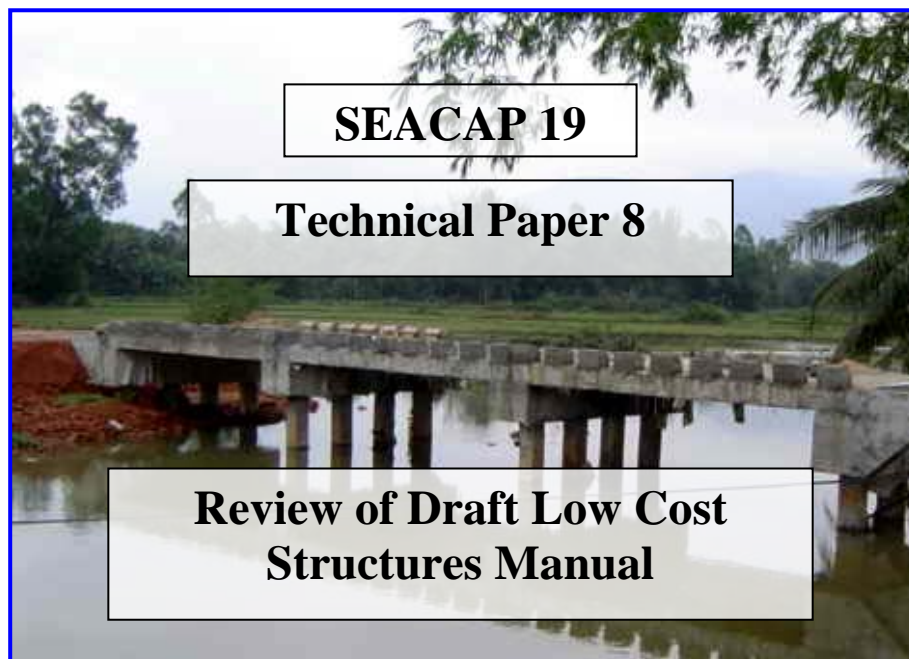


**ROYAL GOVERNMENT OF CAMBODIA**

**SOUTH EAST ASIA COMMUNITY ACCESS  
PROGRAMME**

**DEVELOPMENT OF LOCAL RESOURCE BASED  
STANDARDS**



**June 2008**

**UNPUBLISHED PROJECT REPORT**



**UNPUBLISHED PROJECT REPORT**

# **SOUTH EAST ASIA COMMUNITY ACCESS PROGRAMME**

## **SEACAP 19**

### **DEVELOPMENT OF LOCAL RESOURCE BASED STANDARDS**

#### **Technical Report 8**

##### **Review of Draft Low Cost Structures Manual**

**By**

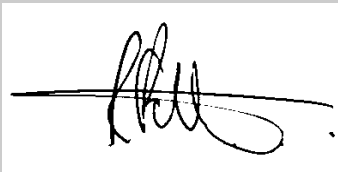

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**Prepared for: Project Record:** SEACAP 19. Development of Local Resource Based Standards

**Client:** DfID; South East Asian Community Access Programme (SEACAP) for the Royal Government of Cambodia

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**ABBREVIATIONS & ACRONYMS**

ADB	Asian Development Bank
CNCTP	Cambodia National Community of Transport Practitioners
DfID	Department for International Development
EIC	Engineering Institution of Cambodia
ENS	Engineered Natural Surface
gTKP	global Transport Knowledge Partnership
ILO	International Labour Organisation
ITC	Institute of Technology of Cambodia
KACE	Khmer Associated Consulting Engineers
KaR	Knowledge and Research
km	kilometre
LBAT	Labour-Based Appropriate Technology
m	metre(s)
mm	Millimetre(s)
MPa	Mega pascals
MPW&T	Ministry of Public Works and Transport (Cambodia)
MRD	Ministry of Rural Development (Cambodia)
NGOs	Non-Governmental Organisations
NRDP	North-western Rural Development Project
ORN	Overseas Road Note
PDP	Provincial Development Programme
PDRD	Provincial Department of Rural Development
PIARC	World Road Association
QA	Quality Assurance
Ref.	Reference
RFP	Request for Proposal
RGoC = RGC	Royal Government of Cambodia
SEACAP	South East Asia Community Access Programme
SEILA	Multilateral donors - Government Rural Infrastructure Development Programme
SIDA	Swedish International Development Agency
SOE	State Owned Enterprise
TMP	Transport Mainstreaming Partnership
ToR	Terms of Reference
TRIP	Tertiary Roads Improvement Project
TRL	Transport Research Laboratory
UK	United Kingdom
UN	United Nations
UNCDF	United Nations Capital Development Fund
UNOPS	United Nations Office for Project Services
WB	World Bank
WLC	Whole Life Costs

