Intech Associates
CONSULTING ENGINEERS

TRL

Department for International Development
SEACAP PROGRAMME

Rural Road Maintenance & Surfacing Discussion Paper

SEACAP 2
CAMBODIA Transport Mainstreaming Partnership
Phase 1

December 2005

Foreword

This document is based on a working paper first prepared in February 2003 as part of the Intech Associates input to the design phase of the World Bank Funded Provincial and Rural Infrastructure Project (PRIP).

It was the result of investigations of the current road maintenance situation and constraints identified at that time on the main and rural road networks.

Many of the conditions and constraint remain today, and the document is therefore considered an important reference for consideration and development of initiatives to achieve a cost effective, affordable and sustainable road maintenance system on both the rural road network.

The suggested starting point for the process is a thorough understanding of the current situation, condition of the network, traffic data and axle loading, financial and physical resources available, stakeholders, organisational capacity and constraints to performance.

Since the original document production, the severity of the vehicle overloading situation has come more into focus and the need to develop a coherent and workable Road Law[1]. The recommendations of the November 2004 MPWT and MRD joint workshop are included as an Appendix to this document.

Where appropriate, updating comments have been incorporated in this document.

The Recommendations of this document on Maintenance and the use of Gravel/laterite Surfacing are contained in Section 5.

This document is an output from projects funded by the UK Department for International Development (DFID) for the benefit of developing countries. The views expressed are not necessarily those of the DFID.

1 Proceedings of The National Workshop on Road Planning, Pavement Design & Overloading Prevention, 11th - 12th November 2004, MPWT and MRD.

TABLE OF CONTENTS

APPENDICES

ABBREVIATIONS AND ACRONYMS

ADB	Asian Development Bank
AFEO	Asian Federation of Engineering Organisations
ASEAN	Association of Southeast Asian Nations
AusAID	Australian Agency for International Aid
CFRTD	Cambodia Forum for Rural Transport Development
CNCTP	Cambodia National Community of Transport Practitioners
DFID	Department for International Development
DTW	A Mechanical Engineering NGO
EU	European Union
FAO	Food and Agriculture Organisation
FFW	Food For Work
GMSARN	Greater Mekong Sub-region Academic & Research Network
GTZ	German Agency for Technical Co-operation
HQ	Head Quarter
IFAD	International Funds for Agricultural Development
IFG	International Focus Group (for Rural Road Engineering)
IFRTD	International Forum for Rural Transport Development
ILO	International Labour Organisation
IRAP	Integrated Rural Accessibility Planning
IRD	Integrated Rural Development
ITST	Institute of Transport Science and Technology
JFPR	Japanese Fund for Poverty Reduction
JICA	Japanese International Co-operation Agency
LB	Labour Based
LBAT	Labour-Based Appropriate Technology
LBRIRMP	Labour-Based Rural Infrastructure Rehabilitation and Maintenance Project
MoF	Ministry of Finance
MoT	Ministry of Transport
MPWT	Ministry of Public Works and Transport (Cambodia)
MRD	Ministry of Rural Development (Cambodia)
NCP	National Community of Practitioners
NFG	National Focus Group (for Rural Road Engineering)
NGOs	Non-Governmental Organisations
NPA	Norwegian People's Aid
NPRD	National Programme to Rehabilitate and Develop Cambodia
NRDP	North-western Rural Development Project
ODA	Official Development Assistance
PDP	Provincial Development Programme
PDRD	Provincial Department of Rural Development
PIARC	World Road Association
PIP	Public Investment Programme
PLG	Partnership for Local Governance
PMU	Project Management Unit
PRASAC	Programme de Rehabilitation et d'Appui au Secteur Agricole du Cambodge

PRDC	Provincial Rural Development Committee
PRIP	Provincial and Rural Infrastructure Programme
RD&RP	Rural Development and Resettlement Project
RDS	Rural Development Structure
RGC	Royal Government of Cambodia
RIIP	Rural Infrastructure Improvement Project
RRGAP	The Rural Road Gravel Assessment Programme
RRSR	The Rural Road Surfacing Research
RRST	Rural Roads Surfacing Trials
RTI	Rural Transport Infrastructure
RT2	Rural Transport 2nd Project, Vietnam
SEACAP	South East Asia Community Access Programme
SEDP I	First Five-Year Socio-Economic Development Plan, 1996-2000
SEDP II	Second Five-Year Socio-Economic Development Plan, 2001-2005
SEILA	Multilateral Donors - Government Rural Infrastructure Development Programme
SIDA	Swedish International Development Agency
SWOT	Strengths, Weaknesses, Opportunities & Threats
TBA	To Be Assessed
TKP	Transport Knowledge Partnership
TMP	Transport Mainstreaming Partnership
ToR	Terms of Reference
TRIP	Tertiary Roads Improvement Project
TRL	Transport Research Laboratory
UN	United Nations
UNCDF	United Nations Capital Development Fund
UNDP	United Nations Development Programme
UNICEF	United Nations Children's Fund
VDC	Village Development Committee
WB	World Bank
WFP	World Food Programme
ZOPP	German acronym for Goal Orientated Project Planning

1 ROAD MAINTENANCE CONCEPTS

It is necessary at the outset of this discussion to define what is meant by maintenance. Unfortunately, in the past, it has been the practice in Cambodia to understand almost any works on the road network, including full reconstruction, as 'maintenance'.

What does correct maintenance actually involve? The following definitions are recommended for the Cambodian road network based on the PIARC International Road Maintenance Handbook (Reference 1).

Planned Maintenance involves works to correct defects and carry out repairs to the road and road structures in a timely way. Maintenance work can be categorized and prioritised as follows:-

Priority	Category	What is involved?
1.	EMERGENCY	Immediate reaction to events which sever access such as flood washouts – sometimes a temporary repair
2.	ROUTINE – BASIC	Vegetation control, maintenance of the drainage system, earth works and road surface – mostly labour-based and carried out as a regular operation annually
3.	ROUTINE – RESPONSIVE	Mechanical grading of earth and gravel roads, repair potholes and cracks in paved roads, and traffic signs and other road furniture – requires specific skills and equipment
4.	PERIODIC	Full re-gravelling or bitumen re-sealing, major repairs to structures

PLANNED and timely maintenance will minimise the deterioration of the road and help to prevent expensive rehabilitation works:-

"A stitch in time saves nine"

Preventive Maintenance involves limited investments in the network to improve access or serviceability of the route and reduce the future maintenance burden. This can include:-

1.	SPOT IMPROVEMENTS	These are small scale and very low cost, E.G. Install/ upgrade culverts/structures, or paving, sealing or reconstructing critical or problematic short sections (e.g. 100m in length)
2.	PREVENTIVE PERIODIC MAINTENANCE	These are higher cost activities, E.G. Armouring and bituminous sealing of gravel/laterite surfaces, or providing a low-maintenance surface to an gravel/laterite road

Rehabilitation or re-construction is usually the result of the FAILURE of the maintenance system.

2 AN APPRECIATION OF THE CURRENT MAINTENANCE SITUATION

Investigations have revealed the following information regarding maintenance of roads in the PRIP project area. These circumstances are believed to extend to most parts of the Cambodia road network.

2.1 Maintenance Funding

Funds have not been allocated on a sustainable, recurrent basis for national road maintenance by Ministry of Economy and Finance (MoEF) for National, Secondary National and Provincial category roads (responsibility MPWT). Funds allocated to the PDWTs for work on the network are against project bids, which are invariably for rehabilitation works.

A national fund has been set up based on increased fuel taxes in January 2002 to pay for road investment and maintenance. Disbursements from this fund were expected to commence in 2003. However, there are concerns that the lack of distinct separation of the roles of maintenance and rehabilitation will result in much of the fund being spent on rehabilitation to the detriment of sustainable maintenance efforts.

Also for Tertiary roads (MRD), no regular national maintenance budget has previously been available. Maintenance funds have only been provided on some donor funded projects, however these arrangements cease at some stage at or after completion of the projects. It is understood that MRD was to be allocated US$1.2 million for the year 2003; sufficient to cover routine maintenance only of the "maintainable" network, however insufficient for any realistic programme of periodic re-gravelling of the very substantial laterite road network.

2.2 Maintenance Situation

National and Provincial Road Conditions as of beginning of 2001	Total (Km)	Non-maintainable		Maintainable	
		Km	%	Km	%
National Roads	1,988	1,088	55	900	45
Other National Roads	2,177	2,027	93	150	7
Subtotal National Roads	4,165	3,115	75	1,050	25
Provincial Roads Region 1: Tourist Sector in Siem Reap, Preah Vihea, Kampong Thom provinces.	1,470	1,420	97	50	3
Provincial Roads Region 2: Industrial Sector, including the whole seashore of the country.	955	905	95	50	5
Provincial Roads Region 3: Agricultural Sector east of the Mekong River.	1,130	1,080	96	50	4
Subtotal Provincial Roads	3,555	3,405	96	150	4
Grand Total 2001	7,720	6,520	**84**	1,200	**16**

Table 2.1 – National and Provincial Road Length and Condition 2001, Source RTI overview

The situation regarding maintenance of the main road network is particularly poor by international standards, due principally to the political and economic problems of recent decades under the Khmer Rouge regime and associated conflicts.

Table 2.1 summarises the situation on the main road network in 2001, with only **16%** of roads maintainable.

The WSA[2] report on Maintenance Planning and management estimated the MPWT network to be much larger at 12,156km, with **28%** of the roads in excellent, good or fair condition (interpreted to be maintainable).

How much money is needed for REAL maintenance nationally?

For the maintainable MPWT national and provincial network, assumed[3] to be currently about 3,500km and an estimated average requirement of US$2,500/km/year, this amounts to more than **US$8 million per year**

For the approximately 3,500km of MRD rehabilitated laterite roads and an estimated average requirement of US$1,600/km/year, this amounts to more than **US$5 million per year**

These figures exclude emergency maintenance requirements.

