

LAO PEOPLE'S DEMOCRATIC REPUBLIC
PEACE INDEPENDENCE DEMOCRACY UNITY PROSPERITY

MCTPC - SEACAP 21 - DFID

**SLOPE STABILISATION TRIALS
ON ROUTE 13N
KASI – PHOU KHOUN – LUANG PRABANG
AND ROUTE 7
PHOU KHOUN – LUANG PRABANG/XIENG KHUANG BORDER**



MODULE 4 REPORT

SUBMITTED BY



in association with



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SEACAP 21 Slope Stabilisation Trials
Module 4 Report

INFORMATION DISSEMINATION

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LIST OF ABBREVIATIONS

ADB	Asian Development Bank
ASIST-ILO	Advisory Support, Information Services and Training – International Labour Organisation
BAC	Basic Access Component
CMC	Community Road Maintenance Committee
CRM	Community Road Model
DFID	Department for International Development
DPWT	Department of Public Works and Transport
ESCAP	Economic and Social Commission for Asia and the Pacific
LCG	Lao Consulting Group
LRD	Local Roads Division
LSRSP	Lao-Swedish Road Sector Project
MAF	Ministry of Agriculture and Forests
MCBRP	Microfinance Capacity Building and Research Programme
MCTPC	Ministry of Communication, Transport, Post and Construction, now MPWT
MPWT	Ministry of Public Works and Transport
NAFRI	National Agriculture and Forestry Research Institute
NAWACOP	National Watershed Conservation Project
OPWT	Office of Public Works and Transport
PBMC	Performance-Based Maintenance Contract
PMO	Project Management Office
P RTP	Participatory Rural Transport Planning
PTI	Public Works and Transportation Institute (of MPWT)
RAD	Road Administration Division
RMP	Road Maintenance Project
SEACAP	South East Asia Community Access Programme
SIDA	Swedish International Development Agency
SPT	Standard Penetration Test
TOR	Terms of Reference
UNDP	United Nations Development Programme
URI	Urban Research Institute (now PTI)
VMC	Village Maintenance Committee
WG	Weathering Grade

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SUMMARY

Information dissemination strategy

The strategy adopted by the project was to maximise the amount of relevant knowledge that could be disseminated through the course of the two-year project. This started with discussions on international best practices brought by the specialists on the team, but soon expanded as the early results began to emerge from the project's trials.

The information dissemination strategy was shaped by the terms of reference for the project and hence underlies this ("Module 4") component of the work that was commissioned. A range of different media were used to promote the knowledge that was both brought to and derived from the project's trials. The paragraphs below summarise these. The report itself is laid out under the same major headings and key supporting material is annexed.

Knowledge Exchange Workshop

The Knowledge Exchange Workshop was held early in the project's timetable and was intended to define a baseline of the information available in the Lao PDR regarding the stabilisation of slopes beside roads. To the local participants, it represented the first main technical introduction to the project's scope and intended trials. To the international specialists, it provided a good introduction to a number of resource people and documentary materials within Laos.

Training sessions

The scope of the project was too limited to allow for the creation of a formal training course, but a number of opportunities were taken to provide training to road sector personnel. These included seminars for staff of Provincial Departments of Public Works and Transport, and informative pre-bid meetings for contractors. There was also a considerable amount of training of counterpart staff on-the-job. Several opportunities were also taken for dissemination through participation in regional seminars in other countries, and in study tours to the project's trial sites.

Technical guidelines

Three main documents have been produced under this heading, as follows.

- *Slope Maintenance Site Handbook*: a practical guide for technical site staff.
- *Slope Maintenance Manual*: a Laos-specific guide to slope maintenance issues for the professional engineer.
- *Slope Maintenance Specifications*: contract-oriented technical specifications for all appropriate slope stabilisation and protection works.

Slope Maintenance Workshop

This was the final key event of the project, at which the specialists presented their conclusions from the trials. This was based around the iterative process of slope problem assessment and diagnosis, design of remedial measures, construction and subsequent long term maintenance. It aimed to put the international knowledge and findings from the trials into a format and context relevant to the Lao PDR's road network and administrative setting. Considerable discussion was generated, and this will have helped to inform decisions on the best way forward.