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## **1 INTRODUCTION**

A Low Cost Structures manual was developed to a preliminary draft stage using DfID funding under the previous Knowledge and Research (KaR) programme (Assignment R6851). The draft document has been recognised as an important knowledge compilation but was required to be completed, finalised and disseminated to achieve benefit from the already substantial investment. There is also an identified need to assess this document in the context of the Cambodian rural road environment and its applicability to the up-dating of Cambodian Rural Road Standards.

A SEACAP 19 inception phase review of this Task has highlighted the following points:

The defined aim of this task is not to produce a final version of the Low Cost Structures Manual, but to assess the status and applicability of an existing draft document

The first key activity is to review the status of the unfinished manual and to estimate the work and additional associated resources required to complete it.

The manual as it stands should then be reviewed as to its potential usefulness within the Cambodian Low Volume Rural Road (LVRR) context in particular and the regional environments in general. Suggestions should be made, in conjunction with local stakeholders, as to any further work, including field trials, which may be required.

## **2 BACKGROUND**

The Water, Engineering and Development Centre at Loughborough University (WEDC) was contracted under KaR R6851 to compile a preliminary version of a Low Cost Structures Manual. This was carried out to an initial but incomplete stage by the year 2000.

It is understood that the preliminary draft (herein referred to as Draft 1). was more extensive than originally envisaged and no agreement was reached on finalisation, publishing format and financing. Minor sections of text and sourcing of certain supporting photographs had still to be completed. Final text editing and formatting, and document review were also still required. At that time approaches were made, including by TRL, to try to secure funding to complete the document and publish the work, however these were not successful.

No further initiatives were taken relating to this document until a specific need for this category of knowledge was identified in SEACAP discussions with the Royal Government of Cambodia in connection with the priority rural transport needs. This review was subsequently included in the SEACAP 19 assignment.

## **3 DOCUMENT CURRENT STATUS**

The WEDC team that had compiled the preliminary Draft 1 document has since dispersed. However, appreciating the importance of the initial work, one of the team members and principal author; Paul Larcher, took the initiative to secure the copyright and to work the document into its current form suitable for review. This is referred to as Draft 2.

A copy of this Draft 2 of the Low Cost Structures Manual has been obtained for review by SEACAP 19 by agreement with the copyright holder.

## 4 DOCUMENT CURRENT FORMAT

### 4.1 Overview

The Low Cost Structures (LCS) Manual is a practical **planning, design, construction and maintenance** guide for LVRR small structures in developing countries and economies in transition. It has been designed to supplement the recognised available important document on medium sized structures: TRL Overseas Road Note 9, and the inspection guidance provided by Overseas Road Note 7. Although aimed primarily at those responsible for the design and construction of LVRR structures in developing countries, the information contained in the manual would be of interest to policy makers and others interested to promote the use of local resource based methods to achieve low cost, sustainable access and transport infrastructure for rural communities in developing countries.

### 4.2 Document Structure

Draft 2 of the LCS Manual consists of two volumes.

The first volume is in A4 format and contains the main body of text which provides extensive guidance on the use of a range of small structures. This volume consists of 178 pages. As well as the use of reinforced concrete, which is the commonly used material for rural road structures in developing countries, the document includes the use of alternative materials such as:-

- Un-reinforced concrete
- Stone and stone masonry
- Brick and block masonry
- Timber and organic materials

For reasons of local availability of materials and skills, these alternatives may provide more appropriate, affordable, economic or socially beneficial solutions to a specific structure location.

It is recognised that these alternatives are often not used in developing countries due to lack of available information on their use, and also importantly, that they are not accommodated by existing national standards and specifications. Therefore, even if there is an awareness and readiness to use the alternatives, there is usually no procedure or precedent to do so.

