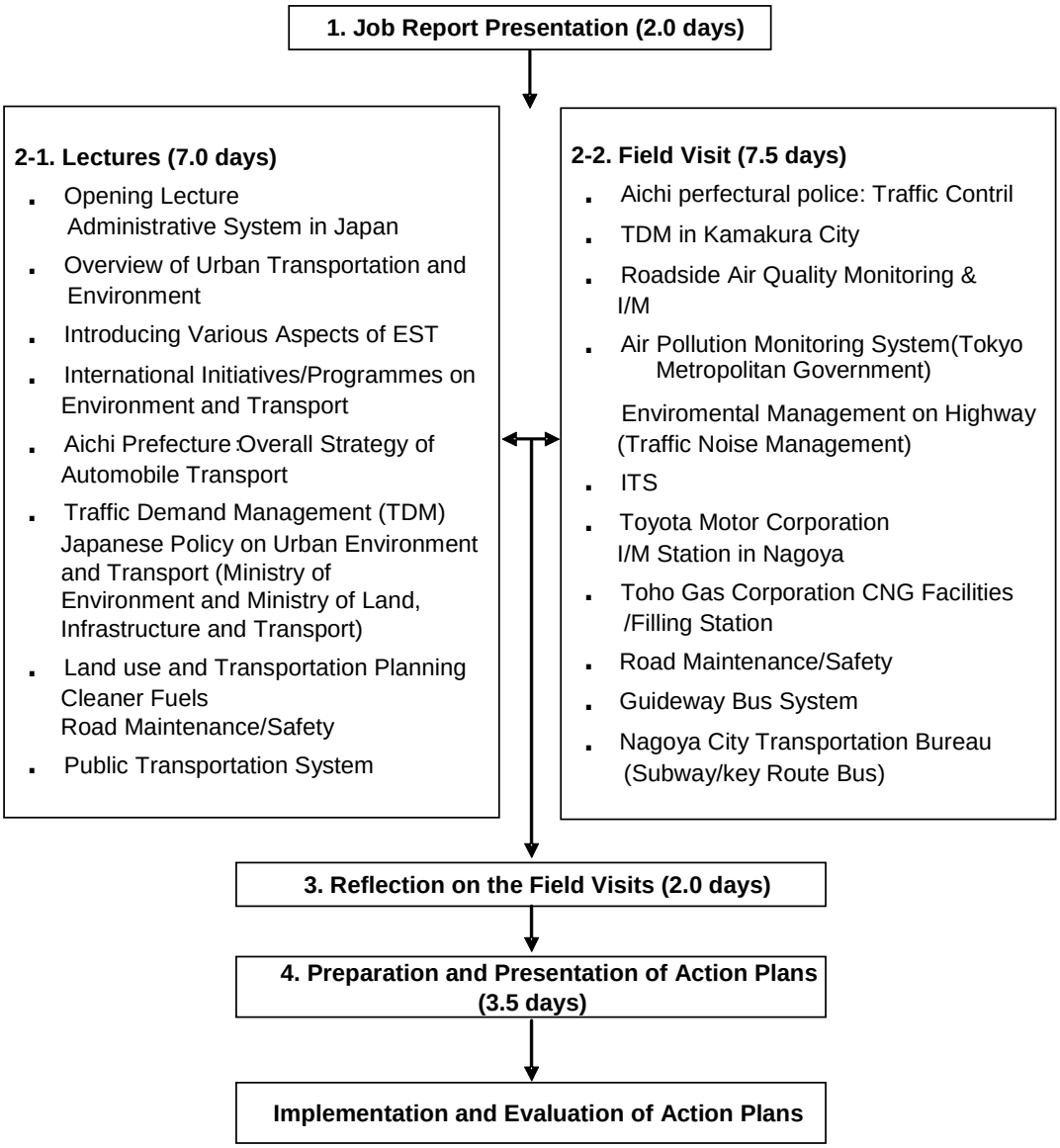


Figure 3.4.1 Course Program

(2) Group Training Course in Regulation and Type Approval System for Safety and Environmental Protection of Motor Vehicles

Mr. Nop Kilarith (MPWT) had participated in the group training course in Regulation and Type Approval System for Safety and Environmental Protection of Motor Vehicles since January 24 until March 3, 2006. The objectives of the course were i) to understand an outline of administrative systems for motor vehicles in Japan with its relevant laws, rules and regulations, and ii) to devise suitable future managerial and/or operational plans for administration systems concerning safety, environmental and technical regulation, inspection, certification and registration for motor vehicle in respective countries.

CHAPTER C-4 PUBLIC RELATIONS

4.1 Objective of Public Relations for the Study

The Study Team published three (3) newsletters, scheduled to be issued during the study period, for the purpose of public relations for the study. The newsletter is intended to disseminate a variety of information to the different stakeholders and update them on the different activities and progress of the Study.

In principle, the three newsletters, as 10 page summaries, were published in accordance with the progress of the reports of the Master Plan Study: inception report, progress report and interim report. Many pictures taken at the site surveys were shown in the newsletters as well.

4.2 Target Reader Stakeholders

The target readers of the newsletters are the MPWT, related agencies, international donors, NGOs, etc. Seventy (70) copies of the newsletters were delivered respectively.

In particular, the international donors appreciated reading the newsletters to get an update on progress and activities of the Master Plan Study.

CHAPTER C-5 ISSUES TO BE ADDRESSED AND RECOMMENDATIONS

5.1 Problems of the Capacity Development in Cambodia

(1) Inconsistency in Training

There are many opportunities to participate in workshops and training seminars supported by donor countries for the staff of ministries, but that training does not have the consistency of the policy on the capacity development. When invitations to a workshop arrive, the staff are nominated on an ad hoc basis. Participants enjoy the discussion in a one-day workshop; however, the ideas with most potential that came up in discussions could not be implemented afterwards. The valuable knowledge and information from the workshops stopped at the individual participants without returning the benefits to the organizations.

It is hard to make effective use of the training due to the lack of a consistent policy to utilize the results of the workshops and seminars without the feedback mechanisms of the capacity development program.

(2) Lack of follow-up and support from top management

Linked with the above issue, the top management provides less follow-up and support to the implemented trainings. They appoint the participants to the seminars without deep consideration and do not give particular attention to the results. Even if the international donors and NGOs introduce a bottom-up approach to capacity development, it can hardly succeed without top-down decision making.

Human resources are assets of an organization and capacity development is regarded as one of the significant policies for the operation of an organization. Unless the top management promotes an effective well-organized capacity development program with strong determination and leadership, the operation of the ministries will not improve.

(3) Concentration of information

We can observe that the opportunity to acquire new technology and new information is concentrated on a few staff. The trained persons have to have the responsibility for dissemination of the information and knowledge received to the wider organization.

(4) Lack of "OJT" system

At present, there are not enough capable engineers in MPWT for the medium and large-scale road development and improvement projects. MPWT engineers should identify the project flow and cycle from project preparation and implementation to operation/evaluation. Although international donors have carried out many construction works, the MPWT has not used these opportunities for learning the skills and technology. Working together with international contractors at the

construction site is a good opportunity for OJT.

(5) Importance of site visits

Experience of real situations on site is required. Lectures and workshops are limited in providing practical solutions. Otherwise the differences of recognition in terms of the road network administration between the central office in Phnom Pen and the provincial offices are getting wider.

(6) Unclear promotion system

The promotion system is not based on the issues of capacity development. A transparent and merit-based promotion system still has to be established. It is said that political party ties and/or payments to superiors determine promotions; in other words, posts can be bought. Top management should instigate a competency assessment system to prevent government stagnation.

It is necessary to improve and enhance the administrative capacity of the organizations as well as the individual capacity development of staff members.

5.2 Recommendations

(1) Strategic Continuous Capacity Development Program

In order to realize the appropriate road network administration suggested by the Master Plan Study, the Ministry needs a consistent vision for Capacity Development. At the same time, a strategic system and mechanism should be designed in order to disseminate the capacity development efficiently. The key points of the strategic program guided by the analysis of the above-mentioned problems are listed below.

- **Top management** should utilize the Strategic Capacity Development Program for the purpose of enhancing the organization responsible for the road network administration
- A consistent training program should be organized **according to management levels**
- **A mechanism** for the rapid dissemination of results should be designed
- **On-the-Job Training** from seniors to juniors should be a function of the Ministry
- **Site visits** should be utilized together with lectures for deeper understanding
- A motivation system including **promotion and payment** should be reviewed

Under the strategic program supported by top leaders, the individual activities should be organized according to the listed key points. The details of the points are stated below, but again the Study Team emphasizes that the coordination of the key points is critical for success of the Capacity Development.

(2) Clarification of Capacity Development Program

The Ministry needs a vision for Capacity Development based on a consistent policy to realize the appropriate road network administration suggested by the Master Plan Study.

Based on the vision of the Capacity Development, the clarified target of the capacity development

according to each level should be taken into consideration in designing the program. The contents of the training should be formulated according to the level and the function of respective targets as shown in the below table. By formulating the strategic capacity development program, each individual seminar and workshop will become more effective.

Table 5.2.1 Necessary Competency by Carrier

Target	Issues to be learned
Carrier of central government	Road Administration, Budgeting, Procurement of financial resources, Project Planning, Project Evaluation
Staff working for regional office	Implementation of road project (tender, contract, supervision etc.), project budget control
Local staff	Quality control, schedule and process control

(3) Efficient Dissemination Model of Capacity Development

The following figure shows the cascade model of expanding knowledge and information that takes effectiveness and efficiencies into consideration.

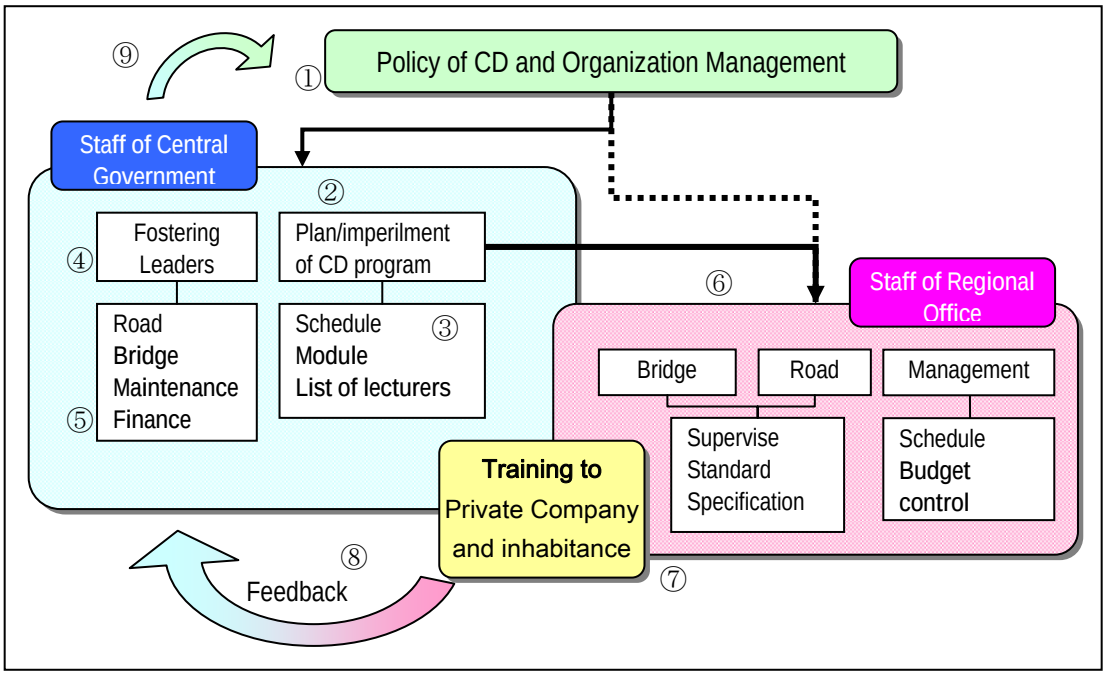


Figure 5.2.1 Dissemination Model of Capacity Development

The mechanism is:

1) Policy of Capacity Development and Organization Management is appreciated by top management,
2) Designated staff of central government design the structure of program,
3) Modules and textbooks of the program are developed by designated staff,
4) Potential staff members are selected by expertise as core-trainers for the dissemination,
5) Selected staff members of each expertise are trained by advanced experts,
6) Core-trainers train the staffs of regional offices such as the DPWT and DRD,
7) Trained staff in regional offices instruct the sub-contracted companies,
8) The process of the program implementation are monitored by central government, and then

9) Feedback from the site is utilized for improvement of the further capacity development and organization management.

(4) On-the-Job Training

Experience is the most effective and efficient way to learn operations, so that an OJT system should be introduced in the capacity development program.

Senior officers should review the key points and meanings to the subordinate staff at the appropriate time in the process of the operation, otherwise the subordinates will not understand the relationship of the operations. It is important for superiors to educate their subordinates to be attentive self-starters.

Education of the junior staff is one of the critical tasks for proper operation of the agencies. The degree of the contribution towards capacity development of the staff should be one of the criteria of the competency assessments for promotion.

Participation in the construction/rehabilitation projects funded by international donors is also very efficient OJT. By working with construction workers, the engineering staff of the MPWT can learn the real process of the construction projects, so they will be able to implement future projects independently. Engineers of the MPWT should be more involved in the operation of road network projects and contribute more as a responsible ministry. Capacity Development is not realized alone, so that opportunities of receiving donations such as project implementation and materials should be utilized effectively.

(5) Utilization of Model Sites

Several model sites should be selected as the starter for the program implementation. Advanced regional offices that are well organized in road maintenance could be model sites for the practice of the modules. It will be very significant in terms of maintenance and operation of the road network to make best practice of capacity development.

It would be ideal if the other regional offices follow the lead of the model sites, so the program is expanded to the other provincial offices by following the best practice model. In the end, the mechanism of the capacity development and organization management can be disseminated all over the country.

(6) Review of Promotion System and Penalty System

As mentioned before, payments and promotion are not secured by the transparent fair system. The MPWT should have accountability of the criteria for the promotion system. Corruption and/or inconsistencies about promotion always reduce the motivation of staff.

Competency and qualification should be taken into consideration for promotion as well as the degree of the contribution for the capacity development and enhancement of the organization.

CHAPTER C-6 CAPACITY DEVELOPMENT PLAN

6.1 Objective of the Capacity Development Program

The objective of the Capacity Development Plan is to enhance the administration capability of the Ministry of Public Works and Transport responsible for road network administration in the Kingdom of Cambodia.

There are two aspects when considering the capacity development, (i) individual human resources and (ii) the organization's power. The Capacity Development Program is designed to maximize the capability of the existing assets of the MPWT and DPWT.

6.2 Target of the Capacity Development

(1) Targeted Beneficiaries

The targets of the capacity development are the MPWT and DPWT. As need arises, the MRD/DRD, private construction companies and the inhabitants of the communities at the sites would be involved as related stakeholders.

(2) Targeted Area

Starting from Phnom Penh, the target area will gradually expand year by year, and it will eventually cover all of Cambodia.

6.3 Log Frame of the Capacity Development Program

The details of the Capacity Development for Maintenance, which is regarded as urgent issue, are shown in Part B of the Report. The concept is the same as that mentioned here in Part C, but it is more focused on Maintenance and written in practical detail. On the other hand, the log frame (logical framework) here considers the Capacity Development of the overall Ministry.

Table 6.3.1 shown below is the log frame of the proposed Capacity Development Program. However, the proposed log frame was formulated based, without a comprehensive study, on discussions with all related agencies. It is recommended that the program be reviewed again when the nominated key persons start the CD program. The ideas and requests from the practical operations staff are very important in designing the programs.

The Overall Goal is an ultimate goal of the MPWT and DPWT, and the Objective of the Program is the direct goal to be realized by the program. The Program focuses on the Capacity of Development and Empowerment of Organization that is the foundation of the governmental administration.

The expected result has two parts that are i) targeting the improvement of individual capability indicated at 1, 2, 3 in the Log Frame and ii) targeting organizational empowerment shown at 4, 5, 6.

Table 6.3.1 Log Frame of Capacity Development

	Indicator
Overall Goal: Optimal Road Network Administration by MPWT/DPWT in cooperation with the related stakeholders	Maintenance by independent resources
Objective of the Program: Capacity Development and Empowerment of Organization (MPWT & DPWT)	Improvement of the operations & managements
Expected result: 1. Involvement of top management in terms of CD for organization's empowerment 2. Proper administration capability including budgeting, budget procurement and project planning, etc., according to levels of responsibility 3. Proper engineering skills and knowledge by levels of responsibility 4. Establish independent sustainable maintenance system and institution 5. Establish effective implementation and supervision system of the construction project 6. Establish cooperation system with private sectors	 1.1 Vision of CD and Organization 1.2 Involvement of the Steering Committees 1.3 Monitoring the result of CD 2.1 Well functioning dissemination system 2.2 Budget 2.3 Project 3.1 Competency and certification 3.2 Design and/or approved by staffs of MPWT/DPWT 4.1 Well functioning maintenance system 5.1 Well functioning construction project 6.1 Well functioning cooperation system with private sectors
Activities: 1.1 Identify the problem and constraints of the CD and Organization Empowerment 1.2 Organize comprehensive CD program 1.3 Monitor CD program 2.1 Establish modules and textbooks for administrative issues 2.2 OJT and lectures 3.1 Establish modules and textbooks for engineers 3.2 OJT and lectures for engineers in particular 4.1 Identify the problems of maintenance to be improved 4.2 Practice and supervise the maintenance at sites 5.1 Review ongoing construction projects 5.2 Involve the projects as trainees, auditors and supervisors 6.1 Identify the constraints of cooperation system with private sector 6.2 Hold workshop and seminar targeting private sector	**Input:** Human Resources: -Expert and Adviser -Managers -Staffs Equipment: -Equipment for maintenance -Equipment for construction Budget -Running cost of CD

The program should be well balanced to provide governmental officers with both engineering and administration skills. In other words, the MPWT needs human resources with both engineering knowledge and administrative capacity.

The Study Team recommends receiving proper support from international donors who can verify individual foreign experts and organize a harmonized holistic capacity development plan using practical OJT and grant aid of equipment.

Table 6.3.2 outlines the capabilities the officers should learn as soon as possible.

Table 6.3.2 Detailed Components of the Capacity Development Program

Phase	Phase I		Phase II	
	Engineering	Administration	Engineering	Administration
Transfer from	Foreign Expert	Foreign Expert	MPWT/NRMC	NRMC
Transfer to	MPWT/DPWT	MPWT/DPWT	DPWT/Contractors	MPWT
Activity	-Identification of construction work -Project preparation -Supervising of construction work -Control of progress -Inspection of construction work -Quality control system	-Identification of project process -Management of income & expense -Management of project schedule -Management of procurement	-Introduction of lifecycle cost management -Implementation of training of trainers to DPWT & contractors -Planning of new development & improvement -Demarcation of MPWT & DPWT for engineering	-Management of fund -Finding fund sources -Planning of new development & improvement -Demarcation of MPWT & DPWT for administration
Expected Outcome	-Original text or guideline for construction works -Training program & modules for MPWT & DPWT -Daily report -Monthly & quarterly reports -Preparation of as-built drawing -Construction cost analysis -Project impact evaluation	-Preparation of balance sheet -Monitoring system of schedule control -Establishment of procurement system -Training program & modules for administration -Introduction of data base	-Course for training of trainers - Feasibility Study -Detailed Design -Analysis for project cost -Annual & short term budget plan for development & improvement	-Course for training of trainers -Annual & short term budget plan of fund allocation & institutional management -Registration system of local contractor
Viewpoint of Assessment	-Individual & project unit understanding of construction work -Stable implementation (observation of schedule) -Preparation of intelligible report -Verifiable indicator (Physical, Economic & Environment)	-Transparency of procurement procedure -Analysis of balance sheet -Delay or ahead of project schedule -Understanding of job description	-Trainee's understanding -Capability of planning for development & improvement (gap of plan stage & actual work) -Evaluation of local contractors	-Trainee's understanding -Evaluation of local contractors -Timely disbursement of fund

The MPWT should put the establishment of institutional management before everything else. However, the MPWT has not managed and supervised road development and improvement before. Firstly, the MPWT should identify the hard and easy areas of the road construction project, determine the project cycle and follow the procedure of road maintenance management, which is described in Part B of the Report.

6.4 Other Issues to be Addressed

To achieve the targets above, the following issues should be taken into account.

(1) Improvement of National Road Maintenance Committee (NRMC)

In the Report, "Part B: Institutional Development for Road Maintenance," it was suggested that the National Road Maintenance Committee, which would consist of the MPWT, MEF and related agencies including international donors, be established for administration of road maintenance, particularly the appropriate allocation of budget. In the first stage, the NRMC will be expected to play the role of the budget authority for the Ministry of Economy and Finance. Then it will expand its authority to include budget planning, road infrastructure policy formulation and road infrastructure strategy formulation for road development and improvement as a representative of the agencies related to the Road Maintenance. NRMC shall be in charge of finding the investment fund sources, allocation of budget, management of quality control and assessment of projects that are to be supported by road authorities.

In principle, the MPWT has to have its own individual decision-making system for road maintenance based on a technical background. Since the capacity of the MPWT has not yet mature enough, the NRMC, consisting of related agencies such as the Ministry of Economy and Finance, will have to be involved in the decision-making process of the Road Network Administration. After completing the capacity development and organization empowerment, the roles and authorities should be headquartered at the MPWT. Capacity development is a critical issue of the MPWT in order to make a proper budget system.

(2) Establishment of Project Implementation System in MPWT

At present there are not enough capable engineers for the medium and large-scale road development and improvement projects of the MPWT. First, the MPWT engineers should identify the project identification. The Study Team proposes that MPWT engineers join with each road improvement project site funded by foreign donors and learn from management mechanisms at each stage. They then have to develop the project implementation, which consists of construction supervision and maintenance planning, formulation of construction standards, supervision and monitoring of performance by local funds, supervision and monitoring of donor-funded development and improvement projects.

