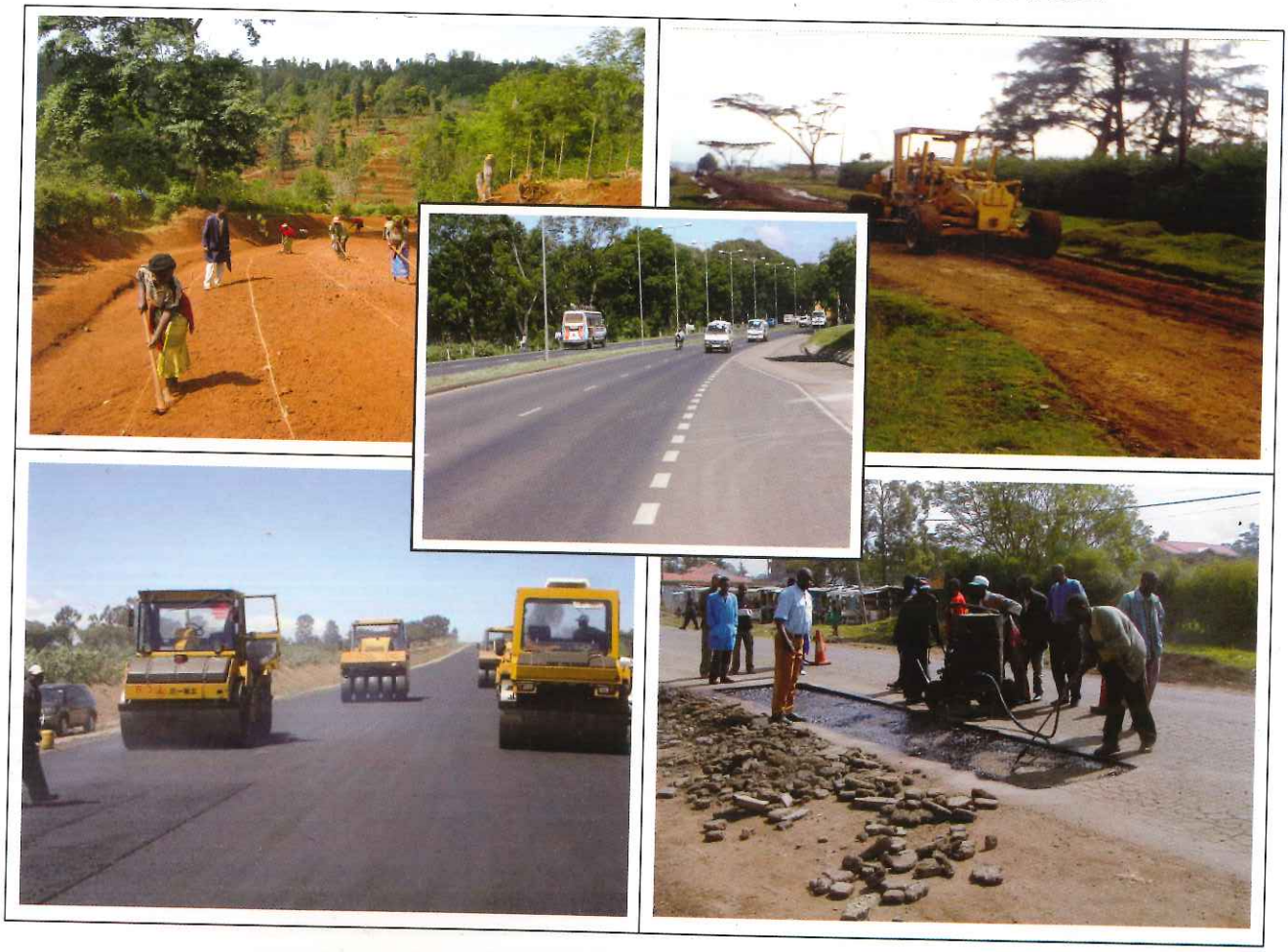
ENG. M.O. NDEDA

REPUBLIC OF KENYA

MINISTRY OF ROADS

ROAD MAINTENANCE MANUAL



PART - I
INSPECTION

PART - II
EVALUATION

PART - III
EXECUTION

CHIEF ENGINEER MATERIALS TESTING & RESEARCH MINISTRY OF ROADS P.O.BOX 11873 - 00400 NAIROBI	MAY 2010	PERMANENT SECRETARY MINISTRY OF ROADS P.O.BOX 30260 -00100 NAIROBI

ENG. M.O. NDEDA

FOREWORD

The Ministry of Roads is responsible for the planning, development and maintenance of the public roads infrastructure in the country. This is done through the three Road Authorities, namely: Kenya National Highways Authority, (KeNHA) for major roads (International, National Trunk and Primary Roads) Kenya Rural Roads Authority (KeRRA) for rural and small town roads, Kenya Urban Roads Authority (KURA) for urban roads. Funds for road maintenance are disbursed by the Kenya Roads Board (KRB) which is also a state corporation.

The Ministry lays great emphasis on road maintenance in order to protect the resources already invested in the road infrastructure. In this regards, the importance of appropriate manuals to guide both public and private practitioners has been recognized as key to road management and maintenance including needs assessment, evaluation and execution of works.

I call upon the road authorities and other players in the sector to make full use of the manuals in order to improve the quality of our road networks.

This manual has been produced through technical support by the Government of Japan through Japan International Cooperation Agency (JICA) to streamline maintenance activities in the road section. I wish to thank the Government of Japan for both their financial and technical assistance.

HON. FRANKLIN BETT, EBS, MP
MINISTER FOR ROADS

MESSAGE BY THE PERMANENT SECRETARY; MINISTRY OF ROADS

Roads play a crucial role in the social economic development of any country. Currently in Kenya, roads carry more than 90% of freight and passenger traffic in the country and hence their importance cannot be under estimated.

To enable the achievement of its vision "***to attain and sustain world class roads infrastructure to enhance socio-economic development***" the Ministry lays great emphasis on the maintenance of classified and unclassified roads network estimated at over 160,000km. In order to achieve the ministry requires in excess of Kshs. 20 billion per year for road maintenance. One of the major challenges facing the road sub-sector is inadequate road maintenance. In an effort to address the problem of maintenance, the Government has produced this road manual to be the basis of planning and implementation of maintenance works. The manual is in three sections, namely; inspection, evaluation and execution. The manual is prepared for the management and maintenance practitioners and other technical staff. It has been developed to be a guide for road maintenance contractors and consultants in the planning and executing of maintenance works.

This manual will enable road maintenance activities to be executed on the basis of standard strategies and procedures in order to ensure cost effectiveness in the preservation of the road infrastructure assets and high quality roads in the country.

The Ministry appreciates the assistance provided by Japanese International Cooperation Agency (JICA) in the development of this manual, and all the technical staff who were involved in its development.

It is my expectation that the manual will play its intended purpose of enabling the aspirations contained in the Kenya Vision 2030, Medium Term Plan and the Millennium Development Goals.

ENG. M.S.M. KAMAU, CBS, HSC

PERMANENT SECRETARY

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CHAPTER 1 INTRODUCTION

This manual has been produced as a standard reference to assist the road agencies in Kenya in the maintenance of the road network in an efficient and consistent standard.

Road infrastructure is one of the fundamental factors in increasing the socio-economic performance of a nation. From this viewpoint, it cannot be stressed enough that road maintenance activities after the completion of construction are an essential factor in maintaining the road facility and providing good conditions for road users.

If the related road maintenance staff, engineers, inspectors and technicians, etc., execute road maintenance based on different policies and methods, then it is unlikely that a consistent high quality of roads can be sustained. Therefore, road maintenance activities should be executed on the basis of the same policies and methods in order to achieve economical road maintenance and high quality roads.

This road maintenance manual is comprised of the following three parts:

Part I : Inspection
Part II : Evaluation
Part III : Execution

This manual has taken account of the basic conditions in Kenya. Engineers and inspectors in each region should consider the details of the road maintenance system based on this manual and the characteristic conditions in their region. Engineers and inspectors should also refer to existing handbooks and manuals such as:

(a) International Road Maintenance Handbook, Volume I, II, III, IV, PIARC, 1994
(b) Road Maintenance Handbook, Volume I, II, III, IV, UN, 1982
(c) Road Maintenance Manual, RD of MORPW, 1992

This manual was considered by a Working Group that consisted of members of the JICA Study Team together with engineers from the Ministry of Roads (MOR), the Ministry of Local Government (MOLG), Kenya Wildlife Service (KWS), and Nairobi City Council. The manual which was first published in 2001 in three volumes has been reprinted as one volume.

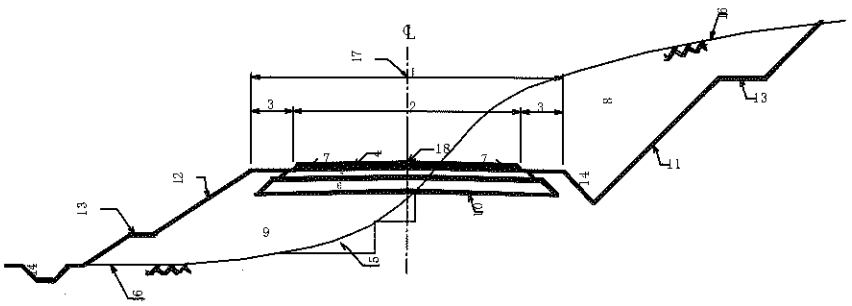
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CHAPTER 2 GLOSSARY OF TERMS

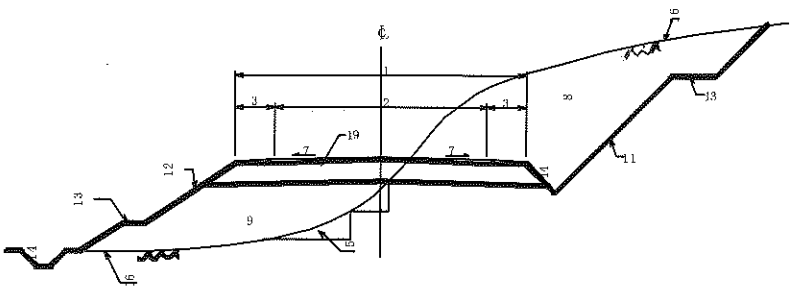
This chapter contains a glossary of terms that are used in this manual.

2.1 Cross Section

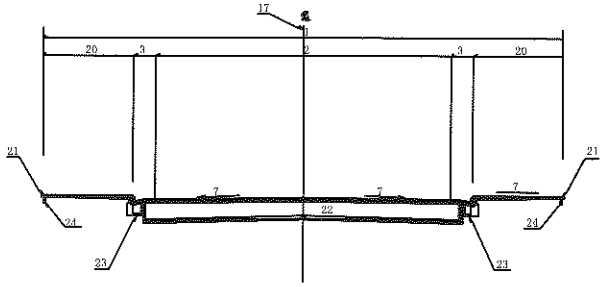
The typical cross sections of paved, unpaved and urban roads are as follows;



Paved Road



Unpaved Road



Urban Road (Town Road)

1. Roadway
2. Carriageway
3. Shoulder
4. Surfacing
5. Base
6. Subbase
7. Camber (Cross Fall)
8. Cut
9. Embankment
10. Formation Level (Top of Subgrade)
11. Back Slope
12. Side Slope
13. Berm
14. Side Ditch
15. Benching
16. Natural Ground Level
17. Centre-line
18. Marking
19. Gravel
20. Footpath
21. Road Reserve
22. Pavement
23. Side Drain
24. Kerb Stone

2.2 Glossary of Terms

The main "Glossary of Terms" is as follows:

Glossary of Terms

Abutment
Structure support to bridge deck and retains the road embankment

Adhesion
Sticking quality, for example, holding aggregate to the binder in chip sealing

Aggregate
Crushed local rock or stone

Apron
Floor of concrete, masonry or stone at the inlet or outlet of a culvert or waterway to prevent scour.

Asphalt Concrete
Road construction material usually comprising a mixture of bitumen and aggregate, also known as hot-mix or hot-rolled asphalt.

Base Course
The main structural element of the pavement, between surface course and subbase.

Benching
A stepped platform cut in an embankment to prevent earth slipping. Can also be used as stepping to provide a level base for additional fill material.

Berm
A low ridge or bund of soil to collect or redirect surface water.

Binder
An adhesive material, usually bitumen or bitumen emulsion, used to seal the road surface, also providing a waterproof layer to receive and hold aggregate. The most common binders are bitumen based. A binder is also used to hold aggregate together in bituminous mixtures.

Binder Course
The layer forming part of the bituminous surfacing immediately below the wearing course.

Bitumen
Bitumen (called asphalt cement in the US) is a black to dark brown sticky material composed principally of high-molecular-weight hydrocarbons. Most bitumen is derived from the distillation of crude oil. Bitumen is a thermoplastic material that gradually liquefies when heated.

Borrow Pit
An excavation outside the road limits from which suitable material is obtained, usually for earthwork or regravelling operations.

Box Culvert
A culvert of rectangular cross-section, usually constructed in reinforced concrete.

Bridge
A structure with a span of 6 metres or more, providing a means of transit above land and/or water or above an obstruction, whether natural or artificial.

Camber (Cross Fall)
The transverse slope applied to the carriageway on a section of straight alignment.

Causeway
Low-level structure constructed across streams or rivers with openings to permit water to pass below road level.

Carriageway
The part of the road used by vehicular traffic.

Catchment Area
The area from which water runs off by gravity to a collecting point.

Catchpit
A covered, accessible chamber with a sump for collection of silt forming part of the drainage system and permitting inspection and maintenance of underground drainage pipes.

Centre-line
The middle of the carriageway, normally marked with a yellow dashed line on a paved road.

Compaction
Compacting embankment and pavement materials by roller to increase their density. It improves the mechanical properties of materials.

Cross-fall
The transverse gradient or fall across a formation or pavement.

Cross-section
Section through the road construction at right angles to the centre-line.

Crown
The highest part of a cambered surface, usually on or near the centreline.

Culvert
A duct, usually rectangular or circular, for carrying surface water under the road.

Cut (Cutting)
Excavation in natural ground usually with graded slopes.

Cut-off Drain
A drain cut to intercept surface water flowing from adjacent land and to prevent it reaching a pavement or other prepared surface.

Back Slope
A soil plane constructed at an angle to the horizontal.

Cycleway
The track which is mainly used for bicycle traffic. The track is separated with other parts of road by kerb stone or its similar structures.

Ditch (Drain)
A long narrow excavation designed or intended to collect and drain off surface water.

Drainage
The interception and removal of ground and surface water by artificial or natural means.

Drainage Channel
A waterway or gutters that take away surface water.

Drift or Ford
A stream or river crossing over which the stream or river water can flow.

Earthworks
General term of construction works involving soil and rocks(e.g. excavation, loading, hauling, spreading and compaction).

Side Slope
An artificially constructed soil plane at an angle to the horizontal.

Fill (Embankment)
Earthworks constructed to formation level, raising the road above the surrounding natural ground.

Footbridge
A pedestrian bridge; crossing the carriageway/railway/waterway as an overpass to ensure the safety of pedestrian and smooth flow of vehicle traffic.

Footpath
The track which is mainly used for pedestrian. The track is separated with other parts of road by kerb stone or its similar structures.

Gabion
The steel mesh cage filled with cobble stone or crushed stone. This is mainly used for revetment and foot protection.

Gravel
A non-cohesive, coarse granular material, resulting from natural disintegration of rock with or without finer material. In general the particles are irregular or flaky. It is used as material of surface course and to correct loss of shape, ruts, potholes and erosion gullies.

Guardrail
A safety barrier on embankment or river crossing structure

Gutter
A shallow waterway provided at the edge of the road to carry surface water longitudinally.

Headwalls
The walls located on the top of outlet/inlet of culvert. The walls of inlet direct the flow into the culvert, while the walls of outlet provide a transition from the culvert to the outlet channel. Headwalls also protect the embankment from erosion by flood waters.

Inlet
The point at which surface water enters a pipe culvert or box culvert.

Invert
The lowest point of the internal cross section of a ditch or culvert.

Lane
The width of carriageway required to accommodate one line of traffic.

Manhole
Accessible chamber with a cover forming part of the drainage system used for inspection and maintenance of underground drainage pipes/channels.

Mitre Drain
Short, open, skew ditches used to remove water from the roadside ditches or gutters. Use of this reduces the required size of the side ditches.

Original Ground Level
Line of natural ground.

Outfall
The point at which water discharges from a pipe or box culvert.

Paved Road
For the purpose of this manual a paved road is a road with a concrete surface, concrete block, bituminous surface or surface dressing.

Pavement
The road structure above the formation, designed to spread the loading to the subgrade.

Pipe Culvert
A pipe of circular cross-section usually made of concrete or steel.

Premix
Premix is a paving material manufactured by mixing aggregates, filler and bitumen. Most premix is mixed and placed hot. Premix is used in the construction of wearing course, binder courses and base courses.

Prime Coat
A coating of low viscosity binder applied to a surface of stabilised or naturally compacted soil or aggregates before sealing or paving.

Road Reserve (Right-of-way)
The area and land corridor reserved for a road and public utilities over which members of the public have the right of way.

Road Furniture
Road or street furniture e.g. traffic sign, traffic board, traffic signal, lane marking, guardrail, street light, etc.

Roadway
The portion of a road including shoulders for vehicular use.

Scour Checks
The structures to prevent scouring of drains. Simple scour checks may be constructed of wood pegs or stones. All scour checks should have an apron downstream built of stones or grass turves pinned to the ditch invert with wooden pegs.

Shoulder
Paved or unpaved part of the road next to the outer edge of the carriageway provided to allow vehicles to stop for emergency use and improve on road safety.

Side Drain
Drain beyond the shoulders, parallel to the centerline, to take the run-off from the road surface.

Slope
A natural or artificially constructed soil plane at an angle to the horizontal.

Sub-base
The layer of material between the base course and the subgrade

Subgrade
Road pavement foundation consisting of insitu or improved material.

Superelevation
The raising of the outside level of the road on curves to reduce the effect of centrifugal forces and improve road-holding qualities.

Surfacing
Top layer of the pavement. Consists of wearing course, and sometimes a base course or binder course.

Surface Dressing
A sprayed or hand applied film of bitumen covered with a layer of single sized stone chippings, which is then rolled.

Tack Coat
Asphalt material to bond lower layer (asphalt material or cement) and upper layer (asphalt mixture). It is sprayed on surface of lower layer.

Traffic Lane
The portion of the carriageway defined by road marking for the movement of a single line of vehicles.

Transverse Joint
Joint at right angles to the road centreline.

Transverse Joint Taper
Slope or ramp of asphalt mix at the end of a freshly laid asphalt course.

Unpaved Road
For the purpose of this manual an unpaved road is a road with a gravel or earth surface

Wearing Course
The part of the road surface in contact with traffic wheels.

Wing-wall
Retaining wall adjacent to a bridge abutment or culvert headwall constructed to retain and protect the embankment.

CHAPTER 3 CONTENTS OF MANUAL

This road maintenance manual has three parts. The contents are as follows:

(1) Part I; Inspection

The Inspection Part describes the inspection methods and includes the following:

- Inspection sheets
- Defect descriptions
- Frequency of inspection
- Safety methods during inspections

(2) Part II; Evaluation

This part describes the methods for evaluating defects and the selection methods for repair works.

Part II includes the following:

- Evaluation standards
- Selection methods for execution of maintenance works

(3) Part III; Execution

This part describes the methods for repair works, cleaning and clearing based on the evaluation results.

Part III includes the followings:

- Contents of each execution method
- Safety method during execution of the works

The manual classifies three types of road maintenance as follows:

(a) Routine Maintenance
Operations required to be carried out once or more per year on a section of road. These operations are typically small scale or simple, but widely dispersed, and require skilled or un-skilled manpower. The need for some of these can be estimated and planned on a regular basis e.g. vegetation control.

(b) Periodic Maintenance
Operations that is occasionally required on a section of road after a period of a number of years. They are normally large scale and require specialist equipment and skilled resources to implement, and usually require the temporary deployment of those resources on the road section. These operations are costly and require specific identification and planning for implementation, and often require design.

(c) Emergency (Urgent) Maintenance
Certain unforeseen situations necessitating remedial action to be taken as soon as possible e.g. flood damage, slips, etc.

CHAPTER 4 INSPECTION ITEMS

4.1 Inspection Items

This manual covers the road defects as shown in Table 4.1.

Table 4.1 Road Defects

Item	Sub-Item	Defects
Paved Roads (Bitumen)	Surface	Cracking (4.2), Potholes (4.3), Rutting/deformation (4.4), Heaving/shoving (4.5), Stripping/fretting (4.6), Bleeding (4.7), Glazing (4.8), Edge damage (4.9), Waving(4.10), Obstructions (4.11)
	Base Course	Spot failure
	Sub-base	Spot failure
	Subgrade	Spot failure
Concrete Roads		Loss of surface texture (4.12), Cracking (4.13), Joint settlement (4.14)
Unpaved Roads	Carriageway	Loss of camber (4.15), Rutting (4.16), Potholes (4.17), Corrugations (4.18), Erosion gullies (4.19), Soft spots (4.20), Obstructions (4.21), Loss of gravel depth (4.22)
Shoulder		Obstruction (4.23), High vegetation (4.24), Scour (4.25), Shoulder/carriageway step (4.26), Rutting (4.27), Depressions (4.28), Potholes (4.29)
Slopes	Back/Side/Cut/ Embankment Slope	High vegetation (4.30), Erosion (4.31), Earth slip/landslide (4.32), Rock avalanche (4.33), Collapse of slope protection (4.34)
Embankment		Collapse (4.35), Settlement
Drainage	Culverts	Silting (4.36), Blockage by debris (4.37), Settlement cracks (4.38), Erosion of stream bed at culvert outlet (4.39), Headwall/apron/wing-wall damage (4.40), Collapse of culvert (4.41)

Item	Sub-Item	Defects
	Ditches and Drains	Obstruction (4.42), Silting (4.43), Ponding in ditch or on shoulder (4.44) Invert and sides of ditch are eroded. (4.45) Ditch lining is damaged. (4.46) Erosion at drainage outfall (4.47)
	Manholes and Drainage Pipes	Water is flowing up at manhole. (4.48) Manhole cover or grating is missing. (4.49) Manhole is covered with soil and vegetation. (4.50) Catchpit sump is silted up. (4.51)
Structure	Drifts and Causeways	Settlement (4.52), Erosion, Debris (4.53) Guideposts are damaged or missing. (4.54)
	Retaining Walls/ Stone Masonry	Settlement (4.55), Cracking (4.56), Collapse (4.57)
Road Furniture		Dirty (4.58), Damaged (4.59), Missing (4.60)
Footpath		Potholes/depression (4.61), Obstructions (4.62)

Note: (4.1) indicates Table No.

4.2 Definitions of Each Defect

The Definition of Defects sheets have been developed to provide a uniform definition and understanding of the defects across Kenya. Each defect has a single sheet which has a number of elements:

(a) Item and Sub-Item
The item and sub-item are taken from the List of Defects included in this manual.

(b) Defect
Each defect on the List of Defects has a separate sheet.

(c) Description
The description is designed to give as much information as is necessary to identify the defect on site and to distinguish it from other defects.

(d) Possible Causes
The possible causes are listed to help staff to identify the most likely cause or causes of this defect. This is important because different causes may require different actions for repair. This is particularly so in the case of water in the pavement which may require drainage works or maintenance to be carried out in addition to the pavement repairs.

(e) Effect (if neglected)
This gives a summary of what might happen if this defect is not repaired. This helps staff to appreciate the potential deterioration of the pavement.

(f) Inspection Reporting Method
This states the information to be measured and/or recorded on the inspection sheet. This will vary for different defects and in some cases involves measurement and in others the assessment of a defect ranking from A to B.

(g) Photograph
A photograph of each defect is provided to make it absolutely clear as to the nature of each defect.

The main definitions of each defect are shown in Tables 4.2 to 4.62.

Definition of common defects are provided in Tables 4.2 - 4.62

DEFINITION OF COMMON DEFECTS

Table 4.2

FEATURE ITEM	Paved Roads (Bitumen)
SUB-ITEM	Surface
DEFECT	Cracking

Description:

Alligator
Alligator cracking is a series of interconnecting cracks creating interconnected patterns. The cracks initiate at the bottom of the asphalt surface and propagate to the surface, initially as one or more longitudinal parallel cracks. After repeated traffic loading, the cracks interconnect, forming many-sided, sharp angled pieces that resemble chicken wire or the skin of an alligator. Alligator cracking occurs only in areas subjected to repeated traffic loading, such as the wheel paths.

Transverse
Transverse cracks run perpendicular to the direction of traffic flow. Transverse cracks can start at the curb or shoulder, be contained in only one lane, or extend completely across the roadway. These cracks can also start in the middle of a lane or at the centreline.

Longitudinal
Longitudinal cracks occur parallel to the direction of traffic flow, Longitudinal cracks can occur along the centreline, in mid-lane, in the wheel tracks and along the edge. Cracks can be relatively short in length or run the entire pavement section length.

Table 4.2

FEATURE ITEM	Paved Roads (Bitumen)
SUB-ITEM	Surface
DEFECT	Cracking

Possible Causes:

Alligator
- Inadequate pavement thickness.
- Low modulus base.
- Brittle base or wearing course (e.g. cemented, aged).
- Fatigue failure of the asphalt pavement under repeated traffic loading.

Transverse
- Reflection of shrinkage crack or joint in an underlying base (common with portland cement concrete or cemented materials).
- Construction joint or shrinkage crack (due to low temperature or bitumen hardening) in asphalt surfacing.
- Structural failure of portland cement concrete base.

Longitudinal
- Reflection of shrinkage crack or joint in an underlying base (common with portland cement concrete, cemented base of asphalt surfacing).
- Poorly constructed paving lane joint in asphalt surfacing.
- Daily temperature cycles or asphalt hardening.
- Displacement of joint at pavement widening.
- Volume change of expansive clay sub-grade.
- Cyclical weakening of pavement edge.
- Differential settlement between cut and fill.

Effect (if neglected):

- Allows water to enter the pavement causing softening and weakening of the pavement and lower layers. This may cause early failure of the pavement.
- If severe, causes uneven ride for the motorist and may reduce traffic speed.

Inspection Reporting Method:

- Scaling % of sub-section length.

Inspection Tools:

- Tape

Table 4.2

FEATURE ITEM	Paved Roads (Bitumen)
SUB-ITEM	Surface
DEFECT	Cracking

Alligator



Transverse



Table 4.2

FEATURE ITEM	Paved Roads (Bitumen)
SUB-ITEM	Surface
DEFECT	Cracking

Longitudinal



Table 4.3

FEATURE ITEM	Paved Roads (Bitumen)
SUB-ITEM	Surface
DEFECT	Potholes

Description:

Potholes are small bowl-shaped depressions on the pavement surface/base course, usually less than one metre in diameter. They generally have sharp edges and vertical sides near the top of the hole. Their growth is accelerated by free water collecting inside the hole. Potholes are reproduced when traffic abrades small pieces of pavement surface. The pavement then continues to disintegrate because of poor surface quality, weak spots in the base or subgrade, or because it has reached a condition of high-severity alligator cracking. Most potholes are structurally related distresses ad should not be confused with ravelling and weathering. When holes are created by high-severity alligator cracking, they should be identified as potholes.

Possible Causes:

- Asphalt content too low.
- Excessive heating of asphalt.
- Poor quality mixture.
- Lack of compaction allowing ingress of water.
- Excessive axle loads.
- Mechanical damage to the road due to poor reinstatement of roads after services installations.
- Injury to pavement.
- Spills or leakages.

Effect (if neglected):

- Allows water to enter the pavement causing softening and weakening of the pavement and lower layers. This may cause early failure of the pavement.
- If left unrepaired, can rapidly expand the extent of the damage.
- Creates poor ride quality for the motorist and may reduce traffic speed.
- If large can cause damage to vehicle wheels and tyres.
- Can create an accident risk.

Inspection Reporting Method:

- Scaling length, width, depth and number of potholes.

Inspection Tools:

- Tape

Table 4.3

FEATURE ITEM	Paved Roads (Bitumen)
SUB-ITEM	Surface
DEFECT	Potholes

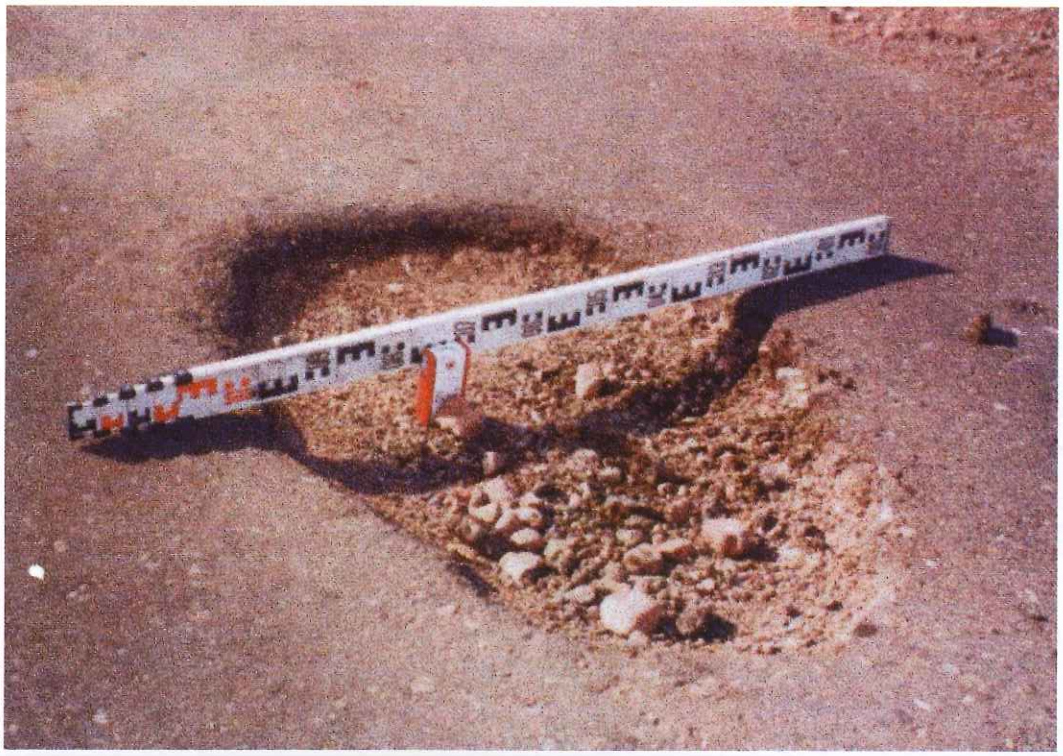




Table 4.4

FEATURE ITEM	**Paved Roads (Bitumen)**
SUB-ITEM	**Surface**
DEFECT	**Rutting/Deformation**

Description:

Rutting is characterised by longitudinal depressions in the pavement surface that occur in the wheel paths of a roadway

Possible Causes:

- Inadequate pavement thickness.
- Inadequate compaction in surfacing or base.
- Inadequate strength (stability) in surfacing or base.
- Excessive bitumen in the mix.
- Excessive axle loads.

