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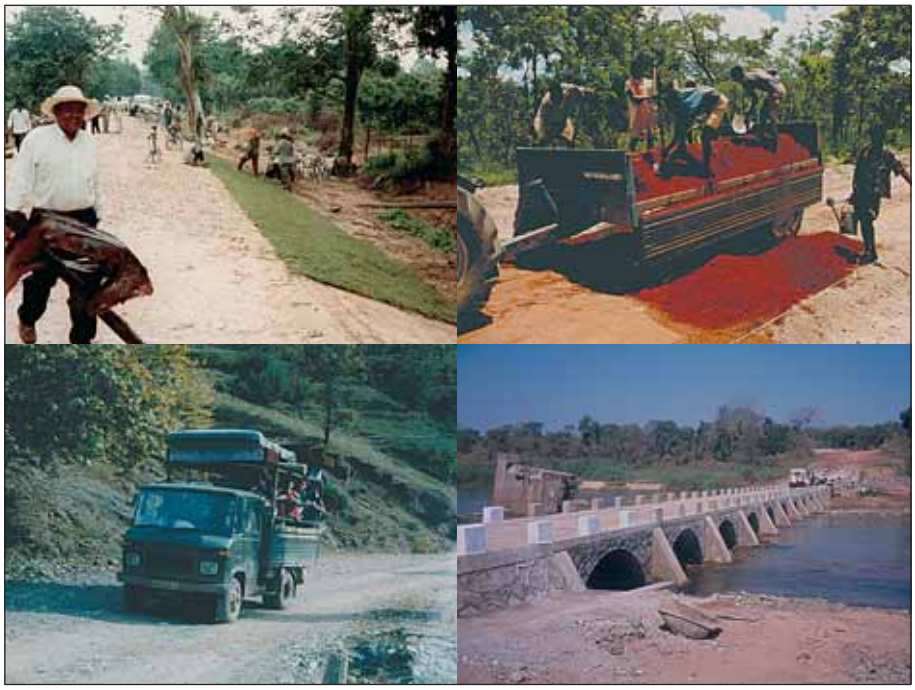
OVERSEAS ROAD NOTE 20



Management of rural road networks

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OVERSEAS ROAD NOTES

Overseas Road Notes are prepared principally for road and transport organisations in developing countries. A limited number of copies are available to other organisations and to individuals with an interest in road management, and may be obtained from:

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Foreword

Rural road networks are vital for the development of any country, and particularly so for most developing countries. Rural areas are the home for large numbers of people, the farms which produce crops for consumption and export, and strategic sites such as power stations and border posts. However, rural roads, along with other rural facilities, often receive less than their fair share of spending and many fall into disrepair. Communities become isolated and lose their access to schools, health centres, social support networks and sources of income. At the same time, teachers and medical staff are unable to visit the rural facilities where they do their work. Crops cannot be transported to markets and buying depots and much needed income is lost. Rural poverty grows and livelihoods become unsustainable.

To reverse this trend, rural roads must be well managed. Money must be spent efficiently and the needs of the road users – farmers, villagers, traders and government officials – must be met. This is good road management and, if carried out in tandem with other institutional improvements, is likely to secure a fairer proportion of the budget in the following years and bring about sustainable improvement to a road network.

In many rural areas roads fall into two groups. The first are low volume roads where social use is significant. Many of these roads are in poor condition. The second are higher volume roads where economic use is dominant. These roads are normally in reasonable condition. This document has been written primarily to guide the management of the first group of roads.

Road management is more complex than simply identifying defects and repairing them. It involves a wide range of additional aspects. These should be familiar to all road managers, but are of particular importance to a manager of low volume roads working with low levels of funding.

Road management is much more effective if the road manager involves road users, consultants, contractors and others in the planning and implementation decisions. Road users have personal interest in travelling on a well managed road, while the road industry has skills to offer and commercial interest in the work.

When the needs of road users are taken into account, it is often found that their priority is to have safe and reliable access along many of their roads rather than the opportunity for fast travel along only a few. This is achieved by repairing only those sites where access has been lost, is at risk or is dangerous. The standard is referred to as Basic Access and is the most efficient way of satisfying the needs of a large proportion of the rural population.

Unfortunately, providing safe and reliable access on all roads may still require more money than is currently available. It may sometimes be necessary to prioritise roads. The important ones will be improved, the less important ones will be left until more money is available. Several procedures for prioritising roads are described in this document, some using economic criteria, some social and some a combination, but all suitable for the participation of the road users.

One of the consequences of improving roads is that accidents tend to rise. A road manager should anticipate this, carry out engineering measures to improve safety and address issues such as education and enforcement.

It is possible to retain a local focus when moving from making plans to implementing them. Whereas most roadworks used to be carried out by government bodies, private organisations now do most of this work. Locally based contractors, whether commercial companies or community groups, give employment to local people and are more likely to respond to the needs of local people. A road manager should support local contractors wherever possible.

With all these aspects to the role of a road manager, it is essential that clear guidance is available. This document is aimed at providing that guidance so that road managers can manage their networks of low volume rural roads for the benefit of their local community.

Martin Sergeant

Head of Profession

Infrastructure and Urban Development

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CONTENTS

Part 1: Introduction

1.1 The importance of rural roads

This document provides guidance on the management of rural road networks. These networks are important to those who travel along them and to those who live alongside them in four ways.

Social development

Rural roads are essential for the well being of rural communities. Isolation from schools, clinics and social gatherings is recognised as a major cause of poverty – reliable access to social facilities and transport services can reduce isolation and poverty.

Economic development

The agricultural production of small rural farms is vital for most countries. Agricultural produce must reach markets and buying depots as reliably as possible. Other industries such as tourism and mining are also reliant upon rural roads. The growing dependence of rural households on non-farm income also underlines the importance of reliable road networks.

Rural administration

District administrators, public workers and community representatives are dependent upon a reliable network of rural roads.

Strategic need

Some facilities in rural areas are sufficiently important that access is required at all times. These include power stations and border posts. Certain rural roads may also be required for national defence or internal security reasons.

However, rural road networks can bring harm to communities. This includes exploitation of their timber resources, the spread of transmissible diseases, an increase in road accidents and adverse environmental impacts. This document explains many of these issues, and suggests ways of addressing them.

1.2 Audience

This document is targeted at Road Managers who are responsible for the management of a network of low volume rural roads within a constrained budget. The Road Manager may be working within government or the private sector. The network for which he or she is responsible is likely to have some roads in good condition and others in poor condition.

The document has been written to suit a Road Manager working within an annual cycle of planning, budgeting and implementation.

It is hoped that the document will also be of interest to consultants, contractors, policy makers, economists and social development workers.

1.3 Basis of the document

The guidance within this document is based upon two main principles.

1 The first priority is to carry out maintenance of roads which are already in good or fair condition. Then, and if funds remain, roads in poor condition are prioritised for rehabilitation to a good condition. If this principle is not followed, a cycle of rehabilitation, lack of maintenance and repeated rehabilitation will ensue, which is expensive and disruptive to the Road Administration and road users.

2 When funds are readily available, they should be used to permit safe, reliable, rapid and comfortable travel. When funds are constrained, they should be used to provide safe and reliable access.

Together, the principles should lead to a cycle of reliable access, confidence, rural investment, traffic growth, increased funding and sustainable network improvement.

1.4 Scope

This document guides a Road Manager through an initial phase of clearly defining a road network and then an annual cycle of planning, budgeting and implementation. This cycle addresses the maintenance of roads in good or fair condition and the rehabilitation of roads in poor condition. The document uses the following definitions:

Maintainable	A road, or a section of road, is in a maintainable, or good or fair, condition if it serves the needs of the road users and has only minor defects which can be rectified using routine or periodic maintenance.
Unmaintainable	A road, or a section of road, is in an unmaintainable, or poor, condition if it does not serve the needs of the road users as a result of major defects which require rehabilitation.
Maintenance	Activities to rectify minor defects to restore a road to a good condition, or prevent future defects.
Routine maintenance	Maintenance activities which are normally required annually or more frequently, which are often specified on a repeated cycle and which normally suit lengthworkers and small contractors. These include cutting grass and clearing drains.
Periodic maintenance	Maintenance activities which are normally required less frequently than annually, which are often specified in response to a minor defect and which normally suit small and medium contractors. These include regravelling a gravel road.
Rehabilitation	Activities which are specified in response to major defects and which are required to return a road to a maintainable condition. These include repairing a collapsed culvert and reforming a damaged length of carriageway.

1.5 Exclusions

This document does not cover the following topics:

New construction

The document covers the maintenance and rehabilitation of existing roads. In general and unless other priorities apply, this is a better use of scarce funds than new construction and does not unduly add to the burden on Road Managers.

Sealed roads

The document covers the management of tracks, earth roads, gravel roads and improved surfaces. It does not cover the detail of sealed road assessment and repair, although much of the planning and implementation guidance can be applied to all road types.

Design standards

The document guides a Road Manager in how to set standards appropriate to the function and usage of each road, but does not consider design standards (carriageway widths, curvatures, and so on) in detail.

A complete road management system

The document addresses a number of problems that occur in road management and suggests solutions to each problem. The Road Manager should select the most appropriate solution for his or her situation. Where national procedures exist for individual steps, the Road Manager should follow those.

Standard forms

The document provides example forms for use in suggested solutions. The Road Manager should use the guidance to produce his or her own forms according to national standards.

Institutional and organisational issues

The document suits a Road Manager working in a variety of institutions and organisations but does not consider these arrangements in detail.

Staff management

Issues of training, motivation and delegation are beyond the scope of this document.

1.6 The need for computers

National road networks are often managed using sophisticated planning software. However, this document has been written for Road Managers who cannot rely upon permanent access to computers. Thus computers are not required for making day to day decisions, but can be used for producing forms, storing and processing information and calculating budgets.

1.7 Structure of the document

Table 1.1 describes the objective of each part of this document, and explains what will be carried out and what decisions will be made at each step.

Table 1.1 Document structure

Objective	*Section*	*Description of the Section*
Part 1: Introduction		
To provide background to the document		
Part 2: Network definition		
To define a road network in preparation for an annual cycle of planning and implementation.	2.1	List all roads in the network.
	2.2	Carry out an inventory of all roads.
	2.3	Classify the roads in the network.
Part 3: Planning		
To identify and schedule the activities required to maintain roads in good or fair condition and to rehabilitate roads in poor condition within the available budget.	3.1	Establish participatory frameworks.
	3.2	Select the most appropriate technology
	3.3	Estimate the costs of managing the network (four methods).
	3.4	Submit a request and receive a budget.
	3.5	Reduce costs to meet the budget (four methods).
	3.6	Make roads safe for the users.
	3.7	Identify required maintenance and rehabilitation activities.
	3.8	Schedule & package the activities ready for implementation.
	3.9	Carry out long term strategic planning.
Part 4: Implementation		
To arrange for an organisation to implement the required activities.	4.1	Identify the appropriate implementing organisation.
	4.2	Identify the most suitable contract.
	4.3	Manage the contract.
	4.4	Ensure safety on site.
Part 5: Useful information		
To provide information on organisations and publications that may be of use to the Road Manager.	5.1	Organisations.
	5.2	Publications.
Annexes		
To provide supporting information to the text.	A	Glossary to explain terminology in the text.
	B	Photographs to illustrate technical issues.
	C	The calculation of an Equivalent Daily Traffic.
	D	Provide a very low cost Partial Access standard.
	E	Carry out emergency work.
	F	Protect the environment during and after site operations.
	G	Activity Planning Sheets giving detail of all activities.

Part 2: Network definition

The objective of Part 2 is to define a road network in preparation for an annual cycle of planning and implementation.

Part 2 has three steps:

2.1 List all roads in the network.

2.2 Carry out an inventory of all roads.

2.3 Classify the roads in the network.

These three steps are described as single activities to be carried out only once. However, since the road network will change over time, the Road Manager should ensure that lists, inventories and classifications are kept up to date with regular checking and revision.

2.1 Road List

The first step is to record all roads in the network on a Road List as shown in Table 2.1. 'Road' refers to all routes and should include tracks to water sources and other sites.

Table 2.1 Road List

				District:	
Road No.	From	To	Classification *(see Section 2.3)*	Road Type	Length
Example:					
RD123	*Tunja*	*Tocansipa*	*Feeder*	*Gravel*	*23km*

'Type' refers to the construction and surface of the road. Four types are shown in Table 2.2 although local definitions may be used if they differ from these. Each type is suitable for different traffic levels and external influences. Choosing the most appropriate type is covered in detail in Section 3.5 and Table 3.15.

Table 2.2 Road types

Type	*Track*	*Engineered earth*	*Gravel*	*Improved surface*
Description.	Traditional route, cleared vegetation, informal structures.	Camber, drains and designed structures.	As engineered earth plus an imported gravel surface.	As engineered earth plus a surface layer such as bricks, stones or blocks.
Remarks	Tracks are suitable for low traffic levels if the riding surface is able to consolidate, strengthen and remain dry. Maintenance is rarely required.	Engineered earth roads are more durable than tracks. Maintenance using nearby soil can be cheaper than for a gravel road. Deterioration is rapid when maintenance is neglected.	Gravel can be durable and cost effective, but needs continuous and costly replenishment when traffic is heavy or the climate is harsh. Deterioration is rapid when maintenance is neglected. Gravel is becoming scarce in many regions.	Improved surfaces can be very durable and suitable for heavy traffic. If local materials are used, maintenance costs can be low. Improved surfaces are more durable than gravel or earth when maintenance is neglected.

The Road Manager may decide to divide a road into shorter lengths, or segments, of typically 5 kilometres. The use of segments can simplify information collection and recording. Sections should also be defined on the Road List.

2.2 Road inventory

The second step is to collect more detailed information on the roads in the network. The inventory records the permanent features of the road and is used for long term future reference. An inventory is required for each road, and should record the location of single features such as structures and junctions, and the location where features such as carriageway width or road type change.

2.2.1 Recording information

The inventory may record summary or detailed information. The Road Manager should produce forms for recording inventory information according to local requirements and practice. Table 2.3 shows the items that should be included in all inventories and the additional information that a Road Manager may decide to record if time and resources permit.

Table 2.3 Inventory items

Items essential for all inventories	*Additional items if time and resources permit*
Road number (and link number if used).	Terrain (flat, rolling or mountainous).
Road type.	Gradient of road (up or down, and % slope).
Datum point from which all distances are measured.	Curvature (straight, broad or sharp curves).
Surface material.	Sites with reported high accident rates.
In situ soil type.	Rainfall (total annual fall and duration of the rainy season).
Width of carriageway.	Location of road building materials (gravel, stone and water).
Mitre drains and interception ditches.	Villages (including population where known).
Water crossing structures (type of structure and its size).	Markets.
Retaining walls (type and size).	Health facilities.
Traffic levels and most common vehicle types (see Annex C).	Schools.
Junctions (no. of joining road).	Other strategic facilities (such as border posts or electricity stations).
Road signs, distance posts, edge delineators and other furniture.	Land use (village, farmland, forest).
Vulnerable sites (flooding, landslide or erosion).	Sites of environmental importance or where damage has been seen.

Prior to the inventory, the installation of distance or kilometre posts is strongly recommended. They are useful when recording inventory information and later for road condition and accident data. They also show a high level of commitment by the Road Manager to the road users and local communities. Posts can be made from any suitable locally available and durable material. They can also give the name of the nearest village or town. They should be installed on the road shoulder at least 1.5 metres from the carriageway. Regular replacement of missing distance posts is recommended.

While carrying out the inventory, it may become apparent that a road has two or more distinct links. For instance, a ridge road may descend to a valley floor or carry much less traffic beyond a village. It may be

worth using additional numbering to distinguish the different links, such as R123-1 and R123-2. Subsequent planning decisions, such as setting standards or prioritising roads for rehabilitation, can then consider these links separately.

If survey resources are low, a decision can be made to omit roads from the inventory for which funding is extremely unlikely. However, the alignment should still be shown on maps of the network and the inventory should be completed as soon as resources permit.

2.2.2 Presenting information

Road inventory information is normally presented on the same form on which it was recorded. It can also be presented in a more visual manner. This can be done in a number of ways.

Maps of a network

- Terrain map. The roads in the network are marked onto a geographical map. This enables the Road Manager to relate the road to inventory information such as villages, water catchments, junctions, material sources and terrain. Terrain maps are often permanently displayed in road management offices.

- Scale map. A to-scale map is drawn of the road network. Like the terrain map, the scale map can show inventory information, but can also be regularly updated with information such as overall road condition, the extent of contracts or planned activities. If the map is digitised, it can be updated quickly and stored for future reference. If colour is used well, these maps can be understood very easily. These maps are also often displayed in road management offices.

- Diagrammatic map. The roads are shown as straight lines between junctions. The map is not to scale, but shows the extent of the network with great clarity. This map is useful for showing road type, structures and junctions. These maps can be digitised.

Maps of a single road

- Strip map or road log. Each road is represented by a single straight line along which inventory information – features of the road itself or items on either side – can be marked. Strip maps are useful for finding inventory items when on site. Long roads can be divided into several pages. Strip maps can be made onto pre-printed blank forms. Figures 2.1 to 2.3 are examples of strip maps. Figure 2.1 shows junctions, water crossings, road numbers and ground conditions over a 25 kilometre length of road. Figure 2.2 is similar to this, showing junctions, water crossings, canals and social amenities over one kilometre. Figure 2.3 is a pre-printed blank form on which inventory items, as listed, can be marked. The form can extend downwards to allow road condition information to be recorded.

- Road segment maps. Each road is divided into segments of typically 5 kilometres. Inventory items are marked onto a map of each segment. The map shows curvature and the full carriageway width, unlike the single straight line of a strip map. Segment maps can be copied onto road condition, monthly measurement and accident recording sheets and can be used at many stages of the road management cycle. Figure 2.4 is an example of a road segment map. It shows a wide variety of information including road curvature, shoulder and carriageway widths, distances, distance posts, embankments, cuttings, junctions, bridges, culverts and road signs.

2.3 Road classification

The third step is to classify the roads in the network. Although it is probable that a network will already be classified according to national practice, a Road Manager is advised to understand the basis of the classification and may be able to have some influence if the network is being reclassified.

By placing each road in a hierarchy, classification indicates the importance of a road within the network. Classification can be based upon a number of factors such as traffic levels or political importance. The classification in Table 2.4 is suggested for a rural network. It combines function, ownership and usage with the creation of core networks at national and local level. In this classification, a rural Road Manager may be responsible for tertiary, feeder and access roads, and take some responsibility for unclassified roads. The classification of each road can then be completed on the Road List. The Road Manager may wish to reduce the number of classifications. In this case, Feeder roads could be reclassified as Tertiary roads.

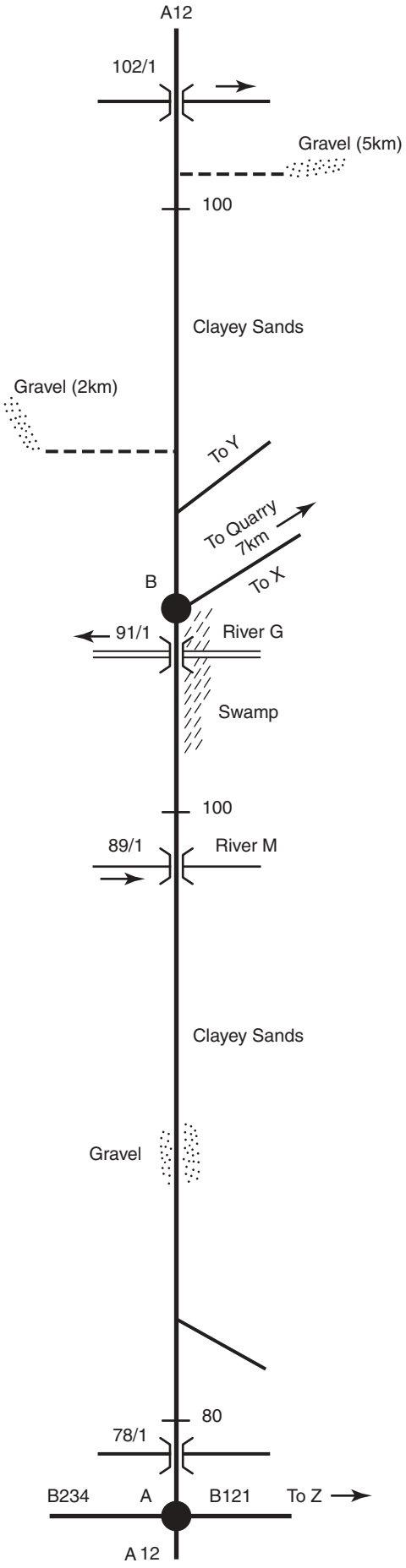
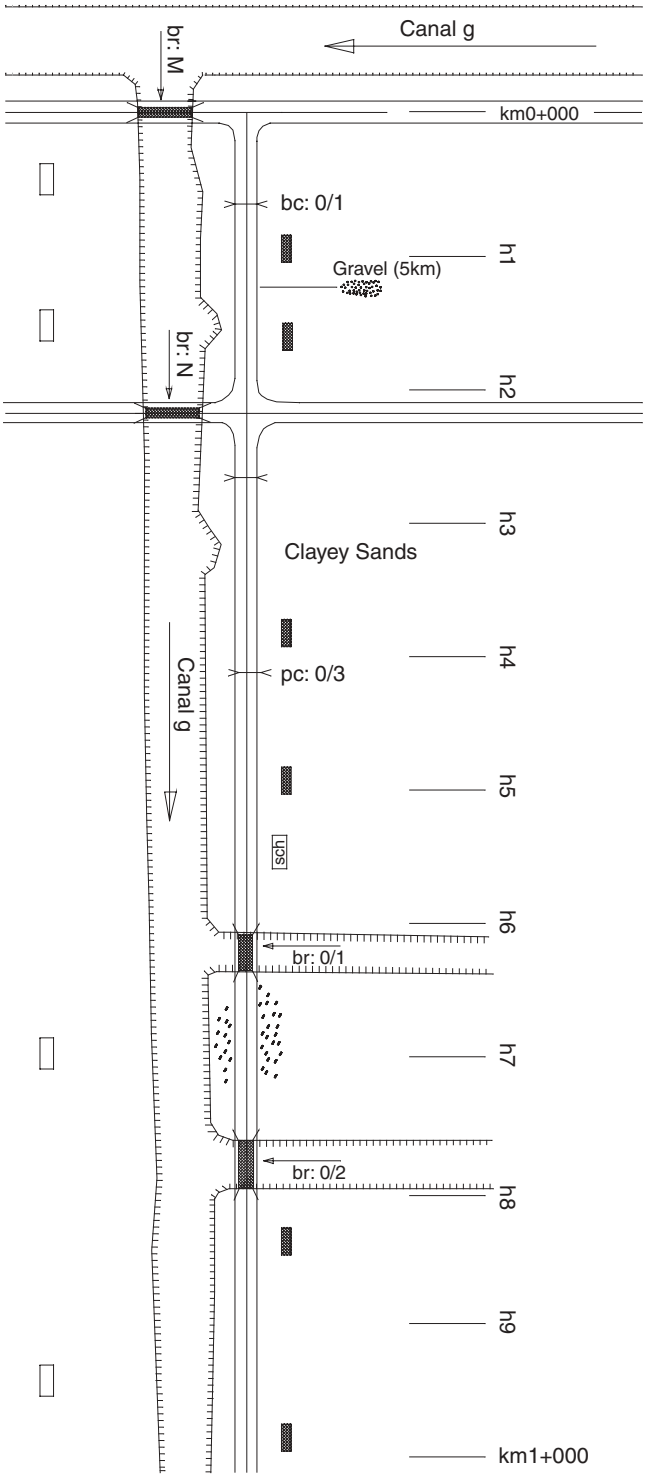


Figure 2.1 Strip map



Legend:

- sch School
- Village
- House
- Culvert
- Bridge
- Footpath
- Road/Track
- Swamp
- Gravel

br: 0/2 Km0, second Bridge
bc: 0/2 Km0, second box Culvert
pc: 0/3 Km0, third pile Culvert

(*Courtesy of the Second Rural Transport Project, Vietnam, WSP imc in association with TDSI and TEDI)*

Figure 2.2 Strip map

Vietnam Rural Transport Project	Road Inventory / Line Diagram	MINISTRY OF TRANSPORT (PMU18)

Province:	District:	Start time:	Finish time:	Prepared by:	Date:
Road Code:	Road name:	From Km:	To Km:	Approved by:	Page:

Strip Map (Existing features)

Village		Ditch	
House/Hut	SCH	School	
Bridge	HCL	Health clinic	
Culvert	BP	Borrow pit	
Road/Track		Footpath	

Chainage Km / Metres

0 50 100 150 200 250 300 350 400 450 500 550 600 650 700 750 800 850 900 950 1000

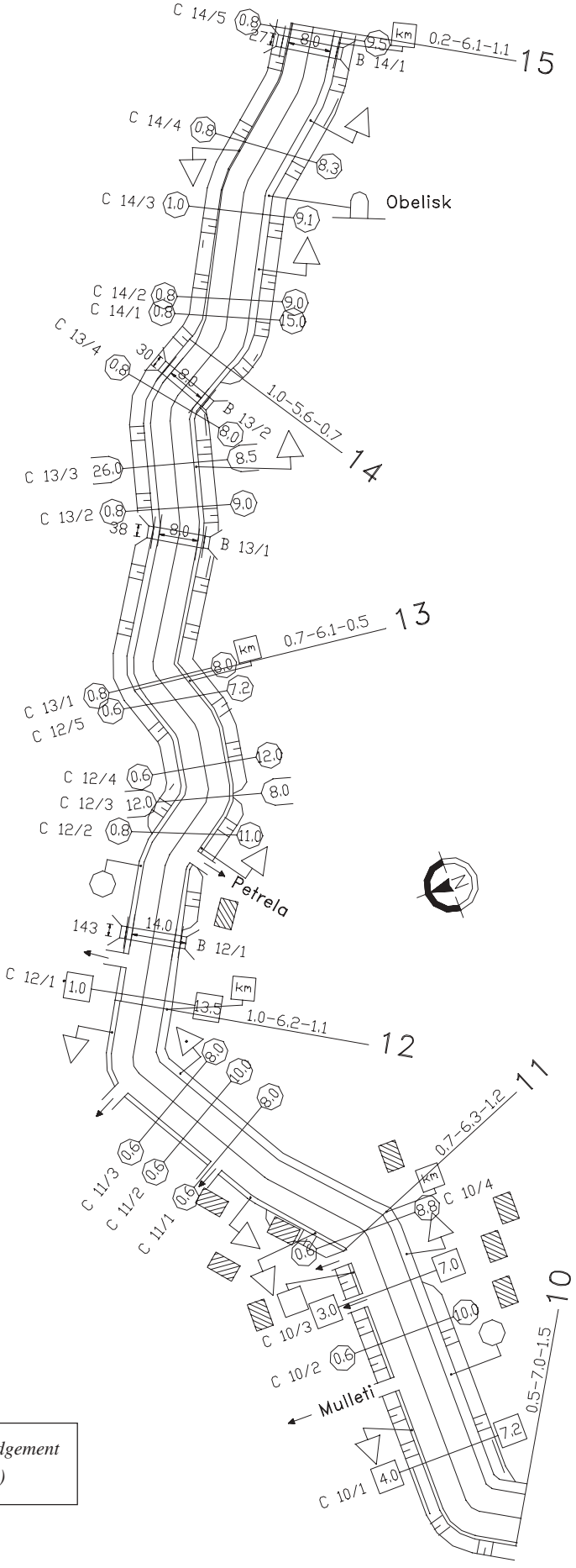
Notes

Inventory

- Road Surface/Shoulder Width (m)
- Road Surface Type
- Fill Height/Cut Depth (m) +: Fill -: Cut
- Subsoil Type
- Topography

(*Source: Technical Guidelines, Second Rural Transport Project, Ministry of Transport (PMU18) Vietnam)*

Figure 2.3 Strip map



(With acknowledgement to Robert Butler)

Figure 2.4 Road segment map

Table 2.4 Suggested rural road classification

Classification	*Description of roads under each classification*
Primary	Connects major borders and ports. Links primary administrative centres (often Provinces or Regions). Connects to sites of national strategic importance. Forms part of a national core network. Is owned at central government level. Carries the highest traffic levels.
Secondary	Connects minor borders and ports. Links secondary administrative centres (often Districts). Connects to sites of local strategic importance. Forms part of a national core network. Is owned at central government level.
Tertiary	Links rural areas to primary and secondary administrative centres. Connects to significant population centres, and major markets and health centres. Forms part of a local or District core network. Is owned at local government level.
Feeder	Links to tertiary roads. Connects to lesser population centres, and minor markets and health centres. Forms part of a local or District core network. Is owned at local government level.
Access	Links to feeder roads. Connects to all remaining population centres. Is owned at local government level.
Unclassified	Links to access and feeder roads. Informal routes, formed by usage. Is owned by private or community landowners over whose land it passes. The local government may seek to adopt unclassified roads which form important routes.

Part 3: Planning

The objective of Part 3 is to identify and schedule the activities which are required to maintain roads in good or fair condition and to rehabilitate roads in poor condition within the available budget.

Part 3 has nine elements:

3.1 Establish participatory frameworks.

3.2 Select the most appropriate technology.

3.3 Estimate the costs of managing the network.

3.4 Submit a request and receive a budget.

3.5 Reduce costs to meet the budget.

3.6 Make roads safe for the users.

3.7 Identify required maintenance and rehabilitation activities.

3.8 Schedule and package the activities ready for implementation.

3.9 Carry out long term strategic planning.

3.1 Participatory frameworks

It is possible for a Road Manager to manage a road network with little or no contact with outside parties. The manager can survey the roads, make plans, let contracts and feel that the network is being well managed. However, the plans may not suit the people who use the roads and the contracts may not be well designed. Without guidance and feedback, the Road Manager will not actually know whether or not the network is being well managed.

The Road Manager is at the centre of two important frameworks whose members have much to contribute to the effectiveness of road management. These two frameworks include the road users or clients for whom the Road Manager is working, and the organisations which can supply road management products and services to the Road Manager. By encouraging the participation of the members of both frameworks, the Road Manager can feel much more confident that the network is being well managed.

3.1.1 Road users participatory framework

Road users, those who are in some way affected by the condition of the road, are the customers of the Road Manager. They pay fuel taxes, bus fares, market taxes and so on and should expect to have some control over the improvements that are made to their road network. Given the opportunity, they will give much help to the Road Manager. A number of groups within a road user participatory framework are given in Table 3.1.

Table 3.1 Road users participatory framework

Individual road users in the local community.	Traders.
Village leaders and councils.	Local government council or assembly.
Women's groups.	Local labourers.
Local government workers; teachers and health workers.	Farmers, farming co-operatives and agro-businesses.
Police.	NGOs, when representing local communities.
National security and emergency forces.	Transport service providers.

Clearly, road management will be more effective with the help of this wide range of people. The Road Manager should decide which of these groups should be involved in the framework. This will depend upon available time, the budget for improvements and local customs and practices.

The Road Manager can use this participatory framework to involve road users in many road management functions and thus benefit the entire road management cycle. These functions include the following:

Initial consultation

Consultation between Road Manager and road users can identify the roads in the network and help the Road Manager understand the main problems with the network and, in general terms, how the road users would like to see it improved.

Gathering local information

Local people know which roads are impassable in the rains, where villages are located, where gravel can be found and how high rivers flow when full.

Identifying priority roads and setting standards

Perhaps the most useful help that the road users can give is to tell the Road Manager where funds would be best spent and endorse decisions that are made. Several of the prioritisation procedures in Part 3 of this document depend upon the views of the road users.

Developing community contractors

Community contractors can arise from local communities in response to a need for infrastructure improvements. These are described in Section 4.1

Participating on Tender Boards

Tender Boards are used to administer the transparent letting of road improvement contracts. Road users on a Tender Board can ensure that the contract is let in the best interests of the local communities. Tender Boards are described in Section 4.3.

Auditing

Road users are able to record information which will help the Road Manager or another organisation carry out formal audits of the completed works and the contract. The information may be as diverse as the sites where specific activities were carried out and the safe working practices of the contractor. Audits are described in Section 4.3.

Providing a Partial Access standard

When funds are very low, a Road Manager may have little option but to delegate responsibility for ownership, fund-raising and contributions in kind, planning and implementation of road improvements to the local community. This is covered in Annex D.

Reporting emergencies

A Road Manager cannot respond to an incident which causes danger or loss of access if the information has not been passed on. Police, traders and other government workers are likely to identify emergencies very soon after they occur. This is covered in Annex E.

Environmental protection

Since local communities are vulnerable to environmental degradation, they can provide much information on environmental risks and mitigation measures and, once contracts are let, can monitor the environmental compliance of a contractor. This is covered in Annex F.

Long term monitoring

With guidance from a Road Manager, members of a community are able to monitor social, economic and environmental change over time to help the Road Manager evaluate planning and implementation procedures.

Road users may take the initiative and mobilise themselves to contribute to road management, but it is more likely that a Road Manager may have to take the first steps in encouraging participation. There are no prescribed methods for encouraging participation, but various methods are available. They include the following:

Regular visits

There is perhaps no better way to make contact with, and learn from, a local community than to make regular visits and meet people. Such visits demonstrate interest in the needs of the road users and commitment to the improvement of their roads.

Road Bulletins

A regular newsletter will demonstrate the commitment of the Road Manager to participation, be a formal channel for providing information to road users and act as a focus for communication between all parties with an interest in the road network.

Participatory appraisal techniques

These techniques enable road users to provide information on their local area and express their wishes for road improvements. They make use of visual tools, such as maps, models and drawings.

Semi-structured interviews

Information can be gathered from road users in an informal interview which can be made less intimidating and more productive than an interview with a rigid structure.

Questionnaire surveys

These can be used if the Road Manager wants to obtain detailed information on a community, although they are the least participatory of these four methods.

It is strongly recommended that a social development worker with experience of road user participation is involved at this stage. Documents, which may help when encouraging participation, are listed in Section 5.2.

Throughout the management cycle there will only be genuine participation if the Road Manager is honest and open with information such as Provincial Development Plans and available budgets. This openness will prevent two common problems that can occur during participatory consultation. Firstly, if road users do not trust the Road Manager, they will not accept the results, wasting much time and money. Secondly, if done with no discussion of budgets, participation can create high expectations which, if not realised, can cause disillusionment amongst the road users and make future participation much less productive.

3.1.2 Road industry participatory framework

A road network will be managed much more effectively if the Road Manager makes use of other organisations with skills in various aspects of road management or who are able to supply road management products and services. It will also be beneficial to obtain endorsement from these organisations of the road management principles which the Road Manager wants to follow. These organisations are listed in Table 3.2. The table includes the contractors who currently carry out road maintenance and rehabilitation contracts, but also demonstrates the limited extent to which the wider private sector has become involved in road management, a situation which a Road Manager may decide to change.

It is clear that a participatory framework with members as diverse as those in Table 3.2 will have a much greater amount of skill and experience than a Road Manager working alone in a rural road office.

Recent reforms of many road industry sectors around the world have been led by foreign consultants. It is suggested that these transitions might have been smoother if national consultants had been given the opportunity to take a greater role. The Road Manager can learn from this and is encouraged to allow contractors, local organisations and knowledge based industries to participate in rural road management whenever possible.

Table 3.2 Road industry participatory framework

Knowledge based industries	*Contractors and producers*
Road Administration design departments and specialists.	Contractors.
Design consultants.	Suppliers of quarry products, cement and bitumen.
Foreign consultants.	Manufacturers of signs and barriers.
Contract adjudicators and legal specialists.	Manufacturers of tractors, trailers and hand tools.
Training institutions.	
Testing services.	
Social and community development organisations.	
Environmental consultants.	*Locally based organisations*
Project and contract management consultants.	Community contractors.
Surveying and mapping organisations.	NGOs, when supplying services to the community.
Universities.	Community groups supplying local materials.
Research organisations.	Local blacksmiths and other tradesmen.
Banks and other sources of credit.	
Transport economics consultants.	

3.2 Technology choice

Maintenance and rehabilitation of rural roads can be carried out using a variety of technologies:

- Equipment intensive methods use mechanical plant wherever possible, and manual labour only on activities unsuited to machines, such as culvert repair and pothole filling.
- Labour intensive methods use labour wherever possible, and machines only on activities unsuited to manual labour, such as compaction and long distance haulage.
- Labour based methods, also known as *'intermediate technology'* or *'light equipment supported'* use a combination of equipment and labour to achieve a balance between employment generation and productivity while remaining cost effective.

Table 3.3 compares the three methods and is of use when deciding if a particular technology should be specified for an activity or a contract.

If labour rates are US$2 or less per day at typical 2003 exchange rates, it is likely that labour based and labour intensive methods will be cost effective. If rates are US$10 or more per day, they are unlikely to be cost effective. If rates are between US$2 and US$10 per day, the cost effectiveness will depend on a number of factors such as labour and equipment availability, the time available for recruitment and the capacity of local contractors. The decision to specify one technology or the other or to allow contractors to choose will depend upon cost effectiveness and the many other factors presented in Table 3.3.

3.2.1 Promoting labour based methods

Table 3.3 identifies the advantages that labour based methods can bring to the Road Administration, the implementing organisation, and the communities living alongside the road. It is appropriate at times to promote and then support labour based methods in order to maximise these advantages. A number of measures to promote and support labour based methods are shown in Table 3.4.

The ambition of contractors to expand to include equipment intensive methods at a national or international level is normal and should be welcomed. Therefore contractors should be designated as 'trained in labour based methods' rather than as 'labour based contractors'. It is recommended that labour based methods are promoted for around 5 years, after which technology choice is open to commercial forces.

3.2.2 Protecting labour on site

Labourers employed for short contracts are vulnerable to maltreatment. This can be due to the short duration of the employment, the absence of other local employment opportunities, the isolation of a site, the presence of single women, or a lack of awareness of labour rights.