The MPWT engineers then need to master the project preparation (FS, DD), pre-construction work (ROW Acquisition, Bidding and Contracting) and project operation/evaluation. This knowledge should be kept in not only the General Directorate of Public Works but also in the General Directorate of Administrative Services and in the General Directorate of Transport. The MPWT should prepare the original project cycle for road development and improvement.

For developing provincial organizations the DPWT should also acquire knowledge in the following: 1) Regional road network management, 2) Road inventory, condition survey and traffic

counts, 3) Detailed planning and budgeting of road maintenance operations, and 4) Management of road maintenance, improvement and development construction. The DPWT should develop individual ability and build project units in several regions to strengthen the structure. As it is important for the MPWT to decentralize the implementation of construction, the MPWT should manage the road network in Cambodia and the DPWT should be responsible for site management with staff mobilized from central offices.

(3) Collaboration with the Private Sector

Many employees are working in construction industries and the economy has been strengthened by those industries. If the construction market is poor and dependent on foreign funds for road construction the government organizations, which have the skill and operational expertise, may be changed to a private company. It is not easy to establish such a reform but the following three business functions are considered for usual practice:

1) Consultant business as the core of road design
2) Regional construction business for utilization of facilities and equipment
3) Regional maintenance business for utilization of labor and light equipment

The following are necessary conditions: 1) sustainable project supply, 2) substantial cash flow, 3) technology support, and 4) Local favor policy (ex. priority order to local company, compulsory joint venture with local company).

In Cambodia, it will be difficult to achieve privatization by 2020, so the Study Team has introduced it as a guide for economic growth. However, it is necessary to strengthen development of construction technology and management before everything else.

(4) Security of Funds

There are currently only a few national budgets for road development and improvement so the road network in Cambodia has been constructed from foreign funds either in grants and aid or as loans. In the case of loan assistance, Cambodia will repay its debts after a period of grace. Therefore, Cambodia should be seeking domestic funds such as earmarked funds for the purpose of maintenance or rearranging its budgeting scheme. Chapter MP-A-13 describes this in detail.

PDM (Logical Framework) of Taskforce in Development Strategy 1/2

Summary of the Tasks	Indicators	Source of Indicators	External Factors
Overall Goal: Improvement of road infrastructure in order to contribute to national socio-economic development by promotion of synergy effects among other infrastructures and potentials of the respective areas.	1) Average speed (km/hour) of transportation, traffic density, transportation cost 2) Socio-economic indicators (production, income, education, health) 3) Degree of people's satisfaction	1) Traffic density 2) Statistical data 3) Questionnaires	
Objective of Development Strategy Taskforce: Establish a master plan for road construction, particularly for one-digit and double-digit national roads, that effectively enhances and contributes to the national development plan and clarifies the functions of categorized roads by their obligations and authorities. Establish a rural roads network plan, for two-digit national roads and three-digit regional roads, that contributes to the regional development plans.	Final Report will contain: 1) Cambodian development strategy and plans consistent with the development plans of neighboring countries 2) Road network program budgeted by a minimized financial plan 3) Proposed practical O&M system for a sustainable road network 4) Regional development plans that fully utilize the potential factors 5) Recommendations for maximizing the benefits by implementing a mechanism between roads and communities	1) Agreement among stakeholders 2) Discussion in Parliament 3) Budgeting	・ No budget for implementation
Expected Results: 1. Clarification of the functions of each categorized road, such as positions in international networks and roles in domestic development. 2. Proper establishment of road networks that promote regional development and contribute to the national economy. 3. Planning of road projects according to the beneficiaries' demand. 4. Improvement of C/P's planning and presenting skills capabilities.	1-1) Segmentation of Cambodian road network in MGS 1-2) Report on study trip by C/P 1-3) Regional development plan 2-1) Correlations between road network and socio-economic factors 2-2) Identification of regional characteristics concerning road conditions 3-1) Results of questionnaire survey 3-2) Prioritization of road projects 4-1) Achievement of capacity development	1-1) Interim Report, Final Report 1-2) Interim Report 2-1) Progress Report 2-2) Result of SWOT analysis 3-1) Interim Report 3-2) Final Report 4-1) Monthly report of C/P and the result of Management By Objectives through Self Control (MBO)	

PDM (Logical Framework) of Taskforce in Development Strategy 2/2

Actions:	**Input:**	**Pre Condition:**
1-1 Review Development Plans of surrounding countries and GMS program 1-2 Review Cambodian road networks and surrounding international road networks 1-3 Study of road infrastructure projects supported by the international organizations and major donors 1-4 Study trip to Thailand and Laos to learn road network strategy (including O&M system) 1-5 Study trip to Vietnam to learn road network strategy (including O&M system) 1-6 Comparative analysis on road network systems of neighboring countries 1-7 Consideration of Cambodia's macro development strategy 1-8 Execution of public relations for the national road network development strategy 2-1 Review social indicators of Cambodia 2-2 Review economic indicators and structure of industries 2-3 Analysis of mechanisms caused by road construction projects 2-4 Trial Simulation of synergy effects among various factors 2-5 Selection of target areas for feasibility study 2-6 SWOT Analysis of the potential areas 2-7 Prioritization of the potential projects 2-8 Establishment of a regional development plan 3-1 Implementation of Questionnaire survey 3-2 Analysis of survey results 3-3 Consideration of medium and long term visions for regional development 4-1 On-the-job training for C/P's capacity development for field study, planning and presentation	**［Cambodia］** 1) 2) 3) 4) 5) 6) 7) **［Japan］** 1) Initial cost (PC, Printer, FAX, UPS, Software, Anti-virus, PC desk chairs) 2) Consultancy fees 3) Daily allowance and accommodation cost of C/P's business trip 4) Workshops, Study tours 5) Cost of data input 6) Sub-contract (Questionnaire survey)	

PDM (Logical Framework) of Taskforce in Social and Environment Consideration 1/2

Summary of the Tasks	Indicators	Source of Indicators	External Factors
Overall Goal: Road project will be implemented smoothly without negative impact to environment and society.	1) Objections from people and NGOs 2) Differences between plan and actual construction works	1) Meeting record of stakeholder meeting 2) Supervision record for construction work	
Objective of Development Strategy Taskforce： The road M/P objective, which is minimize negative impact to environment and society, will be formulated	1) Objection s from people and NGOs	1) Meeting record of stakeholder meeting	
Expected Results： 1. To grasp present conditions and issues of laws and regulations regarding environmental and social consideration 2. To evaluate positive and negative impact for environment and society by road project and its usage. Understand the points for environmental social considerations for future road project. 3. To facilitate understanding of stakeholders and hear public opinions, then to reflect to the M/P and build consensus. 4. To facilitate understanding of stakeholders by information disclosure and dissemination. 5. To consider environment and society for formulation of goal and strategy for road improvement 6. To consider environment and society for formulation of M/P 7. To consider environment and society for formulation of priority road improvement plan	1) Clarify issues 2) Evaluation result and clarification of consideration points 3) Holding meeting and record meeting 4) Goal and strategy for environmental and social considerations 5) IEE 6) IEIA	1) Interim Report 2) Interim Report 3) Meeting Minutes 4) Interim Report 5) Interim Report 6) Interim Report	

PDM (Logical Framework) of Taskforce in Social and Environment Consideration 2/2

Actions:	Input:	Pre Condition:
1. Law and regulation review for environmental and social consideration 1-1 Environmental assessment law 1-2 Protect/conservation area 1-3 ROW 1-4 Resettlement and compensation 1-5 Land tenure **2. Environmental evaluation for road improvement/usage** 2-1 Past road project review 2-2 Simple interview of local residents **3. Stakeholder meeting** 3-1 Discuss and determine the member, agenda, manner for discussion, content and manner for information to be disclosed 3-2 Hold meetings **4. Information disclosure** 4-1 Establish Web site 4-2 Discussion and determine the information to be disclosed 4-3 Update Web site **5. Formulation of goal and strategy for road improvement** 5-1 Clarify the points for environmental and social consideration. 5-2 Formulation of goal and strategy of environmental and social consideration for road improvement 5-3 Reflect environmental and social consideration to goal and strategy formulation for road improvement 5-4 Preparation Process for Planning of Resettlement Action Plan **6. Formulation of M/P** 6-1 Conduct IEE for entire M/P 6-2 Comparative analysis for alternatives at IEE level 6-3 Scoping for priority projects **7. Formulation of priority road improvement plan** 7-1 Conduct IEIA 7-2 Public consultation 7-3 Consideration for resettlement plan 7-4 Consideration for monitoring mechanism	**［Cambodia］** 1) Counterpart (MPWT) 2) Counterpart (MOE) 3) Cooperation with NGOs **［Japan］** 1) Environmental and Social Consideration Expert(Ibayashi) 2) Public Consultation Expert (Leakhana)） 3) Web site establishment for information disclosure 4) Sublet for review of laws and regulations for environmental and social considerations（Proposed） 5) Sublet for environmental assessment for road improvement/usage (Proposed) 6) Sublet for IEIA (Proposed)	

PDM (Logical Framework) of Taskforce in Road Infrastructure 1/2

Summary of the Tasks	Indicators	Source of Indicators	External Factors
Overall Goal: Improvement of road network consistent with regional development, tourism, inland water transportation and railways Contribution to efficiency of domestic transportation and distribution	1) GDP 2) Income level 3) Vehicle possession		International and domestic economic problem
Objective: Proposal in M/P and Pre-F/S will be adopted as a national plan and MPWT or other related organization will implement the projects.	1) National road development strategy 2) Road maintenance strategy 3) Financial plan for road development and maintenance	1) MPWT 2) MPWT 3) MEF	Political: Sinking of priority of road sector due to policy change Administrative: Less coordination among administrative organization
Expected Results: 1. Updating of inventory (LRCS) for single and double digit national roads and triple digit provincial roads 2. Setting of design standard that corresponds to functions and roles of the roads 3. Formulation of road network development plan considering consistency and priority of railways and inlands water transportation 4. Traffic demand forecast consistent with regional development scenario 5. Preparation of guide paper for installing traffic safety facilities 6. Preparation of implementation plan for prioritized routes (5 sections)	1-1) LRCS 2-1) National development plan 2-2) Road design standard 2-3) Traffic demand forecast 3-1) Road development plan 3-2) Railway development plan 3-3) Inland water transportation development plan 3-4) Traffic demand forecast 4-1) Road design standard 4-2) Road inventory 4-3) Traffic Volume 4-4) Travel Speed 5-1) Guide paper for the installation of road safety facility 5-2) Road inventory 5-3) Accident data 6-1) National development plan 6-2) Road development plan 6-3) Traffic demand forecast	1-3) MPWT 2-3) CDC, MOP 2-4) MPWT 2-5) Prepared in this Study 3-1) MPWT 3-3) RRC 3-4) MPWT 3-5) Prepared in this Study 4-1) MPWT 4-2) MPWT 4-3) MPWT, Prepared in this Study 4-4) MPWT, Prepared in this Study 5-1) Prepared in this Study 5-2) MPWT 5-3) MPWT, Police 6-1) CDC, MOP 6-2) MPWT 6-3) Prepared in this Study	

PDM (Logical Framework) of Taskforce in Taskforce in Road Infrastructure 2/2

Activities:	**Inputs:**	**Pre Condition:**
1-1 Review for Existing Road Inventory Data 1-2 Supplemental Road Inventory Survey 2-1 Review for Progress of SEDP-2 Programs and Development Plan 2-2 Review for Road Facility Design Standard and Design Application of other Project 2-3 Review for Past Flood Damage Data and Site Survey 2-4 Setting Target Design Level of Road Structure as per Road Function 2-5 Classification of Road Function for Each Route or Link 2-6 Formulation of Road Structural Standard as per each Road Function 2-7 Cost Estimation for Rehabilitation and Up-grade toward Target Design Level 2-8 Formulation of Road Development Master Plan 3-1 Review for Exiting Railway and Inland Water Infrastructure Conditions and Development Plan 3-2 Functional Assigning between Railway, Inland Water and Road 4-1 Review for Traffic Conditions Data (Vehicle Registration, traffic survey, and so on) 4-2 Traffic Survey 4-3 Demand Forecast Analysis 5-1 Review for Existing Road Traffic Safety Conditions 5-2 Policy Formulation for Road Safety Facility Installation 5-3 Formulation of Draft Guide Paper for Road Safety Facility Installation 6-1 High Priority Project Selection 6-2 Formulation of Road Structural Standard as per each Road Function 6-3 Topo and Geotechnical Survey 6-4 Road Facility Design 6-5 Cost Estimation 6-6 Formulation Construction Planning 6-7 Project Economical Evaluation 6-8 Preparation for Project Implementation Plan	**［Cambodia］** **［Japan］** 1) Initial investment (Computer, Printer, FAX, UPS, Software, Anti-virus, desk, chair, and so on) 2) Allowance for member, mobilization fee 3) Workshop, Training tour in Japan 4) Input data 5) Local subcontract	

PDM (Logical Framework) of Taskforce in Road Management 1/2

Summary of the Tasks	Indicators	Source of Indicators	External Factors
Overall Goal: Periodic maintenance of the national road network and improvement of arterial roads, which form the nationwide trunk line network for local development in Cambodia.			
Project Purpose: Periodic road maintenance.	1) Average vehicle speed 2) Number of traffic accident	1) MPWT, MRD, DPWT, District Government 2) Road Rehabilitation Project Location Referencing and Condition Survey (LRCS) 3) District Police	・ Weather condition ・ Vehicle condition ・ Driver manner
Expected outputs: 1. Functional Organization 2. Smooth and safe traffic 3. Functional Road Improvement and Maintenance with Stable Financing	1-1) Scope of Work for each implementation agency 1-2) Implementation staff for each implementation agency 2-1) Road maintenance unit cost per budget, road maintenance km and contract 2-2) Working rate per year for owned machinery 3-1) Financing, income and expenditure for road improvement and maintenance 3-2) Income from toll road	1-1) Road length register 1-2) Maint. Organization Chart 2-1) Contract, maintenance length and bridge(m2) in each implementation agency 2-2) Annual activity report 3-1) Budget and Statement in each implementation agency 3-2) National budget	・ Changing of road maintenance length due to changing of organization ・ Capability of local contractor ・ Improvement of road law for financing

PDM (Logical Framework) of Taskforce in Taskforce in Road Management 2/2

Activities:	**Inputs:**	**Preconditions：**
1-1 Survey on the Road Responsibility in Administrative Classification of Roads（MPWT, MRD, DPWT, District Government） 1-2 Survey on the Present Implementation Flow for Road Maintenance 1-3 Survey for Number of Staffs, Road Maintenance Budget and Scope in previous 5 years in Organization 1-4 Responsibility and Scope for each Organization 1-5 Frame of Maintenance Plan and Implementation Schedule in each term 1-6 Suggestion of Salary System in the Organization 1-7 Checking of Road Law 1-8 Utilization of private sector in Maintenance Program 1-9 Capacity Building on the Road Administration 2-1 Quote the maintenance unit cost in previous 5 years based upon the categorized road sectors/study roads 2-2 Capable contractor's; Number engaged in road repair, their magnitude and record in each province 2-3 Survey on the frame on repair/achievement of contract of categorized road in each province 2-4 Analyze the collected data and confirm the essence of the above 2-5 Frame the road maintenance plan considering the proposed typical cross section in each categorized road 2-6 Improve the road maintenance plan based upon the continual road maintenance fund 2-7 Improve the road maintenance plan based upon the continual road maintenance fund 2-8 Capacity building on the road maintenance plan 3-1 Road Improvement budget in previous 5 years 3-2 Analysis on the present road financing 3-3 Toll, toll body and purpose for income on existing toll road 3-4 Condition of Earmarked funds 3-5 Condition of implementation for toll road 3-6 Capacity building on the road maintenance plan	**［Cambodia］** 1) Counterpart 3 persons 2) Office space 20m2 3) All data, information and document for road maintenance budget and statement **［Japan］** 1) Computer, printer, FAX, UPS, software and office furnitures 2) Per diem for surveyor, Transportation 3) Workshop, Expenses for site tour 4) Input data 5) Sublet to local consultant	・ Counterpart for Institutional, road maintenance and financing expert ・ Two vehicles ・ Support from MPWT in case of contacting to MRD, DPWT, district Government, MEF (CDC), MOP ・ Road Structure Ordinance

Full name	:	CHEAM SOVANNY
Sex	:	Male
Date of birth	:	January 5, 1964
Place of birth	:	Prey Veng Province
Work Place	:	Ministry of Public Works and Transportation
Expertise	:	Civil Engineer, / MBA

1. TASK WORKS

As a counterpart for the project of the Road Network Development in the Kingdom of Cambodia being conducted by the JICA Study Team, I attended the workshop on Development Strategy and Road Infrastructure.

2. INTERESTING EXPERIENCES

The Master Plan study for the Road Network Development in the Kingdom of Cambodia is to formulate a road network master plan with a target year of 2020 as well as to propose a restructuring plan for the road sector including a road maintenance mechanism. This is a good opportunity for the MPWT and also for the Royal Government of Cambodia.

This is the part of the "Rectangular Strategy", which has been declared in the political program of the Royal Government. The improvement of the road network is the strategy for the Cambodian economy, because this field will increase regional trade, tourism, agriculture and give priority to the rural development. A highly effective infrastructure will assist the increasing of small and medium enterprises of the country. On the other hand, with the project the JICA study team is providing good chances to the MPWT staff to get the experience on road construction such as traffic survey, socio-economic, development strategy including Multi-Growth Pole Development, Development of International Corridors, Enhancement of Rural Economic Development, National Integration, Regional Development for Poverty Reduction. Some staff can go to training in Japan to get new technology for improving capacity building.

3. LEARNING FROM THE MASTER PLAN STUDY

During my time with the Road Network Development in the Kingdom of Cambodia knowledge has been gained, such as: study on prioritization of rehabilitation roads, improving capacity development of infrastructure, criteria and factors for prioritization, definition of improvement works, road capacity improvement, road network improvement, road upgrading to required standard, road rehabilitation and road maintenance works such as below:

- Improvement of existing road network

– Use existing road network

– Improvement of existing road

- Strengthening of road network and capacity

– Four lane widening, ring road and bypass

- Reinforcement of road network

– Alternative route

Understandings on issues to be considered in Initial Environmental Impact Assessment (IEIA) are summarized as followings.

(1) Considerations for Particular Area

(i) Agriculture/Forestry Area

(ii) Industrial Area

(iii) Tourism Area

(2) General Considerations for Road Development

(i) Resettlement

(ii) Fauna and Flora (Natural Environment)

(iii) Air Pollution, Noise and Vibration

(3) Considerations for New Road Construction and 4-Lane Widening

The formulated road network development plan should be based on the development strategy as well as several conditions such as the existing network, pavement condition, future traffic volume and on-going projects.

Development potentials and constraints were also considered from eight (8) aspects, that is, Geography, Population, GRDP, Agriculture, Manufacture, Tourism/Service, Mining Resources and Environmental Conservation.

In principle, the output of the master plan study concerning the development strategy, estimation of future traffic volume, environmental consideration, road development plan in 2020, improvement measures including cost estimate, prioritization of project, financial prospect, implementation program and selection of priority projects for the pre-feasibility study.

4. MY FUTURE PERSONAL PLAN

After my experiences with the JICA Study Team on the project of the Road Network Development in the Kingdom of Cambodia my objectives are looking for donors to supply funds and to cooperate with the MPWT to develop the infrastructure of Cambodia. But I expected that the Government of Japan will provide on going Grain Aid for the rehabilitation of infrastructure in Cambodia. The present the country needs are as below:

1) To select the highest priority segments of the whole road network to be rehabilitated or improved, and to carry out pre-feasibility study, including design as well as pre-environmental impact assessment; and

2) To promote transfer of knowledge and technology, which is necessary for the formulation of the road development plan and implementation of road improvement and maintenance management, to the DPWT and road management authorities of Cambodia.

Full name	:	SAN PISET
Sex	:	Male
Date of birth	:	June 16, 1979
Place of birth	:	Pursat Province
Work Place	:	Ministry of Rural Development
Expertise	:	Economics

The development strategies for formulating the Road Network Master Plan

The road network system is the strategy for uplifting the Cambodian economy. The Study on Road Network Development for formulating the Master Plan is now being undertaken by the JICA study team at the Ministry of Public Works and Transport and cooperation with other Ministries such as Ministry of Economic and Finance, Ministry of Environment and Ministry of Rural Development. The Study will express clearly and precisely the road network system in the whole country, to carry out pre-feasibility study on the high priority project section. It is also complies with the Rectangular Strategy, which has been declared in the political program of the Royal Government of Cambodia.

First of all, I would like to offer my sincere thanks to the Team Leader and all Japanese members of JICA Study Team who provided me the good chance of working with this study. In the organization chart, JICA Study Team is divided into four parts, which are Road Infrastructure Team, Development Strategy Team, Road Management and Maintenance Team and Environmental and Social Consideration Team. In the duration of studying, JICA Study Team has requested to each

Ministry a government staff member to study and work as a counterpart to assist any works related to the study.

I acted as a counterpart from Ministry of Rural Development and had the opportunity to join in the Development Strategy Team of the study, since April 2005. In my task, I did collect data from fields and other Ministries, and then transfer it to Computer. All data were updated during the study.

In addition to that, I prepared weekly reports after finishing the activities of the week and collected the new activities for the next week from the leader of the taskforce. Monthly reports were prepared every month and was submitted to team leader for recording.

The most interesting experiences were the counterpart's workshop and attending the seminars conducted by the Study Team. It was good for counterparts to learn and share experiences during study. In the workshop, JICA Study Team let all counterparts to present their own topics that related to the Road Network Development and Financial Procedure in Cambodia and all activities of counterpart had been done in the field trip. Workshop was a general meeting that we could open everybody's mind to discuss and share knowledge to improve or find the good ways to achieve our goals. Especially, we learned from the Japanese members about their experience on our topic. Seminars were very important occasions for Team Leaders to conduct the process of Master Plan and showing what is going on of the problem in the time study.