Effect (if neglected):

- If water is able to penetrate into the body of the pavement, then there will be a rapid increase in the degree of rutting often leading to cracking and break-up of the pavement.
- If excessive can reduction in serviceability and reduce vehicle travel speeds and in very severe cases, may be an accident risk.

Inspection Reporting Method:

- Scaling average depth.

Inspection Tools:

- Tape
- Straight edge

Table 4.4

FEATURE ITEM	Paved Roads (Bitumen)
SUB-ITEM	Surface
DEFECT	Rutting/Deformation

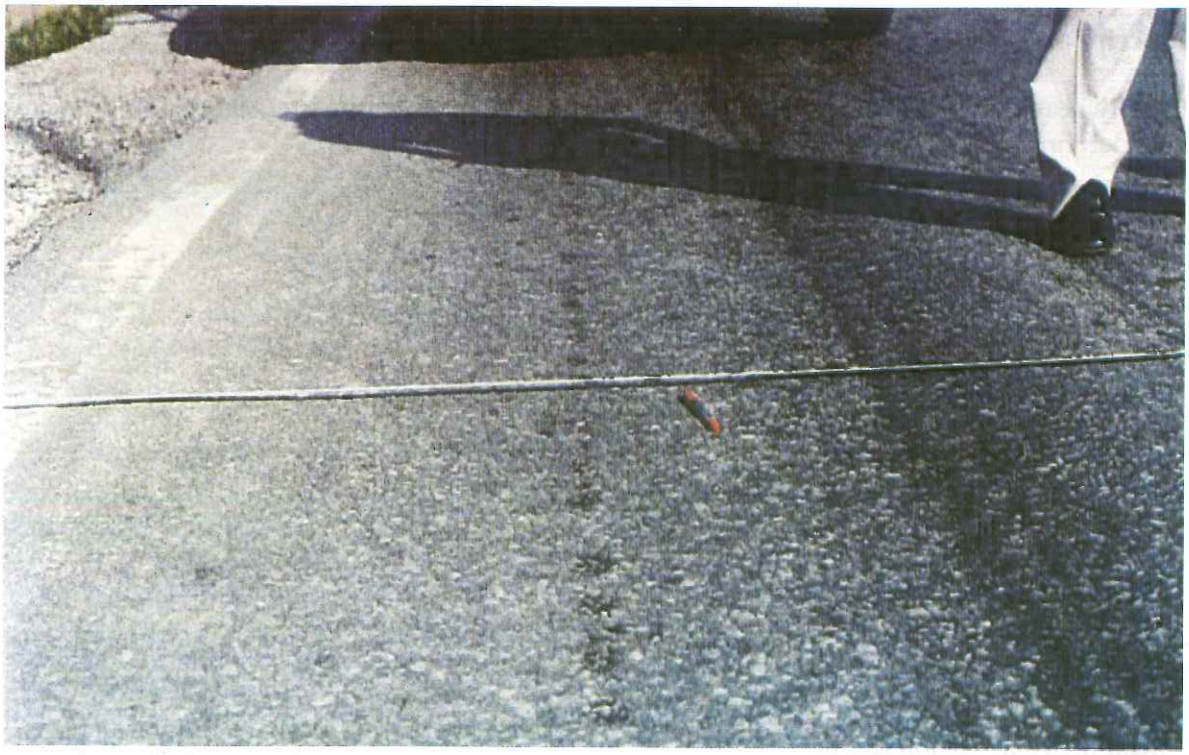




Table 4.5

FEATURE ITEM	Paved Roads (Bitumen)
SUB-ITEM	Surface
DEFECT	Heaving/Shoving

Description:

Usually heaving/shoving occurs on either side of the wheel tracks. The irregularities are associated with deformation and subsidence.

Possible Causes:

- Ingress of water: reduced bearing capacity of the pavement.
- Materials: of poor quality.
- Workmanship: insufficient compaction.
- Traffic: passage of vehicles which are too heavy for the pavement structure.

Effect (if neglected):

- Forcing up of weak materials as deformation occurs.
- Progressive disintegration of the pavement.

Inspection Reporting Method:

- Scaling of sub-section length.

Inspection Tools:

- Tape

Table 4.5

FEATURE ITEM	Paved Roads (Bitumen)
SUB-ITEM	Surface
DEFECT	Heaving/Shoving



Table 4.6

FEATURE ITEM	Paved Roads (Bitumen)
SUB-ITEM	Surface
DEFECT	Stripping/Fretting

Description:

Stripping/Fretting is the wearing away of the pavement surface caused by the dislodging of aggregate particles and loss of asphalt binder. This generally indicates that the asphalt binder has hardened significantly. Removal of the coarse aggregate of a sprayed seal leaving the binder exposed to tyre contact – can happen as the loss of individual stones, or as the complete loss of stone in a localised area.

Possible Causes:

- Low binder contents
- Poor binder to stone adhesion (dirty or hydropholic aggregates, without effective precoating with adhesion agent or wet stone etc.)
- Ageing or absorption of binder.
- Stone deterioration.
- Incorrect blending of binder.
- Inadequate rolling before opening the seal to traffic.
- Poor workmanship.

Effect (if neglected):

- Progressive break-away of chippings resulting in the surfacing becoming more slippery, more permeable, or worn out by traffic.

Inspection Reporting Method:

- Scaling of sub-section length.

Inspection Tools:

- Tape

Table 4.6

FEATURE ITEM	Paved Roads (Bitumen)
SUB-ITEM	Surface
DEFECT	Stripping/Fretting





Table 4.7

FEATURE ITEM	Paved Roads (Bitumen)
SUB-ITEM	Surface
DEFECT	Bleeding

Description:

Bleeding is a film of bituminous material on the pavement surface which creates a shiny, glass-excessive amount of asphalt cement in the mix and/or low air void content. It occurs when asphalt fills the void of the mix during hot weather and then expands into the pavement surface.

Possible Causes:

- Excessive application rate of binder, with respect to stone size.
- Excessive prime coat being incorporated into the seal.
- Excessive binder in underlying surface (patch or flushed area).
- Primer seal covered before volatiles in primer binder have evaporated.

Effect (if neglected):

- The road surface becomes slippery when wet and hazardous to traffic.
- Separation and break-away of surface layer under the action of traffic.

Inspection Reporting Method:

- Defect ranking.

Inspection Tools:

- Nil.



Table 4.8

FEATURE ITEM	Paved Roads (Bitumen)
SUB-ITEM	Surface
DEFECT	Glazing

Description:

Wear or embedment of chippings in the surfacing giving a smooth, shiny appearance.

Possible Causes:

- Wear/Polishing of the surface chippings.
- Embedment of the chippings into the base.

Effect (if neglected):

- Continued wear of the chippings resulting in the pavement surface becoming more and more slippery, particularly when wet. This creates a hazard to traffic and potential for accidents.

Inspection Reporting Method:

- Defect ranking.

Inspection Tools:

- Nil.

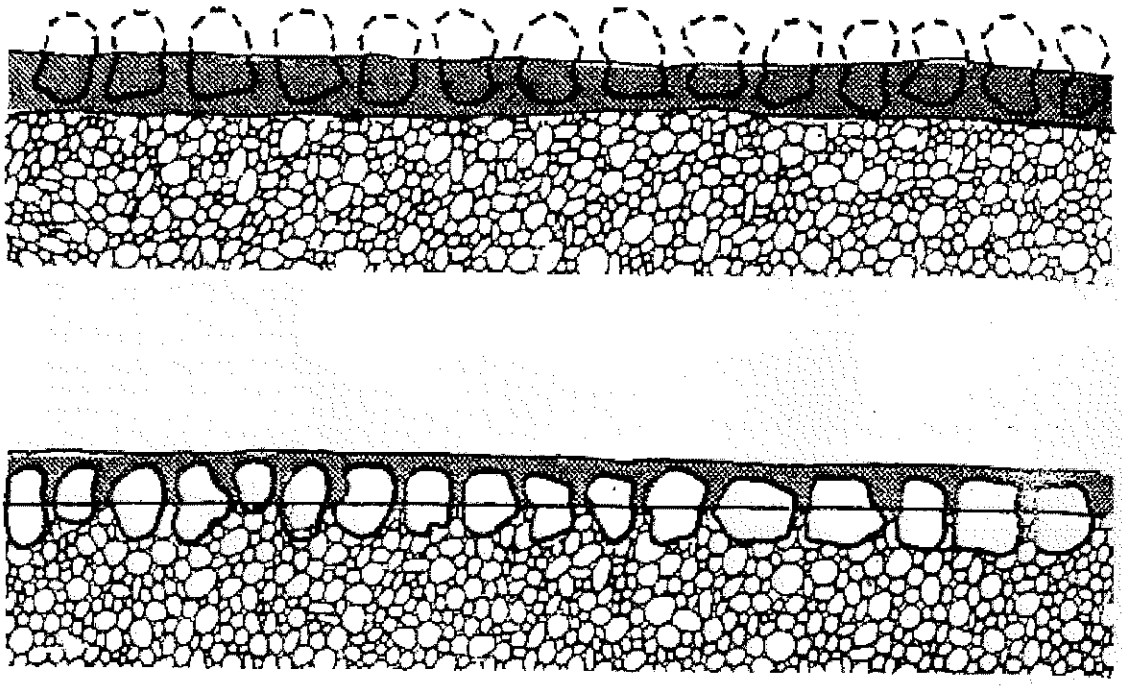


Table 4.9

FEATURE ITEM	Paved Roads (Bitumen)
SUB-ITEM	Surface
DEFECT	Edge Damage

Description:

Edge damage is a difference in elevation between the pavement edge and the shoulder and occurs along the edge of the pavement.

Possible Causes:

- Wear of the shoulder (formation of step).
- Action of water.
- Insufficient compaction of the edges of bituminous pavements.
- Road is too narrow.
- Excessive axle loads.

Effect (if neglected):

- Rapid deterioration during the rainy season.
- Traffic action will worsen the defect.

Inspection Reporting Method:

- Scaling % of sub-section length and average depth.

Inspection Tools:

- Tape



Table 4.10

FEATURE ITEM	Paved Roads (Bitumen)
SUB-ITEM	Surface
DEFECT	Waving

Description:

Undulations in the road surface of a longer wavelength than corrugations.

Possible Causes:

- Poor quality materials.
- Variations in compaction and bearing capacity of lower layers.
- Poor quality or lack of prime coat or tack coat.
- Material not suited to temperature range.

Effect (if neglected):

- In hot weather, surface stripping can occur.
- Poor ride quality for motorist.

Inspection Reporting Method:

- Defect ranking.

Inspection Tools:

- Nil.



Table 4.11

FEATURE ITEM	Paved Roads (Bitumen)
SUB-ITEM	Surface
DEFECT	Obstructions

Description:

Rocks, trees or tree branches, soil heaps, wind blown sand, debris and abandoned vehicles on the road surface.

Possible Causes:

- Material fallen from slopes or trees.
- Material blown or washed onto the road surface.
- Debris left by road users.
- Debris from road accidents.
- Animal carcasses.

Effect (if neglected):

- Hazard to road users.

Inspection Reporting Method:

- Defect ranking.

Inspection Tools:

- Nil.

Table 4.11

FEATURE ITEM	Paved Roads (Bitumen)
SUB-ITEM	Surface
DEFECT	Obstructions



Table 4.12

FEATURE ITEM	Concrete Roads
SUB-ITEM	Surfacing
DEFECT	Loss of Surface Texture

Description:

Surface texture is worn down and stripped away by traffic.

Possible Causes:

- Using soft aggregate.
- Inadequate construction work (e.g., compacting was not enough, wrong concrete mix, wrong grooving depth or type of grooving).

Effect (if neglected):

- Loss of friction grip for vehicle tyres creating a safety risk.
- Water is unable to disperse from the carriageway along the grooves creating standing water on the carriageway and a serious accident hazard.

Inspection Reporting Method:

- Scaling % of sub-section length.

Inspection Tools:

- Tape

Table 4.12

FEATURE ITEM	Concrete Roads
SUB-ITEM	Surfacing
DEFECT	Loss of Surface Texture





Table 4.13

FEATURE ITEM	Concrete Roads
SUB-ITEM	
DEFECT	Cracking

Description:

Longitudinal or transverse cracks in the pavement surface.

Possible Causes:

- Excessive dry condition during the construction work.
- Bearing capacity of subgrade/sub-base is not enough.
- Inadequate structure/function of joint.
- Thickness of concrete slab is not enough.
- Poor quality of concrete.
- Differential settlement of ground.
- Excessive axle loads.
- Underground utility services (e.g., water pipe leakage, electrical cable etc.)

Effect (if neglected):

- Increased extent or severity of cracking causing potential premature pavement failure.
- Water penetration causing softening of lower layers and potential pavement failure.

Inspection Reporting Method:

- Scaling % of sub-section length.

Inspection Tools:

- Tape

Table 4.13

FEATURE ITEM	Concrete Roads
SUB-ITEM	
DEFECT	Cracking





Table 4.14

FEATURE ITEM	Concrete Roads
SUB-ITEM	
DEFECT	Joint Settlement

Description:

The vertical movement of the concrete on one side of a joint relative to that on the other side of the joint.

Possible Causes:

- Insufficient compaction of subgrade/base course.
- Differential settlement of ground.
- Due to pumping action.
- Inadequate function of dowel bar and/or tie-bar.
- Water penetration of the joint causing softening of the supporting layers.

Effect (if neglected):

- Increased severity of settlement causing a hazard to traffic.
- Increased water penetration causing softening and erosion of the supporting layers.
- Cracking of concrete adjacent to the joint.

Inspection Reporting Method:

- Defect ranking.

Inspection Tools:

- Nil.

Table 4.14

FEATURE ITEM	Concrete Roads
SUB-ITEM	
DEFECT	Joint Settlement

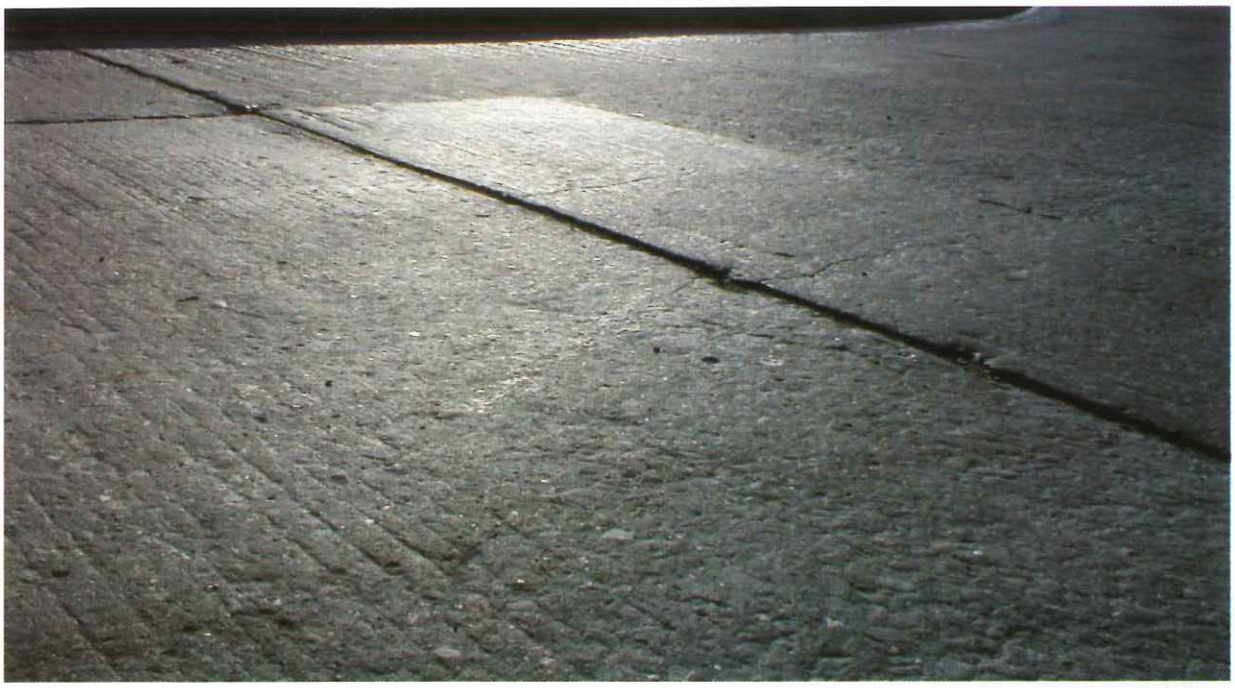




Table 4.15

FEATURE ITEM	Unpaved Roads
SUB-ITEM	Carriageway
DEFECT	Loss of Camber

Description:

Camber of the road is flat and non-existent, or has a reverse camber with road edges higher than the centre portion of the road surface, thereby trapping or preventing surface water from draining away.

Possible Causes:

- Poor construction or maintenance practice.

Effect (if neglected):

- Flooding and water penetration causing softening of pavement and making the road impassable.

Inspection Reporting Method:

- Defect ranking.

Inspection Tools:

- Nil.



Table 4.16

FEATURE ITEM	Unpaved Roads
SUB-ITEM	Carriageway
DEFECT	Rutting

Description:

Rutting is characterised by a longitudinal depression in the road surface that occur in the wheelpaths of a roadway.

Possible Causes:

- Inadequate wet strength of subgrade.
- Wear by attrition due to traffic or erosion of surface material.
- Excessive loose material.
- Traffic compaction of subgrade.
- Excessive axle loads.

Effect (if neglected):

- Causes poor ride quality.
- Water can collect in rut and cause aquaplaning problem for vehicles.

Inspection Reporting Method:

- Defect ranking.

Inspection Tools:

- Nil.



Table 4.17

FEATURE ITEM	Unpaved Roads
SUB-ITEM	Carriageway
DEFECT	Potholes

Description:

Bowl-shaped depressions in the road surface which can be oval, or irregular in shape.

Possible Causes:

- Ponding of water.
- Excessive weakening of layer by moisture and/or traffic action.
- Inadequate initial compaction.
- Variable quality of materials.
- Insufficient structural thickness.
- Excessive axle loads.

Effect (if neglected):

- If left unrepaired, can rapidly expand the extent of the damage.
- Creates poor ride quality for the motorist and may reduce traffic speed.
- If large can cause damage to vehicle wheels and tyres.
- Can create an accident risk.

Inspection Reporting Method:

- Scaling length, width, depth and number of potholes.

Inspection Tools:

- Tape



Table 4.18

FEATURE ITEM	Unpaved Roads
SUB-ITEM	Carriageway
DEFECT	Corrugations

Description:

A series of closely-spaced crest and valleys in the form of corrugation. The corrugation resembles an old fashioned "washboard" surface. Corrugations always occur with the ripples perpendicular to the direction of travel and more pronounced at the wheelpaths, although it can and sometimes does cover the whole pavement surface area.

Possible Causes:

- Insufficient pavement structural thickness (pavement strength)
- Inadequate quality of base material for prevailing climatic and traffic conditions. Most common in dry conditions.
- The weeds.

Effect (if neglected):

- Vehicle jumps as it travels over the corrugations.
- Vehicle slips sideways and driver must maintain firm steering control.
- Generally reduces vehicle travel speed.

Inspection Reporting Method:

- Defect ranking.

Inspection Tools:

- Nil.



Table 4.19

FEATURE ITEM	Unpaved Roads
SUB-ITEM	Carriageway
DEFECT	Erosion Gullies

Description:

Erosion gullies are longitudinal depressions in the road surface that normally occur in the wheel paths and the sides of the roadway.

Possible Causes:

- Rain water running along the wheel paths.
- Poor transversal drainage or high road gradient.
- Sewage/Pipe water leaks at urban areas.

Effect (if neglected):

- Ponding of water in the gullies softening the pavement and making the road impassable.
- Reduced vehicle travel speed.

Inspection Reporting Method:

- Scaling % of sub-section length and average depth.

Inspection Tools:

- Tape

Table 4.19

FEATURE ITEM	Unpaved Roads
SUB-ITEM	Carriageway
DEFECT	Erosion Gullies





Table 4.20

FEATURE ITEM	Unpaved Roads
SUB-ITEM	Carriageway
DEFECT	Soft Spots

Description:

Localized softening of the running surface. Subgrade soils may be punched up through a gravel surface, usually with the broken surface are surrounded by depression or dishing type of distortion. Distress most likely to occur in the wheel tracks.

Possible Causes:

- Caused by the sheer failure of the base of subgrade soil.
- Traffic action combined with excessive moisture from improperly drained surface.
- Poor quality materials.
- Lack of compaction.

Effect (if neglected):

- Road becomes impassable to traffic.
- Soft spot extends to require major reconstruction.

Inspection Reporting Method:

- Defect ranking.

Inspection Tools:

- Nil.

Table 4.20

FEATURE ITEM	Unpaved Roads
SUB-ITEM	Carriageway
DEFECT	Soft Spots





Table 4.21

FEATURE ITEM	Unpaved Roads
SUB-ITEM	Carriageway
DEFECT	Obstructions

Description:

Rocks, trees or tree branches, soil heaps, wind blown sand, debris and abandoned vehicles are on the road surface.

Possible Causes:

- Material fallen from slopes or trees.
- Material blown or washed onto the road surface.
- Debris left by road users.
- Debris from road accidents.

Effect (if neglected):

- Hazard to road users.

Inspection Reporting Method:

- Defect ranking.

Inspection Tools:

- Nil.



Table 4.22

FEATURE ITEM	Unpaved Roads
SUB-ITEM	Carriageway
DEFECT	Loss of Gravel Depth

Description:

Gravel in windrows along the centre of the road alongside the wheel tracks, or along the shoulder, all parallel to the direction of traffic. Traffic action also segregates coarse aggregates from the fine particles and then moves loosened aggregates away from the wheel tracks to form windrows parallel to the direction of traffic over the less travelled roadway.

Possible Causes:

- Loose compaction at construction or regravelling.
- Segregation of coarse aggregate from the fine particles by traffic action.

Effect (if neglected):

- Road is closed to traffic.
- Softening of surface making it impassable to traffic.

Inspection Reporting Method:

- Scaling % of sub-section length.

Inspection Tools:

- Tape



Table 4.23

FEATURE ITEM	Shoulder
SUB-ITEM	
DEFECT	Obstructions

Description:

Rocks, trees or tree branches, soil heaps, wind blown sand, and abandoned vehicles/debris are on the shoulder.

Possible Causes:

- Material fallen from slopes or trees.
- Material blown or washed onto the shoulders.
- Debris left by road users.
- Debris from road accidents.

Effect (if neglected):

- Hazard to road users.
- Obstruction of water flow from carriageway.

Inspection Reporting Method:

- Defect ranking.

Inspection Tools:

- Nil.

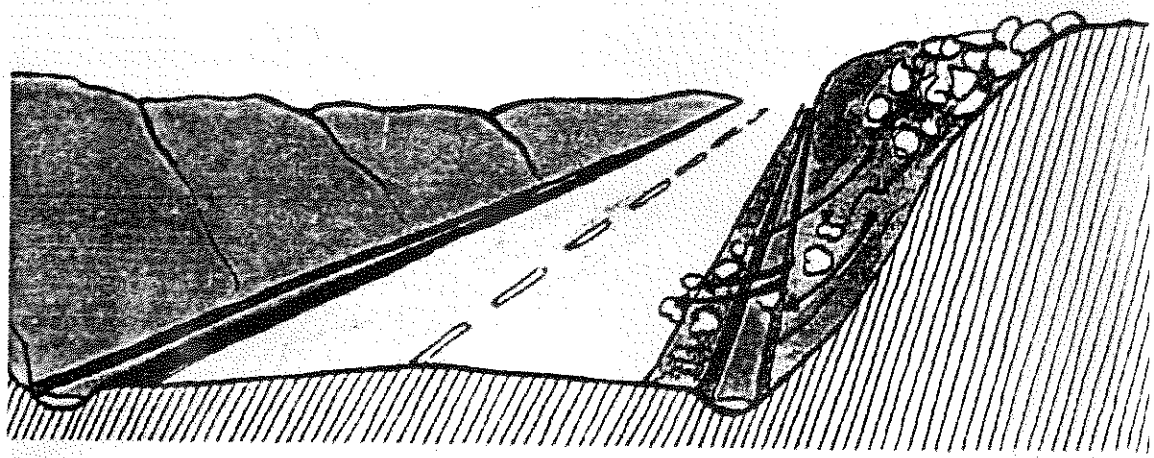


Table 4.24

FEATURE ITEM	Shoulder
SUB-ITEM	
DEFECT	High Vegetation

Description:

Vegetation growth overruns shoulder and reaches or approaches roadway edge.

Possible Causes:

- Grass, weeds, brushes or trees have been allowed to grow unchecked.

Effect (if neglected):

- Surface water can pond at the edge of the carriageway and weaken the pavement.
- Silt accumulates at the edge of the carriageway.
- The visibility for road users is reduced, with increased risk of accidents.
- Increased fire hazard in the dry season.

Inspection Reporting Method:

- Defect ranking.

Inspection Tools:

- Nil.



Table 4.25

FEATURE ITEM	Shoulder
SUB-ITEM	
DEFECT	Scour

Description:

Loss of edge support to pavement.

Possible Causes:

- Lack of positive edge drainage.
- Poor edge compaction.

Effect (if neglected):

- A safety hazard for motorists.
- Further deterioration likely, exposing lower pavement layers to possible softening due to water action.
- Complete break up of the shoulder and pavement edge.

Inspection Reporting Method:

- Scaling % of sub-section length.

Inspection Tools:

- Tape



Table 4.26

FEATURE ITEM	Shoulder
SUB-ITEM	
DEFECT	Shoulder/Carriageway Step

Description:

Loss of edge support to pavement.

Possible Causes:

- Lack of positive edge drainage.
- Poor edge compaction.

Effect (if neglected):

- A safety hazard for motorists.
- Further deterioration likely, exposing lower pavement layers to possible softening due to water action.
- Complete break up of the shoulder and pavement edge.

Inspection Reporting Method:

- Scaling % of sub-section length.

Inspection Tools:

- Tape

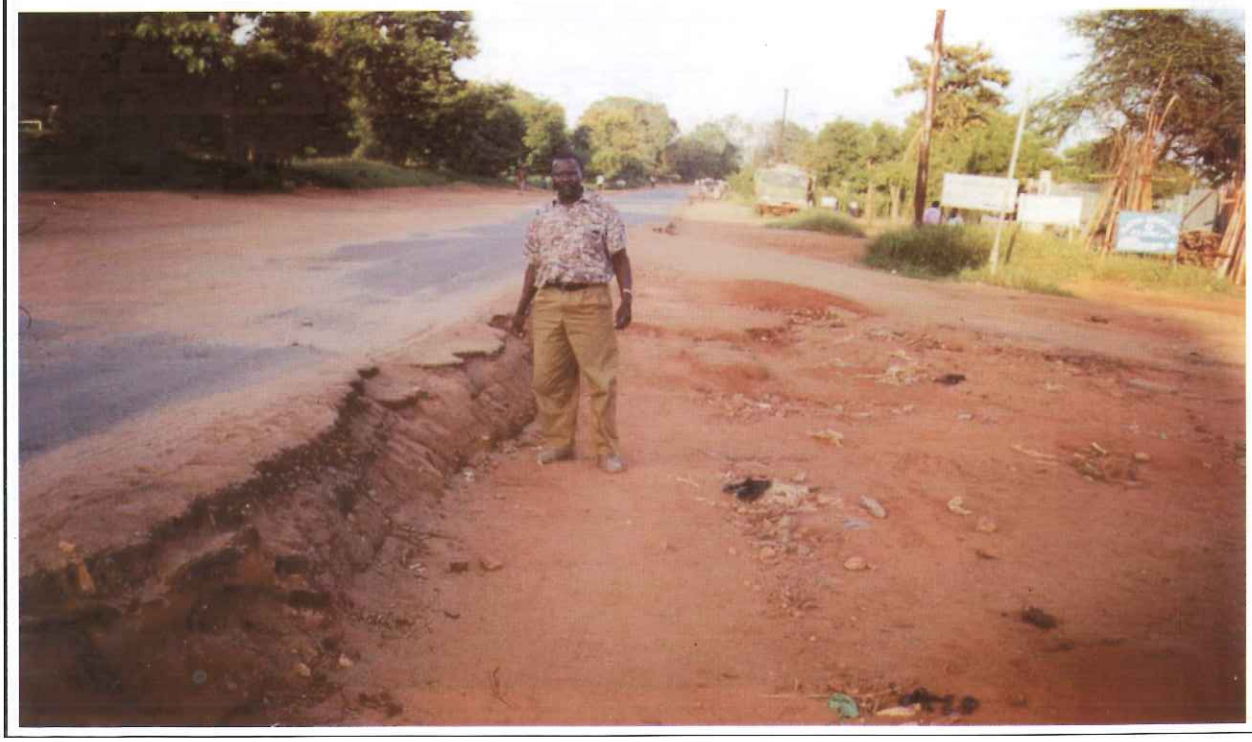


Table 4.27

FEATURE ITEM	Shoulder
SUB-ITEM	
DEFECT	Rutting

Description:

Rutting is characterised by a longitudinal depressions in the surface.

Possible Causes:

- Carriageway is too narrow.
- Excessive loose material.
- Traffic compaction.
- Excessive axle loads.
- Construction too shallow.

Effect (if neglected):

- Further deterioration and failure of the shoulder.
- Standing water in the ruts penetrating to the lower layers causing early failure.

Inspection Reporting Method:

- Defect ranking.

Inspection Tools:

- Nil.



Table 4.28

FEATURE ITEM	Shoulder
SUB-ITEM	
DEFECT	Depression

Description:

Any deviation of surface from its original shape (other than described for corrugation or rutting). Depressions usually take the shape of dishing, bumps or dips which are noticeable, all of which give rise to pitch, roll, or jarring drop in a moving vehicle.

Possible Causes:

- Differential settlement of subgrade or base materials.
- Lack of subgrade support.
- Embankment slope failure.

Effect (if neglected):

- Water ponding in the depression can penetrate the lower layers and cause softening and potential early failure.
- Depressions may expand into cracking and potholes.

Inspection Reporting Method:

- Scaling % of sub-section length.

Inspection Tools:

- Tape



Table 4.29

FEATURE ITEM	Shoulder
SUB-ITEM	
DEFECT	Potholes

Description:

Bowl-shaped depressions in the surface oval, or irregular in shape.

Possible Causes:

- Ponding of water.
- Excessive weakening of layer by moisture and traffic action.
- Inadequate initial compaction.
- Variable quality of materials.
- Insufficient shoulder depth.

Effect (if neglected):

- If left unrepaired, can rapidly expand the extent of the damage.
- Standing water can penetrate the lower layers causing early failure.
- Failure of the shoulder could lead to pavement edge failure.

Inspection Reporting Method:

- Scaling length, with, depth and number of potholes.

Inspection Tools:

- Tape



Table 4.30

FEATURE ITEM	Slope
SUB-ITEM	Back/Side Slopes
DEFECT	High Vegetation

Description:

Vegetation growth overruns slope and reaches or approaches roadway edge reducing visibility and so creating a safety hazard.

Possible Causes:

- Insufficient grass cutting, bush clearing and tree trimming.