Therefore currently two constraints exist to the application of “Local Resource Based” methods to LVRR LCS provision, namely:

- Available Knowledge, and
- An “enabling” national application framework

The LCS Manual addresses the first knowledge constraint, and its review is the main focus of this Technical Paper 8. This document also comments on the issues to be tackled to create an enabling environment to disseminate and mainstream this valuable knowledge.

The contents list for Volume 1 of the draft LCS manual is shown in Figure 2. The second volume is in two parts: A3 standard drawings are provided for a range of small structures (21 drawings) along with the Bills of Quantities for these example structures. The contents list for Volume 2 is shown in Figure 3.

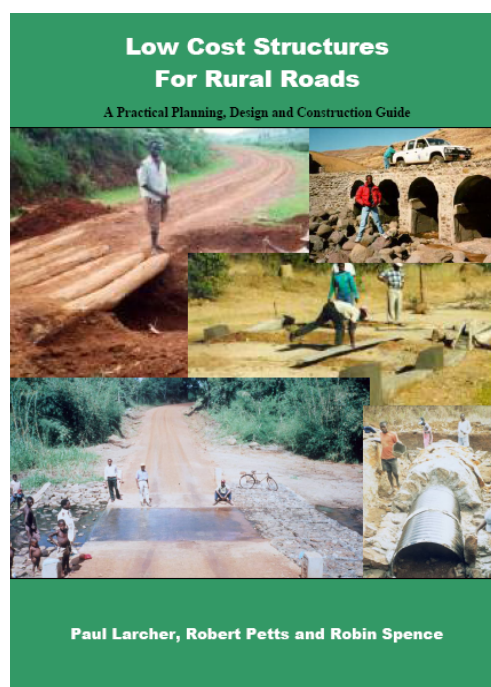


Figure 1: Draft 2 Manual Cover

## Low Cost Structures For Rural Roads

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**Figure 2: Draft 2 LCS Manual Volume 1 - Contents List**

DESIGN DRAWINGS AND BILL OF QUANTITIES

**Contents**

Introduction

How to use this manual

Design Drawings and Bills of Quantities

Bill of Quantities - Preliminary works

Drifts

1.1 Gabion drift

1.2 Pitched stone drift

1.3 Masonry stone drift

Culverts

2.1 Single pipe culvert

2.2 Alternative Culvert Arrangements: Twin barrel culvert

2.3 Alternative Culvert Arrangements: Drop inlet and cast insitu pipes

2.4 Box and slab culvert

2.5 Masonry arch culvert

Vented Fords

3.1 Vented ford

Large Bore Culverts

4.1 Large multi-bore culvert

Bridges

5.1 Gabion abutment

5.2 Masonry abutment

5.3 Masonry pier

5.4 Timber pier

5.5 Simple reinforced concrete deck

5.6 Sawn timber deck

5.7 Round timber deck

**Figure 3: Draft 2 LCS Manual Volume 2 - Contents List**

## 5 DOCUMENT REVIEW

### 5.1 Work carried out since WEDC compilation

Since the preparation of Draft 1 of the manual under the WEDC contract, the principal author has carried the work further on his own initiative to bring the document to a state suitable for peer review (Draft 2).

The principal tasks involved were:-

- Completion of draft final version text ready for editorial review
- Compilation and referencing of additional photographs
- Formatting and refining text
- Initial editing and proofing of text and drawings
- Electronic documentation

This work has involved more than one person-month of input.

### 5.2 Detailed comments Draft 2

Draft 2 has been completed to a stage ready for peer review. As part of this SEACAP 19 assignment detailed editorial review comments have been made on a pdf version of the draft manual, which is included on the CD accompanying this paper.

In addition to these detailed comments some general review observations are summarised in the following paragraphs.

#### *Volume 1*

The document comprehensively tackles the range of issues relevant to plan, design, construct and maintain a range of low cost structures using available local resources. The materials include:-

- Reinforced concrete
- Un-reinforced concrete
- Stone and stone masonry
- Brick and block masonry
- Timber and organic materials

It excludes specialist types or components of structures such as steel frame, lattice and Bailey bridges, and piling, on which there are judged to be adequate alternative guides available.

The focus is particularly on relatively simple technologies that are suitable for construction by local contractors and communities using local skilled and unskilled labour. Although it is aimed primarily at practitioners, there are relevant issues raised that should be of interest to anybody concerned about the provision of sustainable transport infrastructure.