Table 3.3 Equipment and labour technologies compared

Equipment intensive	*Labour based*	*Labour intensive*
Typical plant		
Bulldozers, motor graders, large trucks, loading shovels, other specialist equipment.	Tractors, trailers, small trucks, towed graders, power tillers, pedestrian rollers, water bowsers, hand tools.	Shovels, wheelbarrows, bush knives, mattocks, hand rammers.
Long term employment to:		
Drivers, mechanics and operators.	Supervisors, mechanics, operators and some labour.	Supervisors, some labour.
Short term employment to:		
Unskilled local labourers (few).	Skilled and unskilled local labourers (many).	
Community involvement		
Low.	High.	High.
Production rates		
High.	Medium.	Low.
Suitable activities*		
Compaction, long distance haulage, dragging, grading.	Excavation, grass cutting, drain clearing, grubbing, repairing damage to scour checks, drains and structures.	
Quality of output		
High. Supervision is very important for each technology to achieve high quality.		
Advantages		
• Familiar to most Road Managers. • Opportunity for contractors to invest in equipment. • Rapid mobilisation.	• Opportunity for contractors to invest in equipment. • Tractors are versatile; utilisation is often high. • Suitable for emerging contractors. • Suitable for most rural infrastructure needs. • Modest fuel consumption.	• Low capital requirements.
	• Encourage local ownership and self reliance. • Stimulate local economy and local entrepreneurs. • Light equipment and tools can be manufactured locally. • Skills learnt locally are flexible for other employment. • Employment can be targeted at vulnerable groups.	
Disadvantages		
• Expensive and requires foreign exchange. • Repayment requires long term workload. • Large plant is inflexible; utilisation can be low without high workload. • Spare parts and fuel can be expensive or hard to obtain. • Requires good mechanical and maintenance support. • Problems transporting to remote sites. • High fuel consumption.	• Danger of trapping contractors as 'labour based contractors'.	• Minimal investment opportunities. • Not suited to compaction and haulage.
	• Unfamiliar to some Road Managers. • May not be accepted if seen as forced labour. • Recruitment and training can be time consuming. • Possible labour shortages at harvest time and in remote areas. • Sites are vulnerable to labour strikes/withdrawal. • Success depends on prompt labour payment. • Locally manufactured items can be of poor quality.	
Main reasons for selection by client		
High production rates, familiarity.	Combination of production, employment & ownership, Government policy.	Employment generation and local ownership, Government policy.

** Activity Planning Sheets in Annex G describe the suitability of a large number of activities to labour and equipment based methods.*

Table 3.4 Promoting and supporting labour based methods

- Organise site visits and seminars to encourage commitment to labour based methods from politicians, donors, Road Managers, members of the road industry participatory framework and local communities.
- Provide training courses in labour based methods and labour management. Two factors which can determine the success of labour based methods are good site planning and the correct use of incentive schemes such as daily tasks. Restrict contracts to contractors whose staff have attended these courses or who have otherwise shown competence.
- When planning a project, consider the use of labour and equipment based methods. It may be decided to restrict bids to one technology (or to specify a technology for certain activities) for reasons including cost and technical suitability. If bids using both technologies are accepted, compare bids equally using normal assessment criteria.
- Use designs and specifications suitable for labour based methods. Limit the quantities of excavation and haulage, identify nearby material sources and do not specify activities which require large equipment.
- As in all contracts, include a contractual obligation to pay labour on time, protect workers rights and provide health and safety protection.
- Let contracts of adequate duration to permit recruitment and training of local labourers.
- When assessing bids, use the company history and staff experience of working in communities and with labour based methods as assessment criteria.
- Allow advance payments to enable contractors to pay labourers during the first few months or allow the client to pay labourers directly if the contractor fails to do so.
- As with equipment based methods, ensure good supervision. Poor supervision leads to poor production rates and poor quality, losing the commitment and support of outside parties.
- Encourage the establishment of local hand tool producers. Ensure that their tool quality is high and that contractors know of the benefits of using good tools.

Social issues and the protection of labour rights are important to the road sector. This protection is often national policy or written into the law, but less frequently turned into practice. Measures which contractors should take, whichever technology is being used, are given in Box 3.1.

3.3 The costs of managing the network

In order to obtain funds for maintenance and rehabilitation activities from a funding source (Treasury, Ministry or Road Fund), it is necessary to estimate the cost of managing the network. Costs can be estimated in a number of ways. Four methods are given in Table 3.5.

All the methods require the establishment of unit costs, whether for an individual activity per unit output or for annual maintenance costs per kilometre of road. These unit costs must be established locally and must include all labour, equipment and material inputs and mobilisation and overhead costs so that they reflect the expected cost to the Road Administration. The unit cost will therefore depend upon the chosen technology. The unit costs can either be built up from the separate inputs or taken from the Road Administration's records of completed contracts.

3.3.1 Method 1: Rapid Condition Survey

This method is based upon a rapid survey of all the roads in the network. The survey is carried out as follows. The road is driven in kilometre lengths. After each kilometre, an assessment is made of the average condition of the road over the past kilometre. The carriageway is assessed, and for engineered roads, the drainage is also assessed. In addition a brief survey is made of all culverts and bridges. Each item is given a rating from 1 (for no defects) to 5 (for total failure).

Box 3.1

Labour protection measures

Daily task rates

Activities are normally divided into daily tasks to encourage labourers to complete a known amount of work in a day, thus assisting site planning. Many labourers need to work on their farm or at home after their day's work is complete. Daily tasks should be set to allow this. National guidance on daily tasks may be available but may need to be adjusted to suit local conditions such as density of bush or heaviness of soil.

First Aid

All sites must have first aid facilities staffed by a trained health worker. Access to a nearby clinic must be possible at all times in case of more serious injury. For very small sites or mobile operations, at least one person in the team should have basic First Aid training and carry a First Aid kit.

HIV/AIDS/STDs

Site camps create an environment conducive to the spread of sexually transmitted diseases (STDs). Encourage health educators to visit site camps, make condoms readily available, allow time for workers to visit families, and provide treatment for treatable STDs. It may be possible to refund the costs of health educators' visits.

Gender issues

Encourage women to take employment. Set targets for female involvement, although these targets should not be contractually binding. Use religious networks and women's groups to advocate female involvement. Explain to men's groups why women should have the opportunity to work. Single sex work gangs may be appropriate in some communities.

Minimum wage

Comply with legally enforceable minimum rural wages, although reduction may be agreed between the contractor and legal authority if a daily task has been based on less than 8 hours at a normal rate of work. The contractor can decide to pay more than the minimum wage if he or she chooses.

Minimum age

Comply with legal minimum ages. The general minimum age may be relaxed by two years for light work (which is neither hazardous nor compromises schooling or the ability to benefit from it) with legal consent. This may be relevant where children are forced to carry family responsibilities as a result of the death, absence or disability of their parents. Ages may have to be estimated in the absence of birth certificates.

Importing labour

It is preferable to employ locally than to import labourers who have been trained on other sites. This increases a sense of community ownership, benefits the local economy, allows labourers to work on their farms and reduces HIV/AIDS and other problems in site camps. Local people may disrupt a site if they feel they are being denied opportunities by imported labour. It is normally acceptable, however, for a contractor to retain a core of skilled labourers to help with training on new sites.

Non-discrimination

Recruit fairly across all sectors of the community (sex, religion, ethnic, etc) and ensure that no group uses the employment opportunity to exert improper control over another.

Community monitoring

Communities involved in labour based works should be given the opportunity to form groups to monitor the contractor's compliance with protection measures. The democratic selection of such groups is critical to ensure they are representative of the community.

Labour representation

Encourage unions or groups to represent the interests of labourers on site.

Worker's compensation

The contractor must have adequate insurance to pay for treatment and to provide compensation to site workers in case of disablement or injury. This is often a legal requirement. It is common to include insurance premiums as a preliminary item in a Bill of Quantities.

Table 3.5 Cost estimation methods

	Method	*Key features*
1	Rapid Condition Survey. **RECOMMENDED**	Quick – around 50 km of survey per day. A reasonable prediction of costs. Takes actual road condition into account – suitable for roads in poor condition.
2	Engineer's Estimate.	Slow – around 10 km of survey per day. An accurate prediction of costs. Takes actual road condition into account – suitable for roads in poor condition. Expensive to survey all roads at this level of detail.
3	Estimate based upon local influences.	Very quick, but approximate. Does not require a site visit. Takes account of factors which affect costs, but not actual road condition. Not suitable for roads in poor condition.
4	Estimate based upon historical records.	Very quick, but approximate. Does not require a site visit. Suitable if road has been maintained in good condition for several years.

Each rating is associated with a remedy to restore the item to a rating of 1. The remedy may not exactly match the required works but will be indicative of the required cost. A unit cost should be calculated for each remedy. A total cost can then be estimated by adding the cost to restore the carriageway and drainage over each kilometre to the cost to restore each culvert and bridge. The items, ratings and remedies for the four road types are shown in Table 3.6. The table can be extended to include additional items, such as drifts and steep slopes in need of stabilisation. The Road Manager may decide to assemble typical photographs to show each item at each rating from 1 to 5 in order to achieve consistency within a survey team.

For instance, a kilometre of engineered earth road may have a surface rating of 3, a drainage rating of 2 on each side and include a double and a single culvert, each with a rating of 2. Therefore the cost should be calculated for a kilometre of heavy grading, two kilometres of drain clearance, and the cleaning of three culvert barrels.

It will often be necessary to estimate separately the costs of activities such as major structural repair and slope stabilisation, as these can vary greatly.

The Road Manager may decide to adjust the length of road for which a single rating is given. A distance of 200 or 500 metres may be used, or the length may vary depending upon the rate of change of the condition. Using variable lengths is more accurate but requires a very observant assessment of change and careful recording of length.

In later sections of this document, a distinction will be made between a good-to-fair or maintainable condition, where minor defects can be rectified using normal maintenance techniques, and a poor or unmaintainable condition where rehabilitation of major defects is required. Table 3.7 shows how condition is defined.

3.3.2 Method 2: Engineer's Estimate

This method estimates the likely price of a contract to complete the required works. It has two steps.

1. Identifying the required activities. This is described in Section 3.7.

2. Costing the required activities. This is described in Section 3.8.

In normal circumstances, individual activities are identified only when contracts are being prepared for which funds are known to be available. Therefore this method is suitable only for authorities with sufficient technical and financial resources.

Table 3.6 Rapid Condition Survey ratings

Item	*Track*		*Engineered earth*		*Gravel*		*Improved surface*	
Rating	*Description*	*Remedy*	*Description*	*Remedy*	*Description*	*Remedy*	*Description*	*Remedy*
Carriageway								
1	No defects.	Routine activities only.	No defects.	Routine activities only.	No defects.	Routine activities only.	No defects.	Routine activities only.
2	Minor defects.	Minor surface repair.	Minor defects.	Light grade or manual repair of defects.	Minor defects.	Light grade or manual repair of defects.	Minor defects.	Minor surface repair.
3	Major defects, but access is not at risk.	Major rut or pothole repair.	Major defects, but access is not at risk.	Heavy grading or manual filling of ruts and potholes.	Major defects, but access is not at risk, gravel less than 75 mm.	Heavy grading or manual filling of defects; regravel.	Major defects, but access is not at risk.	Major surface repair.
4	Access is lost or at risk, passage is dangerous.	Form camber and side drains.	Access is lost or at risk, passage is dangerous.	Reform camber and drains.	Access is lost or at risk, passage is dangerous.	Reconstruct road and regravel.	Access is lost or at risk, passage is dangerous.	Reform camber and drains and reconstruct improved surface.
5	Inaccessible, track has failed.	Import material; form camber and side drains.	Inaccessible, road has failed.	Reform camber and drains; provide a gravel surface.	Inaccessible, road has failed.	Reconstruct road and provide an improved surface.	Inaccessible, road has failed.	Reform camber and drains and reconstruct improved surface.
Drainage *(average of left and right sides)*								
1	n/a	n/a	No defects.	Routine activities only.	No defects.	Routine activities only.	No defects.	Routine activities only.
2	n/a	n/a	Minor sedimentation or erosion.	Clear drain or repair erosion.	Minor sedimentation or erosion.	Clear drain or repair erosion.	Minor sedimentation or erosion.	Clear drain or repair erosion.
3	n/a	n/a	Major sedimentation or erosion but no danger or risk to access.	Clear drain or repair erosion; construct scour checks.	Major sedimentation or erosion but no danger or risk to access.	Clear drain or repair erosion; construct scour checks.	Major sedimentation or erosion but no danger or risk to access.	Clear drain or repair erosion; construct scour checks.

Continued ....

Table 3.6 (Continued) Rapid Condition Survey ratings

Item	*Track*		*Engineered earth*		*Gravel*		*Improved surface*	
Rating	*Description*	*Remedy*	*Description*	*Remedy*	*Description*	*Remedy*	*Description*	*Remedy*
Drainage *(average of left and right sides) (Continued)*								
4	n/a	n/a	Major damage to drains, access is at risk.	Repair erosion, construct scour checks, dig mitre drains.	Major damage to drains, access is at risk.	Repair erosion, construct scour checks, dig mitre drains.	Major damage to drains, access is at risk.	Repair erosion, construct scour checks, dig mitre drains.
5	n/a	n/a	Complete failure of drainage system.	Reconstruct drainage system.	Complete failure of drainage system.	Reconstruct drainage system.	Complete failure of drainage system.	Reconstruct drainage system.
Culverts								
1	No defects.	No work required.	No defects.	No work required.	No defects.	No work required.	No defects.	No work required.
2	Minor sedimentation or erosion.	Clear silt or repair erosion.	Minor sedimentation or erosion.	Clear silt or repair erosion.	Minor sedimentation or erosion.	Clear silt or repair erosion.	Minor sedimentation or erosion.	Clear silt or repair erosion.
3	Major sedimentation or erosion, but access is not at risk.	Major clearing or repair required.	Major sedimentation or erosion, but access is not at risk.	Major clearing or repair required.	Major sedimentation or erosion, but access is not at risk.	Major clearing or repair required.	Major sedimentation or erosion, but access is not at risk.	Major clearing or repair required.
4	Impassable or dangerous to pass.	Structural repair: equivalent to half replacement cost.	Impassable or dangerous to pass.	Structural repair: equivalent to half replacement cost.	Impassable or dangerous to pass.	Structural repair: equivalent to half replacement cost.	Impassable or dangerous to pass.	Structural repair: equivalent to half replacement cost.
5	Collapsed or absent culvert.	Replace culvert; consider enlarging.	Collapsed or absent culvert.	Replace culvert; consider enlarging.	Collapsed or absent culvert.	Replace culvert; consider enlarging.	Collapsed or absent culvert.	Replace culvert; consider enlarging.

Continued ....

Table 3.6 (Continued) Rapid Condition Survey ratings

Item	*Track*		*Engineered earth*		*Gravel*		*Improved surface*	
Rating	*Description*	*Remedy*	*Description*	*Remedy*	*Description*	*Remedy*	*Description*	*Remedy*
Bridges								
1	No defects.	No work required.	No defects.	No work required.	No defects.	No work required.	No defects.	No work required.
2	Minor sedimentation or erosion.	Clear silt or repair erosion.	Minor sedimentation or erosion.	Clear silt or repair erosion.	Minor sedimentation or erosion.	Clear silt or repair erosion.	Minor sedimentation or erosion.	Clear silt or repair erosion.
3	Major sedimentation or erosion, but access is not at risk.	Major clearing or repair required.	Major sedimentation or erosion, but access is not at risk.	Major clearing or repair required.	Major sedimentation or erosion, but access is not at risk.	Major clearing or repair required.	Major sedimentation or erosion, but access is not at risk.	Major clearing or repair required.
4	Impassable or dangerous to pass.	Structural repair: equivalent to half replacement cost.	Impassable or dangerous to pass.	Structural repair: equivalent to half replacement cost.	Impassable or dangerous to pass.	Structural repair: equivalent to half replacement cost.	Impassable or dangerous to pass.	Structural repair: equivalent to half replacement cost.
5	Collapsed or absent bridge.	Replace bridge: requires a detailed survey.	Collapsed or absent bridge.	Replace bridge: requires a detailed survey.	Collapsed or absent bridge.	Replace bridge: requires a detailed survey.	Collapsed or absent bridge.	Replace bridge: requires a detailed survey.

Table 3.7 Rapid Condition Survey – overall condition assessment

Individual item	*Entire road*	*Requirements*
Maintainable		
Rating of 1, 2 or 3	95%* or more of all ratings are 1, 2 or 3	Maintenance
Unmaintainable		
Rating of 4 or 5	5%* or more of all ratings are 4 or 5	Rehabilitation

** These percentages are only a guide and may be adjusted locally*

3.3.3 Method 3: Estimate based upon local influences

This method assumes that costs depend upon the length of the road, the number of structures, and the local external influences (traffic, terrain, soil and climate).

1 Using Table 3.8, estimate the annual maintenance costs of each maintainable road by multiplying the lengths of road of each type and the number of bridges and culverts by unit costs.

2 Multiply this total by factors for traffic, terrain, soil and climate according to inventory information.

3 If an influence was not included in the inventory, use the middle factor.

This method depends upon appropriate factors for traffic, terrain, soil and climate. The Road Manager should set unit costs and the factors to suit actual maintenance costs.

Table 3.8 Cost estimation – local influences

Item	*Unit*	*Quantity*	*Unit cost*	*Total*
Length of track	km		*Set*	
Length of engineered earth	km		*unit costs*	
Length of gravel	km		*according to*	
Length of improved surface	km		*local conditions*	
No of culverts	no.		*and chosen*	
No of bridges	no.		*technology*	
			Total	

Influence	**Description**	**Factor**		
Traffic *(Equivalent Daily Traffic)*	> 200	1.5		
(see Annex C)	50 – 200	1.1	x	
	< 50	1.0		
Terrain	Mountainous	1.5		
	Rolling	1.1	x	
	Flat	1.0		
Soil	Erodible	1.5		
	Slippery	1.1	x	
	Durable	1.0		
Climate	Seasonal, intense rain	1.5		
	Seasonal, mild rain	1.1	x	
	Uniform rain pattern	1.0		**Total cost**

3.3.4 Method 4: Estimate based upon historical records

If a road has been maintained in good condition for several years with no major change in circumstances such as a rapid traffic rise or severe flood damage, and good records have been kept, these records can be used to estimate future maintenance costs. This can be done in two ways. Either the contract costs over the last five or more years can be averaged and an allowance made for recent inflation, or the quantities over the last five or more years can be averaged and multiplied by current unit rates.

The use of historical records is most suited to maintenance activities. However, they can be used for rehabilitation works if the Road Manager feels confident that the current poor condition is similar to the condition when earlier rehabilitation was carried out. Historical records are less accurate for rehabilitation than for maintenance.

3.4 Submitting a request and receiving a budget

After estimates have been completed, a submission is made for funding to the Treasury, Ministry or Road Fund. This submission should include additional costs as follows:

Overheads

This includes staff costs and quality control testing costs when appropriate.

Inflation

If contracts are expected to last longer than a year, the submission should include provision for expected inflation. If inflation is very high, provision may be included in shorter contracts.

Emergency work

An allowance for emergency work may be included within the main submission or may be submitted separately. This allowance may be 5-10% of the estimated road management costs, depending on local terrain, climate and traffic.

The way in which the submission is presented to the funding source depends upon the existing institutional and financial systems. In all cases, a certain level of detail is required so that expenditure can later be audited against the planned works. The Road Manager is expected to follow the current practice within his or her organisation.

The level of detail in the submission can vary. In some cases a single figure may be sufficient; in others the cost for each individual road may be required, with more detailed information such as technology choice.

The submission may have to be divided into maintenance and rehabilitation because each activity type is funded by a separate source or by separate streams within the same source. In this case the distinction referred to in Table 3.7 will be of use. However, it may be necessary to further divide maintenance into routine and periodic costs, or provide more detail for the rehabilitation works. In this case, Table 3.7 is insufficient and a more detailed condition survey will be required.

The funding source will consider submissions from all Road Administrations and will allocate budgets according to its agreed procedures. These may be based upon factors such as historical precedent, network size, quality of submission and technology choice.

Each Road Administration will then be told the budget that it will receive and if it will be given in instalments. Since funds are normally constrained, these funds are likely to be less than the submitted costs. In this case, the funding source and the Road Administration will enter a period of negotiation during which the latter will reduce its costs to meet the available budget.

3.5 Reducing costs to meet the budget

In order to meet the available budget, it is normally necessary to reduce the required road management costs. Costs can be reduced in a number of ways using a variety of social, economic, strategic and technical criteria. Four methods are given here. Table 3.9 gives a summary of each method. The selection may depend upon local or national policy, for instance in the priority given to poverty reduction, local industry or road user participation.

Table 3.9 Cost reduction methods

1. Set the standards to which roads will be maintained.	2. Maintain roads in good condition before rehabilitating roads in poor condition.	3. Select roads for rehabilitation using established and agreed procedures.	4. Use other technical solutions to reduce costs.
Select one of 3 standards. **Full**: provide safe, reliable, quick and comfortable year round travel. **Basic Access**: provide safe and reliable year round access. **Partial Access**: provide a minimum level of access at very low cost.	It is more cost effective to maintain a road in good condition than to rehabilitate, omit maintenance and then rehabilitate again. Thus maintain the roads that are in good condition first.	**Select one of 7 procedures.** **1.** HDM and RED. **2.** Core network. **3.** Socio-economic benefit/ cost analysis. **4.** Integrated Rural Accessibility Planning. **5.** Cost Effectiveness Indicator. **6.** Point scoring. **7.** Activity matrix.	**Select one of 5 solutions** **1.** Upgrade a road. **2.** Defer an activity. **3.** Reduce activity frequency. **4.** Downgrade a treatment. **5.** Apply a Partial Access standard.

Normally, the entire length of a road is considered as a single item when making planning decisions. However, if a road naturally divides into links with different characteristics, such as traffic levels, population density or terrain, it may be worthwhile distinguishing these links with additional referencing. The use of links was introduced in Section 2.2. The Road Manager may decide to consider links separately when using the following methods.

It is recommended that a combination of all four methods is used to reduce costs to meet the available budget. However, if the available budget has been defined separately for maintenance and rehabilitation, care must be taken to ensure that the reductions produce a submission that reflects the division of the budget.

3.5.1 Method 1: Set standards

Costs may be reduced by setting the standard to which each road in the network is maintained. It is recommended that roads in a network are maintained to different standards according to the function and usage of each road. Where traffic levels are low and the road less important, it is possible to overlook certain sites yet still provide a level of service suitable for the road users at reduced cost. Three standards are recommended: Full, Basic Access and Partial Access. Table 3.10 defines each of these standards. It describes the level of service that it will provide, explains on which roads it should be applied and shows how it is achieved.

The main text of this document is concerned with Full and Basic Access. Basic Access and Partial Access are described in more detail in Boxes 3.2 and 3.3. Important issues relating to Partial Access are covered in Annex D.

The use of three standards does not affect the quality of work or the suitability of the road for maintenance. Whichever standard is set, the quality of work should be high and normal maintenance activities will maintain the required level of service.

In order to estimate the cost reduction by setting standards according to road function and usage, the Rapid Condition Survey (Method 1 in Section 3.3) can be used. Revised costs are estimated as follows:

- Full standard. Include all estimated costs.
- Basic Access standard. Include only those carriageway costs derived from ratings of 4 or 5, but include all drainage and structures costs.
- Partial Access standard. This is harder to estimate. In practice, estimate a nominal low figure and then use the funds as efficiently as possible.

Table 3.10 Standards for road maintenance

Standard	*Full*	*Basic Access*	*Partial Access****
Level of service.	Safe, reliable, quick, and comfortable year round travel for all road users.	Safe and reliable year round access – minimum requirement for socio-economic development.	Minimum level of access at very low cost. Access may not be year round and may not suit all vehicle types.
Which roads?	• Primary and Secondary roads. • Tertiary, Feeder and Access roads over 50 km in length or with EDT* above 100**	• Tertiary, Feeder and Access roads less than 50 km in length and with EDT* below 100** that are in a maintainable condition or prioritised for improvement.	• Tertiary, Feeder and Access roads in poor condition that are not prioritised for improvement. • Unclassified roads.
How is the standard achieved?	1. Carry out work on all sites identified under Basic and Partial Access. 2. Improve sites where: • Road surface is rough and speeds are reduced. • Other non-critical defects exist.	1. Carry out work on all sites identified under Partial Access. 2. Improve sites where. • Year round access is not possible for a typical vehicle (normally a medium truck). • Access cannot be guaranteed to last the rainy season. • Road is excessively rough; speeds are very low. • Road condition is likely to rapidly deteriorate under traffic or rain. • Erosion is likely to worsen.	Improve sites where: • Passage is impossible even in emergency. • Passage puts people and vehicles in danger.

* *Equivalent Daily Traffic – see Annex C.*

** *Road length and Equivalent Daily Traffic levels should be set according to the local situation. 50 km and an EDT of 100 are suggested in the absence of other guidance. A distance is set because a round trip that takes more than 8-10 hours may deter many traders and commercial transport operators.*

*** *Partial Access – see Annex D.*

3.5.2 Method 2: Maintenance before rehabilitation

Method 2 is very simple. It acknowledges that regular maintenance of a road in good or fair condition is cheap and cost effective whereas long periods of no maintenance and deterioration interspersed with bouts of rehabilitation are expensive for the Road Administration and disruptive to road users. Therefore roads in good or fair condition should be maintained before roads in poor condition are considered for rehabilitation.

Returning to the Condition Survey (Method 1 in Section 3.3), if 95% or more of all ratings are 3 or less, the road is said to be in a good or fair, or maintainable, condition. If 5% or more of all ratings are 4 or more, the road is said to be in poor, or unmaintainable, condition.

Cost reductions are estimated by removing all roads in unmaintainable condition from the submission.

This method may often meet resistance from parties who are unwilling to spend money on roads which appear to be in good condition. The Road Manager should reassure these parties of the importance of maintaining roads which are already in good or fair condition.

Box 3.2

Basic Access should be:

Reliable
Local traders will buy vehicles, and farmers will plant surplus crops only if they can rely on a road being open next year. Communities must be able to rely on access to health and other facilities at all times.

Safe
All road users have a right to safe travel.

Year round
Access should be available throughout the year, although short term closures during the rains may be accepted. If these closures are longer than one or two days, some drivers, especially commercial operators, will attempt passage. Passengers will be put in danger, the road may be damaged or blocked and costly repair will be necessary. Longer periods of closure restrict development and long term isolation is a key element of poverty. In some countries with long and heavy monsoons, it is difficult to provide year round access and longer closures must be accepted, particularly for heavy vehicles.

Suitable for all vehicle types
The road should be useable by all vehicle types that may require access. A medium sized truck can be used as a standard vehicle, although on tracks within villages a motorbike or a draught animal may be more appropriate. However, it may be necessary to prevent very large vehicles passing to protect the carriageway and structures, vulnerable roadside communities or areas rich in timber.

Spot improvements

The activities required to achieve Basic Access are often referred to as *spot improvements* as they tend to be in isolated spots rather than a single long length of improvement. Spot improvements may entail changing the road type of a short section to suit external influences such as traffic, terrain or in situ soil. Spot improvements are normally required at sites where there has been damage from running or standing water or where the soils are very weak. Spot improvements should include sites where access has been lost and sites where access is at risk (see Table 3.10). As traffic levels increase, sites for spot improvements will be identified progressively – a site which was stable under low traffic, may require improvement if it is to be stable under higher traffic.

The disadvantages of Basic Access

Although the reduced costs enable funds to be spread more widely, providing Basic Access through spot improvements has disadvantages in practice. Road Managers unfamiliar with an area find it difficult to predict defects; contractors find it difficult to organise the isolated works; there are less employment opportunities for local labour; and administrations, politicians and the public do not like the variable appearance of the road. Promoting the standard can therefore sometimes be difficult, although it will be easier if the members of the participatory frameworks in Section 3.1 have been involved throughout the road management cycle.

3.5.3 Method 3: Prioritise roads for rehabilitation

Method 2 proposes not carrying out work on roads in poor condition. This is because the rehabilitation of these roads is not cost effective if future maintenance cannot be guaranteed. However, where good road management and reliable funding ensure future maintenance, a Road Manager should aim to expand the maintainable network by rehabilitating those roads in poor condition. This expansion should be gradual such that maintenance needs remain within capacity and budget, but should continue until all roads are in good condition.

Method 3, therefore, involves identifying the roads in poor condition where rehabilitation will give the most benefit to the road users. This is termed *prioritisation*. Seven prioritisation procedures are given here. Table 3.11 gives a summary of each procedure to enable the most suitable one to be used.

Box 3.3

Partial Access should be:

Low Cost
Very low levels of funding are likely to be available. Local people may be able to contribute labour or materials.

Minimum level of access
This level of access will not necessarily suit all vehicle types, nor will it provide access at all times during the year. A target level of access may be for pedestrians, bicycles and motorcycles during the dry season and intermittently during the rains. Partial Access may be seen as the first stage, with motorable year round Basic Access being provided as development begins and greater expenditure becomes justified.

The disadvantage of Partial Access

The disadvantage of Partial Access is that it may not be suitable for the commercial vehicles which are likely to try to use the roads as the local economy develops and upon which much rural development relies.

(Further details of Partial Access are given in Annex D)

Table 3.11 Prioritisation procedures

	Procedure	*Key features*
1	HDM and RED.	The Road Economic Decision (RED) model is a simplified version of the complex Highway Development and Management (HDM) software package. In both cases a computer is required to run software.
2	Core network.	Based upon creating and maintaining a core within the network. The core can be identified in a variety of ways.
3	Socio-economic benefit/cost analysis.	Suited to a Basic Access standard on low volume roads. Combines technical analysis with a cycle of community consultation.
4	Integrated Rural Accessibility Planning.	Places very high priority on participation and the needs of rural households. Most suitable for very low volume roads and village tracks. Often used in association with other infrastructure and mobility projects.
5	Cost Effectiveness Indicator.	Rapid and requires little data collection. Uses population as an indicator of the social impact of road improvements.
6	Point scoring.	The decision can be based upon social and economic indicators. Flexible, any indicator may be easily incorporated into the procedure.
7	Activity matrix.	Prioritises roads primarily by traffic volume. Prioritises activities by their impact upon keeping a road open.

Cost reductions are estimated by including only those roads prioritised for rehabilitation. Table 3.10 is used to determine the standard to which each road will be improved and Method 1 in Section 3.3 is used to estimate the rehabilitation costs.

- Full standard. Include all estimated costs.
- Basic Access standard. Include only those carriageway costs derived from ratings of 4 or 5, but include all drainage and structures costs.

These various procedures prioritise roads using social, economic, strategic and technical criteria. Environmental considerations are not included. If the Road Manager wishes to incorporate environmental costs and benefits into a decision, he or she is referred to Annex F for guidance.

Procedure 1: HDM and RED

Highway Development and Management (HDM) software carries out multi-year analyses of road investments. The analyses compare the costs of road improvements with the time savings and lower vehicle operating costs on roads of reduced roughness. HDM is suited to roads where access is reliable and traffic is high. The Road Economic Decision (RED) model is similar to HDM but includes the analysis of lost access by costing the use of detours and the effect of suppressed demand. Both models are computer based. If these are used, RED is recommended for traffic levels of 50-200 vehicles per day and HDM for levels above 200. See Part 5 for further information on HDM and RED.

Procedure 2: Core network

This procedure is based upon creating a core of roads within the larger network. The core comprises the more important roads in the network, and will often reflect how the roads were classified. In a District, the core is likely to include all Tertiary roads and some Feeder roads. The core may be based upon loops to encourage public transport to use circular routes or on single branches to ensure widespread benefits. Using a combination of participation and technical overview, the Road Manager should identify the core roads and check that they form a complete and connected system. Prioritisation entails bringing the entire core up to a maintainable condition and then extending the core as funds become available. The core roads should be marked onto a map of the network.

Procedure 3: Socio-economic benefit/cost analysis

This procedure is suited to low volume roads where the benefits come from providing access rather than reducing vehicle operating costs. The procedure typically follows a four step cycle of consultation, screening, technical analysis and consultation.

Step 1: Participatory consultation

Make contact with appropriate road users (see Section 3.1). The manner of this contact will depend upon local custom and practice. Explain the process of consultation. Explain how the procedure works and how the final decision will be made at a second consultation. With the road users, establish the criteria for selecting candidate roads, for the screening and technical analysis, and for adjusting the ranking after the analysis has taken place. Again with the road users, identify candidate roads.

Step 2: Screening

The Road Manager may have to screen the roads to remove inappropriate road selections. To properly screen roads, it may be necessary to discuss development plans at Provincial or Regional level. In the absence of local issues, it is recommended that a road is removed from the ranking if it:

- closely duplicates the route and catchment of an existing maintainable road;
- does not connect to a maintainable road; or
- does not benefit the majority living within its catchment.

It is recommended that a road is added if it:

- has strategic importance.

Step 3: Technical analysis

The following analysis shows how to calculate an Accessibility Index for each road based on accessibility benefits and costs.

Estimate the *Accessibility Benefit* from providing access on each candidate road. Record:

- Population within the road catchment (P). The road catchment may be defined as all communities within a certain radius from the road and closer to the road than any other accessible road. 10 kilometres is often used as a catchment radius.
- Equivalent Daily Traffic (EDT) (see Annex C).
- Length of road in km (K).
- Weeks per year during which the road is impassable (WP).
- Additional weeks per year during which vehicles experience severe difficulty in travelling along the road (WT).

Assuming that the road is rehabilitated to a Basic Access standard by addressing all sites of impassability and severe difficulty, calculate the Accessibility Benefit as follows.

$$\textit{Accessibility Benefit} = [(P \times X) + (EDT \times 365)] \times K \times [WP + (WT/4)]$$

X is a factor to convert a desirable level of social movement to an annual traffic volume. X may take the value of 1 on the basis of a typical figure of 5 return trips per person per year in a vehicle taking an average of 10 people. X may be adjusted to suit estimated local vehicle usage.

The Accessibility Benefit can be adjusted to suit local preference by incorporating additional factors. For instance, it may be felt that rural poverty, isolation from health services or markets, or strategic need should raise the priority of a road. If so, the Accessibility Benefit could be multiplied by a factor (in the region of 1.2 to 2) if the relevant condition applies. If adjustment is made, care must be taken when comparing roads in different areas.

Estimate the *Accessibility Cost* of rehabilitating the road to a Basic Access standard. Return to the Condition Survey (Method 1 in Section 3.3) and add the costs derived from carriageway ratings of 4 or 5 to all drainage and structures costs. Roads where EDT is greater than 100 (see Table 3.10), may be rehabilitated to a Full standard. For these roads, the *Full Cost* is the cost derived from all ratings for all items.

Since a structure is durable and lasts longer than a carriageway or drainage improvement, it is recommended that an *Adjusted Accessibility Cost* is calculated by halving all structural repair and replacement costs. This will increase the priority given to improvements which will provide access over a long time period.

Calculate the Accessibility Index of the road.

$$\frac{\text{Accessibility Benefit}}{\text{Adjusted Accessibility Cost}}$$

Rank the roads by Accessibility Index with the highest first. Since this procedure considers the costs of only the first year of rehabilitation works, if two or more roads have similar Accessibility Indexes, the roads whose long term maintenance costs are likely to be lower should be ranked more highly.

Alongside each ranked road write the Accessibility Cost (or the Full Cost for roads where EDT is greater than 100 – see Table 3.10). Select roads according to the ranking, summing the costs until the funds are exhausted. Additional restrictions may be applied to the selection process. For example, a limit of two roads per secondary administrative unit may be set.

Step 4: Return to consultation

Return to the community and present the ranking and road selection. Rankings may be adjusted up or down using the criteria which were established in Step 1. The final decision as to which roads will be rehabilitated belongs to the community. The technical analysis is for their guidance only.

Procedure 4: Integrated Rural Accessibility Planning (IRAP)

IRAP is a local level planning tool which prioritises rural investments by considering the needs of rural households. These needs include access to facilities such as health services, farms, agricultural processing, markets and water supplies. Those using IRAP seek to address these needs by classing accessibility problems (in terms of time, cost, frequency, convenience or possibility) as either due to difficulties in travel ('lack of mobility') or due to the distance from the household to a facility. Accessibility improvements can therefore include relocating facilities, encouraging transport services or rehabilitating roads and tracks.

The IRAP procedure was developed from experience in Africa and Asia. It is best used at local government level and should be seen as a tool to complement existing planning methods. It is low cost and easy to use, and requires participation by both local government and rural communities.

IRAP involves a sequence which maps and assesses the entire network, plans maintenance for the roads in maintainable condition, and then prioritises roads in poor condition. Since this sequence is also the basis for this document, only the IRAP prioritisation procedure is described here. It has four steps.

Step 1: Number of people

Identify the communities, and estimate the number of people, within the road catchment. The catchment may be defined as in Step 3 of Procedure 3.

Step 2: Socio-economic impact

Socio-economic impact, the key to the IRAP process, can be estimated in a number of ways. The following is just one of these. Firstly, identify a number of indicators. These may include agricultural potential of the surrounding area, access to a good water supply, access to the nearest market, and road condition before improvement. Secondly, each indicator is weighted to show its relative importance to those living in the road catchment. Thirdly, for each road, a score is given for each indicator (1 when the item is a minor problem or low potential, 3 when intermediate and 5 when severe or high potential). Each score is weighted and the total is calculated for each road. Participation of all parties (for deciding indicators, weightings and scores) is vital during this step.

Step 3: The cost of the improvements

Estimate the costs as accurately as possible. Method 1 in Section 3.3 is suitable.

Step 4: The benefit/cost ratio

Calculate the benefit/cost ratio for the proposed roads using the population, the socio-economic score and the improvement costs.

$$\frac{(\text{population served}) \times (\text{total socio-economic score})}{\text{cost of improvements}}$$

Rank the roads by ratio. Since this procedure considers the costs of only the first year of rehabilitation works, if two or more roads have similar benefit/cost ratios, the roads whose long term maintenance costs are likely to be lower should be ranked more highly. Select roads by ranking until funds are exhausted. Further details of IRAP are available from ILO/ASIST (see Section 5.1).

Procedure 5: Cost Effectiveness Indicator

This procedure is used for prioritising low volume roads where the main objective is poverty relief. Calculate the Cost Effectiveness Indicator by dividing the cost of upgrading the road from impassability to a Basic Access standard by the population served by the road (using the method described in Step 3 of

Procedure 3). It is assumed that low cost designs will be used. Rank road interventions using this indicator, smallest first. Since this procedure considers the costs of only the first year of rehabilitation works, if two or more roads have similar Cost Effectiveness Indicators, the roads whose long term maintenance costs are likely to be lower should be ranked more highly. Select roads for improvement until funds are exhausted. The indicator can also be used to give an upper limit to the cost which should be spent on improvements per person living alongside the road.

A development of this procedure is to divide the indicator by additional factors relating to the socio-economic impact of the improvements. Factors might be based upon the agricultural potential of the surrounding area, current school attendance or the time taken to travel to the District centre, but should be determined according to local preference and conditions.

Procedure 6: Point scoring

This is a procedure which incorporates both social and economic benefits. It allocates points to a road based on a variety of indicators. Points are normally associated with the benefits derived from improving the road. As such, it only indicates the benefits of an investment and so may prioritise an expensive option. Screening can be used to remove these options, or points can be deducted for expensive interventions. The roads with the most points are prioritised for improvement until funds are exhausted.

The indicators used for points scoring must be chosen according to local priorities. However, Table 3.12 lists some of the indicators which may be chosen and suggests the maximum points which might be allocated.