2.3 Maintenance Arrangements

Funds are issued to the Provincial Departments of Works and Transport to carry out works on the main and secondary road network. However these funds are issued against bids for 'projects' that are usually essentially rehabilitation in nature. There are no effective routine arrangements for basic activities such as drainage maintenance, pothole patching, edge repairs and crack sealing.

There are ad hoc arrangements for the maintenance of certain sections of National road whereby a contract is made with a contractor to carry out maintenance work. However it has not been possible to obtain information on the funding or scope of this arrangement, or the documentation.

Certain projects under MRD included the funding and arrangements for the maintenance of project roads, as indicated in the following Table 2.2 (Year 2000 data).

The table indicates that for the 9,104km of roads rehabilitated to the end of the year 2000, maintenance funds and arrangements were in place for only 1,523km **(17%).** The completion of a number of projects (ILO Upstream and RIIP), mean that future maintenance funding and arrangements for tertiary roads will fall almost completely under the responsibility of the MoEF and MRD.

2 Study for Strengthening the Maintenance Planning & Management Capabilities at the MPWT, by Wilbur Smith Associates (WSA), Cambodia, July 2002,

3 Based on WSA estimates of the National situation of good and fair condition roads, 2002.

Table 2.2, below, illustrates the estimated length of tertiary roads and the length of roads that have been improved and are under MRD's responsibility for the present time[4].

NO	PROVINCE	POP	AREA (Km2)	ADB RIIP	KfW TRIP	ILO	MRD PAP	MRD PIP	PRIVATE	OTHER	WFP Laterite	TOTAL Laterite	WFP FFW	TOTAL (km)
1	Banteay Meanchey	577,300	6,679			116.7	9.5			333.3		459.5	556.6	1,016.1
2	Battambang	791,958	11,702			173.5	9.5			26.2	12.6	221.8	742.0	963.8
3	Kampot	527,904	4,873	85.3			21.8	5.5	27.0	10.4	66.5	216.5	315.1	531.6
4	Kandal	1,073,586	3,568	75.2		9.4		24.0	80.0			188.6	207.2	395.7
5	Kep	28,677	336					1.4	4.0			5.4	3.0	8.4
6	Kompong Cham	1,607,913	9,799	127.9	522.1			40.8	30.0			720.8	506.2	1,227.0
7	Kompong Chhnang	416,999	5,521		33.4		11.1	45.0			24.5	114.0	174.7	288.7
8	Kompong Speu	598,101	7,017				28.7	56.0	30.0	45.0	71.3	231.0	541.1	772.0
9	Kompong Thom	568,454	13,814		60.0		24.7				17.3	102.0	541.2	643.3
10	Koh Kong	131,912	11,160				3.7	15.1				18.8		18.8
11	Kratie	262,945	11,094		18.7			37.8	17.1			73.6	24.9	98.5
12	Mondulkiri	32,392	14,288									0.0		0.0
13	Odor Meanchey	68,836	6,158									0.0	65.0	65.0
14	Pailin	22,844	803									0.0		0.0
15	Phnom Penh	997,986	290						40.0			40.0	5.3	45.3
16	Preah Vihear	119,160	13,788								2.6	2.6	35.4	38.0
17	Prey Veng	945,129	4,883	79.2	54.2			81.8				215.2	675.4	890.6
18	Pursat	360,291	12,692			93.4	7.7	12.5		48.7		162.3	284.9	447.2
19	Rattanakriri	94,188	10,782									0.0		0.0
20	Siemreap	695,485	10,299			135.5				8.0	1.9	145.4	607.8	753.2
21	Sihanoukville	155,376	868						11.6			11.6	2.0	13.5
22	Stung Treng	80,978	11,092									0.0	69.0	69.0
23	Svay Rieng	478,099	2,966	70.6					45.0			115.6	242.5	358.1
24	Takeo	789,710	3,563	111.9		44.9		12.0	43.4		50.8	262.9	197.4	460.3
	(include Tonle Sap)		3,000											
	TOTAL	11,426,223	181,035	550.1	688.5	573.4	116.7	331.8	328.0	471.6	247.5	3,307.5	5,796.7	9,104.2
	Fund Available for Maintenance			530.5	688.5	145.0		0.0	0.0	0.0		1,363.9	159.2	1,523.2
	No Fund for Maintenance			19.6	0.0	428.4	116.7	331.8	328.0	471.6		1,943.5	5,637.5	7,581.0

Table 2.2 – Rural Roads that have been improved/rehabilitated.

4 Ministry of Rural Development, Rural Infrastructure Rehabilitation Program, December 2000.

Nearly all of the rehabilitated MRD roads are either earth or laterite surface. These are particularly susceptible to lack of maintenance. Rehabilitated Tertiary roads can be expected to deteriorate to an un-maintainable condition (requiring further reconstruction) in less than 5 years, without adequate maintenance funding and arrangements. The ADB-RIIP and ILO projects have been completed without effective follow up maintenance arrangements being put in place. Without early intervention on maintenance it is feared that these roads will deteriorate and require complete reconstruction.

Figure 1 – A donor funded project gravel road within 2 years of maintenance cessation (dry season and impassable by motor car!)

2.4 Resources for Road Maintenance

In discussions with the Provincial departments of Public Works and Rural Development it was discussed what equipment was available for works, including maintenance.

The road works equipment is of varying quality and age and does not constitute a working fleet suitable even for works supervision and force account emergency maintenance.

The manpower situation in the two ministries at HQ and provincial level and the private sector is weak (Reference 11).

The Provincial Departments of Rural Development have no road maintenance equipment.

2.5 Problem Analysis

Discussions were carried out with the Ministries HQ personnel and provincial staff in Siem Reap province; the best resourced of the PRIP provinces. In order to be able to develop appropriate interventions to achieve effective maintenance arrangements, it is necessary to appreciate the constraints that currently prevent this being achieved.

The World Bank itself has admitted:-

"The evidence is abundant that satisfactory basic *(maintenance)* systems can seldom be established in less than fifteen to twenty years and that help may still be needed thereafter to deal with expansions of maintenance workload and to avoid retrogression."

"*The Road Maintenance Problem and International Assistance, World Bank***"***, December 1981.*

It is also evident that road maintenance theories and systems have mainly been derived from More Developed Country circumstances and that it is often even problematic in those well resourced countries to translate the good intentions into reality. Rural poverty, severe financing and resourcing constraints, and unique physical and operating environment challenges make the establishment of effective rural road maintenance systems in Cambodia particularly difficult.

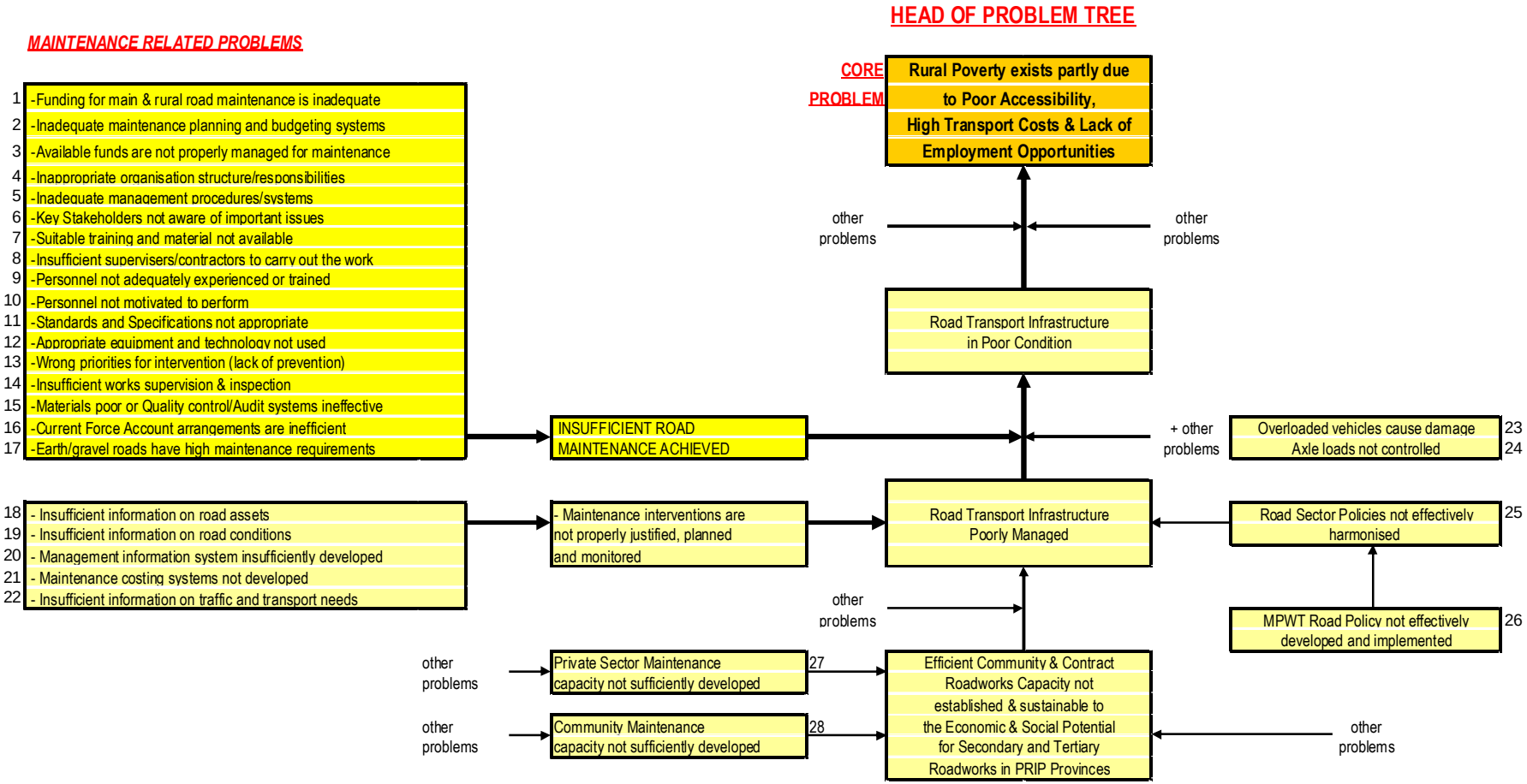
Despite the foregoing, if all of the problems currently afflicting the PRIP road network maintenance will be identified and tackled in a thorough, comprehensive and informed way, there is no reason why the object of an effective rural road maintenance system cannot be achieved within a reasonable timescale. However, the extent and complexity of the task must be fully appreciated. If any of the identified constraints are not tackled, then the efforts to improve the situation will be compromised and will have limited impact.