Effect (if neglected):

Overgrown trees or branches can fall and block the carriageway.
- Visibility for road users is reduced, with increased risk of accidents.
- The vegetation can block the drainage system or prevent it being inspected or maintained.
- Increased fire hazard in the dry season.

Inspection Reporting Method:

- Defect ranking.

Inspection Tools:

- Nil.



Table 4.31

FEATURE ITEM	Slope
SUB-ITEM	Cut/Embankment Slope
DEFECT	Erosion

Description:

The wearing away of material by natural causes such as water or wind.

Possible Causes:

Cut Slope
- Slope is too steep.
- Poor quality materials.
- No protection on slope surface.
- Runoff water, spring water and seepage water.
- Weathering surface of slope.
- Lack of proper compaction during construction.
- Lack of cut-off drainage.

Embankment Slope
- Slope is too steep.
- Lack of drainage system.
- Poor construction methodology or quality of materials.
- No protection on slope surface.
- Runoff water, spring water and seepage water.
- Water force of river and sea.
- Weathering surface of slope.
- Lack of proper compaction during construction.

Effect (if neglected):

Cut Slope
- Road may be closed causing traffic disruption.
- Side ditch and other concrete structures may be damaged, and cause drainage problems.

Embankment Slope
- Shoulder and roadbed may collapse.
- May cause landslide.
- Side ditch and other concrete structures may be damaged, and cause drainage problems.

Inspection Reporting Method:

- Defect ranking.

Inspection Tools:

- Nil.

Table 4.31

FEATURE ITEM	Slope
SUB-ITEM	Cut/Embankment Slope
DEFECT	Erosion





Table 4.32

FEATURE ITEM	**Slope**
SUB-ITEM	**Cut/Embankment Slope**
DEFECT	**Earth Slip/Landslide**

Description:

Slope material sliding downhill because of instability or water penetration.

Possible Causes:

Cut Slope
- Too steep slope gradient.
- Lack of drainage system.
- Lack of berm and berm ditch.
- Rain water and underground water runoff between top soil and foundation rock.
- Dip of rock or weathered rock tends to slide.

Embankment Slope
- Water running between natural ground and fill material.
- Poor construction methodology.
- Too steep slope gradient.
- Lack of berm and berm ditch.
- Lack of proper compaction.
- Lack of bearing capacity of lower layers.

Effect (if neglected):

Cut Slope
- May cause serious problems for third parties.
- May close road to traffic long term.
- Urgent countermeasures required.

Embankment Slope
- May cause serious problems for third parties.
- May close road to traffic long term.
- Urgent countermeasures required.

Inspection Reporting Method:

- Scaling % of sub-section length and average height/depth.

Inspection Tools:
- Tape
- Levelling staff

Table 4.32

FEATURE ITEM	Slope
SUB-ITEM	Cut/Embankment Slope
DEFECT	Earth Slip/Landslide





Table.4.33

FEATURE ITEM	Slope
SUB-ITEM	Back Slope
DEFECT	Rock Avalanche

Description:

Displaced rock material falling by means of gravity.

Possible Causes:

- Dip of rock causes rock fall.
- Poor quality control of construction works.
- Weathering rock causes rock fall.
- Developing joint of rock.
- Seepage water makes rock layer slippery.

Effect (if neglected):

- Road may be closed causing traffic disruption.
- Side ditch and other concrete structures may be damaged, and cause drainage problems.

Inspection Reporting Method:

- Defect ranking

Inspection Tools:

- Nil.

Table 4.33

FEATURE ITEM	Slope
SUB-ITEM	Back Slope
DEFECT	Rock Avalanche





Table 4.34

FEATURE ITEM	Slope
SUB-ITEM	Side/Cut/Embankment Slope
DEFECT	Collapse of Slope Protection

Description:

The failure of slope retaining structures such that they are unable to work as designed.

Possible Causes:

Cut Slope
- Poor quality materials.
- Lack of bearing capacity of structure.
- Caused by rock fall.
- Lack of proper compaction of the surface allowing slope to crack.
- Unstable cut slope deforms and causes defects.

Embankment Slope
- Unstable embankment causes slope protection defects.
- Poor quality fill material.
- Poor quality control of construction.
- Weathering surface of slope.
- Washing out underneath of embankment by river water.

Effect (if neglected):

Cut Slope
- Causes poor countermeasure function for slope defects.
- Rain water causes softening and weakening of the slope.
- May cause erosion, rock avalanche and landslide.

Embankment Slope
- May close road to traffic or create a hazard and disturb the traffic flow.
- Side ditch and other concrete structures may be damaged, and cause drainage problems.

Inspection Reporting Method:

- Scaling length, width and height of damaged section.

Inspection Tools:
- Tape
- Levelling staff

Table 4.34

FEATURE ITEM	Slope
SUB-ITEM	Side/Cut/Embankment Slope
DEFECT	Collapse of Slope Protection



undersecuring

Table 4.35

FEATURE ITEM	Embankment
SUB-ITEM	
DEFECT	Collapse

Description:

Movement of the embankment such that the structural integrity of the material has failed making it unable and unsafe to take the design loads.

Possible Causes:

- Lack of compaction.
- Poor materials.
- Saturation due to lack of drainage or flooding.
- Softening of sub-grade due to groundwater or lack of drainage.
- Scouring of toe by water action.
- Earthquakes or other natural disasters.
- Excessive axle loads.

Effect (if neglected):

- Road must be closed causing traffic disruption.
- Difficult and expensive reconstruction.

Inspection Reporting Method:

- Defect ranking.

Inspection Tools:

- Nil.

Table 4.35

FEATURE ITEM	Embankment
SUB-ITEM	
DEFECT	Collapse





Table 4.36

FEATURE ITEM	Drainage
SUB-ITEM	Culvert
DEFECT	Silting

Description:

Culvert is blocked by silt.

Possible Causes:

- Invert slope too flat.
- Culvert constructed too low, so that material from the stream bed is deposited in the culvert.
- Vegetation and floating debris carried by the water have become lodged in the culvert.

Effect (if neglected):

- The intended waterway opening will be so reduced that flood water cannot flow.
- Water will back-up or pond on the upstream side of the culvert and may eventually over-flow the road embankment with the risk of the road being washed away.

Inspection Reporting Method:

- Defect ranking.

Inspection Tools:

- Nil.

Table 4.36

FEATURE ITEM	Drainage
SUB-ITEM	Culvert
DEFECT	Silting





Table 4.37

FEATURE ITEM	Drainage
SUB-ITEM	Culvert
DEFECT	Blockage by Debris

Description:

Culvert is blocked by debris.

Possible Causes:

- Invert slope too flat.
- Culvert constructed too low, so that material from the stream bed is deposited in the culvert.
- Vegetation and floating debris carried by the water have become lodged in the culvert.

Effect (if neglected):

- The intended waterway opening will be so reduced that flood water cannot flow.
- Water will back-up or pond on the upstream side of the culvert and may eventually over-flow the road embankment. The road is then in danger of being washed away.

Inspection Reporting Method:

- Defect ranking.

Inspection Tools:

- Nil.

Table 4.37

FEATURE ITEM	Drainage
SUB-ITEM	Culvert
DEFECT	Blockage by Debris





Table 4.38

FEATURE ITEM	Drainage
SUB-ITEM	Culvert
DEFECT	Settlement Cracks

Description:

Cracks appearing on the surface of the road above the culvert.

Possible Causes:

- Settlement of soil below culvert.

Effect (if neglected):

- Minor damage: If the settlement is minor, only light cracking will result in headwalls, wingwalls and the main structure. This will hardly affect the functioning of the structure but cracks should be sealed as soon as possible.

- Major damage: If the settlement is severe, it will cause large relative movement of culvert pipes so that embankment soil will enter through the cracks and block the culvert, or the culvert may collapse. The culvert must then be reconstructed.

Inspection Reporting Method:

- Defect ranking.

Inspection Tools:

- Nil.

Table 4.38

FEATURE ITEM	Drainage
SUB-ITEM	Culvert
DEFECT	Settlement Cracks

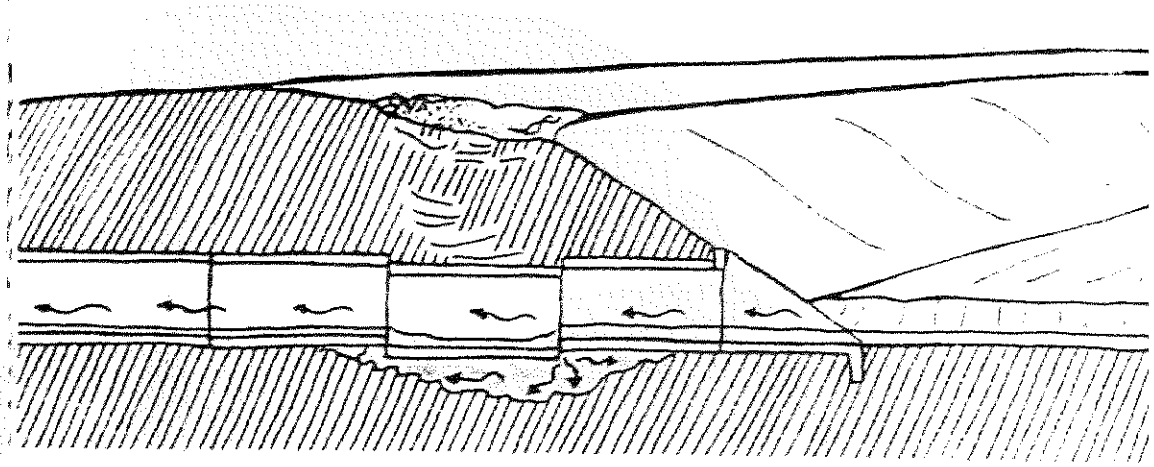


Table 4.39

FEATURE ITEM	Drainage
SUB-ITEM	Culvert
DEFECT	Erosion of Stream Bed at Culvert Outlet

Description:

Stream bed of culvert outlet is eroded by water flow.

Possible Causes:

- The culvert invert has been constructed at too steep a gradient so that the water flows too fast.
- The culvert invert has been constructed too flat with an excessive drop at the outfall (these are design or construction mistakes).

Effect (if neglected):

- The stream bed is washed away and a pool or ravine develops.
- The culvert downstream head and wingwalls and even a section of the culvert and road embankment can collapse into the pool or ravine.

Inspection Reporting Method:

- Defect ranking.

Inspection Tools:

- Nil.

Table 4.39

FEATURE ITEM	Drainage
SUB-ITEM	Culvert
DEFECT	Erosion of Stream Bed at Culvert Outlet





Table 4.40

FEATURE ITEM	Drainage
SUB-ITEM	Culvert
DEFECT	Headwall/Apron/Wingwall Damage

Description:

Headwall/Apron/Wingwall is damaged (e.g., cracked, collapsed).

Possible Causes:

- Minor settlement.
- Scour or erosion.
- Poor construction.
- Poor design.
- Unexpected condition on site.

Effect (if neglected):

- Erosion at the headwall/apron/wingwall.
- Culvert blockage or collapse.

Inspection Reporting Method:

- Defect ranking.

Inspection Tools:

- Nil.

Table 4.40

FEATURE ITEM	Drainage
SUB-ITEM	Culvert
DEFECT	Headwall/Apron/Wingwall Damage





Table 4.41

FEATURE ITEM	Drainage
SUB-ITEM	Culvert
DEFECT	Collapse of Culvert

Description:

Culvert collapsed by external force.

Possible Causes:

- Excessive load by heavy traffic.
- Damaged by rock fall.
- Poor materials.
- Weak foundation.
- Inadequate cover to culvert.

Effect (if neglected):

- May cause traffic accidents.
- Allows water to enter cracks and causes weakening of the road bed.
- Runoff water causes landslide.
- Reduces drainage capacity with potential for flooding upstream and consequent damage to the road foundations.

Inspection Reporting Method:

- Defect ranking.

Inspection Tools:

- Nil.

Table 4.41

FEATURE ITEM	Drainage
SUB-ITEM	Culvert
DEFECT	Collapse of Culvert





Table 4.42

FEATURE ITEM	Drainage
SUB-ITEM	Ditches & Drains
DEFECT	Obstructions

Description:

Trees, branches, grass cuttings, silt and artificial waste block the flow of water.

Possible Causes:

- Vegetation growth, bushes, fallen trees, debris, loose silt, loose rocks.
- Illegal settlement.

Effect (if neglected):

- Blockage of ditch leading to flooding, erosion and potential erosion of ditch slopes.

Inspection Reporting Method:

- Defect ranking.

Inspection Tools:

- Nil.

Table 4.42

FEATURE ITEM	Drainage
SUB-ITEM	Ditches & Drains
DEFECT	Obstructions





Table 4.43

FEATURE ITEM	Drainage
SUB-ITEM	Ditches & Drains
DEFECT	Silting

Description:

Water flow is blocked due to silting of drains.

Possible Causes:

- Invert slope is too flat, the water cannot flow at sufficient speed.

Effect (if neglected):

- Blockage of the ditch causing flooding and potential erosion of the ditch slopes.

Inspection Reporting Method:

- Scaling thickness of silt.

Inspection Tools:

- Tape
- Levelling staff



Table 4.44

FEATURE ITEM	Drainage
SUB-ITEM	Ditches & Drains
DEFECT	Ponding on Ditch or on Shoulder

Description:

Water overflowed from ditch/drain.

Possible Causes:

- The ditch cross-section is too small.
- The ditch gradient is too flat.
- Obstruction in the ditch.

Effect (if neglected):

- The shoulder material becomes soft and can easily erode.
- The pavement can also be flooded and thereby weakened.

Inspection Reporting Method:

- Defect ranking.

Inspection Tools:

- Nil.



Table 4.45

FEATURE ITEM	Drainage
SUB-ITEM	Ditches & Drains
DEFECT	Invert & Sides of Ditch are Eroded

Description:

Invert and side of ditch are eroded by water flow.

Possible Causes:

- Invert slope is too steep.
- Invert and slopes are not compacted.
- Material too soft and needs protection.

Effect (if neglected):

- The erosion becomes more severe and the sides collapse causing flooding and endangering the shoulder and pavement.

Inspection Reporting Method:

- Defect ranking.

Inspection Tools:

- Nil.

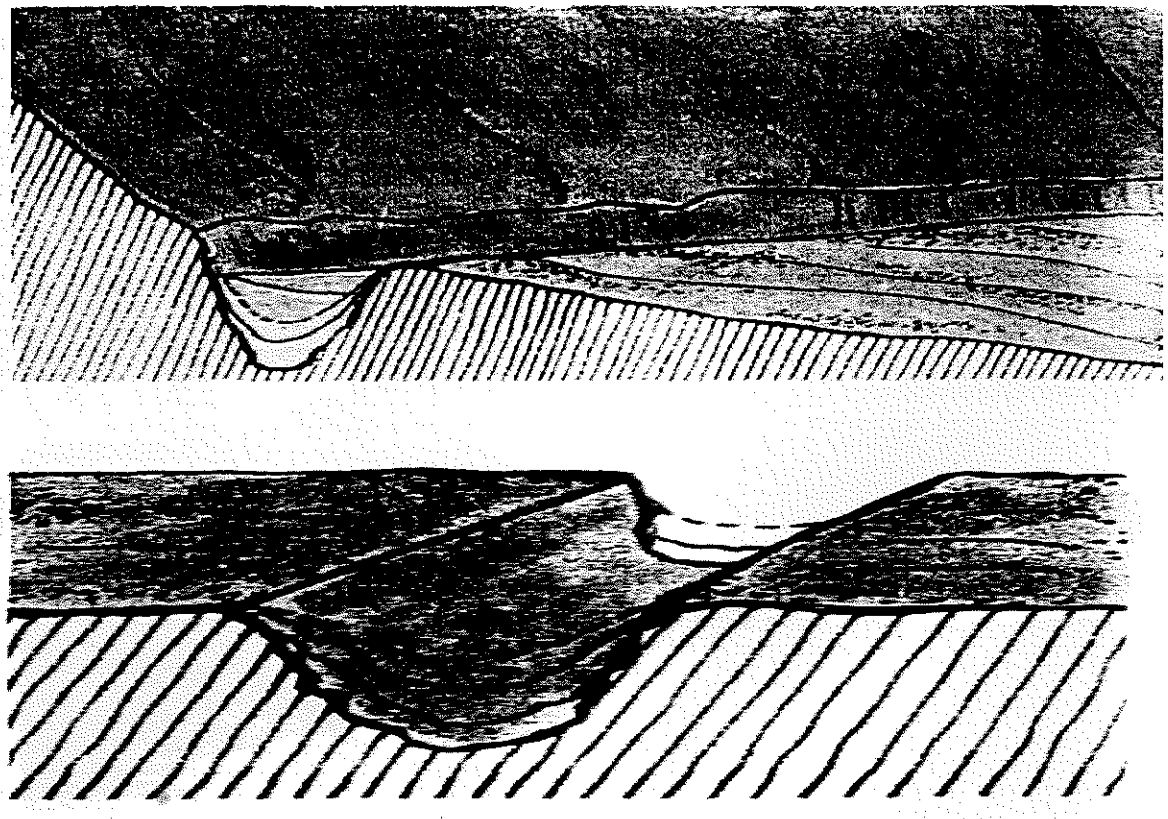


Table 4.46

FEATURE ITEM	Drainage
SUB-ITEM	Ditches & Drains
DEFECT	Ditch Lining is Damaged

Description:

Part of the lining has been broken, dislodged or damaged.

Possible Causes:

- Poor construction workmanship.
- Soil settlement, erosion of soil under ditch lining.
- Poor alignment or sudden change in flow direction.
- Damage caused by debris.

Effect (if neglected):

- When flowing water reaches the soil protected by the lining, erosion starts. The amount of soil washed away increases; the lining is further damaged by loss of support, leading to complete destruction of the lining.

Inspection Reporting Method: Defect ranking.

Inspection Tools:

- Nil.



Table 4.47

FEATURE ITEM	Drainage
SUB-ITEM	Ditches & Drains
DEFECT	Erosion at Drainage Outfall

Description:

Drainage outfall is eroded by water flow.

Possible Causes:

- Ditch gradient is too steep making water flow too fast
- Flow too concentrated.
- Soft material at outfall.

Effect (if neglected):

- Erosion will continue back into the ditch and the drainage structure and also increase in the area of the outfall. The erosion may eventually threaten the road as well as the surrounding land.

Inspection Reporting Method:

- Defect ranking.

Inspection Tools:

- Nil.



Table 4.48

FEATURE ITEM	Drainage
SUB-ITEM	Manhole & Drainage Pipes
DEFECT	Water is Flowing up at Manhole

Description:

Water is overflowing onto road surface from the manhole/pipe.

Possible Causes:

- The manhole or connected underground pipes are blocked and water cannot flow as intended.
- Downstream pipe is broken or silted up.
- Poor construction (e.g., small diameter inserted after larger diameter pipe to cause backing up.

Effect (if neglected):

- Flooding of road shoulder or carriageway.
- Drainage system becomes ineffective, danger of earth slip or weakening of pavement.

Inspection Reporting Method:

- Defect ranking.

Inspection Tools:

- Nil.

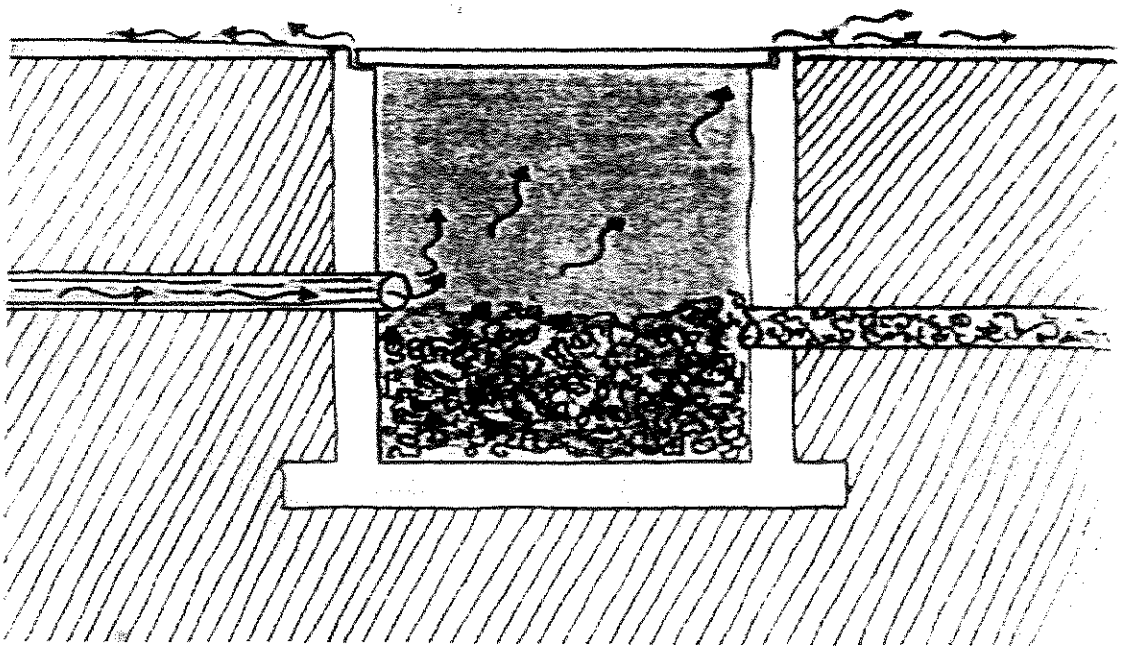


Table 4.49

FEATURE ITEM	Drainage
SUB-ITEM	Manhole & Drainage Pipes
DEFECT	Manhole Cover or Grating is Missing

Description:

There is no manhole/ditch cover/grating on road surface/shoulder/verge.

Possible Causes:

- Accident, vandalism.
- Cover/Grating broken.

Effect (if neglected):

- Open manholes/ditches become a danger to vehicle, people and animals.
- Vegetation and debris have uncontrolled access and blockage can occur..

Inspection Reporting Method:

- Defect ranking.

Inspection Tools:

- Nil.

Table 4.49

FEATURE ITEM	Drainage
SUB-ITEM	Manhole & Drainage Pipes
DEFECT	Manhole Cover or Grating is Missing





Table 4.50

FEATURE ITEM	Drainage
SUB-ITEM	Manhole & Drainage Pipes
DEFECT	Manhole is Covered with Soil & Vegetation

Description:

Manhole is covered with soil and vegetation.

Possible Causes:

- Silting of the ground area at manhole, manhole cover level possibly set too low.
- Manhole covered during new construction or maintenance works.

Effect (if neglected):

- Possible blockage of the drainage system at the manhole, due to an undetected accumulation of silt in the manhole.
- Unable to find the manhole in an emergency.

Inspection Reporting Method:

- Defect ranking.

Inspection Tools:

- Nil.

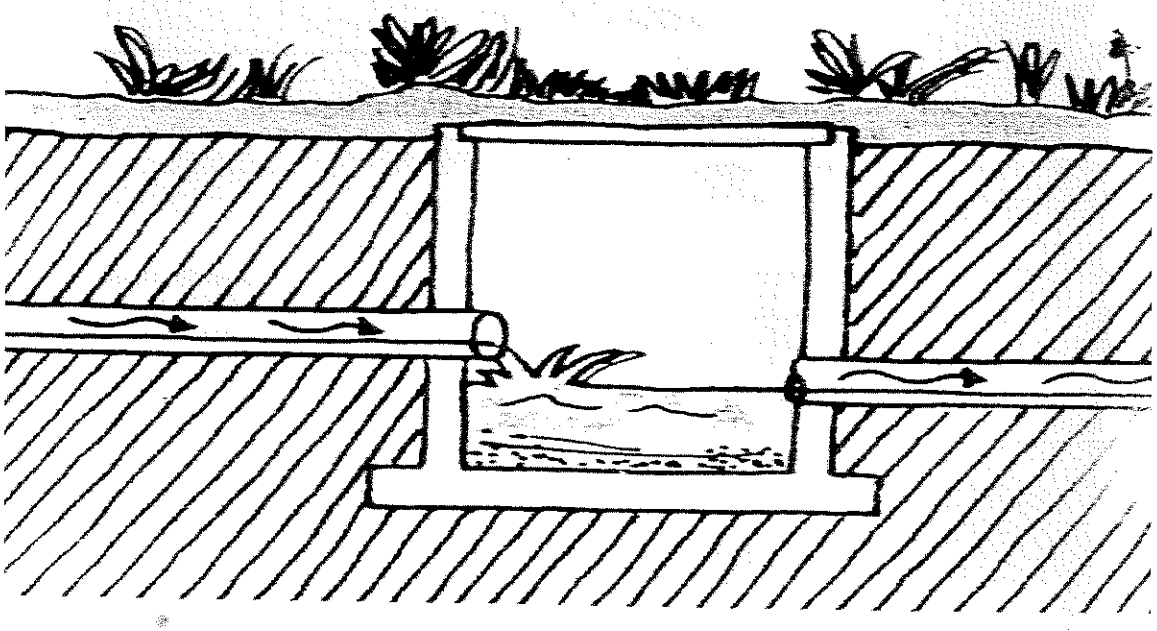


Table 4.51

FEATURE ITEM	Drainage
SUB-ITEM	Manhole & Drainage Pipes
DEFECT	Catchpit Sump is Silted up

Description:

Catchpit sump is filled with silt.

Possible Causes:

- Silt and debris collecting in the sump has not been removed sufficiently and regularly.

Effect (if neglected):

- Possible blockage of the drainage system at the catchpit, or down stream due to a build up of silt or debris.

Inspection Reporting Method:

- Defect ranking.

Inspection Tools:

- Nil.



Table 4.52

FEATURE ITEM	Structures
SUB-ITEM	Drift & Causeways
DEFECT	Settlement

Description:

The vertical movement of the drift or causeway putting at risk the ability to carry the design loads.

Possible Causes:

- Poor construction or construction materials.
- Scouring or erosion.
- Excessive axle loads.

Effect (if neglected):

- Unsafe conditions for road users.
- Risk of further settlement and potential collapse.
- Reduction in the capacity of the water flow.

Inspection Reporting Method:

- Scaling % of sub-section length.

Inspection Tools:

- Tape



Table 4.53

FEATURE ITEM	Structures
SUB-ITEM	Drift & Causeways
DEFECT	Debris

Description:

Surface of drift/causeway is covered with debris.

Possible Causes:

- Natural movement of riverbed material by flowing water.

Effect (if neglected):

- The limits of the paving cannot be seen; vehicles may drive onto loose river bed material at the edge of the drift and become damaged or immobilised.

Inspection Reporting Method:

- Defect ranking.

Inspection Tools:

- Nil.

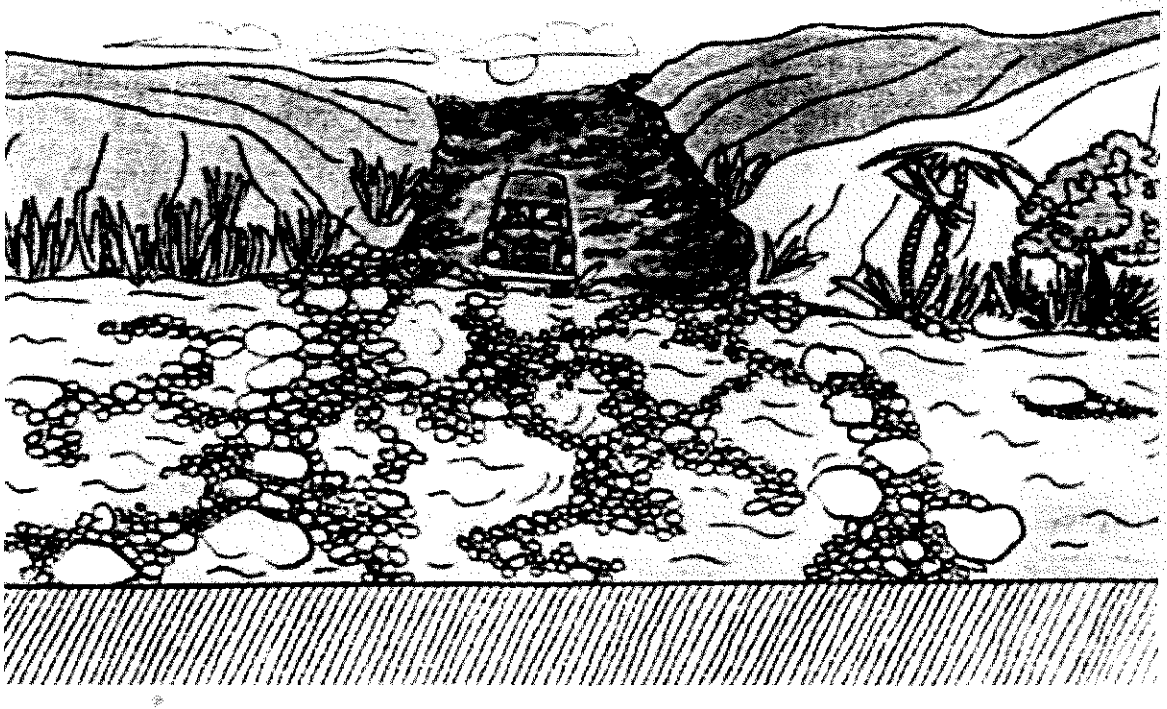


Table 4.54

FEATURE ITEM	Structures
SUB-ITEM	Drift & Causeways
DEFECT	Guide Posts are Damaged or Missing

Description:

Guide posts/markers are damaged or missing.

Possible Causes:

- Accident, flood damage and vandalism.

Effect (if neglected):

When the drift/causeway becomes submerged during flood, the edge of the pavement cannot be seen. Vehicles can accidentally drive into deep water.

Inspection Reporting Method:

- Defect ranking.

Inspection Tools:

- Nil.