1. INFORMATION DISSEMINATION STRATEGY

1.1 Introduction

The stated task under this heading was to devise and implement an appropriate information dissemination strategy. From the beginning, this was seen as a key part of the project: there was clearly no purpose in conducting trials if the approach and results were not publicised widely through and beyond the road sector. The paragraphs below describe the strategy adopted by SEACAP 21, and the method by which it was implemented.

It should be noted from the outset that this report covers only the main SEACAP 21 project. It does not encompass the work of the additional SEACAP 21-002 project, the Feasibility Study for a National Programme to Manage Slope Stability. That had its own outputs and dissemination process, which both learnt from and contributed to the main project but was reported separately.

1.2 Strategy objective

The spreading of knowledge is a key aim of SEACAP 21. As stated by the terms of reference, “the research purpose of the project is to determine and disseminate best-practice appropriate road technologies, and to support sustainable ownership mechanisms for the construction and maintenance of rural roads”. The project’s objective is “to extend the present methodologies for the construction of rural access roads used locally, and in SE Asia generally, to cover problems related to land-slips on the mountainous roads in Lao PDR”. There is a requirement to produce specifications, guidelines, manuals etc to “influence activities for change in indicators of standard practice”.

The project was set up mainly to undertake a series of trials and disseminate the results. The scope of training was therefore highly limited, and could not, for example, extend to the provision of full trainers’ manuals, handouts and other lecture materials, or any substantial training course. From the beginning we anticipated producing a substantial technical manual, and using this as the basis for the final dissemination event (i.e. the slope stabilisation workshop).

1.3 Decision-making analysis to target project knowledge outputs

In the broad context, the material disseminated by SEACAP 21 must fit within the framework of the new Rural Transport Infrastructure Policy. This was being scrutinised by a committee in the MCTPC, but unfortunately was not released during the life of the project.

The practical management of roads, including maintenance, is administered through a Department of Public Works and Transport (DPWT) in each of the seventeen Provinces. Within the DPWT there are two Offices, to cover National and Provincial roads respectively. Responsibilities for District and Rural Roads are delegated to Offices of Public Works and Transport (OPWTs) in each District. It is the engineers in these tiers of the organisation, as well as among the consultants and contractors whose services they procure, that are the target groups for SEACAP 21’s knowledge outputs.

The project’s knowledge outputs should be linked as far as possible to the existing systems for managing the different categories of roads, since it is these processes that SEACAP 21 seeks to enhance. The paragraphs below therefore summarise the context of the decision-making undertaken by the people who form the target audience just described, in relation to roadside slope management.

At present the scope of road management only extends to roadside slopes when they fail (i.e. through emergency maintenance). The objective of the project’s material is to provide the MPWT with the tools it needs to include an element of preventative slope management in its maintenance strategy, thereby reducing the occurrence of failures that require emergency maintenance. However, because

many failures will not be detectable in advance, the tools must also cover the appropriate action to be taken in emergencies.

Maintenance of National roads is organised through the Road Management System (RMS). The yearly cycle of the RMS starts with a road condition survey and inventory on a 2- to 3-year cycle and is carried out by consultants engaged by MPWT, with support from the Public Works and Transportation Institute (PTI) and the Planning and Technical Division (PTD) of the central MPWT. Data collection is done in February and March, and entered into the system in April and May. However, separate arrangements are made for emergency maintenance, under a different budget. Before the rains, the RAD writes to the DPWTs, asking them to identify sections of road where problems are expected. The way that DPWTs undertake the assessment in response to this appears to vary from province to province, and to be somewhat ad hoc. Once replies are received from the DPWTs, bids are then invited, and contracts awarded, for contractors to provide a site presence and rapid emergency response on specified lengths of roads. If an emergency occurs, usually a landslide, then the contractor must clear it immediately and the actual quantities of debris shifted are estimated and agreed by the DPWT's and contractor's site engineers.