From the discussions carried out the following problem tree (Figure 2 following) was developed which, to varying degrees, applies to both the MPWT and MRD road network and responsibilities. The MRD is however more fortunate in that basic maintenance management systems appropriate for laterite gravel roads have been developed under ILO and RIIP programmes. Despite this, these require further development to be applicable for earth and other road surfaces and to manage the funds and resources in the coming environment of increased financial allocations for maintenance.

FIGURE 2 **PRIP RURAL TRANSPORT PROBLEM ANALYSIS**

Focussing on current Road Maintenance Constraints

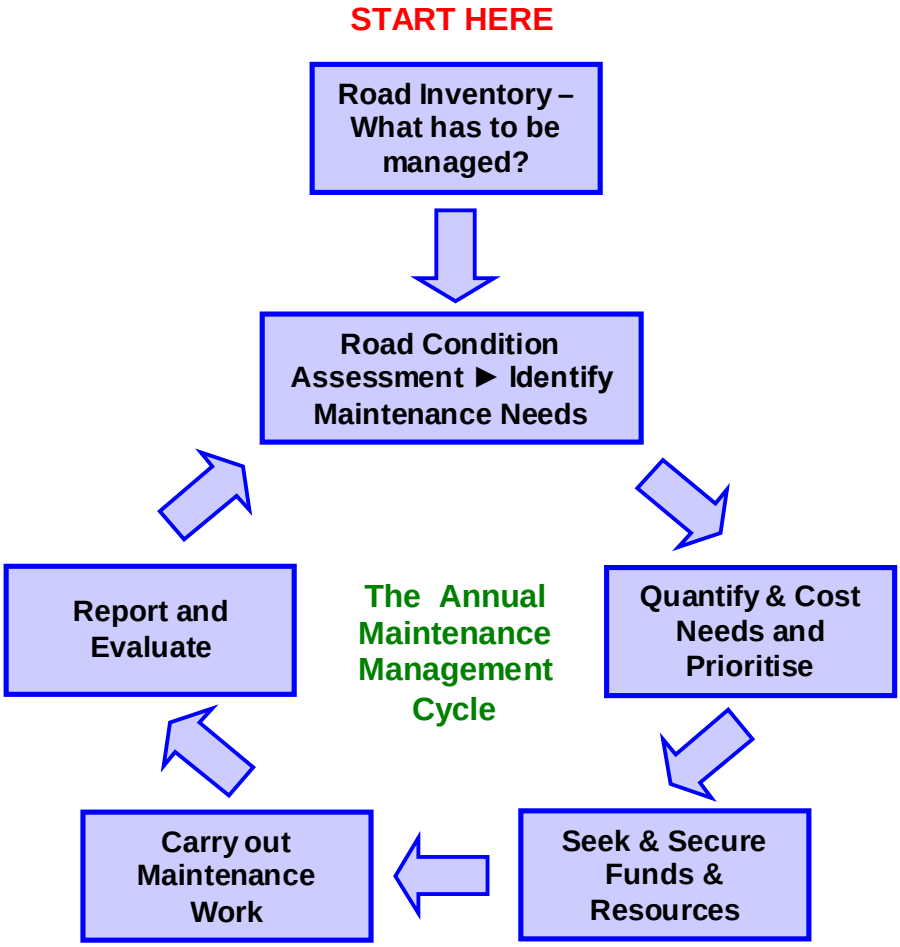
Key existing Problems have been identified and made into statements, then arranged into a 'tree' or 'root system' of 'cause & effect' relationships.
One particular problem may be caused by one or more other problems. A particular problem may occur at different locations in the 'tree'.
Understanding these relationships will help develop initiatives to overcome or reduce the impact of the problems.



Each identified problem should be tackled by a single or number of initiatives. Thereby problems will be overturned and positive contributions will be made to improve the current situation.
e.g. in the scenario of 'SUFFICIENT road maintenace achieved', that should contribute to 'Road Transport Infrastructure in GOOD condition'?

2.6 Road Maintenance Management – The Professional Approach

The diagram below indicates the main activities involved with Road Maintenance Management. The Technical Ministry Policy on Road Maintenance should provide the initial framework for developing an appropriate management system.



The maintenance management systems should be developed based on this initial and annual process. The maintenance management systems should be sufficient to meet the management needs and tailored to the realistic expected funding, resources, organisational and trained personnel situation. However they should be simple to understand and use.

It is not desirable to develop a maintenance management system based only on catering for project only roads. Maintenance systems must be developed suitable for the provincial roads administrations of both MPWT and MRD to apply to their entire provincial networks.

A number of initiatives have been taken to address the road maintenance management situation. These are described in the following sections.

2.7 Strengthening MPWT Road Maintenance Planning and Management Capabilities

A review of recommendations by the ADB Funded Study for Strengthening the Maintenance Planning & Management Capabilities at the MPWT, by Wilbur Smith Associates (WSA), Cambodia, July 2002, was carried out by the ILO team, with respect to applicability to the PRIP project implementation.

The review was carried out on the basis of the study final report documentation available at that time. However, it was not possible to consult with Wilbur Smith Associates (the authors). Furthermore, the computer based maintenance management system piloted by the consultants and recommended by them for adoption on a national basis was not available to be examined by the reviewers.

The key findings of the review are as follows. References are made to the problem tree (Figure 2) regarding constraints to be addressed:-

GENERAL - WSA recommended Maintenance Management software seemed suitable for use in the PRIP provinces (however this needs to be verified through test usage). *(The proposed system tackles Constraints 18 – 22)*. The WSA RMMS proposals need to be complemented with a substantial number of other initiatives for effective network implementation:-

a. **INSTITUTIONAL CAPACITY** – Existing capacity is weak. Further investigations are required to develop a range of workable initiatives for an improved and appropriate institutional capacity to support effective Maintenance Management (MM) systems. This work should be scheduled for pre- or early system implementation *(Constraints 2,3,4,5,6,7,8,9,10,14,15,16).*

b. **ADAPTION TO RESOURCE CONSTRAINTS** – Maintenance planning procedures have to be developed to adapt annual plans to needs and resources according to priorities that also need to be developed. Routine Maintenance should be a priority. Spot improvement strategies may be appropriate on some routes *(Constraints 1,2,20).*

c. **DETAILED CONDITION SURVEYS** – Survey strategy and detailed format need to be developed further *(Constraint 19).*

d. **PERFORMANCE AUDIT** – This important independent function should be developed either within the civil service or with local private sector input. *(Constraint 15.)*

e. **TRANSPARENCY** – It is recommended that the format and arrangements for a published (and freely available to stakeholders) Annual Report should be developed *(Constraints 1,5,6,10,15).*

f. **POLICY – MPWT** policy with regard to network management and maintenance must be developed as a framework reference to allow appropriate and effective further development of the maintenance management systems *(Constraints 25,26).*

g. **AXLE LOAD CONTROL** – Axle load control is currently ineffective. A policy and pragmatic strategy on axle loading including road design considerations and implications is required. Axle load surveys and review have been recommended before PRIP pavement designs are finalised *(Constraints 23,24,25,26).* This is closely allied to a need to update and develop an appropriate and workable **ROAD LAW**.

Figure 3 - Construction trucks are often grossly overloaded

h. **CAPACITY BUILD UP** - Increased funding flows should be matched to the improved capacity to manage them *(All constraints).*

g. **HDM4** - could be used as a maintenance planning and strategy tool (Constraints 1,2,3,6,11,13,17,26). However the data requirements, administration costs and sustainability issues of such a system make it difficult to justify for national network planning in a severely resource constrained environment such as Cambodia.

h. **FURTHER REVIEW OF DESIGN STANDARDS** – There are some key issues to be investigated and discussed that could help to reduce the maintenance burden (Constraints 11,12,13,15,17,23). There is potential to develop standards that make better use of the local resources such as labour and local materials.

Figure 4 - Some Main Road works are already labour intensive, however improvements are required in labour regulations (including safety) techniques and quality control.

i. **REHABILITATION versus MAINTENANCE** – The ILO recommended policy is consolidating maintenance on the maintainable network as a priority. This policy was not elucidated in the WSA report (Constraint 26).

These further suggested maintenance management system development requirements are substantial, however they are essential for an effective maintenance management system for MPWT roads. It was recommended that the necessary expert resources are provided to carry out this task.

2.8 MRD - RIIP Road Maintenance Arrangements

A Rural Road Maintenance Management manual was developed under the ADB funded Rural Infrastructure Improvement Project (RIIP)[5]. The maintenance management system is intended to be applied to gravel/laterite roads improved in the RIIP provinces.

The management system is paper based and includes the basic requirements of maintenance management:-

- Data collection
- Assessment of maintenance requirements
- Determination of priorities
- Preparation of cost estimates
- Planning maintenance works
- Maintenance implementation
- Contract management
- Reporting and monitoring

An assessment of the system identified the following improvements as being required for application to the PRIP roads to achieve effective maintenance management:-

- Maintenance of other surfaces besides laterite (engineered earth, alternative low maintenance surfaces),
- Preventive periodic maintenance justification (low cost sealing of certain gravel laterite routes rather than re-gravelling),
- Financial management including accommodation of different sources of funds and inputs,
- Need to computerise the basic data management functions,
- A standard road inventory data collection form to be designed,
- Establishment of objective but simple defect criteria for condition surveys,
- A standard road condition data collection form to be designed to identify routine maintenance deficiencies, need for periodic maintenance (such as re-gravelling) and any spot improvement requirements,
- Automatic conversion of maintenance needs into costed maintenance and spot improvement works quantities,
- Application of priorities,
- Presentation of works quantities within budget constraints,
- Justification of maintenance expenditures and advice regarding the consequences of funding shortfall on future resource and funding needs,
- Options for implementation including large contractors, small contractors, length-persons, community groups, voluntary labour (e.g. national road maintenance day inputs) with appropriate contract or agreement documentation,

5 I T Transport October 1999.

- Reporting and performance assessment system to determine effectiveness of the maintenance, including an annual public report.