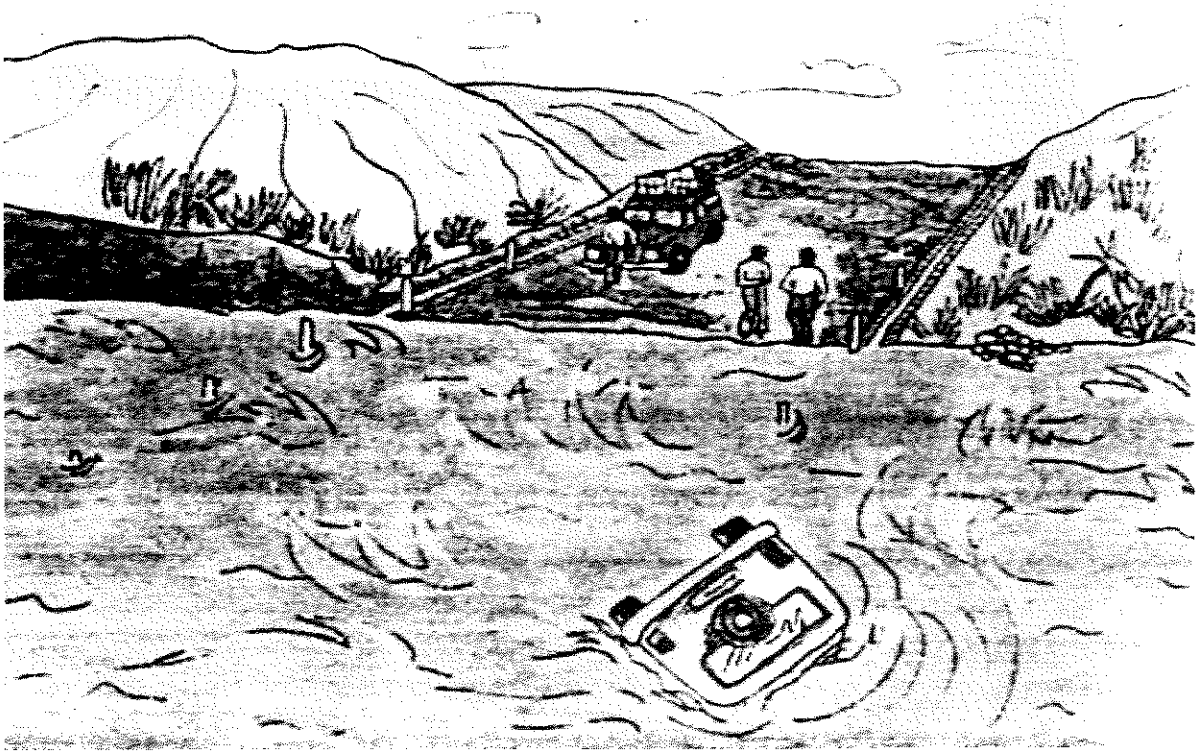


Table 4.55

FEATURE ITEM	Structures
SUB-ITEM	Retaining Wall/Stone Masonry
DEFECT	Settlement

Description:

Due to insufficient bearing capacity of retaining wall/stone masonry is settled.

Possible Causes:

- Softening of sub-grade due to ground water, flood or lack of drainage.
- Lack of compaction below foundations.

Effect (if neglected):

- Risk of collapse.
- Risk of retained material spilling onto the road.

Inspection Reporting Method:

- Scaling length and height of damaged section.

Inspection Tools:

- Tape
- Levelling staff



Table 4.56

FEATURE ITEM	Structures
SUB-ITEM	Retaining Wall/Stone Masonry
DEFECT	Cracking

Description:

Crack is running on surface of retaining wall/stonemasonry.

Possible Causes:

- Vehicle impact
- Insufficient wall thickness
- Excessive build up of water behind wall due to lack of or blocked weep holes/drainage.

Effect (if neglected):

- Risk of collapse if left.

Inspection Reporting Method:

- Defect ranking.

Inspection Tools:

- Nil.



Table 4.57

FEATURE ITEM	Structures
SUB-ITEM	Retaining Wall/Stone Masonry
DEFECT	Collapse

Description:

Retaining wall/stone masonry is collapsed.

Possible Causes:

- Vehicle impact
- Insufficient wall thickness
- Inadequate foundations
- Landslide, major slip or rock fall
- Excessive build up of water behind wall due to lack of or blocked weep holes/drainage.

Effect (if neglected):

- Wall and retained material may block road.
- If material is left unsupported, risk to retained slope

Inspection Reporting Method:

- Defect ranking.

Inspection Tools:

- Nil.

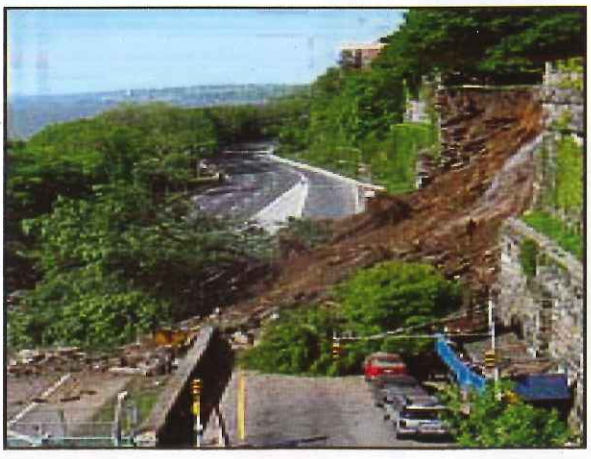


Table 4.58

FEATURE ITEM	Road Furniture
SUB-ITEM	
DEFECT	Dirty

Description:

Road furniture (e.g., road sign) is dirty and /or dusty.

Possible Causes:

- Traffic raises dust clouds during dry weather or splashes mud during wet weather onto signs and posts.

Effect (if neglected):

- The sign does not serve intended use.
- The danger of rusting of a steel plate sign increases.
- Increased danger of accidents.

Inspection Reporting Method:

- Defect ranking.

Inspection Tools:

- Nil.



Table 4.59

FEATURE ITEM	Road Furniture
SUB-ITEM	
DEFECT	Damaged

Description:

Road furniture (e.g., road sign) is damaged.

Possible Causes:

- Traffic accident, vandalism or brush fire.

Effect (if neglected):

- The road users lose the benefit of important traffic signs and the danger of accidents is increased.

Inspection Reporting Method:

- Defect ranking.

Inspection Tools:

- Nil.



Table 4.60

FEATURE ITEM	Road Furniture
SUB-ITEM	
DEFECT	Missing

Description:

Road furniture (e.g., road sign) is missing.

Possible Causes:

- Weathering, corrosion or vandalism.

Effect (if neglected):

- The road users lose the benefit of important traffic signs and the danger of accidents is increased.

Inspection Reporting Method:

- Defect ranking.

Inspection Tools:

- Nil.



Table 4.61

FEATURE ITEM	Footpath
SUB-ITEM	
DEFECT	Pothole/Depression

Description:

Potholes are small usually less than one metre in diameter bowl-shaped depressions on the pavement surface. They generally have sharp edges and vertical sides near the top of the hole.

Possible Causes:

- Asphalt content too low.
- Excessive heating of asphalt.
- Poor quality mixture.
- Lack of compaction allowing ingress of water.

Effect (if neglected):

- Allows water to enter the pavement causing softening and weakening of the pavement and lower layers. This may cause early failure of the pavement.
- If left unrepaired, can rapidly expand the extent of the damage.
- Obstacle for pedestrians.

Inspection Reporting Method:

- Scaling length, width, depth and number of potholes.

Inspection Tools:

- Tape



Table 4.62

FEATURE ITEM	**Footpath**
SUB-ITEM	
DEFECT	**Obstructions**

Description:

Rocks, trees or tree branches, soil heaps, wind blown sand, debris, rubbish and abandoned vehicles are on the footpath.

Possible Causes:

- Material fallen from slopes or trees.
- Material blown or washed onto the footpath.
- Debris/Rubbish left by road users.

Effect (if neglected):

- Hazard to pedestrians.

Inspection Reporting Method:

- Defect ranking.

Inspection Tools:

- Nil.

CHAPTER 5 INSPECTION SHEETS AND METHODS

5.1 Routine Inspections

5.1.1 Inspection Sheets

Five (5) routine inspection sheets have been prepared as shown in Tables 5.1 to 5.5:

Form PR	: Paved Roads
Form UR	: Unpaved Roads
Form RF/RS	: Road Furniture and Roadside Structures
Form DSS	: Drainage System and Drainage Structures
Form URB	: Road Facilities in Urban Roads

Basis of each inspection sheet is as follows:

(a) All defect items to be inspected are shown on the sheet.
(b) Each sheet covers a 2 km section of road.
(c) The following basic data is entered on each inspection sheet:
District name,
Date of inspection,
Inspector's name,
Road number,
Road class,
Surface type,
Location,
Terrain, and
Cause of defects.

5.1.2 Inspection Methods

Inspectors use the above inspection sheets and carry out inspections based on the following inspection methods:

(1) Inspectors should prepare inspection sheets for each road section.

(2) When inspectors find a defect, the defect should either be measured or ranked in accordance with Table 5.12, to "Condition Ranking of Defects". The defect measurement or ranking is entered on the inspection sheet. The "Condition Ranking", or measurement, should be carried out according to the list in the "Definition of Each Defects".

Tables 5.6 to 5.8 shows the examples of entry methods on inspection sheets.

(3) Inspectors should use the same inspection sheets for one to two years, because these sheets can also be used as a record for repair work.

Tables 5.6 and 5.8 shows examples of entry method for defect and repair records.
Red entries indicate results from a second inspection, and yellow entries indicate the completion of execution works.

(4) Inspectors should select the most likely the cause of the defect from those given in Tables 4.2 to 4.62 "The Definition of Each Defect".

Tables 5.6 to 5.8 show entry method examples for defect causes.

(5) Inspections for carriageways, shoulders and road facilities should be carried out from a vehicle at a running speed of less than 20 km/hr in order to accurately defect. Upon finding a defect, the inspector will leave his vehicle to carry out further inspection.

(6) Basic inspection activities are proposed as follows:

- Inspectors carry out inspections on three (3) days per week.

- Inspectors arrange the inspection data and prepare the reports to engineers on the other two (2) days. Table 5.9, "Report of Inspection Results and Execution Plan", shows the format of the inspection report.

  Inspectors should enter the following items in the report:
  District,
  Reporter's Name,
  Date of Report,
  Route No.,
  Road Class,
  Location,
  KM,
  Defect Type, and
  Condition Ranking of Defects

  In addition, Inspectors should submit to engineers the inspection sheets.

- The inspection distance in one (1) day is estimated to be approximately 50 km.

(7) The basic flow for inspection is shown in Figure 5.1.

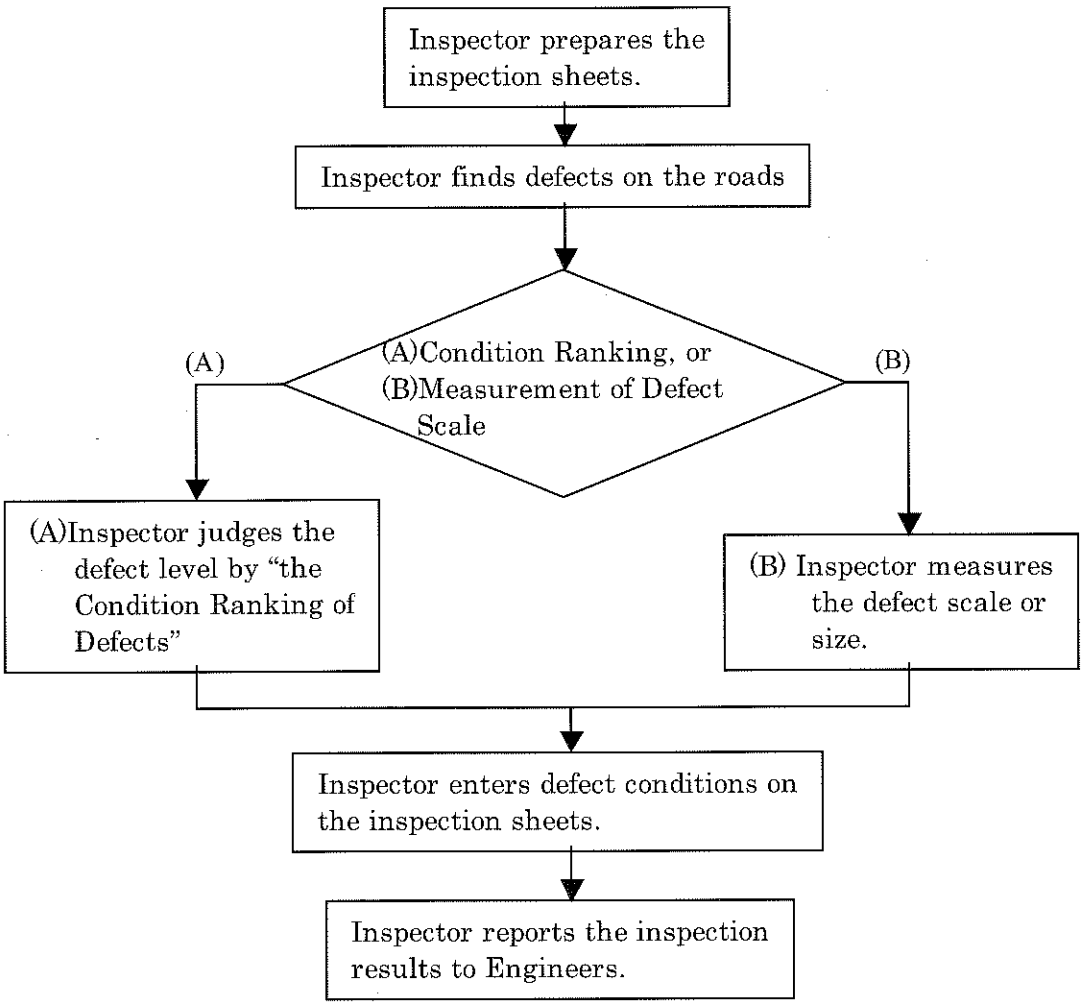


Figure 5.1 Activity Flow for Inspection

Table 5.1 **Form PR Road Condition Survey for Paved Roads (Routine)** ____ of ____

District			Date of Inspection		/ /		Inspector's Name							
Road No.					/ /		Pavement Type		Concrete or Asphalt Concrete or Surface Dressing or Block Paving					
Location	km from		Road Class		Class									
Location (km)														
Shoulder (Left Side)	Defects	Obstructions												
		High Vegetation												
		Scour												
		Shoulder/Carriageway Step												
		Rutting/Depressions												
		Potholes (Area x Depth x Nos.)												
	Cause of Defects													
Carriageway	Defects	Cracking												
		Potholes (Area x Depth x Nos.)												
		Rutting/Deformation (Depth)												
		Heaving/Shoving												
		Stripping/Fretting												
		Bleeding												
		Glazing												
		Edge Damage												
		Wave												
		Obstructions												
		Spot Failure of Base Course												
		Loss of Surface Texture												
		Joint Settlement												
	Cause of Defects													
Shoulder (Right Side)	Defects	Obstructions												
		High Vegetation												
		Scour												
		Shoulder/Carriageway Step												
		Rutting/Depressions												
		Potholes (Area x Depth x Nos.)												
	Cause of Defects													
Terrain:Mountainous(M), Rolling(R), Hilly(H) or Flat (F)														

Table 5.2 **Form UR** **Road Condition Survey for Uupaved Roads (Routine)** _____ of _____

District			Date of Inspection		/ /		Inspector's Name					
Road No.					/ /		Pavement Type		Gravel or Earth			
Location	km from				/ /							
Road Class	Class				/ /							
Location (km)												
Shoulder (Left Side)	Defects	Obstructions										
		High Vegetation										
		Scour										
		Shoulder/Carriageway Step										
		Rutting/Depressions										
		Potholes (Width x Depth x Nos.)										
	Cause of Defects											
Carriageway	Defects	Loss of Camber										
		Rutting (Depth)										
		Potholes (Width x Depth x Nos.)										
		Corrugations										
		Erosion Gullies										
		Soft Spots										
		Obstructions										
		Loss of Gravel Depth										
	Cause of Defects											
Shoulder (Right Side)	Defects	Obstructions										
		High Vegetation										
		Scour										
		Shoulder/Carriageway Step										
		Rutting/Depressions										
		Potholes (Width x Depth x Nos.)										
	Cause of Defects											
Terrain:Mountainous(M), Rolling(R), Hilly(H) or Flat(F)												

Table 5.3 **Form RF/RS Road Condition Survey for Road Furniture and Roadside Structures (Routine)** ____ of ____

District			Date of Inspection		/ /		Inspector's Name						
Road No.					/ /		Location		km from				
Road Class	Class				/ /								
Location (km)													
Road Furniture (Left Side)	Defects	Dirty											
		Damaged											
		Missing											
Structure (Retaining Wall etc.) (Left Side)	Defects	Settlement											
		Cracking											
		Collapse											
	Cause of Defects												
Slope (Left Side)	Defects	High Vegetation											
		Erosion											
		Earth Slip/Landslide											
		Rock Avalanche											
		Collapse of Slope Protection											
	Cause of Defects												
Embankment	Defects	Settlement											
		Collapse											
	Cause of Defects												
Slope (Right Side)	Defects	High Vegetation											
		Erosion											
		Earth Slip/Landslide											
		Rock Avalanche											
		Collapse of Slope Protection											
	Cause of Defects												
Structure (Retaining Wall etc.) (Right Side)	Defects	Settlement											
		Cracking											
		Collapse											
	Cause of Defects												
Road Furniture (Right Side)	Defects	Dirty											
		Damaged											
		Missing											
Terrain:Mountainous(M), Rollin(R), Hilly(H) or Flat(F)													

Table 5.4 **Form DSS Road Condition Survey for Drainage System or Drainage Structures (Routine)** ____ of ____

District			Date of Inspection		/ /		Inspector's Name						
Road No.					/ /		Location		km from				
Road Class	Class				/ /								
		Location (km)											
Structure (Drifts and Causeways)	Defects	Settlement											
		Erosion											
		Debris											
		Cracking											
		Potholes											
		Guide Posts Damaged/Missing											
	Cause of Defects												
Drainage (Culvert)	Defects	Silting											
		Blockage by Debris											
		Settlement Cracks											
		Erosion of Stream Bed											
		Headwall/Apron/Wingwall Damage											
		Collapse											
		Loose Bolts											
		Rust											
	Cause of Defects												
Drainage (Ditches and Drains)	Defects	Obstructions											
		Silting											
		Ponding in Ditch											
		Erosion of Invert and Side Ditch											
		Damage of Ditch Lining											
		Erosion at Drainage Outfall											
	Cause of Defects												
Drainage (Manholes & Drainage Pipes)	Defects	Water is flowing up at manhole.											
		Manhole cover or grating is missing.											
		Manhole is covered with soil.											
		Catchpit sump is silted up.											
	Cause of Defects												
Terrain:Mountainous(M), Rolling(R), Hilly(H) or Flat(F)													

Table 5.5 **Form URB Road Condition Survey for Road Facilities in Urban Roads (Routine)** ____ of ____

City/Town			Date of Inspection		/ /		Inspector's Name							
Road No.					/ /		Location		km from					
Road Class	Class				/ /									
Location (km)														
Road Lighting	Defects	Dirty												
		Damaged												
		Missing												
Traffic Signs	Defects	Dirty												
		Damaged												
		Missing												
Traffic Signals	Defects	Dirty												
		Damaged												
		Missing												
Traffic Boards	Defects	Dirty												
		Damaged												
		Missing												
Footpath	Defects	Cracking												
		Potholes (Area x Depth x Nos.)												
		Wave												
		Obstructions												
	Cause of Defects													
Karb Stones	Defects	Settlement												
		Cracking												
		Collapse												
	Cause of Defects													
	Defects													
	Defect													
	Defect													
	Defect													
	Defect													
	Defect													
Terrain:Mountainous(M), Rollin(R), Hilly(H) or Flat(F)														

Table 5.6 **Form PR Road Condition Survey for Paved Roads (Routine)**

District	Migori		Date of Inspection		18/12/2001		Inspector's Name		ABC				
Road No.	A-1				15/02/2002		Pavement Type		Concrete or (Asphalt Concrete) or Surface Dressing or Block Paving				
Location	0 km from Migori		Road Class		Class A								
Location (km)			0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	
Shoulder (Left Side)	Defects	Obstructions											
		High Vegetation						110 160					
		Scour						A C					
		Shoulder/Carriageway Step											
		Rutting/Depressions											
		Potholes (Area x Depth x Nos.)											
	Cause of Defects							Compaction					
Carriageway	Defects	Cracking		280 280			B				D		
		Potholes (Area x Depth x Nos.)		(15x20)x2x8			840 940				660 720		
		Rutting/Deformation (Depth)		(25x30)x3x8									
		Heaving/Shoving											
		Stripping/Fretting			540	700							
		Bleeding				A B							
		Glazing							230 300				
		Edge Damage							C				
		Wave											
		Obstructions											
		Spot Failure of Base Course											
		Loss of Surface Texture											
		Joint Settlement											
	Cause of Defects			Load	Binder size		No drain		Load		No drain		
Shoulder (Right Side)	Defects	Obstructions									810		
		High Vegetation									B		
		Scour											
		Shoulder/Carriageway Step			430 480								
		Rutting/Depressions			B								
		Potholes (Area x Depth x Nos.)											
	Cause of Defects				Narrow Carriageway						No cut		
Terrain: Mountainous(M), Rolling(R), Hilly(H) or Flat (F)			←		F			*		R		→	

Table 5.7 **Form DSS Road Condition Survey for Drainage System or Drainage Structures (Routine)** 1 of 12

District	Migori	Date of Inspection	18/12/2001	Inspector's Name	Abc
Road No.	A-1		15/02/2002	Location	0 km from Migori
Road Class	Class A		1 1		

		Location (km)	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
Structure (Drifts and Causeways)	Defects	Settlement								480		
		Erosion				660				D(D)		
		Debris				D(P)						
		Cracking										
		Potholes										
		Guide Posts Damaged/Missing										
	Cause of Defects			280		—			300	No Protection		
Drainage (Culvert)	Defects	Silting		D(S)					C(P)			
		Blockage by Debris										
		Settlement Cracks									680	
		Erosion of Stream Bed					840				A	
		Headwall/Apron/Wingwall Damage					B(P)					
		Collapse										
		Loose Bolts										
		Rust										
	Cause of Defects			Gradient			Water		Gradient		Soft Soil	
Drainage (Ditches and Drains)	Defects	Obstructions										
		Silting										
		Ponding in Ditch						80 100				
		Erosion of Invert and Side Ditch						C				
		Damage of Ditch Lining										
		Erosion at Drainage Outfall										
	Cause of Defects							Soft Soil				
Drainage (Manholes & Drainage Pipes)	Defects	Water is flowing up at manhole.								480		
		Manhole cover or grating is missing.								D		
		Manhole is covered with soil.										
		Catchpit sump is silted up.										
	Cause of Defects									—		
Terrain: Mountainous(M), Rolling(R), Hilly(H) or Flat(F)			←		F		→		←	R		→

Table 5.8 **Form URB Road Condition Survey for Road Facilities in Urban Roads (Routine)** ____of____

City/Town	Nairobi City		Date of Inspection		19/12/200/		Inspector's Name		Abc			
Road No.					/ /		Location		km from			
Road Class	Class				/ /							
Location (km)			0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
Road Lighting	Defects	Dirty										
		Damaged			300							
		Missing			D							
Traffic Signs	Defects	Dirty										
		Damaged										
		Missing										
Traffic Signals	Defects	Dirty						60				
		Damaged						C				
		Missing										
Traffic Boards	Defects	Dirty										
		Damaged										
		Missing										
Footpath	Defects	Cracking										
		Potholes (Area x Depth x Nos.)										
		Wave										
		Obstructions										
	Cause of Defects											
Karb Stones	Defects	Settlement							270 300			
		Cracking							B			
		Collapse										
	Cause of Defects											
	Defects											
	Defect											
	Defect											
	Defect											
	Defect											
	Defect											
Terrain:Mountainous(M), Rollin(R), Hilly(H) or Flat(F)			←				F					→

Table 5.9 Report of Inspection Results and Execution Plan

District				Location			
Road No.		Road Class	Class	From			
Inspector's Name :				Engineer's Name :			
Date :				Date :			
Km	Defect Type	Condition Ranking of Defects	Recommended Action	Planned Action	Quantity	Estimated Cost (Kshs.)	Remarks
Total							

5.2 Urgent Inspection

5.2 1 Inspection Sheets

There is one (1) form for urgent inspections and this is shown in Table 5.10. Basic policies of the inspection sheets are as follows:

(a) The inspection sheet indicates all the defect items for urgent maintenance.
(b) The sheet records only the defect point or section.
(c) The inspection sheet records the basic data such as the district name, date of inspection, inspector's name, road number, road class, and location.

5.2.2 Inspection Methods

Inspectors should use the above inspection sheet and carry out the inspection based on the following inspection method:

(1) The Inspector should prepare the inspection sheets only for sections with defects.
(2) The data entry method is the same as for routine inspections.
(3) An example of the entry method is shown in Table 5.11.
(4) Inspectors arrange the inspection data and prepare the reports to engineers as shown in Table 5.9. The data entry method is the same as for routine inspections.

5.3 Condition Ranking of Defects

If the inspectors cannot measure the size or the scale of the defect, then the inspectors should judge the damage level of the defect based on Table 5.12 "Condition Ranking of Defects". This ranking consists of four (4) ranking levels, "A" to "D". Also, the road elements for ranking are divided into four (4) items as follows:

- Carriageway and Shoulder
- Drain (Ditches)
- Culvert
- Others

Table 5.10 **Form UGT** **Road Condition Survey (Urgent)** ____ of ____

District			Date of Inspection	/ /		Inspector's Name					
Road No.			Road Class	Class		Location		km from			
Location (km)			km - km		km - km		km - km		km - km		km - km
Carriageway	Defects	Obstructions									
Footpath	Defects	Obstructions									
Slope	Defects	Erosion									
		Earth Slip/Landslide									
		Rock Avalanche									
Embankment	Defects	Collapse									
		Settlement									
Ditches and Drains	Defects	Obstruction									
Drainage (Manholes)	Defects	Water is flowing up at manhole.									
		Manhole cover or grating is missing.									
Structure (Drafts, etc.)	Defects	Debris									

Table 5.11 **Form UGT** **Road Condition Survey (Urgent)** 1 of 1

District	Migori	Date of Inspection	15/12/2001	Inspector's Name	Abc
Road No.	A-1	Road Class	Class A	Location	0 km from Migori

Location (km)			11.5 km - km	15.3 km - 15.4 km	km - km	km - km	km - km
Carriageway	Defects	Obstructions	D (Stone)				
Footpath	Defects	Obstructions					
Slope	Defects	Erosion		C			
		Earth Slip/Landslide					
		Rock Avalanche					
Embankment	Defects	Collapse					
		Settlement					
Ditches and Drains	Defects	Obstruction					
Drainage (Manholes)	Defects	Water is flowing up at manhole.					
		Manhole cover or grating is missing.					
Structure (Drafts, etc.)	Defects	Debris					

Table 5.12 Condition Ranking of Defects

Ranking	Rank A	Rank B
Carriageway and Shoulder	(1) Minor defects (2) Vehicles can pass at normal design speed for paved roads or at a speed of more than 60 km/hr for unpaved roads. (3) No immediate action but need to continue monitoring. (4) Removing obstructions	(1) Minor defects (2) Vehicles can pass at normal design speed for paved roads or at a speed of 60 to 40 km/hr for unpaved roads. (3) Normal routine maintenance required such as: - Local sealing, Crack sealing, Spot sealing - Grading - Patching - Manual reshaping - Sanding (4) Removing obstruction
Drain (Ditches)	(1) Minor defects (2) No immediate action but need to continue monitoring. (3) Removing obstructions	(1) Minor defects such as: - Local erosion - 1/2 silted drainage (2) Collapse but functions maintained (3) Normal routine maintenance required such as: - Cleaning - Local reconstruction (4) Removing obstructions

Ranking	Rank C	Rank D
Carriageway and Shoulder	(1) Major defects (2) Vehicles can pass at a speed of 40 to 20 km/hr, but running conditions are not smooth. (3) Routine or periodic maintenance required such as: - Heavy grading (recovery of material + compaction) - Manual heavy reshaping - Regavelling - Resealing (4) Removing obstructions	(1) Major defects (2) Vehicles cannot pass at a speed of more than 20 km/hr. (3) Routine or periodic maintenance required such as: - Heavy reshaping - Regravelling - Overlay, Surface dressing (4) Reconstruction including rehabilitation (5) Emergency maintenance required (6) Removing obstructions
Drain (Ditches)	(1) Major defects such as: - 3/4 silted drainage - Ditch lining is damaged - Ponding (2) Collapse but functions maintained (3) Routine or periodic maintenance required such as: - Cleaning - Repair lining - Reshape (4) Removing obstructions	(1) Major defects such as: - Erosion - Fully silted drainage (2) Collapse and functions lost (3) Routine or periodic maintenance required such as: - Cleaning (4) Reconstruction including rehabilitation (5) Emergency maintenance required (6) Removing obstructions

Ranking	Rank A	Rank B
Culvert	(1) Minor defects. - Spot cracking (2) No immediate action but need to continue monitoring. (3) Removing obstructions.	(1) Minor defects such as ; - Cracking - Local collapse - 1/2 silted culvert (2) Collapse but functions maintained (3) Normal routine maintenance required such as ; - Sealing - Cleaning - Repair for local collapse (4) Removing obstructions.
Others	(1) Minor defects - Spot crack (2) No immediate action but need to continue monitoring. (3) Removing obstructions	(1) Minor defects such as: - Local erosion - Dirty of road furniture - Crack (2) Collapse but functions maintained (3) Normal routine maintenance required such as: - Filling - Cleaning - Crack sealing (4) Removing obstructions

Ranking	Rank C	Rank D
Culvert	(1) Major defects such as ; - Collapse - 3/4 silted culvert (2) Collapse but functions maintained (3) Routine or periodic maintenance required such as ; - Cleaning - Local reconstruction (4) Removing obstructions.	(1) Major defects such as ; - Collapse - Fully silted culvert (2) Collapse and function lost (3) Routine or periodic maintenance required such as ; - Cleaning (4) Reconstruction including rehabilitation. (5) Emergency maintenance required. (6) Removing obstructions
Others	(1) Major defects such as: - Collapse - Damaged road furniture (2) Collapse but functions maintained (3) Routine or periodic maintenance required such as: - Local reconstruction - Repair of road furniture (4) Removing obstructions	(1) Major defects such as: - Collapse - Settlement - Earth slip/landslide - Missing road furniture (2) Collapse and functions lost (3) Routine or periodic maintenance required such as: - Replacement of road furniture (4) Reconstruction including rehabilitation (5) Emergency maintenance required (6) Removing obstructions

CHAPTER 6 FREQUENCY OF INSPECTION ACTIVITIES

6.1 Routine Inspection

The frequency of routine maintenance is shown in Table 6.1. Since this is a practical and desirable frequency for each item, engineers and inspectors should decide on the inspection frequency in each region based on the staffing, maintenance budget, terrain, climate, defect types and rainfall, etc.

Table 6.1 Frequency of Routine Inspection

Items	Frequency		Remarks
	Practical	Desirable	
Carriageway of Paved Road	Every 2 months	Every week	
Carriageway of Unpaved Road	Every 2 months	Every week	
Footpath	Every 2 months	Every week	
Shoulder	Every 2 months	Every week	
Slopes	Every 4 months	Every month	Include after rainy season
Embankment	Every 4 months	Every month	Include after rainy season
Drainage	Every 4 months	Every month	Include before rainy season
Roadside Structures	Every 4 months	Every month	
Road Furniture	Every 2 months	Every week	

The basic policies for the practical frequency of the routine inspection are the follows:

(1) Routine inspection for slope and embankment should be executed after rainy season to find any major problems.
(2) Routine inspection for drainage should be executed before rainy season to prevent road serious damage such as the collapse of embankment and drainage facilities, silting and flooding.
(3) It is proposed that the inspection frequency be increased in the near future when the road maintenance budget has improved.

Also, the practical inspection schedule is shown in Figure 6.1.