Table 3.12 Prioritisation by points scoring

Indicator	*Suggested points for allocation*
Population served.	Population / (road length × 10) up to a maximum of 100.
Current road condition.	50 for poor condition; 10 for good condition.
Local social factors, for example poverty.	25 points for accessing an area of acknowledged poverty.
Connections with other roads.	50 for linking to Primary/Secondary; 25 for linking to Tertiary/Feeder; 10 for linking to Access.
Traffic levels (motorised plus non-motorised).	25 points for high traffic; 15 for medium; 5 for low (define high, medium and low to reflect the typical traffic range).
Economic potential.	25 points for accessing an area of acknowledged potential.
Existing transport services.	25 points for a daily bus service.
Health, market, educational, agricultural processing, tourist, religious or administrative facilities.	5-25 points per facility.

Procedure 7. Activity matrix

This procedure prioritises maintenance activities by the traffic volume, surface type and strategic need of the road and by the type of the activity. To follow the procedure, firstly categorise each road using Table 3.13a. The numbers 1 to 48 in Table 3.13b then determine the order in which activities should be carried out. Using this procedure, urgent activities on strategic roads should be carried out first and special activities on unpaved roads with less than 50 vehicles per day should be carried out last. The Road Manager should note that this method will omit roads where traffic has ceased flowing as a result of lost access. The Road Manager should only use this procedure if confident that the matrix selects the activities most effective in maintaining access.

For the purposes of cost estimation, unless activities in every maintenance activity category have been selected, it is assumed that a Basic Access standard will apply.

Table 3.13 a and b Prioritisation by matrix

Table a: Road categories

Road category	*Average daily traffic*	*Surface type*
1	Strategic roads	Paved
2	> 1000	Paved
3	500 – 1000	Paved
4	200 – 500	Paved
5	> 200	Unpaved
6	< 200	Paved
7	50 – 200	Unpaved
8	< 50	Unpaved

Table b: Activity prioritisation

	Priority Road category							
Type of maintenance activity	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Urgent	1	7	8	9	10	11	12	13
Routine drainage	2	14	15	16	17	18	19	20
Routine pavement	3	21	24	27	30	33	36	39
Periodic	4	22	25	28	31	34	37	40
Other routine	5	23	26	29	32	35	38	41
Special *	6	42	43	44	45	46	47	48

** major activities such as capital works or reconstruction.*

3.5.4 Method 4: Other technical solutions

A number of additional technical solutions are available which can enable a Road Manager to reduce costs. They should be used as appropriate. However, whereas the cost reduction methods described above consider standards and road selection, these solutions require an understanding of specific activities, which are not normally identified in detail until a budget has been received. Therefore it may be necessary to carry out more detailed analysis of certain roads where Solutions 1 or 2 may be suitable or to make assumptions about the cost savings by applying Solutions 3, 4 or 5 across the network. Table 3.14 gives a summary of each solution.

Table 3.14 Technical solutions to reduce costs

	Solution	*Summary*
1	Upgrade a road.	An investment in a road to reduce maintenance costs Suitable if funds are available for upgrading.
2	Defer an activity.	Defer works for one or two years if access and safety are not put at risk.
3	Reduce activity frequency.	Suitable if access and safety are not put at risk.
4	Downgrade a treatment.	Carry out a cheaper holding treatment for up to two years.
5	Apply a Partial Access standard.	Provide a minimum level of access at very low cost Suitable when no other solutions remain.

Solution 1: Upgrade a road

In Table 2.2 four road types are described. Each road type is suitable for different traffic levels and external influences. In many rural networks, roads can be found that have been built to a type unsuitable for their specific influences. For instance, a gravel road under high rainfall, on a steep hill, or subjected to heavy traffic, may rut and erode more quickly than it is possible or cost effective to maintain. In this case it is recommended that the road is upgraded with an improved or bituminous surface. Alternatively, a track prone to ponding and potholing may be upgraded with a camber and side drains or an earth road unable to support existing traffic may be upgraded with a layer of gravel. As a guide, if the estimated saving in annual maintenance costs is more than 20% of the cost of the upgrade, it is probable that long term cost savings will be made. The upgrade should go ahead, although funding rules may require the funds to be obtained through a separate channel.

If a Basic Access standard is being applied to the road, a short length of upgrading may be carried out as a spot improvement. In the example of the above gravel road, the hill may be upgraded since damage is likely on a steep gradient, but other, less steep sections may be left as gravel.

Table 3.15 indicates the range of external influences for which each road type is suitable. The table is intended to show how a change in external influence can affect the suitable road type rather than indicate the exact point at which an upgrade is justified. Traffic levels are given only as a guide since traffic is only one of the many influences that can determine suitability. One of the major implications of considering the suitability of the road type is a reduction in gravel usage. As gravel sources become exhausted and haulage distances rise, well maintained engineered earth roads and various types of improved surfaces are likely to replace gravel in many rural road networks. Gravel is also likely to be used less in urban areas as the adverse health implications of dust are increasingly acknowledged.

Table 3.15 Road type suitability

Type	Track	Engineered earth	Gravel	Improved surface
Description	Traditional route, cleared vegetation, informal structures.	Camber, drains and designed structures.	As engineered earth plus an imported gravel surface.	As engineered earth plus a surface layer such as bricks, stones or blocks.
Suitability	Very low traffic levels (<20 vehicles per day), light vehicles, flat terrain or gentle gradients, mild climate, well drained firm in situ soil.	Low traffic levels (10-100 vpd), medium vehicles, gentle terrain, mild climate, firm in situ soil, poor supply of gravel, regular maintenance.	Moderate traffic levels (25-200 vpd), medium sized trucks, moderate terrain, light seasonal rainfall, good supply of gravel, regular maintenance.	High traffic levels (> 100 vpd), heavy vehicles, steep hills, intense rainfall, urban areas, poor in situ soils, good supply of surfacing materials.

Solution 2: Defer an activity

Some activities may be deferred for one or two years to reduce costs. Since activities should not be deferred if they put the condition of the road or the safety of road users at risk, this solution is most suitable for activities such as reducing carriageway roughness, replacing a drift with a bridge, or non-critical safety measures.

Solution 3: Reduce activity frequency

A number of maintenance activities are required at regular intervals during the year. For example, grass may have to be cut three times a year for reasons of visibility, drainage, encroachment and pedestrian access. To reduce costs, the frequency of an activity can be reduced, although it is very important to ensure that this will not put the condition of the road or the safety of road users at risk. This solution should be seen as a temporary measure and used for a maximum of two consecutive years.

An application of this solution is to carry out maintenance during short periods of activity. If road deterioration and vegetation growth are slow during the dry season, a period of maintenance after the rainy season, and a possible second period before the next rains will reduce costs. This solution can be used whether or not the work is carried out by lengthworker or larger contractor.

Solution 4: Downgrade a treatment

Although there is a most appropriate treatment for every defect, it may sometimes be possible to restore or secure access with a cheaper alternative. An example may be to repair drain erosion instead of constructing scour checks. However, the alternative may be less durable and so should be seen as temporary, or a ‘holding treatment’, for a maximum of two years before funds are sought for the most appropriate treatment. This solution should be used only on roads with very low traffic levels. Alternative treatments can be found on the Activity Planning Sheets in Annex G.

Solution 5: Apply a Partial Access standard

It may occur that a road with very low traffic and which serves little purpose is being maintained to a Basic Access or even a Full standard. To reduce costs, a Partial Access standard may be applied. This

will not be a popular decision and represents a waste of long term investment, so should only be used when no other solutions remain.

3.5.5 Summary of how to reduce costs to meet the budget

In order to reduce costs to meet an available budget, and to ensure a reasonable spread of funds around the network, a Road Manager should follow the steps in Box 3.4.

Box 3.4

Reducing costs to meet the budget

1. Maintain all roads in good or fair condition. Provide a Full or Basic Access standard according to function and usage.
2. Rehabilitate priority roads in poor condition. Provide a Full or Basic Access standard according to function and usage.
3. Provide a Partial Access standard on all other roads.
4. Employ other technical solutions when appropriate.

The Road Manager should not forget that this document is based upon a cycle of reliable access, confidence, rural investment, traffic growth, increased revenue and sustainable network improvement. The Road Manager should have a long term target, helped by budgets expanding in response to good road management, of gradually raising standards across the network until all roads are well maintained at a Full standard.

3.6 Safety engineering

Nearly one million people are killed world wide in road accidents each year. Around half of these deaths are on rural roads in low income countries. Reducing accident related deaths through safety engineering will make a major contribution to social well being and economic development. Road accidents have three types of causes: the driver, the vehicle and the road environment, although most accidents are multi-causal. A Road Manager has influence over only the road environment, but should use this influence to allow vehicles to travel safely, to protect pedestrians and cyclists from vehicles, and to provide adequate warning of potentially dangerous sites.

Table 3.16 provides guidance on producing a safe environment for all road users. The Road Manager should select from the listed solutions according to likely budgets, road classification and traffic levels. The chosen solutions can be combined with other required maintenance and rehabilitation works for implementation. All solutions, including warning signs and traffic calming, should comply with national standards. Some of the solutions are suitable for sealed roads.

3.6.1 Recording accident information

A Road Manager is also encouraged to liaise with traffic police and regularly review accident data. Good accident records should include the following:

- location of accident, using distance posts if installed;
- number and type of vehicles;
- number and severity of casualties;
- direction of travel;

- road curvature;
- accident type;
- time of day;
- weather;
- surface condition;
- dust levels.

With careful scrutiny, the data will often reveal patterns and suggest solutions. For instance, accidents only in the rain may identify a lack of skid resistance or poor drainage and suggest a localised surface improvement. Marking accident data onto strip maps or road segment maps will allow straightforward matching of accidents with road curvature or junctions. Accident information can also be recorded in a software package for a more detailed analysis of patterns.

On very low volume roads, police information will be limited. The Road Manager should ask local residents for accident information.

3.6.2 Enforcement and education

Police enforcement of speed and alcohol limits, vehicle roadworthiness and good driver behaviour is also recognised as a key factor in accident reduction. A Road Manager is also encouraged to set up community and school education programmes to make road users aware of road safety, particularly as traffic levels may increase on a well managed network.

3.7 Recording defects and identifying required activities

The Road Manager has now defined the road network and has reduced the road management plans until the costs meet the available budget. To have achieved this, the Road Manager has made a number of decisions regarding road and activity selection. The next step is for the Road Manager to determine, within these reduced plans, the actual activities that will be packaged for implementation. This step is normally carried out annually. Its timing will depend upon the planning, budgeting and implementation cycle of the Road Administration, but is best carried out after the rains when defects will be most severe.

This section therefore covers the identification of those required activities. Activities can be split into three groups according to how they are identified.

Group 1: Scheduled

A number of activities are predictable and required at regular intervals, often several times per year. An example is grass cutting. The Road Manager knows that grass will grow during the rainy season and that it will need cutting perhaps midway through and shortly after the rainy season.

A condition survey therefore does not need to assess the severity of the defect in order to identify a required activity. Rather, it needs to assess the extent of the item which will require treatment at a predictable frequency or interval. For example, the survey does not need to record the height of grass, but the area of grass which will need to be cut. Recording the area will allow the need for regular grass cutting to be identified even if it is surveyed shortly after the grass has been cut or during the dry season when it has died back. Similarly, the survey does not need to record the thickness of sediment in a drain, but the length of drain which will need to be cleared.

Many routine maintenance activities are predictable and can be scheduled. Some periodic maintenance activities are also predictable and can be scheduled, even if at a lower frequency. Scheduling activities can therefore be rapid if there is sufficient information to enable the Road Manager to estimate when the activity will be required.

With many activities, the Road Manager does not know exactly where it will be required, but is sure that it will be required somewhere along a road. For example, it is impossible to predict where erosion will occur or which culvert aperture will block, but it is likely that there will be erosion and blocked culverts

Table 3.16 Producing a safe environment for road users

Accident type	
Possible problem/cause	*Solution*
Multiple vehicle	
Head on	
Vehicle enters oncoming lane.	• Widen road. • Remove sharp crests and inner curve obstacles to improve visibility. • Improve and maintain road condition. • Provide centre line markings on sealed roads, especially on bends.
Carriageway is too narrow for current traffic usage.	• Widen road. • Provide passing places with signs indicating spacing distance. • Provide signs warning of narrow carriageway. • Slow traffic with well signed traffic calming measures.
Useable width has been reduced by encroachment.	• Remove obstacles and cut vegetation to 1.5 m from carriageway. • Provide temporary signs warning of reduced width.
Useable width has been reduced by road damage.	• Repair damage; continue maintenance. • Provide temporary signs warning of reduced width.
Bridge deck is narrower than carriageway.	• Provide gabions or flared barriers to protect end of bridge. • Provide rumble strips on the approach if a sealed surface. • Provide signs warning of reduced width. • Indicate which direction has priority over oncoming traffic.
Dangerous overtaking manoeuvres.	• Provide parking/passing places. • Improve visibility by cutting vegetation or battering back slopes. • Sight distance must be greater than stopping distance at speed. • Provide signs and road markings warning against overtaking. • Seal road or use dust palliatives to eliminate or reduce dust.
Side impact	
Restart. Vehicle stops at junction, restarts and is then hit from the side.	• Cut vegetation at junction to increase visibility. • Widen shoulder at junction to increase visibility. • Provide signs warning of approaching junction on major road.
Overshoot. Vehicle does not stop at junction and is then hit from the side.	• Provide signs warning of approaching junction on minor road. • Provide large sign on major road opposite the minor road entry. • Cut vegetation at junction to show vehicles approaching from side. • Avoid crossroads if possible; use staggered junctions.
Single vehicle	
Run off road	
Vehicle loses control due to poor condition.	• Provide signs warning of poor road condition. • Provide edge delineators on outside edge of shoulder. • Provide barriers when road is embanked. • Eliminate corrugations, ruts and potholes; continue maintenance.
Vehicle loses control due to high speed.	• Ensure that road geometry is consistent along a road. • Provide signs warning of speed limits. • Encourage police to enforce speed limits.

Continued ....

Table 3.16 (Continued) Producing a safe environment for road users

Possible problem/cause	*Solution*
Accident type	
Run off road	
Vehicle runs off road at a tight bend.	• Avoid tight bends where possible. • Provide barriers and edge delineators on outside of the bend. • Provide signs and road markings warning of tight bend. • Widen and/or super-elevate the carriageway around the bend. • Improve the skid resistance of the road surface.
Vehicle veers off road and cannot recover.	• Provide edge delineators on outside edge of shoulder. • Flatten side slope to 1:5 or less. • Increase shoulder width between carriageway and side drain. • Excavate more mitre drains and reduce side drain depth. • Cover drains with concrete slabs in urban areas. • Excavate a side drain shape which will not trap vehicle wheels.
Hit object on carriageway	
Vehicle hits debris left on road.	• Remove debris as soon as possible. • Provide warning signs if immediate removal is not possible.
Hit object alongside carriageway	
Vehicle hits culvert head wall.	• Provide impact protection to head wall. • Lengthen culvert barrel and re-site headwalls. • Paint the headwall white for greater visibility.
Vehicle hits tree or other obstacle.	• Remove tree and other vegetation within 1.5 m of carriageway. • Paint the tree trunk white for greater visibility. • Re-site all obstacles greater than 1.5 m from carriageway.
Vulnerable road users	
Pedestrians, cyclists, animal carts, etc.	
Traffic speeds are too high in towns and villages.	• Provide signs warning of local speed limits. • Encourage police to enforce local speed limits. • Calm traffic with speed humps, road narrowings, raised level pedestrian crossings & low speed zones.
Road is too narrow for the mix of road users.	• Segregate road users using edge delineators, road markings, kerbs or barriers, especially on bridges. • Retain construction detours for use by vulnerable road users. • Provide an off-carriageway footpath/cycle lane. • Widen drain to act as a dry season footpath. • Widen shoulder to 1.5 metres; pave the shoulder. • Ensure vegetation is regularly cut. • Flatten drain slopes to provide an emergency refuge for cyclists. • Provide off-carriageway areas for market traders.
Poorly located or non-existent bus stops.	• Provide formal bus stop lay-bys. • Provide an off-carriageway bus park.

Some of these solutions are described on Activity Planning Sheets in Annex G. For other solutions, more specialist design, construction and maintenance guidance should be sought.

and it is therefore worth scheduling that activity. Over time the Road Manager will get used to the quantity which is likely to be required every time the activity is scheduled.

Group 2: Condition responsive

Other activities are unpredictable and required at irregular intervals. An example is the repair of structural damage to a culvert. The Road Manager cannot predict when a culvert will need repair and will arrange repair only when the severity of a defect has reached an intervention level at which repair is necessary. Once the defect has been repaired, the activity will not be needed again until the defect reoccurs.

A condition survey therefore must record a defect and its severity for comparison with an intervention level in order to identify a required activity.

Many periodic maintenance and rehabilitation activities are unpredictable and must therefore be identified in response to a condition, although other unpredictable activities, such as routine maintenance repairs to scour checks, will also be required in response to a condition.

Group 3: Emergency

Some activities are required at short notice if access has been lost or if road users are in danger. Emergency works are normally identified and carried out in a parallel system to the annual cycle of planning, budgeting and implementation, and are covered in Annex E.

3.7.1 Recording defects

To record defects, a survey form is required. The form must be suitable for completion by a technician or inspector, and with sufficient detail such that the Road Manager is able to identify most of the required activities and estimate required quantities when the form has been brought back to an office. For major activities such as structural repair or embankment construction, it may be necessary to request further investigation by the Road Manager.

A typical survey form, in this case suitable for earth and gravel roads, is shown in Figure 3.1. It records reference, condition and quantity information. For defects for which activities are normally scheduled, the form records the extent of the item which is predicted to require treatment; for defects for which activities are identified in response to a condition, the form records the extent and also the severity of the defect. The form also records carriageway, shoulder and verge widths to enable areas to be calculated if required.

The form shown is only an example. The Road Manager should design a form to suit the defects which are most likely on the roads for which he or she is responsible. The Road Manager should consider how to record the defects in the most appropriate way. For example, a defect may be recorded by area, depth, quantity or a clearly defined severity code, often using a scale from ‘1’ for good condition to ‘5’ for very poor condition. A defect may be recorded using a combination, such as an area of potholing and the pothole depth. Figure 3.1 gives examples of these alternatives. If the severity of a defect is assessed, the way it is recorded must be compatible with the way that intervention levels are defined so that condition responsive activities can be identified from the information on the form.

A ‘Remarks / Actions’ column is useful to record additional information such as a suggested solution or the need for a second visit for further assessment.

3.7.2 Identifying required activities

It is very important that the correct activity is identified from a recorded or predicted defect. Many Road Managers have experience in identifying the correct activity, but for those who do not, Table 3.17 is provided. This table lists most of the defects which are found on unsealed roads and relates each defect to a particular activity. It also describes both the probable cause of the defect so that the Road Manager can prevent it re-occurring, and the likely effect if the defect remains untreated so that the Road Manager will understand the need for the activity. Finally, the table refers to the Activity Planning Sheets in Annex G where each activity is described in more detail.

These Activity Planning Sheets contain guidance on setting frequencies if an activity is scheduled, or intervention levels if it is condition responsive, and on how these may vary according to the standard of the road. It should be noted that in many cases the appropriate frequency or intervention level will also depend upon local external influences such as traffic, climate and terrain.

CONDITION SURVEY FORM - EARTH AND GRAVEL ROADS

District	Road no.	From	To	Classification	Surveyor	Date

						Vegetation					Drainage					Structures					Surface						Road furniture			
From (km)	To (km)	Road type (earth or gravel)	Carriageway width	Shoulder width	Verge width	Grass to be cut	Bare soil	Steep and unstable slope	Site to be reinstated	Bush to be cleared	Drains to be cleared	Vegetation in base of drain	Erosion in drain	Erosion in shoulder or side slope	Drains fully blocked	Aperture is sedimented	Aperture is blocked	Minor structural damage	Structure has collapsed of is absent	Headwall is hard to see at night	Debris on the road	Corrugations or general minor damage	Major damage to riding surface	Isolated potholes (P) or ruts (R) (depth)	Thickness of gravel	Gravel dust is a problem	Sign is dirty (S), damaged (D) or missing (M)	Barrier is damaged (D) or missing (M)	Edge delineators damaged (D) or missing (M)	Remarks / Actions
		E/G	m	m	m	m^2	m^2	m^2	m^2	m^2	m	m	m^2	1-5	m	no.	1-5	1-5	no.	no.	1-5	1-5	1-5	mm	mm	1-5	Qty	1-5	Qty	

1 - Condition is good 5 - Condition is very poor See local guidance for full definitions

Figure 3.1 Condition Survey Form

Table 3.17 Defect – Cause – Effect – Activity Table

Defect	*Cause of the defect*	*Effect if the defect is not rectified*	*Activity required to rectify the defect*	*Activity Planning Sheet no.*
Vegetation				
Grass is high.	Vegetation growth without maintenance.	Visibility is reduced. Pedestrians walk in road.	Cut grass.	1
Vegetation growing on riding surface.	Road has been out of use for some time.	Vegetation will be incorporated into road.	Grub vegetation	2
Topsoil on riding surface.	Road has been out of use for some time.	Topsoil will be incorporated into road if not removed. Vegetation will grow.	Remove topsoil	3
Bare soil.	Excavation at a work site. High rainfall strips topsoil.	Vegetation is unable to grow. Erosion is likely.	Place topsoil if necessary. Plant vegetation.	4 5
Steep and unstable slope.	Excavation at a work site. Road widening.	Landslip/erosion is likely. Access can be lost. Environmental damage.	Stabilise slope.	6
Work site has not been reinstated.	Site was used for an activity such as gravel extraction.	Mosquito breeding. Environmental damage.	Reinstate site.	7
Bush growing on road alignment.	Road has been out of use for some time.	Road cannot be properly maintained. Damage to vehicles.	Clear bush.	8
Tree growing on road alignment.	Road has been out of use for some time.	Access is lost Danger to road users.	Remove tree.	9
Drainage				
Drain is sedimented.	Flowing water has deposited sediment in drain.	The drain may overtop and damage the carriageway.	Clear drain.	10
Vegetation in base of drain.	Drain has been poorly maintained.	Drain will block very rapidly and overtop.	Grub vegetation.	2

Continued ....

Table 3.17 (Continued) Defect – Cause – Effect – Activity Table

Defect	*Cause of the defect*	*Effect if the defect is not rectified*	*Activity required to rectify the defect*	*Activity Planning Sheet no.*
Erosion in side drain.	Flow in drain is too high or too fast. Soil is erodible.	Erosion will worsen. Carriageway may be undermined.	Repair erosion. Construct/repair scour checks. Line drain. Dig mitre drains.	11 12 13 14
Scour checks are damaged.	Flow in drain is too high or too fast.	Damage and erosion will continue.	Repair scour checks. Dig mitre drains.	12 14
Water ponding in drain.	Drain was dug to an inconsistent gradient.	Soft spots may develop and weaken riding surface.	Reform drain gradient.	15
Erosion in shoulder or side slope.	Volume of water flowing laterally into side drain.	Drainage system will be damaged and carriageway cut.	Repair shoulder/slope erosion. Plant vegetation.	16 5
Side or mitre drain is fully blocked.	Drain has not been cleared for a long time.	Drain will overtop and damage the road.	Re-dig drain.	14
Side or mitre drain is absent.	Drain was never dug. Poor planning of drainage.	Drainage system will not operate as intended.	Dig side or mitre drain as required	14
Run-off entering side drain and eroding into carriageway.	Road is lower than surrounding land or built across side-long ground.	Erosion can cut road and access can be lost.	Dig interception ditch.	14
Structures Aperture is sedimented.	Flowing water has deposited sediment.	The aperture may overtop, damaging the carriageway and the structure.	Clear aperture.	17
Aperture is blocked.	Large debris, such as trees, are caught in the aperture.	The force of the water may shift and damage the structure.	Clear aperture.	17
Inlet and/or outlet channel is eroded.	Flow in channel is too high or too fast.	Erosion may undermine structure.	Repair channel erosion. Form erosion protection.	11 18

Continued ....

Table 3.17 (Continued) Defect – Cause – Effect – Activity Table

Defect	*Cause of the defect*	*Effect if the defect is not rectified*	*Activity required to rectify the defect*	*Activity Planning Sheet no.*
Erosion around abutment walls or wing walls.	Water concentrates on the riding surface and flows around the walls.	Structure may be undermined by erosion and collapse.	Repair abutment erosion. Plant vegetation.	19 5
Minor, non-critical damage to structure.	Impact from vehicle, poorly constructed or overtopped.	Structure may gradually weaken.	Minor structural repair.	20
Major damage to structure, risk of collapse.	Impact from vehicle, poorly constructed or overtopped.	Structure is liable to collapse. Year round access will be lost.	Major structural repair.	21
Structure is badly damaged, has collapsed or is absent.	Impact from vehicle, poorly constructed or overtopped.	Access is only possible during the dry season by bypassing the structure.	Replace / construct structure.	22
Headwall is hard to see at night.	Head wall is made of a dark material.	Danger to road users.	Paint headwalls.	23
Track Debris on road (large or small)	Dead animals, rocks and abandoned vehicles	Danger to road users, especially at night	Remove debris	24
Potholes in riding surface.	Water collects in small depressions and potholes develop.	Vehicles may lose control. Deterioration will increase as more water collects.	Repair potholes.	25
Ruts in riding surface.	Surface becomes wet and loses strength.	Ruts worsen, access becomes difficult or is lost.	Repair ruts.	26
General deterioration of track.	Track is unsuitable for climate, terrain, traffic levels and current maintenance practices.	Track will become impassable and access will be lost.	Form camber and side drains (Gravel if necessary).	27 35
Soft spot in riding surface.	Surface is unable to dry out. Localised area of weak soil.	Soft spot will increase and access will be lost.	Remove material, and Fill, and Compact.	28 29 30
Riding surface inundates with water in rainy season.	Track is too low.	Track will become impassable when wet.	Form embankment, and Compact.	31 30

Continued ....

Table 3.17 (Continued) Defect – Cause – Effect – Activity Table

Defect	*Cause of the defect*	*Effect if the defect is not rectified*	*Activity required to rectify the defect*	*Activity Planning Sheet no.*
Engineered earth road				
Debris on road (large or small).	Dead animals, rocks and abandoned vehicles.	Danger to road users, especially at night.	Remove debris.	24
Road is prone to corrugations.	Some materials corrugate naturally under traffic.	Corrugations will increase if not treated.	Drag.	32
Corrugations, loss of camber, widespread potholes and ruts.	Road surface has not been maintained properly.	Vehicles may lose control. Deterioration will increase.	Grade.	33
Major damage to riding surface.	Inadequate maintenance. Use by heavy vehicles.	Access will be lost.	Reshape.	34
Isolated potholes in riding surface.	Water collects in small depressions and potholes develop.	Vehicles may lose control. Deterioration will increase as more water collects.	Repair potholes.	25
Isolated ruts in riding surface.	Surface becomes wet and loses strength.	Ruts worsen, access becomes difficult or is lost.	Repair ruts.	26
Weak material or rocks in riding surface.	Poor construction.	Road condition may worsen. Damage caused to vehicles.	Remove material.	28
Voids or cavities in riding surface.	Earth has been removed. Surface has eroded.	Surface deteriorates.	Fill, and Compact.	29 30
Road inundates with water in rainy season.	Road surface is too low for flood levels.	Access will be lost in the rains. Damaged surface will make dry season access difficult.	Form embankment, and Compact.	31 30
General deterioration of earth road.	Earth road is unsuitable for climate, terrain, traffic levels and current maintenance practices.	Road will become impassable and access will be lost.	Gravel, or Provide improved surface.	35 36

Continued ....

Table 3.17 (Continued) Defect – Cause – Effect – Activity Table

Defect	*Cause of the defect*	*Effect if the defect is not rectified*	*Activity required to rectify the defect*	*Activity Planning Sheet no.*
Gravel road				
Debris on road (large or small).	Dead animals, rocks and abandoned vehicles.	Danger to road users, especially at night.	Remove debris.	24
Road is prone to corrugations.	Some gravels are more prone than others.	Corrugations will develop if not treated.	Drag.	32
Corrugations, loss of camber, widespread potholes and ruts.	Road surface has not been maintained properly.	Vehicles may lose control. Deterioration will increase.	Grade.	33
Major damage to riding surface.	Inadequate maintenance. Use by heavy vehicles.	Access will be lost.	Reshape.	34
Isolated potholes in riding surface.	Water collects in small depressions and potholes develop.	Vehicles may lose control. Deterioration will increase as more water collects.	Repair potholes.	25
Isolated ruts in riding surface.	Surface becomes wet and loses strength.	Ruts worsen, access becomes difficult or is lost.	Repair ruts.	26
Gravel layer is thin.	Gravel has been lost through erosion and dust.	Base layer is not strong enough and will fail rapidly.	Re-gravel.	35
Lengthworkers have no gravel for repairs.	Supply has been inadequate.	Lengthworkers unable to repair future surface damage.	Stock pile gravel.	37
Gravel generates dust.	Gravel is broken down under traffic and lost as dust.	Health problems in villages. Danger to road users. Need for frequent regravelling.	Provide a sand cushion. Provide dust palliatives. Provide improved surface.	38 39 36
Sand cushion forms windrows.	Sand cushion is spread by traffic and not maintained.	Gravel is lost as dust. Windrows can pose a danger to road users.	Drag.	32
General deterioration of gravel road.	Gravel road is unsuitable for climate, terrain and current traffic levels.	Road will become impassable and access will be lost.	Provide improved surface.	36

Continued ....

Table 3.17 (Continued) Defect – Cause – Effect – Activity Table

Defect	*Cause of the defect*	*Effect if the defect is not rectified*	*Activity required to rectify the defect*	*Activity Planning Sheet no.*
Improved surface				
Debris on road (large or small).	Dead animals, rocks and abandoned vehicles.	Danger to road users, especially at night.	Remove debris.	24
Surface is damaged.	Erosion, wetting, impact or poor construction.	Vehicles may lose control. Damage will increase.	Repair improved surface.	40
Road furniture				
Road sign is dirty.	Deliberate soiling or due to gravel dust.	Danger to road users if warnings are not seen.	Clean road sign.	41
Road sign is damaged or missing.	Theft or impact by vehicle.	Danger to road users if warnings are not seen.	Repair / replace road sign.	42
Barrier is damaged or missing.	Theft or impact by vehicle.	Danger to road users if slopes are unprotected.	Repair / replace barrier.	43
Edge delineators are damaged or missing.	Theft or impact by vehicle.	Danger to road users if the road edge is unmarked.	Repair / replace edge delineators.	44
Distance posts are damaged or missing.	Theft or impact by vehicle.	Recording road information is more difficult.	Repair / replace distance posts.	45

Most activities can be identified from a recorded defect and an estimation of the required quantity. Long grass should be cut, blocked drains cleared and a damaged road surface repaired. Some activities, however, are more complicated and will require a detailed assessment. The extent of structural damage must be measured, an embankment site must be surveyed and a bridge or high embankment must be carefully designed. Time and resources must be available for site visits and further investigation as necessary. The need for detailed assessment is described on the Activity Planning Sheets of the relevant activities.

3.8 Scheduling, packaging and Bills of Quantities

Scheduling involves identifying when the required activities should be carried out during the year. Packaging involves grouping the activities together ready for implementation. Bills of Quantities are contractual documents listing the required activities within each package.

This section has been written to suit conventional measurement contracts. The Road Manager is referred to Section 4.2 if performance contracts are to be used.

3.8.1 Scheduling

The required activities have now been identified. The Road Manager should now prepare an annual schedule of all these activities. This schedule shows when each activity should be carried out during the year and its approximate duration. Three pieces of information are important when preparing the schedule.

Timing

Some activities must be carried out at particular times in the year in relation to the rainy season. For instance, grass grows most rapidly when the soil is wet and should therefore be cut during and at the end of the rainy season. Drains should be cleared shortly before the rains begin.

Frequency

Some activities are required at regular intervals. For instance, during the dry season, a gravel road may require regular dragging or grading to prevent traffic induced corrugations or rutting.

Dependency

Some activities can only be carried out after others have been completed. For instance, scour checks can be constructed only after the drains have been repaired.

Guidance on timing, frequency and dependency can be found on the Activity Planning Sheets in Annex G. Within these constraints, a Road Manager should also try to spread activities through the year in order to create a constant work load. The annual schedule can be represented on a bar chart as shown in Table 3.18.

As the Road Manager builds up the annual schedule, he or she can also make provisional plans for activities such as regravelling which are not required every year. The plans can be incorporated into long term schedules, also known as rolling programmes.

3.8.2 Packaging

After preparing a schedule of required activities, the Road Manager should combine the activities into packages ready for implementation. Where works are to be implemented by private sector contractors, the Road Manager may choose to form packages to suit contractors of different capability and capacity in order to develop a well balanced road contracting sector (see Section 4.1). Where Government in-house units are to be used, packaging is still required to suit the unit concerned. The size, contents, start date and duration of each package depend on a number of factors:

1 It is common to divide the activities into routine maintenance, periodic maintenance and rehabilitation. This may be for one of two reasons. Firstly, contracts will be available to contractors of different capability and size. Secondly, funds for each activity type may come from different sources. If activities are divided in this way, routine maintenance packages often last for a year and may

Table 3.18 Annual schedule bar chart

	Month											
	1	2	3	4	5	6	7	8	9	10	11	12
			← *Rainy season* →									
Road ……												
Grass cutting							■					
Drainage		■			■		■					
Structures									■	■		
Road ……												
Grass cutting							■					
Drainage		■			■		■			■		
Gravel grading	■					■						

therefore include some activities to be carried out several times, while periodic maintenance and rehabilitation packages last only as long as required to complete the work. An advantage of annual packages is that minor defects can be rectified before they become severe and the package can include emergency response (see Annex E).

2 If emergency response has been arranged separately or is unlikely to be required, it may be cost effective, and convenient for the Road Manager, to package a number of activities into one short duration contract. For example, in many situations, the deterioration of low volumes roads in the dry season can be very slow. It is then normally possible to group all maintenance and rehabilitation activities into a single package for implementation shortly after the rainy season. An additional short contract can be let just before the rains if some dry season deterioration has occurred, as might happen under higher traffic levels.

3 It is recommended that packages are sized such that contracts will be spread evenly across all suitable contractors of different sizes. If the packages are too big, a small contractor will be over-stretched and inefficient; if too small, a large contractor will be operating below capacity and will not be cost effective. Activities of a similar type on neighbouring roads may be packaged together if necessary.

4 If a particular technology is being promoted, the activities within the package must suit that technology. For example, if a contract is to specify the use of labour based methods, it should not include activities for which large items of plant are necessary.

5 As a rule, a small number of large packages is more efficient to implement and administer than a large number of small packages.

3.8.3 Bills of Quantities

In most contracts, payment is made on the basis of the measurement of a range of completed activities as listed on a Bill of Quantities (BoQ). A BoQ should be prepared for each package to enable contracts to be prepared for implementation. The BoQ will become part of the legally binding contract documentation.

The BoQ is often divided into sections for clarity. Each activity is listed within the appropriate section. The following sections are typical but the Road Manager should follow local practice where possible:

1	Preliminaries	Provide insurance, establish camps.
2	Vegetation	Clear bush, remove trees, plant vegetation.

3	Drainage	Clear or dig drains, repair erosion.
4	Carriageway	Form camber, grade, fill potholes.
5	Gravel surface	Excavate, haul, spread and compact gravel.
6	Structures	Repair or construct culverts, bridges and drifts.
7	Road furniture	Install, clean or repair signs and barriers.
8	Dayworks	Rates for labourers and tradesmen for additional works.

A typical BoQ is shown in Table 3.19.

Table 3.19 Typical Bill of Quantities

BILL OF QUANTITIES

Page ..... of .....
Date

Road Name		Road No.		Length	
Item no.	Description	Unit	Quantity	Rate	Amount
	These four columns describe what is required and are completed by the Road Manager.				
	Example:			These two columns give the cost of each required activity and are completed by the contractor.	
	Section 4 Carriageway				
4.4	*Grade carriageway*	*m*	*250*		

Note that if a package includes several repetitions of an activity, the total quantity required over the duration of the contract must be included in the BoQ.

The BoQ is used by contractors to estimate bidding prices for a contract. For each activity, the contractor estimates a unit cost by including labour, equipment and material costs, administrative and supervision overheads and a provision for profit. Quantities and unit costs are multiplied, and then summed together with the costs of single items such as camp establishment and insurance. The total price is submitted and used by the Road Administration to assess bids and award the contract (see Section 4.3).

It is suggested that a layout map is provided with the BoQ in the tender documents to show the contractor where the quantities of each activity are located as this may affect site planning and operating costs. Locating activities by kilometre length is sufficiently accurate at the tendering stage. A typical layout map is shown in Table 3.20.

These maps add to the transparency of road management by allowing formal audit by the Road Manager and the funding organisation and informal audit by the road users.

3.8.4 Engineer's Estimate

The Road Manager may also use the BoQ to estimate the costs of carrying out activities. This may be when seeking funds (Method 2 in Section 3.3) or at the tendering stage to assess bids from contractors (Section 4.3).

The Road Manager should use the BoQ as above to estimate likely bidding prices for a contract. Making an Engineer's Estimate requires experience of site management, work methods, input costs, equipment

Table 3.20 Activities layout map

Road Name						**Road No.**					
	Km	**0-1**	**1-2**	**2-3**	**3-4**	**4-5**	**5-6**	**6-7**	**7-8**	**8-9**	**9-10**
Item no.											
		Example									
2.1		*100*	*250*	*200*	*150*				*200*	*300*	
2.3		*50*		*50*	*35*	*25*					
3.2			*150*					*350*	*400*		

and labour productivity, and equipment maintenance and utilisation. The best way to make the estimate is to look at a package of activities from the perspective of a contractor who must include all costs if he or she is to remain in business.

A contingency should then be added to the estimate. This is an allowance for additional costs due to either slightly under-estimated quantities or unforeseen activities such as rock breaking in an excavation. A contingency is typically 3% of the estimated price. A contingency can also be used to cover emergency works in a stand-by contract.

3.9 Long term strategic planning

This document is primarily concerned with an annual cycle of planning, budgeting and implementation. Decisions are based on the current usage of the network, or, if it is currently impassable, its potential usage. However the Road Manager should also try to predict how road use may change in the long term, so that the roads may be properly prepared.

3.9.1 Long term changes in road use

Road use may change in three ways:

Increased traffic volumes

This document is based upon the use of good management practice to lead to a cycle of reliable access, confidence, rural investment, traffic growth, increased funding and sustainable network improvement. An increase in traffic volume should be anticipated.

Increased vehicle weights

Just as traffic volumes are likely to increase as rural economies and industries grow, it is also likely that heavier vehicles will use the roads.

Urbanisation

Over time, it is possible that a village may grow into a small town. Urban roads pose different problems for a Road Manager, such as restrictions on drain outfalls and the greater impact of dust. A Road Manager should anticipate these and other similar changes such as the development of industrial sites.