The data processing functions could be computerised using linked Microsoft Excel spread sheets and Access database[6]. Alternatively a simple existing commercial package, such as that proposed by WSA for MPWT could possibly provide the basic functions, which could be tailored to the MRD requirements. The options need to be evaluated with samples of the available software.

A methodology is required for prioritising the routes in a province or district, so that the limited funds may be allocated accordingly. The ILO IRAP approach could be used. This approach would also benefit from the GIS based mapping developed by ILO.

Since the preparation of these recommendations ILO and Intech-TRL have developed proposals for a Transport Infrastructure Management System (TIMS) based on the development of the existing IRAP systems. (Appendix 2). It is proposed to develop such a system under the Planned SEACAP 19 initiative.

A report on Rural Road Maintenance Management[7] also identified the need for MRD to supplement the RIIP management system with improved guidelines on:-

- Preparation of contract packages,
- Preparation of contract documents,
- Standard procurement procedures,
- Supervision and certification of maintenance work,
- Monitoring the effectiveness of maintenance.

2.9 ROMAPS for MRD Road Network

ROMAPS is a computer based routine maintenance management system developed by Roughton International of UK. A presentation of the system was made to MRD in Phnom Penh in late 2002. Discussions were held with personnel involved in application of the system to summarise views on its applicability in Cambodia.

The system is well developed and comprehensive, suitable for application on a large road network or national basis. However it must be appreciated that for such a system to work cost-effectively, there are a number of pre-requisites. These are:-

- The **costs** of installing, operating and supporting/maintaining the system must be provided (establishment costs estimated[8] as more than US$70,000),
- **Funding** for the actual routine maintenance works should be guaranteed for at least about 50% of the maintainable road network needs a number of years ahead (i.e. on a sustainable basis), otherwise the management effort involved may be inefficient,
- The **costs** of carrying out the initial inventory survey and annual condition surveys (including staff, allowances and transport costs) should be guaranteed for the whole of the maintainable road network a number of years ahead (i.e. on a sustainable basis),

6 Preliminary system has been developed under ILO Upstream and requires refinement for wider application.

7 Rural Road Maintenance Management Issues, I T Transport for MRD, April 2002.

8 To include licence fee, computer equipment, 3 man-months TA

- The **personnel** for carrying out the surveys and managing the system data must be trained and employed (and retained) on a basis that motivates them sufficiently to perform,
- All **stakeholders** (provincial, technical ministry and Ministry of Finance) are convinced of the benefits and support the use of the system.

ROMAPS will effectively help an organisation to refine routine maintenance operations that are already reasonably established. In the situation where the awareness, support, funding, institutional, organisational and human resource situation is severely deficient, the sustainable benefits of investment in such a system at this time are questionable. The issues of emergency and periodic maintenance, and spot improvement management also need to be considered.

2.10 Cambodia 4th Forum for Rural Transport and Development meeting

The Fourth Cambodian Forum for Rural Transport and Development met in Kampot on 23 and 24 January 2003 to discuss the Topic of Sustainable Rural Road Maintenance. Some of the important recommendations to be made by the Forum meeting were:-

- Adopt the use of road surfaces other than gravel/laterite to reduce the maintenance burden (except where gravel laterite is available close by),
- Planned and justified maintenance funding should be forthcoming from MoEF on a regular basis,
- Mobilise additional funds from various other local and international sources,
- Develop effective funds management systems,
- Formalise ownership of sub-tertiary routes by the communities and agree responsibilities for maintenance,
- Develop partnership of communities and authorities in achieving maintenance,
- Utilise local resources: labour, contractors, materials, locally made equipment, wherever possible,
- Improve works quality control arrangements,
- Prioritise maintenance allocations according to physical needs, and social and access considerations,
- Prevent usage of the roads by oversize or overloaded vehicles,
- Organise public and stakeholder campaigns to raise awareness and develop publicity material (including posters) for road maintenance and to provide training,
- Institute a National day each year for community inputs on rural road maintenance activities (with support from other stakeholders).

2.11 MRD Maintenance Management Needs

The ILO suggested that a basic but comprehensive approach is required to the management of the MRD network in the immediate future. This should be to take the existing ILO and RIIP maintenance management systems and combine them to develop a common MRD system.

The system should be developed further in the aspects identified in sections 2.8 – 2.10.

These further development requirements are substantial in terms of expert resources required in the short term, however they are essential for an effective maintenance management system for MRD roads. It was recommended that resources be provided to carry out this task in the PRIP pre-implementation phase, or early in the PRIP implementation.

2.12 TIM Workshop, June 2005

A Transport Infrastructure Management Workshop was held in Phnom Penh under the auspices of CNCTP on 23 and 24 June 2005. The workshop was opened officially by the Deputy Prime Minister and Minister of Rural Development: H.E. Luy Lay Sreng. Participants from MPWT, MRD and other sector stakeholders contributed to presentations and discussions on development of effective rural road infrastructure management.

The workshop participants recommended the following initiatives to be taken regarding the development of a Road Transport Infrastructure Management Strategy/System (TIMS) in Cambodia:

- **Planning:** this should involved data collection with close collaboration with Communes. The current constraint at planning stage is to develop Village Development Committee (VDC) capacity (60% of villages have VDC).

- **Budgeting**
  - MRD must develop clear strategy for allocating Maintenance funds.
  - Any new MRD Maintenance Management System initiatives should be compatible with a TIMS approach.

- **Implementation**
  - MRD should have appropriate road standards and specifications.
  - Promote and support local contractors.
  - Promot LBAT where suitable and cost effective for employment creation.

- **Maintenance Options and Arrangements**
  - Length person, large and small contractor (payment systems to be refined).
  - Encourage participation from charities, Monks, villagers.
  - Encourage equitable voluntary contributions of labour or material in appropriate circumstances.
  - Restrict access to heavy vehicles (Close roads during wet periods and have an effective axle loading control mechanism).
  - Promote road ownership and community participation
  - Promote contributions and toll collection for road maintenance if transparent and cost-effective.
  - Decentralise road management to Community Level.
  - Investigate alternative sustainable pavements (higher initial cost/less maintenance burden)
  - Expand surfacing trials and disseminate to other provinces.

3 RECOMMENDATIONS ON THE FUTURE MAINTENANCE ARRANGEMENTS

These proposals were developed under the ILO PRIP preparation project. The views expressed in this section are merely those of consultants and not necessarily the views of MPWT, MRD or the Royal Government of Cambodia.

3.1 MPWT Emergency Maintenance

This section deals with the recommended arrangements for Emergency Maintenance of PDWT roads.

i WHAT DOES EMERGENCY MAINTENANCE ACTUALLY INVOLVE?

For the Provincial Departments of Public Works and Transport these activities should include:-

- Minor Repair of bridge structures caused by erosion, flooding or vehicle damage (Bailey, reinforced concrete or timber bridges),
- Repair or replacement of failed, collapsed or washed out culverts
- Repair flood inundation, erosion or failure damage to road embankment and pavement,
- Remove and repair landslide damage
- Temporary repair to road potholes or craters pending permanent repair
- Creating temporary traffic diversions routes for any of the foregoing incidents.

Figures 5 and 6
Typical Emergency Works Situations - Photographs Intech Associates and Intech Beusch

ii NEED FOR INSTANT AND EFFECTIVE RESPONSE

By its nature, emergency maintenance is unpredictable and can be required at any time on the network when traffic passage is severed or endangered.

There are particular circumstances of the Cambodia main road network that require a specific and tailored response to the emergency maintenance needs. These are:-

- The weak subgrade soils in many locations, the heavy wet season rainfall intensity, the annual flooding and vehicle overloading, cause frequent route severances and need for emergency repairs which require an instant response from the Provincial

administrations,

- The road network is poorly developed (about 75% having been lost during the years of conflict). There are usually no all-weather alternative routes for situations of main road route severance, making an instant response to any severances vital.
- It is necessary to have a skilled, professional and experienced team to tackle the emergency works quickly, effectively and safely (both for workers and road users).
- Specific skills are required, such as the assembly, repair and dismantling of some of the numerous Bailey and timber bridges, and paving repairs.

iii FORCE ACCOUNT OR CONTRACTOR APPROACH?

Considerations regarding the Current PDWT **force account** arrangements include:-

- Most PDWT departments have existing manpower (which is under-utilised),
- It would take time (and resources) to disband the existing force account arrangements,
- It is desirable for the PDWT to have an operational unit so that productivity and cost data can be analysed and compared to private sector arrangements,
- The PDWT could keep and manage a stock of Bailey Bridge parts and timber bridge components for response to emergency needs.

Effective **contractor** arrangements for emergency works are currently difficult to achieve for the current Cambodian main road network situation because:-

- The local contracting industry is poorly developed,
- Contracting capability in the provinces is very limited,
- The local contracting market is often severely distorted affecting pricing,
- Contract documents and arrangements for emergency works are not developed and it would be difficult to develop a contract framework to effectively deal with the range and sporadic occurrence of these works in a cost-effective way,
- Existing competent contractors are usually fully utilised on rehabilitation works,
- Contractor's continuity of the necessary skills and experience cannot be guaranteed,
- Funds availability and cashflow and contract administration problems may delay response to emergencies,
- All of the funds for an emergency works job would need to be available before a contractor could be mobilised, whereas, for a force account unit the equipment and personnel are already paid for and only minimal funds for operating costs have to be available,
- There is potential for contract disputes that would cause delays or the effectiveness of the emergency works.

iv STRENGTHEN PDWT FORCE ACCOUNT CAPACITY

Notwithstanding the above Contractor constraints for emergency works, there are a number of existing constraints to the Force Account system for emergency works arrangements that need to be tackled effectively. These are:-

- The nature of emergency works means that for substantial periods of the year the emergency works unit would be idle. Therefore other activities should be planned and scheduled to be carried out in between emergency works activities. It is recommended that the unit use their same skills and resources to carry out spot gravelling or other spot improvement works.
- Specific budget, accounting, reporting and performance auditing procedures must be developed for both the emergency works and the spot improvement works.