Items	Inspection Schedule (Month)						
	2	4	6	8	10	12	14
Carriageway and Shoulder	*	*	*	*	*	*	*
Footpath and Road Furniture	*	*	*	*	*	*	*
Slopes and Embankment	*		*		*		*
Drainages		*		*		*	
Roadside Structures	*		*		*		*

Note : * Execution of Inspection

Figure 6.1 Practical Inspection Schedule

Inspection for slope and embankment, drainage and roadside structures that are carried out at four (4) monthly intervals should not be executed same time because there would be too much inspection work involved. The inspectors should consider these inspection times based on the volume of inspection items. For example, if the inspection for slopes, embankment and roadside structures are carried out in the first and fourth months, then the inspection for drainage can be carried out in the second and sixth months.

6.2 Urgent Inspection

Urgent inspection should be carried out after the following events:

(1) After heavy rain
Heavy rain can cause road damage such as collapse of embankment, slope, drainage and structures. Therefore, the inspectors should inspect the roads after heavy rain.

(2) After information of problems from road users or residents
The maintenance office may receive information from road users or residents regarding road defects or major damage. These reports should be investigated to maintain the roads to an acceptable standard.

(3) After major traffic accidents
Major traffic accidents may cause pavement damage and damage to traffic furniture (traffic sign, traffic board, traffic signal, guardrail, etc.). The maintenance office should receive reports of major traffic accidents from police office but it may also come from users or residents. The inspector should visit the site to check for any such damage and to organise any necessary urgent repairs.

CHAPTER 7 SAFETY METHODS FOR INSPECTION

When inspection is being carried out on the carriageway, it is the inspector's responsibility to see that adequate measures are taken to warn and protect road users and inspectors. He should consider and instruct all inspection members in the safety measures, including traffic control, and the use of temporary road signs.
This manual proposes the following control methods for traffic flow:

7.1 High Traffic Volume Roads

Before Inspection work starts, warning signs and cones should be placed around the work area. Work should be carried out on one side of the road at a time, allowing traffic to pass on the other. Signs and cones should be placed in the following order:

(a) "Speed limit" signs should be placed 100m in front of the work area.
(b) Cones should be placed in a taper at the approaches to the inspection work area and at a maximum spacing of 10 m along the middle of the road next to the inspection work area.

Also, traffic controllers should stand next to the cones in the centre of the road to operate the reversible "Stop/Go" signs.
The controller closest to the oncoming traffic should decide when to stop the flow and allow traffic to travel in the other direction.

Figure 7.1 shows the basic traffic control method.

7.2 Low Traffic Volume Roads

The engineers should also consider and approve the use of a simple system of traffic control as follows:

(a) Two controllers should stand at the start of the work area.
(b) Cones should be placed at the start of the work area.

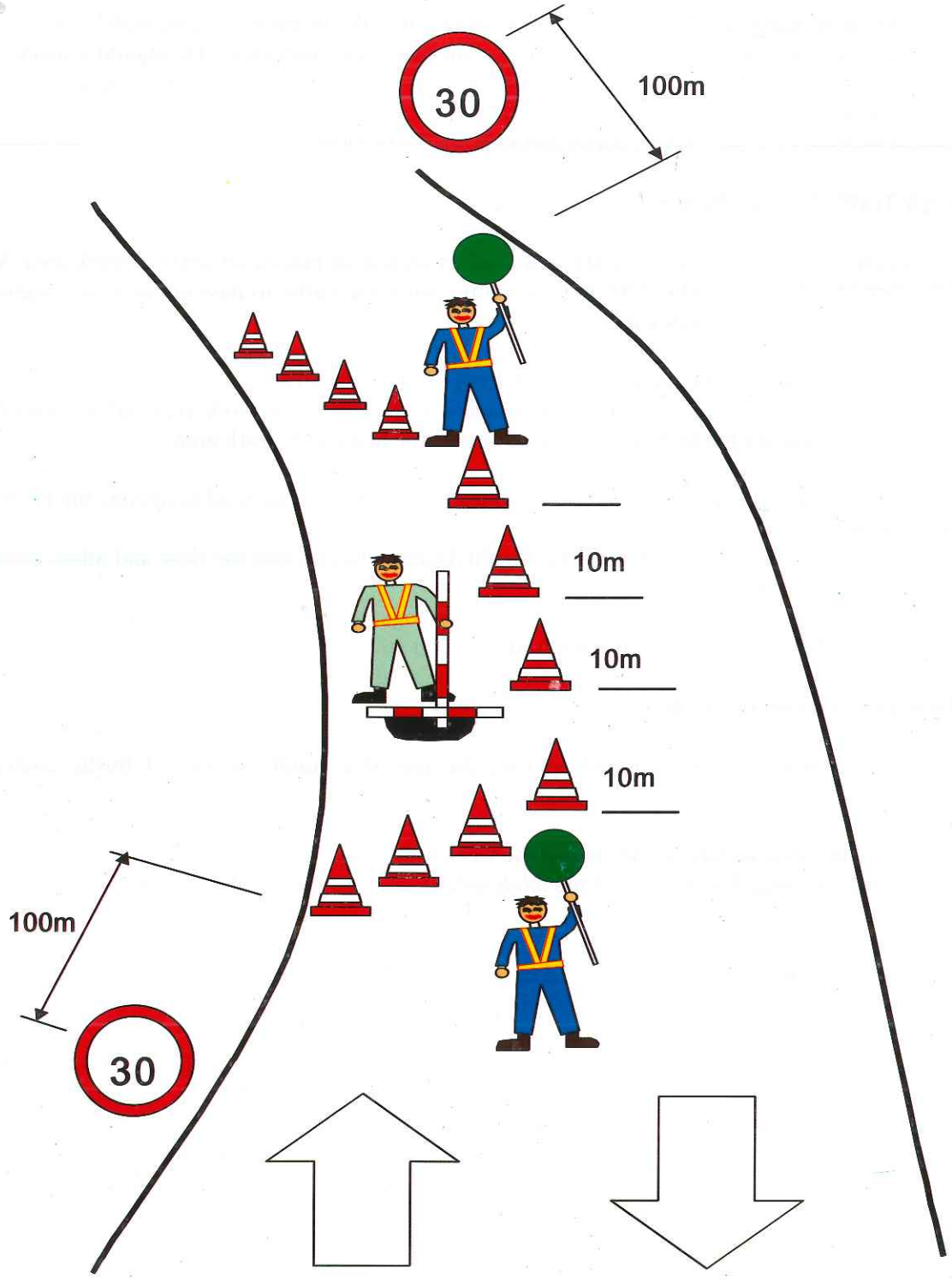


Figure 7.1 Safety Method for Inspection

ROAD MAINTENANCE MANUAL PART-II: EVALUATION

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CHAPTER 8 EXECUTION WORKS

8.1 General

The selection of appropriate works for execution is crucial to ensure good road conditions. Therefore, engineers should evaluate and select the execution works based on inspection results, execution costs, and defect records.

Figure II: 4.1 show the "basic flow for evaluation activities" for execution work selection.

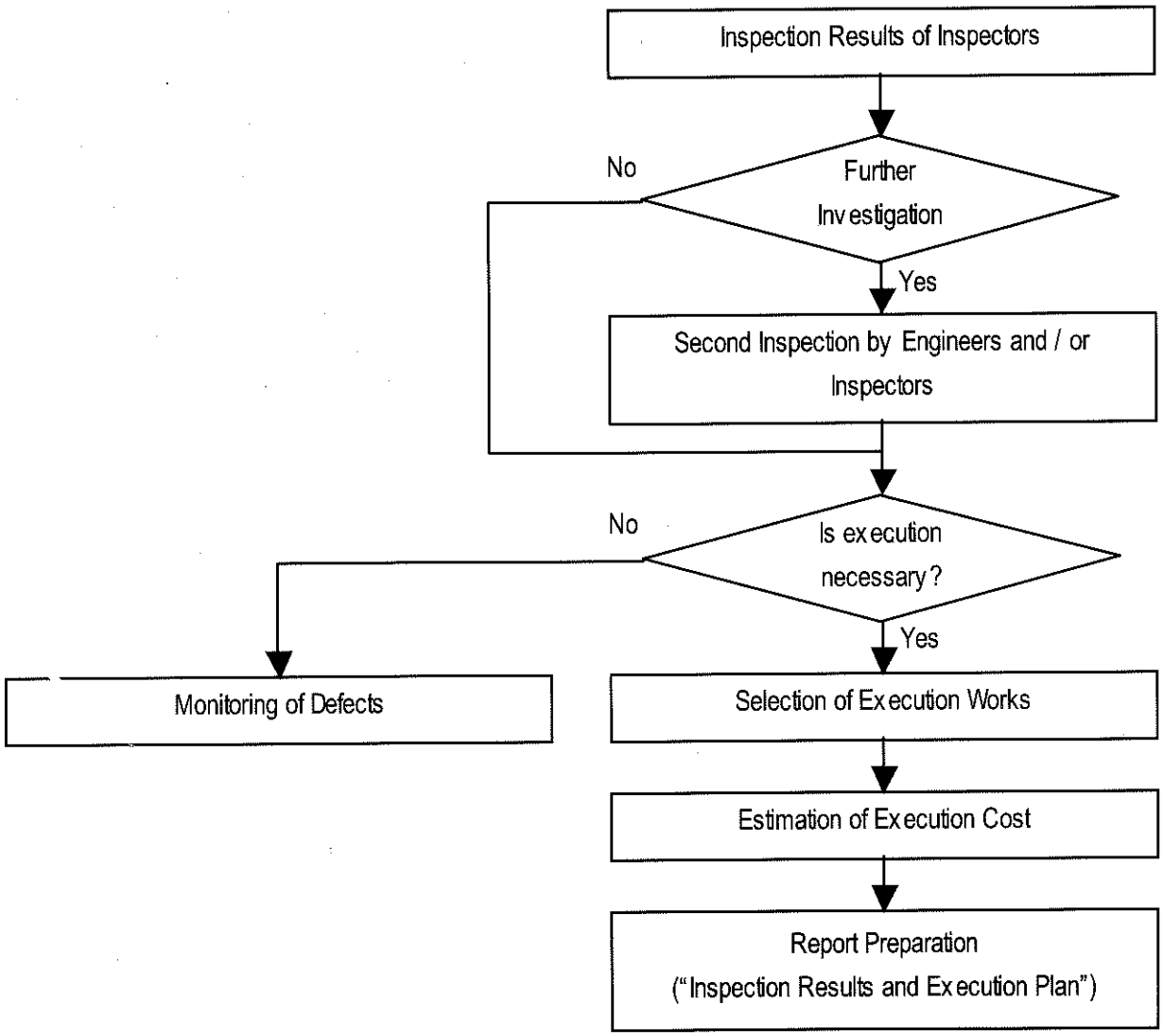


Figure 8.1 Basic Flows for Evaluation Activities

8.2 Execution Works

Execution works for each type defect should be considered based on the experience of road maintenance in Kenya and the sub-Sahara region.

Table 8.1 shows the main execution works for routine, periodic and urgent maintenance. Also, this Table shows the basic selection policies for routine and periodic maintenance activities between the execution works and evaluation rankings.

Table 8.1 Execution Works for Each Defect

Item	Sub-Item	Defects	Routine Maintenance		Periodic Maintenance		Urgent Maintenance
Paved Roads (Bitumen)	Surface	Cracking	Spot sealing	(B)	Resealing	(C)	
			Crack sealing	(B)	Surface dressing	(D)	
			Patching	(B,C,D)	Overlay	(D)	
		Potholes	Patching	(B,C,D)	Surface dressing	(D)	
					Overlay	(D)	
		Rutting/Deformation	Patching	(B,C,D)	Planing	(C,D)	
			Spot planning	(B,C)	Overlay	(D)	
		Heaving/Shoving	Patching	(B,C,D)	Planing	(C,D)	
			Spot planing	(B,C)	Overlay	(D)	
		Stripping/Fretting	Spot sealing	(B)	Resealing	(C)	
					Surface dressing	(D)	
					Overlay	(D)	
		Bleeding	Sanding	(B,C)	Overlay	(D)	
		Glazing	Sanding	(B,C)	Surface dressing	(D)	
		Edge damage	Patching	(B,C,D)	Spot Reconstruction	(C,D)	
			Spot reconstruction	(C,D)			
		Waving	Patching	(B,C,D)	Overlay	(D)	
		Obstructions	Moving obstructions	(A,B,C,D)			Moving obstructions
	Base course	Spot failure	Base repair	(C,D)			
	Sub-base	Spot failure	Sub-base repair	(C,D)			
	Subgrade	Spot failure	Subgrade repair	(C,D)			
Concrete Roads		Loss of Surface Texture			Re groove surface	(C,D)	
		Cracking	Sealing	(B,C)			
		Joint Settlement			Pressure/vacuum	(C,D)	
					Bitumen overlay	(D)	

Table 8.1 Execution Works for Each Defect

Item	Sub-Item	Defects	Routine Maintenance		Periodic Maintenance		Urgent Maintenance
Unpaved Roads	Carriageway	Loss of camber	Reshaping	(C,D)	Grading	(C)	
			Grading	(B,C)	Regravelling	(C,D)	
		Rutting	Reshaping	(C,D)	Grading	(C)	
			Grading	(B,C)	Regravelling	(C,D)	
			Dragging	(C)			
		Potholes	Filling	(B,C)	Grading	(C)	
			Patching	(C,D)	Regravelling	(C,D)	
		Corrugations	Reshaping	(C,D)	Grading	(C)	
			Grading	(B,C)	Regravelling	(C,D)	
			Dragging	(C)			
		Erosion gullies	Reshaping	(C,D)	Grading	(C)	
			Grading	(B,C)	Regravelling	(C,D)	
			Dragging	(C)			
		Soft spots	Filling	(C,D)	Grading	(C)	
			Spot patching (Replace with better material)	(B)	Regravelling	(C,D)	
			Grading	(B,C)			
			Dragging	(C)			
		Obstructions	Moving obstructions	(A-D)			Moving obstructions
		Loss of Gravel Depth			Regravelling	(C,D)	
Shoulder		Obstructions	Moving obstructions	(A-D)			Moving obstructions
		High vegetation	Bush clearing	(B,C)			
		Scour	Filling	(C,D)	Reconstruct	(D)	
			Spot reconstruction	(B,C,D)	Add ditch	(C,D)	
		Shoulder/carriageway step	Spot reconstruction	(B,C,A)	Reshaping	(C,D)	
					Grading	(C)	
					Filling	(C,D)	
		Rutting	Filling	(B,C,D)	Grading	(C)	

Table 8.1 Execution Works for Each Defect

Item	Sub-Item	Defects	Routine Maintenance		Periodic Maintenance		Urgent Maintenance
Shoulder		Depressions	Filling	(B,C,D)	Grading	(C)	
		Potholes	Filling	(B,C,D)			
			Patching	(C,D)			
Slopes		High vegetation	Bush clearing	(B,C)			
		Erosion	Filling	(B,C)	Install cut-off ditch	(C)	Re-cut
			Re-cut	(C,B)	Grassing	(C,D)	
					Planting	(C,D)	
					Re-cut (Install berm)	(C,D)	
		Earth slip/landslide	Filling	(B,C)	Re-cut	(C,D)	Gabion installation
			Benching	(C,D)	Gabion installation	(C,D)	
			Grassing	(C,D)	Cribwork	(D)	
			Drainage	(C,D)	Retaining walls	(D)	
		Rock Avalanche	Remove unstable rock	(B,C)	Netting installation	(C,D)	Moving unstable rock
			Netting installation	(C,D)	Shotcrete	(D)	
			Shotcrete	(D)	Re-cut	(C,D)	
			Re-cut	(D)	Benching	(C,D)	
		Collapse of Slope Protection	Gabion installation	(C,D)	Reconstruction	(C,D)	
Embankments		Collapse			Filling/Gabion	(C,D)	Place warning signs
							Moving obstructions
		Settlement			Filling	(C,D)	Place warning signs
							Move obstructions

Table 8.1 Execution Works for Each Defect

Item	Sub-Item	Defects	Routine Maintenance		Periodic Maintenance		Urgent Maintenance
Drainage	Culverts	Silting	Clearing and cleaning	(B,C,D)			
		Blockage by debris	Clearing	(B,C,D)	Install debris rack	(C,D)	
		Settlement cracks	Sealing of cracks	(B,C,D)	Reconstruct culvert at correct level and fall	(C,D)	
		Erosion of stream bed at culvert outlet	Filling	(B,C,D)	Construct outfall basin	(C,D)	
		Headwall/apron/wingwall damage	Headwall/apron repair	(B,C,D)	Reconstruct (headwall/ apron/ wingwall)	(C,D)	
		Collapse of Culvert			Reconstruct culvert	(C,D)	
		Obstructions	Clearing	(B,C,D)			Moving obstructions
		Silting	Cleaning	(B,C,D)	Reshape, regrade or deepen	(C,D)	
					New mitre drain	(C,D)	
		Ponding in ditch or on shoulder			Reshape, regrade or deepen	(C,D)	
					New mitre drain	(D)	
		Invert and sides of ditch are eroded	Regrade/realign	(B,C)	Regrade/realign	(C,D)	
			Line ditch	(B,C)	Line ditch	(D)	
			Provide scour protection	(C,D)	Provide scour protection	(D)	
		Ditch lining is damaged	Repair lining	(C,D)	Realign ditch	(D)	
	Ditches and Drains	Erosion at drainage outfall			Construct cascade	(C,D)	
					Flatten gradient	(C,D)	
					New mitre drain	(D)	
					Reconstruct ditch	(D)	

Table 8.1 Execution Works for Each Defect

Item	Sub-Item	Defects	Routine Maintenance	Periodic Maintenance	Urgent Maintenance
	Manholes and Drainage Pipes	Water is flowing up at manhole	Clear manhole and pipes (B,C,D)	Relay pipes (C,D)	Place warning signs
		Manhole cover or grating is missing	Replace cover or grating (C,D)		Replace cover or grating
		Manhole is covered with soil and vegetation	Clear manhole area (B,C,D)		
		Catchpit sump is silted up	Clean catchpit sump (B,C,D)		
Structures	Drifts and Causeways	Settlement		Repair works (C,D)	
		Erosion	Clearing (B,C,D)		
		Debris	Clearing (B,C,D)		Clearing
		Guide posts are damaged or missing	Replace or repair guide posts (C,D)		
	Retaining Walls/Stone Masonry	Settlement		Reconstruction (C,D)	
		Cracking	Sealing (B)	Reconstruction (C,D)	
		Collapse	Gabion installation (C,D)	Reconstruction (C,D)	
				Gabion installation (C)	
Road Furniture		Dirty	Cleaning (B,C,D)		
		Damaged	Repair/replace (C,D)	Repair/replace (C,D)	
		Missing	Replace (D)	Replace (C,D)	
Footpath		Pothole/depression	Filling (B,C)		
			Patching (B,C,D)		
		Obstructions			Moving obstruction

CHAPTER 9 SELECTION OF EXECUTION WORKS

9.1 Selection Methods

The engineers should select the execution works based on the following methods:

(1) Engineers should consider the damage scale and/or condition ranking based on inspection results by inspectors and/or engineers. The condition ranking for each defect is shown in Table 9.1 that the inspectors use.

(2) Engineers should select the execution works based on the follows:
- Inspection results
- "Execution Works for Each Defect" (Table 8.1)
- "Condition Ranking of Defects" (Table 9.1)
- "Maintenance Intervention Levels" (Tables 9.3, 9.4 and 9.5)
- Execution costs and maintenance budget

(3) Execution costs should be estimated based on fixed unit cost in the region. Therefore, engineers should fix the unit cost in each region.

Table 9.1 Condition Ranking of Defects

Ranking	Rank A	Rank B
Carriageway and Shoulder	(1) Minor defects (2) Vehicles can pass at normal design speed for paved roads or at a speed of more than 60 km/hr for unpaved roads. (3) No immediate action but need to continue monitoring. (4) Removing obstructions	(1) Minor defects (2) Vehicles can pass at normal design speed for paved roads or at a speed of 60 to 40 km/hr for unpaved roads. (3) Normal routine maintenance required such as: - Local sealing, Crack sealing, Spot sealing - Grading - Patching - Manual reshaping - Sanding (4) Removing obstruction
Drain (Ditches)	(1) Minor defects (2) No immediate action but need to continue monitoring. (3) Removing obstructions	(1) Minor defects such as: - Local erosion - 1/2 silted drainage (2) Collapse but functions maintained (3) Normal routine maintenance required such as: - Cleaning - Local reconstruction (4) Removing obstructions

Ranking	Rank C	Rank D
Carriageway and Shoulder	(1) Major defects (2) Vehicles can pass at a speed of 40 to 20 km/hr, but running conditions are not smooth. (3) Routine or periodic maintenance required such as: - Heavy grading (recovery of material + compaction) - Manual heavy reshaping - Regavelling - Resealing (4) Removing obstructions	(1) Major defects (2) Vehicles cannot pass at a speed of more than 20 km/hr. (3) Routine or periodic maintenance required such as: - Heavy reshaping - Regravelling - Overlay, Surface dressing (4) Reconstruction including rehabilitation (5) Emergency maintenance required (6) Removing obstructions
Drain (Ditches)	(1) Major defects such as: - 3/4 silted drainage - Ditch lining is damaged - Ponding (2) Collapse but functions maintained (3) Routine or periodic maintenance required such as: - Cleaning - Repair lining - Reshape (4) Removing obstructions	(1) Major defects such as: - Erosion - Fully silted drainage (2) Collapse and functions lost (3) Routine or periodic maintenance required such as: - Cleaning (4) Reconstruction including rehabilitation (5) Emergency maintenance required (6) Removing obstructions

Ranking	Rank A	Rank B
Culvert	(1) Minor defects. - Spot cracking (2) No immediate action but need to continue monitoring. (3) Removing obstructions.	(1) Minor defects such as ; - Cracking - Local collapse - 1/2 silted culvert (2) Collapse but functions maintained (3) Normal routine maintenance required such as ; - Sealing - Cleaning - Repair for local collapse (4) Removing obstructions.
Others	(1) Minor defects - Spot crack (2) No immediate action but need to continue monitoring. (3) Removing obstructions	(1) Minor defects such as: - Local erosion - Dirty of road furniture - Crack (2) Collapse but functions maintained (3) Normal routine maintenance required such as: - Filling - Cleaning - Crack sealing (4) Removing obstructions

Ranking	Rank C	Rank D
Culvert	(1) Major defects such as ; - Collapse - 3/4 silted culvert (2) Collapse but functions maintained (3) Routine or periodic maintenance required such as ; - Cleaining - Local reconstruction (4) Removing obstructions.	(1) Major defects such as ; - Collapse - Fully silted culvert (2) Collapse and function lost (3) Routine or periodic maintenance required such as ; - Cleaining (4) Reconstruction including rehabilitation. (5) Emergency maintenance required. (6) Removing obstructions
Others	(1) Major defects such as: - Collapse - Damaged road furniture (2) Collapse but functions maintained (3) Routine or periodic maintenance required such as: - Local reconstruction - Repair of road furniture (4) Removing obstructions	(1) Major defects such as: - Collapse - Settlement - Earth slip/landslide - Missing road furniture (2) Collapse and functions lost (3) Routine or periodic maintenance required such as: - Replacement of road furniture (4) Reconstruction including rehabilitation (5) Emergency maintenance required (6) Removing obstructions

9.2 Standards for Selection

Some defects can be evaluated the damage level based on the damage value as follows:

In order to determine road maintenance interventions, or the frequency at which maintenance works are executed, it is necessary to determine the serviceability levels of a road via for example a roughness index. This may be achieved by using the Overseas Road Note 5 published by the UK's TRL, which gives a table of road roughness values for different serviceability levels (see Table 9.2). The table gives a range of IRI and BI values for serviceability descriptions for both paved and unpaved roads. Based on this table of descriptions and experience in Kenya, it is possible to set intervention levels as a guide for road engineers.

Table 9.2 Road Roughness Values for Different Road Serviceability Levels

Paved Roads			Unpaved Roads		
Serviceability Description	**M/km IRI**	**Mm/km BI**	**Serviceability Description**	**M/km IRI**	**Mm/km BI**
Ride comfortable over 120km/h. Undulation barely perceptible at 80 km/h in range 1.3 to 1.8. No depressions, potholes, or corrugations are noticeable: depressions <2mm/3m. Typical high quality asphalt 1.4 to 2.3. High quality surface treatment 2.0 to 3.0.	1.5-2.5	1000-2000	Recently bladed surface of fine gravel, or soil surface with excellent longitudinal and transverse profile (usually found only in short lengths)	1.5-2.5	1000-2000
			Ride comfortable up to 80-100km/h. Aware of gentle undulations or swaying. Negligible depressions (e.g., < 5mm/3m) and no potholes.	3.5 –4.5	2500-3500
Ride comfortable up to 100-120 km/h. At 80km/h, moderately perceptible movements or large undulation may be felt. Defective surface: occasional depressions, patches or potholes (e.g., 5-15mm/3m or 10-20mm/5m with frequency 1-2 per 50m) or many shallow potholes (e.g., on surface treatment showing extensive ravelling). Surface without defects: moderate corrugations or large undulations.	4.0-5.5	3000-4000	Ride comfortable up to 70-80 km/h but aware of sharp movements and some wheel bounce. Frequent shallow to moderate depressions or shallow pot- holes (e.g., 6-30mm/3m with frequency 5-10 per 50m). Moderate corrugations (e.g., 6-20/0.7-1.5m)	7.5-9.0	6000-7000
			Ride comfortable up to 50 km/h (or 40-70 km/h on specific sections). Frequent moderate transverse depressions	11.5-13.5	9500-11500

Paved Roads			Unpaved Roads		
Ride comfortable up to 70-90 km/h, strongly perceptible movements and swaying. Usually associated with defects: frequent moderate and uneven depressions or patches (e.g., 15-20mm/3m or 20-40mm/5m with frequency 5-3 per 50m). Occasionally potholes (e.g., 1-3 per 50m). Surface without defects: strong undulations or corrugations	7.0-8.0	5500-6500	(e.g., 20-40mm/3-5m at frequency 10-20 per 50m) or occasional deep depressions or potholes (e.g., 40-80 mmm/3m with frequency less than 5 per 50m). Strong corrugations (e.g., <20 mm/ 0.7-1.5m).		
Ride comfortable up to 70-90 km/h, strongly perceptible movements and swaying. Usually associated with defects: frequent moderate and uneven depressions or patches (e.g., 15-20mm/3m or 20-40mm/5m with frequency 5-3 per 50m). Occasionally potholes (e.g., 1-3 per 50m). Surface without defects: strong undulations or corrugations	9.0-10.0	7000-8000	Ride comfortable at 30km- 40km/h. Frequent deep transverse depression and/or pot- holes (e.g., 40- 80mm/1-5m with frequency less than 5 per 50m) with other shallow depression. Not possible to avoid all the depressions expect the worst.	16.0-17.5	14000-15000
Necessary to reduce velocity below 50 km/h. Many deep depressions potholes and severe disintegration (e.g., 40-80 mm deep with frequency 8-16 per 50m).	11.0-12.0	9000-10000	Ride comfortable at 20-30km/h. Speed higher than 40-50 km/h would cause extreme discomfort and possible damage to the car. On the good general profile: frequent deep depression and/or pot-holes (e.g., 40-80 mm/1-5m and occasionally very deep depressions (e.g., <80mm/ 0.6-2m) On a poor general profile: frequent moderate defects and depression (e.g., poor earth surface).	20.0-22.0	18000-20000

Intervention levels are included which are based on the UK's TRL findings regarding surface condition criteria and surface roughness criteria. The intervention levels on roughness are shown below.

Roads require resurfacing when surface irregularity measured by a bump integrator exceeds the following values:

- Trunk Roads 2,800 mm/km (IRI = 4)

Roads require overlay or reconstruction when the surface irregularity exceeds the following values:

- Trunk Roads 3,400 mm/km (IRI = 5)
- Other Roads 3,750 mm/km (IRI = 5)

Equivalent IRI numbers shown in the brackets above are derived using a conversion formula from the TRL's Overseas Road Note 5 (A Guide to Road Project Appraisal) and is as follows:

- m/km IRI = $0.0032^{0.89}$ (mm/km BI)

Tables 9.3 and 9.4 shows some maintenance intervention levels for unpaved roads and paved roads. Table 9.5 also shows some maintenance intervention levels for road structure.

Table 9.3 Maintenance Intervention Levels: Unpaved Roads

Defect	Level	Extent (% of sub - section length)	Action	Programme	Notes
Gravel thickness	<50 mm	>20 %	Re-gravel	Periodic	
Camber Roughness Rutting Corrugation Potholes	(Various criteria : see ORN1)	-	Grade-drag	Routine	Planned on a programmed basis

Table 9.4 Maintenance Intervention Levels: Paved Roads

Defect	Level	Extent (% of sub-section length)	Climate/traffic category	Defect	Extent (%of sub-section length)	Action	Programme
Stripping or fretting	Any	<10	All	-	-	Spot sealing	Routine
		>20	All	-	-	Resealing,	Periodic
						Surface dressing,	
						Overlay	
Edge damage	Erosion from original edge >150mm	>20	All	-	-	Patching,	Routine
						Filling,	
						Spot Reconstruction	
		>50	All	-	-	Spot Reconstruction	Periodic
Rutting (surface dressing on granular base)	<10mm	-	Rainfall > 1500 mm/yr or Traffic <1000 vehicles/day	Wheeltrack	<5	Crack sealing	Routine
				Cracking	>5	Surface dressing	Periodic
				Non-wheeltrack Cracking	<10	Crack sealing	Routine
					>10	Surface dressing	Periodic
			Rainfall< 1500mm/yr and Traffic< 1000 vehicles/day	Wheeltrack Cracking	<10	Crack sealing	Routine
					>10	Surface dressing	Periodic
				Non-wheeltrack cracking	<20	None	-
					>20	Surface dressing	
	10-15mm	>10	All	Any cracking	_	Treat cracks depending on extent as above	Routine/ periodic
						Further investigation	
	>15mm	<10	All	Cracking only associated with local ruts	_	Patching	Routine
				Other cracking	_	Patching excess rutting and treat cracks depending on extent as above	Routine/ periodic
		>10	All	Any cracking	_	Further investigation	_

Defect	Level	Extent (% of sub-section length)	Climate/traffic category	Defect	Extent (%of sub-section length)	Action	Programme
Rutting (asphaltic concrete)	<10mm	-	Rainfall >1500mm/yr or Traffic>1000 vehicles/day	Any cracking	<5	Crack sealing	Routine
					5-10	Surface dressing	Periodic
					>10	Further investigation	_
			Rainfall <1500mm/yr and Traffic<1000 vehicles/day	Any cracking	<10	Crack sealing	Routine
					10-20	Surface dressing	Periodic
					>20	Further investigation	_
	>10mm	<5	All	Cracking only associated with local ruts	_	Patching	Routine
				Other cracking	_	Patching excess rutting and treat cracks depending on extent as above	Routine/ Periodic
		>5	All	Any cracking	_	Treat cracks depending on the extent as above	Routine/ Periodic
						Further investigation	_
Rutting (asphaltic concrete or surface dressing on stabilized road base)	<5mm	_	Rainfall>1500mm/yr or	Any cracking	<10	Crack sealing	Routine
			Traffic>1000 vehicles/day		>10	Resealing and surface dressing	Periodic
			Rainfall< 1500mm/yr or	Any cracking	<20	Seal cracks	Routine
			Traffic<1000 vehicles/day		>20	Resealing and surface dressing	Periodic
	5-10mm	>10	All	Any cracking	_	Treats cracks depending on extent as above	Routine/ Periodic
						Further investigation	_
	>10mm	<5	All	Cracking only associated with local ruts	_	Patching	Recurrent
				Other cracking	_	Patching excess rutting and treat cracks depending on extent as above	Routine/ Periodic
		>5	All	Any cracking	_	Further investigation	_

Table 9.5 Maintenance Intervention Levels: Structures

Elements	Defects	Level	Extent (% of sub-section length)	Action	Programme
Shoulders	Scour, Rutting, Depressions	Visual assessment	>20	Fill, Spot reconstruction	Routine
			>50	Reconstruction, Add ditch	Periodic
	Shoulder/ carriageway step	>50 mm	>50	Spot reconstruction	Routine
			>50	Reshaping, Grading, Fill	Periodic
Slopes	Erosion	Visual assessment	>20	Fill, Re-cutting	Routine
			>50	Re-cutting	Periodic

CHAPTER 10 REPORTING OF EXECUTION PLAN

The engineers should make the report for execution plan after selection of execution works. The format of the report is shown in Table 10.1, "Report of Inspection and Execution Plan". The following three (3) items in the Table are entered by Inspectors:

- KM
- Defect Type
- Condition Ranking of Defects

The engineers should add the following items to above items, and report the "Report of Inspection and Execution Plan" to headquarter.