In addition to that, I learned lots from other counterparts about Traffic Survey, Road Maintenance, Financial Procurement, Initial Environment and Overseas Training of counterpart staffs to get new technology for improving capacity building.

Through this study, I got a clear understanding about the master plan on road network in Cambodia. Learned from master plan about road development study plan based on the development strategy and has formulated an implementation program taking into consideration the future financial situation in short, medium and long term. There I realized the study plan is a good strategy to manage everything before we do activities in the future.

After the Master Plan Study, I got a clear understanding about the master plan on the road network in Cambodia. Moreover, it is to assist Cambodian government policy to reduce the poverty. I hope that I will learn more experiences from the JICA team on methodology to establish Master Plan. MRD will adopt the Master Plan for managing financing Rural Roads in the future.

Full name	:	You Dara
Sex	:	Male
Date of birth	:	06 October 1974
Place of birth	:	Takeo Province
Work Place	:	Ministry of Public Works and Transport
Expertise	:	Civil Engineering

REPORT ON LESSONS LEARNED FROM JICA STUDY TEAM

1. Background

The Royal Government of Cambodia (RGOC) has made the restoration of the country's road infrastructure and its essential institutions a high priority. The transport sector is a primary target, and much has been achieved in the road sector. As the first step, the Japanese Government and a number of bilateral agencies are also active in transport and the Ministry of Economy and Finance (MEF) and the Ministry of Public Works and Transport (MPWT) are closely coordinating with each other to maintain the road length of 1,241.50 Km under the Japanese Government co-financing support of $1,750, 251 for a one year project in 2003-2004. The first step project has provided the development, reduced the national expense and improved transportation in Cambodia, which was ended in December 2003. In order to have the sustainable development routine maintenance program, the JICA Study Team and the Ministry of Public Works and Transport have worked closely to develop a budget planning guideline for a routine maintenance program for Cambodia. This budget planning guideline is closely related to the government plan to improve and maintain all the road networks, which a fundamental need to save the road life in use, reduce maintenance expense and traffic safety. The budget planning guideline for routine maintenance is very import for sustainable development and technical capacity development in road management and maintenance. Therefore, I am assigned to participate with the JICA Study Team on the Road Network Development in the Kingdom of Cambodia taking part in road management and maintenance.

2. Lessons Learned

Through the provided excellent capacity building program of JICA study team, my knowledge and experiences have been broadly extended in many aspects such as road management and integration with other relevant sectors, in addition, I am now able to understand clearly the basic concept of road maintenance activities and its benefits for developing the practical guideline for road maintenance in Cambodia. Starting from this point of view, I would be able to assess the potential of road management and road maintenance.

Further more, skills and experiences I obtained from the JICA study team are very beneficial to me to address the road management and maintenance element of the smart growth requirements in efficient road planning program. As a result I can then utilize and modify them to suit the particular geographical and meteorological conditions of Cambodia. New engineering technologies are developed while existing methods went through many improvements and advances to cope with rapidly progressing motorization. It is no exaggeration to say that the successful implementation of road management and maintenance guideline has played a key role in national development.

Based on the above knowledge, skills and experiences that I have from the JICA study team in the field of road management and maintenance will enable me to deal with and fulfill the government's overall development goal for infrastructure management. Especially the road planning programs will establish an efficient (that is, low cost and competitive) transport network that maximizes the contribution of transport services to economic growth and regional cooperation. For instance objectives are to:

- Rehabilitate, maintain, and expand transport infrastructure to facilitate the integration of markets and maximization of trade, giving priority to rural development, domestic and international trade routes, and tourism facilities;
- Improve the efficiency of use of existing infrastructure and institutional performance;
- Increase revenues from the transport sector to cover an increasing share of maintenance and development costs;
- Strengthen institutional capacity in sector planning and management and to promote increased private sector participation in financing transport infrastructure development.

3. Conclusion

In conclusion, my experiences and skills I learned from JICA study team are very important and useful for me to contribute my knowledge, skills and experiences to expand the country needs.

Full name	:	NOP Kilarih
Sex	:	Male
Date of birth	:	March 1, 1970
Place of birth	:	Kam Pot Province
Work Place	:	Ministry of Public Works and Transport
Expertise	:	Civil Engineer

First of all, I would like to express my sincere thanks to the government and people of Japan for donating to Cambodia to helpfully to reconstruct the road infrastructure that has been damaged by the long period of civil war in our country. Most of the roads were constructed in the period 1920 – 1930; these roads are damaged by overload, heavy traffic and periodical flood and lack of road maintenance.

The Study road network master plan has taken since April, 2005 to July 30, 2006. The project has been run smoothly by the Japan International Cooperation Agency with cooperation from the Ministry of Public Work and Transport, Ministry of Economic and Finance, Ministry of Environment and Ministry of Rural Development. The JICA study team and counterpart staff worked very active to express clearly and precisely for road network in the whole country, to carry out pre-feasibility study on the high priority project. It is also complies with the Rectangular Strategy of the Royal Government which has been declared in the political program of the Prime Minister, the 3rd Legislation of the National Assembly. The Royal Government has pointed out that "transportation networks have an important role as blood vessel for linking all areas of the Kingdom of Cambodia to become an economic structure which ensures its internal integration and integrate the Cambodian economy to the regional economy and the world. For the Cambodian economic situation, at present, infrastructure networks have important role "Train engine head of economic growth" and the effective means to reduce poverty, and difficulty of the people. Because this field will increase regional trade, tourism, agriculture and provide priority to the rural development. The high effectiveness of transportation infrastructure is to assist to the increasing of small and medium enterprises and provide priority to the rural development in the country.

The project has taken approximately 18 months and I have been working with the JICA study team for the road network master plan in Cambodia. It is a very complicated project for me but I have a good chance to upgrade myself and also push me to learn hard what I have never obtain before. I expect that, through the provided excellent work in project my knowledge will be broadly extended in many aspects such as transport planning and traffic engineering urban planning, hazard and mitigation planning infrastructure maintenance management, project evaluation, structure system planning, etc. In addition, I am able to understand clearly the basic concept of infrastructure management and its benefits for transport planning travel demand and transport systems management. Starting from this point of view, I am able to assess the potential of technologies for applicant in road planning programs, and can develop strategy and recommendations for increasing Cambodian opportunity to implement infrastructure management technologies.

Further more, skills I obtained from the road network master plan study are very beneficiary for me to address the transportation element of the smart growth requirement in road planning programs and also have major functional work elements of the long range plan for transportation, transportation system management and regional transportation plan.

Moreover, my qualification acquired from the JICA study team will be significantly helpful for the improvement of quantity and quality of road infrastructure in Cambodia. This will be tremendously beneficial for the development of Cambodia as the priority of nation policy in transportation field has been place on the reconstruction, maintenance and rehabilitation of the exiting road infrastructure, which were seriously damaged following the civil war.

Secondly, this project will be helpful to the counterpart staff of the Ministry of Public Work and Transport for the development of human resource for building capacity in the department. Also it provides confidence, ability and knowledge to provide my colleagues in order to develop human resources in the country.

Based on the above, the knowledge, skills and experiences that I have from the JICA study team on the road network master plan will enable me to deal with and fulfill the Ministry's overall development goal for infrastructure management. The road planning programs especially will establish an efficient transport network that maximizes the contribution of transport services to economic growth and regional cooperation.

In conclusion, this project will be very useful and helpful to the development of Cambodia and it is going along with Royal of Government Cambodia vision. The project fulfills the agreement with Royal Government Cambodia and Japan Government. As Cambodia gets benefit from the project, I would like to say thank you to the government and people of Japan once again for helping to reconstruct roads and bridges in the Kingdom of Cambodia and to strengthen the economy of Asian countries. When complete the project will not cover the whole country, so I would like to urge the Government of Japan to continue to extend the donation to develop other parts of the country that are increasingly important to link the project in the development of an Asian highway.

Full name	:	YIN Borin
Sex	:	Male
Date of birth	:	July 12, 1970
Place of birth	:	Phnom Penh
Work Place	:	Ministry of Public Works and Transport
Expertise	:	Civil Engineering

The Kingdom of Cambodia is now doing its utmost in the reconstruction and development of society and national socio-economy. Transportation is the strategy for Cambodian economy, because this field will increase regional trade, tourism and agriculture and provide priority to the rural development. The high effectiveness of transportation infrastructure is to assist with

increasing the number of small and medium enterprises. The infrastructures, the economic ties, the existing transportation networks of Cambodia were seriously damaged from war. The restoration and construction of infrastructures are the principle priority, second square part of the "Rectangle Strategy", which has been declared in the political program of the Royal Government, the 3rd Legislation of the National Assembly. The Royal Government has pointed out that "transportation networks have an important role as blood vessels for linking all areas of the Kingdom of Cambodia to become an economic structure which ensures its internal integration and to link the Cambodian economy to the regional economy and the world. In the Cambodian economic situation, at present, infrastructure networks have an important role, "Train engine head of economic growth" and the effective means to reduce poverty, and difficulty of the people.Through the good capacity building knowledge of the JICA study team we will be able to confidently broadly extend in many aspects as well as road infrastructure and integrate with other relevant to fields. Moreover, I would be able to understand clearly the basic concept of road activities and benefit from developing the practical guideline for road network system in Cambodia. Starting at this point of view, I would be able to assess the potential of roads and bridge structures in Cambodia.

Further more, skills and experience I obtained from the JICA study team are very beneficiary to me and my department to address the road and bridge management elements and smart growth requirements in efficient road planning programs. As a result I can utilize and modify to the particular geographical and metrological conditions of Cambodia. Engineering and technologies are developed while existing methods went though many improvements and advances to cope with the rapidly progressing motorization.

In conclusion, it is a good opportunity for me to work in cooperation with the JICA study team to share experience and skills to develop human resources for young engineers in the Ministry of Public Works and Transport. On the other hand, skills and experience that I learn from the JICA study team will be important and useful for me to contribute my knowledge to my colleague in my department.

Full name	:	Tan Thira
Sex	:	Male
Date of birth	:	February 13, 1977
Place of birth	:	Kratie Province
Work Place	:	Ministry of Public Works and Transport
Expertise	:	Civil Engineer

Lesson Learnt From The Study on Road Network Development In Cambodia

I. Introduction

Road Transport plays a crucial role in the development of Cambodia through economic boost, regional and international integration, and particularly possible access to market. Unfortunately, road network in Cambodia was severely damaged following the last two decades of civil war. The road deterioration is result in the disconnection between some parts of the country, particularly between the remote areas and central areas, which leads to gradually widen gag between the poor and the rich. Considering the important role of road transport, the Royal Government of Cambodia (RGOC) has put the road infrastructure reconstruction, rehabilitation, and maintenance as one of highest priorities in its rectangular strategy. It is the fact that road infrastructure improvement would not be effectively and efficiently achieved without an appropriate plan and mechanism. That is why the Government of Cambodia has requested the Government of Japan to provide a technical assistance in formulating the realistic and holistic plan and mechanism for road network development in Cambodia. In response to this request, the Government of Japan assigned its official execution agency, Japan International Cooperation Agency (JICA), to be responsible for the study. JICA has dispatched the study to JICA Study Team, which is composed by Nippon Koei co,.Ltd. and Katarhira and Engineering International, to prepare a master plan for road network development.

The study of the master plan for road network development has been taken for approximately 18 months, which is divided into five steps. Only three steps were conducted in Cambodia and other two steps were undertaken in Japan.

Regarding the involvement of the Government of Cambodia to facilitate smooth execution of the study, the ministry of public works and transport is assigned to be the counterpart agency of the JICA Study Team. Fortunately, I was assigned by ministry of public works and transport to work with the JICA Study Team as a counterpart. During my performance with the JICA Study Team I have learnt new knowledge and skills through on job-training and oversea training as it is mentioned on the objectives of the study.

II. Lesson Learnt

As the counterpart in road infrastructure working team, I involved almost main activities, which were undertaken in three steps in Cambodia. The participation in the main activities has offered me new knowledge and skills, which are very important for my career in the present as well as in the future.

Firstly, I learnt how to prepare road and bridge inventory. In this road and inventory, I have to classify road and bridge into different categories based on its function, its pavement type and condition, and its carriage width. To do this, I have to collect all available drawings in the ministry and I also have to go fields to gather the exact condition of road and bridge in order to prepare an accurate inventory, which enable me to clearly understand the drawings. The accurate road and bridge inventory is very crucial for reviewing the existing road and bridge condition, which is very

useful to identify the existing road and bridge problems and issues.

Secondly, I also learnt how to prioritize the road and bridge reconstruction and rehabilitation projects. In this circumstance, I am required to score each road and bridge improvement projects based on main criterions including engineering factor, financial factor, and social and environmental factor. The scoring of road and bridge improvement project initiates me to deeply understand the essence of each factor that affects on prioritization of road and bridge projects. In addition, it also helps me to effectively and efficiently prepare road and bridge planning.

Thirdly, as technical structural standard as per road and bridge classification is required to establish in master plan hence I have a chance to learn the way to prepare technical structural standard for road and bridge.

Fourthly, I was luckily selected to do training in Japan on urban environment and transport for six weeks as a part of technical transfer to counterpart. During this training I have learnt about the 9 basic key elements of environmentally sustainable transport, namely, urban infrastructure, land use planning, transportation demand management and non motorized transport, road safety and maintenance, vehicle emission control, cleaner fuel, roadside air quality monitoring and assessment, traffic noise management, and knowledge base and research. Of course, these key elements are not directly relevant to formulate master plan for road network development but they are crucially important for sustainable transport in order to meet the present need and future need by taking into account of economic aspect, environmental aspect, and social aspect.

Finally, as each counterpart staff is needed to give individual presentation regarding what they have learnt from their study team to share the knowledge to other counterpart staff and the ministry' staff so I also can learn other interesting knowledge such as traffic survey, road maintenance mechanism and management. Additionally, I gain also useful knowledge through sharing experience from Japanese staff as well as from the ministry' staff.

III. Conclusion

For sure, during almost 18 months that I have worked with JICA Study Team for the study on road network development I have gained a lot of useful and interesting knowledge and skills from my actual work particularly from Japanese staff. The outcomes will be very useful for me to upgrade and improve my ability and skills in order to potentially contribute to the ministry of public works and transport as well as to the development of Cambodia.

Full name	:	Mao Phanarith
Sex	:	Male
Date of birth	:	January 31, 1967
Place of birth	:	Kampot Province
Work Place	:	Public Works Research Center, Ministry of Public Works and Transport
Expertise	:	Geographic Information System (GIS)

The study on road network development in the Kingdom of Cambodia carries out the main topics of the Road Network Master Plan study. The JICA study team worked at the Ministry of Public Works and Transport in cooperation with other Ministry such as Ministry of Rural Development, Ministry of Economy and Finance.

According to the main topic of the Master plan study, I have been carrying out map editing activities and targeting the establishment of the Road Network Master Plan. The map work that has been done in this project is:

+ Reclassify :
  - Road digit according to national road (1 Digit), secondary national road (2 Digit), and provincial road (3 Digit) based on the LRCS data.
  - Calculation road distance (1 & 2 digits) covered each provinces.
  - Road condition, road lanes, road improvement structure, road funded and years structure on Cambodia road map.
  - Calculation of people living along the road, school, temple, church with buffer 1000 m and est.

+ General Road Network map of Cambodia:
  - Prepared population density map of Cambodia.
  - Prepared inland port, ferry, airport, sea port map.
  - Prepared construction material map
  - Prepared triangle development zones map: Tourist, Industrial and Agro-Industrial.
  - Prepared flooded condition map, regional map and road map links to neighboring countries.
  - Prepared Mineral resources map of Cambodia.
  - Prepared protection area map, road rehabilitation / maintenance studies and project.

+ Landuse map of Cambodia.

+ Geology map of Cambodia and Construction material map.

+ And all kind of location map.

+ Ortho Mapping Profiles of Secondary National Road No. 57

In this project the most interesting experience is Ortho Mapping Profiles of Secondary National Road No. 57 because I have learned how to do the Ortho map profile by links GIS application and AutoCad software and also capability of development, procedure for prioritization and planning road networks.

:

Full name		Yim Chamnan
Sex	:	Male
Date of birth	:	March 20, 1966
Place of birth	:	Kandal province, Cambodia
Work Place	:	Ministry of Environment
Expertise	:	Civil Engineering and Environment

Title : My experience in the Study Team

The Royal government of Cambodia (RGC) and the Government of Japan decided to conduct the study on the Road network Development in Cambodia. In this connection, the Study has been conducted by the JICA Study Team and Ministry of Public Work and Transport (MPWT), in cooperation with the ministry of Economic and Finance (MEF), Ministry of Rural Development (MRD) and Ministry of Environment (MoE), Cambodia. The Study is formulating the Master Plan of Road Network Development in the whole country, to carry out a pre-feasibility study of the Road Network Development in Cambodia, on the high priority project section and includes Social and Environmental consideration. The road network development is a major strategy of the Government of Cambodia for the development of many sectors such as: economic, agriculture, tourism and local and regional trades with sustainable environmental development.

Firstly, I would like to say thanks to Japanese Government, Team Leader and all the Japanese experts of the JICA Study Team, educating and providing me the good changes and experiences working during this study. In the study the JICA Study Team divided into four teams, which are: Road Infrastructure Team, Development Strategy Team, Road management and Maintenance Team, and Social and Environmental consideration Team. In the operation of the study for each

team the JICA Study Team requested the counterparts to assist with any work activities needed for the study.

I am a counterpart from Ministry of Environment, related to the Study, I am working in the Social and Environmental Consideration Team. In this study I participated in the Social and Environmental Team for many months since April, 2005 with my task, collected existing data of environmental situation concerning the road network development in Cambodia, including law sub-decree and other regulations and meeting with officials of line ministries and also attended in field visit to collect existing social and environmental resources in the project areas for conducting an initial environmental examination.

I am very happy to joint as counterpart in this study team. I get many experiences from JICA Study Team, counterparts, and central and provincial governmental officials, and NGOs staffs during data collection, field visit and workshops or seminars about Road Network Development within social and environmental protection.

This study is very important for Cambodia to use or implement this Master Plan of Road Network Development for improving or developing the road network of Cambodia in the future, it is a government policy for reduction poverty in Cambodia, because the road network is important for economic development. The study plan is a good solution to manage and control or protect everything including environmental resources before we decide on and start the project.

After this Study of Master Plan, I will understand clearly about important ideas or comments in the master plan on Road Network in Cambodia. Moreover, this study can assist Government of Cambodia to implement by this plan in the future. I believe that I will jointly work with theJICA Team on another development project and I will learn more experiences from the JICA Team to develop environmental management plans for many different projects in Cambodia.

PRE-FEASIBILITY STUDY ON THE HIGH PRIORITY PROJECTS

CHAPTER 1 HIGH PRIORITY PROJECTS FOR PRE-FEASIBILITY STUDY

1.1 Short Term Projects in Master Plan

To establish a realistic and effective implementation program, the Study team adopted the basic concept for an implementation program of the Master Plan as follows:

(1) On-going projects should be completed in the short-term plan

National road, especially 1 and 2-Digit roads are very important road network forming the national and regional economy, therefore, all the on-going rehabilitation projects related for 1-Digit and 2-Digit roads being implemented or committed by international funding agencies and donors shall be completed in the short term plan.

(2) Access to the provincial capital should be improved as soon as possible

Taking into consideration an importance of administration services by government to rural areas, 2-Digit roads linking to provincial capitals with a poor condition should be improved as early as possible either in short-term or medium-term plan.

(3) Implementation of Urgent Bridge Rehabilitation Program

Although most of 1-Digit and some important 2-Digit roads have already been rehabilitated, many of temporary bridges are still left behind in narrow and poor conditions in the completed sections of 1-Digit and 2-Digit roads. The rehabilitation of these temporary bridges are included as a part of upgrading works in the master plan, however, upgrading of these roads are planned in the medium-term of long term plan. Since the bridge on major road results to major impact and loss in the local socio-economic activities, when collapsed, the Study Team recommends that these bridges should be improved as soon as possible and implemented under the "Urgent Bridge Rehabilitation Program".

Based on the above concept, the Study Team set the target of implementation for short-term, medium-term and long-term by the result of project evaluation and available funds based on the financial study.

The projects proposed in the short term plan (2006 -2010) are shown as follows:

Table 1 Priority Projects Proposed in the Short term Plan (2006 - 2010)

Projects Proposed in the Short Term		Length (km)	Improvement Measures	Funding Source	Existing Condition
1-Digit NR	NR.1 (1-1, PP-Neak Leuong)	60.0	Road upgrading	Japan	Under construction
	NR.1 (1-2, Neak Leuong Bridge)	2.0	New bridge const.	Japan	F/S
	NR.2 (2-2, Takeo-VN Border)	57.0	Road upgrading	Japan (Non project fund)	Completed
	NR.3 (3-2, Kampot-Veal Rinh)	54.0	Road upgrading	Korea, WB	Under construction
	NR.5 (5-5, Sisophon -Thai Border)	47.0	Road upgrading	ADB	Under construction
	NR.6 (6-4, Siem Reap - Sisophone)	48.0	Road upgrading	ADB	Under construction
	NR.7 (7-3,4 Kratie-Laos Border)	193.0	Road upgrading	China	Under construction
2-Digit	NR.33 (33-1, Kampong Trach-Lork)	17.0	Road upgrading	ADB	Committed

Table 1 Priority Projects Proposed in the Short term Plan (2006 - 2010)

Projects Proposed in the Short Term		Length (km)	Improvement Measures	Funding Source	Existing Condition
NR	NR.48 (Chamker Loung-Thai Border)	161.0	Road upgrading	Thailand	Under construction
	NR.57 (Battambang-Pailin-Thai Border)	103.0	Road upgrading	-	-
2-Digit NR	NR.62 (62-1, Thanal Baek - Tbeng Meanchey)	243.0	Road upgrading	WB	Under construction
	NR.64 (Svay Thom - Dang Rek)	134.0	Road upgrading	Thailand	Committed
	NR.65 (Dam Deck - Trapeang Prey)	21.0	Road upgrading	WB	Under construction
	NR.71 (Treung -Kompong Thmar	58.0	Road upgrading	ADB, WB	Under construction
	NR.72 (Kreat Tboung - Smach)	14.0	Road upgrading	Local	Completed
	NR.78 (78-2, Bang Lung - Vietnam Border)	70.0	Road upgrading	Vietnam	Committed
Urgent Bridge Rehabilitation Program					
	Phase I: South-east Block	-	Bridge rehab.	-	-
	Phase II: North-west Block	-	Bridge rehab.	-	-

1.2 Pre-feasibility Study Projects

Pre-feasibility study projects were selected on the following reasons, excluding the under construction and committed projects:

(1) The Improvement of National Road No. 57 (Battambang – Pailin – Thai Border)

Reasons for selection:

i) This road is very important route linking-up from Battambang to Pailin city and is applicable to the basic concept (2).

ii) This route is assessed in the highest rank as a result of project evaluation in terms of economic and social impacts.

iii) The Cambodian government gives a high priority to the development and life improvement in this area.