The maintenance of Provincial, District and Rural (Village) roads is organised through the Provincial Road Maintenance Management System (PRoMMS). The DPWT undertakes an annual condition survey and puts the resulting data into the program; this shows the current maintainable network and a long-list of works. It is submitted to the central LRD, along with a list of priorities; these priorities are generated automatically by PRoMMS, on the basis of "class lists" of seriousness of the different factors. The LRD checks the submissions and allocates the available national budget to a short-list for all 17 provinces. The short-lists are then sent back to the provinces for revision and detailed planning; these are then approved by the LRD. The provinces implement the works. Under this system, slope problems really enter only as a sub-set of "access constraints", but this small category in the program hides the potential complexity of resolution, which is where the SEACAP 21 project's manual can contribute. Assessment of a failing slope would also allow the DPWT to determine whether it qualifies for special treatment under the separate emergency maintenance fund that exists for Provincial and District roads.

An initiative of the Local Roads Division, supported by the Lao-Swedish Road Sector Project 3, is the development with the National University of Laos, of a rural road engineering curriculum. This is based on a combination of Lao and international best experience. Material derived from this project must either fit into the framework of the curriculum or must act as a complementary reference to it. The material that has been developed consists of fairly detailed notes on all the topics covered. These are in a form that could be used for handouts. There are module summary sheets that give objectives, further reading and other guidance for each sub-module, but those relating to the modules listed above are somewhat lacking in detail. In general, these courses offer very sound knowledge on rural road engineering and will certainly help the graduates to understand the overall processes of planning, designing, constructing and maintaining low cost rural roads. What it will not do is to produce specialists in any aspects of this process. It seems that the intention is for a large number of individuals to attend the courses so that they understand the broader picture, and then to specialise on the job, according to the role that they are assigned. Unfortunately this valuable piece of work therefore only has indirect benefit in the development of a national programme for managing slope stability in the road sector. This is because, at the level of understanding that is required, a relatively small number of specialists are needed, rather than general engineers with a broad perspective. While it will help to raise awareness of the issues, it will not in itself provide a means to resolving the current skills gap

1.3 On-the-job training

Training of counterpart staff

Counterpart Lao staff were trained on-the-job by the international consultants. This was carried out through semi-formal training sessions, as well as informally through coaching and mentoring in routine activities. Most of the individuals involved in this are from the local consultant partner

company, LCG. However, a counterpart officer assigned to the project from MPWT was also a key recipient of this training.

During the construction of the Phase 2 trials, arrangements were made for DPWT staff to be attached to the site supervision team, thereby broadening the training on-the-job.

This training covered all of the practical aspects of the project as far as innovative techniques being introduced, from site assessment, through design and implementation to post-construction monitoring.

Training of contractors

There were two main areas of training for contractors. One was in formal pre-bid meetings, where bidders for slope stabilisation works contracts were given a detailed explanation of the type of activities required by the project. The other was for the winning contractors, through on-the-job training by the site supervision team. This latter category followed the same semi-formal and informal procedures as used for the training of counterpart staff (see above), though obviously only covering the innovative techniques of implementation. In this respect the on-the-job training used a cascading arrangement, since the training of contractors' personnel was carried out by the Lao counterpart staff.

1.4 Knowledge Exchange Workshop

This is covered in section 2 below.

1.5 Seminars for the participating DPWTs

Meetings and seminars are held whenever the international specialists are visiting. An example of this was a one-day seminar given at Luang Prabang in December 2006. This was held partly in the DPWT office and partly on site, and included a hands-on bio-engineering exercise. Further liaisons of this nature were held whenever the opportunity arose; in practice the intermittent nature of specialist visits meant that it was restricted to about two events per year. The secondment of DPWT staff to the site supervision team in Phase 2 helped to enhance knowledge transfer to those organisations

1.6 Slope Stabilisation Workshop

This is covered in section 5 below.