3.9.2 Strategic changes to a road

The roads in a network may be prepared for these changes in four main ways. A road may be upgraded, widened, made safer or improved in overall condition:

Upgrading

Upgrading, an improvement in the surface construction, will provide a stronger road to suit higher traffic levels and heavier vehicles. If a gravel surface is upgraded to an improved or a bituminous surface, it will be dust free and will suit a more populated environment. A road may also be upgraded to save on future maintenance costs. In this case it is suggested (see Method 4, Solution 1 in Section 3.5) that if the estimated saving in annual maintenance costs is more than 20% of the cost of the upgrade, it should be carried out.

Widening

Roads which carry higher traffic levels and wider, heavier vehicles may need to be widened.

Made safer

It is particularly important that roads with rising traffic levels are made safe. A number of measures are presented in Section 3.6 to improve the safety of all road users.

Overall condition improvement

A Road Manager will set intervention levels at which a defect should be corrected by a condition responsive activity. An example may be the roughness at which a gravel surface is graded. As road usage increases, a Road Manager may decide to reduce intervention levels to improve overall condition. Alternatively, a Road Manager may decide to reduce the traffic volume at which a Full standard will be applied in order to bring more roads up to this higher standard.

3.9.3 Strategic studies

Decisions that form part of an annual cycle are concerned with providing access and maintaining good condition. Strategic plans, however, often need careful analysis. The studies which may be needed include the following.

Traffic growth forecasts

A strategic plan must be based upon an estimate of traffic growth and any increased use of heavy vehicles. These studies should identify any developments, such as local industries, and should identify on which roads improvements are required.

Maintenance expenditure reviews

It is important to estimate how much a strategic plan will cost. The cost should be balanced against the benefits that the plan will bring to the network in terms of lower maintenance costs and the wider social and economic development benefits. It may be necessary to compare several alternative plans. The Road Manager may be required to submit strategic plans to a separate or dedicated funding source. In order to smooth the financial demands of a plan, it is often spread over a period of several years and referred to as a rolling programme.

3.9.4 The importance of the annual management cycle

It is important for a Road Manager to be prepared for changes in road use, but the manager is advised that long term strategic plans are worth making only if the network is maintained in good condition through a regular annual cycle of planning, budgeting and implementation.

Part 4: Implementation

The objective of Part 4 is to arrange for an organisation to implement the required activities.

Part 4 has four steps:

4.1 Identify the appropriate implementing organisation.

4.2 Identify the most suitable contract.

4.3 Manage the contract.

4.4 Ensure safety on site.

4.1 Implementing organisations

Until recently, all maintenance and rehabilitation was carried out by Government *in-house*, or *force account*, units. However, for reasons of productivity, cost effectiveness and transparency, a large proportion of work is now contracted out to a variety of private sector organisations. This section will help identify the most appropriate implementing organisation.

4.1.1 In-house units

Although the use of in-house units is in decline, where the private sector is still developing road management capacity or where contractors are liable to form cartels, it is recommended that in-house units are retained. However, it is recommended that they operate commercially and, as far as possible, on equal terms with the private sector. Ideally they should be separated from the Road Administration, tender for work, include all costs when they submit prices and not receive grants of equipment. Some Road Administrations, however, may wish to retain a limited number of linked in-house units for specific activities such as emergency works, but as the private sector becomes more mature, diverse and numerous, this function is likely to be equally well or more efficiently performed by the private sector.

4.1.2 Private sector organisations

It is common to classify and license private sector organisations to indicate the size of contract and type of work for which they may compete. The following classifications are used:

Individual lengthworker

This is a term for a man or woman who undertakes the routine maintenance of an allocated length of road, normally between 1 and 2 kilometres. A lengthworker normally lives alongside their allocated length of road and is often provided with tools and regularly supplied with gravel for pothole and erosion repair. Periodic maintenance is normally carried out by other parties. Letting, administering and supervising individual lengthworker contracts is inefficient in time, money and quality; alternatives are for several lengthworkers to form into a small contracting organisation or to take a routine maintenance sub-contract with a larger contractor.

If individual lengthworkers are employed on a network, the Road Manager should ensure that they are provided with sufficient information on the standards which their work must meet and should ensure that they are adequately supervised in order to achieve these standards. It is very common for unsupervised lengthworkers to do little more than cut grass.

Since lengthworkers normally work alone, they can be vulnerable to traffic accidents. A lengthworker should put warning signs along the road in both directions before starting work.

An advantage of lengthworkers is their presence on site. If emergencies occur, they can inform the Road Manager or the main contractor. They are also able, with adequate training and supervision, to rectify minor defects without specific instruction before they become severe.

Community contractor

Community contracting combines the efficiency and contractual responsibility of the private sector with the benefits of local participation and development. There are a variety of arrangements and responsibilities for a community contractor, although they all have some features in common.

A community contractor is an organisation which grows from within the community in response to a need for local improvements. It is often formed from the local community development organisation, which may act as initiator, fund raiser, supervisor and joint client with the Road Administration. Outside support organisations may also be involved. If profit is made, it is returned to the community, usually to fund future maintenance. Contracts are often allocated on agreed rates rather than tendered. A community contractor may cease to exist after the improvements are complete and reform when more work is required.

The technical skills of community contractors are limited and they often need assistance from a Road Administration. Complex work may be let to a commercial sub-contractor. The scale of works is less than that of a small contractor. Most activities use labour based or labour intensive methods and give employment to the local population. A community contractor can take on a range of duties from the provision of labour to executing an entire project. The latter carries more risk, but offers more opportunities for community development. Table 4.1 lists the advantages and disadvantages of using community contractors. Reference should also be made to Table 3.3 for the additional issues associated with labour based or labour intensive methods.

Table 4.1 Advantages and disadvantages of community contracting

Advantages	*Disadvantages*
Close relationship between client, contractor and beneficiaries.	Community development organisation may not fully represent the people.
All parties have incentive for success.	Slack supervision can result in poor quality.
Community empowerment, ownership and development.	Slow decision making, participation and on site progress.
Paid employment and training for community members.	Training and mobilisation may take time pre-contract.
Can be cost effective.	Excessive support required from outside parties.
Rapid contract start up due to absence of tendering.	Reliant upon sympathetic local administration.
Can generate future commercial contractors.	

In some countries, it is illegal to let government contracts to organisations that have not been legally registered as contractors. If this restriction applies, the Road Manager should seek special dispensation, let the contract through an intermediary organisation, or assist community contractors to register as either small contractors or, if it exists, in a distinct community contractor class.

For further information on community contractors, the Road Manager is referred to the document listed in Section 5.2.

Petty contractor or Micro enterprise

A petty contractor is a private organisation (unlike a community contractor), but is likely to use labour intensive methods, carry out routine maintenance activities in a very local area, or even act as a labour-only sub-contractor. A petty contractor may need only a limited level of technical qualification and competence among the staff. A petty contractor may be a co-operative of around 10 to 20 members.

Micro enterprises are co-operatives or community associations, organised as private enterprises which operate in a similar way to a petty contractor. These have been very successful in South America.

Small contractor

A small contractor might be operating only in a local area, but have ambition to grow in size, technical capacity and geographical range. Small contractors may be trained in labour intensive or labour based methods, but most wish to expand to include equipment intensive methods as well. Equally, a small contractor is likely to be capable of carrying out work on unsealed roads only, but often has the ambition to expand to take on bituminous sealing and repair work. The desire to expand is normal and should be welcomed and encouraged. A small contractor should have some technically qualified staff.

Medium and large contractors

A medium contractor may be expanding from provincial scale contracts to national operations. A medium contractor is likely to have bought equipment and be interested in using that investment as much as possible, and may have learnt new skills such as the construction of improved and bituminous surfaces. A medium contractor should have a number of well qualified staff.

A large contractor will operate nationally and, possibly, internationally and may be interested in large, area-wide, multi-year performance contracts, possibly sub-contracting smaller packages to small contractors.

4.1.3 Developing a contracting sector

A strong local contracting sector has a number of benefits. It operates efficiently and saves scarce funds. It wins contracts and boosts the local economy. It can be focused on the needs of the local road users and is able to use labour based methods if appropriate. Successful small contractors can develop and form part of a strong national economy.

However, small local contractors face a number of constraints. They must compete with larger outside contractors, have limited access to funds, have limited bidding experience, and are reliant on locally tendered contracts.

A strong local contracting sector is advantageous to all parties and is often national policy. Developing and supporting local contractors is therefore an important part of the job of a Road Manager. A number of measures, many of which are within the capacity of a Road Manager, are given in Box 4.1.

4.2 Contracts

Whether maintenance and rehabilitation work is being carried out by a private sector contractor or a commercialised in-house unit, a contract will be required, although it may not be needed if the in-house unit is not yet fully commercial. Contracts can take a variety of forms; a number of these are covered below.

4.2.1 Measurement and performance contracts

A major distinction exists within the various contract forms. This distinction concerns how the requirements of the client are defined. In measurement contracts, a technical specification describes what work must be carried out for payment to be made. In performance contracts, a performance standard describes the level of service that the road must provide for payment to be made. This distinction is covered in more detail in Table 4.2.

Some typical technical specifications suitable for inclusion in a measurement contract are shown in Box 4.2. Technical specifications can be based upon information in the Activity Planning Sheets in Annex G.

A detailed discussion of contract documentation is beyond the scope of this document, although guidance on technical specifications and performance standards are found on the Activity Planning Sheets. The Road Manager should follow national practice regarding contracting procedures and conditions of contract for issues such as approval, dispute and completion.

4.2.2 Forms of contract

It is recommended that contracts should be based upon nationally or internationally recognised forms of contract. This can prevent the use of one-off contracts, which can be either over-complicated and hard to use or over-simplified with key contractual omissions and doubtful legal standing. Such one-off contracts can make it difficult for small contractors to move from one sector to another or from local to national projects and especially to projects with international funding. In the absence of national mandatory requirements, the following internationally recognised forms of contract are recommended.

- FIDIC Short Form of Contract. This contract will be familiar to many Road Managers and is flexible, allowing for additional clauses to be added when necessary.

- World Bank Procurement of Simple Works. This contract is a reduced version of the lengthy Procurement of Works, Smaller Contracts, and is based on the above FIDIC contract and World Bank experience.

- ICE NEC Engineering and Construction Short Contract. This contract was written to be easier to use and less confrontational than more traditional forms of contract.

Box 4.1

Developing and supporting local contractors

Measures to develop and support a local contracting sector include the following.

Development

- Develop contractors until there is a small amount (10-25%) of over capacity for the expected long term flow of contracts. If numbers are too low, there will not be competition for contracts; if numbers are too high and contractors receive contracts intermittently, they may go bankrupt or leave the sector, thereby wasting training and other costs.
- Establish a local training capacity. Provide training in technical, mechanical, financial, commercial and managerial skills and in the issues affecting technology choice.
- Assist contractors in obtaining licences. Restrict licenses to contractors who have qualified through a training programme or who have otherwise demonstrated competence.
- Encourage the formation of contractors' associations for mutual support and representation.
- Facilitate contractor mentoring during and after training.
- Make equipment available to contractors. Ensure that contractors know the true cost of owning and operating equipment. Provide opportunity to the contractors to buy equipment. Permit legal transfer of title after the end of projects.
- Assist in the establishment of private sector plant pools or lease hire arrangements. A contractors' association would be an appropriate body to operate these arrangements.
- Build government, donor and industry support for local contractors and projects in which local contractors will be able to bid for the majority of the works.

Contract

- Limit the contractor's risk by using appropriate forms of contract. Train contractors with payment for instructed work on a cost-plus basis, move to instructed work on fixed rates, and offer contracts for competition as soon as the contractors are ready.
- When using fixed rates, it is better to err on the side of generosity to provide some initial security.
- Ensure that contract documentation is based on nationally or internationally recognised forms.
- Advance payments are often required for contractors with low financial resources.
- Target local contractors by offering contracts of an appropriate type, size and technology choice.

Administrative and Policy

- Ensure that the market operates in a transparent manner. Include the assessment criteria in the Instructions to Bidders. Publicise reasons for contract award and contract prices. Do not permit contracts to be bought.
- Establish pre-qualification, selection and award procedures. Treat bids from small and large contractors equally. Award contracts on the basis of a financial *and* technical submission to promote construction quality. Target local contractors by including a locally registered address in the criteria used for assessing bids.
- Be wary of high bids which may indicate restrictive practices, such as cartels or collusion, which may reduce the opportunities for developing contractors.
- Make punctual inspections of completed work. Reduce the number of signatures needed. Ensure that payments are prompt and regular. Interim percentage payments can be simpler than detailed monthly measurements
- Ensure adequate and competent administrative and supervisory capacity for an increased number of smaller contracts.
- Promote an enterprise culture among local entrepreneurs based on ethical business principles of integrity and honesty.
- Ensure a constant and long term flow of contracts and that adequate funding exists to pay the contractors.
- Offer small contracts which will suit local contractors.
- Provide advances and access for contractors to reliable banking services.
- A decentralised administration will allow contracts to be awarded more rapidly, greater support to be given to local companies and higher quality supervision to be carried out.
- Encourage political support for the development of local contractors.

Table 4.2 Comparison of measurement and performance contracts

	Measurement contract	*Performance contract*
How are the requirements defined?	• The client defines technical specifications, work methods and required quantities. • The contractor completes the required activities.	• The client defines required performance standards. • The contractor selects work methods to meet the standards for a defined period of time.
Basis of making payments	• Payment is made for the amount of work completed to the technical specification. • A measurement of completed quantities determines the payment (normally monthly). • Measuring many work items can be time consuming and expensive.	• Payment is made when the condition of the road is at or above a defined performance standard (level of service). • A check of condition releases a regular payment (normally monthly but more frequent checks can be made). • Checking condition of key features can be rapid and cheap.
Are deductions made to payments?	Payment is made only for work meeting the technical specification.	Payment can be reduced or penalties can be imposed when road condition does not meet the standard. In severe cases, a contract may be terminated.
Contract duration	• Maintenance contracts are often let for 12 months. • Rehabilitation contracts often have a date by which to complete the works. The duration is often less than one year, giving the contractor little time to gain local knowledge.	• Contracts are often let for 3 years and can be up to 10 years. • The long duration gives the contractor adequate time to gain local knowledge, benefit from innovation and maintain a road in a constant and good condition.
How does the contractor make a profit?	By increasing the efficiency of his operations while meeting the technical specifications.	By increasing efficiency and using innovation to reduce the work required to achieve the performance standards.
Scope for innovation	Low. The contractor is expected to follow standard methods and procedures.	High. The contractor can select technologies, methods and materials and carry out preventative maintenance to reduce the work required to meet the performance standard.
Where does the risk lie?	If the contractor meets the contractual requirements, the risk of not meeting the needs of road users is with the client.	The contractor carries the risk for his own decisions but may charge for carrying that risk. The contract must not impose risk beyond the control of the contractor.

Continued ....

Table 4.2 (Continued) Comparison of measurement and performance contracts

	Measurement contract	*Performance contract*
Suitable for…..		
Which contractors?	Emerging and mature contractors.	• Mature and skilled contractors only. • Skilled inspectors are also required.
Which activities?	Suitable for all activities.	More suitable for routine and periodic maintenance.
Emergency works?	The contractor may not be permanently engaged and able to undertake emergency works.	The contractor is permanently engaged and can undertake emergency works.
Providing a Basic Access standard?	Suitable.	Suitable.
Insecure long term funding?	Suitable – contracts can be let when funding becomes available.	Unsuitable – funding must be guaranteed for the entire contract period.
What is the experience of most authorities?	High – measurement contracts are familiar, proven and accepted.	Low – performance contracts are unknown to most Road Administrations.
Conclusion	• Tried and trusted contract form. • Suitable for all contractors. • Suitable when funding is unreliable. • Easier to specify labour based methods.	• A novel contract form. • Possible cost savings in the long term. • Lower assessment burden. • Contractor develops local knowledge. • **Contractors must be mature, feel responsibility to the road users, technically competent at preventative maintenance and able to estimate the true price of carrying risk.** • **Client must be mature and able to establish and then follow transparent checking and auditing procedures.**

Box 4.2

Typical technical specifications

1202 CLEANING AND CLEARING

The Contractor shall clean and clear the existing side drain, ditch, pipe and box culverts to original line and level.

The Contractor shall ensure that all side drains, ditches and culverts shall be cleaned of any spoil, mud, slurry or other materials likely to impede the free flow of water.

The Contractor shall remove and dump outside the highway right of way all the excavated, swept, or collected material at a place approved by the Project Manager and in accordance with the Environmental Management Plan.

Materials resulting from the cleaning shall be stockpiled as suitable or unsuitable separately. The suitable materials shall be used in the reconstruction of the existing embankment and shoulders as directed by the Project Manager.

The existing side drain, pipe and box culverts shall be cleaned maintaining the original cross section, base level and position in the profile and as instructed by the Project Manager.

At the end of the Works, and before the final acceptance is given by the Project Manager, the above works shall be cleared of fallen lumps or blocks.

1204 CUTTING, GRUBBING AND CLEARING FROM ROADSIDE VEGETATION

In the roadside all stumps and roots exceeding 75 mm in diameter shall be removed. Clearing shall consist of the removal of all trees, brush, other vegetation, rubbish and all other objectionable material, including the disposal of all material resulting from the clearing and grubbing.

The materials resulting from the cutting, grubbing and clearing shall be transported and deposited in stockpiles proposed by the Contractor and approved by the Project Manager and in compliance with the requirements of the Environmental Management Plan.

The voids resulting from grubbing shall be backfilled with approved material and compacted to a density of at least the density of the surrounding ground.

1209 CEMENT MORTAR

The cement mortar shall be mixed in the proportion 1:3 either by hand or mechanically until its colour and consistency are uniform. The constituent materials shall be accurately gauged, allowance being made for bulking of sand. Mortar shall be made in small quantities only as and when required by the Project Manager. Mortar, which has begun to set or has been mixed for a period more than the setting time of cement, shall not be used.

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All three contracts specify the appointment of an impartial adjudicator in order to reduce the chances of a dispute going to Court. Standard forms of contract must be obtained from the publisher and must not be used in breach of copyright.

4.2.3 Available types of contract

A number of contract types are available. Table 4.3 gives a summary of each. Emergency works are covered in Annex E.

The following paragraphs address the various differences that exist between contracts in terms of how bids are assessed on financial grounds and how payment is made during the contract. Most contracts are awarded on the basis of a combination of a financial and a technical proposal. The latter explains how the

Table 4.3 Contracts

Contract type	*Suitability*
Short duration contracts	
1 Normal measurement contract.	Suitable for periodic maintenance and rehabilitation.
2 Simple measurement contract.	Can save on measurement costs, but requires skilled inspectors.
3 Lump sum contract.	This contract is not common for rural road works.
4 Cost plus contract.	For contractors undergoing training or for items of work where a specification is difficult to set.
Term contracts	
5 Term measurement contract.	Suitable for routine maintenance.
6 Performance contract.	Suitable for a mature contractor and mature client.
7 Lengthworker contract.	Suitable for routine maintenance if adequately trained and supported.
8 Residual site presence.	Unsuitable if the contractor will be under-utilised.
9 Community contract.	Suitable for contractors which have grown from within the local community.

contractor intends to complete the work and describes how any specific problems will be overcome. A technical proposal is common to all the contracts described here.

Contract 1: Normal measurement contract

This is the most common contract type for maintenance and rehabilitation and is the basis of this document. Required quantities of each activity are listed in a Bill of Quantities (BoQ) as described in Section 3.8. For each activity, the contractor estimates a unit cost which is then multiplied by the quantities on the BoQ to give a total price. This price is submitted and is used by the Road Administration to assess bids and award the contract (see Section 4.3). At regular intervals, normally monthly, the actual quantities of completed work that meets the technical specification (see Activity Planning Sheets in Annex G) are measured and the contractor is paid the value of the quantities multiplied by the contract unit rate. This contract requires careful measurement and regular site supervision.

A normal measurement contract is often used for periodic maintenance and rehabilitation.

Contract 2: Simple measurement contract

Whereas a normal measurement contract divides the required work into individual activities, this contract type measures work on a larger scale. Quantities are estimated, costed, measured and paid as usual, but the BoQ has much fewer items. The items will depend on local requirements, but may be as follows:

1 Preliminaries, as a single sum.

2 Routine maintenance, per kilometre.

3 Carriageway formation, per kilometre.

4 Gravelling, per kilometre (the haul distance is provided in the tender documents).

5 Structures, an itemised list of requirements.

Just as single activities on a normal measurement contract have a technical specification, so a specification can be provided for these composite activities. This contract removes much of the measurement burden of a normal measurement contract.

This contract requires skilled and experienced inspectors to ensure that all necessary work is carried out under the composite activities.

Contract 3: Lump sum contract

A lump sum contract takes the process of grouping activities to the extreme. It is, in effect, a single activity measurement contract. The contractor is paid a single price on full completion of the required works, although advance payments and part payments for partial completion may be made. There is considerable risk for the contractor in this contract type. It is not common for rural road works.

Contract 4: Cost plus contract

In a cost plus contract, the actual costs incurred by the contractor are repaid with an agreed percentage addition for profit. Unless the site production records are subject to external checking, the contractor has little incentive to work efficiently, and the contract is generally not cost effective. In rural road networks, this contract type is normally only used when contractors are undergoing training or for items of work where a technical specification or performance standard is difficult to set.

Contract 5: Term measurement contract

A normal measurement contract is used to complete periodic maintenance and rehabilitation activities that are specified in response to an identified defect. In contrast, a term measurement contract can be used for routine activities that will be repeatedly required during the year. Expected quantities are listed on a BoQ, bids are assessed and contracts awarded as above, but the contract will also include information on when the activities should be carried out. The contract may also include provision of an emergency response capability.

Contract 6: Performance contract

A performance contract is a relatively new approach to road maintenance and rehabilitation. Instead of estimating the cost of carrying out a clearly defined set of activities, a contractor must first determine what activities will be most cost effective at keeping a road at or above a defined performance standard. The contractor therefore has the opportunity to innovate with new methods to reduce costs. Cost reductions can either be included in the bid in order to increase the chance of success, or saved until, if the contract is won, they can be used to increase profit; the contractor must choose how to use innovative ideas. Performance contracts therefore suit only mature contractors who are able to properly determine the activities to meet required standards, innovate to reduce costs, and bid with great care. Equally, the Road Manager has the opportunity to save on the time required to measure quantities, but must be mature enough to set, and enforce compliance with appropriate performance standards. Contractors submit a price for their planned activities to achieve the required standards. These prices are assessed and the contract awarded. During the term of the contract, when the road condition is at or above the performance standard, the contractor is paid a contracted and normally constant amount.

The required road condition is specified using performance standards. These standards, like performance contracts, are relatively new and still in development, although typical standards are given in the Activity Planning Sheets in Annex G. The Road Manager is encouraged to set standards suitable for the network for which he or she is responsible. The chosen performance standards will vary depending on whether a Full, Basic Access or Partial Access standard is being applied. For example, under Basic Access, ‘accessibility’ is required, but ‘safe driving speed’ is less important.

A number of features are covered in Table 4.2; others of note are as follows:

- Contracts can be let for a single road of several kilometres over 2 years or for a network of more than a thousand kilometres over 10 years. The latter will suit large contractors, who may choose to sub-contract packages to small contractors.

- It is recommended that a contractor is given time to achieve performance standards, perhaps by increasing the compliance requirement from 10% of road length in the first month to 100% by the sixth, twelfth or eighteenth month.

- Several performance standards include a response time whereby penalties are applied if the defect is not rectified within this time. Standards with a set response time are generally those associated with accessibility and safety.

- Performance contracts can be used on roads in poor condition, although initial rehabilitation should be specified, using agreed rates and measured quantities, to bring the road into a maintainable condition. Combining rehabilitation and maintenance in this way can encourage the contractor to produce high quality work.

- The resident nature of performance contracts enables them to be extended for the contractor, at agreed rates, to attend at emergencies, respond to public complaints and collect inventory data. If these additional services are included, a simple maintenance contract becomes a more comprehensive road management responsibility. Such a contract may appeal to a contractor/consultant joint venture or a consultant offering sub-contracts.

It is recommended that Road Managers consider introducing performance contracts when the contracting sector is sufficiently mature. The rate at which they are introduced will depend upon the sector but the following programme is suggested:

1 Start with performance contracts for routine maintenance only.

2 Start with one year contracts and increase to three years or more as the Road Administration and contractors gain experience.

3 Bring in performance contracts for periodic maintenance when the sector is ready. These should be for three years or more due to the lower frequencies of periodic maintenance.

Using performance contracts for rehabilitation works is not recommended.

The transition to performance contracts will bring change to the Road Administration and contractors. All parties should be encouraged to co-operate. The transition should be gradual. Cost savings may emerge when contractors learn to accept risk. Further guidance should be sought before beginning any introduction of performance contracts. The World Bank (see Section 5.1) is a useful source of information.

Contract 7: Lengthworker contract

This contract type is a form of performance contract whereby a lengthworker is expected to keep his or her allocated length of road (normally between 1 and 2 kilometres) in good condition using routine maintenance activities. However, a lengthworker is often paid a monthly sum based on a specified attendance time (normally 10 days per month), in effect a day-works contract. This can lead to problems if standards are not achieved. The situation is not helped by a loose definition of 'good condition' and the lengthworker's reliance upon supplies of tools and materials from other parties. Given the difficulty of guaranteeing standards from an agreed attendance time, it is recommended that performance standards are provided and clearly explained, and that lengthworkers are paid for performance rather than attendance. It is recommended that lengthworkers are not penalised for poor performance if supplies have been inadequate, and that assistance is made available at events such as storm washouts which require more than normal routine maintenance. Due to the costs of administering small contracts, lengthworkers are often sub-contracted to a larger contractor.

Contract 8: Residual site presence

As contractors complete stages of a rehabilitation measurement contract, they are often paid a monthly fee for routine maintenance of the completed length of road until the entire contract is complete. However, where traffic is light, and deterioration only occurs during rains, the contractor will be under employed and may even leave the site, thereby wasting time and money. In such a case it is recommended that contracts are let without a residual maintenance duty and each stage handed over as soon as it is complete.

This duty is different to a standard warranty or maintenance period where the contractor, quite reasonably, is expected to guarantee the quality of the completed work and correct any defects which arise in the period, typically one year.

Contract 9: Community contract

Community contracts enable organisations, which have grown from within the local community, to carry out work under a transparent arrangement. They can be for a variety of services from the supply of labour or materials to the maintenance and rehabilitation of a section of road. They can be paid on the basis of measurement or performance, although in most situations the former is more appropriate. The contracts should be drawn up according to the required services and the roles of the various parties but should be based upon nationally recognised forms of contract.

Community contractors are not normally expected to derive their own unit costs. When there is no competition, unit costs will be negotiated between the contractor and the client, although if two community contractors are interested, the technical proposals may also be assessed. Contract documentation should be transparent and understandable by those unfamiliar with contracting. A contract may permit assistance from a Road Administration or for complex work to be let to a commercial sub-contractor. As the contract is completed, monthly measurements take place, the profit normally being returned to the community and retained for future maintenance.

Although the client and contractor roles are often carried out by members of the same community with the same incentive for success, conflicts of interest may arise. Whilst pressure from community residents can help to resolve conflicts, dispute clauses are required since, if conflicts persist, long term maintenance may not be secure.

For further information on community contracts, the Road Manager is referred to the document listed in Section 5.2. Although this document addresses urban infrastructure, the principles are common to rural projects.

4.3 Contract management

A contract obliges a contractor to provide an agreed service or product and a client to pay for the service or product. A contract has additional functions such as ensuring that work is completed on time, monitoring the quality of output and resolving disputes. It is essential that a Road Manager is familiar with the basic principles of contract management. Contract management is a very suitable role for private sector consultants.

There are four steps in contract management:

1 Invite bids from contractors.

2 Assess bids and award contracts.

3 Manage an active contract.

4 Auditing and evaluation.

The detail of each step depends upon the size of the contract. The larger the contract, the wider the invitation to bid and the more time that will be spent on assessment, management auditing and evaluation.

A Road Administration is likely to have its own mandatory procedures for contract management. These should be followed, but if absent, the following guidance is provided.

A local Tender Board can be set up to administer an invitation to bid, pass bids to the Road Administration for assessment, and check the final decision for procedural correctness. A Tender Board normally comprises government staff, or their representatives, but can include representatives from the road user participatory framework. Its function is to eliminate corruption, create transparency and accountability, and speed up the tendering process.

4.3.1 Invite bids

Contracts may be offered to contractors in four ways:

Open bidding

The contract is advertised and tender documents made available. These documents include Instructions to Bidders, Conditions of Contract, Bills of Quantities and Technical Specifications. Technical drawings, work programmes, layout maps (Table 3.20), method statements for complex activities and Environmental Management Plans (see Annex F) may also be included if required. These documents enable interested parties to plan their resources, estimate their costs and bid for the contract. Allowing any contractor with the appropriate licence to bid is very transparent, but may result in an excessive number of bids and wasted costs which contractors will recover on later bids. An alternative is to use a short list using pre-qualification criteria to reduce the number of bidders.

Pre-qualified bidding

Bidding is restricted to between 3 and 5 pre-qualified contractors. Pre-qualification involves assessing contractors against criteria such as financial and technical competence, history of successful contracts, financial guarantees, staff qualifications and training, available equipment and contractor licence. This is a cost effective and transparent method of invitation. Pre-qualified contractors then bid using tender documents as above. Provided at least 3 contractors bid, this is a cost effective and transparent method of invitation.

Canvassed bidding

A limited number of appropriately licensed contractors (typically between 3 and 5) are invited to bid. Selection is either random or follows the preferences of the Road Administration. Canvassing may rotate around the available contractors although care is required if contracts of different sizes are offered. Canvassing is cost effective, but is the least transparent method of invitation.

Allocation

Contracts can be allocated directly to a contractor. This method can be used for emergency works, on training sites, when suitable contractors are very scarce or for works of very low value. In other situations, this method is not recommended. When a contract is allocated, rates must be negotiated between the contractor and the Tender Board.

4.3.2 Assess bids and award contract

The bids received must be assessed prior to awarding the contract. In the absence of national procedures, a suggested method of assessing bids on technical and cost grounds is as follows:

Step 1: Form an assessment team

A team should be formed with between four and six members. The members should have detailed knowledge of road management, contracting and project supervision, and can be drawn from other government departments or the private sector.

Step 2: Assess the proposals

The following describes a two envelope process which is normal for larger contracts. The assessment team may choose to accept single proposals for small contracts, using the technical information merely to establish competence and awarding the contract to the bidder with the lowest price.

Technical proposals

The team will assess bids using criteria and weightings as included in the Instructions to Bidders. These criteria may include company staff, the company history on similar projects, a written understanding of the requirements of the contract and the intended work programme. The company history of working in a community and managing a labour force may be used for contracts where labour based methods are specified, and local companies can be weighted highly if there is a policy of support to a local contracting sector:

1 Open the technical proposals first.

2 Assess them using the agreed criteria and weightings and give a percentage score. Reject a bid if the assessment is low.

3 Reject bids that do not comply with requirements such as completion dates, staff qualifications or technology choice.

Financial proposals

1 Open the financial proposals only if the associated technical proposal is not rejected.

2 Check each proposal for mathematical errors.

3 Assess a proposal very carefully if its price is less than 80% of either the Engineer's Estimate or an average of the bids, as this price may be impractical and bankrupt the contractor. Reject the bid if this appears to be the case.

4 Assess a proposal very carefully if its price is more than 120% of either the Engineer's Estimate or an average of the bids, as this may indicate incorrect assumptions in the tender documents (such as the proximity of material sources) or restrictive practices by contractors. Reject the bid if restrictive practices are evident.

5 Derive a percentage score. If a price is 10% above the lowest price, give it a score of 90%, if 20% above, give it 80%. Check that individual unit rates are realistic; if not, request confirmation. A contractor may submit high unit rates if extra work is expected. Study the expected schedule of payments in a long duration contract – early payments may be raised for cash flow purposes.

Combine technical and financial scores in a pre-determined ratio. It is suggested that this ratio is between 10:90 and 40:60. After the Tender Board has checked the tendering process, begin negotiations with the contractor with the highest combined score.

Step 3: Negotiate and award

1 Negotiate with the contractor to seek any confirmations or clarifications that may be required about the tender, agree unit rates and the work programme and confirm staff who will work on the contract.

2 After negotiations have been concluded, award the contract.

Duration of the contract letting process

The time from the decision being made to let a contract to work beginning on site is often longer than expected. All parties must accept the time involved if the contracts are to be well prepared, let to the most suitable contractor and achieve the required outcome. The typical time for each stage is given in Table 4.4. A total time may therefore be between 3 and 8 months.

Table 4.4 Timing of the contract letting process

Prepare tender documents	15 to 45 days
Invite and receive bids	15 to 45 days
Assess bids	30 to 60 days
Obtain approval to award a contract	7 to 30 days
Negotiate and award contract	15 to 30 days
Mobilisation on site	15 to 45 days

4.3.3 Managing an active contract

After a contract has been awarded, it becomes a legal document with which work on the road is monitored and evaluated. Monitoring and evaluating a road, and the activities along it, is vital for proper road management. For all forms of monitoring and evaluation, good records must be kept.

Calling off quantities

In Section 4.2, a short term measurement contract is said to be suitable if long term funding is insecure. However, at times funding cannot even be guaranteed for the duration of a one year measurement contract.

In such a case, the Road Manager should not allow any activities to take place for which funding is not in place and available for payment. It is therefore suggested that the Bill of Quantities is seen as a reservoir, from which quantities can be called off in batches when funds have been received from the source.

Quantities are called off using a sheet which identifies where the next batch of activities are to be carried out. A typical call off sheet is shown in Table 4.5 and may often be a more detailed version of the layout

Table 4.5 Quantity call off sheet

Road Name						**Road No.**					
Strip map or road segment map of the relevant length of road can be copied here											
	From	0	200	400	600	800	1000	1200	1400	1600	1800
	To	200	400	600	800	1000	1200	1400	1600	1800	2000
Item no.											
	Example										
2.1	*10*	*20*	*20*	*20*	*30*	*40*	*50*	*50*	*50*	*60*	
2.3	*5*	*5*	*10*	*15*	*15*						
3.2						*25*	*25*	*30*	*30*	*40*	

map shown in Table 3.20. If strip maps or road segment maps are being used (see Section 2.2), they can be copied onto the call off sheets to show more clearly the sites of the work.

The Road Manager may also use this system of calling off quantities in batches to prevent work becoming too widely spread over the site and excessive disruption being caused to road users. If this arrangement is to be used, it must be clearly described in the tender documents.

Call off sheets or layout maps add to the transparency of road management by allowing formal audit by the Road Manager and the funding organisation and informal audit by the road users. This transparency adds to the confidence that all parties have in road management.

Quality and quantity control

It is important to monitor how a contractor is complying with the contract in terms of quantities, technical specifications, and performance standards. The frequent presence of the Road Manager on site will improve compliance, although contractors should have internal quality control or quality assurance procedures to identify problems before inspections or measurements. This internal checking is important regardless of the chosen technology. The contract may oblige the contractor to keep quality records such as the properties of the gravel used on the road.

Costs and production rates

These should be monitored for four reasons:

1 It is usual for contractors to submit intended work programmes in their bids. The Road Manager should monitor production on a weekly and monthly basis to check compliance with the programme.

2 It is important to build up a complete management history of each road. This record will be useful when justifying expenditure and demonstrating a long term improvement in condition through good road management.

3 One impact of using the private contracting sector is that the Road Administration may lose direct contact with production methods and costs. The Road Manager must know costs and production rates in order to estimate annual maintenance costs and future financial requirements, compare contractors with an in-house unit, set production targets and identify weaknesses in current methods.

4 The Road Manager should keep long term records of annual costs on each road. These records can reflect changes as technologies become familiar and contractors become more efficient, identify long term cost increases and provide the data from which future costs can be estimated. It will be useful if these costs are recorded by work category, such as routine maintenance, periodic maintenance and rehabilitation.

Environmental monitoring

Compliance with environmental contract clauses, an Environmental Management Plan and general environmental standards is important. Guidance is provided in Annex F.

4.3.4 Auditing and evaluation

Audits and evaluations take place after the contract has been completed. They provide a thorough review of the planning and implementation cycle and increase the transparency of road management.

Auditing

Audits are integrity checks to ensure that a procedure or an operation has been carried out correctly. A contract is audited to check that it has been properly completed. A financial audit checks that the funds have been spent only on the completed works and a technical, or quality, audit checks that those completed works comply with the work specified in the contract. A safety audit can also be made to check that the road is as safe as intended for all road users (see Section 3.6). Ideally audits should be carried out by different people to those involved in planning, design and implementation, although this may be difficult to arrange in some rural areas. It is usual to carry out audits on only a sample of contracts within an annual batch.

Evaluation

Evaluation entails reviewing the procedures used during planning and implementation. Particularly if new procedures are being introduced, it is important to change elements if they have not worked as intended. These may include cost estimation methods, prioritisation procedures, tendering procedures or specific contract clauses. Perhaps an estimated unit cost was unrealistic, a procedure produced an unrealistic result or a contract clause was difficult to enforce. The evaluation should be discussed widely, including amongst the contractors, to make contract management more effective.

4.4 Site safety

The Road Manager must ensure that the contractor uses safe working practices on site. The Road Manager should explain to the contractor the impact that an accident will have on both the worker and his or her family. A schedule of penalties for non-compliance can be included in a contract. Safety issues relating to specific activities can be found on the Activity Planning Sheets in Annex G. Site safety is often covered by national regulations. In the absence of clear regulation, general safety issues and the duties of the contractor, which could be included in the contact documentation, are presented in Box 4.3.

Box 4.3

Site safety measures

General operations
Many labourers may be unfamiliar with site practices and equipment. Provide training to recruited labour on the dangers of site work, precautions (how to avoid danger) and protection (how to protect against harm when danger cannot be avoided).

Driving
Many site accidents are driving related. Ensure that only competent drivers drive on the site. Warn and then dismiss drivers who drive poorly. Do not permit any driving under the influence of alcohol or other drugs.

First Aid
All sites must have first aid facilities staffed by a trained health worker. Access to a nearby clinic must be possible at all times in case of more serious injury. For very small sites or mobile operations, at least one person in the team should have basic First Aid training and carry a First Aid kit.

Manual excavation
A group of labourers working closely together can put each other at risk of injury. Instruct a supervisor to ensure that labourers are well spread out along a gravel quarry face or a drain excavation line.

Gravel pit excavation
Vertical gravel faces can collapse and trap labourers. Excavate a maximum vertical face of 1 metre with a horizontal step of at least 2 metres to the next face to reduce this risk.

Tractor operations
Only the driver may sit on a moving tractor. No one should sit on mudguards or other parts of a tractor. All passengers should sit within, and not on the sides of a towed trailer.