(2) Urgent Bridge Rehabilitation Program (Phase I: South-east Block)

Reasons for selection:

i) This program is assessed in the highest rank and is applicable to the basic concept (3).

ii) South-east block was selected as the first phase of implementation taking into account an impact of regional economy and its big population.

iii) The Cambodian government gives a high priority to the development and life improvement in this area.

PACKAGE A

THE PROJECT FOR IMPROVEMENT OF NATIONAL ROAD NO.57

CHAPTER A-1 INTRODUCTION

1.1 General

In the Road Network Development Master Plan Study, the JICA Study Team has proposed a road network development plan up to 2020 and an implementation plan for road development including prioritization of the projects and improvement measures.

The Improvement of National Road No.57 was identified as one of the highest priority projects and therefore a pre-feasibility study was conducted.

1.2 Purpose of Pre-feasibility Study

The purpose of this Pre-feasibility Study is to comprehensively evaluate the feasibility of improving this road based on the following aspects:

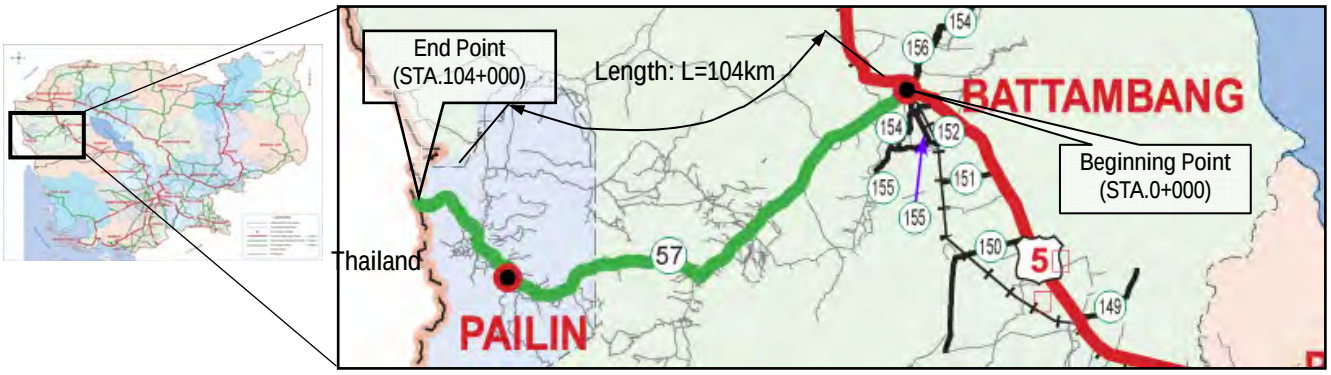
(1) Estimation of the project cost based on the preliminary design and the implementation plan based on the optimum construction method and schedule
(2) Economic and financial analysis
(3) Estimation of the maintenance cost
(4) Estimation of landmine/UXO survey and clearing requirements.

1.3 Project Description for Improvement of National Road No.57

National Road No.57 (NR57) is located in flat, rolling terrain and mountainous areas of the northwest part of Cambodia. The route length is 104km connecting the province of Battambang with Pailin city and the Thai Border. The existing roadbed is generally laterite, and there are 14 temporary bridges and 3 concrete bridges on this route.

The improvement targets for this road are as follows:

(1) To upgrade the road to be suitable for all weather conditions.
(2) To upgrade the road capacity to be sufficient to meet the national demand.
(3) To upgrade to permanent bridges.
(4) To upgrade the road with proper traffic accident safety precautions.



CHAPTER A-2 GENERAL CONDITION AND ENGINEERING SURVEY

2.1 Natural Condition

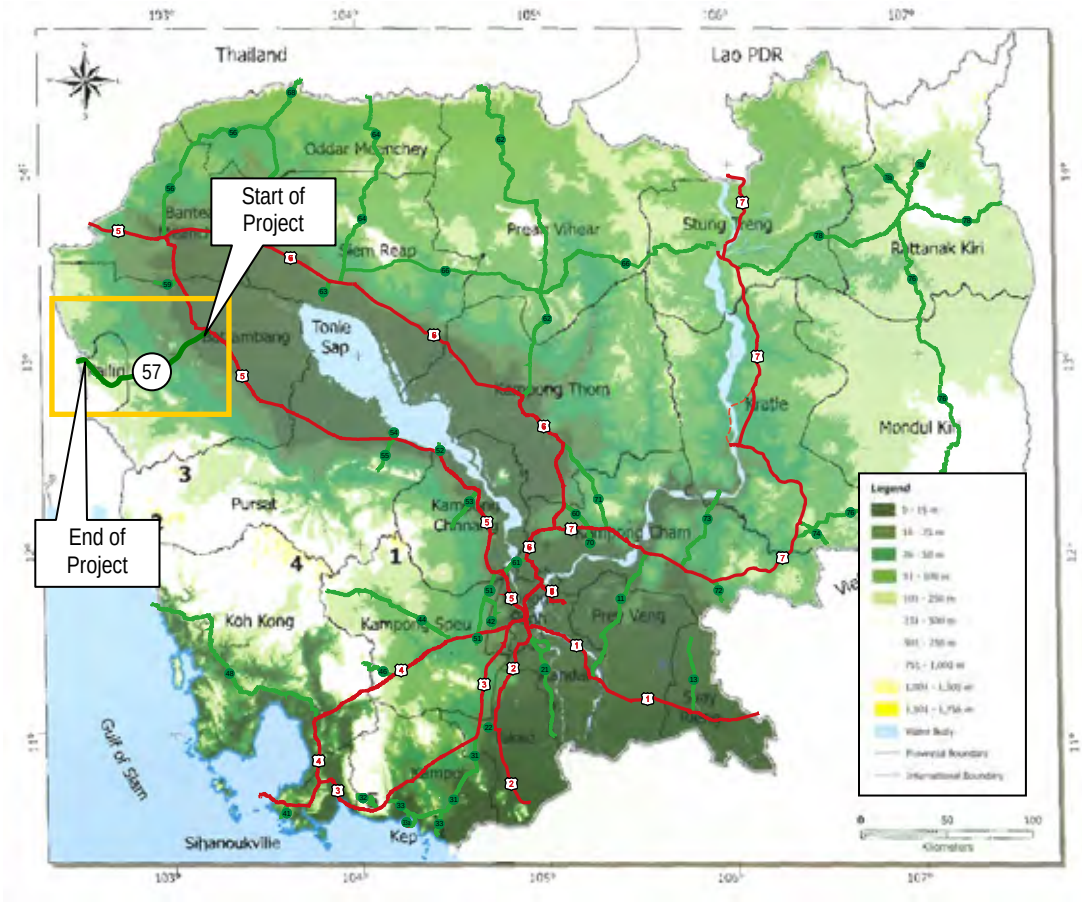
2.1.1 Geography and Geology on the Project Site

The geographical conditon of NR.57 is classified into the following:

(1) Low Elevation and Flat Area – the section beginning in the urban district of Battambang city

(2) Rolling Terrain Area – the midsection, in the middle of Battambang province

(3) Mountainous Area – the end section from the border of Pailin city and Battambang province to the Thai Border



Base map: The Altas of Cambodia, National Poverty and Environment Maps, Save Cambodia's Wildlife with Support from Danida

Figure 2.1.1 Project Site Elevations

The elevation of Battambang city is around 12m and NR.57 runs south-westward through low land with an elevation of 12-60m up to Km50. A section with a length of about 1km, in the vicinity of Km17, was overtopped during the flood of 2000. From around Km50, NR.57 goes into a hilly area with a gentle slope and reaches its highest point of 260m at Km78. After passing Km78, its elevation begins to lower, changing the hillside to the left. NR.57 goes through the urban area of Pailin city around Km85 and reaches its end point on the Thai border, where the

elevation is around 110m. It has the max gradient of 6% at Km78+100.

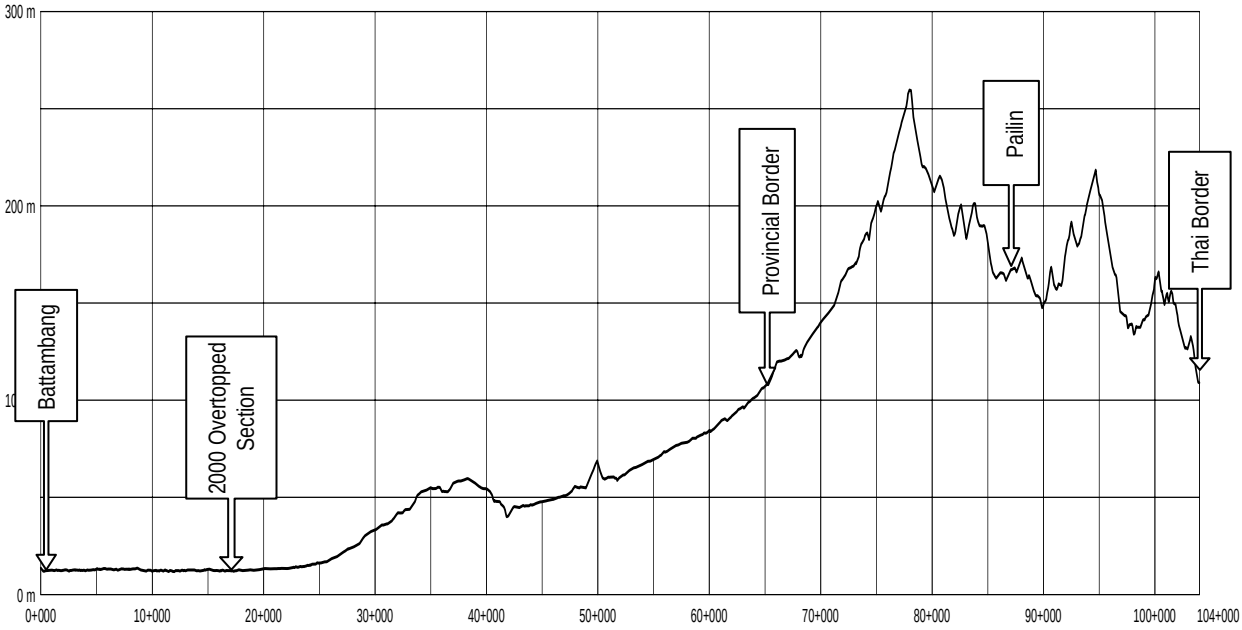
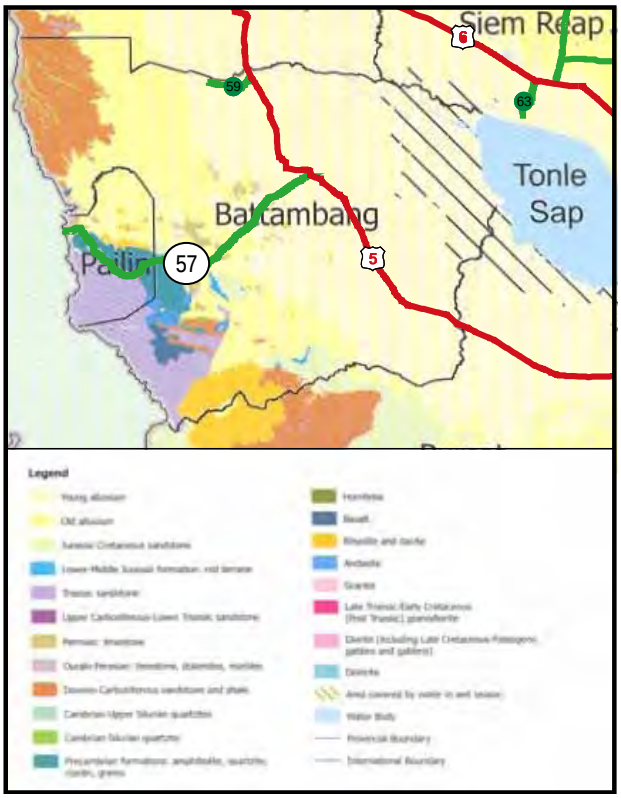


Figure 2.1.2 Profile of the Existing NR.57

The general geological conditions in the vicinity of the project site are shown in **Figure 2.1.3**.

The geology of the area that NR.57 traverses can be divided into two (2) sections. The first half (from the beginning point in Battambang city to around Km50), in the low land, is covered by young and old alluvium. The young alluvium decreases gradually as the land goes away from Tonle Sap lake. On the other hand, the second half contains Lower-Middle Jurrasic formation. The hill lying on the west side of NR.57 is composed mainly of Triassic sandstone.



Base map: The Altas of Cambodia, National Poverty and Environment Maps, Save Cambodia's Wildlife with Support from Danida

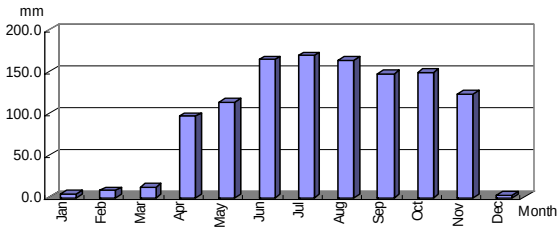
Figure 2.1.3 Geology of the Project Site

2.1.2 Hydrology and Geology on the Project Site

The annual rainfall for the project site is in the range of 1,200-1,400mm and 1,400-1,600mm, which comparatively can be considered on average to be less than that the average for the whole country of 1,400-1,600mm.

Base map: Department of Meteorology

This is a tropical monsoon region and the annual mean temperature is about 27°C, while that of the area after Km63 is 1-2°C lower since the elevation there goes over 100m.



Source: http://hydro.iis.u-tokyo.ac.jp/GAME-T/GAIN-T/routine/cambodia/

Figure 2.1.4 Distribution of Annual Rainfall and Monthly Rainfall at Battambang

2.2 Socio-Economic Condition

2.2.1 Population

NR.57 starts at Battambang, which is the provincial center of Battambang, through Pailin with the provincial center at Krong Pailin and terminates at the Thailand border totaling approximately 104 km. This road passes through three (3) districts in Battambang province and Pailin in Krong Pailin.

The population along NR.57 in 2005 was estimated at approximately 177,970 persons, with 148,600 in Battambang and 29,370 in Pailin. It is expected to increase to 201,780 in 2010, 227,550 in 2015, and 254,320 in 2020 as shown in **Table 2.2.1**.

Table 2.2.1 Existing and Future Population in Direct Influence Area, 2005-2020

Province/District		2005	2010	2015	2020	AAGR (%)
Battambang	Svay Pao	18,246	20,344	22,582	24,840	1.021
	Baran	92,909	103,594	114,989	126,488	1.021
	Rattonak Mondol	37,443	41,749	46,341	50,975	1.021
	S-Total	148,598	165,687	183,912	202,303	1.021
Pailin	Pailin	29,372	36,098	43,642	52,022	1.039
Total		177,970	201,785	227,554	254,325	1.024

Notes: 2005: Estimated on the basis of 2004 village data

2010, 2015, 2020: forecasts based on the growth rate in the Master Plan

2.2.2 Land Use

Figure 2.2.1 shows the existing land use along NR.57. From this figure, the following observations are made:

(1) The land use in Svay Pao and Baran districts in Battambang Province consists predominantly of paddy field. However, that in Rattonak Mondol district consists of shrub as well as coniferous

and deciduous forest due to it being a highland area.

(2) The land use in Pailin district also consists of shrub plus coniferous and deciduous forest. However, in this area land use is being changed to plantations of cash crops due to having the advantage of accessibility to the Thai border.

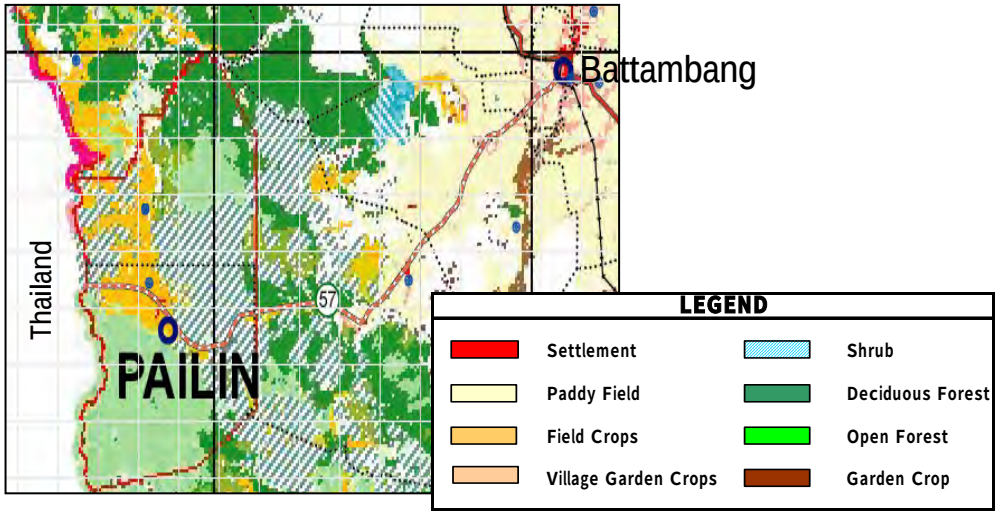


Figure 2.2.1 Existing Land Use along NR.57

2.2.3 Number of Vehicles

The number of vehicles and motorization rates by districts are shown in **Tables 2.2.2** and **2.2.3**, respectively. From these tables, the following findings are made:

Table 2.2.2 Number of Vehicles in Direct Influence Area of NR.57, 2005-2020

Province/District		Type	2005	2010	2015	2020
Battambang	Svay Pao	Motor Cycle	1,562	1,953	2,363	2,883
		Car/Tractor	242	317	399	491
		Total	1,804	2,269	2,762	3,373
	Baran	Motor Cycle	4,069	5,086	6,154	7,508
		Car/Tractor	1,061	1,390	1,751	2,154
		Total	5,129	6,475	7,905	9,661
	Rattonak Mondol	Motor Cycle	1,423	1,779	2,152	2,626
		Car/Tractor	396	519	653	804
		Total	1,819	2,297	2,806	3,430
	S-Total	Motor Cycle	7,054	8,817	10,669	13,016
		Car/Tractor	1,698	2,225	2,803	3,448
		Total	8,752	11,042	13,472	16,464
Pailin	Pailin	Motor Cycle	2,114	2,304	2,489	2,812
		Car/Tractor	256	263	434	530
		Total	15,700	19,815	24,183	29,555
Total		Motor Cycle	9,168	11,122	13,158	15,828
		Car/Tractor	1,954	2,488	3,237	3,978
		Total	24,453	30,857	37,655	46,019

Notes: 2005: Estimated on the basis of 2004 village data
2010, 2015,2020: forecasted based on the growth rate in the Master Plan

The highest motorization rate is observed at Svay Pao district in Battambang Province and among

the others the next highest is at Pailin district. This is due to the comparatively high incomes in these two districts. The lowest motorization rate is observed at Rattonak Mondol. This may be due to it being a low-income district.

Table 2.2.3 Motorization Rate in Direct Influence Area of NR.57, 2005-2020

Province/District		Type	2005	2010	2015	2020
Battambang	Svay Pao	Motor Cycle	0.082	0.077	0.086	0.095
		Car/Tractor	0.013	0.016	0.018	0.020
		Total	0.095	0.092	0.104	0.115
	Baran	Motor Cycle	0.044	0.049	0.054	0.059
		Car/Tractor	0.011	0.013	0.015	0.017
		Total	0.055	0.063	0.069	0.076
	Rattonak Mondol	Motor Cycle	0.038	0.043	0.046	0.052
		Car/Tractor	0.011	0.012	0.014	0.016
		Total	0.049	0.055	0.061	0.067
	S-Total	Motor Cycle	0.047	0.053	0.058	0.064
		Car/Tractor	0.011	0.013	0.015	0.017
		Total	0.059	0.067	0.073	0.081
Pailin	Pailin	Motor Cycle	0.072	0.064	0.057	0.054
		Car/Tractor	0.009	0.035	0.047	0.048
		Total	0.081	0.098	0.104	0.102
Total		Motor Cycle	0.052	0.055	0.058	0.062
		Car/Tractor	0.011	0.012	0.014	0.016
		Total	0.062	0.067	0.072	0.078

Note: Computed using number of vehicle as shown in **Table 2.2.2** divided by population as shown in **Table 2.2.1**.

2.3 Engineering Survey

2.3.1 Topographic Survey

A topographic survey for the preliminary design for the improvement of NR.57 has been carried out in accordance with the following scope of work:

(1) Control Point Survey: 31 points

Thirty-one(31) control points, made of concrete piles with a metal rivet on the head, were installed at about 3.5km intervals along the road. The points/monuments were established in safe locations so they can remain untouched during the road construction phase. The locations have been selected to provide a good reception of signals from the GPS satellites (i.e. in open areas). In places where there is a possibility for landmines the point location has been selected according to the safety requirements and the monument constructed accordingly.

(2) Road Centerline Profile Survey: 104 km (500 m pitch)

A road centerline profile survey was conducted to cover the existing NR.57. The exact locations of the Beginning Point and Ending Point have been based on the instructions given at the site.