The manual provides practical and concise information and step by step guidance on all aspects of the process from the planning through to the maintenance of LVRR structures. The detail provided relates to the complexity of the structure. Guidance is provided on all aspects of the design process, costing and sets out the requirements for effective management and maintenance of the completed structures.

The manual is both a practitioners' handbook and a basis to update existing national standards and specifications to include the improved and more sustainable use of local resources. This should substantially assist efforts to introduce more environmentally sound transport infrastructure solutions and support national employment and poverty alleviation initiatives.

The manual is logically set out with chapters covering each of the aspects as set out in Figure 4

Flow diagram of the planning, design and construction process

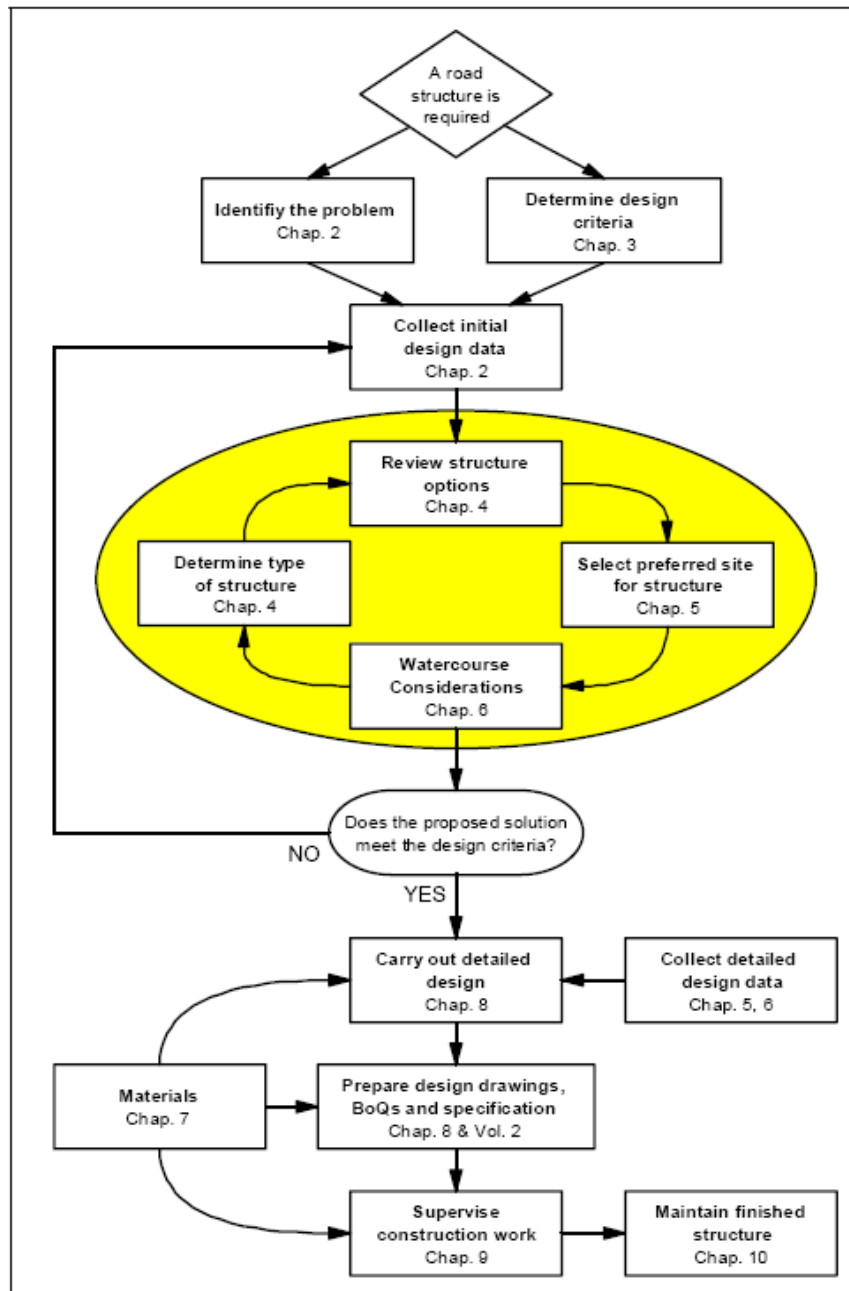
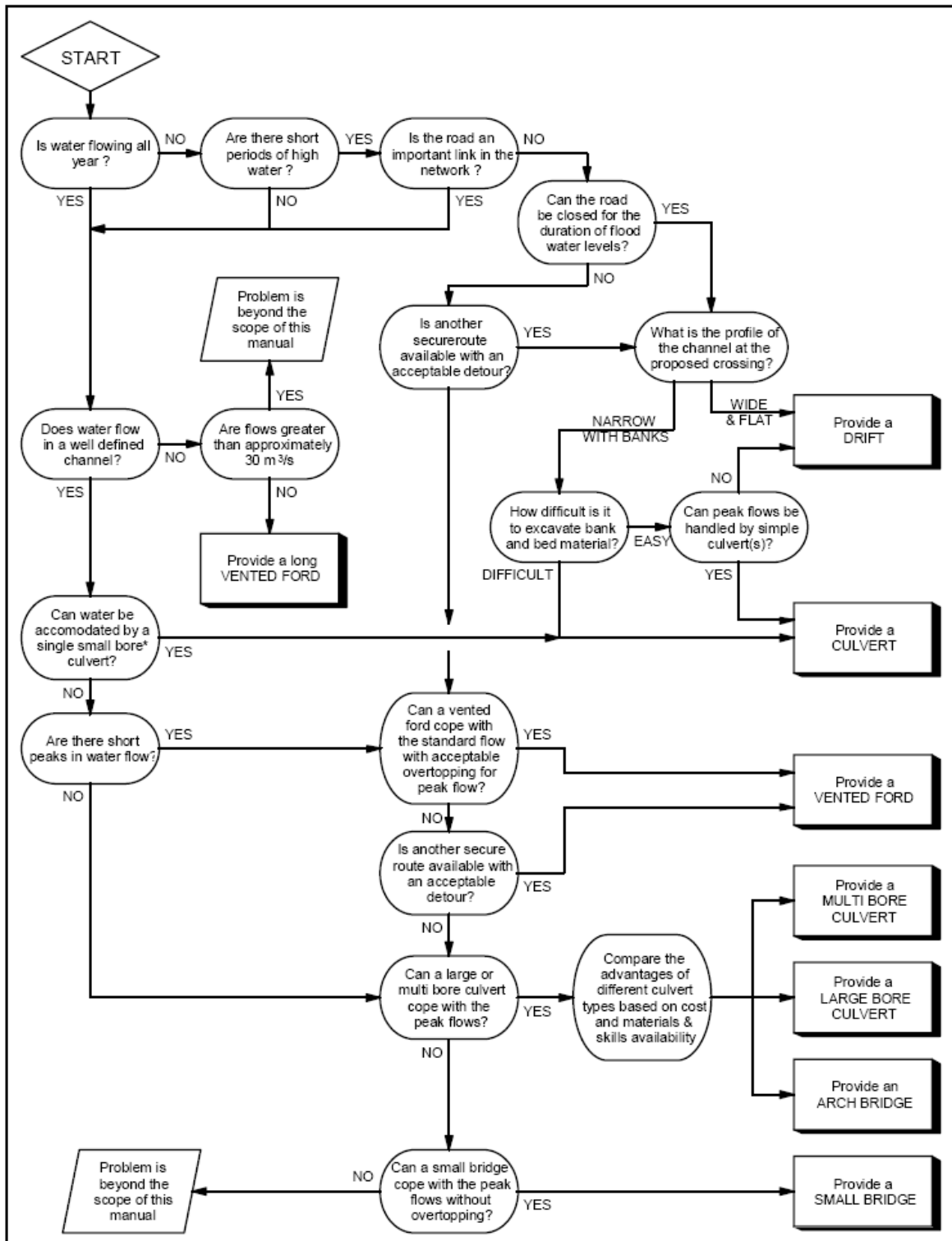


Figure 4 (extracted from Draft 2 of the manual)

The manual includes a ‘Route Map’ for the selection of the most appropriate type of structure, as shown in Figure 5

**'Route map' for the selection of a suitable structure**



\*Small bore – diameters less than 900mm

**Figure 5 (extracted from Draft 2 of the manual)**

*Volume 2*

Volume 2 of the draft manual contains sets of standard drawings and Bills of Quantities suitable for incorporation/adaptation into national guidelines or documentation.