Equipment operations
Instruct a worker to accompany all motorised plant to ensure that labourers are aware of its movements, particularly when reversing. Motorised plant should carry no passengers.

Clothing
Activities such as concreting and bitumen work require specialised protective clothing. This can include gloves, boots, overalls, goggles, dust masks and face masks. Hot bitumen will require heat resistant clothing. Explain clearly the dangers of working with these materials. Ensure that the protective clothing is worn. Provide an adequate supply of cleaning materials.

Rock breaking
Issue all workers producing chippings or aggregate with goggles and gloves. Ensure that the protective equipment is worn.

Tree felling
Trees can fall in unexpected directions. Maintain a clear area of radius greater than the height of the tree. One worker should announce when the tree is ready to fall.

Traffic management
Place warning signs in front of and behind each work gang such that vehicles have adequate distance to slow down and stop. One worker with a flag should be present at each end of the works to warn drivers of the activities ahead. If the carriageway is blocked, make a detour available at all times. See the International Road Maintenance Handbooks (listed in Section 5.2) or national guidance for recommended sign layouts.

Lengthworkers
Lengthworkers are vulnerable to traffic accidents when working alone. The lengthworker should put warning signs along the road in both directions before starting work.

Public safety
Roads are public places. Ensure that members of the public are protected from site activities. Provide pedestrian detours if necessary. When closing gravel pits, batter back all vertical faces. Instruct equipment drivers to drive slowly, especially on small access roads with poor visibility. Protect culvert excavations with barriers. A contractor may be legally required to provide third party insurance against damage to people and property when on the site.

Part 5: Useful information

If the Road Manager or other readers would like more detailed information on the subjects in this document, they are referred to the following organisations and publications.

5.1 Organisations

ILO – Advisory Support, Information Services and Training (ILO/ASIST)

The International Labour Organisation (ILO) is the UN agency which seeks the promotion of social justice and internationally recognised human and labour rights. The ILO has a unique tripartite structure with workers and employers participating as equal partners with governments. ILO/ASIST, part of the ILO's Employment-Intensive Investment Programme, seeks to contribute towards the alleviation of poverty through the use of local-level planning methodologies and employment-intensive strategies in the provision of rural and urban infrastructure. ILO/ASIST has two Regional Programmes, run by the following offices, and publishes a regular *Bulletin*.

ASIST – Asia Pacific
UN Building 7th Floor B-side
PO Box 2-349
Rajdamnern Nok Avenue
Bangkok 10200
Thailand
T: +66 2 2882235
F: +66 2 2881062
E: asist-ap@ilo.org
www.ilo.org/asist and www.iloasist.org

ASIST – Africa
PO Box 210
Harare
Zimbabwe
T: +263 4 369 824-8
F: +263 4 369 829
E: asist@ilo.org
www.ilo.org/asist

Department for International Development (DFID)

DFID has a large programme of development assistance and also commissions research and dissemination projects with a transport theme. DFID also has a website whose purpose is to raise awareness of the importance of transport for development, within the context of developing countries. Many documents, including the ORN series, can be downloaded from this website. The address is www.transport-links.org

1 Palace Street
London SW1E 5HE
United Kingdom
www.dfid.gov.uk
Public Enquiry Point
T: (within the UK): 0845 300 4100
T: (outside the UK): +44 (0)1355 84 3132
F: +44 (0)1355 843 632
E: enquiry@dfid.gov.uk

World Bank

The World Bank finances many rural transport projects in developing countries and coordinates the Rural Travel and Transport Programme and the Road Maintenance Initiative of the Sub-Saharan African Transport Program (SSATP). Its Rural Transport Thematic Group has produced important knowledge products on rural transport. A large amount of material is available at www.worldbank.org/transport/rt_over.htm

1818 H Street N.W.
Washington D.C.
20433
USA
T: +1 (202) 473-1000
F: +1 (202) 477-6391
www.worldbank.org

World Road Association (PIARC)

PIARC is a non-political and non-commercial association with a main objective of becoming the world leader in providing information on roads and road transport policy and practices within an integrated sustainable transport context. It co-ordinates international technical committees, organises international seminars and publishes documents.

La Grande Arche
Paroi nord, niveau 8
92055 La Defense
Paris
France
T: +33 (1) 47 96 81 21
F: +33 (1) 49 00 02 02
E: piarc@wanadoo.fr
www.piarc.org

International Forum for Rural Transport and Development (IFRTD)

IFRTD is a global network of individuals and organisations encompassing community organisations, national and international NGOs, academia, governments, donor agencies, consultants, and technical institutions. Its mission is to promote policies and practices that address access and mobility as a means to eradicating rural poverty. IRFTD has a decentralised Secretariat based in the UK, Kenya, Peru and Senegal. IFRTD publishes *Forum News* quarterly. The UK address is given below.

113 Spitfire Studios
63-71 Collier Street
London N1 9BE
United Kingdom
T: +44 (0)207 713 6699
F: +44 (0)207 713 8290
E: ifrtd@ifrtd.org
www.ifrtd.org

International Federation of Consulting Engineers (FIDIC)

FIDIC is an international federation of national associations of consulting engineers. FIDIC acts as a forum for the exchange of views and information and actively encourages the discussion of matters of mutual concern among member associations. More information, including order forms for contracts and other publications, is available on the website.

PO Box 311
CH-1215
Geneva 15
Switzerland
T: +41 22 799 49 00
F: +41 22 799 49 01
E: fidic@fidic.org
www.fidic.org

Institution of Civil Engineers (ICE)

ICE is an independent engineering institution representing almost 80,000 professionally qualified civil engineers in the UK and worldwide. The objectives of ICE are to promote learning and training, provide professional status, act as a voice of the profession and facilitate best practice. ICE also publishes standard forms of contact, including the NEC series of contracts, suitable for international use.

One Great George Street
Westminster
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www.ice.org.uk

TRL Limited

TRL Limited is one of the largest and most comprehensive international independent research centres working in land transport. The international staff work on projects for a range of clients including DFID, the World Bank and the African and Asian Development Banks.

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5.2 Publications

General road management

- *Overseas Road Note 1 Maintenance Management for District Engineers.*
- *Overseas Road Note 2 Maintenance Techniques for District Engineers.*

ORN 1 is a practical guide to the management of road maintenance operations. ORN 2 describes the principal techniques used to maintain rural roads. Some aspects of these two ORNs have been covered by this current document. ORN 1 and 2 may be obtained from TRL.

Design and Appraisal of Rural Transport Infrastructure: Ensuring Basic Access for Rural Communities. Jerry Lebo and Dieter Schelling World Bank Technical Paper No. 496 April 2001. This document describes many issues relating to the management of low volume rural roads. These include the use of Full, Basic Access and Partial Access standards, the use of the Cost Effectiveness Indicator for road prioritisation and bio-engineering.

Overseas Road Note 15 Guidelines for the design and operation of road management systems. TRL Limited 1998. This document offers guidance to help engineers and managers reach informed decisions about the type of computer based road management system which will best match the needs of their Road Administration and the most effective methods for operating the system. This document also explains much key road management terminology. ORN 15 can be downloaded from the DFID Transport Links website or obtained from TRL.

Road Maintenance Management Concepts and Systems. Richard Robinson, Uno Danielson and Martin Snaith University of Birmingham and the Swedish National Road Administration 1998. This book is a reference textbook to ORN 15 and provides full description of the many issues within road management.

International Road Maintenance Handbooks. PIARC 1994. These four handbooks provide foremen and supervisors with practical guidance on road maintenance operations. They also include guidance on site safety and traffic management. The handbooks can be obtained from TRL. The four volumes are:

1 Maintenance of roadside areas and drainage.
2 Maintenance of unpaved roads.
3 Maintenance of paved roads.
4 Maintenance of structures and traffic control devices.

Participation

A Trainer's Guide for Participatory Learning and Action, J N Pretty *et al*. International Institute for Environment and Development, London 1995. This guide is part of the IIED Participatory Methodology Series. It provides a range of materials on participatory methods for development, and is aimed at social development workers, researchers and policy makers.

Community Participation in Road Maintenance – Guidelines for Planners and Engineers. IT Transport Ltd. 2000. This document guides transport planners and engineers who wish to engage communities and other groups in the rehabilitation and maintenance of transport infrastructure.

The Rural Transport Policy Toolkit. TRL 2002. This document is aimed at those setting rural policy, but includes guidance on consultation with members of a road users participatory framework. This document can be obtained from TRL.

Labour protection

Implementing Labour Standards in Construction: A Sourcebook. Sarah Ladbury, Andrew Cotton and Mary Jennings WEDC, Loughborough University 2003. This document provides guidance on the collaborative process and contractual issues involved in the practical implementation of labour standards, as a contribution to poverty reduction and labour rights.

Prioritisation procedures

HDM and RED. HDM is administered by PIARC; RED can be obtained from the World Bank

Socio-economic benefit/cost analysis. This procedure was adapted from a method developed by TRL on behalf of DFID.

Integrated Rural Accessibility Planning (IRAP). ASIST – Asia Pacific ILO/ASIST 2000 This document describes the varied access needs of all members of rural communities, explains how IRAP satisfies those needs and guides the reader step by step through the process. It can be obtained from ILO/ASIST.

Cost Effectiveness Indicator. This is included in *Design and Appraisal of Rural Transport Infrastructure*, as above.

Point scoring. A number of countries and Road Administrations use point scoring procedures.

Activity matrix. This matrix was presented in the second edition of ORN 1.

Road types and standards

Rural Accessibility Footpaths and Tracks: A field manual for their construction and improvement. Employment-Intensive Investment Branch, International Labour Office, Geneva 2002. This document presents practical measures to improve or upgrade paths and tracks in developing countries and gives guidance on providing technical assistance to local communities. This will be of particular use when providing a Partial Access standard.

Earth Roads Their Construction and Maintenance. Jack Hindson: revised by John Howe and Gordon Hathaway, Intermediate Technology Publications Ltd 1983. This book provides very straightforward guidance on constructing and maintaining village roads (tracks) and market roads (engineered earth roads).

Management Guidelines for Unsealed Roads. T Toole, G Morosiuk, RC Petts (Intech Associates) and S Done TRL Project Report PR/INT/234/01 2001. This report provides technical guidance to Road Managers, planners and engineers to effectively manage unsealed road networks. Although mainly concerned with a Full standard, the report provides guidance on a Basic Access standard. This document can be obtained from TRL.

- *Manual for the labour based construction of bituminous surfacings on low volume roads.* TRL PR/INT/237/01.
- *Rationale for the compilation of international guidelines for low-cost sustainable road surfacing.* LCS Working Paper No. 1 Intech Associates March 2002.

These two documents provide guidance on a variety of improved surfaces, with specific focus on their construction using labour based methods. Associated documents can be found on the DFID Transport Links website above.

- *Overseas Road Note 3. A guide to surface dressing in tropical and sub-tropical countries.*
- *Overseas Road Note 18. A guide to the pavement evaluation and maintenance of bitumen-surfaced roads in tropical and sub-tropical countries.*
- *Overseas Road Note 31. A guide to the structural design of bitumen-surfaced roads in tropical and sub-tropical countries.*

These three documents provide guidance on bitumen surfaced roads. They can be obtained from TRL.

Structures

Overseas Road Note 7 A guide to bridge inspection and data systems for district engineers. TRL Limited 1988. This document provides an engineer with guidance on the establishment and operation of an effective bridge and culvert record system.

Overseas Road Note 9 A Design Manual for Small Bridges. TRL Limited 2000. This document provides guidance to assist and simplify the process of planning and designing small bridges and culverts. Erosion protection works and submersible structures such as causeways are also described.

Safety

Microcomputer Accident Analysis Package. MAAP is a software package which is used to record and analyse information about accidents collected by the police or other agencies. It can be adapted to suit different data collection forms, has the ability to provide summary statistics, trends in the data and identify accident clusters based on GIS locations, and can help identify common patterns of accident at specific locations. The package is available from TRL who normally provide assistance in setting up the system.

Towards Safer Roads in Developing Countries: A Guide for Planners and Engineers. TRL, Ross Silcock and Overseas Development Administration *(now DFID)* 1991. This manual was intended to be a first point of reference for most engineering aspects of road safety. It gives practical guidance to professionals and decision-makers in developing countries on how to make their road networks safer. The manual outlines the different stages involved in planning and designing road networks and introduces safety conscious design principles as they relate to both accident prevention and accident reduction. The manual can be obtained from TRL.

Cost and Safety Efficient (CaSE) design of rural roads in developing countries. TRL 2001. Following a statistical analysis of road accidents and geometric features in several developing countries a series of CaSE notes have been produced on four key specific features that can have a bearing on accident occurrence on rural roads. Among the findings are that the provision of segregated footpaths is often very economically worthwhile, and that the optimal width of shoulders should be 1.5 metres. The CaSE notes can be obtained through the DFID Transport-Links website.

Contractor development

Employment-Intensive Infrastructure Programmes: Capacity Building for Contracting in the Construction Sector. Peter Bentall, Andreas Beusch and Jan de Veen, International Labour Office, Geneva, 1999. These Guidelines present the current experience of contractor development programmes which aim to introduce cost effective employment-intensive approaches to infrastructure works while respecting basic labour standards and correct working conditions.

Community contracting

Community Contracts in Urban Infrastructure Works, Practical Lessons from Experience. Jane Tournée and Wilma van Esch, ILO, 2001 (first draft 1998). This report provides useful guidance in the use of community contracts. Although written for urban works, the principles also apply in a rural environment.

Environment

Road Maintenance and the Environment. Lantran, J.M. Road Maintenance Initiative. SSATP Report. Africa Technical Department and Sahelian Department The World Bank 1994. This document provides guidance on environmental protection and suggests contract clauses, two of which have been used in the text.

Bio-engineering

- *Roadside Bio-engineering Reference Manual & Site Handbook.* Department of Roads, His Majesty's Government of Nepal, 1999.
- *Bio-Engineering for Effective Road Maintenance in the Caribbean.* Natural Resources Institute 1996.

These DFID funded documents describe the principles and techniques of slope stabilisation using vegetation. Although written specifically for Nepal and the Caribbean, these documents apply to all countries with slope erosion and stability problems.

Annex A: Glossary

Road user	Any individual who is affected by the condition of the road, whether positively (eg. a market trader), negatively (eg. a victim of a road accident) or indirectly (eg. someone dependent upon a travelling health worker).
Maintainable	A road, or a section of road, is in a maintainable, or good or fair, condition if it serves the needs of the road users and has only minor defects which can be rectified using routine or periodic maintenance.
Unmaintainable	A road, or a section of road, is in an unmaintainable, or poor, condition if it does not serve the needs of the road users as a result of major defects which require rehabilitation.
Maintenance	Activities to rectify minor defects to restore a road to a good condition, or prevent future defects.
Routine maintenance	Maintenance activities which are normally required annually or more frequently, which are often specified on a repeated cycle and which normally suit lengthworkers and small contractors. These include cutting grass and clearing drains.
Periodic maintenance	Maintenance activities which are normally required less frequently than annually, which are often specified in response to a minor defect and which normally suit small and medium contractors. These include regravelling a gravel road.
Rehabilitation	Activities which are specified in response to major defects and which are required to return a road to a maintainable condition. These include repairing a collapsed culvert and reforming a damaged length of carriageway.
Spot improvements	Maintenance or rehabilitation activities at isolated sites along a road to provide Basic Access. The appearance of the road will vary along its length. The road type may also vary along its length.
Upgrading	Activities to increase capacity or raise a road to a higher road type, for instance providing an improved surface to a gravel road. Upgrading can often result in reduced maintenance costs.
Emergency works	Activities required at short notice to restore access after sudden closure or make safe a dangerous site (eg. repairing a collapsed culvert).
Road	The term can be used generically to refer to all roads, tracks and paths.
Road type	The construction and surface of the road. Four road types are used in this document: track, engineered earth road, gravel road and an improved surface. Each type is suitable for different traffic levels and other external influences.
Classification	Classification indicates a hierarchy of road importance within a network. Typical classes are primary, secondary, tertiary, feeder, access and unclassified and reflect function, ownership and usage.
Standard	The level of service provided by a road. In this document, three standards are recommended: Full, Basic Access and Partial Access.
Full	Safe, reliable, quick, and comfortable year round travel.
Basic Access	Safe and reliable year round access. Short term closures are normally accepted. Basic Access is normally the minimum requirement for socio-economic development.

Partial Access	Minimum level of access at very low cost. Partial Access may not be year round. See Annex D.
External influences	Traffic, terrain, soil, climate and other influences beyond the control of the Road Manager.
Safety engineering	Use of engineering principles to make a road environment safe for all road users.
Defect	Where the road does not comply with the technical specifications.
Cause	The reason that a defect has arisen.
Effect	The outcome if a defect is not rectified.
Activity	Works to rectify a defect. Maintenance activities will rectify minor defects; rehabilitation activities will rectify major defects.
Intervention level	The severity of a defect at which repair is necessary. Intervention levels may vary according to the standard of the road.
Equipment intensive	Work methods which use machinery wherever possible and labour only when necessary.
Labour intensive	Work methods which use labour wherever possible and machinery only when necessary.
Labour based	Work methods which use a combination of equipment and labour. The combination is often chosen to achieve a balance between employment generation and productivity while remaining cost effective.
Measurement contract	A contract where payment is made on the basis of the quantity of work completed to a technical specification.
Technical specification	Technical specification describes the detail (dimensions, materials and so on) of a road, or the output of a maintenance or rehabilitation activity.
Performance contract	A contract where payment is made when the condition of the road is at or above a defined performance standard or level of service
Performance standard	Performance standards describe the required condition of a road under a performance contract.

Annex B: Access, defect and treatment photographs

This annex illustrates many of the issues covered in this document, including reliable access, the range of road types, the application of standards and spot improvements, improved surfaces, bio-engineering, appropriate structures and safety engineering.

Tracks

Most of the photographs in this section show tracks which provide or, with some improvements, can provide a Basic Access standard.

1

This track has no drains or camber. However, because of the low traffic levels, the well draining soil, the gentle slopes, the non-flooding terrain and vegetation which strengthens the soil, it is stable and strong and requires minimal maintenance to keep open all year round.

2

This track is similar to the above, although visibility is reduced by the tight corners and high vegetation. For safety reasons, the vegetation should be cut regularly.

3

This is an overgrown but stable track. The woody stumps found between the wheel-tracks should be removed to prevent damage to bicycle and car tyres. The high vegetation should also be cut to improve visibility and to reassure pedestrians afraid that snakes may be hiding in the grass.

4

The soil along this rutted track is fine and poorly draining, so water ponds in any depression and the soil is pulverised into mud. The track becomes impassable, and every vehicle passage makes the condition worse. In dry weather, the resulting ruts are deep and hard to pass. The track should be locally raised and well cambered to prevent water ponding on the riding surface.

5

Rain falling on the surface of this inclined track flows down the gradient forming small erosion channels. Little water absorbs into the well compacted fine soil. The channels concentrate the water and can grow into severe longitudinal erosion. The track has become impassable and vehicles must detour through the undergrowth. The track should be reformed with camber, side drains and mitre drains or the solution shown below can be used.

6

This diversion bank traps water running down the track and diverts it off the carriageway into side drains. Being drier, the track downhill remains in reasonable condition. Diversion banks are a very low cost improvement measure. They also serve to reduce traffic speed. They can be made of compacted soil, stones or logs. The bank in the photograph should have been constructed diagonally across the track so that water is not trapped in ruts in the wheel tracks.

7

Surface material has worn away from this track to reveal rounded lateritic bedrock. The track is stable and passable at low speed. Removing the rock or forming a stable camber over the rock with imported material will be difficult and expensive. Unless the bedrock extends over a long length, severely disrupts traffic or damages tyres, leaving the track in its current condition may be the best solution.

8

Four wheel drive passage down this extremely rocky track is very slow and requires great care, while the vehicle, particularly the tyres, can be damaged. This track is clearly not providing safe and reliable access. Providing access will require major improvement work or route realignment.

9

This track passes through an area which floods in the rainy season. Large ponds may be present year round, and during the rains the entire route is under water. Year round access can only be provided by a very expensive and long embankment. The road is nearly 100 km long, which may justify providing a Full standard (see Table 3.10).

10

This road was formed from a stable track. However, the soil is light and non-plastic and the little vegetation which has grown is unable to give strength to the road structure. With no maintenance, it is likely that the road will return to a track in a short time. If access had been a priority, the track may have been left as it was. This illustrates how forming a track into a road can impose a maintenance burden on an under-resourced Road Manager.

Footpaths

This photograph shows how reliable access can be provided at very low cost on a footpath.

11

This narrow stone lined channel allows pedestrians to cross a stream with ease and prevents erosion of the footpath. It is a very low cost improvement. If the hillside below the path were prone to erosion, an outfall structure would be required. The channel can also collect and dispose of water that might flow down the footpath itself.

Roads

This section includes many of the defects that can be found on engineered earth and gravel roads.

12

This photograph shows a good gravel road. It has a camber, side drains and mitre drains, although the latter are hard to see. With two or three years of vegetation growth on the shoulders and side slopes, the road will be more durable and erosion resistant.

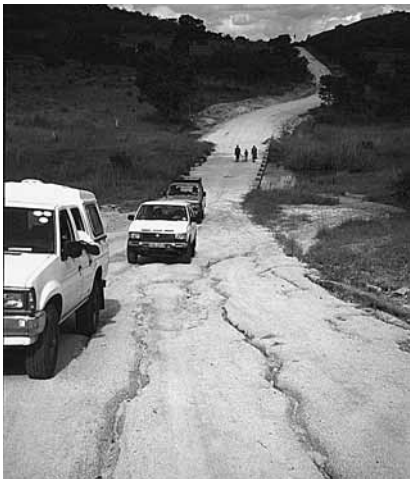
13

This road has corrugations approximately 75 mm deep. Access has not been lost and vehicle operating costs (VOCs) are not high, but the road is dangerous to travel on at speed as control can be easily lost. Dragging can eliminate initial minor corrugations and prevent the problem getting worse, but grading is required when they reach this advanced state. (Photograph courtesy of CSIR, South Africa)

14

This road has been well formed. However, inadequate maintenance has left ruts in the wheel tracks while the poor quality gravel has little resistance to erosion. The ruts concentrate water and form gullies in the shoulders. More frequent grading or rut filling of the surface and vegetation on the shoulders would reduce the gullying. Unless resolved, the problem will worsen and access will eventually be lost.

15



Longitudinal erosion is beginning to form deep gullies in this carriageway. Maintaining the camber with regular grading would have prevented this happening, although that is hard to do on a carriageway as wide as this.

16

A side drain on this secondary road has become blocked with sediment. Water has overtopped, cut across the carriageway and caused significant damage. Deterioration will continue until the drain is cleared and water properly disposed of. Similar problems can occur if road users block drains in order to access road side properties. If this happens, the Road Manager should explain to road users the problems caused by blocking drains and then help them form small culverts to access their properties.

17

A camber is required to shed water from a carriageway. This secondary road has not been graded for a long time, the camber has been lost and potholes are developing. Each vehicle passage worsens the situation. The road should be reshaped as soon as possible.

18

Another section on the same secondary road has deteriorated further. Passage is very slow in the dry season and impossible in the rains. Slow speed may be acceptable on short access routes, but is a particular problem on long national routes where vehicles will not make a journey unless they can do so at reasonable speed. Further, the road is now too rough for two wheel drive vehicles that would normally expect to be able to travel on national routes. This section of road should be reconstructed.

19

This secondary road is well maintained, but is very wide. The carriageway will collect a large amount of rainfall and it will be difficult to maintain a camber. Despite the obvious recent maintenance, the crown is flat and small potholes are already developing. Roads are often prepared in this way ready for a seal, but the seal is often not completed.

Improved surfaces

A number of the defects in the earlier photographs, and in the first four in this section, could be eliminated with improved surfaces.

20

The fine soil on this road is dusty when dry and very slippery when wet. Gravel is hard to find in this area, so an improved surface, bituminous or non-bituminous, is recommended.

21

This photograph shows the level of dust that can be generated from a gravel road. The dust brings health problems to villages, affects agricultural output, is dangerous when vehicles pass or attempt to overtake and demonstrates why gravel must be frequently replenished. (Photograph courtesy of CSIR, South Africa)

22

This ascent from a vented drift will often remain wet as water falls from passing vehicles. The gravel will therefore be weak and slippery. A short length of an improved surface will eliminate these problems and prevent access being lost.

23

This steep hill on clay soil is difficult to ascend when dry and impossible when wet. The hill is suitable for spot improvement with an improved surface.

24

This embanked road has been surfaced with two layers of bricks in a herringbone pattern. The manufacture of these bricks uses local clay and local skills, although there are concerns of excessive wood use in the kilns. When an upgrade is planned, the bricks can be lifted, manually broken and used as a water bound macadam base below a bituminous seal.

25

A concrete surface is very strong, but steel reinforcing bars make it very expensive. Bamboo strips are proving to be a suitable low cost alternative to steel bars.

26

This photograph shows a proprietary system whereby a pre-formed grid of polythene strips is tensioned and filled with a cement stabilised sand. The result is a type of in-situ block pavement. The strips are profiled to form keys between blocks, allowing load to be transferred and the surface to flex without cracking. The polythene grid retains the blocks, removing the need for edge beams or kerbs. (Photograph courtesy of Scott Wilson Africa Limited)

The following four photographs use a stone surface to illustrate the durability of an improved non-bituminous surface. The same principles apply for brick and block surfaces.

27

This photograph shows a stone surface. Large, dressed edge stones retain smaller, undressed stones and in doing so form a simple drain. The surface is also cambered to shed water. The surface is rough, but extremely durable. Repairs can be made very simply by removing the damaged area and relaying the stones.

28

Despite traffic, flowing water and a total loss of camber, this steeply inclined stone surface remains stable and accessible. Improved surfaces are suitable for use as spot improvements on steep sections which would otherwise rapidly become impassable.

29

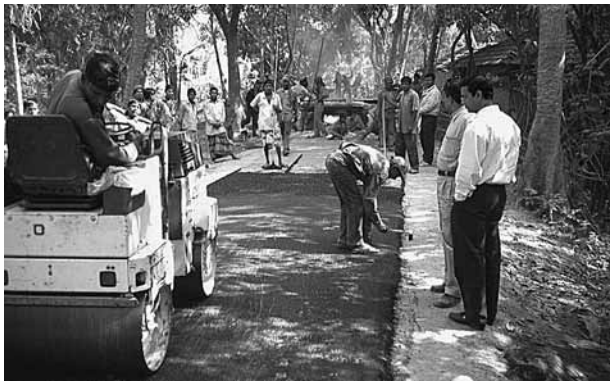
A stone surface remains passable for many years. This surface has lost all shape as the stones have been pressed into the base material. However, the stones give strength and erosion resistance to the base, which remains passable to a wide variety of vehicles.

30

This embankment across low lying and seasonally flooding land has a stone surface. Perhaps because of disruption to the works, perhaps to save funds, only half has been surfaced. When dry, the full width is accessible. When wet, the surfaced half provides reliable access.

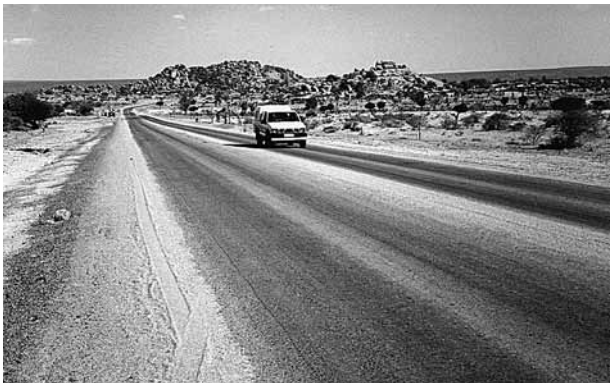
The following two photographs show bituminous surfaces. Although not included in this document, bituminous surfaces are described in documents listed in Section 5.2.

31



This photograph shows a thin seal being constructed using labour based methods on a broken brick water bound macadam base. Aggregate and bitumen are heated and then mixed over fire. The mix is transported by bicycle, spread manually to the thickness of thin spacer bars and compacted by a vibrating twin drum roller.

32



This road has been surfaced with an Otta seal. Bitumen is sprayed onto the base, a graded aggregate is spread onto the bitumen and the surface is then rolled with pneumatic tyred rollers to move the bitumen up through the aggregate. The sand along the side of the road is the residue from a blinding operation which is often required in the months after construction if excess bitumen moves up under the effect of traffic.

Labour and equipment

This section illustrates labour based methods and typical light equipment used to support the labour.

33

The formation of this tertiary road is being constructed using labour based methods.

34

A typical construction site where labour based methods are used is likely to have tractors, trailers, twin drum pedestrian rollers and water bowsers. The sides of this trailer hinge down to make loading and unloading easier.

35

This locally manufactured grader is towed by a tractor and can be used for formation works and for maintaining earth and gravel surfaces.

Erosion

Although erosion is a defect in many of the photographs in this Annex, this section looks specifically at the problem of erosion and a number of solutions.

36

Erosion began in this culvert outfall channel some distance downstream. The erosion has moved upstream and is now undercutting the apron, putting the entire structure at risk of collapse. Run-off around the wingwalls has contributed to the problem. The downstream erosion needs to be controlled by reforming the channel and constructing scour checks. Then any structural damage should be repaired, and the wingwalls extended down to apron level and backfilled.

37

This photograph shows a well protected culvert outfall. There is no route for water to cut around the wingwalls. The outfall channel is built to a gradient of around 2% which should prevent erosion further downstream.

38

This side drain has become very severely eroded over many years without maintenance. The road is likely to collapse into the void and road users are in great danger. The erosion damage must be repaired, and scour checks and mitre drains installed.

39

This photograph, looking downhill, shows a scour check to reduce erosion. It is well built with wooden stakes and stones and well shaped to keep the water flowing in the centre of the drain. A mitre drain was dug at the bend in the road but more should have been dug to divert the water onto the surrounding land. Grass has also been planted along the shoulder line in an attempt to prevent erosion.

40

Run off from the surrounding land is causing serious erosion to this very badly maintained road. It is necessary to protect the inside face of the side drain or to dig interception drains to channel the water to a water course or a culvert. Interception ditches are more effective than drain lining, but maintenance can often be overlooked if they are out of sight.

41

This road shoulder is badly eroded. The extent of erosion can be seen from the height of the wingwall, originally at ground level. Shoulder erosion often occurs near water crossings as water concentrates at the low point on the road surface and then runs off the shoulder. The shoulder should be reconstructed and vegetation planted on the steep slope.

42

Slopes often erode if they are steep and unprotected. Turf is being laid on this embankment to protect it from erosion. The turf was grown in a nursery specifically for this use.

43

Grass is establishing itself naturally on this shoulder. Grass can be deliberately planted (see the earlier photograph of a scour check) or topsoil can be added to encourage natural grass. One danger of maintaining road surfaces with a grader is that this protective grass may be removed.

Bio-engineering

A variety of bio-engineering measures can be used to prevent erosion and stabilise slopes.

44

This deep erosion gully was formed during a few days of intense rain. After some rehabilitation landscaping, the slopes were protected against further erosion with contoured vegetation. In the right hand corner, a set of concrete steps should prevent pedestrians wearing out a channel which may initiate erosion, while the main structure is a gabion cascade bringing the water course down to a gabion protected channel in the base.

45

This combination of dry masonry retaining wall, timber crib walls and contoured planting has been constructed to stabilise a slope. After two years the measures were well rooted and secure. (Photograph courtesy of Ruth Schaffner, consultant, Oberhofen, Switzerland')

Water crossing structures

This section shows a wide variety of structures to carry water across a carriageway. Some of the problems with design and construction are also described.

46

The stream at this site required a water crossing structure. However, with the road and stream at the same level, a culvert would have resulted in either excessive earthmoving or vertical curvature. It was decided to construct a drift. Erosion protection is placed upstream (cut off wall and loose rock) and downstream (two cut off walls and gabion mattresses). Guide posts are also provided. Grassing of the area surrounding the gabions is important. Providing an improved surface on the approaches will be a worthwhile improvement to prevent problems of wet and slippery gravel.

47

This multi-bore culvert takes a tertiary road across a water course. The culvert has not been well maintained and the few repairs carried out have been inadequate. The culvert is difficult and dangerous to cross and likely to be impassable in the rains. The culvert should be reconstructed to ensure access and safety.

48

In hilly terrain, a substantial structure may be required to both support a culvert pipe and span a short gully. This structure has been built using locally available materials.

49

This small bridge on a track provides reliable and safe access across a stream. Since the track either side of the crossing is passable year round, the bridge is a worthwhile spot improvement.

50

In many situations, a road may cross a water course and then continue across low lying land. An isolated bridge would cross the water course, but embankments are needed to provide access along the entire route. This photograph shows a submersible bridge between embankments that will provide year round access.

51

This photograph shows a causeway or vented drift. The raised blocks act as depth and width guides when in flood. They are spaced so that they can act as stepping stones for pedestrians. The inside edges are chamfered so as not to damage vehicle tyres or trap water-borne debris.

52

Culverts can be built in many ways. Pipes of corrugated galvanised sheet can be installed quickly but are expensive and often hard to obtain. This culvert is built with a wet masonry arch over removeable pipe formwork, thereby reducing the reliance on imported materials. It was necessary to convince the masons, using wooden shaped blocks, that the arch would stand when the formwork was removed, but once convinced, they quickly adopted their new skills.

53

A masonry arch can be constructed to a larger size than in the above photograph, as in this structure with a span of around 5 metres. The formwork must be very carefully constructed.

54

This double culvert has masonry walls upon which a reinforced concrete cover slab is being built. Previously excavated soil is used as formwork for the cover slab and will be removed when the concrete has gained sufficient strength.

55

This bridge is constructed entirely from stripped logs. It survived floods which destroyed a number of nearby pipe culverts and remained fully passable.

56

This small bridge has a mass concrete base slab, masonry abutments and pier and a reinforced concrete deck. The deck was cast using local timber formwork and falsework. Decks can also be made of dressed timber. Timber is easy to obtain in many areas, uses local suppliers and is easier to construct than a concrete deck. If the timber deck is built without load spreaders or running strips, it is easy to inspect for damage or rot.

57

This rough log deck has been built on the abutments and piers of an earlier structure. It is in danger of imminent collapse and every crossing places the vehicle and passengers at great risk. A poorly built deck such as this can also restrict the water flow, leading to overtopping, and should be replaced as a matter of urgency.

58

Logs can be used to construct an informal, but safe deck as in this photograph. This deck is not at risk of collapse, although the logs could have been placed closer together to make crossing easier for bicycles and pedestrians.

59

Simple techniques can be used to construct long bridges. This bridge uses masonry and reinforced concrete to cross a wide seasonal river. It is submersible and has flared piers with no parapet railings to help debris pass over the top. The earlier structure can be seen in the background – its higher level was perhaps unable to shed debris and contributed to its failure. The new structure was built using labour based methods by a contractor within a formal training programme.

60

This culvert is free flowing and the road is currently passable, but the outfall channel is blocked with silt and high vegetation. An inadequate attempt at repairing the erosion behind the wingwall will put access at risk in the likely event of further overtopping. The erosion should be properly repaired and the outfall channel fully cleared.

61

This culvert has minimal cover over a large diameter corrugated sheet pipe. The surface of the pipe is visible from above. Lack of cover is a problem for a normal small diameter culvert, but here it could cause sudden collapse and loss of life. The culvert should be inspected carefully and adequate cover provided as a matter of urgency.

62

It is important to correctly determine the flow requirement of a culvert. This single aperture culvert was built without consideration of the catchment area and potential run off volume. In a single storm it overtopped and rendered the road accessible to only four wheel drive vehicles.

63

After the above culvert overtopped, it would have been disruptive and expensive to rebuild a higher capacity culvert. An easier solution was to repair the erosion damage and construct a downstream cut off wall as a weir. The culvert may overtop but the short length of road will act as a long drift. Gabions support the wall and have been topsoiled and grassed. The headwall was raised to reduce erosion close to the outfall.

Safety

The final photographs illustrate a number of the points in Section 3.6.

64

This photograph shows low cost edge delineators being used to indicate a steep drop. They are made from half-buried oil drums filled with sand and capped with concrete. They are painted white for greater visibility, particularly at night.

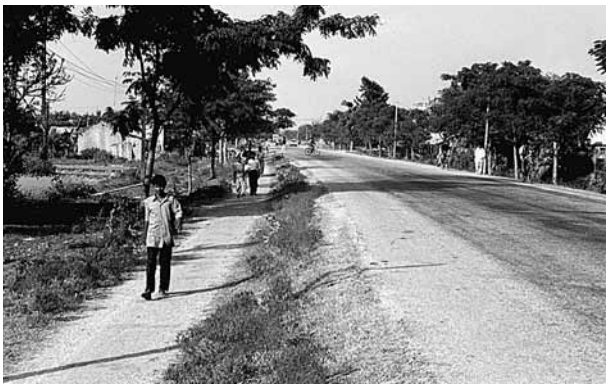
65

The pedestrians on this unpaved road have no option but to walk on the riding surface, close to moving traffic. Unless the grass is cut, the verge widened or a separate footpath formed, they are unable to avoid conflict with traffic.

66

This footpath has been built several metres from moving traffic. The distance, the drain and the added height protect pedestrians from vehicles although it is noted that the deep and steep sided drain may trap vehicle wheels. This is a relatively high cost solution.

67



This footpath has been formed very simply within the wide verge and segregates pedestrians and cyclists from moving traffic.

68

This road has been built with wide shoulders where pedestrians can walk safely. However, in the dry season, the wide side drain provides even greater safety from traffic.

69

This bus stop lay-by is clearly marked and delineated from moving traffic. Those leaving the bus are protected from traffic. Bus stops such as this can be easily made on unpaved rural roads.

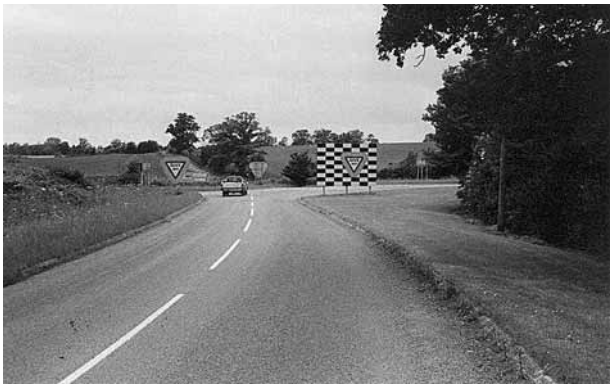
70

This sign and the kerbing segregate vulnerable road users and slow local traffic from higher speed through traffic. Pedestrians clearly feel safe in the segregated lane.

71

This truck was prevented from a very long fall by a barrier of gabions. Filled with stones and tied together with wire, gabions can form a very effective edge barrier.