2. KNOWLEDGE EXCHANGE WORKSHOP

The task here was to conduct a Knowledge Exchange Workshop at an early stage in the project to bring together the key stakeholders.

A Knowledge Exchange Workshop was held in the MCTPC Conference Room 1 on the morning of 30th January 2007 and attended by approximately 70 participants. The Workshop programme is shown in Figure 2-1.:

Figure 2-1: Programme of the Knowledge Exchange Workshop

Topic	Speaker
Registration	
Welcome	Laokham Sompheth (DDG DoR)
Introduction to the SEACAP Programme	Salter
SEACAP 21 – The Project in Detail	Hunt, Carruthers, Howell
Coffee Break	
Slope Stability in Mountainous Terrain	Hearn
Bio-engineering Techniques	Howell
Q & A	
Wrap up Comments and Closure	Laokham Sompheth (DDG DoR)
Buffet lunch	

Given that the purpose of the workshop was to describe the project and exchange views on the problems of slope stabilisation and remediation in Lao PDR, it was a success and provided a very useful forerunner for the workshops to be held later in the project. The discussion provoked several pertinent topics to be aired and provided a good opportunity for the team members to arrange further follow-up meetings.

However, a useful lesson learnt from this workshop was the problem of providing good simultaneous translation into Lao. This clearly required further thought. It was also felt that future workshops would need to be designed to allow for a longer discussion period.

3. TRAINING SESSIONS

This task was defined as ensuring that training sessions are conducted throughout all Modules. In the project Inception Report, we wrote that “For Module 4, the TOR require that ‘training sessions are conducted throughout all Modules for transferring knowledge at all hierarchical levels in the provinces’. Although we will endeavour to achieve this, we suggest that the main formal training emphasis be placed towards the end of the project when we have something to show and training manuals have been prepared. There will be, of course, a significant element of on-the-job training for the local consultant and Ministry personnel working with the international staff throughout the duration of the project.”

That, broadly, is how the training elements of the project have evolved. What was not foreseen at that time was the opportunities that would arise for broader dissemination outside the MPWT network. The paragraphs below record the main dissemination events through the two years of the project, in addition to the Knowledge Exchange Workshop (see section 2) and the Slope Maintenance Workshop (see section 5).

Seminar at Luang Prabang DPWT

A formal seminar was held at the Luang Prabang DPWT in December 2006, by both local and international staff of the project. Powerpoint presentations were made of the project’s work, and in particular of the Phase 1 trials. The low cost approach was explained and particular emphasis given to the use of bio-engineering by the project. Following the presentations, the event moved to field sites on Road 13 North, where the role of vegetation was explained. It finished with a short hands-on session to demonstrate the practical aspects of key bio-engineering works. Around twenty DPWT staff attended, and the event was held mainly in Lao, with the international specialist’s contributions translated.

Contractors' Pre-bid Meetings

Pre-bid meetings were held for contractors in February 2007 (for Phase 1) and October 2007 (for Phase 2). Special presentations were made by the project specialists in Lao, to explain the nature of the works that were being tendered. These were done in such a way as to share practical information, since it was obvious that in each event only one contractor would actually undertake the work, so that it was logical to make use of the time to transfer knowledge to the others.

Article in *Ground Engineering*

An article written by one of the project's international specialists, Dr. Gareth Hearn, was published in the April 2007 edition of *Ground Engineering* (see Annex B). This described the work that was being undertaken and helped to bring international recognition to the Lao road sector, in a journal that is widely circulated among sectoral professionals.

Presentation in Kathmandu, Nepal

The opportunity was taken on 20th December 2007 of one of the project's specialists visiting Kathmandu, to make a presentation on the project's activities and early findings. This was made at a seminar arranged by the Department of Roads, and attended by around 30 members of staff from that organisation and the local roads equivalent, the Department of Local Infrastructure Development and Agricultural Roads, other transport sector representatives and donor personnel. This helped to show to a regional neighbour how Laos is building up its capabilities in off-road maintenance.