Levelling was carried out to provide the control points and profile points with elevation (Z). There was no previously established elevation benchmark in the Pailin city area. Therefore the levelling has been tied only to the Public Works levelling line benchmarks (BM60 and BM61) in

Battambang province. Double line (forward and backward) levelling has been carried out between the established control point monuments.

The elevations of the Beginning Point and Ending Point, all regular points at 500m intervals, all intersections and major points such as structures (bridges, culverts, road junctions, etc.) within the interval were measured based on the control points with the coordinates taken using hand-held GPS (Datum: Indian 1960). Every surveyed point is indicated by a pin and painting on the road surface while the point numbers are marked at the roadside.

(3) Road Cross-Section Survey: 31 sections (40 m width)

1) Phase I

The Road Cross Section Survey was carried out at the Beginning Point in Battambang to Point Km47 away from Battambang City in such a way that every point at an interval of 3.5km, every intersection and major points within the regular 3.5km interval have been measured using the levelling instrument and measuring tape.

Elevations within the cross section were measured at 5m intervals and at all breaks including edge of carriageway, edge of pavement, edge of sidewalk, edge of side-ditch, hedge and for both overhead and underground utility lines.

2) Phase II

The Road Cross Section Survey was carried out from Point Km47 to the End Point by the Thai border, as Phase II, within areas where it is documented that landmines have been cleared (marked by green) and pointed out by the specialists.

In other areas, outside the cleared areas (marked by green), the cross section survey covered the road surface area only, to the edge of the road in order to avoid landmine accidents.

(4) Photo Mosaic Preparation: 104 km

An aerial photo mosaic (1/10,000, A3 size) has been prepared using aerial photos taken at a scale of 1/40,000 and/or 1/25,000 to cover the road near the Thai border where photo coverage existed. The scanned photos necessary for the preparation of the photo mosaic were provided.

Rectification was conducted before preparation of the mosaic using rectified SPOT images and other relevant GIS base data in the possession of the Public Works Research Centre of the Ministry of Public Works & Transport.

<u>Mapping process</u>

1) Projection

The projection was defined to be the same as the projection system for the GIS base data for Cambodia with the following definitions:

- Projection: UTM, Zone 48;
- Ellipsoid: Everest 1830;
- Datum: Indian 1960
- Unit: Meter.

2) Ortho-Photo Preparation

The ortho-photos were prepared in the ORTHO BASE Module of the ERDAS software. The aerial photograph, spot ortho-image, DTM and projection were used as parameters to produce the ortho-photo.

o GCP Pick Up

The GCPs were picked up based on the geo-reference SPOT images for clearly defined features such as the intersection of a riverbank with a stream and the meandering point of the river or stream. The GCPs were collected throughout the photo scene.

The RMS (Root Mean Square) error was kept as low as possible, which in general remained within 10 (i.e. inaccuracy within 1 pixel).

o Ortho-Rectification

The ortho-rectified photo output from the above process was evaluated by comparing it with the SPOT Ortho-image. The comparison indicated the matching of the linear features of riverbank; road and land use patterns **Figure 2.3.1**.

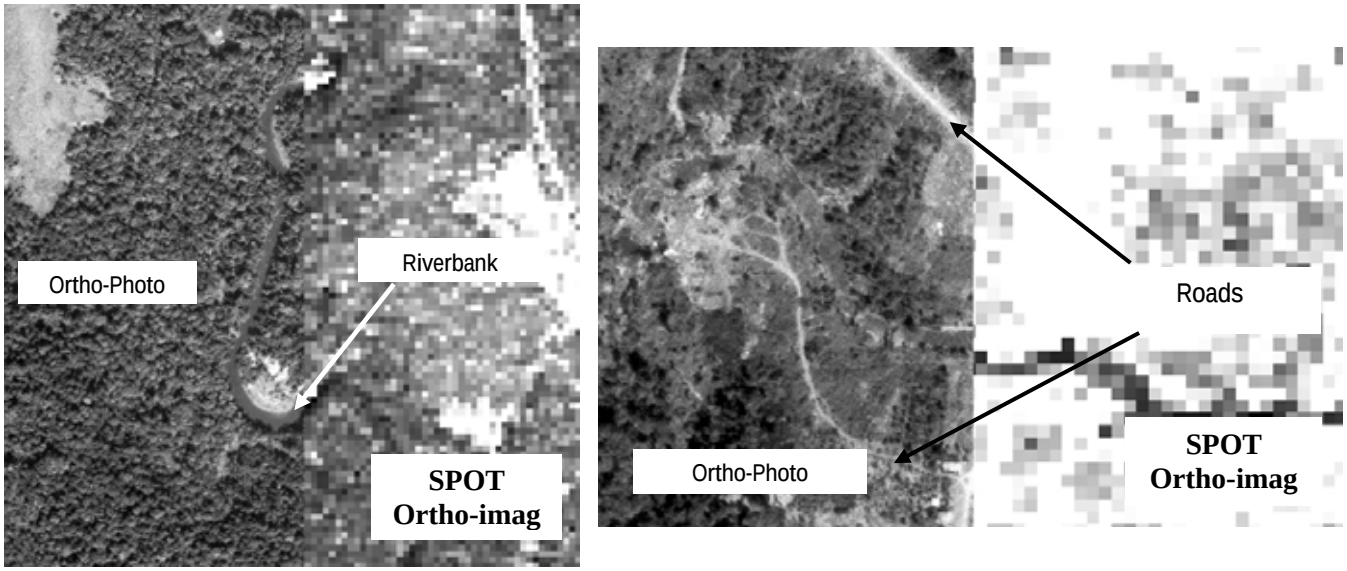


Figure 2.3.1 Ortho-Photo Preparation

- Preparation of ortho-photo of study area

The ortho-rectified photo of the study area was clipped to extract the required area and was combined with the ortho-photos covering the study area as shown in **Figure 2.3.2**.

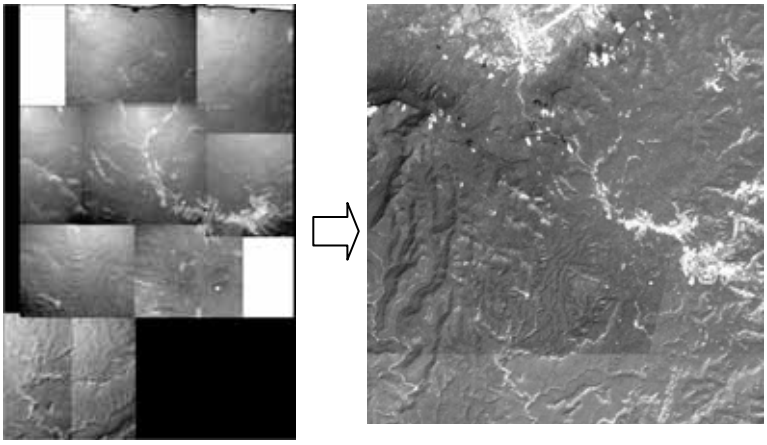


Figure 2.3.2 Ortho-Photo of Additional Mapping Area

2.3.2 Geotechnical Investigation

The geotechnical investigation for the preliminary design of bridges along NR.57 has been carried out in accordance with the following scope of work.

(1) Mechanical Boring:

Mechanical boring or boreholes were conducted at three (3) sites near the selected bridges, Km41+800, Km60+000, and Km90+000 (Battambang side and Pailin side).

(2) Standard Penetration Test

Standard penetration tests to find the N-value and sampling were carried out at 1.00 m intervals at each borehole.

(3) Laboratory Tests

Laboratory tests on the selected samples were conducted for following tests:

1) Specific Gravity
2) Density
3) Moisture Content
4) Grain Size Analysis
5) Atterberg Limits

Each borehole log is shown in **Figure 2.3.3**.

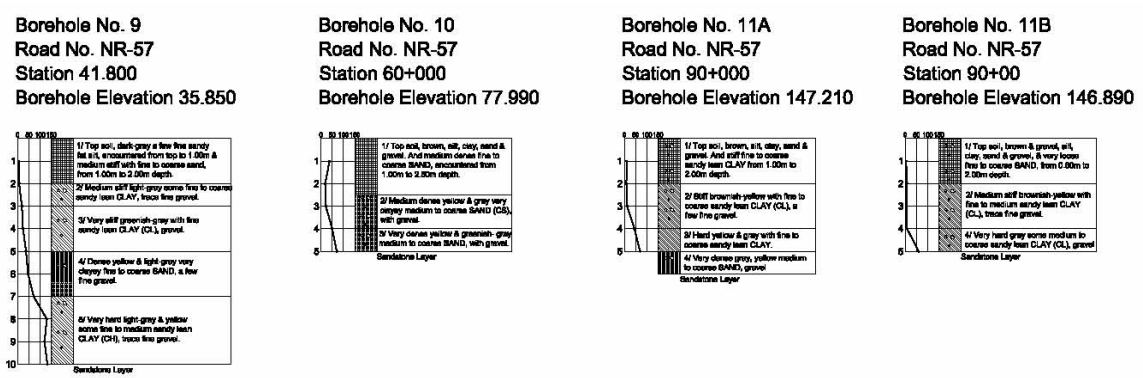


Figure 2.3.3 Borehole Logs

2.3.3 Drainage Survey

Drainage structures such as pipe culverts and box culverts along NR.57 can be summarized as shown in **Table 2.3.1**. Despite the bushes and grass that has grown around their inlets or outlets, most of the drainage structures can still be used. However, a further detailed survey on flood marks and/or a site inquiry, by interviews, is necessary to examine the past high-water level records at inlets or outlets.

During the investigation stage of the pre-feasibility study, about 20 cm of overtopping on the road surface was observed in the year 2000 around Km17.

Table 2.3.1 Existing Pipe and Box Culverts along NR.57

No.	Province	Station	Structure Type	Length (m)	Width (m)	Condition
1	Battambang	003+550	RC Slab Culvert	3.9	7.0	Flow Direction: South North
2	Battambang	004+800	RC Pipe Culvert	2-Φ0.60	9.0	
3	Battambang	005+100	RC Slab Culvert	3.2	7.0	Pond Preng, Flow Direction: South North
4	Battambang	005+300	RC Slab Culvert	3.0	7.0	Irrigation Canal
5	Battambang	005+700	RC Slab Culvert	3.0	7.0	Flow Direction: South North
6	Battambang	005+800	RC Slab Culvert	3.0	7.0	Pond Preng, Flow Direction: North South
7	Battambang	006+300	RC Slab Culvert	3.0	7.0	Pond Preng, Flow Direction: South North
8	Battambang	006+800	RC Slab Culvert	3.0	7.0	Flow Direction: South North
9	Battambang	007+300	RC Slab Culvert	3.0	7.0	Flow Direction: South North (Pond)
10	Battambang	008+000	RC Slab Culvert	3.0	7.0	No Function
11	Battambang	008+300	RC Slab Culvert	3.0	7.0	Flow Direction: South North
12	Battambang	008+700	RC Slab Culvert	6.0	7.0	Pond Preng, Irrigation Canal with sluice gate control
13	Battambang	009+100	RC Slab Culvert	3.0	7.0	Irrigation Canal with sluice gate control
14	Battambang	010+300	RC Slab Culvert	3.0	7.0	No Function
15	Battambang	010+400	RC Slab Culvert	3.0	6.7	
16	Battambang	010+900	RC Slab Culvert	3.5	7.0	South: Paddy Field, North: Pond
17	Battambang	011+100	RC Slab Culvert	4.0	6.6	South: Paddy Field, North : Canal
18	Battambang	011+300	RC Slab Culvert	3.0	7.0	South: Paddy Field, North : Canal
19	Battambang	011+700	RC Slab Culvert	3.0	7.0	South: Paddy Field, North: Pond
20	Battambang	011+900	RC Slab Culvert	3.0	6.7	South: Pond, North: Paddy Field
21	Battambang	012+100	RC Slab Culvert	3.0	7.0	Both Sides: Pond
22	Battambang	012+500	RC Slab Culvert	3.0	7.0	South: Canal, North: Paddy Field
23	Battambang	012+800	RC Slab Culvert	3.0	6.6	Irrigation Canal
24	Battambang	013+000	RC Slab Culvert	3.0	6.4	South: School, North: House & Paddy Field
25	Battambang	013+300	RC Slab Culvert	4.0	6.4	
26	Battambang	013+600	RC Slab Culvert	3.0	5.5	South: Canal, North: Paddy Field
27	Battambang	013+900	RC Slab Culvert	3.0	7.0	South: Paddy Field, North: Canal
28	Battambang	018+400	RC Pipe Culvert	3-Φ1.00	10.0	
29	Battambang	018+900	RC Slab Culvert	3.0	6.0	Both Sides: Paddy Field

Table 2.3.1 Existing Pipe and Box Culverts along NR.57

No.	Province	Station	Structure Type	Length (m)	Width (m)	Condition
30	Battambang	020+200	RC Slab Culvert	4.0	6.7	Irrigation Canal
31	Battambang	021+600	RC Slab Culvert	3.0	5.7	
32	Battambang	024+100	RC Slab Culvert	6.0	5.7	Irrigation Canal
33	Battambang	025+000	RC Slab Culvert	3.0	6.0	Irrigation Canal
34	Battambang	025+700	RC Pipe Culvert	2-Φ1.00	10.0	South: Paddy Field, North: Pond
35	Battambang	027+700	RC Pipe Culvert	2-Φ1.00	10.0	Both Sides: Paddy Field
36	Battambang	031+000	RC Pipe Culvert	1-Φ1.00	10.0	South: Paddy Field, North: Pond
37	Battambang	033+300	RC Pipe Culvert	1-Φ0.80	10.0	Creek Preah Peal
38	Battambang	034+200	RC Pipe Culvert	2-Φ0.80	10.0	Creek Preah Peal
39	Battambang	036+200	RC Pipe Culvert	1-Φ0.80	10.0	Creek Amph
40	Battambang	036+500	RC Pipe Culvert	1-Φ0.80	10.0	
41	Battambang	037+600	RC Pipe Culvert	1-Φ0.80	10.0	
42	Battambang	038+000	RC Pipe Culvert	1-Φ0.80	10.0	
43	Battambang	038+300	RC Pipe Culvert	1-Φ0.80	10.0	Creek Krab Ko, Flow Direction: North South
44	Battambang	039+800	RC Pipe Culvert	1-Φ0.80	10.0	Creek Krab Ko, Flow Direction: North South
45	Battambang	042+800	RC Pipe Culvert	1-Φ0.80	10.0	
46	Battambang	043+800	RC Pipe Culvert	1-Φ1.00	10.0	Creek Khvaek, Flow Direction: North South
47	Battambang	047+500	RC Pipe Culvert	1-Φ0.80	10.0	Ditch along both roadsides.
48	Battambang	048+700	RC Pipe Culvert	1-Φ1.00	10.0	Ditch along both roadsides.
49	Battambang	049+300	RC Pipe Culvert	1-Φ1.00	10.0	Both Sides: Paddy Field
50	Battambang	051+000	RC Pipe Culvert	1-Φ1.00	10.0	South: Paddy Field, North: Pond
51	Battambang	051+900	RC Pipe Culvert	1-Φ0.80	10.0	Both Sides: Pond
52	Battambang	052+800	RC Pipe Culvert	1-Φ1.00	10.0	
53	Battambang	054+200	RC Pipe Culvert	1-Φ1.00	10.0	Both Sides: Pond
54	Battambang	054+900	RC Pipe Culvert	1-Φ1.00	10.0	Irrigation Canal
55	Battambang	061+900	RC Pipe Culvert	1-Φ1.00	10.0	
56	Battambang	064+300	RC Pipe Culvert	1-Φ1.00	10.0	
57	Pailin	066+600	RC Pipe Culvert	1-Φ1.01	11.0	Flow Direction: North South
58	Pailin	071+200	RC Pipe Culvert	1-Φ1.00	12.0	
59	Pailin	072+300	RC Pipe Culvert	1-Φ1.00	12.0	Both Sides: Pond
60	Pailin	072+700	RC Pipe Culvert	1-Φ1.00	12.0	
61	Pailin	077+797	RC Pipe Culvert	1-Φ1.00	12.0	
62	Pailin	077+977	RC Pipe Culvert	1-Φ1.00	12.0	
63	Pailin	078+127	RC Pipe Culvert	1-Φ0.60	12.0	
64	Pailin	079+257	RC Pipe Culvert	1-Φ1.00	12.0	
65	Pailin	080+521	RC Pipe Culvert	1-Φ1.00	12.0	
66	Pailin	080+797	RC Pipe Culvert	1-Φ1.00	12.0	
67	Pailin	083+800	RC Slab Culvert	5.0	8.0	Small creek, Flow Direction: West East
68	Pailin	084+426	RC Pipe Culvert	1-Φ0.60	12.0	
69	Pailin	085+294	RC Pipe Culvert	1-Φ0.60	12.0	
70	Pailin	085+887	RC Pipe Culvert	3-Φ1.00	12.0	
71	Pailin	086+100	RC Pipe Culvert	1-Φ0.80	12.0	Creek Ta, Flow Direction: South North
72	Pailin	087+000	RC Pipe Culvert	1-Φ0.80	12.0	
73	Pailin	087+200	RC Pipe Culvert	1-Φ0.60	12.0	
74	Pailin	087+900	RC Pipe Culvert	1-Φ0.60	12.0	
75	Pailin	088+522	RC Pipe Culvert	1-Φ0.60	12.0	
76	Pailin	090+546	RC Pipe Culvert	1-Φ0.80	12.0	
77	Pailin	090+705	RC Pipe Culvert	1-Φ0.80	12.0	
78	Pailin	091+705	RC Pipe Culvert	2-Φ0.80	12.0	
79	Pailin	091+448	RC Pipe Culvert	2-Φ0.80	12.0	
80	Pailin	091+803	RC Pipe Culvert	1-Φ0.60	12.0	
81	Pailin	092+140	RC Pipe Culvert	1-Φ0.60	12.0	
82	Pailin	092+260	RC Pipe Culvert	1-Φ0.80	12.0	
83	Pailin	092+751	RC Pipe Culvert	1-Φ0.60	12.0	
84	Pailin	093+374	RC Pipe Culvert	1-Φ0.80	12.0	Flow Direction: East West
85	Pailin	093+700	RC Pipe Culvert	1-Φ0.80	12.0	

Table 2.3.1 Existing Pipe and Box Culverts along NR.57

No.	Province	Station	Structure Type	Length (m)	Width (m)	Condition
86	Pailin	094+465	RC Pipe Culvert	1-Φ0.60	12.0	Flow Direction: East West
87	Pailin	094+700	RC Pipe Culvert	1-Φ0.60	12.0	
88	Pailin	094+970	RC Pipe Culvert	1-Φ0.60	12.0	
89	Pailin	095+517	RC Pipe Culvert	2-Φ0.80	12.0	
90	Pailin	095+852	RC Pipe Culvert	2-Φ0.80	12.0	
91	Pailin	096+146	RC Pipe Culvert	1-Φ0.60	12.0	
92	Pailin	096+667	RC Pipe Culvert	1-Φ0.60	12.0	
93	Pailin	096+619	RC Pipe Culvert	2-Φ0.80	12.0	
94	Pailin	097+052	RC Pipe Culvert	1-Φ0.80	12.0	
95	Pailin	097+700	RC Pipe Culvert	1-Φ0.80	12.0	Flow Direction: East West
96	Pailin	097+900	RC Pipe Culvert	1-Φ0.60	12.0	
97	Pailin	098+772	RC Pipe Culvert	1-Φ0.60	12.0	
98	Pailin	099+500	RC Pipe Culvert	1-Φ0.60	12.0	Small creek, Flow Direction: South North
99	Pailin	099+800	RC Pipe Culvert	1-Φ0.60	12.0	North Side: Elementary School, Flow Direction: North South
100	Pailin	100+300	RC Pipe Culvert	1-Φ0.80	12.0	Flow Direction: North South
101	Pailin	101+000	RC Pipe Culvert	1-Φ0.60	12.0	
102	Pailin	101+200	RC Pipe Culvert	1-Φ0.60	12.0	
103	Pailin	101+260	RC Pipe Culvert	1-Φ0.80	12.0	
104	Pailin	101+700	RC Pipe Culvert	1-Φ0.80	12.0	Flow Direction: North South
105	Pailin	102+700	RC Pipe Culvert	1-Φ0.81	12.0	Both Sides: Drain, Flow Direction: North South

Note: 1) Study Team site inspection was conducted on February 2006
2) Beginning point of station (Km 0+000) is at intersection of NR.5 and NR.57 in Battambang

Past high-water level records at Battambang station as summarized in **Table 2.3.2** are used as a reference for the preliminary road design of NR.57.