72



This minor road meets a major road at a T junction. Large signs have been provided to warn approaching drivers and prevent them overshooting the junction. Similar signs can be provided at low cost at junctions of lower volume, unpaved roads. Clear signs are particularly required at cross roads where a minor road may appear to pass straight over the junction. An alternative solution is to add a slight stagger to the minor road at the junction.

Annex C: Equivalent Daily Traffic

In order to plan and cost maintenance and rehabilitation works, it is often useful to calculate an equivalent daily traffic volume. Whereas a 'total vehicle count' does not differentiate between small and large vehicles, an equivalent traffic count takes vehicle type into account and so addresses the extra damage caused by a single large vehicle or, conversely, the extra benefit that accessibility for large vehicles can bring to a community.

Carry out a traffic survey. On Primary and Secondary roads, count traffic in both directions for 7 days and for 24 hours each day. On Tertiary roads and below, count traffic in both directions from dawn until dusk for 2 days. If traffic is known to pass at night, multiply by 1.2 to estimate the 24 hour count; if no traffic passes at night, the 24 hour count equals the day count. Avoid market days and intense periods of harvest activity if possible. 1 day counts are too variable and should not be used.

Calculate the average daily traffic for each vehicle type. Convert the average daily traffic to an equivalent daily traffic using the factors in Table C1 and sum to give the total equivalent daily traffic.

Table C1 Equivalent traffic conversion

Vehicle type	*2 or 7 day count*	*Daily count*	*Night factor (1.0 or 1.2)*	*Average daily count*	*Equivalent traffic factor*	*Equivalent Daily Traffic*
Truck and bus					5	
Tractor					4	
Small bus					2	
Pick up					1	
Car					0.8	
Animal					0.2	
Motorcycle					0.1	
Bicycle					0.05	
Pedestrian					0.02	

The count should be carried out during the dry season. Wet season counts are often very low due to poor road conditions, a handicap that good road management seeks to eliminate.

If it is impossible to organise a traffic survey, traffic can be estimated from a moving observer count. The 12 hour count, Q, is estimated as follows:

$$Q = \frac{(x+y)\times 720}{t}$$

where x = the number of vehicles passing in the opposite direction

y = the number of vehicles which overtake minus those which are overtaken

t = the time taken to drive the road in minutes

This calculation should be made for each vehicle type and then night factors and equivalent traffic factors multiplied as appropriate.

Since a moving observer count can be inaccurate, particularly when traffic volumes are low, it is recommended that a minimum of one count in each direction, and preferably two in each direction, are made and then averaged.

Annex D: Providing a Partial Access standard

This document recommends that all roads are rehabilitated to, and then maintained at, one of three standards. These are Full, Basic Access and Partial Access and are described in detail in Method 1 of Section 3.5.

The main text is concerned with Full and Basic Access, levels of service which permit year round safe access and which are generally seen as necessary for socio-economic development. Although the Road Manager should aim to bring all roads in the network up to a Full or Basic Access standard, when funds are constrained this may not be possible.

However, the lower priority roads will not be abandoned and the people living alongside them ignored. This document proposes that those roads where a Full or Basic Access standard cannot be funded, are maintained at a Partial Access standard. Although there is no single procedure for a Partial Access standard, the following principles will apply.

Particularly in the context of Partial Access, 'road' can refer to all routes, including tracks and footpaths.

1 Funding

There will be very low levels of government funding available for these roads. Local people should be encouraged to contribute, although contributions should depend upon their means. For instance, a local business may contribute financially while others may give materials or their labour, or collect funds. Locally generated funding will be able to fund only low cost activities.

2 Level of access

The level of access that can be provided under Partial Access will depend very much on the local conditions, particularly the soil, terrain and climate.

With very limited budgets, it is unlikely that a road in a tropical climate can be made accessible all year round. It is more likely that access will be available in the dry season and intermittently during the rains. It is also possible that roads will not be accessible to a medium sized truck, a vehicle which is often seen as a standard vehicle when assessing accessibility. A more reasonable target would be to provide access to pedestrians, bicycles and motorcycles, although larger vehicles may be able to travel in the dry season.

It is important to ensure that wherever access is provided, it is safe. If dangers exist, such as a footbridge over fast running water or a stream subject to flash floods, they should be very clearly explained to the local community.

3 Implementation

Funds may be available to let small contracts, in which case implementation will be similar to that for other standards, although the nature of the works may differ. The Road Manager may decide to instruct the local community in simple techniques such as drainage works and erosion repair, since regular contracted maintenance of the road is unlikely.

Alternatively, if a community shows commitment to improving its own roads, whether externally funded or as part of its own contribution, the Road Manager may make brief, but regular visits to advise and then supervise the community carrying out the work itself. Subsequent visits by the Road Manager will be useful to monitor road condition and maintenance by the community, but will depend on resources.

4 Ownership

It may be worthwhile for a Road Administration to consider delegating ownership of a road to the local community. The community will therefore take full responsibility for the condition of the road, but will also have the opportunity to generate funds from road users. This fund collection may be as levies from traders at local markets or as tolls from road users.

5 The participation of local communities

The level of access provided will be dependent upon the level of involvement of the local community. Involvement can range from ‘spontaneous mobilisation’, where communities take the initiative and may ask for outside help, to ‘passive participation’ where communities are informed of what is happening by an outside party. The more involved that a community becomes, the more likely it is that a Road Administration will be able to help with advice, resources, equipment and time. Through the road user participatory framework (see Section 3.1), the Road Manager should encourage communities along low priority roads to mobilise themselves.

6 Technical considerations

Partial Access is provided by repairing sites which are in such a poor condition that access is impossible, even in an emergency, or where passage is dangerous to people and vehicles. It is likely that attention will focus on sites which are adversely affected by water. These include water crossings, marshy areas, steep hills and areas of slippery soil. Suggested solutions are given in Table D1. Clearly some of these solutions may also be used to provide a Basic Access standard – they are listed here as they are low cost and suit implementation by local communities.

7 The future of Partial Access

It is likely that a community will find socio-economic development difficult on roads maintained at a Partial Access standard. This standard should be seen as a temporary state to prevent isolation and hardship, from which roads will be improved as soon as funds are available.

Table D1 Low cost solutions to provide Partial Access

Problem	*Solution*	*Description*
Water crossing is required.	Cross drain.	Direct the stream into a narrow, stone lined channel across the footpath, over which pedestrians can step. A maximum width of 50 cm is recommended.
	Culvert.	Culverts can be made from large rocks or a small log structure. Alternatively, cement pipes or bamboo culms can be buried to take water under the road.
	Stepping stones.	If the stream is not deep, heavy flat topped rocks may be used to provide access to pedestrians.
	Drift.	In a drift, the road passes through the water. The bed of the stream should be reinforced with large flat stones to provide a firm smooth surface.
	Footbridge.	Larger structures (over 2 metre span) can be constructed using logs or cut timber. Great care should be taken to ensure that the structure is safe.
	Boat.	For wide rivers, it may be easier and cheaper to provide a boat, or encourage a member of the community to establish a service. Strong jetties are required.
Marshy areas.	Stepping stones.	Only suitable for pedestrians, stepping stones can be made from single large rocks, wooden boxes filled with small stones or sandbags filled with concrete.
	Board walk.	A raised wooden platform can be supported from either logs laid on the ground or posts driven into the ground. The structure should be regularly inspected.
	Raised path.	Place two thick logs on either side of the path, fix with stakes and fill in between with compacted soil to form a raised path
	Detour.	It is possible that the road was formed when the area was dry. The easiest solution is to realign the road around the marshy area.
Steep hills.	Zig-zag paths.	A maximum gradient of 10% and leg length of 40 metres is recommended for paths. A reduced gradient should be used at the hairpin bends.
	Steps.	Useful for very steep hills. The steps can be made from stone or logs. Steps are not suitable for wheeled transport and may not suit pack animals.
Areas of slippery soil.	Surfacing.	The soil can be surfaced with a granular or sandy soil, possibly only along the wheeltracks, or small stones rammed into the soil. If necessary, the road may be realigned around the area.
Erosion along the road surface.	Diversion bank or ditch.	A shallow diagonal ridge or channel across an inclined road. This traps water running along the road and diverts it into a drain in the surrounding land. The ridge can be made of logs, stones or compacted soil.
Longitudinal drain erosion.	Protected drains.	Drains can be lined with stones to prevent erosion. Drains can also be filled in with single sized stones and will thus be less likely to collapse.
Drain erosion from run off.	Interception ditches.	A parallel ditch can be dug uphill from a drain to collect run off water and prevent damage to the road.
Damaged footpaths.	Improved footpaths.	Improve a footpath with a camber and side drains. Provide a stone surface to the footpath.

Annex E: Emergency work

The main text of this document covers an annual cycle of planning, budgeting and implementation. Defects are assessed and the required activities identified. This cycle suits defects which are minor or where condition is deteriorating gradually. It does not suit defects which occur suddenly and cause immediate danger or loss of access. In practice, emergency work is carried out using a parallel system of identification and response. This annex covers that parallel system.

1 Identify

A large proportion of emergencies are due to a lack of maintenance. A culvert overtops when it has become blocked with sediment and debris, a road gets washed away when a side drain is not regularly cleared and a vehicle overturns when a gravel layer wears away. A Road Manager who prioritises maintenance will reduce the number of emergencies on the network.

Nevertheless, unforeseen emergencies can happen. An overloaded truck may destroy a structure or very high rainfall may destroy culverts, bridges and lengths of carriageway. These can cut off rural communities, and place those attempting to pass in danger. Even minor problems such as debris on the road can restrict access. All emergencies, large or small, should be dealt with as soon as possible.

It is essential that an efficient communication system is in place through which reports of emergencies can be passed to the Road Manager. This communication system should be based upon the road user participatory framework since it includes networks of local traders, police, government staff and others who are likely to see or hear of emergencies very soon after they occur. Section 3.1 provides guidance on establishing and maintaining participatory frameworks.

2 Respond

When responding to an emergency, the Road Manager should decide if a temporary or permanent solution is required. This decision will depend upon the impact of the lost access, the practicalities of the site, and the available plant and materials. For instance, if a structure or length of embankment has been washed away, the wet conditions are likely to make reconstruction difficult. In this case a temporary detour with a pre-fabricated culvert pipe might provide access until reconstruction can begin in the dry season. Table E1 lists a number of typical solutions used in emergencies.

Table E1 Typical solutions to emergencies

Emergency	*Cause*	*Temporary solution*	*Permanent solution*
Damaged structure.	Overloaded vehicle.	Detour, Bailey bridge or low level structure.	Repair and strengthen structure. Restrict access to large vehicles.
Damaged structure.	High water flow.	Detour, Bailey bridge or low level structure.	Repair structure and increase flow capacity.
Approaches to structure washed away.	Water overtops structure.	Temporary fill.	Reconstruct more resistant approaches, increase flow capacity.
Flooding.	Area wide flooding.	Sand bag protection.	Raise level of road.
Washed out road.	Side drain overflowed.	Repair road.	Repair side drain, dig more mitre drains.
Washed out road.	Run off from side.	Repair road.	Dig interception ditches.
Overturned vehicle.	Slippery road surface.	Remove vehicle.	Provide an improved surface.
Blocked road.	Landslide.	Clear material using labour or equipment.	Protect slope with retaining walls or bio-engineering.

Unless available funds are very limited and the terrain, climate and traffic make the threat of emergencies very unlikely, the Road Manager is advised to have some form of emergency response capacity. This capacity may be provided in four ways.

- The first is to retain an in-house unit specifically for emergency response. Minimal administrative procedures may be required and the response is effective. Unless the private sector is competent at assessing the risks of providing an emergency response, this solution is recommended.

- The second is to establish call-off or stand-by contracts with local contractors. These contracts are based upon a specified response time, and a set of unit rates for responding to specific situations, or for using equipment, labour and materials on a daily or quantity basis. When an emergency is identified, the contractor is informed and work begins within the response time. The contract will often include a fixed payment to provide a stand-by presence and a contingency figure to cover a likely level of emergency work.

- The third solution is to include emergency response within annual maintenance contracts. A tender for the annual routine maintenance of a section of a network may include emergency response with unit rates either for each response or for equipment, labour and materials as above. The contractor may also be required to manage a system for identifying emergencies. If lengthworkers are being used for routine maintenance, they will be the basis of this network. As above, a contract may include a contingency figure to cover a likely level of emergency work.

- The fourth solution is to arrange a contract with a contractor whenever an emergency arises. This is not recommended.

If annual maintenance contracts are used, the third method is recommended. If not, the choice between the first and second will depend upon the plans of the Road Administration for the in-house units.

3 Funding

In order to be able to fund emergency response, dedicated funding is required. It is common for an allowance for emergency works (often 5-10% but may depend upon the local terrain, climate and traffic) to be included in the funding submission covered in Section 3.4. This allowance may be passed to the Road Administration, and accounted for as it is used, or made readily available at the central source. With an estimate of the required funds, the Road Manager can draw from this allowance.

Annex F: Environmental protection

People in rural areas are dependent upon the surrounding environment for their livelihoods. It is therefore essential that maintenance and rehabilitation activities do not contribute to environmental degradation. This annex does not cover all aspects of environmental protection, but guides the Road Manager through the steps that should be taken when working in an environmentally sensitive way.

Environmental protection is likely to have growing influence on the design, construction, maintenance and rehabilitation of rural roads.

1 Identify environmental impacts

Rural roadwork activities, and subsequent use of the road, can have a wide range of adverse environmental impacts. Some of these are listed in Table F1.

Table F1 Environmental impacts

Road work activities	***Impact***
Gravel and rock quarrying.	Loss of top soil; ponding water where mosquitoes might breed. Resource depletion; disturbance of natural habitats; loss of scenic beauty.
Drain construction.	Badly sited drains discharge onto farmland or cause gully erosion. Contamination of surface and underground water sources.
Site camp construction.	Land degradation; firewood removal, contamination of water sources.
Increased site traffic.	Pollution; danger to other road users; noise.
Excavations and soil stripping.	Bare soil can erode; landslips; badly placed spoil can kill vegetation.
Removal of trees.	Increased chance of erosion; loss of natural capital; habitat change.
Taking additional land.	Loss of natural habitats and protected species; loss of tourism. Disturbance of traditional sites; cultural loss; adverse community reaction.
Excavation of river gravel.	Scour of river banks; loss of fertile land.
Brick culverts and surfaces.	De-forestation for brick firing.
Inappropriate material selection.	Increased material haulage and its associated impacts.
Embankment construction.	Disruption of irrigation and drainage patterns.
Subsequent use of the road	***Impact***
Increased logging.	Loss of natural capital; exploitation; damage to land.
Other economic activity.	Encroachment into historical, cultural and ecological areas.
Generated traffic.	Pollution; danger; the effect of dust on human health, livestock and crops; severance of communities on either side of the road or from their fields; severance of natural habitats; disrupting animal movement and migration patterns.

Many of the major, long term, environmental impacts are due to the road and its usage, rather than the activities themselves. However, the Road Manager should concentrate on activities and impacts over which he or she has direct influence.

2 Assess environmental costs

Many environmental impacts are harmful or negative, and impose a burden on communities or the wider environment at either local or national level. It is important to assess each impact and estimate its relative importance. For some impacts it may be possible to identify the costs of an impact and various methods are available to estimate these. One method estimates the cost to eliminate or mitigate the impact; another the cost of compensating those who suffer loss or harm; and another the predicted direct change in market value (for instance, of land). The cost of the impact can then be used when planning road improvements. For instance, it can be incorporated into a benefit/cost calculation when roads are being prioritised for improvement (Method 3 in Section 3.5).

The cost will depend upon the nature of the impact. Table F2 shows how variable environmental impact can be, and therefore how difficult the assessment can be. Where the cost cannot be estimated, a qualitative assessment of importance should be made and balanced with other monetary costs.

Table F2 The variable nature of environmental impacts

Positive or negative.	Major or minor.	Affecting many people or few.
Temporary or permanent.	Reversible or irreversible.	Isolated or cumulative.
Direct or indirect.	Agreed or disputed.	Affecting people or wildlife or both.
Localised or widespread.		

Impacts can be assessed and their importance estimated using a formal Environmental Impact Assessment or a briefer Environmental Appraisal. These should be used during the planning stage and should be discussed with an appropriate professional organisation.

3 Plan protection measures

The solution to most environmentally sensitive activities is to avoid or mitigate the impact, and/or repair any temporary damage after the activity is completed. Table F3 lists a number of protection measures. These measures should be integrated into the design and planning of contracts on rural roads.

Table F3 Protection measures

Protection measure	*Result*
Re-siting or not permitting the activity.	The impact will not occur.
Sealing a gravel road.	No dust; reduced maintenance burden; more sustainable use of scarce gravel resources.
Levelling the spoil from an excavation.	Less water course contamination.
Planting vegetation; bio-engineering*.	Reduce erosion; stabilise slopes.
Traffic calming (speed humps).	Less danger to other road users; less noise.
Enforced use of alternative fuels for brick firing.	Less de-forestation.
Blocking access to large vehicles.	Less danger to other road users; less logging.
Reinstating quarries and borrow pits.	Less chance for mosquito breeding; less unauthorised waste dumping; restore natural habitats and scenic beauty.
Retaining walls and other stabilisation techniques.	Less chance of land slips.

** Documents describing bio-engineering techniques are listed in Section 5.2.*

For larger scale activities, protection measures are normally included in an Environmental Management Plan, which is written in response to the findings of the Environmental Impact Assessment or Environmental Appraisal. The purpose of the Plan is to set out clear actions to ensure that the long term impacts of environmental damage are not ignored in the short term haste to rehabilitate or maintain a road. The Environmental Management Plan is often included in the contract documents for rehabilitation and maintenance works.

4 The participation of local communities

Local communities are vital to environmental assessment and protection. Since their livelihoods are at risk if the land is degraded, they have a long term interest in land issues. They are able to contribute local knowledge to identify environmental impacts, monitor on site operations and help in the design and long term evaluation of mitigation measures. Therefore the Road Manager should use the road user participatory framework to involve local communities in the entire cycle from identification, planning and design to implementation and monitoring.

5 Ensure contractual compliance

Many countries have environmental protection legislation. The Road Manager must be familiar with this legislation and its enforcement. It is also possible to add clauses to a contract to oblige the contractor to work in an environmentally sensitive manner. The Road Manager must monitor site activities to ensure compliance with these clauses and that initial assumptions regarding environmental impact were valid. Typical clauses (adapted from Lantran JM 1994. 'Road Maintenance and the Environment'. Road Maintenance Initiative, SSATP Report. World Bank) are:

- 'Worksite installations. The Contractor shall propose to the supervisor the location of work site installations and detail proposed measures to reduce impacts on the environment of these sites and the people living in the immediate vicinity, as regards both the surface area used (clearing, soil erosion, drainage, waste dumping) and underground impacts (disruption or pollution of the water table). The Contractor and his staff shall inform the Engineer of the location of any protected species of vegetation that may be damaged or destroyed by the Works. These are specified in the [name of legislation]. The Engineer will then instruct the Contractor on the counter-measures to be taken to protect these species. On completion of the work, the contractor shall do everything necessary to restore the sites to their original state. The supervisor shall draw up a report confirming their restoration before acceptance of the works.'

- 'Preparation and supply of gravel materials in pit or quarry. During works execution, the contractor shall ensure: preservation of trees during piling of materials; spreading of stripped material to facilitate water percolation and allow natural vegetation growth; re-establishment of previous natural drainage flows; improvement of site appearance; digging of ditches to collect runoff; and maintenance of ramps where a pit or quarry is declared usable water source for livestock or people living nearby. Once the works are completed, and at own expense, the contractor shall restore the environment around the worksite to its original state. The supervisor shall provide the contractor with a report confirming the restoration before acceptance of the works.'

6 Monitoring and evaluation

Contract clauses and an Environmental Management Plan are of little use if the Road Manager does not monitor compliance with the contract and evaluate the success of the protection measures. As above, local communities can help in monitoring on site operations. The Road Manager should see environmental monitoring and evaluation as a fundamental part of road management to benefit road users and protect rural livelihoods.

Annex G: Activity Planning Sheets

The Activity Planning Sheets in this Annex bring together all the necessary information to enable maintenance and rehabilitation activities to be planned ready for implementation. The Sheets do not include detailed information on carrying out an activity – method statements should be written according to local practice. The Sheets are not definitive and the Road Manager can choose to amend details such as methods of measurement, performance standards and productivity rates according to local practice and can add Sheets for additional activities when required. Unless otherwise stated, a daily task refers to the productivity which should be expected of a single labourer.

A Sheet is provided for every activity identified in Table 3.17. These activities are as follows.

Sheet	*Activity*
Vegetation	
1	Cut grass
2	Grub vegetation
3	Remove topsoil
4	Place topsoil
5	Plant vegetation
6	Stabilise slope
7	Reinstate site
8	Clear bush
9	Remove tree
Drainage	
10	Clear drain
11	Repair erosion
12	Construct or repair scour checks
13	Line drain
14	(Re) Dig drain
15	Reform drain gradient
16	Repair shoulder or slope erosion
Structures	
17	Clear aperture
18	Form erosion protection
19	Repair abutment erosion
20	Minor structural repair
21	Major structural repair
22	Replace or construct structure
23	Paint headwalls
Track, engineered earth road, gravel road and improved surface	
24	Remove debris
25	Repair potholes
26	Repair ruts
27	Form camber and side drains
28	Remove material
29	Fill
30	Compact
31	Form embankment
32	Drag
33	Grade (light and heavy)

34 Reshape
35 (Re) Gravel
36 Provide an improved surface
37 Stockpile gravel
38 Provide a sand cushion
39 Provide dust palliatives
40 Repair an improved surface

Road furniture

41 Clean road sign
42 Repair or replace road sign
43 Repair or replace barrier
44 Repair or replace edge delineator
45 Repair or replace distance post

CUT GRASS **ACTIVITY PLANNING SHEET 1**

A routine maintenance activity, although grass may be cut prior to rehabilitation works.

Description

Grass growing on the shoulders and alongside the side drains is cut to improve visibility for road users and to permit pedestrians to walk in safety and comfort. Grass next to the drains should be cut so that water can flow into the drains. In general, grass should be cut and roots left in place as they prevent erosion and provide strength to the soil. This is particularly important on the shoulders of the road.

Technical requirements

Grass should be cut to a specified height, typically 5 to 10 cm. The width to be cut depends on road curvature. As a guide, on straight roads and outside curves, cut 2 metres beyond the side drains, and on inside curves cut sufficiently wide that the sight distance of approaching vehicles is greater than their stopping distance.

Scheduled or condition responsive?

Grass cutting is normally scheduled. The frequency depends upon climate and soil fertility but should be set so that the grass is cut before it blocks sight lines, causes a danger to road users or disrupts drainage systems. The frequency may be as high as weekly. It is common to cut grass during and at the end of the rainy season.

Full, Basic Access, Partial Access

Full: The activity is required

Basic and Partial Access: The frequency can be reduced if safety is not put at risk. On the roads, traffic speeds are likely to be lower and sight distances shorter.

Payment under measurement contract

Payment is based upon the area of grass which is cut.

Typical performance standard

Grass height should never be more than a specified height, typically 50 cm. A response time of one week may be specified. Grass or other vegetation should not reduce visibility below a specified distance.

Timing in relation to the rainy season

Grass is commonly cut during and immediately after the rainy season. Grass grows very little during the dry season and rarely needs to be cut.

Alternative treatments

In areas where grazing animals are herded along roads, they often keep grass short. Grass cutting may be omitted or frequencies reduced to save costs, although not to the extent that road users and pedestrians are put in danger.

Technology choice

Grass cutting is suitable for labour. A tractor based grass mower is specialised and expensive and is more suited to large and unobstructed areas of level ground.

Safety on site

Labourers with sharp blades should not work too closely. They should be provided with suitable protective clothing. Use signs to warn road users that work is in progress.

Productivity rates

A daily task should be between 200 and 500 m^2 depending on density and type of grass. A tractor based mower may cut between 10 and 20 linear kilometres per day.

Additional resources required

Bush knives, rakes, curved slashers.

Social and environmental considerations

Grass should not be removed by burning, unless the road is being used as a firebreak in a very dry area. Do not remove the roots of the grass. Grass can be sold or made available for winter animal feed.

GRUB VEGETATION **ACTIVITY PLANNING SHEET 2**

Road alignments may be grubbed prior to rehabilitation work or new construction. The bases of drains should normally be grubbed as a routine maintenance activity.

Description

Vegetation should be removed prior to rehabilitation work or when borrow pits are opened so that it is not incorporated into the carriageway. Vegetation in the base of drains should be removed so that it will not impede the flow of water, although it can be left in v-shaped drains if it is cut frequently and very low.

Technical requirements

All parts of the vegetation including the roots should be removed so that it will not regrow. The vegetation should not be pulled up by the stems as this may leave root material in the ground. All grubbed material should be disposed of at an agreed location.

Scheduled or condition responsive?

Grubbing is only identified when vegetation should be removed. However, if a drain is prone to the spread of vegetation, the activity may be scheduled at a similar frequency to that used for grass cutting

Full, Basic Access, Partial Access

The bases of drains should be grubbed at all standards as vegetation can block drains.

Payment under measurement contract

Payment is based upon the area grubbed.

Typical performance standard

The area to be grubbed (base of drain or road alignment) should be free of vegetation, including roots. Vegetation must be properly disposed of

Timing in relation to the rainy season

Grubbing is normally carried out during and immediately after the rainy season. It is easier when the soil is moist. Vegetation grows very little during the dry season and rarely needs to be grubbed.

Alternative treatments

Vegetation can be killed with sprayed chemicals, but this can be harmful to the environment and to people living nearby.

Technology choice

Grubbing is very suitable for labour, although grubbing is possible with a grader. Side drains can be grubbed with a grader if they are v-shaped and have no scour checks.

Safety on site

Labourers with sharp blades should not work too closely and should be aware of passing pedestrians and vehicles. They should be provided with suitable protective clothing such as thick gloves. If vegetation is to be sprayed, specialised protective equipment clothing will be required.

Productivity rates

A daily task is between 200 and 500 m^2 depending on the density of vegetation.

Additional resources required

Labourers should be equipped with bush knives, curved slashers and hoes for removing roots.

Social and environmental considerations

Vegetation should be disposed of at an agreed site.

REMOVE TOPSOIL **ACTIVITY PLANNING SHEET 3**

Normally carried out as part of a rehabilitation contract, often after grubbing and before forming a camber and side drains or opening a gravel pit.

Description

Topsoil is normally removed prior to carriageway rehabilitation so that it does not weaken the road structure or increase the growth of vegetation. Once removed and the road is in use and under maintenance, the activity is rarely required.

Technical requirements

All soil with organic material should be removed and disposed of or stored at an agreed location. The thickness of topsoil should be determined on site. In many sites topsoil is typically 5 to 10 cm thick. If it is thicker, see the alternative treatments below.

Scheduled or condition responsive?

The activity is responsive. Once a road is in use, the activity is rarely required and will not need to be scheduled.

Full, Basic Access, Partial Access

The activity may be required under all standards, but is more commonly required when rehabilitating to a Full standard.

Payment under measurement contract

Payment is normally based upon the volume of topsoil removed.

Typical performance standard

The area must be free of topsoil.

Timing in relation to the rainy season

The activity is normally independent of the rainy season.

Alternative treatments

If topsoil is thick, it can be expensive to remove. It may also be necessary to replace it with new material to raise the level and prevent flooding. In this case, the topsoil can be compacted and covered with a thin inorganic capping layer, or stabilised with lime, cement or fly ash.

Technology choice

The activity suits labour or equipment, depending upon the size and terrain of the site.

Safety on site

Normal site safety practices.

Productivity rates

A daily task should be to remove between 6 and 8 m^3 of topsoil, depending on distance to disposal. A grader may remove topsoil over an area between 1,000 and 2,000 m^2.

Additional resources required

Shovels, wheelbarrows or a mechanical grader.

Social and environmental considerations

If it is likely that topsoil will be required elsewhere on the site, topsoil should be stored for re-use. If not, it can be disposed of at an agreed site or made available for local use.

PLACE TOPSOIL **ACTIVITY PLANNING SHEET 4**

A routine maintenance or a rehabilitation activity.

Description

Bare soil is vulnerable to erosion. Topsoil must be placed on bare soil so that vegetation can grow more quickly, prevent erosion and stabilise slopes.

Technical requirements

Topsoil may be available from removal operations elsewhere on the site. Topsoil is normally spread between 50 and 100 mm thick, although this may depend upon the type of vegetation to be planted. Topsoil should be free of inorganic material. The topsoil should be compacted lightly and watered.

Scheduled or condition responsive?

The activity is responsive, although if topsoil is often washed away by rain or runoff, the activity may be scheduled.

Full, Basic Access, Partial Access

The activity should be carried out to protect slopes against erosion for all standards.

Payment under measurement contract

Payment is based upon the volume of topsoil placed, or the area covered in topsoil to a specified thickness.

Typical performance standard

All bare soil should be covered in topsoil to a specified thickness and planted with vegetation.

Timing in relation to the rainy season

Topsoil should be placed towards the end of the rains so that vegetation can take root but will not be washed away.

Alternative treatments

Topsoil is required if vegetation is to take root. Some locations may already have sufficient topsoil and will not require more.

Technology choice

The activity suits labour or equipment, although some locations may be inaccessible to equipment. Topsoil may be hauled by equipment.

Safety on site

Labourers must not ride on tractors or the edge of trailers. If working near traffic, use signs to warn road users of work in progress.

Productivity rates

A daily task should be to place between 6 and 8 m^3 of topsoil, depending on supply rates.

Additional resources required

Shovels, rakes, wheelbarrows.

Social and environmental considerations

Erosion prevention will reduce sedimentation of water courses and contamination of water supplies.

PLANT VEGETATION **ACTIVITY PLANNING SHEET 5**

A routine maintenance or a rehabilitation activity.

Description

Slopes with no vegetation are vulnerable to erosion. Vegetation must be planted and encouraged to grow in order to prevent erosion and stabilise the slope. Vegetation planting is often preceded by placing topsoil.

Technical requirements

The vegetation used must be suited to the local climate, soil and pests, harmless to people and animals and not a weed. The vegetation must be planted at the specified spacing, typically 15 cm, and to the specified depth and watered until it takes root. It is advised that a nursery of plants suitable for erosion protection is established.

Scheduled or condition responsive?

The activity is responsive to the presence of erosion

Full Basic Access Partial Access

The activity should be carried out to protect slopes against erosion for all standards.

Payment under measurement contract

Payment is based upon the area planted with a specified species and at a specified spacing.

Typical performance standard

All bare soil should be covered in topsoil and planted with vegetation at a specified spacing. A response time of one week may be specified to prevent bare soil or topsoil being washed away.

Timing in relation to the rainy season

Vegetation should be planted towards the end of the rains so that vegetation can take root but will not be washed away.

Alternative treatments

Erosion can be prevented in a number of ways, but vegetation is likely to be the most cost effective way. Alternatively, turfs can be cut and laid over the exposed soil.

Technology choice

The activity suits labour.

Safety on site

If working near traffic, use signs to warn road users that work is in progress.

Productivity rates

A typical daily task is 50 m^2 of planting per day, but this will vary according to the spacing of the plants.

Additional resources required

Hoes, shovels.

Social and environmental considerations

Erosion prevention will reduce sedimentation of water courses and contamination of water supplies.

STABILISE SLOPE **ACTIVITY PLANNING SHEET 6**

Normally carried out after rehabilitation works, but may be required as an emergency after a landslip.

Description

Steep slopes, often the result of road widening or realignment, are liable to slip. This can block a road, cause other environmental damage and endanger road users. Steep slopes should be stabilised to prevent slippage. Stabilisation also helps to prevent erosion.

Technical requirements

A wide variety of techniques exist to stabilise slopes. These include retaining walls, stone pitching, gabions and bio-engineering measures. Bio-engineering involves the use of live vegetation. Because of their complexity and the consequence of sudden failure, it is important that slope stabilisation works are carefully designed. Documents in Section 5.2 provide more information. It is advised that a nursery of plants suitable for slope stabilisation is established.

Scheduled or condition responsive?

Slope stabilisation is often carried out in response to the early signs of a landslip, although it should be carried out as a matter of course whenever a steep slope is exposed.

Full, Basic Access, Partial Access

Landslips can block a road and cut access and can also endanger road users. Slope stabilisation should be carried out for all road standards.

Payment under measurement contract

For small works: according to the area stabilised. For large works: according to a detailed design which should be costed separately.

Typical performance standard

All slopes should be stabilised within a specified time. Roads must not be closed for longer than a specified duration. However, it is more common to pay for slope stabilisation using a design and measured quantities than a performance standard.

Timing in relation to the rainy season

Slopes should be stabilised before the rains as it is often heavy rainfall which causes a landslip.

Alternative treatments

The slope can be battered back so that it is no longer at risk of slipping. A number of alternative stabilisation techniques are available.

Technology choice

Equipment can be used for hauling materials and preparing a slope; labour can be used for planting vegetation and other operations.

Safety on site

Wear hard hats in case of falling materials. Labourers should be protected against falling down steep slopes. If working near traffic, use signs to warn road users that work is in progress.

Productivity rates

Productivity depends upon the stabilisation technique being used.

Additional resources required

Bush knives, spades, hoes and so on according to the technique being used.

Social and environmental considerations

Slope stabilisation practices along roads can help to introduce sustainable land management practices to a community. Slope stabilisation can also protect water supplies. Stabilised slopes should be protected from grazing animals as they can remove vegetation and damage the stabilisation works.

REINSTATE SITE **ACTIVITY PLANNING SHEET 7**

Normally carried out after rehabilitation works.

Description

A work site, particularly a gravel pit, can allow ponds to form where mosquitoes can breed and can disturb natural habitats. They should be returned to their former state. Site camps should also be reinstated.

Technical requirements

The site should be returned to its natural state. Unused construction materials and soil and gravel contaminated by fuel and oil spillage should be removed. Drains should be excavated in gravel pits so that water will not pond, steep slopes should be battered back, overburden and topsoil should be replaced and vegetation planted.

Scheduled or condition responsive?

The activity is responsive to poor site condition. It is often scheduled as the final activity on site.

Full, Basic Access, Partial Access

All work sites should be reinstated after completion, regardless of the standard of the road.

Payment under measurement contract

Payment for site reinstatement is often a lump sum, although gravel pit reinstatement may be paid by the area reinstated.

Typical performance standard

Apart from the completed works, there should be no sign of maintenance or construction activities on site.

Timing in relation to the rainy season

The activity is required when work is finished on site regardless of the season.

Alternative treatments

There is no acceptable alternative to site reinstatement unless a community wish to keep a gravel pit as a water pond.

Technology choice

The activity suits labour and equipment.

Safety on site

Safety measures depend upon the particular reinstatement operation being carried out.

Productivity rates

Productivity rates depend upon the required reinstatement operations.

Additional resources required

Shovels, rakes, supply of topsoil and vegetation.

Social and environmental considerations

Reinstatement will improve the aesthetics of the road, leave a favourable impression of the construction activities and team, prevent environmental degradation of the site, and reduce the chances of the site being used as a waste tip.

CLEAR BUSH **ACTIVITY PLANNING SHEET 8**

Normally carried out prior to rehabilitation work or new construction since routine maintenance activities should prevent bush becoming established on a maintained road.

Description

If a road has not been maintained for some time, woody shrubs will have grown. The bush affects visibility, pedestrian safety and drainage efficiency, attracts grazing animals onto the roads and the roots can damage vehicle tyres. In the extreme, dense bush can block access along a road. All parts of the bush, including roots, should be removed.

Technical requirements

All bush, including the roots, should be removed over the required area. The plants should not be pulled up as this may leave root material in the ground. All material should be disposed of at an agreed site. The width over which bush is to be cleared should be specified and may be similar to the width to which grass is cut.

Scheduled or condition responsive?

The activity is identified in response to the presence of bush on a site and the loss of visibility, although regular grass cutting will normally prevent woody growth becoming established.

Full, Basic Access, Partial Access

Since bush can block drains and affect safety, it should be cleared for all standards.

Payment under measurement contract

Payment is based upon the area of bush cleared. Different rates are often used according to the density of the bush, for instance, light, medium and dense.

Typical performance standard

The road reserve and bases of drains should be clear of woody shrubs, including roots.

Timing in relation to the rainy season

The activity is normally independent of the rainy season.

Alternative treatments

Bush can be killed with sprayed chemicals, but this can be harmful to the environment and to people living nearby. Bush clearing should not be omitted as woody growth will gradually block access along a road.

Technology choice

The activity suits labour.

Safety on site

Labourers with sharp blades should not work too closely and be aware of passing pedestrians and vehicles. They should be provided with suitable protective clothing.

Productivity rates

A typical daily task is between 100 and 300 m^2 depending on the density of bush.

Additional resources required

Bush knives, spades, hoes, axes, picks.

Social and environmental considerations

Bush clearing can increase soil erosion. In some instances it may be justified to leave bush in place.

REMOVE TREE **ACTIVITY PLANNING SHEET 9**

Normally carried out prior to rehabilitation work or new construction since routine maintenance activities should prevent trees establishing on a maintained road.

Description

If a road has not been maintained for some time, trees may have grown. The trees affect visibility, obstruct high sided vehicles or block access along the road. All parts of the tree, including roots, should be removed.

Technical requirements

The entire tree, including its roots, should be removed. It is often easier to excavate the stump and pull the tree over with ropes before sawing the trunk. The tree must be disposed of at an agreed site.

Scheduled or condition responsive?

The activity is identified is response to the presence of a tree. Regular grass cutting will normally prevent trees becoming established. Therefore if the road is in use and under maintenance, the activity will rarely be required.

Full Basic Access Partial Access

Full: The activity is normally required to achieve good road alignment.
Basic and Partial Access: The road may often be diverted around a large tree.

Payment under measurement contract

Payment is made for each tree removed. Rates often vary according to the diameter of the tree at a given height (often 1 metre) above ground level.

Typical performance standard

The road reserve should be free of trees and woody shrubs, including roots.

Timing in relation to the rainy season

The activity is normally independent of the rainy season.

Alternative treatments

A road may be diverted around trees of cultural importance or to save costs.

Technology choice

The activity suits labour or equipment. A bulldozer can pull over most trees with ease, although labourers are better at ensuring that all roots have been removed and therefore will not regrow.

Safety on site

Hard hats are required in case of falling trees. Labourers should be careful when using saws and knives. They should be provided with suitable protective clothing. A labourer should announce when the tree is ready to fall. Traffic and other road users should be kept at a safe distance.

Productivity rates

Productivity depends upon the size and type of the tree, the root structure and the strength of the soil. A daily task can be set as a function of diameter with a tree between 0.2 and 0.5 metres typically taking one day to remove.

Additional resources required

Bush knives, saws, spades, hoes, picks, rope, ladders.

Social and environmental considerations

Tree removal can increase soil erosion. The public can be given access to the firewood. Tree removal may require environmental clearance from the relevant authority.