National University of Laos Students' Visit

In February 2008, the project organised a study tour to a selection of its Phase 1 and Phase 2 sites for some 70 staff and students of the Department of Civil Engineering of the National University of Laos. A newspaper report of this event is given in Annex C. The project specialists described the works on site in both Lao and English, and generated discussions on the reasons for, and effectiveness of, the methods used. Feedback from the students' post-trip evaluation suggested that they felt it to have been very valuable to them.

Feasibility Study Workshops

The project's specialists were also involved in the SEACAP 21-002 Feasibility Study for a National Programme to Manage Slope Stability. There were two seminars, in April and May 2008 respectively, at which this was discussed. Because of the obvious overlap with the main SEACAP 21 project, the opportunity was taken to give examples of work and findings from the project's trials. This increased the exposure of the project among the MPWT's Provincial staff, as DPWT personnel from Attapeu, Khammouan and Luang Prabang, as well as others, were present on both occasions.

Phnom Penh Conference

The project's specialists assisted in the preparation of a paper entitled "Managing Slope Instability in using Civil and Bioengineering approaches in the Lao PDR". This was delivered by Mr Chanh Bouphalivanh, Director of the MPWT's Road Administration Division, at a Regional Workshop organised by the Institute of Technology of Cambodia on 18th and 19th August 2008. The theme of the workshop was "Natural Resources and Materials for Sustainable Development of ASEAN". A copy of the paper is given in Annex D.

SEACAP Practitioners' Meeting

The regional annual SEACAP Practitioners' Meeting is due to be held in Vientiane in November 2008, with an expected attendance of about 120 professionals. Two site visits to the SEACAP 21 trials are planned, one for foreign delegates and the other for Lao attendees.

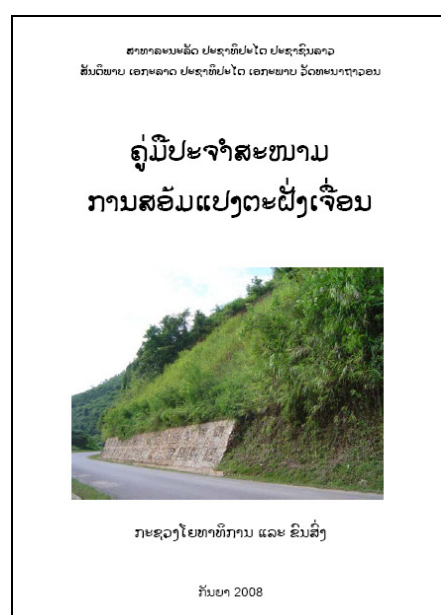
4. TECHNICAL GUIDELINES

The defined task here was to deliver a series of guidelines, design manuals and specifications evaluated in the earlier Modules. As the project evolved, it became clear that there were three main channels for the useful material that the project could generate that would assist the MPWT in the future. These are covered under the three sub-sections below.

4.1 Slope Maintenance Site Handbook

A key project output is the Slope Maintenance Site Handbook. This has been written in English but translated into Lao (see Figure 4-1). While it incorporates best practice from other countries, it was written entirely for the Lao setting. It is structured around the MPWT's Maintenance Activity Codes, which are the administrative basis for all on-road and roadside maintenance, rehabilitation and improvement works. The intention is that, by following this structure, it allows site staff to relate their work to the budget codes under which the expenditure is allocated, thus making direct links between practical tasks and the completion of official accounting formats.

Figure 4-1: Cover of the Lao edition of the Slope Maintenance Site Handbook



The topics covered by the handbook are shown in Figure 4-2. The first section lists the Maintenance Activity Codes (MAC) that are relevant to slope maintenance. The subsequent three main sections, which contain the main technical material, cover the three official maintenance categories of routine, emergency, and rehabilitation and improvement. Within each of these, the technical tasks and guidelines are laid out in sub-sections that are cross-referenced to the actual MACs in section 1. The final section contains simple formats for site inspections and quality checks.