Table 2.3.2 High-water Level Records at Battambang Station

River Name: River Sangkae Unit: (EL.m)

AD	1997	1998	1999	**2000**	2001	2002	2003	2004	Maximum
Jan.	-	6.20	5.54	7.01	7.01	6.81	6.46	5.71	7.01
Feb.	-	5.50	5.20	5.84	5.95	5.49	5.41	5.31	5.95
Mar.	-	5.28	6.00	-	7.94	5.42	6.67	5.19	7.94
Apr.	6.11	5.26	10.19	-	6.22	6.61	6.42	6.11	10.19
May	7.18	5.84	10.75	9.11	8.50	8.44	7.88	9.90	10.75
Jun.	11.92	7.11	11.08	9.23	10.39	7.61	8.32	12.08	12.08
Jul.	12.35	8.77	13.20	12.31	12.14	10.31	13.02	9.68	13.20
Aug.	13.38	7.74	12.02	10.91	11.92	11.59	12.66	11.81	13.38
Sep.	11.83	10.09	9.57	11.06	10.47	11.11	11.30	9.97	11.83
Oct.	11.00	9.94	-	**13.40**	10.94	10.56	11.91	10.14	**13.40**
Nov.	-	7.79	12.37	10.53	11.10	9.63	8.38	8.54	12.37
Dec.	7.63	-	8.63	8.71	8.49	7.95	6.97	-	8.71
Max.	13.38	10.09	13.20	**13.40**	12.14	11.59	13.02	12.08	**13.40**

Source: Department of Hydrology and River Work, Ministry of Water Resources & Meteorology
Note: "-" means not available

CHAPTER A-3 PRELIMINARY DESIGN

3.1 Design Concept and Criteria

3.1.1 Design Concept and Criteria for Road

(1) Design Concept

The following design concepts have been considered in the road design for the Improvement of National Road No.57 (NR.57):

- Existing road alignment has been maintained as far as possible to minimize the construction cost, to avoid landmine contamination area as well as to minimize the negative socio-environmental impacts during construction. Minor re-alignments are done at existing sharper horizontal curves not meeting the design criteria;
- Vertical profile of the road is designed basically with additional new pavement layers thicknesses;
- The design of pavement structure shall consider the soil material predominant on site. The subgrade material is observed to be silty clay (paddy field area) from the beginning of project to Km50 and changes to silty sand until the end of project. The CBR of the existing subgrade material is thus estimated to be 4 for the section till Km50 and 6 afterwards;
- The road profile shall consider the design flood level with sufficient freeboard. Sections observed to be inundated shall be raised to appropriate road level. During site investigation, it was learned that the section of road around Km17 is inundated by about 30cm during heavy rainfalls and the profile is proposed to be raised by at least 1m along that section;
- The existing bridge alignments/locations (where geometric elements comply with the design standard) are maintained as much as possible to minimize additional land acquisition. At locations where sharp curves exist, re-alignment is proposed.

(2) Design Criteria

1) Applicable Design Standards

The design standard used for road design of NR.57 is basically

- The Cambodia ROAD DESIGN STANDARD, Department of Public Works and Transport (MPWT), 2003
  - ⇒ Part-1 Geometry (CAM PW.03.101.99),
  - ⇒ Part-2 Pavement (CAM PW.03.102.99) and,
  - ⇒ Part-3 Drainage (CAM PW.03.103.99).

When no provision exists in the Road Design Standard of Cambodia, AASHTO (A Policy on Geometric Design of Highways and Streets, 2001), JRSO (Japan Road Structure Ordinance), AASHTO Guide for Design of Pavement Structures, 1993) etc. have been applied.

2) Geometric Design Criteria

The summary of geometric design criteria applied in the design of NR.57 is given in **Table 3.1.1**.

Table 3.1.1 Summary of Geometric Design Criteria

Design Elements			Type/Value	Remarks
1	Road Classification		R4/U4	
2	Terrain		Plain/Rolling/Mountainous	
3	Design Vehicles (L x W x H)		16.7 x 2.6 x 4.1	WB- equivalent
4	Design Speed (km/hr)		90 (60)	(60) at Urban/Mountainous
5	Cross-Sectional Elements	Formation Width (m)	14.0	
		Carriageway Width (m)	13.0	
		Traffic Lane Width (m)	3.5	
		Paved Shoulder Width (m)	3.0	AC Binder Course only
		Unpaved Verge Width (m)	0.5	
		Crossfall of Roadway (%)	3.0	6% for unpaved shoulder
		Slope of Earthworks		
		Fill	V : H = 1:2.0	1:1.5 for shallow fill
		Cut	Varies	Varies with soil condition
6	Horizontal Alignment	Horizontal Curve		
		Minimum Radius (m)	335 (135)	() for Design Speed 60km/hr
		Superelevation		
		Maximum Superelevation (%)	6.0	
		Minimum Radii without Se (m)	1500	
7	Vertical Alignment	Maximum Grade (%)	6	
		Vertical Curve		
		Minimum K-value		
		Crest Curve	40 (15)	() for Design Speed 60km/hr
		Sag Curve	30 (15)	() for Design Speed 60km/hr

There are six classified categories in terms of road design standards in Cambodia from R6 (highest class) through R1 (lowest class) for rural roads and U6 through U1 for urban roads.

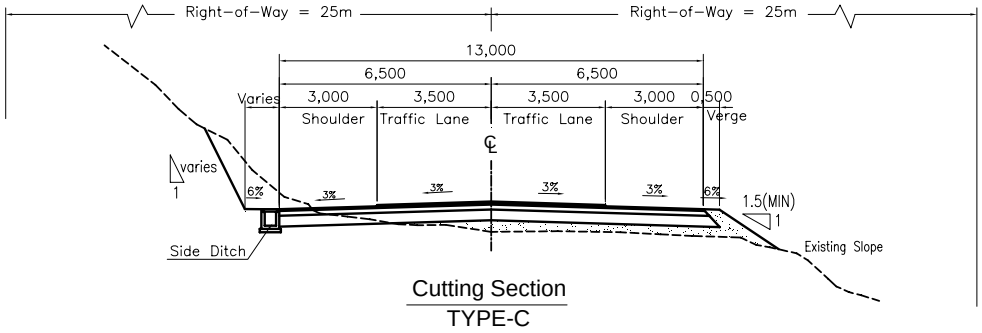
According to the Road Design Standard of Cambodia, “Highways constitute the backbone of the inter-provincial national network and complement the expressway network. They usually link up directly or indirectly the Provincial Capitals and major points of entry/exit to the country and serve long to intermediate trip lengths. Speed service is not so important as in an Expressway but relatively high to medium speed is necessary. Smooth traffic is provided with partial access control.” It has also been mentioned that Standards R4/U4 provide medium geometric standard and serve intermediate trip lengths with medium traveling speeds. It is also usually with partial

access control. The Rural Highway, Major Provincial, Minor Arterial and Major Collector fall under this standard.

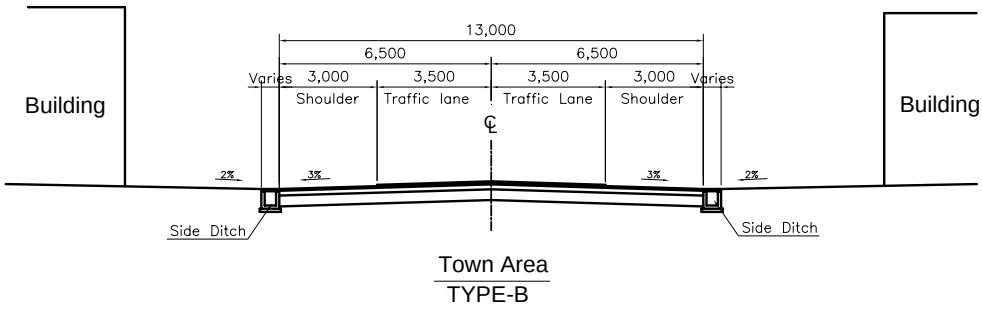
On the basis of these descriptions given in the Road Design Standard of Cambodia, the national road NR.57 is classified as R4/U4.

The design speed along flat terrain is generally taken as 90 km/hr as per the Cambodian Standard. However, as stated in the design concept, major re-alignment is not recommended to avoid adverse socio-environmental effects. At locations where the curvature does not meet the design requirements of 90 km/hr and if a major re-alignment is required, the design speed is reduced to 60 km/hr which complies the urban/mountainous standard.

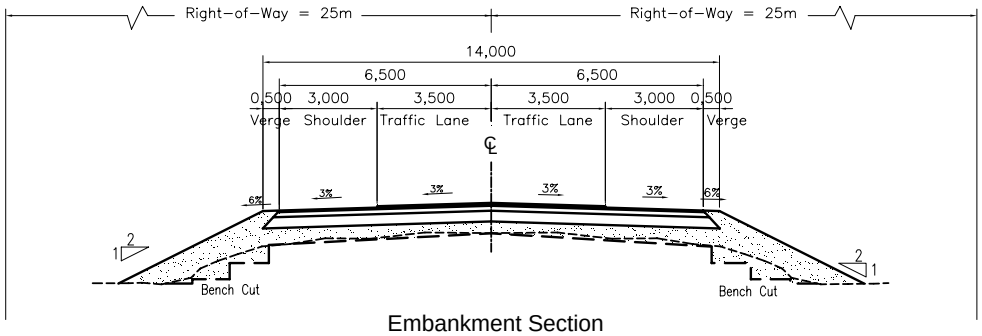
3) Typical Cross Sections



Cutting Section
TYPE-C



Town Area
TYPE-B



Embankment Section
TYPE-A

Figure 3.1.1 Typical Cross Sections

4) Pavement Design Criteria

Road Design Standard of Cambodia presents the design types for pavement structures and does not include detailed procedure. So the AASHTO Guide for Design of Pavement Structure has been applied for the pavement design.

The AASHTO method of pavement design requires basically the following four types of design input requirements:

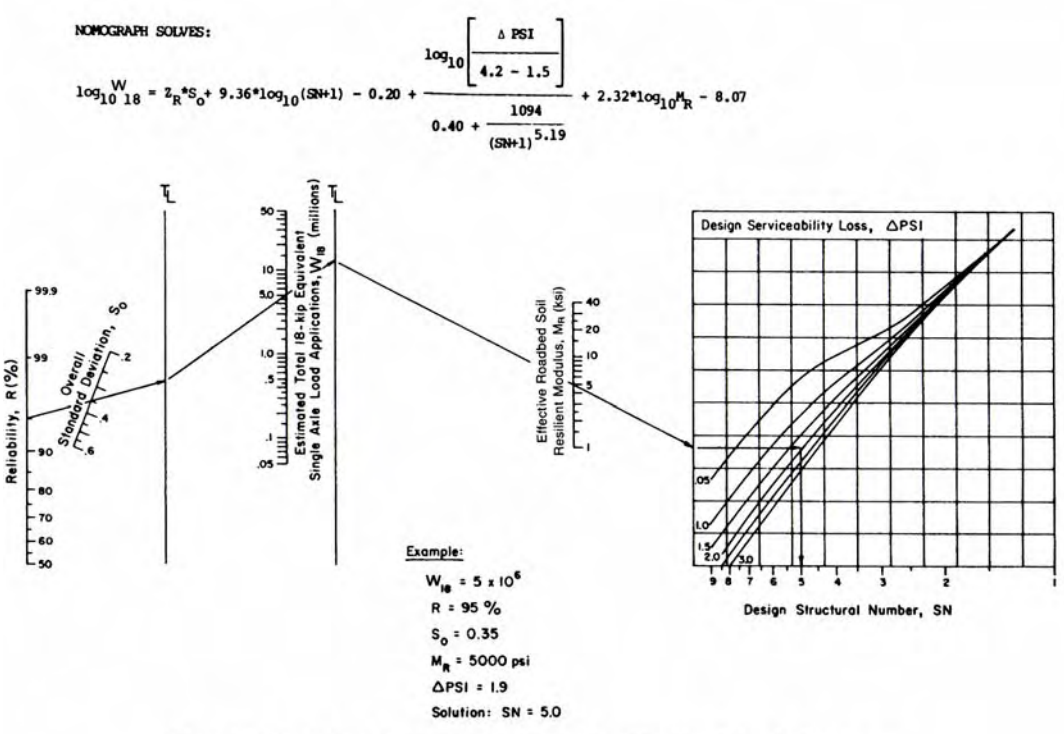
1) Design variables; the design variables include the performance and analysis period, traffic and the selection of parameters like reliability and overall standard deviations. The traffic data includes the estimation of total application of traffic load during pavement life (as obtained from the performance and analysis period) in terms of Equivalent Single Axle Load of 8.2 tones. The directional distribution factor and lane distribution factors are also required as the input design data.

2) Performance criteria; it is based on the concept of serviceability index. The initial serviceability index (p_0) is the serviceability of pavement immediately after construction and the terminal serviceability index (p_t) is the least acceptable serviceability of the pavement near the end of the pavement life before rehabilitation is required. The difference in these two parameters gives the design serviceability loss (ΔPSI).

3) Material properties; the material properties of various layers of the pavement structures from subgrade to subbase, base and surface courses are required in terms of resilient modulus. The resilient modulus of subgrade, subbase and base courses can be derived from the widely used CBR values of the material for these layers.

4) Pavement characteristics; it includes mainly the drainage coefficients for the subbase and base course layers.

For a set of the design input data, the required Structural Number (SN) is estimated from the AASHTO Nomograph or by solving the equation of the Nomograph as shown in **Figure 3.1.2**.



Note: The values of R, S_0 and ΔPSI shown in Figure are examples given in figure of AASHTO and are not the values used in this Study.

Figure 3.1.2 AASHTO Design Equation, Nomograph

A set of the pavement layer thicknesses is then identified which, when combined, will provide the load-carrying capacity corresponding to the design SN. The following equation provides the basis for converting SN into actual thicknesses of surface, base and subbase layers:

$$SN = a_1D_1 + a_2D_2m_2 + a_3D_3m_3$$

Where, a_1, a_2, a_3 = layer coefficients representative of surface, base, and subbase courses, respectively

D_1, D_2, D_3 = actual thickness (in inches) of surface, base, and subbase courses, respectively

m_2, m_3 = drainage coefficients for base and subbase layers, respectively

The design criteria that will be applied in the pavement design based on the AASHTO method is given in **Table 3.1.2**.

Table 3.1.2 Summary of Design Criteria for Pavement Design

Design Input Requirements			Value	Reference
1	Design Variables	Performance Period (years)	10	General
		Analysis Period (years)	10	General
		Traffic		
		Equivalent Single Axle Load (ton)	8.2	AASHTO
		Directional Distribution Factor, D_D	0.6	AASHTO
		Lane Distribution Factor, D_L	1.0	AASHTO
		Reliability (%)	85	AASHTO
		Overall Standard Deviation	0.45	AASHTO
2	Performance Criteria	Initial Serviceability Index, p_0	4.2	AASHTO
		Terminal Serviceability Index, p_t	2.2	AASHTO
		Design Serviceability Loss, ΔPSI	2.0	AASHTO
3	Material Properties	Effective Roadbed Soil Resilient Modulus, M_R (psi)	1500 × CBR	General
		Layer Coefficient for Subbase Course, a_3	from CBR	AASHTO chart
		Layer Coefficient for Base Course, a_2	from CBR	AASHTO chart
		Layer Coefficient for Asphalt Concrete, a_1	Resilient Mod.	AASHTO chart
4	Pavement Characteristics	Drainage Coefficients for Base and Subbase Course, m_2, m_3	1.0	AASHTO

The Cambodian Standard does not clearly stipulate the design period for improvement projects with Asphalt Concrete, although a period of 20-25 years is mentioned for new granular pavement and 10-15 years for Asphalt overlays. AASHTO recommends a performance period of 10-15 years for asphalt concrete pavements and hence a period of 10 years has been used for the design. Other input variables are based on the typical values for major arterial road.

3.1.2 Design Concept and Criteria for Bridge and Structures Along NR.57

(1) Design Concept

In order to meet the project objectives, the following design concepts are adopted to establish the design criteria:

- The bridge shall have the same functional standard as the road – its geometric and cross-sectional elements shall comply with the requirements of the road functional class or category;
- The existing bridge alignment/location (where geometric elements comply with the road standard) shall be maintained as much as possible to minimize additional right-of-way;
- The bridge shall be designed to have minimum adverse social impact through proper

selection of route alignment, proper construction method in urban areas, and minimum disturbance to population and encroachment to private properties;

- Environmental preservation shall be a primary concern through (a) selection of design and construction methodology that will minimize impact and damage to environment, (b) minimum encroachment to rivers and waterways, (d) sufficient clearance to design water level, and (d) provision of proper river protection;
- The bridge shall incorporate appropriate traffic safety facilities in design and construction.
- The scale and type of bridge shall be determined based on:
  - Bridge Length and Superstructure – river width, river discharge, design flood level, freeboard, design loads and durability,
  - Substructure and Foundation – pier height, foundation embedment depth, bearing layer and capacity, design loads, and river protection, and
  - Structure Type – economy/cost-effectiveness, durability, vertical alignment, environmental impacts, constructability, and maintainability.

(2) Design Criteria

1) Applicable Design Standards

- Australian Bridge Design Code, CAM PW.04.101.99, AUSTROADS, 1996
- Cambodian Bridge Design Standard (CBDS),CAM PW.04.102.99, MPWT, 2003
- Cambodian Road Design Standard, Part 3. Drainage (CRDS), CAM PW.03.103.99, MPWT, 2003
- Standard Specifications for Highway Bridges, AASHTO, 1996
- Specifications for Highway Bridges, Japan Road Association, 1996, 2002
- Specification for River Facilities, Japan River Association, 1998.

The basic design requirements will be referred to the Cambodian Bridge Design Standard (CBDS). However, when the said guidelines do not cover other aspects of design or when a safer, more efficient requirement is needed, the design of bridges shall refer to other standards.

2) Design Flood Frequency and Minimum Freeboard

The design flood frequency to be adopted for bridge design is one (1) in fifty (50) years as specified in the CRDS Part 3 for R5 and R4/U4 Category roads. The design maximum flood water level (DFL) shall be determined based on this return flood frequency.

The minimum freeboard from the DFL to the soffit of girders/slabs is recommended to be:

- 1.0m for river discharge >500 - 2,000 m^3/s
- 0.80m for river discharge >200 - 500 m^3/s, and
- 0.60m for river discharge < 200 m^3/s in accordance with the Japan River Facilities.

The above minimum freeboard shall be applied unless the requirements of water navigation clearance prevail. In all cases, bridges under this study have no requirements for water navigation clearance.

3) Bridge Length

The total bridge length is decided based on:

- the maximum design flood water level (DFL) and discharge with a 50-year return period,
- bridge opening that will not constrict river discharge flow, and
- existing topographic and natural condition requiring bridge to span the obstruction.

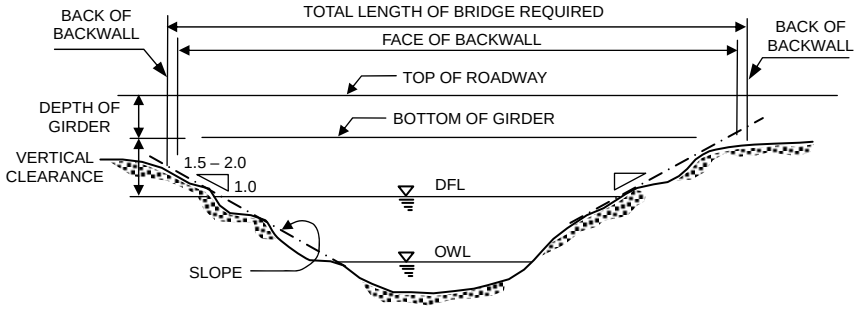


Figure 3.1.3 Planning for Bridge Crossings

4) Typical Cross-Section for Bridge and Culvert

To provide a consistent level of service as required by the CBDS, the traffic lane widths on bridges shall have the same width as that provided on the approach roadway. Moreover, the code requires a minimum of 500mm edge clearance from the adjacent traffic lanes for bridges with or without footways.

Recently constructed bridges along 1-Digit national roads are provided with 1.0m to 1.5m of shoulders which functions as motorcycle/bike lanes to segregate slow-moving from fast-moving vehicles. Moreover, on-going bridge projects under different funding institutions (including ADB, Japan, Thailand, Korea, China, etc.) provide 1.50m shoulder on bridges (see **Table 3.1.3**).

Table 3.1.3 (a) Typical Bridge Cross-Section Dimensions for On-going Projects

Route No.		**NR.1**	**NR.2**	**NR.3**	**NR.3**	**NR.3**	**NR.2**	**NR.5**
Bridges		C1 Section, 2 Bridges	C2,5 Bridges	Kampong Bay Br.	13 bridges	Slakou Br.	Ta Khmau II, Prek Ho Br.	1 bridge
Funding		Japan	Japan	Korea	Korea	Japan	Japan	ADB
Design Speed (km/hr)		80	-	-	-	60	60	80
Cross-Section	Carriageway (m)	3.5 x 2	3.5 x 2	3.5 x 2	3.5 x 2	3.5 x 2	3.5 x 2	3.5 x 2
	Shoulder/Motorcycle Lane (m)	2.5 x 2	1.0 x 2	1.0 x 2	1.55 x 2	1.5 x 2	1.5 x 2	1.5 x 2
	Sidewalk (m)	1.0 x 2	-	1.2 x 2	-	1.0 x 2	1.5 x 2	-
	Total (m)	14.0	9.0	11.4	10.1	12.0	13.0	10.0

Table 3.1.3 (b) Typical Bridge Cross-Section Dimensions for On-going Projects

Route No.		**NR.6**	**NR.7**	**NR.7**	**NR.48**	**NR.56**	**NR.68**
Bridges		46 Bridges	12 Bridges	Sekong Br.	4 Bridges	19 Bridges	20 Bridges
Funding		ADB	China	China	Thai	ADB	ADB
Design Speed (km/hr)		80	80	80	-	80	80
Cross-Section	Carriageway (m)	3.5 x 2	3.5 x 2	3.5 x 2	3.5 x 2	3.5 x 2	3.5 x 2
	Shoulder/Motorcycle Lane (m)	1.5 x 2	1.5 x 2	0.75 x 2	1.5 x 2	1.5 x 2	1.5 x 2
	Sidewalk (m)	-	-	0.75 x 2	-	-	-
	Total (m)	10.0	10.0	10.0	10.0	10.0	10.0

Sidewalks or footways are also being provided on bridges in urban areas and near residential areas.