(a) Condition Ranking of Defects

Engineers should consider and judge the condition ranking or measurement results of defects based on the inspection results.

(b) Action

Engineers should select the execution works based on the defect type, condition ranking and execution costs, etc.

(c) Quantity

Engineers should calculate the quantities of execution works, and enter the quantities of main items.

(d) Estimated Cost

Engineers should estimate the execution costs based on the quantities of execution works and basic unit cost. The engineers should fix the basic unit cost depend on the regional conditions.

Table 10.1 Report of Inspection Results and Execution Plan

District				Location			
Road No.		Road Class	Class	From			
Inspector's Name :				Engineer's Name :			
Date :				Date :			
Km	Defect Type	Condition Ranking of Defects	Recommended Action	Planned Action	Quantity	Estimated Cost (Kshs.)	Remarks
Total							

ROAD MAINTENANCE MANUAL PART-III: EXECUTION

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CHAPTER 11 ACTIVITY SPECIFICATIONS FOR EXECUTION WORKS

11.1 General

The Activity Specifications included in this manual have been developed based on the situations and conditions in Kenya and those successfully in use in other African countries. The objective is to keep them short and specific but giving enough information for both the supervisor and the contractor to be able to fully understand the requirements of each activity to be performed. When they are fully developed and provided the specification and method of measurement are confirmed, these Activity Specifications may be included in the contract for maintenance works.

11.2 Activity Specification

The Activity Specification has a number of elements:

(a) Activity No
This is a currently based on the numbering system in use in the Ministry of Roads, Highway Management System (HMS). This number, which can be up to 7 digits long, comprises three parts; 'item number-sub item number-sub/sub item number'.

(b) Activity Name
The activity name in general has been taken from the HMS but in some cases the name has been simplified.

(c) Date
The date given is the date of preparation/approval so that a schedule of the latest specifications can be maintained.

(d) Classification
The classification states the type of maintenance activity: routine, periodic or urgent.

(e) Description
A very brief description of the activity is provided.

(f) Performance and Scheduling Considerations
This section includes any issues that might affect how or when the activity may be carried out. This could relate to the season e.g. some activities must be carried out in dry weather or be completed before the seasonal rains, or it may relate to other activities being completed in advance. This provides a useful reminder to anyone trying to programme the works.

(g) Typical Personnel
The typical personnel needed for each activity have been included. However, no numbers have been given as these will depend on the extent of the activity.
As more works become contracted out to the private sector, the contractor may want to decide on the personnel requirements to suit his own workforce or to speed up the works and generally to maximise his commercial advantage. In this situation the 'Typical Personnel' may not be relevant.

(h) Basic Equipment
A list of the basic equipment required for the activity is given for guidance and as a reminder to those planning the works activity.

(i) Approved Materials
Where approved materials are required for the activity, they are listed in this section of the specification sheet. It acts as a reminder to the contractor and the supervisor that only approved materials are allowed on site and if necessary, such approval should be obtained in writing in advance from the Engineer to the Contract.

(j) Approved Working Method
This is a simplified step by step guide as to how the activity is to be carried out to comply with the requirements of the contract.

(k) Technical Specifications
Where possible reference has been made to established documents such as the Ministry of Transport and Communications Standard Specification for Road and Bridge Construction. However, this document is primarily for new construction and not for maintenance works, so in some cases other technical reports have been used or specific specifications have been written for the activity in question.

(l) Method of Measurement
Wherever possible, the unit of measurement from the HMS has been used. The item description i.e. what is included in the unit rate, should be considered very carefully based on best practice in Kenya.

Activity Specifications have been prepared for most of the major maintenance activities. Table 11.1 shows the list of activities.

Table 11.1 (1) MAINTENANCE ACTIVITIES

CONTRACT ITEM NUMBERING, DESCRIPTION, UNITS AND CODE

ITEM NO. 4-ROADSIDE CLEARANCE

Item	Sub Item	S/Sub Item	Activity Description	Unit Description	Unit Measure	Unit Code	Table No.
4	50	001	Mechanical mowing	Sq.metres	m^2	SM	11.2
4	50	002A	Heavy bush clearing	Sq.metres of bush	m^2	SM / MT	11.3
4	50	002B	Cutting of tree branches	Metres of girth of trees	m	SM / MT	11.4
4	50	003	Light bush clearing	Sq.metres	m^2	SM	11.5

ITEM NO. 8 – CULVERT CLEANING AND DRAINAGE WORKS

Item	Sub Item	S/Sub Item	Activity Description	Unit Description	Unit Measure	Unit Code	Table No.
8	50	001	Ditch cleaning - mechanical (motor grader)	Cb.metres	m^3	MT	11.6
8	50	001B	Ditch cleaning - mechanical (excavator or backhoe)	Cb.metres	m^3	MT	11.7
8	50	002	Ditch cleaning - manual	Cb.metres	m^3	MT	11.8
8	50	003	Ditches - grass planting	Sq.metres	m^2	SM	11.9
8	50	004	Ditches - earth fill	Cb.metres	m^3	CM	11.10
8	50	005	Ditches - hard core fill	Cb.metres	m^3	CM	
8	50	006	Regrade/realign ditch	Cb.metres	m^3	MT	11.11
8	50	007	Line ditch	Sq.metres of geotextile, Cb.metres of concrete, or Cb.metres of concrete	m^2/m/ m^3	SM / CM	11.12
8	50	008	Construct cascade	Sq.metres	m^2	MT	11.13
8	50	009	Repair ditch lining	Sq.metres	m^2	SM	11.14
8	50	010	Construct new mitre drain	Cb.metres	m^3	MT	11.15
8	60	001	Culvert cleaning - light/partially blocked	Metres of culvert	m	MT	11.16
8	60	002	Culvert cleaning - heavy/fully blocked	Metres of culvert	m	MT	11.17
8	60	009	Culvert / headwall / wingwall crack sealing	Metres of crack	m	MT	11.18
8	60	010	Installation of debris rack	Number of racks	No	NO	11.19

ITEM NO. 8 – CULVERT CLEANING AND DRAINAGE WORKS

Item	Sub Item	S/Sub Item	Activity Description	Unit Description	Unit Measure	Unit Code	Table No.
8	70	001	Culvert headwall repair	Sq.metres of masonry, Cb.metres of concrete	m^2/m^3	CM	11.20
8	70	004	Repair/replace scour check - masonry	No. of scour checks	No	NO	11.21
8	70	005	Repair/replace scour check - wooden	No. of scour checks	No	NO	
8	70	006	Repair/replace scour check - stone	No. of scour checks	No	NO	
8	70	007	Repair/replace scour check - stone pitching	Sq.metres	m^2	SM	11.22
8	90	001	Drift clearing	Cb.metres	m^3	NO	11.23
8	90	005	Drift repairs - cracks	Metres of crack / Cb.metres of pothole	m/m^3	MT / CM	11.24
8	90	006	Drift repairs - potholes	Cb.metres	m^3	CM	
8	100	001	Clear manholes/catchpits	Number of manholes / catchpits	No	NO	11.25
8	100	002	Clear underground pipes	Metres of pipe	m	MT	
8	100	004	Clearing manhole area	Sq.metres	m^2	SM	11.26

Table 11.1 (2) MAINTENANCE ACTIVITIES

CONTRACT ITEM NUMBERING, DESCRIPTION, UNITS AND CODE

ITEM NO. 10 – GRADING AND GRAVELLING WORKS

Item	Sub Item	S/Sub Item	Activity Description	Unit Description	Unit Measure	Unit Code	Table No.
10	50	001	Heavy grading	Sq.metres	m^2	KM	11.27
10	50	002	Light grading	Sq.metres	m^2	KM	
10	60	001	Spot patching (earth and gravel roads)	Cb.metres	m^3	SM	11.28
10	60	002	Gravel patching	Cb.metres	m^3	CM	11.29
10	60	003	Filling (earth and gravel roads)	Cb.metres	m^3	CM	11.30
10	70	001	Regravelling	Cb.metres	m^3	CM	11.31
10	90	001	Dragging	Sq.metres	m^2	KM	11.32
10	90	002	Reshaping (labour-based)	Sq.metres	m^2	KM	11.33

ITEM NO. 11 – SHOULDER MAINTENANCE AND REPAIRS

Item	Sub Item	S/Sub Item	Activity Description	Unit Description	Unit Measure	Unit Code	Table No.
11	50	003	Shoulder reconstruction - mechanical	Cb.metres	m^3	CM	11.34
11	50	004	Shoulder reconstruction - manual	Cb.metres	m^3	CM	11.35

ITEM NO. 15 – PAVED SURFACE REPAIRS AND MAINTENANCE

Item	Sub Item	S/Sub Item	Activity Description	Unit Description	Unit Measure	Unit Code	Table No.
15	50	001	Patching - premix mixed on site	Cb.metres	m^3	SM	11.36
15	50	002	Patching - premix from stockpile	Cb.metres	m^3	SM	
15	50	003	Patching - stabilized gravel	Cb.metres	m^3	SM	
15	60	001	Spot sealing	Sq.metres	m^2	SM	11.37
15	60	002	Crack sealing	Metres of crack	m	MT	11.38
15	60	003	Resealing	Sq.metres	m^2	SM	11.39
15	70	005	Base repair	Cb.metres	m^3	CM	11.40
15	80	002	Slurry sealing	Sq.metres	m^2	SM	11.41
15	80	004	Surface dressing	Sq.metres	m^2	SM	11.42
15	80	005	Sanding	Sq.metres	m^2	SM	11.43

Table 11.1 (3) MAINTENANCE ACTIVITIES

CONTRACT ITEM NUMBERING, DESCRIPTION, UNITS AND CODE

ITEM NO. 20 – ROAD FURNITURE REPAIR AND MAINTENANCE

Item	Sub Item	S/Sub Item	Activity Description	Unit Description	Unit Measure	Unit Code	Table No.
20	50	003	Sign cleaning and painting	Number of signs	No	NO	11.44
20	50	004	Sign repair/replacement	Number of signs	No	NO	11.45
20	50	005	Replace guide/marker posts	Number of posts	No	NO	11.46
20	60	002	Road marking - mechanical	Sq.metres of line	m^2	SM	11.47
20	60	003	Road marking - manual	Sq.metres of line	m^2	SM	11.48
20	70	001	Guardrail repair/replacement	Metres of guardrail	m	MT	11.49

ITEM NO. 50 – CONCRETE ROADS

Item	Sub Item	S/Sub Item	Activity Description	Unit Description	Unit Measure	Unit Code	Table No.
50	50	002	Crack sealing	Metres of crack	m	MT	11.50

ITEM NO. 60 – SLOPES AND EMBANKMENTS

Item	Sub Item	S/Sub Item	Activity Description	Unit Description	Unit Measure	Unit Code	Table No.
60	50	002	Recut slope/benching	Cb.metres	m^3	CM	11.51
60	50	003	Grassing/seeding	Sq.metres	m^2	SM	11.52
60	60	001	Slope stabilisation - Shotcrete	Cb.metres	m^3	CM	11.53
60	60	002	Gabion installation	Sq.metres of gabion mat, Cb.metres of rock	m^2/m^3	CM	11.54
60	60	004	Retaining wall construction	Cb.metres	m^3	CM	11.55
60	70	002	Removal of unstable material/clearing slip material	Cb.metres	m^3	CM	11.56
60	80	001	Installation of cut-off ditch	Cb.metres	m^3	MT	11.57

Each activity specification is shown in Table 11.2 to Table 11.57.

Table 11.2

FEATURE	ROAD RESERVE	
ACTIVITY SPECIFICATION	Activity No: 4-50-001	Activity Name: MECHANICAL MOWING
Classification:	Routine Maintenance	

Description and Purpose:

For cutting of grass by machine along the side of the road or on slopes to provide good visibility for traffic safety.

Performance and Scheduling Considerations:

This activity should only be used when it is more economical than Activity 4-50-003 and provided safe access and working space is available for the machine.

Typical Personnel:	Basic Equipment:	Approved Material:
Foreman Tractor Operator Labourer	Tractor with mower Handtools: slasher, panga	N/A

Method of Measurement:

Work will be measured and paid for on the basis of the area of grass cut. The height and quantity of grass will vary and typical conditions of grass growth are all deemed to have been considered by the Contractor when preparing his tender rate.

Unit: m^2

Approved Work Method:

1. Place warning signs and safety devices in accordance with clause 907 of the MOTC Standard Specification for Road and Bridge Construction or as directed by the Engineer.
2. Uproot small plants, cut bush which cannot be mown and cut grass in t he specified areas to a height of not more than 100 mm (the height of a cigarette packet).
3. Remove vegetation and debris as directed and tidy up the work Area.
4. Measure and record the total length of roadside cut.
5. Remove all signs and safety devices.

Technical Specifications:

1. Grass shall be cut to a height of not greater than 100 mm.
2. Grass shall be cut to a width of at least 3 m measured from the edge of carriageway or shoulder.

Table 11.3

FEATURE	ROAD RESERVE	
ACTIVITY SPECIFICATION	**Activity No: 4-50-002A**	**Activity Name: HEAVY BUSH CLEARING**
Classification:	**Routine Maintenance**	

Description and Purpose:

For cutting, removing and disposing of bushes along the side of the road or on slopes to provide good visibility for traffic safety, and alongside ditches, drains and culverts to permit proper drainage.

Performance and Scheduling Considerations:

Schedule when bush growth obscures traffic visibility, reduces headroom height or is preventing proper drainage or when bushes have grown to a size that is beyond the scope of Activity 4-50-001.

Typical Personnel:	**Basic Equipment:**	**Approved Material:**
Foreman Labourers Tractor operator	Handtools: felling saw, motor saw, axes, picks, pangas. 1 tractor and trailer or Tipper	N/A

Method of Measurement:

Work will be measured and paid for on the basis of area of vegetation cut.
The amount of work will vary and the average condition of bush growth is deemed to have been considered by the Contractor when preparing his tender rate. The sections to be measured under this activity will be marked by the Engineer and agreed by the Contractor before work starts.

Unit: m^2

Approved Work Method:

1. Place warning signs and safety devices in accordance with clause 907 of the MOTC of the Standard Specification for Road and Bridge Construction or as directed by the Engineer.
2. Trim grass around bushes.
3. Cut bushes as directed.
4. Remove cut bushes as directed and tidy up the work area.
5. Measure and record the area of bush clearing.
6. Remove all signs and safety devices.

Table 11.29

FEATURE	UNPAVED ROAD	
ACTIVITY SPECIFICATION	Activity No: 10-60-002	Activity Name: GRAVEL PATCHING
Classification:	Routine Maintenance	

Description and Purpose:

For repairing surface and shoulder defects of gravel roads to eliminate potential road surface hazards, provide a smoother riding surface and improve the road surface drainage. This activity comprises excavation, loading, transport and filling of potholes, ruts, soft spots and erosion gullies.

Performance and Scheduling Considerations:

Potholes and gullies etc. shall be filled immediately they become a danger to traffic or threaten the stability of the road. All potholes with distortion of more than 50 mm measured from a 2 m straight edge should be patched as soon as possible.
Emphasise scheduling before and immediately after the seasonal rains.

Typical Personnel:	Basic Equipment:	Approved Material:
Foreman Driver Labourers Traffic controllers	1 tractor 1 trailer Handtools	Only material approved by the Engineer or his representative may be used.

Method of Measurement:

Work will be measured by volume of loose gravel required to fill the patches.

Unit: m^3

Approved Work Method:

1. Place warning signs and safety devices in accordance with clause 907 of the MOTC Standard Specification for Road and Bridge Construction or as directed by the Engineer.
2. Remove standing water if any.
3. Remove loose and unsuitable material (like expansive clay) from potholes/gullies.
4. Large or deep potholes should have their sides cut back to be vertical.
5. Load tipper or trailer by hand from approved gravel pit.
6. Place material directly in the hole from tipper/trailer in thickness of about 100 mm or dump in heap at edge of carriageway.
7. Moisten filling material if needed and compact by hand rammer.
8. The last layer of patching material shall be filled with gravel to approximately 30 mm above the level of surface and compacted to give a surface which is slightly above the level of the surrounding road surface.
9. Record the volume of material used to fill the patches.
10. Remove all signs and safety devices.

Table 11.30

FEATURE	UNPAVED ROAD	
ACTIVITY SPECIFICATION	Activity No: 10-60-003	Activity Name: FILLING (EARTH AND GRAVEL ROADS)
Classification:	Routine Maintenance	

Description and Purpose:

For repairing surface defects of earth or gravel roads, using suitable patching material found at the roadside or transported manually from gravel stockpiles.
The purpose of the activity is to eliminate potential road surface hazards, provide a smoother riding surface and improving the road surface drainage by filling potholes, ruts, soft spots and erosion gullies. This activity also applies to the repair of shoulder defects.
To be used primarily on low volume roads and where the road surface is of the same material as the surrounding natural soil.

Performance and Scheduling Considerations:

Potholes and gullies etc. shall as far as possible be filled immediately they become a danger to traffic or threaten the stability of the road. All spots with distortion of more than 50 mm measured from a
2 m straight edge should be patched as soon as possible.
Emphasise scheduling before and immediately after the seasonal rains.

Typical Personnel:	Basic Equipment:	Approved Material:
Foreman 1Labourer	Handtools	As directed

Method of Measurement:

Work will be measured and paid for on the basis of the volume of material placed.

Unit: m^3

Approved Work Method:

1. Place warning signs and safety devices in accordance with Clause 907 or the MOTC Standard Specification for Road and Bridge Construction or as directed by the Engineer.
2. Remove any standing water.
3. Remove loose and unsuitable material (like expansive clay) from potholes/gullies.
4. Fill with approved and selected natural material from roadside of gravel material in stockpiles along the road by using head pan or wheelbarrow for transporting material.
5. Moisten filling material if needed and compact by hand rammer.
6. Level material to be slightly above the surrounding road surface.
7. Measure and record dimensions (D x W x L) for each area filled.
8. Remove all signs and safety devices.

Technical Specifications:

1. Compaction of patching material is to be done in layers not exceeding 100 mm and by approved hand rammers not less than 10 kg in weight, and continue until no further impression in the material can be made by the rammer.
2. Material used in patching shall be selected as directed by the Engineer. Unsuitable material will be rejected.

Table 11.30

FEATURE	UNPAVED ROAD	
ACTIVITY SPECIFICATION	Activity No: 10-60-003	Activity Name: FILLING (EARTH AND GRAVEL ROADS)
Classification:	Routine Maintenance	

Description and Purpose:

For repairing surface defects of earth or gravel roads, using suitable patching material found at the roadside or transported manually from gravel stockpiles.
The purpose of the activity is to eliminate potential road surface hazards, provide a smoother riding surface and improving the road surface drainage by filling potholes, ruts, soft spots and erosion gullies. This activity also applies to the repair of shoulder defects.
To be used primarily on low volume roads and where the road surface is of the same material as the surrounding natural soil.

Performance and Scheduling Considerations:

Potholes and gullies etc. shall as far as possible be filled immediately they become a danger to traffic or threaten the stability of the road. All spots with distortion of more than 50 mm measured from a
2 m straight edge should be patched as soon as possible.
Emphasise scheduling before and immediately after the seasonal rains.

Typical Personnel:	Basic Equipment:	Approved Material:
Foreman 1Labourer	Handtools	As directed

Method of Measurement:

Work will be measured and paid for on the basis of the volume of material placed.

Unit: m^3

Approved Work Method:

1. Place warning signs and safety devices in accordance with Clause 907 or the MOTC Standard Specification for Road and Bridge Construction or as directed by the Engineer.
2. Remove any standing water.
3. Remove loose and unsuitable material (like expansive clay) from potholes/gullies.
4. Fill with approved and selected natural material from roadside of gravel material in stockpiles along the road by using head pan or wheelbarrow for transporting material.
5. Moisten filling material if needed and compact by hand rammer.
6. Level material to be slightly above the surrounding road surface.
7. Measure and record dimensions (D x W x L) for each area filled.
8. Remove all signs and safety devices.

Technical Specifications:

1. Compaction of patching material is to be done in layers not exceeding 100 mm and by approved hand rammers not less than 10 kg in weight, and continue until no further impression in the material can be made by the rammer.
2. Material used in patching shall be selected as directed by the Engineer. Unsuitable material will be rejected.

Table 11.8

FEATURE	DRAINAGE	
ACTIVITY SPECIFICATION	Activity No: 8-50-002	Activity Name: DITCH CLEANING - MANUAL
Classification:	Routine Maintenance	

Description and Purpose:

For hand cleaning of debris and siltation of side ditches and turnouts including minor reshaping to restore bottom level and gradient in order to ensure free flow of water collected from the roadway. This activity is for the maintenance of existing ditches, which have silted, become clogged or overgrown. If the ditch has deteriorated to such an extent that the invert level is within 300 mm of edge of roadway level, the ditch should be re-excavated under Activity 8-50-006 (regrade/realign ditch).

Performance and Scheduling Considerations:

Schedule throughout the year, but especially prior to the seasonal rains. Special attention is needed throughout the rainy season. In the case of dense grass growth, bush vegetation in the ditch/turnout, schedule Activity 4-50-002/003 before this activity.

Typical Personnel:	Basic Equipment:	Approved Material:
Foreman Labourers Driver (if required)	Handtools; shovels, picks, rakes 1 Tractor with trailer or Tipper (if required)	N/A

Method of Measurement:

Work will be measured and paid for on the basis of the volume excavated. The amount of work will vary along the ditches, but typical condition of the ditches is deemed to have been considered by the Contractor when preparing his tender rate.

Unit: m^3

Approved Work Method:

1. Place warning signs and safety devices in accordance with clause 907 of the MOTC Standard Specification for Road and Bridge Construction or as directed by the Engineer.
2. Cut and remove all large trees and shrub that have commenced growing within drain. Trim all grass within drain to a height of less than 50 mm leaving a short grass cover throughout the extent of the ditch.
3. Remove silt and debris from the bottom of the ditch.
4. Shape inner and back slopes of ditch.
5. Check the invert of the ditch to ensure sufficient fall to remove water and dig out depth of ditch a needed to facilitate water flow. Clear and widen outfall or add turn-outs as needed that water flows away without creating a scour at the end.

FEATURE	DRAINAGE	
ACTIVITY SPECIFICATION	Activity No: 8-50-002	Activity Name: DITCH CLEANING - MANUAL

6. Where digging is needed ensure the side slopes of the ditch to the agreed slope minimising the possibility of scouring and erosion of invert and side slopes.
7. The debris, silt etc. removed from the ditch shall be spread over the area outside the road, and at least 1 metre clear of ditch edge.
8. Use suitable material from reshaping the ditches and turnouts to strengthen turnout block-off.
9. Tidy up the work site.
10. Measure and record the volume excavated.
11. Remove all signs and safety devices.

Technical Specifications:

1. The ditches shall be cleaned of silt and debris as directed.
2. The gradient of the ditch bottom shall be checked by boning rods or string-line levels and reshaped to ensure a continuous slope to the ditch outlet including turnouts.
3. The ditches shall be reshaped and trimmed to provide smooth stable side slopes.
4. Suitable excavated material shall, where directed, be used to strengthen turnout block-offs.
5. Waste material from ditch cleaning shall be spread 1 m clear of the back slope of the ditch, or removed clear of the road and deposited in a suitable location.

Table 11.9

FEATURE	**DRAINAGE**	
ACTIVITY SPECIFICATION	**Activity No: 8-50-003**	**Activity Name: DITCHES-GRASS PLANTING**
Classification:	**Routine and Periodic Maintenance**	

Description and Purpose:

To plant grass/turf on the slopes and inverts of ditches to reduce scour effects.

Performance and Scheduling Considerations:

Schedule after seasonal rains to allow sufficient time for turf to get established before next rains.

Typical Personnel:	**Basic Equipment:**	**Approved Material:**
Foreman Labourers	Tractor and trailer Handtools: shovels, pick-axe	Turf

Method of Measurement:

Work to be measured and paid for on the basis of the area of turf laid.

Unit: m^2

Approved Work Method:

1. Place warning signs and safety devices in accordance with Clause 907 of the MOTC Standard Specification for Road and Bridge Construction or as directed by the Engineer.
2. Remove all silt and debris.
3. Trim ditch cross-section to line and level.
4. Place turfs over section to be repaired.
5. Peg turfs in place.
6. Water section repaired.
7. Tidy site.
8. Remove all signs and warning devices.
9. Regular watering will be required until the turf has established itself and this should be programmed to suit the local climatic conditions.

Technical Specifications:

1. The turf shall be planted to sufficient depth such that the root is fixed firmly in the slope and invert.

Table 11.10

FEATURE	**DRAINAGE**	
ACTIVITY SPECIFICATION	**Activity No: 8-50-004/005**	**Activity Name: DITCHES-EARTH/HARDCORE FILL**
Classification:	**Routine and Periodic Maintenance**	

Description and Purpose:

The placing and compacting of earth or hardcore to the invert and slopes of ditches to reduce scour.

Performance and Scheduling Considerations:

Schedule to be completed before the seasonal rains.

Typical Personnel:	**Basic Equipment:**	**Approved Material:**
Foreman Labourers	Handtools: Shovels Pick-axe Hand rammer Tractor and trailer	Earth or hardcore as approved by the Engineer.

Method of Measurement:

Work to be measured and paid for on the basis of the volume of fill material.

Unit: m^3

Approved Work Method:

1. Place warning signs and safety devices in accordance with Clause 907 of the MOTC Standard Specification for Road and Bridge Construction or as directed by the Engineer.
2. Remove all silt and debris from section to be treated.
3. Remove all soft material from the slope or invert of the ditch.
4. Place earth or hardcore into the affected section.
5. Compact material and trim cross-section to line and level.
6. Tidy up site.
7. Record the volume of fill material used.
8. Remove all signs and warning devices.

Technical Specifications:

1. The gradient of the ditch bottom shall be checked by boning rods or string-line levels and reshaped to ensure a continuous slope to the ditch outlet including turnouts.
2. The ditches shall be reshaped and trimmed to provide smooth stable side slopes.
3. Waste material from ditch cleaning shall be spread 1 m clear of the back slope of the ditch, or removed clear of the road and deposited in a suitable location.

Table 11.11

FEATURE	DRAINAGE	
ACTIVITY SPECIFICATION	Activity No: 8-50-006	Activity Name: REGRADE/REALIGN DITCH
Classification:	Routine and Periodic Maintenance	

Description and Purpose:

To remove material from the ditch to obtain the correct cross-section and grade or to cut a new cross section on a new alignment. Improvement of the earth ditch to using pre-cast concrete block shall be considered.

Performance and Scheduling Considerations:

Schedule to be completed before seasonal rains.

Typical Personnel:	Basic Equipment:	Approved Material:
Foreman Labourers Tractor operator (if necessary)	Handtools: pickaxe, shovels, hoe 1 tractor and trailer (if necessary)	N/A

Method of Measurement:

Work will be measured and paid on the basis of the volume of excavation due to realigned or regraded.

Unit: m^3

Approved Work Method:

1. Place warning signs and safety devices in accordance with Clause 907 of the MOTC Standard Specification for Road and Bridge Construction or as directed by the Engineer.

REGRADING

2. Set out the gradient required using ranging rods, profiles or similar to ensure water will not pond.
3. Use a template to cut the correct cross section at the new grade every 10 metres.
4. Work between these 10 metre points to trim slopes and invert to the correct grade and cross-section.
5. Check gradient with a line and level or abney level.

REALIGNMENT

6. Set out the new alignment with pegs and stringline.
7. Carry out activities 2 and 5 above.
8. Excavated material shall be spread over the area outside the road and at least 1 m clear of the edge of the ditch or removed from site as directed.

9. Tidy up the site.

Table 11.11

FEATURE	DRAINAGE	
ACTIVITY SPECIFICATION	Activity No: 8-50-006	Activity Name: REGRADE/REALIGN DITCH

10. Measure and record the volume excavation due to regraded or realigned.
11. Remove warning signs and other safety devices.

Technical Specifications:

REGRADING

1. Template shall be used every 10 metres.
2. Work between these 10 metre points to trim slopes and invert to the correct grade and cross-section.

REALIGNMENT

1. Template shall be used every 10 metres.
2. Work between these 10 metre points to trim slopes and invert to the correct grade and cross-section.
3. Excavated material shall be spread over the area outside the road and at least 1 m clear of the edge of the ditch or removed from site as directed.

Table 11.12

FEATURE	**DRAINAGE**	
ACTIVITY SPECIFICATION	**Activity No: 8-50-007**	**Activity Name: LINE DITCH**
Classification:	**Routine and Periodic Maintenance**	

Description and Purpose:

To place a lining to the slopes and invert of the ditch to prevent scour.

Performance and Scheduling Considerations:

Work should be completed before the seasonal rains.

Typical Personnel:	**Basic Equipment:**	**Approved Material:**
Foreman Labourers	Handtools: shovels, wheelbarrow	Lining material: Geotextile Precast blocks In-situ concrete as specified

Method of Measurement:

Geotextile work shall be measured and paid on the basis of the area of lining completed.
Precast concrete block work shall be measured and paid for on the basis of the length of block placing completed.
In-situ concrete work shall be measured and paid for on the basis of the volume of concrete used.

Unit: $m^2/m/m^3$

Approved Work Method:

1. Place warning signs and safety devices in accordance with Clause 907 of the MOTC Standard Specification for Road and Bridge Construction or as directed by Engineer.
2. Clear all debris from ditch.
3. Check ditch cross-section and grade to ensure water will not pond.

GEOTEXTILE

4. Lay in accordance with the manufacturer's instructions.

PRECAST CONCRETE BLOCKS

5. Compact soil slopes.
6. Place bed of mortar (1 cement : 4 Sand) on slopes.
7. Place concrete blocks on mortar bed checking for line and level.
8. Grout up joints with mortar.