Planning, reporting and auditing procedures should minimise the opportunities for resources to be diverted to unauthorised activities, and to ensure that satisfactory performance is attained. Cost recording and awareness need to be improved,

- The WSA report on Maintenance Planning and Management identified the constraint of poor remuneration of MPWT personnel. The report proposed salary increases that are difficult to justify and deliver. However, the possibility of developing a new salary and career structure associated with **performance** related allowances is feasible under the recommendations of the Strategy to Rationalise the Civil Service 2002 – 2006[9] and Sub Decree 83 ANK/BK[10] regarding Priority Mission Group remuneration. Performance related allowances should be considered for every day that field works are carried out **and** targets are met. Allowances should also reflect the costs of working away from the unit base (e.g. lunch allowances). A cost benefit analysis should be able to demonstrate the effectiveness of such a strategy working within the government civil service employment framework,
- The necessary physical resources for each provincial emergency maintenance unit need to be provided.
- A budget line needs to be established for the emergency maintenance unit.
- A budget item and funds for the timely replacement of the emergency unit equipment also needs to be provided,
- Bailey and timber bridges that are dismantled from road rehabilitation projects should be stockpiled at PDWT depots for emergency and spot improvement works. Adequate numbers of key spares should be ensured and the necessary tools and equipment for building, repairing and dismantling should be provided,
- Training in damage assessment, works operations, quality assurance, traffic management and safety is required for the emergency unit staff according to their duties and responsibilities.

These Force account constraints are seen to be much easier to address than the constraints to the contractor approach. It is proposed that MPWT tackle these constraints effectively, and use a force account approach to deal with emergency works for at least the medium term.

Expert inputs are recommended to help MPWT develop these arrangements.

v MRD Emergency Maintenance Arrangements

There is also a requirement for emergency maintenance response on MRD tertiary and sub-tertiary roads in the provinces. To avoid duplication of resources in a constrained environment, it is proposed that the PDWT be capable of meeting emergency maintenance needs of both organisations. However, to ensure effective control of such an arrangement it is recommended that the budget for the operational costs of tertiary roads emergency maintenance is controlled by MRD/PDRD. In this way the emergency resources allocated for rural roads would not be diverted to main roads. PDWT could be appointed to carry out the emergency works under a performance contract arrangement, with funds released for agreed works.

MRD/PDRD should also retain the option of appointing contractors on an ad hoc basis for carrying out tasks such as replacing standard culverts that have been damaged or failed. MRD/PDRD could also issue variation orders on contracts already in progress for such works with suitable costs included for mobilisation etc. within the vicinity. This approach has been developed under the ILO Upstream project and demonstrated as a viable option during the response 2000 flood damage.

9 Council for Administrative Reform January 2003.
10 Signed August 2002.

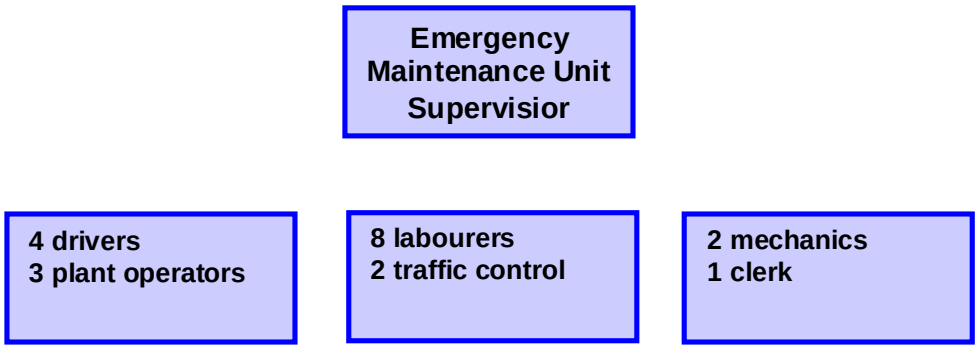
MRD contract documents should include provision for these contingencies.

Expert inputs are recommended to help MRD develop these arrangements.

vi PROPOSED ORGANISATION AND RESOURCING OF PDWT EMERGENCY MAINTENANCE UNITS

The proposed organisational structure of a typical PDWT Emergency Maintenance Unit is illustrated in the following diagram.

Proposed Provincial Emergency Maintenance Unit Organisational Structure



The recommended tools and equipment inventory of a typical PDWT Emergency Maintenance Unit is illustrated in the following table.

Figure 7 - Proposed Provincial Emergency Maintenance Unit Equipment Inventory

EQUIPMENT ITEM	NUMBER	COST NEW (US$)
10 tonne tipper truck	2	TBA
10 tonne flatbed truck with hydraulic lift arm and detachable loading ramps	1	TBA
10 tonne water tanker truck	1	TBA
70hp (52kW) wheeled backhoe loader	1	TBA
5 tonne twin-drum vibro-roller	1	TBA
Towed bitumen heater-sprayer	1	TBA
4WD double cab pick-up	1	TBA
125 cc motorcycle	2	TBA
Portable water pump	2	TBA
Vibrating plate compactor	2	TBA
Portable generator and safety lights	1 set	TBA
Spares for Bailey Bridges	-	10,000
Miscellaneous small tools, safety equipment and temporary road signs	-	10,000
	TOTAL	TBA

Note: the trucks should be the same manufacturer and model established on the local market to ensure ease of spares procurement and maintenance.
The other items should also have spares available on the local market

3.2 Routine and Periodic Maintenance

The ILO Upstream Project successfully carried out routine maintenance of gravel/laterite roads by small scale contractors from September 1999. Periodic maintenance re-gravelling was carried by contract since 2000 until the project completion.

These positive experiences demonstrate the viability and low cost of such an approach.

It is recommended that this contracting approach be extended to the gravel/laterite road maintenance on the PDWT and PDRD networks.

For the bitumen sealed roads rehabilitated under project initiatives, the off-pavement maintenance may be organised in the same way. Pavement maintenance should not be expected to be required in any significant amount in the 5 years after construction. However a small contractor capacity needs to be developed during the construction project implementation period to cater for this need after the completion of the project.

To address this future requirement and develop capacity in good time, and also deal with bad roads not included in any ongoing project, it is proposed to provide training and small contracts for bitumen paved roads to carry out pothole repairs, crack sealing, edge repairs, shoulder repairs and labour based spot rehabilitation of bitumen paved roads.

3.3 Funding Justification and Allocation

The following priorities are recommended for allocation of the available resource for network maintenance. This is based on international guidelines and economic justification.

Budgeting should be based on planned allocations from the forward budgets (3-5 years). Simple economic analysis will enable the consequences of various levels of funding to assessed regarding future road conditions, maintenance burden and rehabilitation requirements. This should form an integral component of annual and forward budget submissions to MoEF.

SUGGESTED PRIORITIES FOR ALLOCATION OF AVAILABLE ROAD MAINTENANCE RESOURCES		
Priority	**Category**	**Road Type**
1.	EMERGENCY	Core Maintainable Network
2.	ROUTINE	Core Maintainable Network
3.	EMERGENCY	Rest of Network to maintain basic access
4.	SPOT IMPROVEMENT[11]	Core Maintainable Network when insufficient funds for full Periodic Maintenance and to reduce future maintenance burden
5.	PERIODIC	Core Maintainable network
6.	PREVENTIVE PERIODIC[12]	Core Maintainable network, to reduce future maintenance burden
7.	SPOT IMPROVEMENT	Rest of network to bring it to maintainable standard

3.4 Use of Gravel/Laterite

Recent research on rural road gravel performance in Vietnam is particularly relevant to Cambodia, which suffers similar problems regarding the use of gravel/laterite as a road surfacing material.

DFID and World Bank are funding the Ministry of Transport (MoT) Second Rural Transport Project (RT2) in Vietnam that is providing basic access roads for communities in 40 provinces of Vietnam (2001 – 2006). Gravel has been the surface usually provided for the project roads. Because of increasing recognition that gravel surfacing is not always the best solution for rural roads in all circumstances in Vietnam, the Government of Vietnam MoT requested studies of alternative surfacings for Rural (District and Commune) Roads in Vietnam under the World Bank and DFID RT2 support. The Rural Road Surfacing Trials (RRST) were planned and are currently being implemented. Subsequently, DFID agreed to fund a scoping study by Intech-TRL within the existing Rural Road Surfacing Research Programme. This sub-study researched the viability of undertaking a national gravel surface performance study in Vietnam; developed appropriate methodologies for the work and proposed a general framework for the Rural Road Gravel Assessment Programme (RRGAP).

The RRGAP Scoping Study revealed that although gravel has been the commonly recommended surfacing in recent rural road rehabilitation programmes, there is little available data on its engineering performance and deterioration. It is evident that Vietnam experiences conditions outside of the envelope of researched knowledge with regard to factors influencing gravel surface performance, compared to most developing countries. In the light of increasing speculation as to the long term cost-effectiveness of gravel surfacing in

11 e.g. spot regravelling or sealing of problem sections.
12 e.g. armouring and sealing of laterite instead of simply re-gravelling

many locations in Vietnam, this knowledge gap is one that requires urgent attention and which has been addressed by the main RRGAP research.

The main RRGAP investigations, carried out by Intech-TRL at 766 road sites, found serious constraints to the use of gravel in most of the studied 16 programme provinces due to factors relating to material quality, material availability, climate, terrain, drainage provision and maintenance. Overall gravel loss figures indicate that around **58%** of the surveyed sites are suffering unsustainable deterioration, while **28%** are losing material at twice the sustainable rate (Figure 8).