**Figure 4-2: Contents list of the
Slope Maintenance Site Handbook**

1.	Definition of Maintenance for Slopes
1.1	Maintenance Activity Codes
1.2	Routine site inspections
1.3	Detailed site inspections
2.	Routine Maintenance of Slopes
2.1	Clear drains and culverts
2.2	Erosion
2.3	Wall repair
2.4	Drainage repair
2.5	Vegetation management
3.	Emergency Maintenance of Slopes
3.1	Safety
3.2	Removal of landslides
3.3	Temporary drainage measures
3.4	Embankment repairs and protection
4.	Rehabilitation and Improvement
4.1	Additional drainage
4.2	Construction of new walls
4.3	Erosion protection using structures
4.4	Erosion protection using vegetation
5.	Inspection Report Forms and Checklists

The Site Handbook is in A5 format and restricted to 33 pages. Its target audience is the technician level staff of the DPWTs, who are qualified to diploma level and are responsible for overseeing works implementation on site. It is amply illustrated with clear photographs, all from the Lao road sector, and the language and technical messages kept as simple and practical as possible. The English version will be published only as an electronic file, but the Lao version will be printed.

4.2 Slope Maintenance Manual

The Slope Maintenance Manual covers the subject matter in much greater depth than the Site Handbook. It is intended to be used by engineers with a reasonable degree of experience and at least a moderate understanding of slope processes. It has not been an easy document to produce, since the subject matter is extremely broad and it is difficult to draw the limits. We have avoided writing a complete text book on slope maintenance issues, but this has had to be achieved at the risk of it being taken out of context and criticised as being incomplete. The intention is to cover the subject in sufficient detail that it provides a practical reference work for the managing engineers, while not covering every eventuality. It is clear that particularly large and complex failures will always require specialist analysis, just as large bridges need specialist design, and would be outsourced by the MPWT for the foreseeable future. The manual therefore attempts to provide the guidance needed for MPWT staff in addressing the great majority of slope problems found in the road network.

The manual is structured around four main thematic sections, which together form an iterative approach to the subject. These are as follows.

- The nature, extent and causes of slope instability in the Lao road sector.
- How to assess the problems, diagnose the processes and identify a solution strategy.
- The approach to the design of the main geotechnical and bio-engineering structures that can be used in the majority of situations.
- The construction of the remedial measures.

In these respects the manual is complemented by the Site Handbook, which covers the practical aspects of slope and wall maintenance. This complements the Site Handbook in telling the engineer what he needs to know when making the decisions that underlie the implementation of the different stages (i.e. assessment, design and construction) that make up the process of maintenance in practice.

The contents of the Slope Maintenance Manual are given in Figure 4-3. As can be seen, there is considerable detail provided to ensure that the user is given ample help in understanding the nature

and scale of problems that he is facing. It ensures that the needs are assessed from the *drainage*, *stabilisation* and *protection* of the slopes, since these are the three essential elements under which slopes are engineered. Within each of these, the available options are explained, be they to do nothing, investigate further or move to a design. The section on design seeks to take the user through the somewhat bewildering range of options for roadside slopes, which are themselves infinitely variable, to come up with a reliable system to ensure that the slope problem is resolved. In doing so, it gives the main parameters for using different types of retaining wall for stabilisation, drainage systems and bio-engineering works for surface protection.