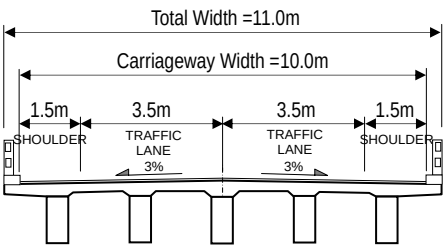
Based on the CBDS and the recent bridge construction trends, the following cross-section dimensions presented in **Table 3.1.4** below and shown in **Figure 3.1.4** are proposed for the bridges:

Table 3.1.4 Proposed Basic Cross-Section Dimensions

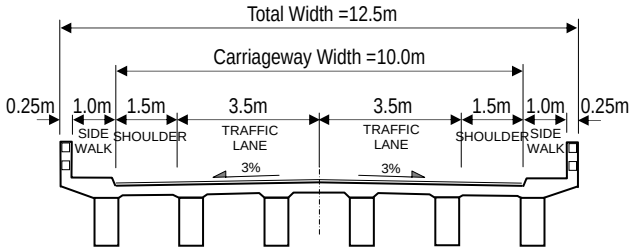
Road Name	No. of Lanes	Bridge Width (m) - **URBAN**				Bridge Width (m) - **RURAL**			
		Traffic Lane	Shoulder/ Motorbike Lane	Side-walk	Total	Traffic Lane	Shoulder/ Motorbike Lane	Side-walk	Total
NR.57	2	2 @ 3.5	2 @ 1.5	2 @ 1.0	12.0	2 @ 3.5	2 @ 1.5	-	10.0

Basically, two traffic lanes are provided on the bridge with the same width as the road section.

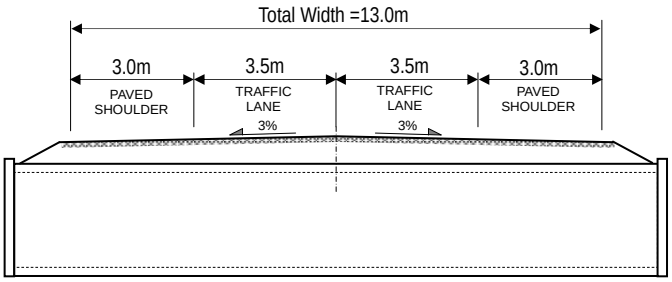
However, the shoulder is narrowed down to 1.5m for motorcycles similar to the newly constructed and on-going bridge projects (although the CBDS requires only 0.5m - 1.0m edge clearance for bridges more than 30m long). This will provide safe and smooth traffic flow on the bridge. Moreover, a 1.0m sidewalk is provided for bridges in urban areas to protect pedestrians while bridges in rural areas are not provided with sidewalk.



(a) NR.57 Road Bridge in Rural Areas



(b) NR.57 Road Bridge in Urban Areas



(c) Box/Pipe Culvert

Figure 3.1.4 Typical Bridge Cross-Sections

5) Bridges vs Box Culverts

The choice between bridge and box culverts depends on:

- The size of stream or waterway – waterways with width less than 6.0m shall be provided with box culverts,
- Stream/Waterway discharge – for streams/waterways with discharge less than 30 m^3/s, box culvert is provided unless existing topography requires bridge, and
- Existing Topography – bridge will be provided in areas where existing topography requires bridge crossing even if water discharge is less than 30 m^3/s.

6) Design Loads

The design loads shall be based on the CBDS with reference to AASHTO and Japanese Specifications. The design loads for bridges are classified as presented in **Table 3.1.5**.

Table 3.1.5 Design Load Classification

Permanent Load		Transient Load	
1	Structure Dead Load	9	Live Load
2	Superimposed Dead Load	10	Pedestrian Traffic Load
3	Earth Pressure Loads	11	Wind Load
4	Normal Water Flow and Buoyancy	12	Earthquake Load
5	Shrinkage and Creep Effects	13	Flood and Debris Impact Load
6	Prestress Effects	14	Differential Temperature Effects
7	Bearing Friction or Stiffness	15	Bridge Temperature Variation Effects
8	Differential Settlement		

i. Dead Load

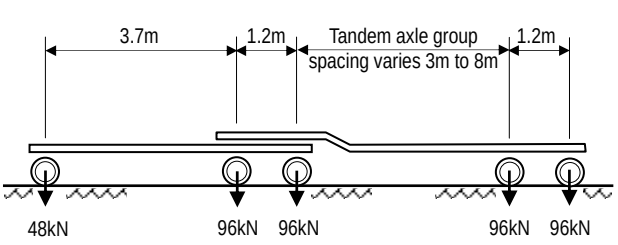
The dead load intensities for the different materials are shown in **Table 3.1.6** below.

Table 3.1.6 Dead Load Intensity

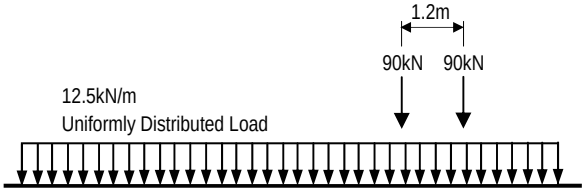
Classification	Item	Unit	Intensity
Dead Load	Aluminum Alloy	kN/m^3	26.7
	Bituminous Wearing Surface, Asphalt	kN/m^3	22.0
	Compacted Earth Filling	kN/m^3	16.0 – 19.0
	Compacted Gravel, Road Material	kN/m^3	19.0 – 23.0
	Concrete (Light Weight)	kN/m^3	12.3 – 19.6
	Concrete	kN/m^3	22.5 – 26.0
	Masonry	kN/m^3	23.5
	Sand – Fine (Dry)	kN/m^3	15.5 – 17.5
	Sand – Coarse (Dry)	kN/m^3	18.0 – 19.5
	Sand (Saturated)	kN/m^3	22.5
	Steel and Other Ferrous Metals	kN/m^3	77.0
	Water, Fresh	kN/m^3	9.8
	Water, Salt	kN/m^3	10.0
Superimposed Dead Load	Wearing Surface, (50 mm thick)	kN/m^2	1.1
	Bridge Parapet	kN/m^3	22.5 – 26.0
	Handrail	kN/m^3	22.5 – 26.0
	Public Utilities	kN/m	None
	Others	kN/m	None

ii. Live Load

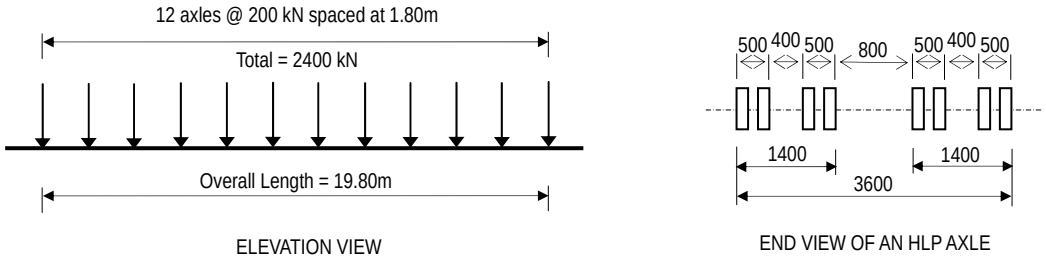
Previous design of bridges in Cambodia utilized different specifications for the design live load (including AASHTO, JRA, AUSTROADS, China, Thailand and other specifications).



(a) T44 Truck Loading



(b) L44 Lane Loading



NOTE: The HLP240 loading shall be assumed to centrally occupy two Standard Design Lanes

(c) Heavy Load Platform Loading (HLP 240)

Figure 3.1.5 Design Live Load

However, with the issuance of the CBDS in 1999, bridges are required to be designed for the effects of the T44 Truck Loading, the L44 Lane Loading and the Heavy Load Platform (HLP240) loading which are heavier than the previous design live loads.

On the other hand, the Asian Highway Standard stipulates for the design of bridges for the effects of AASHTO HS20-44 loading, which is comparatively lighter than the CBDS requirements.

The T44 Truck Loading, the L44 Lane Loading and the Heavy Load Platform (as shown in **Figure 3.1.5**) shall be applied as the design live load in this Study.

iii. Earthquake Forces

There are no records of seismographs inside Cambodia in the World Earthquake database. Moreover, information gathered in neighboring countries indicates there are no recorder epicenters in Cambodia.

The equivalent quasi-static horizontal earthquake force H (kN) is determined as:

$$H = \alpha IKCS\, W$$

W (kN) is the total gravitational force of the nominal dead load subjected to the acceleration and $\alpha = 0.13$, while the other coefficients *IKCS* are set in the code.

However, a uniform acceleration coefficient of a = 0.05 is considered appropriate throughout Cambodia.

"As a minimum requirement for conditions prevailing in Cambodia, the ends of the deck at abutments and at piers of simply supported structures shall allow for a minimum 200mm of horizontal displacement additional to displacements calculated for loadings without falling off the edge of the support" (CBDS).

iv. Wind Forces

Design for wind loading is to be based on a static analysis (quasi-static approach) using a design gust wind speed in conjunction with a mean loading coefficient. The methodology of determining the wind loading is based on the 1992 AUSTROADS Bridge Design Code and the Australian Standard for Wind Loading (AS 1170.2).

v. Thermal Effects

Daily and seasonal fluctuations in air temperature and solar radiation cause both variations in average bridge temperature and differential temperature gradient across structural members. Forces generated from these thermal effects should be considered in the design.

7) Design Properties of Materials

The strengths of material for concrete, reinforcing bars, structural steel and other shall be determined in consideration of the Cambodian standard for materials and strengths and the available materials that have been previously applied to other bridge projects.

A summary of the materials and strengths used in previous projects including ADB, WB, JICA and Japan Grant Aid is presented in **Table 3.1.7** and **Table 3.1.8** which will also be referred to during the basic design in this Study.

Table 3.1.7 List of Materials and Strengths for Concrete used in Bridge Projects

PC Girder	f'_c = 35~42 MPa	Abutment, Piers	f'_c = 24~32 MPa
RC Girder	f'_c = 24~42 MPa	RC Pile (Cast-in Place)	f'_c = 30~32 MPa
RC Slab	f'_c = 24~42 MPa	RC Pile (Precast)	f'_c = 30~32 MPa
Approach Slab	f'_c = 21~24 MPa	Box Culvert	f'_c = 21~32 MPa
RC Hand Rail	f'_c = 21~24 MPa		

Table 3.1.8 Reinforcing Bars and Prestressing Strands used in Bridge Projects

Reinforcing Bars, Deformed	f_y = 400~420 MPa
Reinforcing Bars, Plain	f_y = 240~300 MPa
Prestressing Steel, 7-wire	f_p = 1860 MPa

The Cambodian Bridge Design Code specifies the following strengths:

- Concrete : f'_c = 25, 32, 40 and 50 MPa
- Reinforcing Bars : Plain, f_y = 250 MPa
  Deformed, f_y = 400 MPa
- Prestressing Steel : 7-wire AS1311, f_p = 1750~1860 MPa

To simplify the basic design, reinforced concrete structures shall be designed using concrete compressive strength of f'c = 32MPa while 42MPa shall be used for prestressed concrete members. Reinforcing bars shall have tensile strength of 400MPa.

8) Geotechnical Consideration

Basically, substructure foundations shall be embedded to soil layers with sufficient bearing resistance to support the contemplated loads. Considering the common forms of foundation used in bridge projects in Cambodia, the following bearing capacities shall be used:

- Allowable Bearing Capacity of 400mm x 400mm RC Driven Pile : 500 kN
- Allowable Bearing Capacity of ϕ1000mm RC Cast-in-Place Pile : 2000 kN
- Allowable Bearing Capacity of Spread Footing in Sandstone : *800 - 1000 kPa

*This capacity is assumed since no tests for sandstone was conducted

3.2 Road Design

3.2.1 Existing Road Conditions

NR.57 is a secondary national road (2-Digit) with highway/arterial function connecting the province of Battambang with the province of Pailin on the northwest section of Cambodia. The road stretches 104km long with mostly laterite pavement structure and about 300m concrete pavement at the Thailand border. About 64km of the road is within Battambang province passing through several communes and districts. The road also passes through some temples and tourist destinations including Wat Phnum Sampov, Wat Snoeng and Phnum Yat. It also provides connection to roads leading to Ou Ta Vav Waterfalls (**Figure 3.2.1**). At around Km3 from the beginning point, the road crosses the Cambodian railway.

Figure 3.2.1 Roadside Attractions Along NR.57

The existing road conditions are shown in **Figure 3.2.2**.

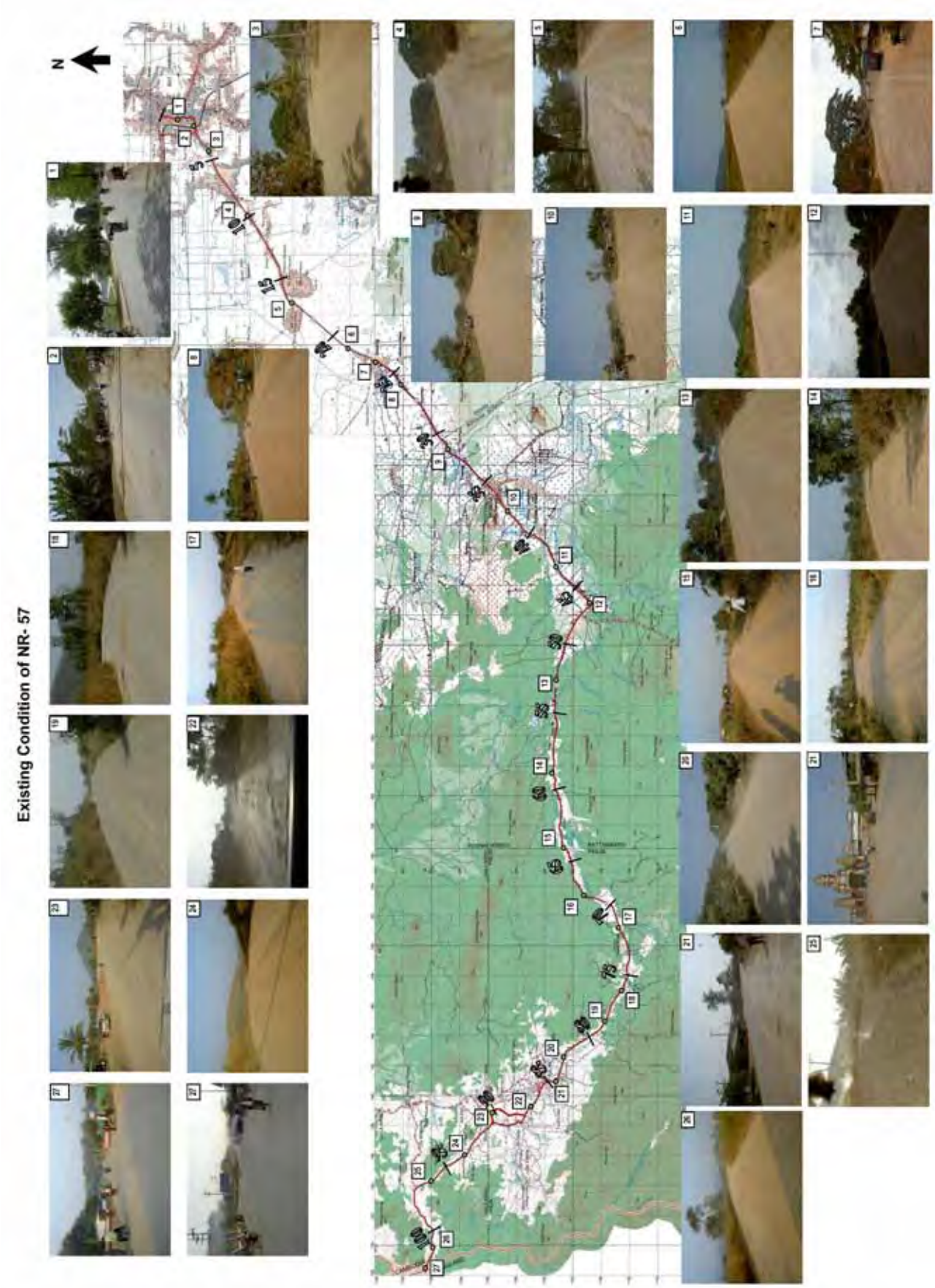


Figure 3.2.2 Existing Road Conditions Along NR.57

Roadside Use

The roadside use from the beginning of the road to about Km18 is mostly residential with some commercial/industrial (local industry like woodworks) establishments and institutional areas like school, temples and military camp.

Roadside use from Km18 to around Km50 is basically agricultural (rice field and vegetable cultivation) and some intermittent residential areas.

The roadside from Km50 to Km80 is basically open area with some agricultural fields and residential areas. Pailin district/municipality is near Km85 where residential and commercial areas concentrate. From the district center to the Thailand border, roadside is mostly open area with some agricultural sections (cash crops and fruit trees). Two casinos also operate at the end of NR.57 on the border with Thailand.

Landmine/UXO Contamination

Landmine contamination in Cambodia has seriously affected national development including infrastructure reconstruction. Among the provinces contaminated by mines/UXO, Battambang and Pailin belong to the top three most contaminated areas. Such contamination includes NR.57 with more than half of the road length suspected of being contaminated by landmines. Several landmine accidents have occurred in these areas with 33% and 16.5% of all accidents in Cambodia for a period between 2002 and 2004 occurring in Battambang and Pailin, respectively.

Contamination map, as shown in **Figure 3.2.3** from the Cambodian Mine Action Center (CMAC) indicates that the section from Km0 to about Km50 is cleared from landmine but beyond that section, most of the roadside along NR.57 are suspected of being contaminated with landmines. This indicates that road development of NR.57 will have to consider the landmine contamination problem seriously.

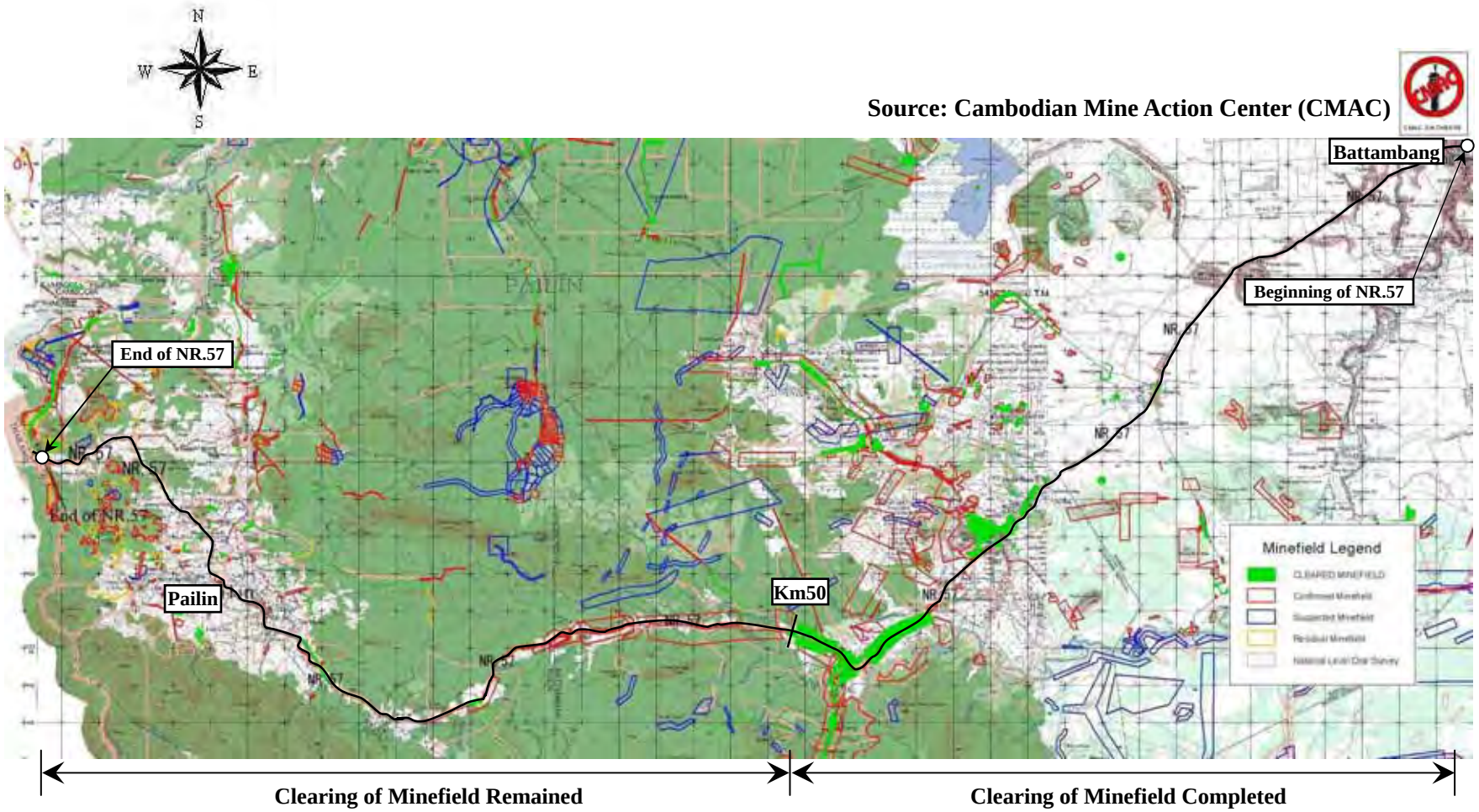


Figure 3.2.3 Landmine Contamination Map Along NR.57

Traffic Conditions

The traffic survey conducted in the year 2005 along NR.57 showed mostly motorcycles at 76% share plying the route. Since NR.57 connects Thailand with Battambang, heavy vehicles with commercial loads are also seen along this route. Most of these trucks are heavily loaded causing collapse of one Bailey bridge in September 2005. The percentage share of the vehicle composition along this route is shown in **Figure 3.2.4**.