CLEAR DRAIN **ACTIVITY PLANNING SHEET 10**

A routine maintenance activity.

Description

When water flows slowly in drains or other channels, it often deposits sediment. If this sediment is not removed, the drain will fill up and eventually overtop and cause damage to the carriageway. The sediment and all other debris must be fully removed.

Technical requirements

A drain should be returned to its original depth, shape and gradient, with no sediment. A drain template cut to the required shape provides a useful guide. Cleared material should be spread thinly in a place from where it cannot be washed back into a drain. Grass may need to be cut or grubbed in the drain before this activity can be carried out.

Scheduled or condition responsive?

Drain clearing is normally scheduled. The frequency depends upon the rate of sedimentation but can be as high as weekly during the rains. After a heavy rainfall the activity can be responsive if the drain is severely blocked.

Full, Basic Access, Partial Access

Since access is most commonly lost due to poor drainage, drains should be cleared under all standards.

Payment under measurement contract

Payment is based upon the length of drain cleared. Extra rates may be paid if sediment is very deep. Alternatively payment can be based upon the volume of material removed.

Typical performance standard

Drains should have the specified cross section and be free of sediment and the drainage system should correctly dispose of all water. During the rains a maximum response time can be specified.

Timing in relation to the rainy season

Drains should be cleared before the rainy season so that the drainage system is ready. It is very likely that drains will require clearing regularly during the rains.

Alternative treatments

If a side drain is v-shaped in profile and free of scour checks, it can be cleared with a grader. Sediment may be less likely to settle in a drain lined with concrete or stone pitching.

Technology choice

Drain clearing suits labour based methods. Graders can be used to clear v-shaped side drains although the operator should be careful not to damage scour checks. Labourers will be required to clear inaccessible drains.

Safety on site

If working on side drains, use signs to warn road users that work is in progress. Gloves may be required.

Productivity rates

A typical daily task can vary from 30 to 300 linear metres depending upon amount and density of sediment and size of drain. A grader supported by 2 labourers may clear around 5 km of v-shaped drain per day.

Additional resources required

Shovels, spades, drain template.

Social and environmental considerations

If drains are not cleared, they can overtop and discharge onto farmland or cause erosion elsewhere.

REPAIR EROSION **ACTIVITY PLANNING SHEET 11**

A routine maintenance activity, but may be required as an emergency activity.

Description

Fast flowing water can erode the sides and the base of side drains or larger channels. If the erosion is not repaired, it will worsen and can cut into the carriageway or undermine a structure. New material must be used to fill the erosion in order to repair the damage and must be well compacted. It is also necessary to identify and eliminate the cause of the erosion, for instance an overtopped stream, an absence of mitre drains or side run off. If this is not done, it is probable that the erosion will re-occur.

Technical requirements

Areas of erosion should be cleaned back to strong soil. Erosion resistant material, approved by the Road Manager, should be excavated nearby and used to fill the erosion void. The material should be filled in layers 50-150 mm thick and compacted (see Activity Planning Sheet 30). This activity may be followed by the construction of scour checks or drain lining, the excavation of mitre drains or another form of erosion protection.

Scheduled or condition responsive?

The activity is often scheduled if erosion is likely to occur frequently. The frequency depends upon rainfall intensity and soil erodibility, although erosion is likely to occur at some location along a road on a daily basis. Alternatively, the activity may be identified in response to erosion at a single site which is either severe or likely to worsen.

Full, Basic Access, Partial Access

Erosion should be repaired at all standards, although it should be done more quickly on roads with higher traffic levels and higher speeds. Since erosion tends to occur where water flow is concentrated across bare soil, it is more likely to occur on an engineered road with camber and drains than on a track.

Payment under measurement contract

Payment is based upon the length of drain repaired, or the volume of material used in the repair.

Typical performance standard

No surface should have eroded more than a specified depth (typically 25 mm) from its original level. During the rains a maximum response time can be specified.

Timing in relation to the rainy season

Erosion should be repaired before the rainy season so that the drainage system is ready. It is likely that repairs will also be required during the rains.

Alternative treatments

Dig more mitre drains to reduce the flow in side drains. Vertical stones embedded in a culvert's outfall apron may reduce water speed and the risk of erosion in the downstream channel. Wider drains will also reduce water speeds and the risk of erosion.

Technology choice

Erosion repair suits labour based methods.

Safety on site

If working near traffic, use signs to warn road users that work is in progress.

Productivity rates

Productivity depends upon the extent of the repairs to be made and the distance between sites. A daily task may require the placing and compaction of between 1 and 3 m^3 of fill.

Additional resources required

Shovels, wheelbrarrows, hand rammers, drain template.

Social and environmental considerations

Care should be taken when selecting the site from which to excavate fill material.

CONSTRUCT OR REPAIR SCOUR CHECKS **ACTIVITY PLANNING SHEET 12**

A routine maintenance activity or constructed during road rehabilitation.

Description

Fast flowing water can erode side drains. Scour checks should be built at intervals in the side drain to disrupt the flow and reduce the speed of the water. If damaged, scour checks should be repaired and more should be built if necessary. It is also recommended that the cause of the erosion is identified and eliminated, for instance an overtopped stream, an absence of mitre drains or side run off. If this is not done, it is probable that the scour check damage will re-occur.

Technical requirements

Scour checks are barriers constructed in side drains with erosion resistant aprons on the downstream side. The principle is to convert an inclined drain into a series of steps to reduce the water velocity. Therefore the required spacing varies according to the gradient. As a guide, at 4% they are not required (although they may be necessary in single sized sands); at 5% the spacing should be 20 metres; at 8% the spacing should be 10 metres; and at 10% the spacing should be 5 metres. If erosion continues, more scour checks should be constructed. The scour check should be concave in elevation to prevent the water spilling around the sides and eroding the carriageway. Scour checks can be constructed from masonry, bamboo, stones or timber.

Scheduled or condition responsive?

Construction. The activity is often carried out during road rehabilitation if justified by a steep gradient.
Repair. The activity is often scheduled if frequent damage is likely. Repairs are sometimes required on a daily basis in heavy rain. Otherwise the activity is required in response to identified damage.

Full, Basic Access, Partial Access

The activity is required for all standards, although side drains are most commonly found on roads to a Full standard with a fully formed cross section and camber.

Payment under measurement contract

Payment is made for each scour check constructed and each scour check repaired. Different rates normally apply for different types of scour check.

Typical performance standard

There should be no erosion in side drains. If scour checks are constructed, there should be no visible damage and, during the rainy season, they should be repaired within a specified time of the damage occurring. Water must not flow around scour checks.

Timing in relation to the rainy season

The activity is required before the rainy season so that the drainage system is ready and is also likely to be needed during the rains.

Alternative treatments

Repair erosion in the drains on a frequent basis. Alternatively, dig more mitre drains to reduce the flow in the side drains.

Technology choice

Constructing and repairing scour checks suits labour.

Safety on site

Sharp knives may be in use. Use signs to warn road users that work is in progress.

Productivity rates

A typical daily task is the construction of 4 to 8 new scour checks. Repair output depends upon the severity of damage, depending on the type of scour check.

Additional resources required

Materials to be used in scour checks, hammers, spades, hoes, hand rammers.

Social and environmental considerations

Eroded material can contaminate water courses. Scour checks often prevent road users cycling in side drains to avoid motorised traffic.

LINE DRAIN **ACTIVITY PLANNING SHEET 13**

A routine maintenance activity.

Description

Some soils erode very quickly when water flows in a drain. The erosion can spread rapidly and cut into the carriageway. The drain can be lined in order to prevent this erosion. A drain can be lined with stones, either with or without mortar. Vegetation can be planted between stones to strengthen the drain although this must be cut frequently and very low to prevent water flow being impeded.

Technical requirements

The drain should be cleaned back to strong soil before the lining is constructed. The drain lining should be non-erodible and stable under heavy rain and water flow. If possible, calculations should be carried out to check that lined drains have adequate capacity for the expected flows.

Scheduled or condition responsive?

The activity is responsive to erosion damage which is likely to worsen, although a quantity of drain lining may be scheduled if erosion is likely to be found along the road on a regular basis.

Full, Basic Access, Partial Access

The activity is required for all standards if erosion is likely to put access at risk.

Payment under measurement contract

Payment is based upon either the length or the area of lining constructed.

Typical performance standard

No surface should have eroded more than 25 mm from its original level. During the rainy season a maximum response time may be specified.

Timing in relation to the rainy season

The activity is required before the rains so that the drainage system is ready. The activity may also be required during the rains if erosion occurs.

Alternative treatments

More mitre drains can be dug to reduce the water flow in a side drain. The drain can be filled with rocks which will allow water to flow and prevent erosion.

Technology choice

The activity is suited to labour.

Safety on site

If rocks are to be broken, goggles and gloves are required. Use signs to warn road users that work is in progress.

Productivity rates

If stone pitching is used to line the drain, a daily task may be 4 to 8 m^2 with mortar or 6 to 12 m^2 without mortar.

Additional resources required

Rocks, cement, water, hand rammer or vibratory plate, manual rock breaking tools, drain template.

Social and environmental considerations

Eroded material can contaminate water courses.

This is normally a routine maintenance activity, but may be required as an emergency activity.

Description

A drainage system must be complete if it is to drain a road. If a drain becomes fully blocked, or if it was omitted, it should be (re) dug. A drainage system comprises side drains, mitre drains and interception ditches. If flow in side drains is too high, extra mitre drains can reduce the flow. Interception ditches prevent run off entering a side drain and eroding the carriageway.

Technical requirements

A drain must follow a designed cross section. A drain template cut to the required shape provides a useful excavation guide. Drains typically are 500 mm wide at the base and have slopes between 1:1 and 1:3, depending on soil stability. The gradient is often around 2%, although this depends on the erodibility of the soil. Mitre drains should not turn out by more than 45º. Turnouts should be reinforced by a bank of compacted soil. Mitre drain spacing depends upon side drain gradient. As a guide, spacing should be 50 m for a gradient of 1% or less (although if very flat, the spacing may be reduced to prevent water ponding); 40 m for a gradient of 1-2%; 25 m for a gradient of 2-5%; 15 m for a gradient of 5-10%; and 10 m for a gradient greater than 10%. If side drains erode, more mitre drains can be dug. Interception ditches normally carry run off to the next water crossing. Cleared material should be spread thinly in a place from where it cannot be washed back into a drain.

Scheduled or condition responsive?

The activity may be scheduled, but is more likely to be required in response to blockage after heavy rain. Alternatively a new drain may be required, for example an interception ditch to prevent run off entering a side drain or a mitre drain to reduce water flow in a side drain.

Full, Basic Access, Partial Access

Since drains move water away from a riding surface, the activity helps preserve road condition and reliable access and is therefore required at all standards.

Payment under measurement contract

Payment is based upon the length of drain dug or for the volume removed. Different rates may be used for different materials or levels of blockage.

Typical performance standard

The drainage system should correctly dispose of all water. Interception ditches should intercept all run off. Drains should have the specified size and shape. As an emergency activity a maximum response time can be specified.

Timing in relation to the rainy season

The activity is required before the rains so that the drainage system is ready for the start of the rainy season. Redigging may also be required during the rains.

Alternative treatments

Drain digging is a low cost activity with no cost effective alternative, although side drains can be protected against run off entry with stone pitching as an alternative to digging an interception ditch.

Technology choice

Drain excavation suits the use of labour. Graders can cut v-shaped side drains although they may not have access to mitre drains and interception ditches. Back-hoe excavators can cut steep sided drains and may be useful in very hard soil.

Safety on site

Use signs to warn road users that work is in progress. Labourers working closely together can put each other at risk of injury. If the activity is carried out by a grader, ensure that it does not damage scour checks and culvert openings in the side drain.

Productivity rates

A daily task may be 10 to 30 metres depending upon soil type and density. A grader may cut 500 to 1,000 metres of drain in a day.

Additional resources required

Spades, hoes, wheelbarrows, drain template.

Social and environmental considerations

Drains must not be sited to discharge onto farmland, cause erosion or contaminate water sources. Drain spoil should be spread so that it is not washed back in to a drain. Landowners should be consulted when planning mitre and interception ditches. The purpose of drains should be explained to road users and local communities to discourage the filling in of drains to facilitate access to roadside properties.

REFORM DRAIN GRADIENT **ACTIVITY PLANNING SHEET 15**

A routine maintenance activity.

Description

If a drain was incorrectly dug or if a vehicle has got stuck in a side drain, the drain may have lengths with zero or negative gradient. Water will collect and soften the surrounding material, including the carriageway. The drain should be reformed to a uniform gradient.

Technical requirements

Points along the drain should be identified where the gradient is correct. By stretching a string line between these two points, the extent of the defect can be seen. Drain material should be smoothed between these two points until there is a constant gradient which will no longer trap water.

Scheduled or condition responsive?

The activity is responsive to standing water and damage to the carriageway. A small amount of drain reforming will normally be carried out by a maintenance worker while completing their other activities.

Full, Basic Access, Partial Access

The activity is only likely to be required on a road to a Full standard with a cross section and side drains.

Payment under measurement contract

Payment is based upon the length of reformed drain, although for small defects, payment is unlikely to be made.

Typical performance standard

There should be no standing water in the drains at any time. During the rains a maximum response time can be specified.

Timing in relation to the rainy season

The activity is required before the rains so that the drainage system is ready. However, since the defect is only likely to be observed during the rains, it should be repaired as soon as possible.

Alternative treatments

There is no alternative to this low cost activity.

Technology choice

The activity suits labour, although if the drain is v-shaped a grader can reform the drain.

Safety on site

Use signs to warn road users that work is in progress.

Productivity rates

Productivity depends upon the severity of the defect but most areas of damage can be repaired within one or two hours.

Additional resources required

Spades, hand rammers, string line, drain template.

Social and environmental considerations

Local people can be encouraged to identify defects of this type. Vehicle drivers should be encouraged to report if they get stuck in a side drain and cause this defect.

REPAIR SHOULDER OR SLOPE EROSION **ACTIVITY PLANNING SHEET 16**

A routine maintenance activity, but may be required as an emergency activity.

Description

Water flowing into the side drains from either the carriageway surface or the surrounding land may erode the shoulder, the outer slope and eventually the carriageway. The erosion should be repaired and protection should be provided against further erosion. It is also necessary to identify and eliminate the cause of the erosion, for instance wheeltrack rutting or side run off. If this is not done, it is probable that the erosion will re-occur.

Technical requirements

Areas of erosion should be cleaned back to strong soil. Erosion resistant material, approved by the Road Manager, should be excavated nearby and used to fill the erosion void. The shoulder or slope should be filled with the material in layers 50-150 mm thick to its original profile, compacted (see Activity Planning Sheet 30) and planted with vegetation to prevent further erosion.

Scheduled or condition responsive?

This activity is often scheduled if shoulder or slope erosion is likely to occur frequently along the road. In heavy rains repairs may be required on a daily basis. Otherwise, the activity is responsive to specific erosion which is likely to worsen or if shoulders are unsafe for vehicles to use, for instance if an erosion gully is deeper than 75 mm.

Full, Basic Access, Partial Access

The activity is required at all standards if erosion is likely to put access and road users at risk.

Payment under measurement contract

Payment is based on either the area repaired or the volume of material used in the repairs.

Typical performance standard

Shoulders and slopes must be free of erosion. Shoulders must be safe for use by pedestrians and vehicles in emergency. Erosion must be repaired within a specified time period.

Timing in relation to the rainy season

The activity is likely to be required only during the rainy season, although erosion should be repaired before the rains.

Alternative treatments

Interception ditches can be dug to reduce the flow down the side slope from the surrounding land. The camber should be maintained so that water does not concentrate in wheel tracks and then cut a gully down the shoulder to the side drain. Shoulder and slope can be protected against further erosion with stone pitching or vegetation.

Technology choice

The activity suits labour.

Safety on site

Use signs to warn road users that work is in progress. Speeds can be restricted if shoulder erosion narrows the riding surface and affects safety.

Productivity rates

Depending on the severity of the erosion and width, a daily task should be between 10 and 100 linear metres. Alternatively between 1.5 and 3 m^3 of material can be placed and compacted in one day.

Additional resources required

Good quality fill or gravel, shovels, hand rammers.

Social and environmental considerations

If a shoulder is eroded, pedestrians are likely to walk on the carriageway and come into conflict with moving traffic. After repair, place topsoil and plant vegetation on the shoulder or slope to prevent further erosion.

CLEAR APERTURE **ACTIVITY PLANNING SHEET 17**

A routine maintenance activity, but may be required as an emergency activity if the aperture is fully or nearly blocked.

Description

When water flows slowly through the aperture of a water crossing structure, it often deposits sediment. If this sediment is not removed, the water will eventually overtop and damage the carriageway and the structure. The sediment must be removed. If large debris is blocking the aperture, it must be removed as an emergency. Drifts must be cleared for similar reasons, although they are less prone to sedimentation and blockage.

Technical requirements

The aperture must be fully cleaned of all sediment and other debris. All sediment must be disposed of in a manner approved by the Road Manager. It is advised that sediment is spread thinly downstream so that it will not re-enter the aperture or get washed into another drain.

Scheduled or condition responsive?

The activity is often scheduled if apertures along the road are likely to be frequently sedimented. The frequency will depend upon the rate of sedimentation or blockage but could be as high as weekly. Otherwise, the activity is required in response to any blockage which disrupts the water flow.

Full, Basic Access, Partial Access

The activity is required for all standards.

Payment under measurement contract

Payment is often made for each aperture cleared, with an extra payment if it is badly blocked. Alternatively, payment can be made for each entrance or exit cleared and for each metre length cleared, according to the diameter of aperture and the depth of sediment. Finally, payment can be based upon the volume of material removed.

Typical performance standard

The structure should be clean and functional. The drainage system should correctly dispose of all water. Alternatively, the cross sectional area blocked by sediment and debris must be less than a specified maximum percentage. During the rains a maximum response time can be specified.

Timing in relation to the rainy season

The activity is required before the rains so that the drainage system is ready. It is also likely that the activity will also be required during the rains.

Alternative treatments

There is no practical alternative to clearing the aperture of water crossing structures, although water jetting may be an alternative to manual removal. Posts fixed in the upstream channel may prevent branches getting stuck in an aperture. These posts can be angled to allow branches to float over the structure if flows are very high.

Technology choice

Clearing apertures suits the use of labour.

Safety on site

Use signs to warn road users that work is in progress.

Productivity rates

Productivity depends very much on the extent of blockage. Productivity may vary from 4 apertures per labourer day to 2 or 3 labourer days to clear a very badly blocked aperture.

Additional resources required

Shovels, spades, bush knives, long handled shovels, crowbars.

Social and environmental considerations

If a blocked culvert overtops, the water can cause erosion across the road, damage the culvert and flood farmland and adjacent dwellings. If the erosion is severe, access can be lost. On occasion communities will deliberately block a culvert in order to provide a washing area. This should be discouraged. If necessary, a washing area should be provided nearby.

FORM EROSION PROTECTION **ACTIVITY PLANNING SHEET 18**

A routine maintenance activity, but if a structure is at risk it may be required as an emergency.

Description

Erosion due to fast flowing water in an inlet or outlet channel can undermine a structure. Erosion protection should be provided to prevent the need for regular repair work. This protection can take many forms including planted vegetation, large stones or 'rip-rap', wide scour checks, stone pitching, gabions (filled with rocks or soil wrapped in filter fabric) or old tyres.

Technical requirements

This activity will often follow erosion repair. The technical requirements depend upon the type of protection provided. All fill materials must be well compacted.

Scheduled or condition responsive?

The activity is normally identified in response to erosion around a structure that is severe or likely to worsen. Minor repairs to erosion protection should be scheduled if regular damage is likely.

Full, Basic Access, Partial Access

The activity is required at all standards, especially if erosion is likely to put access at risk.

Payment under measurement contract

Payment is based upon the volume of material used in the protection, but will depend upon the type of protection provided.

Typical performance standard

No water channel should have eroded more than a specified depth (typically 25 mm) from its original level. All water channels must be protected against erosion.

Timing in relation to the rainy season

The activity is required before the rainy season so that the drainage system is ready. It may also be required during the rains.

Alternative treatments

If a location is prone to erosion, there is little alternative providing protection beyond frequent repair.

Technology choice

The activity suits labour.

Safety on site

Workers should not be exposed to the risk of a soil face collapsing if working in a deep channel.

Productivity rates

Productivity depends upon the type of protection provided.

Additional resources required

Resources depend upon the type of protection provided.

Social and environmental considerations

Erosion protection around structures is very important if reliable access is to be provided.

REPAIR ABUTMENT EROSION **ACTIVITY PLANNING SHEET 19**

A routine maintenance activity.

Description

Since structures are often at low points in a road, water on the riding surface often concentrates at a structure and then flows off the surface and around the abutments. Material behind the wing walls can be eroded. Erosion damage must be repaired and protection provided.

Technical requirements

Areas of erosion should be cleaned back to strong soil. Erosion resistant material, approved by the Road Manager, should be excavated nearby and used to fill the erosion void. The material should be filled in layers 50-150 mm thick and compacted (see Activity Planning Sheet 30). The repair can be lined with stone pitching or planted with vegetation to prevent further erosion.

Scheduled or condition responsive?

The activity can be scheduled if erosion is likely to occur frequently at some of the structures along a road. The activity may also be identified in response to erosion that is either severe or likely to worsen.

Full, Basic Access, Partial Access

The activity is required at all standards, particularly at Full standard if the erosion is affecting the riding quality of the road surface.

Payment under measurement contract

Payment is based upon the volume of material used in the repair.

Typical performance standard

Water crossing structures and the water channel should be free of erosion. During the rains a maximum response time can be specified.

Timing in relation to the rainy season

The activity is required before the rains so that the drainage system is ready for rainfall. The activity is also likely to be required during the rains.

Alternative treatments

There is no alternative to repairing erosion. Erosion protection is likely to reduce the need for the activity in the future.

Technology choice

Erosion repair suits the use of labour.

Safety on site

Use signs to warn road users that work is in progress.

Productivity rates

Productivity depends upon the extent of the repairs to be made. A daily task may require the placing and compaction of between 1 and 3 m^3 of fill.

Additional resources required

Shovels, wheelbarrows, hand rammers.

Social and environmental considerations

Care should be taken when selecting the site from which to excavate fill material. Vegetation can be used on the shoulders to prevent further erosion.

MINOR STRUCTURAL REPAIR **ACTIVITY PLANNING SHEET 20**

A routine maintenance activity.

Description

Minor damage can occur to a structure from vehicle impact, or high water flow. Alternatively the structure may have been poorly built. If not repaired, the damage may worsen and put the structure and road users in danger. The damage should be repaired. Detailed assessment is not normally required.

Technical requirements

Damage should be broken back to sound material and then repaired with good quality material. Concrete and mortar should be cured with damp sackcloth or equivalent for one week.

Scheduled or condition responsive?

The activity is normally identified in response to minor damage, but a small quantity may be scheduled if minor damage is likely to occur.

Full, Basic Access, Partial Access

The activity is required at all standards to prevent the damage becoming worse, requiring more costly repair and blocking access along the road.

Payment under measurement contract

Payment is often based upon the volume of repair materials used, or the area of damage repaired.

Typical performance standard

All structures should be structurally sound and free of damage. Damage should be repaired within a specified time.

Timing in relation to the rainy season

Minor damage repair should be carried out as soon as possible, but may have to wait until water levels subside.

Alternative treatments

If damage is frequent, it may be worth constructing a new structure.

Technology choice

Structural repair suits labour.

Safety on site

Protective clothing should be provided, depending on the repairs being made. Use signs to warn road users that work is in progress.

Productivity rates

Productivity depends very much upon the extent and nature of the damage. See Activity Planning Sheet 22 for detailed productivity rates, but for typical levels of damage a daily task may be to repair between 2 and 5 structures.

Additional resources required

All necessary construction materials, tools and other equipment, depending on type of structure. Skilled labourers are often required.

Social and environmental considerations

If minor damage develops, road users can be placed in danger and access lost.

A rehabilitation activity, but may be required as an emergency activity.

Description

Major damage can occur to a structure from vehicle impact or high water flow. Alternatively the structure may have been poorly built. The damage may cause the structure to collapse, access to be lost and road users to be placed in danger. The damage should be repaired.

Technical requirements

Detailed assessment of damage and description of required repair is normally necessary before work can begin. Access may be restricted across the structure until repairs are complete. Damage should be broken back to sound material and then repaired with good quality material. Concrete and mortar should be cured with damp sackcloth or equivalent for one week.

Scheduled or condition responsive?

The activity is identified in response to major structural damage which does not require a new structure to be built.

Full, Basic Access, Partial Access

The activity is required at all standards, especially if access and road user safety are at risk.

Payment under measurement contract

Payment is either based upon the volume of repair materials used or is calculated separately according to a detailed design. Alternatively, if the damage is hard to assess until work begins, payment may be based upon dayworks.

Typical performance standard

All structures should be structurally sound and free of damage. Repairs should be completed within a specified time. The road should pass smoothly over the top of the structure. Major structural repair may often be paid using a design and measured quantities.

Timing in relation to the rainy season

Major damage repair should be carried out as soon as possible, but may have to wait until water levels subside.

Alternative treatments

If damage is frequent, it may be worth constructing a new structure.

Technology choice

Structural repair suits labour.

Safety on site

Protective clothing should be provided, depending on the repairs being made. Use signs to warn road users that work is in progress.

Productivity rates

Productivity depends very much upon the extent and nature of the damage. See Activity Planning Sheet 22 for detailed productivity rates.

Additional resources required

All necessary construction materials, tools and other equipment, depending on type of structure. Skilled labourers are normally required.

Social and environmental considerations

Structural collapse can place road users in danger and cause immediate loss of access.

REPLACE OR CONSTRUCT STRUCTURE **ACTIVITY PLANNING SHEET** **22**

A rehabilitation activity, but may be required in an emergency in case of collapse from traffic or water flow.

Description

It may not be possible to repair major damage to a structure. If so, or if the structure has collapsed or is missing, a new structure is required to provide year round access. Detailed assessment of the required structure must be made.

Technical requirements

Because of the complexity and cost of a new structure, it should be very carefully designed and specified using appropriate reference material. Larger structures are required for larger water catchments. In the absence of more accurate guidance, for catchments less than 10 hectares an aperture with cross sectional area of 0.5 m^2 should be sufficient, for catchments between 10 and 20 hectares an aperture of 1 m^2 should be sufficient and for catchments between 20 and 50 hectares an aperture of 1.5 m^2 should be sufficient. However, since structural sizing depends upon the local rainfall patterns, more accurate guidance should be obtained when possible. The cross fall through the structure is normally around 2%.

Scheduled or condition responsive?

The activity is identified in response to a collapsed, very badly damaged, inadequate or absent water crossing.

Full, Basic Access, Partial Access

The activity is required although short closures are acceptable under Basic Access. Under Partial Access longer closures are acceptable and access may sometimes be restricted to small vehicles or only pedestrians.

Payment under measurement contract

Payment can be made using a single sum for a defined design, using a rate per metre of culvert barrel, or using rates for the separate operations, such as excavation, concrete slab and masonry wall. Large structures are often assessed and priced separately according to a detailed design.

Typical performance standard

The structure must carry a road of specified width over a water course with an aperture of specified cross sectional area. However, it is more common to pay for this activity using a design and measured quantities than a performance standard.

Timing in relation to the rainy season

Structures are most easily constructed in the dry season when water levels are at their lowest or the site is dry. The drainage system will then be ready for the rains.

Alternative treatments

A number of low cost structures are available to carry a road or footpath over or through a water course. Additional solutions include a boat or raft across a seasonal river.

Technology choice

This activity suits labour. Equipment may be used to transport materials and mix concrete.

Safety on site

If rocks are to be broken, goggles and gloves are required. Use signs to warn road users that work is in progress. A detour around the site will probably be required.

Productivity rates

Typical daily tasks for construction operations are as follows. Break stone for masonry work – 2-4 m^3, depending on hardness of stone. Load, haul and unload stone – 3-5 m^3, depending on haulage distance. Load, haul and unload sand – 5-7 m^3, depending on haulage distance. Installing culvert pipes – 0.5-1.0 metres. Mix and place concrete – 0.5-1.0 m^3. Wet masonry work – 0.5 m^3. Dry masonry work – 1.0 m^3.

Additional resources required

All necessary construction materials, tools and other equipment, depending on type of structure. Skilled labourers are normally required.

Social and environmental considerations

A structure across an impassable water course can be of great benefit to a rural community. Providing access can allow timber resources to be exploited.

PAINT HEADWALLS **ACTIVITY PLANNING SHEET 23**

A routine maintenance activity.

Description

Headwalls which are hard to see at night present a danger to road users.

Technical requirements

Ideally headwalls should be painted with a reflective material, although if this is unavailable or to save costs, white paint can be used. Two coats of paint are often required.

Scheduled or condition responsive?

The activity is identified in response to a headwall close to the carriageway which is hard to see at night or which has been hit by a vehicle at night.

Full, Basic Access, Partial Access

The activity is required at all standards, but is more important on roads to a Full standard where vehicle speeds are higher.

Payment under measurement contract

Payment is based upon either the area painted or the number of headwalls painted.

Typical performance standard

All headwalls must be visible at night with headlights from a specified distance. Headwalls should be painted within a specified response time.

Timing in relation to the rainy season

The activity is carried out when required regardless of the rainy season, although it should not be carried out when it is raining.

Alternative treatments

Wooden stakes can be embedded in the shoulder along the line of the headwall to warn approaching vehicles. Headwalls can be whitewashed with lime.

Technology choice

The activity suits labour.

Safety on site

Use signs to warn road users that work is in progress.

Productivity rates

A daily task may be to paint between 50 and 200 m^2, although productivity depends upon the distances between headwalls.

Additional resources required

Paint, painting and cleaning materials, protective clothing, including gloves and goggles.

Social and environmental considerations

Painted headwalls, like well maintained road furniture, show a high level of commitment by the Road Manager to the road users and local community.

REMOVE DEBRIS **ACTIVITY PLANNING SHEET 24**

A routine maintenance activity, although may be required as an emergency activity if access is blocked or passage is dangerous.

Description

A wide variety of debris can be found on a road, including dead animals, fallen trees, rocks, landslips, damaged tyres and abandoned vehicles. These can be dangerous to moving traffic and can block access. Dead animals can also be dangerous to the health of road users. It may be possible to re-use some debris, such as damaged tyres, for erosion protection.

Technical requirements

The debris should be removed with a specified time period and disposed of at an agreed site. It is acceptable for a labourer to collect debris into piles alongside the road and for a truck or tractor to then take the piles for disposal.

Scheduled or condition responsive?

The activity is often scheduled if debris is likely to be frequently found along the road. Otherwise the activity is identified in response to the presence of debris which can damage a vehicle or disturb travel.

Full, Basic Access, Partial Access

Full: Remove all debris

Basic and Partial Access: Remove debris which restricts access along the road.

Payment under measurement contract

Payment is based upon the length of road kept clear of debris. Alternatively payment can be made using dayworks for removing specific large items, for example abandoned vehicles or fallen trees.

Typical performance standard

The road must be free of debris. Debris must be cleared within a specified time period, for example one day if the debris causes danger or one week if it does not.

Timing in relation to the rainy season

The activity should be carried out when required.

Alternative treatments

Road users should be encouraged not to leave debris on the road surface or in the drains. Litter bins can be provided for small items.

Technology choice

The activity suits the use of labour although equipment may be used to remove large debris for disposal.

Safety on site

Use signs to warn road users that work is in progress. Gloves should be worn.

Productivity rates

A typical daily task is to remove 0.5 m^3 of debris per day, although this depends upon the type of debris and the length of road over which it is spread. An alternative daily task can be to inspect and keep 5 kilometres clear of debris.

Additional resources required

Shovels, rope, knife, collecting bags.

Social and environmental considerations

A clean road surface shows a high level of commitment by the Road Manager to the road users and local community. Much debris will not degrade and must be disposed of in an environmentally sensitive way. Burning debris, especially tyres, should not be encouraged.

A routine maintenance activity.

Description

Small depressions are found in all unpaved road surfaces. Water collects in these depressions, softens the material and as vehicles pass along the road the soft material is displaced and a pothole develops. Eventually vehicles may lose control on the rough surface and access may be lost. It is cost effective to repair potholes before they become deep and disruptive to traffic.

Technical requirements

Potholes must be repaired to a condition specified in terms of roughness or maximum depth of depression. All weak material should be excavated to a square face and replaced with earth or gravel from a source approved by the Road Manager. The material should be moistened if necessary and compacted (see Activity Planning Sheet 30).

Scheduled or condition responsive?

Surface works depend upon the standard to which the road is maintained. Pothole repair may often be scheduled as potholes are likely to occur frequently on unpaved roads. Otherwise, they are repaired according to the definitions in the box below.

Full, Basic Access, Partial Access

Full: All potholes under Basic Access and those which cause traffic to slow or swerve should be repaired. Typically repair will be required at a defect depth of 25 to 50 mm.

Basic Access: All potholes which collect water and are already leading to surface deterioration and lost access should be repaired. Shallow potholes may be left.

Partial Access: The activity is rarely required.

Payment under measurement contract

Payment is based upon the area of potholes repaired, the area of road in which potholes were repaired or the volume of material used.

Typical performance standard

Common road surface standards

- A specified vehicle, can travel safely and comfortably at a specified average speed and never below a specified minimum speed. The specified vehicle must be commonly available to allow inspection by road users.
- Ruts, potholes and corrugations must not be deeper than a specified depth and must not occupy greater than a specified percentage of the road area.
- Reliable access is available at all times, apart from closures of a specified duration (which may vary from a few hours in the dry season to several weeks in the rainy season and may vary on different road classes).
- Road roughness must be below a specified level.
- Road camber must be between 6 and 8% over a specified width. However, camber may have to be reduced to 3 or 4% on high traffic roads if the gravel is clayey as vehicles are forced to stay on their side of the road, rather than straddling the crown, and may slip off during wet conditions.
- Surface damage must be repaired within a specified time period.

Timing in relation to the rainy season

Potholes should be repaired when required, particularly at the start of the rainy season so that rain will be shed and not damage the road.

Alternative treatments

An alternative is to grade the road if potholes are widespread, but this can damage an otherwise strong surface. A second alternative is to regravel the road, but this is more expensive than repairing potholes and is unnecessary if only the potholes have lost material.

Technology choice

The activity suits labour. Equipment is used to transport materials if required.

Safety on site

Use signs to warn road users that work is in progress.

Productivity rates

A typical daily task is to repair minor surface damage over 50-120 metres of road. Alternatively, a daily task may be to use 0.6-1.2 m^3 of earth or 0.9-1.5 m^3 of gravel to repair potholes. Both rates depend on how far the material has to be transported.

Additional resources required

Spade, hand rammer or vibratory plate, wheelbarrow, approved earth or gravel, often in stockpiles along the road.

Social and environmental considerations

Road surface damage increases vehicle operating costs, placing a financial burden on all road users.

REPAIR RUTS **ACTIVITY PLANNING SHEET 26**

A routine maintenance activity.

Description

As vehicles travel along a road, it is common for one to follow the wheeltracks of another. Through either gravel loss or gradual compaction, a rut will be formed. This rut may trap water and prevent it running into the side drain. The wet road material is weakened and displaced by passing traffic, deepening the rut. On gradients, water runs down the ruts, stripping fines from the earth or gravel and causing gullying at the bottom of the gradient. Eventually vehicles may lose control in the ruts and access may be lost. It is cost effective to repair the ruts before they become deep and disruptive to traffic.

Technical requirements

Ruts must be repaired to a condition specified in terms of roughness or maximum depth of depression. All weak material should be removed, the base of the rut should be raked and moistened and the rut should be filled with earth or gravel from a source approved by the Road Manager. The material should be moistened if necessary and compacted (see Activity Planning Sheet 30).

Scheduled or condition responsive?

Surface works depend upon the standard to which the road is maintained. Rut repair may often be scheduled as ruts are likely to occur frequently on unpaved roads. Otherwise, they are repaired according to the definitions in the box below.

Full, Basic Access, Partial Access

Full: All ruts under Basic Access and those which cause traffic to slow or swerve should be repaired.

Basic Access: All ruts which collect water and are already leading to surface deterioration and lost access should be repaired. Shallow ruts may be left.

Partial Access: The activity is rarely required.

Payment under measurement contract

Payment is based upon the length of rut repaired or the volume of material used.

Typical performance standard

See the standards on Activity Planning Sheet 25.

Timing in relation to the rainy season

Ruts should be repaired when required, particularly at the start of the rainy season so that rain will be shed and not damage the road.

Alternative treatments

An alternative is to grade the road, but this can loosen an otherwise strong surface. A second alternative is to regravel the road, but this is more expensive than filling ruts and is often unnecessary if only the ruts have lost material.

Technology choice

The activity suits labour. Equipment may be used to transport materials if required.

Safety on site

Use signs to warn road users that work is in progress.

Productivity rates

A typical daily task is to repair minor surface damage over 50-120 metres of road. Alternatively, a daily task may be to use 0.6-1.2 m^3 of earth or 0.9-1.5 m^3 of gravel to repair ruts. Both rates depend on how far the material has to be transported.

Additional resources required

Spade, hand rammer, wheelbarrow, approved earth or gravel, often in stockpiles along the road.

Social and environmental considerations

Road surface damage increases vehicle operating costs, placing a financial burden on all road users.

FORM CAMBER AND SIDE DRAINS **ACTIVITY PLANNING SHEET 27**

A rehabilitation activity to improve a track in poor condition, although the activity may also be referred to as an upgrading.

Description

A track may be suitable for low levels of traffic. However, as traffic increases the track may deteriorate to the point at which access is at risk. The track should be improved into an engineered earth or gravel road.

Technical requirements

The activity is often preceded by a levelling of the entire road platform, an activity which may be paid according to the volume of earth moved (calculated using horizontal slots cut across the platform) and adjusted according to the type of soil. Material is dug from the side drains and formed into a camber. The road should meet the contract design and specification. Typically, carriageway widths vary from 3 to 6 metres. A camber maintained between 6 and 8% will last longer than a camber maintained around 4%, although 3-4% may be necessary on high traffic roads if the gravel is clayey as vehicles are unable to straddle the crown. Super-elevation is sometimes used on corners, but since surface water running across the full width of the carriageway can lead to transverse erosion, it should only be used if speeds are likely to be high.

Scheduled or condition responsive?

Surface works depend upon the standard to which the road is maintained. The activity is identified in response to the track not meeting the required standards in the box below.

Full, Basic Access, Partial Access

Full: Upgrade a track if quick and comfortable travel is not possible. Only occasionally will a track provide a Full standard.

Basic Access: Upgrade a track if access is not reliable. It may be necessary to upgrade only short lengths of track.

Partial Access: Forming a camber is unlikely to be necessary.