Figure 4-3: Contents list of the Slope Maintenance Manual

1. HOW TO USE THIS MANUAL	6. REMEDIAL WORKS - CONSTRUCTION
2. SLOPE INSTABILITY PROBLEMS	6.1 Safety
2.1 Soil/weathered rock slopes	6.2 Soil/weathered rock slopes
2.1.1 Instability above the road	6.2.1 Slip debris disposal
2.1.2 Instability below the road	6.2.2 Temporary drainage
2.1.3 Instability affecting the entire road bench	6.2.3 Cut slopes
2.1.4 Drainage	6.2.4 Fill slopes
2.1.5 Erosion	6.3 Wall Construction
2.2 Rock Slopes	6.4 Bio-engineering
2.3 Walls	6.4.1 Final slope preparation
3. INSPECTION AND INVESTIGATION	6.4.2 Preparation of bio-engineering materials
3.1 Factors affecting slope and wall stability	6.4.3 Planting work implementation
3.2 Routine Inspections of Roadside Slopes and Structures	APPENDIX A: SOURCES OF FURTHER INFORMATION
3.3 Detailed Site Inspections	APPENDIX B: EXAMPLES OF SLOPE STABILISATION
3.3.1 Introduction	B.1 Failures above the road
3.3.2 Detailed Site Inspection procedure	B.1.1 Failures in colluvium
3.3.3 Prioritisation by hazard and risk	B.1.2 Failures in residual soils/weathered rock
3.4 Geotechnical Ground Investigations	B.2 Failures below the road
3.4.1 Intermediate Ground Investigations	B.2.1 Failures in loose fill slopes
3.4.2 Detailed Ground Investigations	B.2.2 Failures in natural ground
3.5 Movement monitoring	B.3 Failures cutting through the entire road bench
4. DETERMINATION OF TREATMENT MEASURES	B.4 Wall failures
4.1 Determination of remedial treatment for slopes	APPENDIX C: SLOPE MAINTENANCE REPORT FORMS
4.2 Works prioritisation and cost	C.1 Landslide Report Form
4.3 Determination of remedial treatment for walls	C.2 Retaining Wall Report Form
4.4 Drainage improvements	APPENDIX D: LANDSLIDE MAPPING PROCEDURE
4.4.1 Cross drainage	APPENDIX E: TYPICAL DETAILS FOR SLOPE STABILISATION, DRAINAGE AND BIO-ENGINEERING WORKS
4.4.2 Roadside drainage	
4.4.3 Slope drainage	
4.5 River Training and Scour Protection	
4.6 Determination of bio-engineering techniques	
4.7 Rock slope stabilisation	
5. REMEDIAL WORKS - DESIGN	
5.1 Soil/Weathered Rock Slopes	
5.2 Gravity Walls	
5.2.1 Wall uses	
5.2.2 Wall types	
5.3 Other Walls	
5.5 Bio-engineering	
5.5.2 Selection of the appropriate plant species	
5.5.3 Timing of bio-engineering works	

The manual runs to approximately 80 pages and uses a standard A4 report format so that it can be easily reproduced. It is being published in an electronic English-language version, and in both electronic and printed formats in the Lao translation. The Lao cover is shown in Figure 4.4. It is important that this document be reviewed carefully by the MPWT so that it can be adopted for official use.

Figure 4-4: Cover of the Lao edition of the Slope Maintenance Manual



4.3 Technical Specifications for Slope Maintenance

The project has produced a complete set of technical specifications for slope stabilisation and protection works. These are based on international best practice, but were drafted to comply with other MPWT specifications, particularly those used by the World Bank-supported RMP-2, through which the actual trials contracts were financed. They were used in Phase 1 and modified in the light of experience, for Phase 2. There have been subsequent minor modifications to incorporate the lessons learnt.

Works contracts on projects part-financed by the World Bank are in English as the primary and legal language. However, it was felt that because the bio-engineering activities proposed under SEACAP 21 were completely new to the contractors, it would be helpful to have at least those specifications translated into Lao. This was therefore done for both the Phase 1 and Phase 2 bidding exercises. MPWT later requested that all of the project's specifications be translated, so that they form a better resource for future works contracting. This is thought to be the first time that a road sector project has produced a comprehensive set of technical specifications in Lao.

The actual subject matter covered by the specifications is shown in Figure 4-5. As can be seen, they cover all aspects of site preparation, construction and drainage of slopes, and protection works, mainly through bio-engineering. A strength of this set of specifications is that it has been tested through two complete cycles of site trials, and so it can be assumed that, while not perfect, they are sufficiently robust for regular use by the DPWTs.