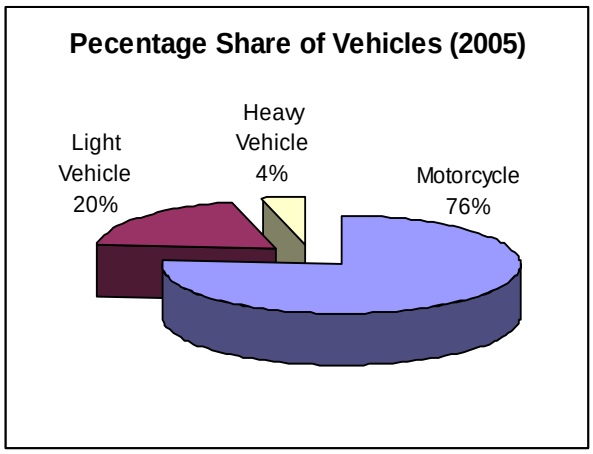


Fig.3.2.4 Vehicle Composition Along NR.57

3.2.2 Road Improvement

(1) Design of Horizontal Alignment

- As stated in the design concept, the road will generally follow the existing alignment to avoid any adverse socio-environmental effects and also to reduce the total construction cost.
- The alignment design is based on the Ortho Mapping produced from the Aerial Photographs of scale 1/40,000 (year 2002) or 1/25,000 (year 1992).
- Due to the limitations of the details available from the Ortho Mapping, the alignment is designed only with the tangents and circular curves. No attempts have been made to fit the alignment including transition curves.
- The initial urban section of Battambang till the intersection shortly after Km 2 may not need any improvement.
- Although the profile seems flat till Km70+000, occasionally there are some grades about or slightly above 2% after Km50+000. The profile grade after Km70+000 is rolling to mountainous with grades occasionally as high as 6%, especially near bridge approaches.

- The list of curves not complying to design speed of 90 km/hr for NR.57 is given in **Table 3.2.1**. It is to be noted that the first three sharper curves are within the urban area of Battambang.

Table 3.2.1 No. of Curves not Complying Design Speed of 90 km/hr

SN	Station		Curves with R<335m (V=90km/hr)	
	From	To	No	Total
1	0+000	10+000	3	12
2	10+000	20+000	1	
3	20+000	30+000	2	
4	30+000	40+000	2	
5	40+000	50+000	4	
6	50+000	60+000	5	61
7	60+000	70+000	5	
8	70+000	80+000	14	
9	80+000	90+000	9	
10	90+000	100+000	20	
11	100+000	104+000	8	

From the nature of the topography, and above data, it has been considered that the section from Km0+000 to Km50+000 is recommended to be improved with a design speed of 90 km/hr. and the section from Km50+000 to the end with a design speed of 60 km/hr. However, for the first section, design speed is recommended to be reduced to 60 km/hr locally, for the curves shown in **Table 3.2.1**.

- The list of existing curves not complying to design speed of 60 km/hr in the whole stretch of NR.57 is given in **Table 3.2.2**.

(2) Improvement in Vertical Alignment

- Design of profile was based on the profile survey data, which was conducted along NR.57 at a distance of every 500m (maximum). Approximate adjustments were made for the survey stationing of profile survey and the stationing from existing road alignment of CAD data created from Ortho Mapping.

- Improvement of vertical alignment was based on the design concept of applying additional pavement structure above the existing road surface. So the profile was generally set at a level higher than the existing surface by additional thickness of new pavement, except at the section where overtopping during rainy season was reported.

Table 3.2.2 List of Existing Curves not Complying Design Speed of 60 km/hr

SN	Station	Existing Condition	Proposed Improvement	Remarks
1	2+100	Urban Intersection at Battambang	Keep existing	
2	41+800	R=50m, bridge approach	Improve with R=200m	Minor re-alignment with center shift of max.30m and bridge location. Reduction of design speed to 60 km/hr
3	47+000	R=70m, sharp curve	Improve with R=150m	Minor re-alignment with center shift of max.8m. Reduction of design speed to 60 km/hr
4	60+000	R=30, bridge approach	Improve with R=150	Minor re-alignment with center shift of max.30 and bridge location
5	83+800	Urban Intersection at Pailin	Keep existing	
6	84+700	Urban Intersection at Pailin	Keep existing	
7	87+350	Urban Intersection at Pailin	Keep existing	
8	89+400	R=90, sharp curve	Improve with R=150m	Minor re-alignment with center shift of max.10m

Note: Except the urban intersections all the sharper curves have been improved for a minimum design speed of 60 km/hr.

- During site investigation, a short section of road around Km 17 was reported to be inundated by about 20 cm. The finished profile grade was set at a level higher than minimum of 1 m along that section. The raising of profile was affected from Km15+000 to Km17+500.

(3) Improvement in Cross Sections

- Cross section survey was done at every 3 km (maximum) and was used as basis for design and earthwork quantity calculations.
- Since detailed data were not available at this stage, the improvement of cross section was based on the concept of widening on both sides.
- The embankment was designed with a fill slope of 1:2. However, for shallow embankment it may be reduced to 1:1.5, as shown in the typical cross sections.
- Approximate locations for applicable types of cross sections are given in **Table 3.2.3**.

Table 3.2.3 Applicable Cross Section Types Along NR.57

SN	Station		Applicable Type of Cross Section	Remarks
	From	To		
1	0+000	4+700	Type B	Urban area of Battambang
2	4+700	14+600	Type A	
3	14+600	17+000	Type B	Local built-up area
4	17+000	22+000	Type A	
5	22+000	24+900	Type B	Local built-up area
6	24+900	35+500	Type A	
7	35+500	37+400	Type B	Local built-up area
8	37+400	47+200	Type A	
9	47+200	48+200	Type B	Local built-up area
10	48+200	71+500	Type A	
11	71+500	82+000	Type C	
12	82+000	90+000	Type B	Urban area of Pailin
13	90+000	102+500	Type C/Type A	
14	102+500	104+000	Type B	Urban border area

(4) Recommendations in Road Design

- Since the design of alignment was based on the Ortho Mapping from aerial photographs, there may be some error in actual radii of curvatures.
- During the detailed stage of the project, it is obvious that the alignment shall be re-designed with the application of proper transition curves, wherever required from design standard.
- It was not possible at this stage to conduct detailed investigation for the locations where

minor improvements were proposed. Only the concepts of improvements were presented and shall be investigated in detail during future stages of the project.

- The initial urban section of Battambang till the intersection shortly after Km2 may not need any improvement. However, it is recommended to study in detail during more detailed design stages, especially for the adequacy of the pavement structures.
- Widening of road was based on the concept of widening on both sides. During detailed studies, this concept may need revision on case by case basis to reduce utility relocation etc.
- The section from beginning point to around Km27, generally, the land is virtually flat and the road is on embankment on both sides. After Km27, it was observed that the area on one side of the road has gentle down slope towards the road. Detailed study on hydrological conditions is recommended during detailed studies.

3.2.3 Pavement Design

(1) Traffic Volume and Design Equivalent Single Axle Load (ESAL)

Traffic survey was conducted at 3 different locations along NR.57. The results of traffic assignment show different values for four different sections along NR.57 based on Network Analysis. The results show that the initial section from beginning point to the intersection at Km17 has substantially higher traffic volume. Though some differences were observed between the forecasted values of other remaining three sections, no substantial difference was observed in terms of designed pavement thickness. Therefore, from pavement design aspects two sections were used, one from Km0 to Km17 and the other from Km17 to the end. The highest forecasted values among the three were used for the latter section.

The performance and analysis periods are taken as 10 years as mentioned in the design criteria. The opening year of improvement of NR.57 is taken as the beginning of year 2011. Traffic forecasts show the results for the years 2010, 2015 and 2020. The growth factors for intermediate years have been calculated from these results. The forecasted results for light and heavy vehicles and the calculation of total Equivalent Single Axle Load (ESAL) values for 10 years are shown in **Table 3.2.4**.

As there was no compiled standard data for axle load for Cambodia, the equivalent single axle factors for light and heavy vehicles are taken as 0.00356 and 1.89 respectively, which are the values applied in the improvement of National Road No.1.

The motorcycle volumes virtually do not contribute to the total design ESAL values and hence are not considered for pavement design.

The Design ESAL for initial and end sections are taken as 0.9 million and 0.3 million respectively.

Table 3.2.4 Traffic Volume and Total Equivalent Single Axle Load (ESAL) for NR.57

Year	Beginning to Km 17					Km 17 to End				
	Light Vehicles		Heavy Vehicles		Total	Light Vehicles		Heavy Vehicles		Total
	VPD	ESAL (0.00356)	VPD	ESAL (1.89)	ESAL Per Year	VPD	ESAL (0.00356)	VPD	ESAL (1.89)	ESAL Per Year
2011	861	1118	172	118754	119872	639	830	41	28387	29217
2012	897	1166	180	123896	125061	680	884	43	29952	30836
2013	935	1215	187	129261	130475	724	941	46	31603	32544
2014	974	1266	195	134858	136123	771	1002	48	33344	34346
2015	1015	1319	204	140729	142048	821	1067	51	35182	36249
2016	1057	1373	212	146098	147471	863	1122	54	37375	38497
2017	1100	1430	220	151672	153102	908	1179	58	39704	40884
2018	1146	1489	228	157458	158947	954	1240	61	42179	43419
2019	1193	1550	237	163465	165015	1003	1304	65	44807	46111
2020	1242	1614	246	169703	171317	1055	1371	69	47600	48971
Both Directions		13539		1435894	1449433		10939		370133	381072
Design ESAL					**869660**					**228643**

(2) Sections for Pavement Design

From the results of traffic volume, NR.57 can be divided into two different sections as explained earlier. Similarly, as mentioned in the Design Criteria, the whole road can be divided into two stretches based on the subgrade CBR values. Therefore, NR.57 is divided into three different sections for pavement design, as shown in **Table 3.2.5**;

Table 3.2.5 Sections for Pavement Design in NR.57

Section		Design ESAL Million	Design Subgrade CBR %
From	To		
Km0	Km17	0.9	4
Km17	Km50	0.3	4
Km50	Km104	0.3	6

(3) Thickness Design

The material properties of the pavement structures used in the design are as given in **Table 3.2.6** based on the Design Criteria and AASHTO charts/equations.

Table 3.2.6 Material Properties of Pavement Layer Materials

Material	CBR	Elastic Modulus (MR)
Subgrade	CBR 4 or 6	6000 or 9000 psi
Aggregate Subbase	CBR≥30	15000 psi
Aggregate Base	CBR≥80	28400 psi
Asphalt Concrete Binder/Surface	--	300000 psi

The required Structural Numbers (SN) and the designed pavement thicknesses for the respective sections of NR.57 are then calculated and are given in **Table 3.2.7**.

Table 3.2.7 Designed Pavement Thicknesses for Different Sections of NR.57

Section		Design ESAL (million)	Design CBR (%)	SN	Asphalt Concrete		Base	Subbase
From	To				Surface	Binder		
Km0	Km17	0.9	4	3.46	4 cm	5 cm	20	25
Km17	Km50	0.3	4	2.91	4 cm	5 cm	15	20
Km50	Km104	0.3	6	2.51	4 cm	5 cm	15	15

(4) Recommendations

- During more detailed stage of the project, the CBR values of existing subgrade material shall be investigated in detail.
- Axle load survey shall be conducted in the vicinity and for the type of heavy vehicles likely to use the road after improvement.
- Traffic survey and forecast shall be done for more classified vehicles, especially in the heavy

vehicle group.

3.2.4 Drainage Design

Sufficient precipitation data is not available along NR.57 for drainage analysis. During site inspection and local hearing it was observed that no serious flood prone area existed except a short section near Km17 with an inundation of about 30cm for a few hours. Site inspection was carried out for all road openings, with the concept that existing openings are adequate except at the flood prone area. Therefore, it was considered that the improvement will apply equivalent opening sizes of the existing ones. The flood prone area is flat plain with the road slope of less than quarter of a percent. It is difficult to precisely quantify the opening in this area under such condition. Based on such observations, it was considered to apply pipe culverts with opening sizes of one meter in this section. The following is the table of inventory and their replacements;

Table 3.2.8 Structure Inventory Selection of Opening on NR.57 (1)

No.	New Bridge No.	Station	Existing Road Structure Type	Length (m)	Width (m)	No. of Spans	Proposed Opening Type Selection
1		002+900	RC Slab Bridge	14.0	6.8	3	RCBC-3
2		003+000	RC Slab Bridge	11.0	6.0	3	RCBC-3
3		003+150	RC Slab Bridge	14.0	7.0	3	RCBC-3
4		003+550	RC Slab Culvert	3.9	7.0	1	RCBC-2
5		003+900	RC Slab Bridge	7.5	7.0	2	RCBC-3
6		004+800	RC Pipe Culvert	2-Φ0.60	9.0		RCPC-2
7		005+100	RC Slab Culvert	3.2	7.0	1	RCBC-2
8		005+300	RC Slab Culvert	3.0	7.0	1	RCBC-1
9		005+700	RC Slab Culvert	3.0	7.0	1	RCBC-1
10		005+800	RC Slab Culvert	3.0	7.0	1	RCBC-1
11		006+300	RC Slab Culvert	3.0	7.0	1	RCBC-1
12		006+800	RC Slab Culvert	3.0	7.0	1	RCBC-1
13		007+300	RC Slab Culvert	3.0	7.0	1	RCBC-1
14		008+000	RC Slab Culvert	3.0	7.0	1	RCBC-1
15		008+300	RC Slab Culvert	3.0	7.0	1	RCBC-1
16		008+700	RC Slab Culvert	6.0	7.0	2	RCBC-2
17		009+100	RC Slab Culvert	3.0	7.0	1	RCBC-1
18		009+700	RC Slab Bridge	7.3	6.3	2	RCBC-3
19		010+000	RC Slab Bridge	10.5	6.5	3	RCBC-3
20		010+300	RC Slab Culvert	3.0	7.0	1	RCBC-1
21		010+400	RC Slab Culvert	3.0	6.7	1	RCBC-1
22		010+900	RC Slab Culvert	3.5	7.0	1	RCBC-2
23		011+100	RC Slab Culvert	4.0	6.6	1	RCBC-2
24		011+300	RC Slab Culvert	3.0	7.0	1	RCBC-1
25		011+700	RC Slab Culvert	3.0	7.0	1	RCBC-1
26		011+900	RC Slab Culvert	3.0	6.7	1	RCBC-1
27		012+100	RC Slab Culvert	3.0	7.0	1	RCBC-1
28		012+500	RC Slab Culvert	3.0	7.0	1	RCBC-1
29		012+800	RC Slab Culvert	3.0	6.6	1	RCBC-1
30		013+000	RC Slab Culvert	3.0	6.4	1	RCBC-1
31		013+300	RC Slab Culvert	4.0	6.4	1	RCBC-2
32		013+600	RC Slab Culvert	3.0	5.5	1	RCBC-1
33		013+900	RC Slab Culvert	3.0	7.0	1	RCBC-1
34		014+800	RC Slab Bridge	11.0	6.2	2	RCBC-3
35		016+000	RC Slab Bridge	10.5	6.8	2	RCBC-3
36		016+300	RC Slab Bridge	9.0	6.8	2	RCBC-3
37		016+400	RC Slab Bridge	10.0	6.5	2	RCBC-3
38		016+500	RC Slab Bridge	9.0	6.5	2	RCBC-3
39		016+800	RC Slab Bridge	9.0	6.5	2	RCBC-3
40		016+900	RC Slab Bridge	10.0	5.5	2	RCBC-3
41		017+100	RC Slab Bridge	9.0	6.0	2	RCBC-3
42		017+900	RC Slab Bridge	9.0	6.5	2	RCBC-3
43		018+400	RC Pipe Culvert				RCPC-1
44		018+900	RC Slab Culvert	3.0	6.0	1	RCBC-1
45		020+200	RC Slab Culvert	4.0	6.7	1	RCBC-2
46		021+600	RC Slab Culvert	3.0	5.7	1	RCBC-2
47		023+100	RC Slab Bridge	7.0	5.8	2	RCBC-3
48		024+100	RC Slab Culvert	6.0	5.7	2	RCBC-2
49		025+000	RC Slab Culvert	3.0	6.0	1	RCBC-1
50		025+700	RC Pipe Culvert	2-Φ1.00	10.0		RCPC-2
51		027+700	RC Pipe Culvert	2-Φ1.00	10.0		RCPC-2
52		031+000	RC Pipe Culvert	1-Φ1.00	10.0		RCPC-1
53		033+300	RC Pipe Culvert	1-Φ0.80	10.0		RCPC-1
54		034+200	RC Pipe Culvert	2-Φ0.80	10.0		RCPC-2
55		*034+400*					RCPC-1
56		*034+700*					RCPC-1
57		*035+800*					RCPC-1
58		*036+200*					RCPC-1
59		*036+500*					RCPC-1

Table 3.2.8 Structure Inventory Selection of Opening on NR.57 (2)

No.	New Bridge No.	Station	Existing Road Structure Type	Length (m)	Width (m)	No. of Spans	Proposed Opening Type Selection
60		039+800	RC Pipe Culvert	1-Φ0.80	10.0		RCPC-1
61	**1**	**40+700**	**Bailey Bridge**	**12.0**	**4.2**	**1**	**RC Slab**
62	**2**	**41+800**	**Bailey Bridge**	**24.0**	**4.2**	**2**	**RC Slab**
63		*040+700*					RCPC-1
64		043+800	RC Pipe Culvert	1-Φ1.00	10.0		RCPC-1
65		047+500	RC Pipe Culvert	1-Φ0.80	10.0		RCPC-1
66		048+700	RC Pipe Culvert	1-φ1.00	10.0		RCPC-1
67		049+300	RC Pipe Culvert	1-Φ1.00	10.0		RCPC-1
68		051+000	RC Pipe Culvert	1-Φ1.00	10.0		RCPC-1
69		051+900	RC Pipe Culvert	1-Φ0.80	10.0		RCPC-1
70	**3**	**51+736**	**Bailey Bridge**	**27.0**	**4.2**	**1**	**RC Slab**
71		*050+800*					RCPC-1
72		*052+200*					RCPC-1
73		054+900	RC Pipe Culvert	1-φ1.00	10.0		RCPC-1
74		056+300	Bailey Bridge	12.0	4.2	1	RCBC-3
75	**4**	**58+823**	**Bailey Bridge**	**24.0**	**4.2**	**1**	**RCDG**
76	**5**	**60+038**	**Bailey Bridge**	**48.0**	**4.2**	**2**	**PCDG**
77		*059+200*					RCPC-1
78	**6**	**63+088**	**Bailey Bridge**	**45.0**	**4.2**	**2**	**RCDG**
79		064+300	RC Pipe Culvert	1-Φ1.00	10.0		RCPC-1
80		*063+000*					-
81	**7**	**65+273**	**Bailey Bridge**	**24.0**	**4.2**	**1**	**RC Slab**
82		066+600					RCPC-1
83	**8**	**68+194**	**Bailey Bridge**	**33.0**	**4.2**	**2**	**RC Slab**
84		071+200	RC Pipe Culvert	1-Φ1.00	12.0		RCPC-1
85		072+300	RC Pipe Culvert	1-Φ1.00	12.0		RCPC-1
86		072+700	RC Pipe Culvert	1-Φ1.00	12.0		RCPC-1
87	**9**	**72+937**	**Bailey Bridge**	**21.0**	**7.0**	**1**	**RCDG**
88		073+200	Bailey Bridge	21.0	4.2	1	RCBC-3
89		073+400	Bailey Bridge	12.0	4.2	1	RCBC-3
90		074+600	Bailey Bridge	15.0	4.2	1	RCBC-3
91		075+700	Bailey Bridge	15.0	4.2	1	RCBC-3
92		*077+219*					RCPC-1
93		*077+399*					RCPC-1
94		*077+549*					RCPC-1
95		*078+679*					RCPC-1
96		*079+943*					RCPC-1
97		*080+219*					RCPC-1
98	**10**	**81+944**	**RC Slab Bridge**	**28.3**	**7.3**	**3**	**RC Slab**
99	**11**	**83+048**	**RC Slab Bridge**	**8.7**	**8.0**	**1**	**RC Slab**
100		083+800	RC Slab Culvert	5.0	8.0	1	RCBC-2
101		*084+517*					-
102		*085+385*					RCPC-1
103		*085+978*					RCPC-333
104		086+100	RC Pipe Culvert	1-Φ0.80	12.0		RCPC-1
105		087+000	RC Pipe Culvert	1-Φ0.80	12.0		RCPC-1
106		087+200	RC Pipe Culvert	1-Φ0.60	12.0		RCPC-1
107		087+900	RC Pipe Culvert	1-Φ0.60	12.0		RCPC-1
108		*089+297*					RCPC-1
109	**12**	**89+850**	**RC Girder Bridge**	**72.0**	**7.0**	**4**	**RCDG**
110		*090+793*					RCPC-1
111		*090+952*					RCPC-1
112		*091+952*					RCPC-2
113		*091+695*					RCPC-2
114		*092+050*					RCPC-1
115		*092+387*					RCPC-1
116		*092+507*					RCPC-1
117		*092+998*					RCPC-1
118		*093+621*					RCPC-1
119		093+700	RC Pipe Culvert	1-Φ0.80	12.0		RCPC-1
120		*094+793*					RCPC-1
121		094+700	RC Pipe Culvert	1-Φ0.60	12.0		RCPC-1
122		*095+270*					RCPC-1
123		*095+817*					RCPC-2
124		*096+152*					RCPC-2

Table 3.2.8 Structure Inventory Selection of Opening on NR.57 (3)

No.	New Bridge No.	Station	Existing Road Structure Type	Length (m)	Width (m)	No. of Spans	Proposed Opening Type Selection
125		*096+446*					RCPC-1
126		*096+967*					RCPC-1
127		*096+919*					RCPC-2
128		*097+352*					RCPC-1
129		097+700	RC Pipe Culvert	1-Φ0.80	12.0		RCPC-1
130		097+900	RC Pipe Culvert	1-Φ0.60	12.0		RCPC-1
131		*099+325*					RCPC-1
132		099+500	RC Pipe Culvert	1-Φ0.60	12.0		RCPC-1
133		099+800	RC Pipe Culvert	1-Φ0.60	12.0		RCPC-1
134		100+300	RC Pipe Culvert	1-Φ0.80	12.0		RCPC-1
135		101+000	RC Pipe Culvert	1-Φ0.60	12.0		RCPC-1
136		101+200	RC Pipe Culvert	1-Φ0.60	12.0		RCPC-1
137		*101+545*					RCPC-1
138		101+700	RC Pipe Culvert	1-Φ0.80	12.0		RCPC-1
139		102+700	RC Pipe Culvert	1-Φ0.81	12.0		RCPC-1