IN-SITU CONCRETE

FEATURE	DRAINAGE	
ACTIVITY SPECIFICATION	**Activity No: 8-50-007**	**Activity Name: LINE DITCH**

9. Fix temporary wooden stop ends based on the volume of concrete available per batch.
10. Place 15/20 concrete and shape to required cross-section.
11. Measure and record the area of geotextile lining completed, or the length ditch where blocks placed, or the volume of concrete used.
12. Remove warning signs and safety devices.

Technical Specifications:

1. Geotextile shall be as specified by the Engineer.
2. Concrete shall be in accordance with the MOTC Standard Specification for Road and Bridge Construction Section 17 concrete works.

Table 11.13

FEATURE	DRAINAGE	
ACTIVITY SPECIFICATION	Activity No: 8-50-008	Activity Name: CONSTRUCT CASCADE
Classification:	Periodic Maintenance	

Description and Purpose:

To construct a cascade to carry water down a slope where a ditch would not have the capacity or would be subject to erosion.

Performance and Scheduling Considerations:

The cascade will dissipate water energy but may still require an apron or outfall basin at the toe of the slope to avoid erosion.

Complete this activity before the seasonal rains.

Typical Personnel:	Basic Equipment:	Approved Material:
Foreman Labourers	Handtools: shovel, pickaxe, hoe	Stone masonry Brick Cement Sand Water

Method of Measurement:

Work to be measured and paid for on the basis of the area of cascade constructed.

Unit: m^2

Approved Work Method:

1. Place warning signs and safety devices in accordance with Clause 907 of the MOTC Standard Specification for Road and Bridge Construction or as directed by the Engineer.
2. Locate the position of the cascade by local inspection or as instructed by the Engineer.
3. Trim the slope to the cross-section required.
4. If required, construct an apron or outfall basin at the toe of the slope.
5. Starting at the toe, install the cascade in stone masonry, brick, concrete or pre-cast units as directed by the Engineer.
6. Tie in the cascade to the edge drain using in-situ concrete smoothed to assist the flow of water down the cascade.
7. Tidy up the site.
8. Measure and record the area of cascade constructed.
9. Remove all warning signs and other safety devices.

Technical Specifications:

Where grout is specified, 1 cement: 4 sand mortal.

Table 11.14

FEATURE	**DRAINAGE**	
ACTIVITY SPECIFICATION	**Activity No: 8-50-009**	**Activity Name: REPAIR DITCH LINING**
Classification:	**Routine Maintenance**	

Description and Purpose:

To repair damaged sections of ditch lining to avoid erosion of the slopes and possible destruction of the ditch.

Performance and Scheduling Considerations:

Schedule to be completed before seasonal rains. This activity can be combined with ditch cleaning activities.

Typical Personnel:	**Basic Equipment:**	**Approved Material:**
Foreman Labourers Operator	Handtools: shovels, pick-axe	Lining material Cement Sand Water

Method of Measurement:

Work shall be measured and paid for on the basis of the area of lining repaired.

Unit: m^2

Approved Work Method:

1. Place warning signs and safety devices in accordance with Clause 907 of the MOTC Standard Specification for Road and Bridge Construction or as directed by the Engineer.
2. Remove all silt and debris from the section to be repaired.
3. Remove the damaged section of lining.
4. Compact the underlying soil.
5. Backfill with suitable material and compact to correct levels.
6. Replace the lining to correct line and level. Precast sections or blocks should be bedded on mortar.
7. Grout up any open joints with mortar.
8. Tidy up the site.
9. Measure and record the area of lining repaired.
10. Remove all signs and warning devices.

Technical Specifications:

1. Mixing proportion of mortal shall be 1 cement: 4 sand in volume.

Table 11.15

FEATURE	**DRAINAGE**	
ACTIVITY SPECIFICATION	Activity No: **8–50–010**	Activity Name: **CONSTRUCT NEW MITRE DRAIN**
Classification:	Periodic Maintenance	

Description and Purpose:

To construct a new mitre drain to reduce the volume of water being carried in the side drain and reduce the potential for erosion in the side drain.

Performance and Scheduling Considerations:

Typical Personnel:	**Basic Equipment:**	**Approved Material:**
Foreman Operator (if necessary) Labourers	1 Grader (if necessary) Handtools : Shovels, pickaxe	N/A

Method of Measurement:

Work to be measured and paid for on the basis of the volume of excavation done.

Unit: m^3

Approved Work Method:

1. Place warning signs and safety devices in accordance with clause 907 of the MOTC Standard Specification for Road and Bridge Construction or as directed by the Engineer.
2. From local inspection decide on the start and finish points for the mitre drain.
3. Excavate by hand or with the grader blade ensuring there is adequate gradient (2% to 6%) to allow water to flow away from the side drain.
4. The mitre drain should make an angle of between 30^0 and 60^0 with the side drain.
5. The cross-section should be trapezoidal with an invert width of 600mm and 1: 1 side slopes.
6. Compact the sides of the drain to minimise the risk of erosion.
7. Tidy up the site
8. Measure and record the volume of excavation done.
9. Remove warning signs and other safety devices.

Technical Specifications:

1. Vertical gradient shall be ensured 2 to 6% to allow water flow away from the side drain.
2. The mitre drain should make an angle of between 30^0 and 60^0 with the side drain.
3. The cross-section should be trapezoidal with an invert width of 600mm and 1: 1 side slopes.

Table 11.16

FEATURE	**DRAINAGE**	
ACTIVITY SPECIFICATION	**Activity No: 8-60-001**	**Activity Name: CULVERT CLEANING – LIGHT (Partially Blocked)**
Classification:	**Routine Maintenance**	

Description and Purpose:

For cleaning siltation and debris from culvert barrel and inlet/outlet structure to ensure free passage of water.
This activity is not intended to be used when the culvert is fully silted. In such a case 8-60-002 should be used.

Performance and Scheduling Considerations:

Schedule mainly before beginning of the seasonal rains.
Schedule at same time as Activity No. 8-50-001/002 to ensure inlet and outlet ditches are clean.

Typical Personnel:	**Basic Equipment:**	**Approved Material:**
Foreman Labourers	Handtools	N/A

Method of Measurement:

Work will be measured and paid for on the basis of the length of culverts cleaned. The amount of work will vary per culvert and the Contractor is deemed to have considered the typical condition of culverts when preparing his tender rate.

Unit: m

Approved Work Method:

1. Place warning signs and safety devices in accordance with clause 907 of the MOTC Standard Specification for Road and Bridge Construction or as directed by the Engineer.
2. Remove debris, silt, etc. from inlet and outlet of culvert barrel.
3. Remove silt material from culvert barrel if necessary by pulling a bucket through the culvert.
4. Place waste material in a safe location well clear of inlet and outlet ditches or remove from site as directed.
5. Record the length of culvert cleaned.
6. Remove all signs and safety devices.

Technical Specifications:

1. All silt and debris shall be removed from the barrel and the inlet and outlet apron areas.
2. Waste material cleaned from the culvert is to be removed and deposited in a safe location clear from the road and ditches or removed from site as directed.
3. The Engineer will indicate the culverts to be cleaned.

Table 11.17

FEATURE	**DRAINAGE**	
ACTIVITY SPECIFICATION	Activity No: **8-60-002**	Activity Name: **CULVERT CLEANING – HEAVY (Fully Blocked)**
Classification:	Routine Maintenance	

Description and Purpose:

For cleaning siltation and debris from culvert barrel and inlet/outlet structure to ensure free passage of water.

Performance and Scheduling Considerations:

Schedule mainly before beginning of the seasonal rains. Schedule at same time as Activity No. 8-50-001/002 to ensure inlet and outlet ditches are clean.

Typical Personnel:	**Basic Equipment:**	**Approved Material:**
Foreman Labourers	Handtools Water tanker with high pressure pump Air compressor	N/A

Method of Measurement:

Work will be measured and paid for on the basis of the length of culverts cleaned. The amount of work will vary per culvert and the Contractor is deemed to have considered the typical condition of culverts when preparing his tender rate.

Unit: m

Approved Work Method:

1. Place warning signs and safety devices in accordance with clause 907 of the MOTC Standard Specification for Road and Bridge Construction or as directed by the Engineer.
2. For culverts less than 900 mm in diameter, clean all built up material from inside the culverts manually or with a high pressure water hose.
3. For culverts larger than 900 mm manually fill small trolleys and have the material dragged out of the culvert.
4. For large box culverts manually, or by small plant such as bobcats or backhoes, remove excess debris and built up sand, mud and silt from the inlet and outlet of the culvert.
5. Place waste material in a safe location well clear of inlet and outlet ditches or remove from site as directed.
6. Record the length of culvert cleaned.
7. Remove all signs and safety devices.

Table 11.17

FEATURE	DRAINAGE	
ACTIVITY SPECIFICATION	Activity No: **8-60-002**	Activity Name: **CULVERT CLEANING – HEAVY (Fully Blocked)**

Technical Specifications:

1. All silt and debris shall be removed from the barrel and the inlet and outlet apron areas.
2. Waste material cleaned from the culvert is to be removed and deposited in a safe location clear from the road and ditches or removed from site as directed.
3. The Engineer will indicate the culverts to be cleaned.

Table 11.18

FEATURE	**DRAINAGE**	
ACTIVITY SPECIFICATION	Activity No: 8-60-009	Activity Name: **CULVERT/HEADWALL/WINGWALL – CRACK SEALING**
Classification:	Routine and Periodic Maintenance	

Description and Purpose:

The repair of cracking to culvert, headwalls and wingwalls which could result in more serious defects if not repaired.

Performance and Scheduling Considerations:

Schedule mainly before beginning of the seasonal rains.
Schedule after Activity 8-60-001/8-60-002

Typical Personnel:	**Basic Equipment:**	**Approved Material:**
Foreman Labourers	Handtools	Cement or epoxy Sand Water

Method of Measurement:

Work will be measured and paid for on the basis of the length of crack sealed.

Unit: m

Approved Work Method:

1. Place warning signs and safety devices in accordance with clause 907 of the MOTC Standard Specification for Road and Bridge Construction or as directed by the Engineer.
2. Repair cracks by rendering with mortar or epoxy resins to cracking area to ensure sufficient cover for the reinforcing steel.
3. Scrub out the exposed areas to remove all dust, debris and loose ravelling concrete and clean with compressed air or clean out with a brush and water if cracks are big enough.
4. Steel brush any exposed rust off the reinforcement.
5. Dampen the scrubbed or cleaned concrete faces and cracked areas.
6. Prepare a mortar to render the cracks and failures of 1 Cement: 4 Sand or use an approved Epoxy.
7. Trowel the mortar or epoxy into the cracks and failures.
8. Ensure that the finished surface is smooth and even with the existing surface.
9. Recheck invert with a spirit level to ensure fall if patching occurs in the invert.
10. Tidy work site.
11. Record the number of culverts, headwalls or wingwalls repaired.
12. Remove all warning signs and safety devices.

Technical Specifications:

Mixing ratio of the mortar to render the cracks and failures is 1 cement: 4 sand.

Table 11.19

FEATURE	DRAINAGE	
ACTIVITY SPECIFICATION	**Activity No: 8-60-010**	**Activity Name: INSTALLATION OF DEBRIS RACK**
Classification:	**Periodic Maintenance**	

Description and Purpose:

The installation of a grill, grid or post structure at the culvert inlet to hold back floating debris too large to pass through the culvert.

Performance and Scheduling Considerations:

Check that the culvert rack and fixings are available from the workshop or have been delivered by the manufacturer.
After installation, the debris rack should be checked and cleared on a regular basis to ensure the free flow of water through the culvert.

Typical Personnel:	Basic Equipment:	Approved Material:
Foreman Labourers	Handtools: Shovel, pickaxe Hammer Drill Screwdriver	Debris rack Fixings Cement Sand Water

Method of Measurement:

Work to be measured and paid for on the basis of the number of racks installed.

Unit: No

Approved Work Method:

1. Place warning signs and safety devices in accordance with Clause 907 of the MOTC Standard Specification for Road and Bridge Construction or as directed by the Engineer.

FIXED TO CULVERT HEADWALL AT INLET

2. Place the rack in position and clear any silt or debris preventing proper location of the rack.
3. Check the fixing position to ensure the full inlet cross-section is covered.
4. Mark the fixing position and drill holes as necessary in accordance with the manufacturer's instructions or as directed by the Engineer.
5. Fix the rack in position using the fixings provided with the rack. Ensure the rack is secure.

FIXED ACROSS THE INLET AWAY FROM THE CULVERT

6. Check the fixing position to ensure the full inlet cross-section is covered.
7. Secure anchor posts in place on each bank. The posts should be bedded in concrete. Allow 3 days for concrete to set.
8. Place the rack in position and clear any silt or debris preventing proper location of the rack.

FEATURE	DRAINAGE	
ACTIVITY SPECIFICATION	Activity No: 8-60-010	Activity Name: INSTALLATION OF DEBRIS RACK

9. Fix rack to anchor posts using the fixings provided. Ensure the rack is secure.
10. Tidy up the site.
11. Record the number of debris racks installed.
12. Remove all warning signs and other safety devices.

Technical Specifications:

The debris rack is to be installed in accordance with the manufacturer's instructions or as directed by the Engineer.

Table 11.20

FEATURE	DRAINAGE	
ACTIVITY SPECIFICATION	Activity No: 8-70-001	Activity Name: CULVERT HEADWALL REPAIR
Classification:	Routine Maintenance	

Description and Purpose:

To carry out repairs to damaged headwalls in various materials to prevent the collapse of the headwall and the potential slip of the material and pavement above the culvert.

Performance and Scheduling Considerations:

Typical Personnel:	Basic Equipment:	Approved Material:
Foreman Labourers	Handtools: Shovel, panga Wheelbarrow Masons hammer	Stone Masonry Cement Sand Water

Method of Measurement:

Dry stone or masonry works shall be measured and paid for on the basis of the area of the wall completed.
Concrete work shall be measured and paid for on the basis of the volume of concrete poured in the wall.

Unit: m^2/m^3

Approved Work Method:

1. Place warning signs and safety devices in accordance with Clause 907 of the MOTC Standard Specification for Road and Bridge Construction or as directed by the Engineer.

DRY STONE (No mortar)
2. Remove all loose stones.
3. Use removed stones and stones dislodged from the headwall for the repair.
4. Any additional stones should have a long flat shape with a minimum dimension of 150mm. Shape if necessary with a masons hammer.
5. Lay stones in stretcher bond with soil joints and tap in place.
6. Measure and record the area of the wall completed.

DRY STONE OR MASONRY (Mortar joints)
7. Proceed as 2 to 4 above.
8. Prepare mortar, 1:4 (cement:sand by volume).
9. Lay stones with a bond allowing minimum overlap of $^1/_4$ the length of the smaller stone.

FEATURE	DRAINAGE	
ACTIVITY SPECIFICATION	Activity No: 8-70-001	Activity Name: CULVERT HEADWALL REPAIR

10. Joints should be a minimum of 10mm. No stone should touch another stone but should be laid fully on a mortar bed.
11. Mortar joints on the face of the headwall should be pointed and raked to produce a durable finish.
12. Measure and record the area of the wall completed.

CONCRETE

13. Remove damaged concrete and cut back to sound material.
14. If required, construct formwork around the damaged area.
15. Prepare concrete as directed by the Foreman.
16. Place concrete in the damaged area and tamp or vibrate to reduce air voids.
17. Allow concrete to set, leaving any formwork in place for 3 days.
18. Measure and record the volume of concrete poured in the wall.
19. Tidy up the site.
20. Remove signs and safety devices.

Technical Specifications:

DRY STONE (No mortar)

1. Any additional stones should have a long flat shape with a minimum dimension of 150mm.

DRY STONE OR MASONRY (Mortar joints)

1. Any additional stones should have a long flat shape with a minimum dimension of 150mm.
2. Mortar, 1:4 (cement:sand by volume).
3. Lay stones with a bond allowing minimum overlap of $^1/_4$ the length of the smaller stone.
4. Joints should be a minimum of 10mm.

CONCRETE

1. Concrete shall be left any formwork in place for 3 days.

Table 11.21

FEATURE	DRAINAGE	
ACTIVITY SPECIFICATION	Activity No: 8-70-004/005/006	Activity Name: REPAIR/REPLACE SCOUR CHECKS
Classification:	Routine and Periodic Maintenance	

Description and Purpose:

To repair or replace severely eroded scour checks using masonry, wood, stone or stone pitching and concrete.

Performance and Scheduling Considerations:

Complete activities prior to seasonal rains.

Typical Personnel:	Basic Equipment:	Approved Material:
Foreman Tractor operator Labourers	1 tractor and trailer Handtools: pickaxe, shovels, hoe	Masonry Stone Wood

Method of Measurement:

Work will be measured and paid for on the basis of the number of scour checks completed. The rate is deemed to include all materials required.

Unit: No

Approved Work Method:

1. Place warning signs and safety devices in accordance with Clause 907 of the MOTC Standard Specification for Road and Bridge Construction or as directed by the Engineer.
2. Excavate a slot across the ditch to 100 mm below the ditch invert level.

MASONRY, WOOD, STONE OR STONE PITCHING

3. Place wooden stakes, masonry, stones or stone pitching such that the cross-section of the ditch is fully covered and the top level of the scour check is 100 mm below the level of the edge of the ditch.
4. Place masonry or stones in the ditch invert downstream of the scour check for a distance of 0.5 m to prevent scouring in this area.

5. Tidy up site.
6. Record the number of scour checks completed.
7. Remove warning signs and other safety devices.

Table 11.21

FEATURE	DRAINAGE	
ACTIVITY SPECIFICATION	Activity No: 8-70-004/005/006	Activity Name: REPAIR/REPLACE SCOUR CHECKS

Technical Specifications:

1. The scour checks to be repaired will be specified by the Engineer.
2. All necessary material brought to the site must be included in the unit rate.
3. Waste material shall be removed at least 1 m clear of the back slope of the ditch or removed and deposited in a suitable area.

Table 11.22

FEATURE	**DRAINAGE**	
ACTIVITY SPECIFICATION	**Activity No: 8-70-007**	**Activity Name: STONE PITCHING**
Classification:	**Routine and Periodic Maintenance**	

Description and Purpose:

To provide scour protection at the toe of slopes, at culvert inlets and outlets and in ditches prone to scouring.

Performance and Scheduling Considerations:

Schedule to be completed before the seasonal rains.

Typical Personnel:	**Basic Equipment:**	**Approved Material:**
Foreman Labourers	Handtools: Hoe, shovel, pickaxe	Approved supply of stone.

Method of Measurement:

Work is to be measured and paid for on the basis of the area of stone pitching completed.

Unit: m^2

Approved Work Method:

1. Place warning sign and safety devices in accordance with Clause 907 of the MOTC Standard Specification for Road and Bridge Construction or as directed by the Engineer.
2. The section to be treated shall be trimmed to line and level.
3. Stones shall be set on edge and securely bedded with the largest dimension at right angles to the flow of water. Stones shall be tightly packed to leave the minimum of voids between stones.
4. Fill voids with suitably shaped and tightly wedged spalls.
5. The top of the pitching should be flush with the adjacent material.
6. Where grout is specified, 1: 4 cement : sand mortar shall be rammed into the wetted voids and smoothed off flush with the face of the pitching.
7. Tidy up the site.
8. Measure and record the area of pitching completed.
9. Remove all warning signs and safety devices.

Technical Specifications:

Work should be in accordance with MOTC Standard Specification for Road and Bridge Construction, Clause 710 and 713.

Table 11.23

FEATURE	DRAINAGE	
ACTIVITY SPECIFICATION	Activity No: 8-90-001	Activity Name: DRIFT CLEARING
Classification:	Routine Maintenance	

Description and Purpose:

The removal of debris and silt from drifts and causeways to avoid danger to traffic.

Performance and Scheduling Considerations:

Typical Personnel:	Basic Equipment:	Approved Material:
Foreman Labourers	Handtools: Shovels Wheelbarrow	N/A

Method of Measurement:

Work to be measured and paid for on the basis of the volume of debris removed.

Unit: m^3

Approved Work Method:

1. Place warning signs and safety devices in accordance with Clause 907 of the MOTC Standard Specification for Road and Bridge Construction or as directed by the Engineer.
2. Remove all debris and silt from the running surface.
3. Material should be disposed of well clear and downstream of the crossing.
4. Where a motor or towed grader is available, this may be used to clear the running surface, however, the windrow must be spread clear and downstream of the crossing and should allow free passage of water.
5. Tidy the site.
6. Measure and record the volume of debris removed.
7. Remove all warning signs and other safety devices.

Technical Specifications:

1. The drift shall be cleaned of debris and silt as directed.
2. Suitable material shall, where directed, be used to strengthen turnout block-offs.
3. Waste material from drift cleaning shall be spread 1m clear of the downstream of the drift, or removed clear of the road and deposited in a suitable location.

Table 11.24

FEATURE	**DRAINAGE**	
ACTIVITY SPECIFICATION	**Activity No: 8-90-005/ 006**	**Activity Name: DRIFT – REPAIR OF CRACKS/POTHOLES**
Classification:	**Periodic Maintenance**	

Description and Purpose:

The repair of cracks and potholes on drifts and causeway to prevent further deterioration.

Performance and Scheduling Considerations:

Activity to be scheduled after clearing the drift.

Typical Personnel:	**Basic Equipment:**	**Approved Material:**
Foreman Labourers	Handtools: Shovel, pickaxe Broom	Sand Cement Water Bitumen or emulsion Watering can pourer

Method of Measurement:

Cracks (005) to be measured and paid for on the basis of the length of crack repaired.
Potholes (006) to be measured and paid for on the basis of the volume of material filled.

Unit: m/m^3

Approved Work Method:

1. Place warning signs and safety devices in accordance with Clause 907 of the MOTC Standard Specification for road and Bridge Construction or as directed by the Engineer.

CRACKS (005)

2. Cracks should be cleaned out removing all soil, sand and dust.
3. Heat bitumen or emulsion to the required temperature.
4. Use the watering can to pour the bitumen into the cracks. Hold the nozzle of the dispenser as close as possible to the road surface and keep the width of spread as small as possible.

POTHOLES (006)

5. Potholes should be broken out to sound material. The hole should be cleaned of dust and loose material.
6. Fill the hole with concrete, mortared stone or bricks to match the existing materials.
7. Measure and record the volume of material used to fill the potholes.
8. Remove all signs and warning devices after allowing sufficient time for materials to cure or set.

Technical Specifications:

Mixing ratio of the mortal to render the cracks and failures is 1 cement: 2 sand: 4 gravel

Table 11.25

FEATURE	DRAINAGE	
ACTIVITY SPECIFICATION	Activity No: 8-100-001/002	Activity Name: CLEAR MANHOLES/CATCHPITS AND UNDERGROUND PIPES
Classification:	Routine Maintenance	

Description and Purpose:

To remove all silt and debris and wash out manholes, catchpit sumps, and underground pipes.

Performance and Scheduling Considerations:

Schedule to be completed before the seasonal rains.

Typical Personnel:	Basic Equipment:	Approved Material:
Foreman Labourers	Handtools: Shovels, pickaxe Brooms Cover lifting Water jet spray. Buckets Rods Pump and hose	N/A

Method of Measurement:

Work to be measured and paid for on the basis of the number of manholes/catchpits cleaned or the length of pipe cleared.

Unit: No/m

Approved Work Method:

1. Place warning signs and safety devices in accordance with Clause 907 of the MOTC Standard Specification for Road and Bridge Construction or as directed by the Engineer.
2. Before entering manhole, check it is free from noxious gases.
3. Remove cover and clear all debris and silt from all manholes or catchpits.
4. Waste material is to be deposited away from all manholes, catchpits and drainage ditches or removed from site as directed by the Engineer.
5. If water still cannot flow, rod from the manhole downstream of the blockage until the blockage has been removed and water flows freely again.
6. If rodding from the downstream manhole is not successful or not possible, pump water from the water filled manhole and clear the blockage from this manhole using rodding equipment.
7. Wash out manhole/catchpit with water jet spray.
8. Clean cover frame and replace cover.

FEATURE	DRAINAGE	
ACTIVITY SPECIFICATION	**Activity No: 8-100-001/002**	**Activity Name: CLEAR MANHOLES/CATCHPITS AND UNDERGROUND PIPES**

9. Tidy up site.
10. Record the number of manholes/catchpits cleared.
11. Remove all signs and warning devices.

Technical Specifications:

1. Waste material from manholes, catchpits or pipes shall be deposited clear of the surrounding area or removed from site and deposited in a suitable location.
2. If noxious gases are suspected, personnel should **NOT** enter the manhole and the matter should be reported to the Engineer as a matter of urgency.

Table 11.26

FEATURE	DRAINAGE	
ACTIVITY SPECIFICATION	Activity No: 8-100-004	Activity Name: CLEAR MANHOLE AREA
Classification:	Routine Maintenance	

Description and Purpose:

The removal of excess vegetation and silt covering the manhole and surrounding area to enable easy access to the cover. This activity is for manholes located off the carriageway.

Performance and Scheduling Considerations:

Schedule at any time of the year but particularly before seasonal rains.
Schedule together with activity 80-100-001.

Typical Personnel:	Basic Equipment:	Approved Material:
Foreman Labourers	Handtools: Shovels, pickaxe, panga Wheelbarrow.	N/A

Method of Measurement:

Work to be measured and paid for on the basis of the number of manhole areas cleared.

Unit: No

Approved Work Method:

1. Place warning signs and safety devices in accordance with Clause 907 of the MOTC Standard Specification for Road and Bridge Construction or as directed by the Engineer.
2. Locate manhole using drainage plan or by trial excavations.
3. Remove all vegetation within a distance or 2 to 3 metres of the manhole and remove from site.
4. Excavate and remove all deposits of silt or soil covering the manhole cover.
5. Excavate to a depth of 100 mm below the manhole cover for a distance of 1 metre from the edge of the manhole.
6. Remove all surplus material from site.
7. Lift cover and check that the manhole is clear of silt and debris in accordance with Activity 8-100-001.
8. Record the number of manholes cleared.
9. Remove all warning signs and safety devices.

Table 11.26

FEATURE	DRAINAGE	
ACTIVITY SPECIFICATION	Activity No: 8-100-004	Activity Name: CLEAR MANHOLE AREA

Technical Specifications:

1. All vegetation shall be removed within a distance or 2 to 3 metres of the manhole.
2. Excavate to a depth of 100 mm below the manhole cover for a distance of 1 metre from the edge of the manhole.
3. Lift cover and check that the manhole is clear of silt and debris in accordance with Activity 8-100-001.

Table 11.27

FEATURE	UNPAVED ROAD	
ACTIVITY SPECIFICATION	Activity No: 10-50-001/002	Activity Name: HEAVY/LIGHT GRADING
Classification:	Routine Maintenance	

Description and Purpose:

Grading is a trimming of the surface and shoulders of an earth or gravel road which should be carried out on a routine basis to restore a smooth riding surface, camber and cross fall by removing high spots and moving the loose material to fill potholes, corrugations and wheel ruts. This will enable rain water to drain off the surface easily. When undertaking grading, material shall be graded towards the centre of the road. No material is added as a part of this activity, but loose rocks, roots and grass shall be removed.
Heavy grading will be carried out with a motor grader or heavy towed grader.
Light grading will be carried out with a light towed grader.

Performance and Scheduling Considerations:

Work is best scheduled after a period of rain when the surface material is moist as this will greatly help compaction of the loosened material by traffic. Roads should be graded when at least one of the following surface conditions exist:

a. Loss of camber having resulted in cross falls less than approximately 3%.
b. Corrugations or ruts with depth of more than approximately 40 mm.
c. Ridges of loose surface material have developed in the centre or on the edge of the road.

If adjacent ditches require cleaning, Activity 8-50-001/002, should be scheduled at least four weeks prior to this Activity.

Typical Personnel:	Basic Equipment:	Approved Material:
Foreman Tractor operator Grader operator Labourers	1 tractor 1 motor grader (Heavy) 1 towed grader (Heavy or light) 1 camber board and spirit level 2 shovels	N/A

Table 11.27

FEATURE	UNPAVED ROAD	
ACTIVITY SPECIFICATION	Activity No: 10-50-001/002	Activity Name: HEAVY/LIGHT GRADING

Method of Measurement:

Work will be measured on the basis of the area graded.

Unit: m^2

Approved Work Method:

1. Place warning signs and safety devices in accordance with Clause 907 of the MOTC Standard Specification for Road and Bridge Construction or as directed by the Engineer.
2. When grading under moist conditions, material shall be graded from both edges of road towards the centre of road. The windrowed material is thereafter spread back across the road depositing all the material to give the correct camber.
3. Where compaction has been instructed, the compaction plant must follow close behind the grader but only on sections where grading has been completed.
4. Check camber at approximately 100 metres intervals along the road.
5. Remove oversize stones and foreign matters.
6. Clear the site.
7. Measure and record the number of area regraded.
8. Remove warning signs and other safety devices.

Technical Specifications:

1. Grading must be carried out over the full width of the road including the shoulder.
2. The blade shall be angled to maintain and /or restore adequate camber of 5-8%.
3. The number of passes per km will vary according to the width of the blade and the width of the road.

Table 11.28

FEATURE	UNPAVED ROAD	
ACTIVITY SPECIFICATION	Activity No: 10-60-001	Activity Name: SPOT PATCHING (Earth and Gravel Roads)
Classification:	Routine Maintenance	

Description and Purpose:

The repair of potholes, soft spots or other surface defects on unpaved roads.

Performance and Scheduling Considerations:

Patching work started must not be left unfinished overnight.

Typical Personnel:	Basic Equipment:	Approved Material:
Foreman Labourers	Handtools: Shovels, pickaxe Hand rammer Watering can	Gravel Suitable earth fill Water

Method of Measurement:

The work will be measured and paid for on the basis of the volume of materials filled. The Contractor is deemed to have allowed for varying depths of patching depending on the severity of the defect.

Unit: m^3

Approved Work Method:

1. Place warning signs and safety devices in accordance with Clause 907 of the MOTC Standard Specification for Road and Bridge Construction or as directed by the Engineer.
2. Mark out squares or rectangles around area to be patched.
3. Include all failed areas within patches and make at least two sides parallel to the direction of traffic flow.
4. Make marking at least 150 mm from the edge of the damage and within sound and undamaged material.
5. Cut along the lines marked on the surface to depth to ensure that the excavation ends in sound in-situ material.
6. Cut the sides vertical and level the bottom of hole.
7. Remove material from hole.
8. Ensure that excavation is clean, hard and dry.
9. Compact the bottom of the patch and ensure that the base of excavation is sound and flat.
10. If the material is dry, the area to be patched should be sprinkled with water and water should also be added to the patching material.
11. Back-fill with approved material in layers not exceeding 150mm depth of loose fill.

Table 11.28

FEATURE	UNPAVED ROAD	
ACTIVITY SPECIFICATION	Activity No: 10-60-001	Activity Name: SPOT PATCHING (Earth and Gravel Roads)

12. Compact material using suitable tampers or compaction equipment, starting around the edges and working into the centre of the patch. Ensure that all edges and corners are compacted uniformly up to line and grade of the existing road pavement.
13. Ensure that the finished patch is approximately 12 mm above the existing pavement to accommodate subsequent subsidence.
14. Tidy up site.
15. Measure and record the volume of materials filled.
16. Remove warning signs and other safety devices.