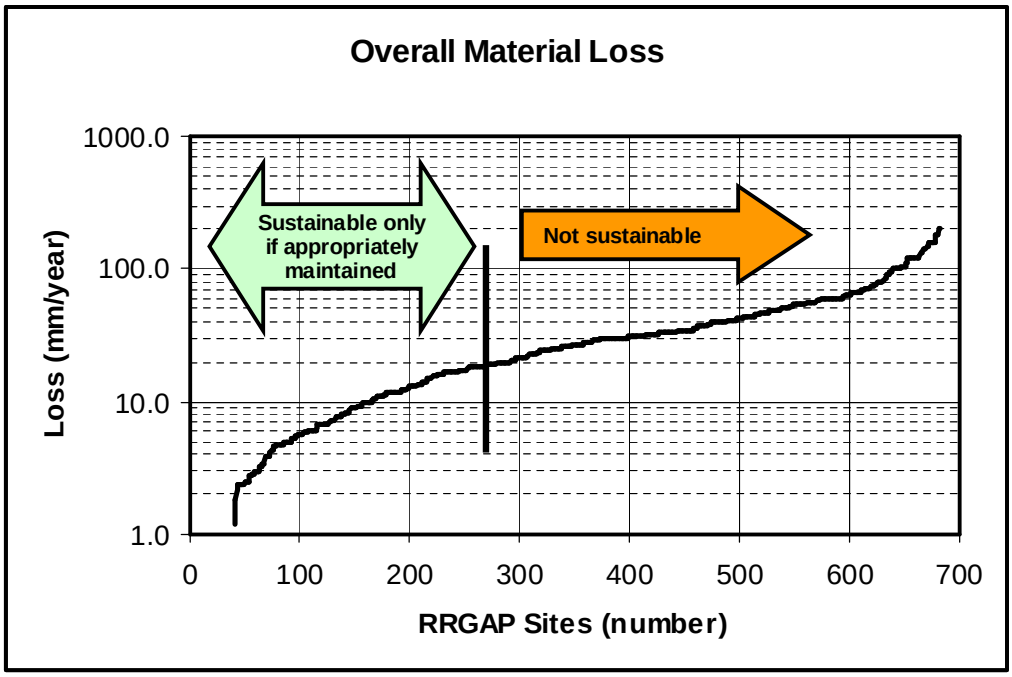


Figure 8 - RRGAP investigations of Annual Gravel Loss on over 700 roads sections

From the RRGAP investigations, and consideration of other complementary research and knowledge of the performance of gravel roads elsewhere, the following guidelines are proposed for the restriction and use of gravel as a rural road surfacing in the range of conditions experienced in Vietnam:-

It is recommended that the use of gravel as a rural road surface in Vietnam be restricted as follows:-

1. Rainfall and longitudinal gradient:
   - Rainfall < 1,000mm/year : restrict use of gravel to road gradients < 6%
   - Rainfall 1,000 – 2,000mm/year : restrict use of gravel to road gradients < 4%
   - Rainfall > 2,000mm/year: do not use gravel – material loss and erosion are likely to be unsustainable.
2. Materials Haulage

   If the materials haulage distance from source to road site is more than 10km, a detailed infrastructure initial and maintenance cost (whole life cost) comparison of gravel and other technically feasible surface options should be carried out. Furthermore, road user costs, and socio-economic consequences that are currently more difficult to measure, such as dry weather dust emissions, local resource use relating to community benefits (employment etc.) and environmental resource consumption factors, should be included in the surface consideration and decision process.

3. Traffic

Gravel should not be used for roads with traffic expected to be higher than 200 (4 wheel) motor vehicles per day. For expected motor traffic levels of more than the equivalent of 100 motor vpd, a whole life cost evaluation of gravel and other technically feasible surface options should be carried out.

4. Flooding

Gravel should not be used on roads liable to regular or occasional flooding.

The following arrangements should be assured to allow any justifiable use of gravel to be cost affective and sustainable:-

5. Quality Control

There should be improved and adequate testing and quality control arrangements and funding in place to approve gravel material sources, and confirm availability of the necessary quantities for both construction and maintenance needs. Furthermore sufficient material testing must be arranged to ensure that the material placed on site conforms to the specifications and contract requirements, and will not deteriorate under traffic.

6. Drainage

There must be adequate provision in the construction and maintenance of the gravel surface to keep the surface crossfall within the serviceable range of 3 – 7 % to ensure drainage of the rainfall from the road surface. This can be achieved either by mechanical grading or manual reshaping (see Figure 9). Soil surfaced shoulders should not be constructed for gravel roads as this risks contamination of the gravel road surface during grading operations, or the trapping of surface water on the road surface as the gravel surface wears down. Shoulders must freely drain away from the road surface, and effective side and turn out drainage must be provided throughout the length of gravel surfaced road, and be maintainable.

Figure 9 - ENGINEERED NATURAL SURFACES: Maintainable using simple locally made equipment

7. Maintenance

There should be adequate arrangements in place to fund and organise the ongoing routine maintenance of the road, particularly the gravel surface, and the periodic maintenance regravelling to restore the material lost due to traffic and rainfall effects.

Discussions of all of these issues are contained in the study Final document (Reference 12).

Application of the RRGAP recommended guidelines will substantially reduce the future use of gravel rural road surfacing in Vietnam, in favour of increased use of other surface types.

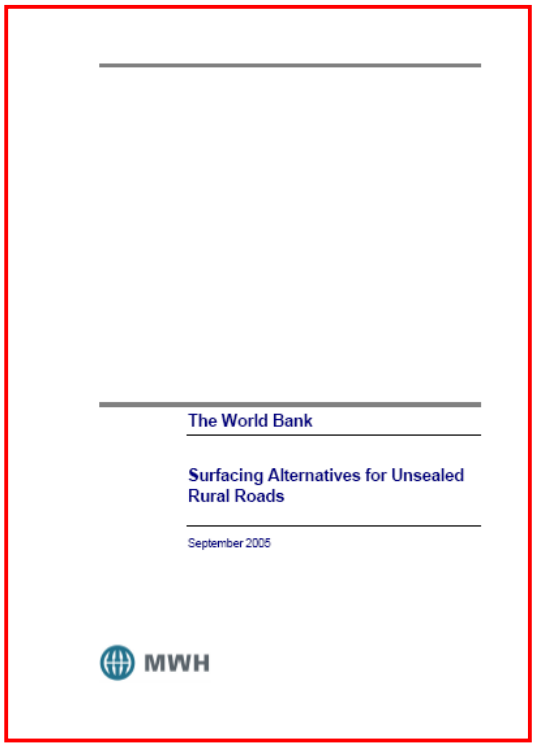
A particular problem that should be recognised with gravel is the rapid deterioration when layer thickness falls below a "residual" amount necessary for the surface to continue to perform. There is often insufficient warning of this occurrence to allow regravelling resources to be mobilised before the gravel surface deteriorates to a condition requiring rehabilitation.

The outcomes of the complementary Rural Road Surfacing Trials (RRST) will allow detailed recommendations to be made on the selection, design and use of a range of surfaces, including gravel, and possible stage and composite (variable surface) construction strategies.

Further research, particularly on the relationship between rainfall and gravel loss, could allow these RRGAP guidelines to be refined, suitable for the range of unsealed road surface materials, terrain and climate experienced throughout Vietnam, and for detailed whole life costing relationships to be developed. The database assembled under RRGAP will allow further investigation of factors affecting gravel road performance that were not possible due to the limited resources available for analysis under this SEACAP 4 study.

A programme of national discussion and dissemination of the results of the RRGAP is required to ensure improved and sustainable sector use of unsealed roads in the range of conditions experienced in Vietnam. The results of the RRGAP will also be of interest to other countries and regions with high rainfall, long gravel hauls or maintenance constraints.

The results of the Vietnam gravel and rural road surfacing research have already been incorporated in the latest World Bank Guidelines on upgrading unsealed roads (Reference 14).



It is recommended that the Cambodian road authorities should carefully consider the findings of the SEACAP 4 Rural Road Gravel Assessment Programme (RRGAP). Application of the guidelines developed would substantially reduce the road maintenance burden, which is currently widely considered to be unsustainable.

The proposed gravel use guidelines are contained in Appendix 3.

4 REVIEW OF TECHNICAL & OTHER GUIDELINES ON ROAD MAINTENANCE ACTIVITIES

4.1 International Road Maintenance Handbook

The PIARC (World Road Association) International Road Maintenance Handbook is in 4 volumes and provides guidance for road supervisors and foremen on all of the common road and bridge maintenance operations on paved and unpaved roads. This PIARC document has been translated into Khmer, arranged by the ILO Upstream Project. Available to be downloaded from www.gTKP.org and www.cnctp.info

4.2 Save Your Country's Roads

This PIARC (World Road Association) document is a short briefing for senior decision makers making a strong case for effective road maintenance. It is available to be downloaded in English-French and English-Khmer from www.cnctp.info

4.3 Other Documentation

The WSA maintenance Planning and Management manuals require to be refined and expanded to include the issues discussed in Section 2.7 for main and secondary roads.

The ILO and RIIP maintenance management documents need to be developed further as recommended in Section 2.11. An initiative is required to combine these documents and extend them to include the maintenance of paved roads (to include the experiences of the ILO-Intech Associates managed Puok Market surfacing trials). See Appendix 2.