The designs are based on extensive field experience and offer possibilities to reduce the design costs on commonly used structure types. The Bills of Quantities also provide useful ‘benchmark’ documents for adaptation for local practice.

### **5.3 Global Relevance**

The manual will fill an identified gap in the published knowledge for rural roads in developing countries. The important existing documents include Overseas Road Notes 9 and 7, which respectively provide guidance on the design and construction of small sized bridges and structures (principally constructed with reinforced concrete), and maintenance of bridges and road structures.

Until now the lack of a low cost structures manual has meant that choices of LVRR structures have been limited by local knowledge and experience. Structures designs have typically either been over-designed using limited and predominantly imported technologies and materials, or have been inadequately designed leading to damage and premature failure of expensive structures. The cost savings, economic and social benefits of the provision of appropriate low cost structures making best use of locally available resources has usually not been possible. It is probable that considerable savings in all LVRR infrastructure expenditures and Whole Life Costs could be made from the widespread application of the knowledge contained in this manual, with related improved levels of service and rural access, and benefits to the rural economy and poverty alleviation.

### **5.4 Cambodia Relevance**

The manual is particularly relevant to the environment of the Cambodia rural road sector. This is characterised by:-

- Severely under-developed rural road network
- Acute shortage of financial resources and technical skills
- Challenging physical environment including high rainfall, flooding, poor foundation conditions and shortage of construction materials in many areas
- Traditional ‘mainstream’ construction materials (cement and steel products) have to be imported making reinforced concrete construction methods expensive.
- Poor operational environment and lack of a functional maintenance regime

Effective dissemination and uptake of the manual in the Cambodian LVRR sector could provide substantial benefits in provision of lower cost and more sustainable road structures, and social benefits from the development of local skills, self sufficiency and employment in the rural areas. Improved rural infrastructure and levels of access would reduce local transport costs and boost the rural economy.

### **5.5 Editorial and Technical Review**

An editorial and technical review has been carried out as part of this assignment under the SEACAP 19 project. This has included:-

- Review, updating and editing the text and supporting knowledge
- Sourcing of additional material and photographs

Recommendations have also been prepared regarding further work required to be carried out to publish the manual and proposed complementary initiatives to support the dissemination and mainstreaming of this important knowledge.

## 6 RECOMMENDATIONS

The following activities are required to complete the existing Draft 2 manual to a Draft 3

- Incorporate comments of this review.
- Number and label all photographs, tables and figures.
- Prepare an index for the document.
- Secure funding for required further work.

The following is required to take Draft 3 to Edition 1

- Circulate the Draft 3 and invite comments from interested sector practitioners by internet and targeted selective distribution.
- Review and incorporate comments from consultative exercise into Draft 3 to become the first publishing Edition 1.
- Identify suitable publishing and distribution arrangements.
- Arrange for electronic posting of Edition 1 on gTKP and other selected websites for free downloading.
- Arrange for a limited print run of Edition 1 for dissemination to selected target audience.
- Support for dissemination and mainstreaming of Edition 1 through gTKP and other selected initiatives (launch events, promotion at selected sector events).

The estimated resources and costs of these initiatives are being advised separately to the SEACAP management.

Due to the substantial potential for application of the manual for the benefit of the Cambodia LVRR sector, the following actions are also recommended:-

- Discussion with MRD and sector development agencies with a view to trialling some of the manual's standard designs within existing or planned projects.
- Investigate the possibility of amending road sector specifications to accommodate the materials options and designs promoted by the manual.
- Develop educational/training material and incorporate the topic of the manual within the ITC<sup>1</sup> curricula.
- Organise a workshop under the auspices of CNCTP to launch the document in Cambodia.

Due to the large areas of Cambodia that have no hard stone construction materials resources (Lake basin and Mekong delta), a study of the potential for introducing brick structures and improvement of the local brick industry should be carried out. It is likely that the knowledge and experience of the vibrant burnt clay brick industry in Vietnam will be an important source of information to bring substantial benefits to the Cambodia LVRR sector.

Consideration should be given to possible further editions incorporating:-

- The results of any field trials and further relevant investigations or developments.

- Review and possible incorporation of the method of flood design outlined in the Annex 3.
- Develop soft ground piling advice for soft ground based on current Vietnam and Bangladesh practice.
- Develop a full detailed design example.