Figure 4-5: Index of the Technical Specifications for Slope Maintenance

PART 1	CLEARING AND GRUBBING
PART 2	DEMOLITION
PART 3	STRUCTURAL EXCAVATION Excavation Backfilling
PART 4	GABION STRUCTURES Box Gabions Gabion Mattresses
PART 5	MASONRY STRUCTURES Mortared Stone Masonry Dry Stone Masonry
PART 6	SLOPE PROTECTION Loose Riprap Grouted Riprap Stone Masonry Hand Laid Embankment Reinforced Concrete Sprayed Concrete
PART 7	SLOPE PREPARATION FOR BIO-ENGINEERING Slope Trimming
PART 8	DISPOSAL OF SPOIL
PART 9	FREE DRAINING STRUCTURAL BACKFILL
PART 10	SUBSOIL DRAINS
PART 11	PIPE CULVERTS
PART 12	DITCH, APRON PROTECTION AND INLET AND OUTLET STRUCTURES
PART 13	FALSEWORK AND FORMWORK
PART 14	STEEL REINFORCEMENT
PART 15	STRUCTURAL CONCRETE
PART 16	SITE PLANTING AND SOWING Sowing with Grass Direct Sowing of Shrubs and Trees Planting of Grass Slips in Lines Planting of Shrub and Tree Seedlings Raised in Polythene Pots Brush Layering Live Check Dams Truncheon Cuttings Large Bamboo Planting
	ANNEX A: LIST OF APPROVED SPECIES FOR BIO-ENGINEERING

5. SLOPE MAINTENANCE WORKSHOP

The remit was to conduct a Slope Stabilisation Workshop in Vientiane at the end of the project. This took place at the MPWT conference centre on 26 September 2008, renamed slightly to take into account the institutional position of slope stabilisation and protection works under the MPWT's road management systems.

The timing and content of the workshop sessions were as shown in Figure 5-1. The intention was to design the workshop on a structure broadly similar to the Slope Maintenance Manual, so that it provided the participants with an iterative process. Having described the geographical setting for slope instability and explained the dynamics and causal factors, it covers the specialists' recommended approaches to scientific site assessment and problem diagnosis. This makes possible a logical prioritisation procedure for situations where there are too many slope problems to be covered adequately by the available resources. Once all this essential background decision making has been completed, the engineer can move on to design and construction. Maintenance then forms the over-arching theme, especially within the institutional establishment of MPWT, since it includes slope monitoring and response mechanisms, hence feeding back into the start of the process. The detailed presentations are provided on the internet via the SEACAP-INFO website, at:

<http://seacap-info.org/?mod=home&act=pdesc&pid=22>.

Figure 5-1: Programme of the Slope Maintenance Workshop

Time	Topic	Led by
0830 - 0900	Registration	
0900 – 0905	Welcome	Laokham Somphet
0905 - 0910	Workshop Programme	Tim Hunt
0910 – 0930	1. SEACAP 21 Project Outline	Tim Hunt
0930 – 0945	2. Laos – Geography	John Howell
0945 – 1000	3. Slope Instability	Tim Hunt
1000 – 1015	4. Causes of instability	John Howell
1015 – 1030	Coffee break	
1030 – 1100	5. Inspection and Investigation	Tim Hunt
1100 – 1115	6. Prioritisation	John Howell
1115 - 1200	7. Design	Tim Hunt
1200 – 1300	Lunch	
1300 – 1330	8. Construction	John Howell
1330 – 1400	9. Maintenance	Tim Hunt
1400 – 1415	10. Lessons learned	Tim Hunt
1415 - 1430	Coffee break	
1430 – 1530	Questions, answers and discussion	Laokham Somphet
1530 – 1545	Wrap-up comments and closure	Laokham Somphet

The workshop drew heavily on the experience gained from the SEACAP 21 trials throughout the technical sessions. All of the very numerous illustrations were from Laos, and mainly from these trials. To draw together the main lessons learnt, a special session was included to dwell on a number of key factors that were considered important by the specialists to bring into the debate since they should be used to help inform future directions in the MPWT's slope maintenance strategy. Finally, drawing on the experience of previous workshops, a significant time was allowed for discussion at the end, to ensure that it was possible to clarify uncertain matters and share the ideas that had been presented or brought by the participants.