5 SUMMARY OF ROAD MAINTENANCE RECOMMENDATIONS

This document contains justification for the following initiatives:

- ***Existing Institutional constraints have been identified in Figure 2. Comprehensive initiatives need to be agreed to overcome them based on the recommendations in this report,***
- ***Dedicated funding and performance monitoring systems should be developed for road maintenance operations of MPWT and MRD,***
- ***MPWT road network management and maintenance policy needs to be developed,***
- ***Maintenance management systems, and operational 'environment' for both MPWT and MRD require substantial further development,***
- ***MPWT recommended to have Provincial Force Account emergency maintenance capability,***
- ***All other maintenance recommended to be implemented by contractors using local resource base methods where feasible,***
- ***Axle load surveys recommended to be carried out prior to finalisation of contracts pavement designs,***
- ***Policies on axle load control and roadworks design with respect to vehicle loading to be reviewed, and Road Law to be improved,***
- ***Axle loading control strategy should be based on analysis and knowledge of the "optimum axle loading" for each part of the road network and economic levels of loading. Differential load limits are likely to be justifiable. Local ownership and responsibility of some tertiary routes is likely to be beneficial.***
- ***Programme of awareness creation, training and capacity building associated with the foregoing issues is required. However, policy, strategy and system development need to be carried out systematically beforehand to provide the basis of these initiatives.***
- ***Because of the complexity of the road maintenance problem the development of workable, affordable and sustainable systems should be piloted and refined before wider application with stakeholders fully involved and convinced of implications and benefits.***
- ***The use of gravel/laterite surfacing should be restricted to only those locations where it can be shown to be cost-effective in whole life cost terms, and where adequate maintenance can be provided. Guidelines are available for gravel use decision making (Appendix 3).***

Maintenance References

1. PIARC International Road Maintenance Handbook, English version 1994, Khmer version 1999.
2. Maintenance Strategy, LBAT Rural Infrastructure Rehabilitation Project, ILO CMB/95/011, Dara Johnston 1996.
3. Rural Road Maintenance Management, I T Transport for MRD, Cambodia, October 1999.
4. ROMAPS Road Maintenance Management System, Roughton and Partners, December 2002.
5. Strengthening the Maintenance Planning and management Capabilities at the Ministry of Public Works and Transport, Cambodia, Wilbur Smith Associates for MPWT and ADB, 2002.
6. Rural Road Maintenance Management Issues, RIIP, MRD Cambodia, April 2002.
7. Policy for Rural Roads, Ministry of Rural Development, Cambodia, 2nd edition 2002.
8. Experiences in the Financing of Community Based Rural Road Maintenance in Cambodia, Dara Johnston, ILO Upstream Project for MRD, September 2001.
9. Transport Sector Strategy Study, Cambodia, N D Lea & JOC , for MPWT, 2002.
10. Proceedings of The National Workshop on Road Planning, Pavement Design & Overloading Prevention, 11th - 12th November 2004, MPWT and MRD.
11. Human Resources Development (Component 8) Working Paper of the SEACAP 2, Cambodia Transport Mainstreaming Partnership, Intech-TRL, May 2005.
12. SEACAP 4, Rural Road Gravel Assessment Programme (RRGAP), Module 4 Final Report, July 2005, Intech-TRL.
13. Rural Road Investment, Maintenance and Sustainability, A Case Study on the Experience in the Cambodian Province of Battambang, Dara Johnstone and David Salter, May 2001.
14. Surfacing Alternatives for Unsealed Roads, World Bank, September 2005.

Appendix 1

Proceedings of The National Workshop on Road Planning, Pavement Design & Overloading Prevention, 11th - 12th November 2004, MPWT and MRD

EXECUTIVE SUMARY

A workshop was organised on 11th and 12th November 2004 jointly by Ministry of Public Works and Transport and Ministry of Rural Development, at the Institute of Technology Cambodia, Phnom Penh. The workshop allowed presentation and discussion of the important issues relating to road planning and selection, road & bridge design, and management of vehicle loading on the Cambodian road networks. Key stakeholders from the Private and Public sector, and Military were present to contribute to the forum.

The workshop made the following Key Recommendations after group & plenary discussions:

1 There is a need for better **Management Information** for improved decision-making. Therefore, an updated MRD **Road Inventory** needs to be established by applying a combination of Transport Infrastructure Inventory and mapping. **IRAP planning** should be the basis for prioritisation for road rehabilitation and maintenance. The MRD road inventory should be linked to the MPW&T Location Reference Database

2 To study the current vehicle loading and the effect on the road, an optimum axle load13 assessment should be carried out to determine the ideal loading conditions for the various categories of road network in Cambodia. This will help to provide informed guidance for consideration on legal regulation and appropriate levels of enforcement. **IRAP Planning** should include the recognition of roads that have a high probability of overloaded traffic (e.g. materials & log haulage).

3 The draft **Road Law** needs to be revised to properly tackle the issue of overloading. The law and sub-decrees related to road ownership, vehicle regulation, traffic, loading & control should be strengthened. Solutions must be identified to achieve an effective enforcement regime.

4 Pavement and surfacing **Designs** need to be improved and based upon road category, vehicle type, traffic, and realistic axle loading forecasts. Standards and design guidelines should be appropriate to traffic, environmental factors, loading, local materials resources and economics.

5 The **Quality of Road Construction** needs to be improved in accordance with design assumptions and the application of appropriate standards and materials specifications.

6 An effective **Maintenance Regime** needs to be established, including sustainable funding and improved management, which will eventually lead to a reduction in pavement whole life and vehicle operation costs.

7 **Further Consultation** is needed after the workshop, with key decision and policy makers. Discussion needs to be promoted at national and provincial level with all stakeholders in both the public and private sectors.

8 More **Research** is required on appropriate designs for improved pavement performance for the particular conditions experienced in Cambodia, in order to lower the construction and whole life costs, contributing towards lower transport costs & sustainable development.

9 **Ownership** of lower category roads; sub-tertiary should be considered for transfer to local authorities, for empowerment; to implement access control and decide traffic development, and contributions to maintenance.

13 Optimum Axle Load is the axle loading at which Total Transport Costs to the national economy are minimised.

Appendix 2

CAMBODIA RURAL TRANSPORT INFRASTRUCTURE MANAGEMENT SYSTEM (TIMS)

Development of a Pilot Scale System

1. BACKGROUND

Under the Northwestern Rural Development Project (NRDP) an Integrated Rural Accessibility Planning (IRAP) rural infrastructure planning system is being mainstreamed in four provinces of north west Cambodia.

Poor rural road maintenance has been identified as one of the major constraints to the Royal Government of Cambodia's development and poverty reduction strategies. One of the identified shortcomings is the absence of a suitable rural road maintenance management system. Consideration has been given to the adoption of proprietary maintenance management systems, however the particular circumstances of Cambodia and characteristics of such systems make this approach inappropriate for Cambodia.

It is proposed to develop the current IRAP tool into an integrated planning and management system for rural transport infrastructure in Cambodia. The system will be developed based on the successful current system. Such an approach will require only modest resources and will be achieved with the involvement of the stakeholders, trialled, and then mainstreamed for the benefit of the rural communities throughout Cambodia.

2. WHY IS AN INTEGRATED PLANNING & MANAGEMENT SYSTEM REQUIRED?

There is an urgent need to develop and mainstream an integrated planning and asset management system for Cambodia's rural infrastructure for the following reasons:-

- To involve rural communities in the prioritisation of rural transport and other rural infrastructure investments (current IRAP role),
- To provide a rational prioritisation between road and other rural infrastructure investments and services within investment and recurrent budgetary constraints,
- To identify the need for, bid for, justify and monitor rural transport infrastructure expenditures to all stakeholders in a transparent and cost effective way,
- To ensure that local-resource-based approaches are properly considered throughout the planning, design, implementation and maintenance phases of rural infrastructure investment, to the optimum benefit of the communities and to ensure sustainability,
- To mobilise community, government and other contributor's resources equitably and effectively,
- To allocate transport infrastructure maintenance resources rationally and cost effectively to rural roads,
- To prioritise and provide cost estimates for candidate road locations and sections for upgrading (effectively a "spot improvement" basic access

approach to maximise the impact of limited resources),

- To provide confidence to stakeholders that all expenditures are cost-effectively administered.
- To enable mainstreaming of the TIMS approach within existing governance structures.

Cambodia Rural Transport Infrastructure Management System **(TIMS)** will integrate the principles of IRAP and transport asset management on a sustainable basis.

3. PROPOSED APPROACH

The framework and preliminary design for the system will be carried out in Phase 1 of the development.

The pilot TIMS will incorporate the following facilities:-

- Existing IRAP planning and inventory functions
- GIS Materials database (from Component 11.2)
- Road Condition information through a simple low cost inspection system
- Routine Maintenance, Spot improvement and periodic maintenance needs
- Unit Rate costing system (component 11.1)
- Works intervention and surface options, and costs
- Prediction model for future works needs and community benefits
- Simple bid documents for funding of the works from RGC development and recurrent budgets, or from donor or NGO sources.

Phase 2 of the development will involve the programming of a pilot version of the system and development of user and training materials.

Phase 3 will include training of users and pilot establishment of the system in 2 of the NRDP provinces.

Phase 4 will involve national roll out of the system.

APPENDIX 3

APPROPRIATE RURAL ROAD SURFACE SELECTION

A Preliminary Decision Management System for the Assessment of Gravel as a Paving Option

The Decision Management System is based on the research carried out in Vietnam under the Rural Roads Gravel Assessment Programme (RRGAP), and Rural Road Surfacing Trials (RRST) by Intech-TRL under DFID and SEACAP support programmes for the Ministry of Transport.

Natural gravel is often the cheapest method of upgrading an earth road to a better quality surface. However, a number of factors mean that in many circumstances in Vietnam, it is not the most appropriate rural road surface.

The Decision Management System guides the user through the objective process of assessing the various factors that influence the suitability of gravel for a specific rural road, or section of the road. Often the varying physical conditions and traffic along a route, including problem sections, will justify a composite approach. This may determine that some sections should be designed with different surfaces, pavement types or standards to achieve the most cost-effective and sustainable use of the limited resources available.