Payment under measurement contract

Payment is based upon the length of road formed with camber and side drains. Different rates may be used for different cross section designs.

Typical performance standard

See the standards on Activity Planning Sheet 25.

Timing in relation to the rainy season

The activity should be carried out when required if access has been lost. It is advised to form a camber shortly after the rains so that it has several months of compaction by traffic before the next rains start.

Alternative treatments

The track could be reformed along a different alignment and moved when required. This is suitable only for low traffic levels and if the track will be moved no more than once per year.

Technology choice

The activity suits labour or a mechanical grader.

Safety on site

Use signs to warn road users that work is in progress.

Productivity rates

When forming a new camber and side drains from a levelled platform, a 10 metre length is an appropriate daily task for 3 labourers.

Additional resources required

Shovels, hoes, rakes and compaction equipment.

Social and environmental considerations

Road surface damage increases vehicle operating costs, placing a financial burden on all road users.

REMOVE MATERIAL **ACTIVITY PLANNING SHEET 28**

A routine maintenance or a rehabilitation activity.

Description

Localised areas of material occasionally have to be removed from the riding surface of a road. These may be soft areas where water has degraded the soil, anthills which are extremely slippery when wet or protruding rocks which obstruct and damage vehicles. The material should be removed and the void filled with an approved material under Activity Planning Sheet 29.

Technical requirements

The unsuitable material must either be fully removed until strong material is exposed, or excavated to a depth of between 500 mm and 1 metre.

Scheduled or condition responsive?

Surface works depend upon the standard to which the road is maintained. This activity is often carried out to repair a soft spot or other area of unsuitable material which may result in a loss of access.

Full, Basic Access, Partial Access

Full: The activity is required if smooth travel is not possible.

Basic Access: The activity is required if access is no longer reliable or is likely to be lost.

Partial Access: The activity is required if even a low level of access is at risk.

Payment under measurement contract

Payment is based upon the volume of material removed and may vary according to the type of material. Payment for rocks may be made according to the size of rock, with rates for different sizes.

Typical performance standard

The standards on Activity Planning Sheet 25 can apply to all road surface activities.

Timing in relation to the rainy season

The activity is carried out when required. If carried out when wet, compaction of the fill will be easier.

Alternative treatments

Rocks, stones or granular material can be compacted into soft material in order to strengthen it. If protruding rocks are extensive and hard to remove, it may be cheaper to cover them with fill, constructing low retaining walls along the carriageway edge as necessary. Rocks may not need to be removed or covered if safe access is not lost or at risk.

Technology choice

The activity suits labour or mechanical excavators.

Safety on site

Use signs to warn road users that work is in progress.

Productivity rates

Typical daily tasks for excavation of various materials are as follows. Sand and silt – 5-12 m^3. Ordinary soil – 5-6 m^3. Hard soil – 2.5-5 m^3. Rock – 1-2 m^3. Boulders – 6-10 if small or 1-2 if large.

Additional resources required

Spades, hoes, wheelbarrows.

Social and environmental considerations

Removed material should be spread thinly and prevented from contaminating water sources or being washed into a drain.

FILL **ACTIVITY PLANNING SHEET 29**

A routine maintenance or a rehabilitation activity.

Description

Localised areas of material occasionally have to be removed from the riding surface of a road. The material should be removed under Activity Planning Sheet 28 and replaced with an approved fill material. On occasion a void or cavity on a road alignment must be filled before a road can be formed or improved, or fill is required to cover protruding rocks which cannot be removed.

Technical requirements

Fill material should be identified and approved by the Road Manager. The area to be filled should be moistened, and then material should be filled in layers 50-150 mm thick and compacted to the required level and shape (see Activity Planning Sheet 30).

Scheduled or condition responsive?

Surface works depend upon the standard to which the road is maintained. The activity is identified in response to a void in the riding surface or to replace excavated unsuitable material.

Full, Basic Access, Partial Access

The activity is required whenever unsuitable material has been removed. If used to fill voids in the riding surface, the activity is required for Basic and Partial Access only if access is no longer reliable or is likely to be lost.

Payment under measurement contract

Payment is based upon the compacted volume of fill placed and compacted.

Typical performance standard

The standards on Activity Planning Sheet 25 can apply to all road surface activities.

Timing in relation to the rainy season

The activity is carried out when required. If carried out when moist, compaction of the fill will be easier.

Alternative treatments

Rocks, stones or granular material can be compacted into soft material in order to strengthen it so that removal is unnecessary.

Technology choice

The activity suits labour and equipment depending on the haulage distance for the fill.

Safety on site

Use signs to warn road users that work is in progress.

Productivity rates

A typical daily task is to place and compact between 1.5 and 3 m^3 of fill.

Additional resources required

Shovels, wheelbarrows, compaction equipment.

Social and environmental considerations

Care should be taken to establish the ownership of sites selected for the excavation of fill material.

COMPACT **ACTIVITY PLANNING SHEET 30**

This activity is required after all activities which disturb soil.

Description

Under the action of vehicles and rainfall, soil naturally consolidates and achieves considerable strength. However, when soil is excavated, moved and placed it becomes loose and loses strength. If it is to rapidly regain its strength, in most cases it must be physically compacted.

Technical requirements

Soil or gravel must be compacted in layers around 100 to 150 mm thick (or 50 mm if hand rammers are used) to the required level and shape. If the layers are too thick, the lower portion of the layer will not be properly compacted. The ideal thickness depends upon the material type and the type of compaction equipment. When compacting a carriageway, compaction should begin at the edges and progress towards the centre. Material should meet a specified level of compaction or density. If tests are not possible on rural sites, the material should be compacted to refusal, where further passes or blows of the compactor result in no additional settlement. However, care is required with some soils, such as single sized sands, which may loosen if over-compacted and which are best compacted by flooding with water and allowing to drain. Material should be compacted at its optimum moisture content to achieve maximum density. Optimum moisture content can be estimated when material can be squeezed in the hand into a ball without emitting water.

Scheduled or condition responsive?

The activity is required whenever material has been loosened and its strength must be regained.

Full, Basic Access, Partial Access

All loosened material must be compacted if it is to regain strength and some erosion resistance.

Payment under measurement contract

Payment is based upon the area compacted or the volume of material compacted in layers of a specified thickness.

Typical performance standard

The standards on Activity Planning Sheet 25 can apply to all road surface activities.

Timing in relation to the rainy season

The timing of the activity depends upon the preceding fill and earthmoving activities rather than the rainy season.

Alternative treatments

Some materials can be placed and then left for compaction by traffic. Trials should be carried out to determine if this will be the case for each material.

Technology choice

Compaction using hand rammers is slow and its quality of output is hard to control. It is only suitable for inaccessible sites such as when backfilling culverts or during isolated pothole repair. Otherwise a mechanical roller – pedestrian or self propelled; dead load or vibratory – is preferred. The selection depends upon the type of material to be compacted – guidance should be sought.

Safety on site

Use signs to warn road users that work is in progress Mechanical rollers should be used only by trained operators.

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Productivity rates

A large self propelled roller may compact around 250 m^3 of material in a day in layers 150 mm thick.

Additional resources required

Water so that the material is compacted at its optimum moisture content, shovels.

Social and environmental considerations

Uncompacted material is prone to rapid erosion, settlement and loss of access.

FORM EMBANKMENT **ACTIVITY PLANNING SHEET 31**

A rehabilitation activity.

Description

Some roads in low lying areas provide dry season access but become covered in flood water for long periods during the rains. If year round access is to be provided, the level of the road must be raised with an embankment. Roads can also be embanked if high water tables weaken the lower layers and put the road surface and access at risk.

Technical requirements

Because of their cost and the consequence of high embankment failure, it is important that sites are carefully surveyed and the embankment carefully designed. The base of the road should be cleaned of all loose material. Suitable fill material should be identified and approved by the Road Manager. The material should be placed in layers 50-150 mm thick, and compacted until the specified embankment level and shape is obtained (see Activity Planning Sheet 30). Embankment slopes are typically 1:3 and should be protected with vegetation.

Scheduled or condition responsive?

The activity is identified in response to a need to provide access during the rainy season.

Full, Basic Access, Partial Access

Full and Basic Access: The activity is required.

Partial Access: The activity is required if access is lost for a long period, but the embankment may be formed with a narrow cross section to save costs.

Payment under measurement contract

Payment is based upon the volume of compacted material in the embankment as it was designed. If formed larger than the design, additional payment should not be made.

Typical performance standard

See the standards on Activity Planning Sheet 25. However, it is more common to pay for high embankments using a design and measured quantities than a performance standard.

Timing in relation to the rainy season

Embankments should be formed when the site is dry or water levels are at their lowest. This will allow maximum time for traffic to give additional compaction and for erosion protection to become established.

Alternative treatments

It may be possible to use an alternative route around a flooded site during the rainy season.

Technology choice

The activity suits labour and equipment. Equipment should be used for haulage (over approximately 100-200 metres) and compaction. Most embankments constructed by labour require a very large labour force.

Safety on site

Use signs to warn road users that work is in progress. Drivers and operators should be very careful when working near labourers. Labourers should not ride on tractors or on the sides of trailers.

Productivity rates

A team of trucks, loader, bulldozer and roller can form between 250 and 400 m^3 of embankment per day.

Additional resources required

Haulage and compaction equipment, shovels, hoes.

Social and environmental considerations

Embankments can disrupt irrigation and drainage patterns and should be designed and constructed with care. They should not cause other areas to flood. Culverts through the embankment should be planned with care. All embankment slopes should be covered with topsoil and planted with vegetation to prevent erosion.

DRAG **ACTIVITY PLANNING SHEET 32**

A routine maintenance activity.

Description

Dry surfaces are prone to form corrugations, or transverse ridges, when trafficked. They form more quickly when the material is fine grained with low plasticity and low particle strength, speeds are higher and traffic volume is higher with a large proportion of old vehicles and unladen trucks. Corrugations cause discomfort, increase vehicle operating costs and, when severe, can be dangerous. Drags are pulled over the surface, often by a tractor or truck and prevent corrugations forming and then developing by shearing off the tops and spreading the loose material across the surface and into the troughs. Drags also spread windrows of loose material.

Technical requirements

Drags can be made from steel cables or beams, grader blades, timber planks, tyres fixed to a frame or small trees. The drag must be approved for use by the Road Manager. The entire surface of the road should be dragged to remove any emerging corrugations. Two to four passes may be required. Dragging is only effective on small corrugations and when there is already some loose material on the surface. Large corrugations should be graded.

Scheduled or condition responsive?

Dragging is scheduled to prevent corrugations forming. The frequency depends upon the type of material, the type of drag, traffic levels and speeds and climate. Trials should be carried out to determine a suitable frequency, which may be as high as weekly.

Full, Basic Access, Partial Access

Full: The activity is required if the road is prone to corrugations.

Basic and Partial Access: The activity is not normally required. Traffic levels may not be high enough to generate corrugations.

Payment under measurement contract

Payment is based upon the area of road dragged or the length of road of a specified width.

Typical performance standard

See the standards on Activity Planning Sheet 25. The road should remain free of corrugations.

Timing in relation to the rainy season

Dragging is normally required only during the dry season.

Alternative treatments

Low costs drags can be made from small trees. Drags can be pulled by animals.

Technology choice

Dragging normally requires mechanical equipment. Drags may be made from a variety of materials.

Safety on site

Use signs to warn road users that dragging is in progress.

Productivity rates

A tractor towed drag can cover a distance of 20-50 km in a day. Productivity depends upon the number of passes required to drag the entire cross section.

Additional resources required

Tractor, drag, labourers.

Social and environmental considerations

Dragging can generate dust. Corrugations increase vehicle operating costs, placing a financial burden on all road users. Severe corrugations can cause vehicles to lose control.

GRADE (LIGHT & HEAVY) **ACTIVITY PLANNING SHEET 33**

A routine maintenance activity.

Description

When an earth or gravel surface has widespread damage, travel is rough and if the damage is severe, vehicles at speed can lose control. The surface should be repaired using a grader. Light grading requires a shallow cut (less than 50 mm) with compaction normally by traffic; heavy grading requires a deep cut (50-100 mm) with rippers if available, watering if the material is dry, and compaction by site equipment. Grading can also restore a camber so that water is shed from the riding surface. Grading should always move material towards the centre of the road.

Technical requirements

The activity may be preceded by repair of deep potholes and ruts. Grading should begin at the edges of the road and move in towards the centre. After grading, the road should have a roughness at or below a specified value and the camber should be as specified. If the surface material forms a crust when dry, it is recommended that instead of light grading, loose material is simply swept across the surface to fill any depressions and the crust left intact.

Scheduled or condition responsive?

Grading is normally scheduled, ideally to maintain the camber at or above 4-6%. The required frequency depends upon traffic, climate and the surface material and should be established locally. Typically a road with 50 vehicles per day will require 1 to 3 gradings per year; a road with 200 vehicles per day will require 3 to 6 gradings per year. The decision between light and heavy grading depends upon the depth of the ruts and potholes. Light grading suits defects less than 50 mm; heavy grading suits defects between 50 and 100 mm.

Full, Basic Access, Partial Access

Grading is normally only required under a Full standard, but if the surface is collecting water which may weaken material and lead to a loss of access, grading can be justified under Basic Access.

Payment under measurement contract

Payment is based upon the area of carriageway which conforms to a technical standard, or the length of road of a specified width.

Typical performance standards

See the standards on Activity Planning Sheet 25.

Timing in relation to the rainy season

Grading is best carried out shortly after the rains since compaction is much more effective on moist material. At other times, a water bowser may be required. Grading may also be required during the rainy season. If a road is dragged during the dry season, grading may not be required.

Alternative treatments

Activity Planning Sheets 25 and 26 describe activities to repair surface damage manually but these activities are less effective at reducing roughness.

Technology choice

Grading requires mechanical equipment, although some light reforming of a carriageway may be possible manually. Graders may be self-propelled or tractor-towed.

Safety on site

Use signs to warn road users that grading is in progress. It may be necessary to provide a detour for traffic. Immediately after light grading, vehicles may slip on loose material and a warning sign may be required.

Productivity rates

A grader can travel between 10 and 40 km per day. Therefore productivity depends upon how many passes are required to grade the entire cross section. A daily task for manual reforming is between 20 and 40 metres of road.

Additional resources required

Heavy grading requires compaction equipment. Watering equipment may be required if the surface material is dry. A camber board is required to check camber.

Social and environmental considerations

Grading can generate dust if the earth or gravel is dry. Road surface damage increases vehicle operating costs, placing a financial burden on all road users.

RESHAPE **ACTIVITY PLANNING SHEET 34**

A rehabilitation activity.

Description

The activity is required in response to major carriageway damage, with defects typically deeper than 150 mm. Travel is difficult and dangerous and access can be lost. Normal grading is insufficient to repair the road. The road must be reshaped. A road under regular maintenance is unlikely to get in a poor condition and require reshaping.

Technical requirements

The material in the carriageway must be ripped to its full depth and reshaped to the required camber. The material should be watered if necessary and compacted in layers 50-150 mm thick (see Activity Planning Sheet 30). After reshaping, the road should have a roughness at or below a specified value and the camber should be as specified.

Scheduled or condition responsive?

The activity is identified in response to very poor carriageway condition, with defects 150 mm and deeper and a total loss of camber.

Full, Basic Access, Partial Access

The activity is often required to repair major damage which makes access difficult or dangerous. Therefore the activity may be required at all standards, but is unlikely to be required on a road under regular maintenance.

Payment under measurement contract

Payment is based upon the volume of material moved or the area reshaped, adjusted according to the depth of defects.

Typical performance standard

See the standards on Activity Planning Sheet 25.

Timing in relation to the rainy season

The activity is carried out when required. It is best carried out shortly after the rains so that the material is moist and suitable for compaction.

Alternative treatments

The road can be realigned, especially at a Basic or Partial Access standard. Alternatively the road can be shaped to a lower camber and an improved surface provided.

Technology choice

The activity suits equipment although it can be carried out by labour.

Safety on site

Use signs to warn road users that work is in progress. A detour may be required if the road is impassable.

Productivity rates

Productivity may be similar to forming a camber and side drains from a levelled platform. For this activity, a 10 metre length is an appropriate daily task for 3 labourers. A team of equipment may reshape between 500 and 1,500 metres of carriageway in a day.

Additional resources required

Camber board to check camber, spades, hoes and compaction equipment or a team of equipment.

Social and environmental considerations

Road surface damage increases vehicle operating costs, placing a financial burden on all road users.

Regravelling is a periodic maintenance activity. Gravelling an earth road is a rehabilitation activity although it may also be referred to as an upgrading.

Description

An earth road may be suitable for a certain level of traffic. However, as traffic increases the road may deteriorate to the point at which access is at risk. The road should be improved with a gravel layer.

A gravel surface continually loses material as dust when dry and in runoff when wet. When the layer becomes thin, new gravel must be added.

Technical requirements

Gravel, ideally meeting national specifications for particle size, grading and plasticity, should be identified and approved by the Road Manager. The existing surface should be cleared of loose material and prepared to the specified camber. Gravel should be spread and compacted in a layer between 100 and 150 mm thick (see Activity Planning Sheet 30). On occasion a thicker layer may be required, in which case it should be compacted as two thinner layers.

Scheduled or condition responsive?

Gravelling is identified in response to an earth road becoming impassable. Regravelling is identified in response to the gravel layer becoming thin, typically 50 to 75 mm in the wheeltracks, although it is often scheduled if gravel loss is constant and the need for more gravel can be predicted. Typically, regravelling is required every 3 to 10 years, depending on the material properties, climate, traffic levels and the resulting rate of gravel loss.

Full, Basic Access, Partial Access

Full: The activity is required.

Basic Access: If a length of road has been gravelled to provide access, it should be regravelled when the layer is thin.

Partial Access: Gravel is rarely used at this standard.

Payment under measurement contract

Payment is based upon the compacted volume of gravel used, although many additional rates are often used for opening access tracks, removing overburden, excavating and hauling gravel and reinstating the gravel pit.

Typical performance standard

See the standards on Activity Planning Sheet 25. A minimum thickness of gravel may also be specified.

Timing in relation to the rainy season

(Re)gravelling should be carried out shortly after the rains so that the gravel is already moist and the surface will have several months of compaction by traffic before the next rains.

Alternative treatments

If gravel loss is high, an improved surface (Activity Planning Sheet 36), a sand cushion (Sheet 38) or dust palliatives (Sheet 39) will often reduce maintenance costs. An improved surface is normally smoother than gravel.

Technology choice

Gravel excavation and spreading suits labour and equipment. Haulage and compaction suits mechanical equipment, although wheelbarrows can be used for distances up to 100-200 metres.

Safety on site

Use signs to warn all road users that gravelling is in progress. The vertical face in a gravel pit should not exceed 1 metre in height. Labourers must not ride on tractors or on the sides of trailers. Tractor and truck drivers should not drive fast on narrow access tracks. It may be necessary to provide a detour for traffic.

Productivity rates

Daily tasks for labour include the following.

- Excavate and stockpile gravel – 1-4 m^3
- Load gravel – 4-6 m^3
- Off load and spread gravel – 6-8 m^3

A tractor and trailer can haul 45-60 m^3 per day.

A team with equipment can gravel a road with between 200 and 500 m^3 of gravel in a day.

Additional resources required

Good quality gravel, a camber board to check camber, haulage and compaction equipment, water.

Social and environmental considerations

Gravel pits can be unsightly and should be carefully reinstated after use so as not to pond water and pose a health and safety risk to local communities.

PROVIDE AN IMPROVED SURFACE **ACTIVITY PLANNING SHEET 36**

A rehabilitation activity, although it may also be referred to as an upgrading.

Description

An earth or gravel road may not be durable enough for the local climate, terrain and traffic levels. Alternatively, the required maintenance regime to maintain condition may be onerous and expensive. In order to prevent deterioration leading to a loss of access, an improved surface is recommended. Dust can also cause health and safety problems for road users.

Technical requirements

A wide variety of low cost bituminous and non-bituminous improved surfaces are available. These include brick paving, bamboo reinforced concrete, dressed stones, chip seals and Otta seals. Since an improved surface can be expensive, it is important that they are carefully selected and designed. Documents in Section 5.2 provide further information. For impervious surfaces, the camber is often reduced to around 3%.

Scheduled or condition responsive?

An improved surface is provided in response to rapid deterioration of an earth or gravel surface.

Full, Basic Access, Partial Access

Full: Long lengths of an improved surface may be provided.

Basic Access: Short lengths of an improved surface may be provided when earth or gravel access is at risk, for instance up steep hills, or to reduce dust through villages or past health centres.

Partial Access: Improved surfaces are unlikely to be used.

Payment under measurement contract

Payment is normally based upon the area of improved surface.

Typical performance standard

The standards on Activity Planning Sheet 25 may be used. If the techniques are new to the contractors, improved surfaces may be paid for using a design and measured quantities. Once an improved surface has been constructed, lower defect depths, lower roughness and higher vehicle speeds can be specified. Additional standards may be used depending on the surface type.

Timing in relation to the rainy season

Improved surfaces should be constructed during the dry season.

Alternative treatments

An alternative is to carry out very frequent grading and regravelling. This can be expensive. An alternative to surfacing a slippery steep hill is to realign the road with zig-zags. Activity Planning Sheets 38 and 39 describe ways to prevent dust generation and gravel loss.

Technology choice

Bituminous surfaces are often constructed by machine, although the documents in Section 5.2 cover the use of labour. Non-bituminous surfaces suit labour based methods.

Safety on site

Each surface has its own specific dangers. These include hot bitumen, flying stone chips and heavy rocks. Protective clothing should be provided as required. Use signs to warn road users that surface work is in progress. It may be necessary to provide a detour for traffic.

Productivity rates

Productivity rates depend upon the improved surface being constructed.

Additional resources required

Some surfaces require little more than excavation tools. Other surfaces require more specialised equipment. Most surfaces require compaction equipment. Hand rammers and vibratory plates are often adequate for block and brick surfaces.

Social and environmental considerations

The use of firewood to burn clay bricks can lead to deforestation. If an improved surface replaces earth or gravel, the reduction in airborne dust benefits human, animal and crop health and the safety of road users. An improved surface will reduce gravel usage, often a scarce resource.

STOCKPILE GRAVEL **ACTIVITY PLANNING SHEET 37**

A routine maintenance activity by a contractor supervising a number of lengthworkers.

Description

If maintenance is carried out by lengthworkers, gravel will be needed to repair potholes, ruts and other minor damage on a gravel surface. Stockpiles of gravel should be provided at intervals along the road for the lengthworker to use when required.

Technical requirements

Gravel from an approved source should be formed into piles close to the road at intervals between 100 and 250 metres. Stockpiles should be restocked sufficiently frequently that lengthworkers are never without gravel for repairs.

Scheduled or condition responsive?

The activity is required in response to a lack of available gravel.

Full, Basic Access, Partial Access

Full: The activity is required wherever a gravel surface is being maintained by lengthworkers.

Basic Access: The activity is required if minor surface repair is required to provide access.

Partial Access: The activity is unlikely to be required.

Payment under measurement contract

Payment for this activity is often included in the repair of potholes and ruts in a gravel surface. Occasionally payment is made separately for the stockpiling of gravel.

Typical performance standard

If standards such as those on Activity Planning Sheet 25 are to be achieved by lengthworkers, gravel must be always available at regularly spaced sites.

Timing in relation to the rainy season

Gravel stockpiles must be available year round. Excavation may be easier when the gravel is moist.

Alternative treatments

If gravel is to be repaired by lengthworkers, there is no alternative to providing them with supplies of gravel.

Technology choice

Haulage of gravel is more efficient by tractor and trailer or truck than by labour and wheelbarrow. Excavation of gravel suits both equipment and labour.

Safety on site

Stockpiles should be located away from the carriageway and not obstruct road users.

Productivity rates

For daily tasks relating to gravel excavation and loading, see Activity Planning Sheet 35.

Additional resources required

Gravel stockpiling requires either mechanical excavators or handtools for labour. Mechanical haulage equipment is recommended.

Social and environmental considerations

Gravel pits can be unsightly and should be carefully reinstated after use so as not to pond water and pose a health and safety risk to local communities.

PROVIDE A SAND CUSHION **ACTIVITY PLANNING SHEET 38**

A routine maintenance activity.

Description

As traffic passes over a dry gravel surface, dust is generated. This dust can harm human, animal and crop health and put road users in danger, while the lost material must be regularly replaced. A sand cushion on a gravel road will limit dust generation and reduce the need for regular regravelling. A sand cushion will also prevent corrugations and other defects forming in the gravel surface and will soften the ride if the gravel is very coarse. A sand cushion is suitable in arid areas where sand is readily available and is more suitable in flat terrain than in a hilly area. Since the sand must be re-spread frequently, a sand cushion is suitable only for road administrations with adequate resources.

Technical requirements

Defects in the gravel surface should be repaired. A layer of sand between 25 and 40 mm should then be spread evenly across the road. The sand should be angular with a maximum particle size of 7 mm. The sand cushion tends to form windrows under traffic and must be regularly maintained by dragging with a tyre drag or, ideally, a blade/tyre combination at less than 10 km/h to re-spread the sand. Frequency of maintenance depends upon traffic levels, but should be carried out after approximately every 500 vehicles, up to a maximum interval of ten days. Some dust will be generated from the sand cushion and re-sanding should be carried out when the layer is less than 25 mm thick.

Scheduled or condition responsive?

A sand cushion is identified in response to the presence of dust or to the previous cushion becoming too thin. Maintenance of the cushion should be scheduled at a frequency as above.

Full, Basic Access, Partial Access

The activity is normally only required on gravel surfaces carrying medium to high traffic volumes. It is unlikely to be required under Basic and Partial Access, unless the lack of visibility is putting road users in danger or the dust is affecting the health of those living alongside the road.

Payment under measurement contract

Payment is based upon the area of road provided with a sand cushion.

Typical performance standard

The road shall be largely free of dust.

Timing in relation to the rainy season

The activity is only required in the dry season.

Alternative treatments

Alternative treatments to prevent dust include an improved surface (Activity Planning Sheet 36), dust palliatives (Sheet 39) and frequent watering during the dry season. However, the use of water can be expensive and may be inappropriate in communities suffering from water shortages.

Technology choice

Labour can spread the sand but equipment is normally required for transport and dragging.

Safety on site

Use signs to warn all road users that work is in progress. If a sand cushion is too thick, vehicles may lose traction and a warning sign may be required.

Productivity rates

A daily task may be to spread between 6 and 8 m^3 of sand.

Additional resources required

Supply of sand, rakes, shovels, drag, supply of sand.

Social and environmental considerations

The reduction in airborne dust benefits human, animal and crop health and the safety of road users. A sand cushion will reduce gravel usage, often a scarce resource.

A routine maintenance activity.

Description

The dust generated from earth and gravel roads can harm human, animal and crop health and put road users in danger. The lost material must also be regularly replaced. The use of dust palliatives can reduce dust generation and the need for regular earth filling or regravelling.

Technical requirements

A variety of dust palliatives can be sprayed on and worked into an earth or gravel surface to reduce dust levels. These materials include waste lubricating oil, diesel, ligno-sulphonates, tars and bitumens, sulphonated oils, salts such as calcium chloride and a large number of related proprietary products. It is very important that trials are carried out of the various alternatives on the roads on which they are intended for use. Further information should be sought before planning a programme of dust prevention.

Scheduled or condition responsive?

The activity may be scheduled if the need for repeated treatment can be predicted. A typical frequency may be monthly, but will depend upon the palliative being used. Otherwise the activity should be identified when dust is noticed behind passing vehicles.

Full, Basic Access, Partial Access

The activity is normally required only on gravel surfaces carrying high traffic volumes. It is unlikely to be required under Basic and Partial Access, unless the lack of visibility is putting road users in danger or the dust is affecting the health of those living alongside the road.

Payment under measurement contract

Payment is based upon the area of road surface treated or the length of road of a specified width.

Typical performance standard

The road shall be free of dust.

Timing in relation to the rainy season

The activity is only required in the dry season.

Alternative treatments

Alternative treatments to prevent dust include an improved surface (Activity Planning Sheet 36), a sand cushion (Sheet 38) and frequent watering during the dry season. However, the use of water can be expensive and may be inappropriate in communities suffering from water shortages.

Technology choice

The activity suits labour although materials can be dispensed from trailer mounted pumps.

Safety on site

Use signs to warn road users that work is in progress.

Productivity rates

Around 1.5 km of road can be treated in one day by a team of tractor, trailer, pump and bowser.

Additional resources required

Dust control materials.

Social and environmental considerations

The reduction in airborne dust benefits human, animal and crop health and the safety of road users. Dust palliatives will also reduce gravel usage, often a scarce resource. Some dust palliative materials are harmful to health and crops and care must be taken to ensure that they are not washed by rainfall into drains and watercourses. Over-spray must be avoided.

REPAIR AN IMPROVED SURFACE **ACTIVITY PLANNING SHEET 40**

A routine maintenance activity.

Description

An improved surface, once damaged, can deteriorate rapidly and be dangerous to travel on. Any damage should be repaired as soon as possible.

Technical requirements

Repair requirements depend upon the type of improved surface. Documents in Section 5.2 provide more specific information. Many improved surfaces can be repaired simply and quickly with a limited supply of tools.

Scheduled or condition responsive?

Surface works depend upon the standard to which a road is maintained. The activity is identified in response to damage.

Full, Basic Access, Partial Access

Full: All defects under Basic Access and those which cause traffic to slow or swerve should be repaired. Typically repair will be required at a defect depth of 10 to 25 mm.

Basic Access: All potholes which collect water should be repaired. Having invested in an improved surface, it is rarely cost effective to let the investment fall into disrepair.

Partial Access: Improved surfaces are unlikely to be found.

Payment under measurement contract

Payment is based upon the area of road repaired.

Typical performance standard

See Activity Planning Sheet 36.

Timing in relation to the rainy season

The activity is required when damage occurs regardless of the rainy season. Repairs may be easier when the road is dry.

Alternative treatments

There is no alternative to repairing an improved surface.

Technology choice

Surface repair normally suits labour, although equipment may be required to transport materials.

Safety on site

Each surface has its own specific dangers. These include hot bitumen, flying stone chips and heavy rocks. Protective clothing should be provided as required. Use signs to warn road users that surface work is in progress. It may be necessary to provide a detour for traffic.

Productivity rates

Productivity depends upon the type of improved surface being repaired.

Additional resources required

Some surfaces require little more than excavation tools. Other surfaces require more specialised equipment. Most surfaces require compaction equipment. Hand rammers and vibratory plates are often adequate for block and brick surfaces.

Social and environmental considerations

Road surface damage increases vehicle operating costs, placing a financial burden on all road users.

CLEAN ROAD SIGN **ACTIVITY PLANNING SHEET 41**

A routine maintenance activity.

Description

Road signs tend to become dirty over time. This is particularly true alongside earth and gravel roads in the dry season. They should be cleaned so that they can be seen and serve their original purpose.

Technical requirements

The road sign should be clean of all soil and dust.

Scheduled or condition responsive?

Sign cleaning should be scheduled whenever signs are likely to be dirty and illegible at a specified distance. The activity can also be required in response to an identified dirty sign.

Full, Basic Access, Partial Access

Since most signs are safety related, they should be cleaned at all standards, although signs are unlikely to be present on many roads maintained at a Partial Access standard.

Payment under measurement contract

Payment is made for every sign cleaned.

Typical performance standard

All road signs must be legible at a specified distance.

Signs must be completely free of dirt. Signs must be cleaned within a specified time of becoming dirty.

Timing in relation to the rainy season

Road signs should be cleaned as soon as the defect has been identified. Cleaning is likely to be required more often in the dry season.

Alternative treatments

If a sign face cannot be properly cleaned, it should be replaced.

Technology choice

The activity suits labour.

Safety on site

Use signs to warn road users that work is in progress.

Productivity rates

A large number of signs can be cleaned in a day, although this depends upon their spacing along the road. In terms of their face area, a daily task might be to clean between 150 and 200 m^2 of sign face.

Additional resources required

Water, cleaning materials, bucket, ladder.

Social and environmental considerations

The activity is required for the safety and benefit of all road users.

REPAIR OR REPLACE ROAD SIGN **ACTIVITY PLANNING SHEET 42**

A routine maintenance activity. The activity is also required when new signs are required for safety, regulation or information purposes or a sign face fades.

Description

Signs alongside a road can be damaged by vehicles or animals or stolen. They should be repaired so that the sign can be seen and will serve its original purpose.

Technical requirements

The sign and post should follow the design specified in the contract.

Scheduled or condition responsive?

The activity is identified in response to damage or loss, although the activity may be specified if damage or loss of signs along a road is likely.

Full, Basic Access, Partial Access

Since most signs are safety related, they should be repaired or replaced at all standards, although signs are unlikely to be present on many roads maintained at a Partial Access standard. Warning signs should be repaired more urgently on roads where speeds are high.

Payment under measurement contract

Payment is made for every sign repaired and every sign replaced.

Typical performance standard

All road signs must be legible at a specified distance. Signs must be repaired within a specified time of being damaged or stolen. This specified time may vary according to the standard or class of the road. All sign posts must be vertical.

Timing in relation to the rainy season

Road signs should be repaired or replaced as soon as the defect has been identified regardless of the rainy season.

Alternative treatments

If posts are stolen, the sign face can be mounted on a convenient tree. If faces are stolen, replacements should be perforated to reduce the chance of theft.

Technology choice

The activity suits labour.

Safety on site

Use signs to warn road users that work is in progress.

Productivity rates

Depending upon the extent of the damage, a daily task may be for the repair of between 2 and 8 signs per day.

Additional resources required

All necessary repair tools and materials and concrete if a base is to be provided.

Social and environmental considerations

The activity is required for the safety and benefit of all road users.

REPAIR OR REPLACE BARRIER **ACTIVITY PLANNING SHEET 43**

A routine maintenance activity, although could be an emergency activity if road users are exposed to danger.

Description

Road barriers prevent vehicles from leaving the carriageway. They may be damaged by vehicles and occasionally may be stolen. They should be repaired or replaced so that they can serve their purpose.

Technical requirements

Because of the consequence of the failure of a barrier under vehicle impact, barriers must be designed, specified and constructed according to the manufacturers guidance. This will ensure that they have adequate strength. Barriers may also be painted to act as edge delineators.

Scheduled or condition responsive?

The activity is identified in response to the barrier no longer serving its intended purpose.

Full, Basic Access, Partial Access

Since barriers are safety related, they should be repaired or replaced at all standards, although they are unlikely to be present on many roads maintained at a Partial Access standard. Barriers should be repaired more urgently on roads where speeds are high.

Payment under measurement contract

Payment is based upon the length of barrier repaired or the length of barrier replaced. In some cases the activity may be paid using dayworks.

Typical performance standard

Barriers must meet the relevant specification. Barriers must be repaired within a specified time of being damaged or stolen. This specified time may vary according to the standard or class of the road, but may be as short as two days.

Timing in relation to the rainy season

The activity is required as soon as the defect has been identified.

Alternative treatments

Barriers can be made of locally cut timber or masonry walling. Edge delineators painted white will warn road users of a steep drop and may be a good alternative to barriers.

Technology choice

The activity suits labour although equipment may be required to transport materials.

Safety on site

Use signs to warn road users that work is in progress. Barrier which has been replaced should be removed from the site when work is complete.

Productivity rates

A daily task may be to repair or replace between 10 and 20 metres of barrier, although productivity depends upon the degree of damage to the barrier.

Additional resources required

All necessary repair tools and materials.

Social and environmental considerations

The activity is required for the safety of all road users.

REPAIR OR REPLACE EDGE DELINEATOR **ACTIVITY PLANNING SHEET** **44**

A routine maintenance activity but may be required in an emergency.

Description

Edge delineators mark the edge of a road and are often used above high drops and on tight corners. They are therefore important for safety reasons, particularly at night. If damaged or missing, they should be repaired or replaced. Theft is possible, although unlikely. If dirty, they should be cleaned and painted.

Technical requirements

Edge delineators can be made of a variety of materials, including reinforced concrete, dressed stone and concreted oil drums. They should be painted white and should be resistant to minor impact and rainfall

Scheduled or condition responsive?

Repair and replacement is identified in response to damage or theft. It may be necessary to clean and paint edge delineators twice a year.

Full, Basic Access, Partial Access

Since edge delineators are safety related, they should be repaired or replaced at all standards, although they are unlikely to be present on many roads maintained at a Partial Access standard. Edge delineators should be repaired more urgently on roads where speeds are high.

Payment under measurement contract

Payment is made for every edge delineator repaired or replaced.

Typical performance standard

Edge delineators must meet the relevant specification. They must be repaired within a specified time of being damaged or stolen, depending on the standard or class of the road.

Timing in relation to the rainy season

Edge delineators should be repaired or replaced as soon as the defect has been identified.

Alternative treatments

Edge delineators can be made from low cost, locally available materials.

Technology choice

The activity suits labour, although equipment may be required to transport materials.

Safety on site

Use signs to warn road users that work is in progress.

Productivity rates

Depending on the type and size of edge delineator and their spacing along the road, a daily task may be to repair between 5 and 20 edge delineators. An alternative daily task may be to clean and paint 50 edge delineators.

Additional resources required

All necessary repair tools and materials, cleaning and painting equipment.

Social and environmental considerations

The activity is required for the safety of all road users.

REPAIR OR REPLACE DISTANCE POST **ACTIVITY PLANNING SHEET 45**

A routine maintenance activity.

Description

Distance posts are very useful for recording inventory information and road condition and accident data. They also indicate commitment to the road by the Road Manager. If damaged or missing, recording information is more difficult and they should be repaired or replaced.

Technical requirements

Distance posts can be made of a variety of materials, including reinforced concrete, dressed stone and concreted oil drums. The posts should be painted white and should be resistant to minor impact and rainfall. They should also give the distance to the nearest town or village and other useful information.

Scheduled or condition responsive?

The activity is identified in response to damage or theft.

Full, Basic Access, Partial Access

Full: Although not essential, the provision of distance posts can normally be justified.

Basic Access: As a low cost measure, they can contribute to a good impression of road management.

Partial Access: They are unlikely to be required.

Payment under measurement contract

Payment is made for every distance post repaired or replaced.

Typical performance standard

Distance posts must be present and visible. All information must be legible. They must be repaired or replaced within a specified time.

Timing in relation to the rainy season

The activity suits labour.

Alternative treatments

Distances can be marked on tree trunks, buildings or structure headwalls alongside the road.

Technology choice

Repair or replacement suits labour although equipment may be needed to transport materials.

Safety on site

Use signs to warn road users that work is in progress.

Productivity rates

Productivity depends upon the type of distance post and their spacing along the road.

Additional resources required

All necessary repair tools and materials.

Social and environmental considerations

The activity is required for the safety and benefit of all road users. Well maintained distance posts indicate a high level of commitment by the Road Manager to the road users and local community.

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