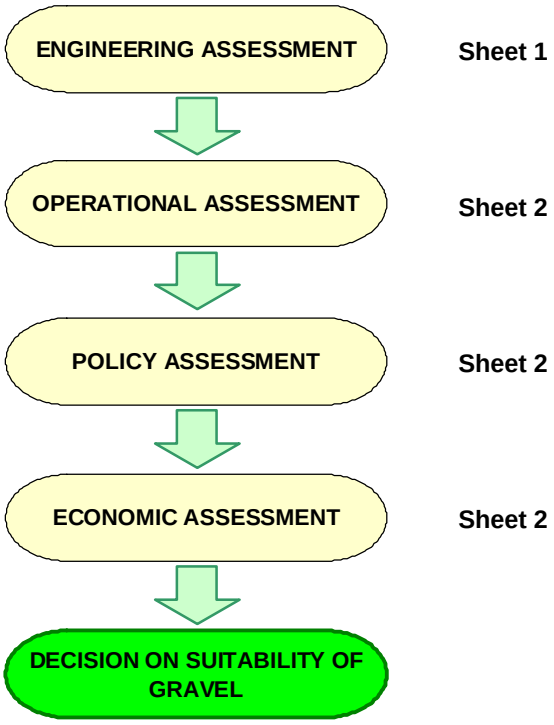
When gravel is assessed not to be the most suitable option, the separate Matrix of Surfacing Options will further guide the user to identify the most appropriate surface options.

THIS IS AN INITIAL DRAFT FOR COMMENTS

Intech Associates - TRL

OVERVIEW OF SURFACE OPTION SELECTION
FOR A RURAL ROAD OR ROAD SECTION

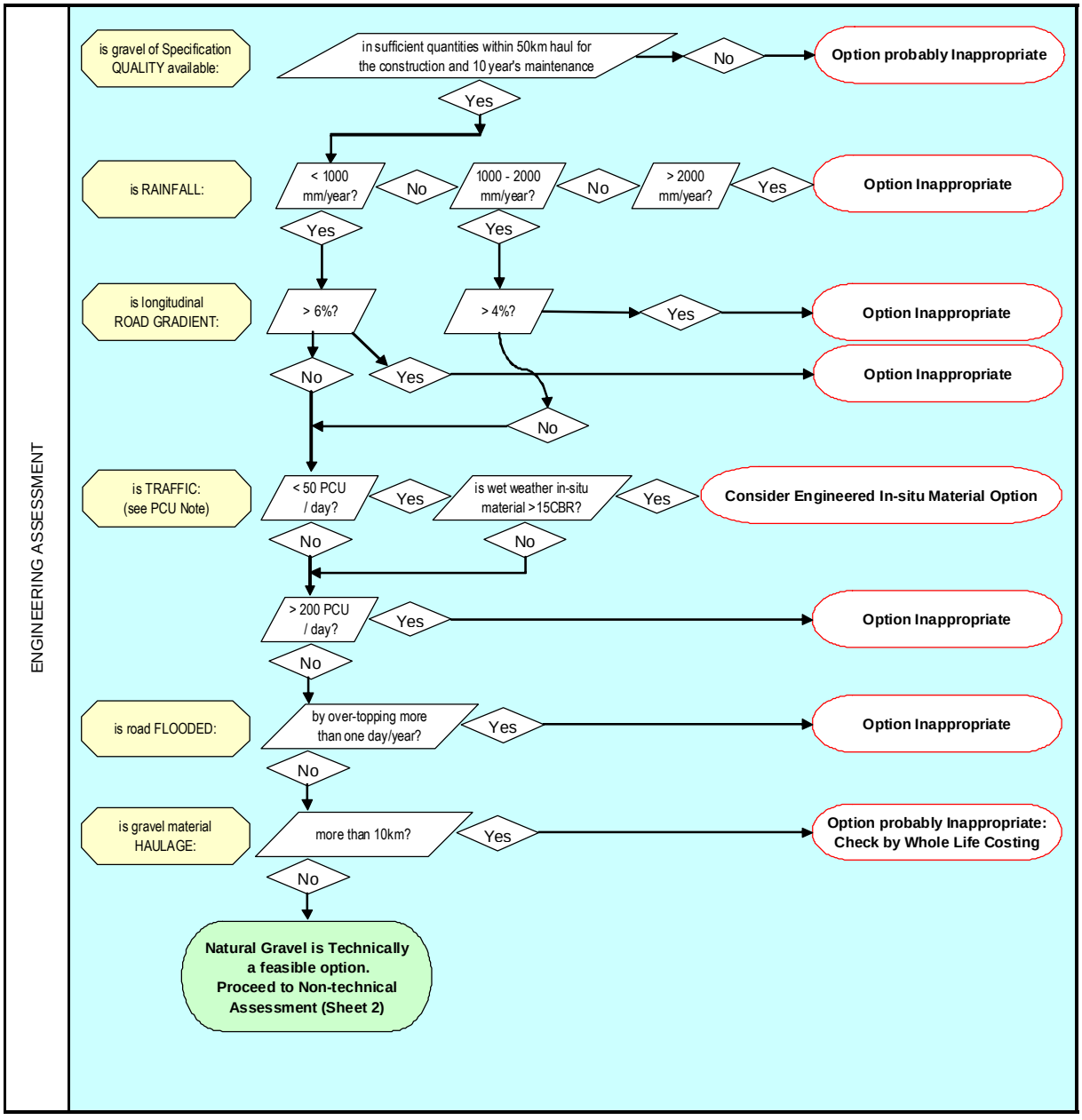
STEP 1 - Consideration of Natural Gravel as a Rural Road Surface Option



STEP 2 - If Gravel is not suitable, Selection of Appropriate Surface Option

Decision Flow Chart for the Consideration of Natural Gravel as a Rural Road Surface Option

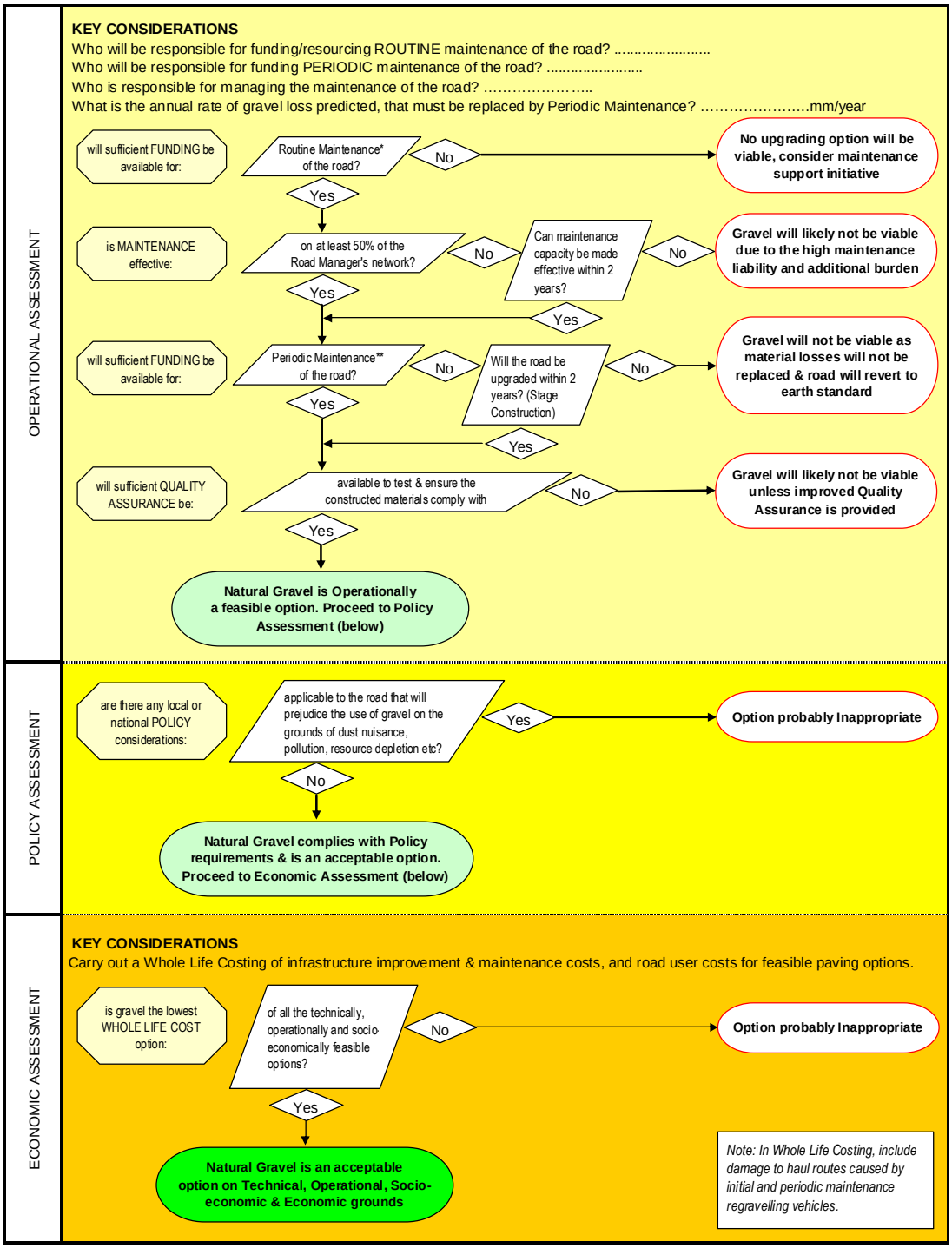
SHEET 1 - Engineering Assessment



NOTES: PCU = Passenger Car Unit (other vehicle types to be converted from traffic surveys and maximum predicted daily flows for next 3 years).
CBR = California Bearing Ratio - Strength in situ measured by DCP, or to be decided by visual assessment
DCP = Dynamic Cone Penetrometer
Engineered Insitu Material = Earth Road Standard with maintained camber and effective drainage system

Decision Flow Chart for the Consideration of Natural Gravel as a Rural Road Surface Option

SHEET 2 - Operational, Socio-economic and Economic Assessment



NOTES: * Routine Maintenance funding includes voluntary labour contributions by the community
** Periodic Maintenance includes the regular and timely re-gravelling to replace the predicted gravel losses