Technical Specifications:

1. Marking shall be made at least 150mm from the edge of the damage and within sound and undamaged material.
2. Back-fill with approved material in layers not exceeding 150mm depth of loose fill.
3. Finished patch shall be ensured approximately 12 mm above the existing pavement to accommodate subsequent subsidence.

Table 11.29

FEATURE	UNPAVED ROAD	
ACTIVITY SPECIFICATION	Activity No: 10-60-002	Activity Name: GRAVEL PATCHING
Classification:	Routine Maintenance	

Description and Purpose:

For repairing surface and shoulder defects of gravel roads to eliminate potential road surface hazards, provide a smoother riding surface and improve the road surface drainage. This activity comprises excavation, loading, transport and filling of potholes, ruts, soft spots and erosion gullies.

Performance and Scheduling Considerations:

Potholes and gullies etc. shall be filled immediately they become a danger to traffic or threaten the stability of the road. All potholes with distortion of more than 50 mm measured from a 2 m straight edge should be patched as soon as possible.
Emphasise scheduling before and immediately after the seasonal rains.

Typical Personnel:	Basic Equipment:	Approved Material:
Foreman Driver Labourers Traffic controllers	1 tractor 1 trailer Handtools	Only material approved by the Engineer or his representative may be used.

Method of Measurement:

Work will be measured by volume of loose gravel required to fill the patches.

Unit: m^3

Approved Work Method:

1. Place warning signs and safety devices in accordance with clause 907 of the MOTC Standard Specification for Road and Bridge Construction or as directed by the Engineer.
2. Remove standing water if any.
3. Remove loose and unsuitable material (like expansive clay) from potholes/gullies.
4. Large or deep potholes should have their sides cut back to be vertical.
5. Load tipper or trailer by hand from approved gravel pit.
6. Place material directly in the hole from tipper/trailer in thickness of about 100 mm or dump in heap at edge of carriageway.
7. Moisten filling material if needed and compact by hand rammer.
8. The last layer of patching material shall be filled with gravel to approximately 30 mm above the level of surface and compacted to give a surface which is slightly above the level of the surrounding road surface.
9. Record the volume of material used to fill the patches.
10. Remove all signs and safety devices.

Table 11.29

FEATURE	UNPAVED ROAD	
ACTIVITY SPECIFICATION	Activity No: 10-60-002	Activity Name: GRAVEL PATCHING

Technical Specifications:

1. Compaction of patching material is to be done in layers not exceeding 100 mm and by approved hand rammers not less than 10 kg in weight, and continued until no further impression in the material can be made by the rammer.
2. Gravel used in patching shall be taken from gravel pits approved by the Engineer. Unsuitable material used will be rejected.
3. When gravel is dry, it shall be moistened prior to compaction.

Table 11.30

FEATURE	UNPAVED ROAD	
ACTIVITY SPECIFICATION	Activity No: 10-60-003	Activity Name: FILLING (EARTH AND GRAVEL ROADS)
Classification:	Routine Maintenance	

Description and Purpose:

For repairing surface defects of earth or gravel roads, using suitable patching material found at the roadside or transported manually from gravel stockpiles.
The purpose of the activity is to eliminate potential road surface hazards, provide a smoother riding surface and improving the road surface drainage by filling potholes, ruts, soft spots and erosion gullies. This activity also applies to the repair of shoulder defects.
To be used primarily on low volume roads and where the road surface is of the same material as the surrounding natural soil.

Performance and Scheduling Considerations:

Potholes and gullies etc. shall as far as possible be filled immediately they become a danger to traffic or threaten the stability of the road. All spots with distortion of more than 50 mm measured from a
2 m straight edge should be patched as soon as possible.
Emphasise scheduling before and immediately after the seasonal rains.

Typical Personnel:	Basic Equipment:	Approved Material:
Foreman 1Labourer	Handtools	As directed

Method of Measurement:

Work will be measured and paid for on the basis of the volume of material placed.

Unit: m^3

Approved Work Method:

1. Place warning signs and safety devices in accordance with Clause 907 or the MOTC Standard Specification for Road and Bridge Construction or as directed by the Engineer.
2. Remove any standing water.
3. Remove loose and unsuitable material (like expansive clay) from potholes/gullies.
4. Fill with approved and selected natural material from roadside of gravel material in stockpiles along the road by using head pan or wheelbarrow for transporting material.
5. Moisten filling material if needed and compact by hand rammer.
6. Level material to be slightly above the surrounding road surface.
7. Measure and record dimensions (D x W x L) for each area filled.
8. Remove all signs and safety devices.

Technical Specifications:

1. Compaction of patching material is to be done in layers not exceeding 100 mm and by approved hand rammers not less than 10 kg in weight, and continue until no further impression in the material can be made by the rammer.
2. Material used in patching shall be selected as directed by the Engineer. Unsuitable material will be rejected.

Table 11.31

FEATURE	**UNPAVED ROAD**	
ACTIVITY SPECIFICATION	Activity No: **10-70-001**	Activity Name: **REGRAVELLING**
Classification:	Periodic Maintenance	

Description and Purpose:

To reinstate full gravel thickness. This activity can be carried out using machine-based or labour-based methods.

Performance and Scheduling Considerations:

Schedule before all gravel material is worn away. Schedule after any required reshaping or drainage works are completed.
Schedule to complete before seasonal rains.

Typical Personnel:	**Basic Equipment:**	**Approved Material:**
Foreman Operator Labourers	Grader Camber board and spirit level Powered or hand roller	Gravel (Approved source) Water

Method of Measurement:

Work to be measured and paid for on the basis of the volume of regravelling. Contractors are deemed to have taken account of the variation in road width which may vary the amount of regravelling work.

Unit: m^3

Approved Work Method:

1. Place warning signs and safety devices in accordance with Clause 907 of the MOTC Standard Specification for Road and Bridge Construction or as directed by the Engineer.
2. Grade the road surface to provide a firm, regular base on which to work.
3. Water and compact graded surface.
4. Spread the gravel and water.
5. Compact gravel.
6. Tidy site.
7. Measure and record the volume of gravel used.
8. Remove any warning signs and safety devices.

Technical Specifications:

1. Camber shall be checked by a camber bound and spirit level.
2. Moisture content, compaction ratio of the gravel shall be checked in accordance with the specified value, and shall be inspected and approved by the Engineer.

Table 11.32

FEATURE	UNPAVED ROAD	
ACTIVITY SPECIFICATION	Activity No: 10-90-001	Activity Name: DRAGGING
Classification:	Routine Maintenance	

Description and Purpose:

Regular and frequent dragging can be used, in the dry season, to delay the formation of corrugations on earth and gravel roads by removing loose material from the surface. Dragging will not remove severe corrugations once they have formed, nor will it restore camber or lost material. These defects must be corrected by grading or reshaping. Dragging can be used for repair of minor surface defects by moving loose materials from high spots to minor potholes, ruts and corrugations. No additional material is provided as part of this activity.

Performance and Scheduling Considerations:

In general drag the road when long stretches of corrugations, minor potholes, wheel ruts or ridges of loose gravel occur. The best result can be achieved under slightly "moist" conditions.
Only to be used where the road surface material is relatively loose.
Emphasise scheduling in the periods between seasonal rains.

Typical Personnel:	Basic Equipment:	Approved Material:
Foreman Tractor operator Labourer	1 tractor 1 drag	N/A

Method of Measurement:

Work will be measured on the basis of the area dragged.

Unit: m^2

Approved Work Method:

1. Place warning signs and safety devices in accordance with clause 907 of the MOTC Standard Specification for Road and Bridge Construction or as directed by the Engineer.
2. Adjust weight of drag and/or angle of cutting blades relative to direction of traffic to suit the surface material type and the type of drag.
3. Carry out dragging of the road surface at a speed of 5 – 10 km/h. Two-lane roads will require four passes with the drag to cover the full width of the road, while two passes are sufficient on single-lane roads (3.5 m width or less). For safety reasons the dragging shall be carried out in the same direction as the traffic flow.
4. Measure and record the area dragged.
5. Remove all signs and safety devices.

Technical Specifications:

1. Only drags approved by the Engineer are to be used. Drags constructed of old grader blades, steel rails or rolled steel joists or similar.
2. Dragging must be carried out over the full width of the road.
3. The number of passes per km will vary according to the width of the drag and the width of the road.

Table 11.33

FEATURE	UNPAVED ROAD	
ACTIVITY SPECIFICATION	Activity No: 10-90-002	Activity Name: RESHAPING (Labour – based)
Classification:	Routine Maintenance	

Description and Purpose:

To restore the camber on earth or gravel roads by returning material from the road sides and shoulder towards the centre of the road. This will enable water to run off the carriageway more easily reducing the chances of water damage to the surface..

Performance and Scheduling Considerations:

Schedule after seasonal rains.

Typical Personnel:	Basic Equipment:	Approved Material:
Foreman Labourers	Handtools: Pickaxe, shovel, hoe, rake, hand rammer, wheelbarrow, camber board and spirit level	Earth or gravel as approved on site.

Method of Measurement:

Work will be measured and paid for on the basis of the area reshaped. Contractors are deemed to have taken into account that roads will vary in width and so the volume of work will vary.

Unit: m^2

Approved Work Method:

1. Place warning signs and safety devices in accordance with Clause 907 of the MOTC Standard Specification for Road and Bridge Construction or as directed by the Engineer.
2. The road surface material is trimmed with a pickaxe or hoe and is raked from the edges or shoulder towards the centre of the road to form the required camber.
3. Local depressions should be filled with material approved on site.
4. All loose material shall be compacted.
5. Tidy up the site.
6. Measure and record the area reshaped.
7. Remove all warning signs and safety devices.

Technical Specifications:

1. The camber is checked with a camber board and spirit level.
2. Compaction of loose material shall be done by hand rammer.

Table 11.34

FEATURE	UNPAVED ROAD SHOULDERS	
ACTIVITY SPECIFICATION	Activity No: 11–50–003	Activity Name: SHOULDER RECONSTRUCTION-MECHANICAL
Classification:	Periodic Maintenance	

Description and Purpose:

The repair of shoulders that have settled or been damaged by traffic or water.

Performance and Scheduling Considerations:

Typical Personnel:	Basic Equipment:	Approved Material:
Foreman Operators Labourers	Motor grader or towed grader Tractor and trailer Roller Hand tools: Shovel, wheelbarrow Camber board and spirit level.	

Method of Measurement:

Work should be measured and paid for on the basis of the volume of shoulder material placed and compacted.

Unit: m^3

Approved Work Method:

1. Place warning sign and safety devices in accordance with Clause 907 of the MOTC Standard Specification for Road and Bridge Construction or as directed by the Engineer.
2. Scarify the surface with the tines on the grader to loosen the surface and allow a key for the new material.
3. New shoulder material should be off-loaded or tipped on the shoulder.
4. The new material should be shaped to slightly above the final level at the correct cross-fall using the grader. Care should be taken not to damage the edge of the carriageway with the blade.
5. Check the cross-fall of the uncompacted material with a camber board and spirit level.
6. Excess material should be graded to the embankment side slope. In cuttings, excess material should be graded into a windrow for removal. Material should not be deposited on the carriageway or into the drainage system.
7. If the material is dry it should be sprinkled with water.
8. Compact the shoulder using a self propelled, towed or pedestrian roller. The compacted surface should butt smoothly onto the road pavement.
9. Check the cross-fall with a camber board and spirit level and reshape as necessary.

FEATURE	UNPAVED ROAD SHOULDERS	
ACTIVITY SPECIFICATION	**Activity No: 11–50–003**	**Activity Name: SHOULDER RECONSTRUCTION-MECHANICAL**

10. Brush all loose material from the carriageway and drainage system.
11. Tidy up the site.
12. Record the volume of new material placed.
13. Remove all signs and warning devices.

Technical Specifications:

1. Cross-fall of the shoulder shall be checked with a camber board and spirit level.

Table 11.35

FEATURE	**UNPAVED ROAD SHOULDERS**	
ACTIVITY SPECIFICATION	Activity No: **11–50–004**	Activity Name: **SHOULDER RECONSTRUCTION-MANUAL**
Classification:	Periodic Maintenance	

Description and Purpose:

The repair of shoulders that have settled or been damaged by traffic or water.

Performance and Scheduling Considerations:

Typical Personnel:	**Basic Equipment:**	**Approved Material:**
Foreman Labourers	Handtools: shovel, pickaxe, wheelbarrow, mattock Camber board and sprit level. Hand rammer or hand roller	

Method of Measurement:

Work shall be measured and paid for on the basis of the volume of shoulder material placed and compacted

Unit: m^3

Approved Work Method:

1. Place warning sign and safety devices in accordance with Clause 907 of the MOTC Standard Specification for Road and Bridge Construction or as directed by the Engineer.
2. The existing surface of the shoulder should be loosened with a pickaxe or mattock to allow a key for the added material.
3. New shoulder material should be off-loaded or tipped on the shoulder.
4. The added material should be shaped to slightly above the final level and at the correct crossfall using a shovel/hoe and rake.
5. The cross-fall of the uncompacted material should be checked with a camber board and spirit level.
6. Excess material should be collected and transported by wheelbarrow for use further along the shoulder or discarded safely by spreading over the embankment slope or at a convenient location.
7. If the material is dry it should be sprinkled with water, using containers or a small water bowser.
8. The shoulder should be compacted using a hand rammer or hand roller. The compacted surface should butt smoothly onto the road pavement.
9. Check the cross-fall with a camber board and spirit level and reshape as necessary.
10. Brush all loose material from the carriageway and drainage system.
11. Tidy up the site.
12. Record the volume of new material placed.
13. Remove all signs and warning devices.

Technical Specifications:

Cross-fall of the shoulder shall be checked with a camber board and spirit level.

Table 11.36

FEATURE	PAVED ROAD CARRIAGEWAY	
ACTIVITY SPECIFICATION	Activity No: 15-50-001/02/003	Activity Name: PATCHING
Classification:	Routine Maintenance	

Description and Purpose:

For the repair of defects on bituminous surfaced roads by placing premix mixed on site (001), premix from stockpile (002), or by placing aggregate and penetrating with liquid bitumen (003). This activity comprises patching of potholes, shoving, depressions, ruts, mesh cracking and pavement edge defects, preparation of defect, filling with approved material and compaction.

Performance and Scheduling Considerations:

Schedule the repair of the defects dangerous to traffic as soon as they can be made free of standing water. Emphasise scheduling before and immediately after seasonal rains. All patching activity is to be completed in a single day.
Before start of work three things need to be done.

- Examine the section of road to be repaired to determine the types of defect to be repaired and the extent of the defects.
- Verify that materials required for the repairs are available.
- Verify that all items of equipment including handtools are available.

Typical Personnel:	Basic Equipment:	Approved Material:
Foreman Operators Labourers Traffic controllers	1 tractor and trailer or tipper 1pedestrian roller Handtools Bitumen dispenser	Bituminous premix (001 and 002) Bitumen (003) Sand (003) Chippings (003) Gravel (001, 002, 003)

Method of Measurement:

Work will be measured on the basis of the volume of premix or bitumen penetrated gravel material placed. The quantity shall be calculated from the size of the area repaired multiplied by 50 mm standard depth. The contractor is deemed to have included in his rate an allowance for backfilling with any base material required.

Unit: m^3

Approved Work Method:

1. Place warning signs and safety devices in accordance with Clause 907 of the MOTC Standard Specification for Road and Bridge Construction or as directed by the Engineer.
2. Mark out the areas to be repaired by chalk or spray paint. Include all failed areas within patches and make two sides parallel to the direction of traffic flow. Make marking at least 150mm from the edge of the pothole or failed area and within sound and undamaged pavement.

FEATURE	PAVED ROAD CARRIAGEWAY	
ACTIVITY SPECIFICATION	Activity No: 15-50-001/02/003	Activity Name: PATCHING

3. Remove standing water.
4. Cut back to sound road base course material so that the sides are vertical.
5. Remove any unsuitable material from area to be repaired. Ensure that dust is swept or blown out of the area to be repaired.
6. Backfill with approved base material and compact in layer of not more than 100 mm. Level the base material at 50 mm below road surface.
7. Prime sides and base with approved bitumen or bitumen emulsion.
8. Place either premix bitumen material (001 and 002) or approved well graded aggregate and penetrating with liquid bitumen (003).
9. Clear local roadside drainage to prevent standing water.
10. Tidy working area.
11. Measure and record the volume of premix or bitumen penetrated gravel material placed.
12. Remove all warning signs and safety devices.

Technical Specifications:

1. Gravel used in patching shall be taken from gravel pits approved by the Engineer.
2. When gravel is dry, it shall be moistened prior to compaction.
3. Compaction of patching material is to be done in layers not exceeding 100 mm by pedestrian roller or by approved hand rammers not less than 10 kg in weight, until no further impression in the material can be made by the roller/rammer
4. Premix may be prepared on site, or elsewhere and should be of the following proportions: 4 parts 12.5 mm aggregates: 1 part quarry dust: 5% by volume bitumen binder. Mixing shall be by mixer or by hand and shall continue until a thorough mix is obtained. If mixed by hand the quantity mixed at one time shall not exceed 1 m^3.
5. Chippings shall be from an approved source.

Table 11.37

FEATURE	PAVED ROAD CARRIAGEWAY	
ACTIVITY SPECIFICATION	Activity No: 15-60-001	Activity Name: SPOT SEALING
Classification:	Routine Maintenance	

Description and Purpose:

The repair of alligator cracking on a surface dressed or asphaltic concrete carriageway and shoulders.

Performance and Scheduling Considerations:

Schedule to complete before seasonal rains to prevent water penetration into the pavement which may cause early failure.

Typical Personnel:	Basic Equipment:	Approved Material:
Foreman Labourers	Wire brush Air compressor and hose Brush Bitumen dispenser (hand lance or watering can)	Bitumen or emulsion

Method of Measurement:

Work shall be measured and paid on the basis of the area of area sealed.

Unit: m^2

Approved Work Method:

1. Place warning signs and safety devices in accordance with Clause 907 of the MOTC Standard Specification for Road and Bridge Construction or as directed by the Engineer.
2. Use wire brush or compressed air to clean crack and remove all loose particles.
3. Mark the area to be sealed at least 150 mm outside any cracked area of the road surface, with two sides parallel to the direction of traffic.
4. Sweep away all dust and loose particles from alongside crack.
5. Ensure that the area is completely dry.
6. For cracks greater than 6 mm clean out to a depth equal to or greater than 10 mm, preferably by use of a routing cutting machine.
7. Produce a slurry by mixing emulsion with 5 mm chippings (aggregate) in the ratio of 6 litres of emulsion to 20 kilograms of 5 mm chippings in a mixer or a barrow.
8. Using flat edged rakes or mops spread the slurry in a thin layer of approximately 5 mm thickness over the whole marked area
9. Allow the area to dry completely before allowing traffic to pass over repair.
10. Tidy up the area.
11. Measure and record area of completed sealing.
12. Remove all warning signs and safety devices.

Table 11.37

FEATURE	PAVED ROAD CARRIAGEWAY	
ACTIVITY SPECIFICATION	Activity No: 15-60-001	Activity Name: SPOT SEALING

Technical Specifications:

1. The area to be sealed is at least 150 mm outside any cracked area of the road surface, with two sides parallel to the direction of traffic.
2. For cracks greater than 6 mm clean out to a depth equal to or greater than 10 mm, preferably by use of a routing cutting machine.
3. Slurry by mixing emulsion with 5 mm chippings (aggregate) in the ratio of 6 litres of emulsion to 20 kilograms of 5 mm chippings in a mixer or a barrow.
4. Slurry layer shall be spread of approximately 5mm thickness over the whole marked area.

Table 11.38

FEATURE	**PAVED ROAD CARRIAGEWAY**	
ACTIVITY SPECIFICATION	Activity No: **15-60-002**	Activity Name: **CRACK SEALING**
Classification:	Routine Maintenance	

Description and Purpose:

The Repair to transverse or longitudinal cracking on a surface dressed or asphaltic concrete carriageway or shoulder.

Performance and Scheduling Considerations:

Schedule to complete before seasonal rains to prevent water penetration into the pavement which may cause early failure.

Typical Personnel:	**Basic Equipment:**	**Approved Material:**
Foreman Labourers	Wire brush Air compressor and hose Brush Bitumen dispenser (hand lance or watering can) Rakes or maps and Tamper	Bitumen or emulsion Chippings

Method of Measurement:

Work shall be measured and paid on the basis of length of crack sealed.

Unit: m

Approved Work Method:

1. Place warning signs and safety devices in accordance with Clause 907 or the MOTC Standard Specification for Road and Bridge Construction or as directed by the Engineer.
2. Use wire brush or compressed air to clean crack and remove all loose particles.
3. Sweep away all dust and loose particles from alongside crack.
4. Ensure that the area is completely dry.
5. For cracks greater than 6 mm clean out to a depth equal to or greater than 10 mm, preferably by use of a routing cutting machine.
6. Heat cut-back bitumen or emulsion to the specified temperature.
7. Spray by bitumen hand lance or pour by watering can the bitumen product into the cracks following the crack pattern.
8. Hold the nozzle of the dispenser as close as possible to the road surface and keep the width of spread to as small as possible.
9. Spread 5 mm chippings (aggregate) over the strip of binder by using suitable hand tool dispenser.
10. Lightly tamp the chippings into the binder.
11. Tidy up work area.
12. Measure and record length of longitudinal and transverse cracks sealed.
13. Remove all warning signs and safety devices.

Technical Specifications:

1. For cracks greater than 6 mm clean out to a depth equal to or greater than 10 mm, preferably by use of a routing cutting machine.
2. Spread 5 mm chippings (aggregate) over the strip of binder by using suitable hand tool dispenser.

Table 11.39

FEATURE	PAVED ROAD CARRIAGEWAY	
ACTIVITY SPECIFICATION	Activity No: 15-60-003	Activity Name: RESEALING
Classification:	Periodic Maintenance	

Description and Purpose:

The resealing of a bituminous surface dressed or an asphaltic concrete carriageway or shoulder using chippings and bitumen or emulsion to ensure the proper surface texture by improving skid resistance and eliminating the effects of wear, oxidation, ravelling, fretting, stripping and bleeding.

Performance and Scheduling Considerations:

Schedule to complete before seasonal rains to prevent water penetration into the pavement which may cause early failure.

Typical Personnel:	Basic Equipment:	Approved Material:
Foreman Operators Labourers	Bitumen distributor Chip spreader Pneumatic tyred roller Brushes or rotary broom	AC-10 Bitumen Bitumen emulsion Chippings

Method of Measurement:

Work will be measured and paid for on the basis of the area of road sealed. Contractors are deemed to have allowed for all materials (bitumen, emulsion, chippings) in their rates.

Unit: m^2

Approved Work Method:

1. Place warning signs and safety devices in accordance with Clause 907 of the MOTC Standard Specification for Road and Bridge Construction or as directed by the Engineer.
2. Clearly mark out the extent of road to be resealed by painting a line across the full width of the road pavement at the start and finish of the area to be sealed.
3. Repair potholes and edge failures.
4. Sweep the full extent of the area to be sealed by tractor broom or hand broom to remove all dust and deposited dirt.
5. Mark the start and finish of the initial bitumen sprayer run which will be dependent on the amount of chippings in spreading trucks on site at the time of spraying.
6. Mark with paint, string-line or small stones the edge line for the sprayer driver to follow.
7. Paper the transverse joints at the start and finish of each run.
8. Set up the Bitumen sprayer 20 metres away from the start of the run and ensure that the spray bar is set to it's correct width and that the driver's guide bar is properly set.
9. Measure and record a dip of the volume of bitumen and sprayer temperature.
10. Immediately behind the bitumen sprayer set-up the chip spreading vehicles.

Table 11.39

FEATURE	PAVED ROAD CARRIAGEWAY	
ACTIVITY SPECIFICATION	Activity No: 15-60-003	Activity Name: RESEALING

11. Set up by the pneumatic tyred rollers immediately behind the chip spreader.
12. The supervisor communicates the hot bitumen application rate clearly to the sprayer driver.
13. Instructor reads off from the chart the correct road speed and communities this speed clearly to the vehicle driver.
14. The bitumen distributor sprays the required rate of bitumen uniformly over the whole extent of the work, without stopping until it has reached the designated finishing point.
15. At the finishing point the driver/operator dips the distributor on flat ground and records the actual bitumen usage.
16. Spread a uniform single layer of chippings from the mechanical chip spreading equipment following close behind the bitumen Distributor.
17. Leave a 150 mm wet edge if needed for the adjoining bitumen run.
18. Ensuring that complete coverage is achieved and that all chippings required are distributed in the work area.
19. Embed the chippings with the pneumatic tyred roller by following close behind at a speed of between 10-15 km/hr.
20. Ensure that the whole mat is uniformly rolled in straight runs.
21. Rollers will continue rolling until instructed to stop and must ensure minimum rolling time is observed.
22. Sweep any excess pile of chippings off the road.
23. Add additional chippings by hand as necessary.
24. If a second coat seal is required immediately after laying the first coat repeat Steps 8 to 23.
25. Ensure that any excess loose chippings from the first coat are removed prior the second coat.
26. Offset Transverse joints on the second coat so not to overlay the same position of first coat.
27. Open road to slow moving traffic and control vehicle speed to minimise flick off of chippings.
28. Clean up and remove waste materials and excess material from shoulders drains and site.
29. Measure and record area resealed.
30. Remove warning signs and safety devices.
31. Return the next day and remove excess chippings or windrows of chippings from the road to ensure a safe traffickable road.

Technical Specifications:

1. Bitumen sprayer shall be set up 20 metres away from the start of the run.
2. Leave a 150 mm wet edge if needed for the adjoining bitumen run.
3. Embed the chippings with the pneumatic tyred roller by following close behind at a speed of between 10-15 km/hr.

Table 11.40

FEATURE	PAVED ROAD CARRIAGEWAY	
ACTIVITY SPECIFICATION	Activity No: 15-70-005	Activity Name: Base Repair
Classification:	Routine Maintenance	

Description and Purpose:

For the repair of base defects on bituminous surfaced roads by placing base material plus premix or aggregate and penetrating with liquid bitumen.

Performance and Scheduling Considerations:

Schedule the repair of defects dangerous to traffic as soon as they can be made free of standing water. Emphasise scheduling before and immediately after seasonal rains. All base repairs are to be completed in a single day.

Typical Personnel:	Basic Equipment:	Approved Material:
Foreman Labourers	Handtools: Shovels, pickaxe Hand rammer, plate compactor or roller	Bituminous premix Bitumen Sand Chippings Gravel

Method of Measurement:

Work shall be measured and paid for on the basis of the volume of material placed and compacted.

Unit: m^3

Approved Work Method:

1. Place warning signs and safety devices in accordance with Clause 907 or the MOTC Standard Specification for Road and Bridge Construction or as directed by the Engineer.
2. Mark out the areas to be repaired by chalk or spray paint making two sides parallel to the direction of traffic flow.
3. Remove standing water.
4. Remove all material from within the marked area.
5. Excavate the marked area down to firm, dry material and trim the walls so they are vertical.
6. Trim the bottom of the hole so that it is flat.
7. Remove all loose material from the hole and ensure the hole is dry and free of water.
8. Backfill with approved base material and compact in layer of not more than 100 mm. Level the base material at 50 mm below road surface.
9. Prime sides and base with approved bitumen or bitumen emulsion.
10. Place either premix bitumen material or approved well graded aggregate and penetrating with liquid bitumen.
11. Clear local roadside drainage to prevent standing water.
12. Tidy working area.
13. Measure and record the volume of material placed.
14. Remove all warning signs and safety devices.

Table 11.40

FEATURE	PAVED ROAD CARRIAGEWAY	
ACTIVITY SPECIFICATION	Activity No: 15-70-005	Activity Name: Base Repair

Technical Specifications:

1. Gravel used in shall be taken from gravel pits approved by the Engineer.
2. When gravel is dry, it shall be moistened prior to compaction.
3. Compaction of material is to be done in layers not exceeding 100 mm by pedestrian roller or by approved hand rammers not less than 10 kg in weight, until no further impression in the material can be made by the roller/rammer
4. Premix may be prepared on site, or elsewhere and should be of the following proportions:
5. 4 parts 12.5 mm aggregates: 1 part quarry dust: 5% by volume bitumen binder.
6. Mixing shall be by mixer or by hand and shall continue until a thorough mix is obtained. If mixed by hand the quantity mixed at one time shall not exceed 1 m3.
7. 5. Chippings shall be from an approved source.

Table 11.41

FEATURE	PAVED ROAD CARRIAGEWAY	
ACTIVITY SPECIFICATION	Activity No: 15-80-002	Activity Name: SLURRY SEALING
Classification:	Periodic Maintenance	

Description and Purpose:

To provide a surface treatment that will seal small cracks and waterproof the surface to prevent ingress of water, to stop ravelling and stripping and to renew the surface texture of old surfacing.

Performance and Scheduling Considerations:

Repair major surface defects such as potholes, rutting or depressions in advance of this activity. Schedule for a dry day.

Typical Personnel:	Basic Equipment:	Approved Material:
Foreman Operator Labourers	Mixer Slurry Machine Pneumatic Tyred Roller Mechanical broom or brushes	Anionic emulsion A4 Or Cationic emulsion K3 Aggregate Filler Water

Method of Measurement:

Work to be measured and paid for on the basis of the area of slurry sealing completed.

Unit: m^2

Approved Work Method:

1. Place warning sings and safety devices in accordance with Clause 907 or the MOTC Standard Specification for Road and Bridge Construction or as directed by the Engineer.
2. Clean area to be treated removing all debris, loose material and dust.
3. Mark start and finish of section to be treated.
4. Mix material in concrete mixer or slurry machine in accordance with the specification requirements.
5. Lay slurry with slurry machine at the rate in the specification.
6. Where instructed by the Engineer, roll with pneumatic tyred roller.
7. Protect from traffic until cured to a firm condition.
8. Measure and record area of treatment.
9. Tidy up the site.
10. Remove warning signs and other safety devices.

Technical Specifications:

Materials and work to be in accordance with Ministry of Public Works Road Department Design Manual Part V Chapter 9.1 (b) and Materials Branch Report No. 339.

Table 11.42

FEATURE	PAVED ROAD CARRIAGEWAY	
ACTIVITY SPECIFICATION	Activity No: 15-80-004	Activity Name: SURFACE DRESSING
Classification:	Periodic Maintenance	

Description and Purpose:

This is used to cover a large surface area where the surface is extremely worn, the surface has become permeable or cracked or there is inadequate surface texture.

Performance and Scheduling Considerations:

This activity must be carried out in dry weather.
Other surface repairs such as, patching or base repairs should be scheduled in advance of this activity.

Typical Personnel:	Basic Equipment:	Approved Material:
Foreman Operators Labourers Flagmen	1 mechanical broom 1 bitumen distributor Chipspreader 1 rubber tyred roller Handtools: shovels, brooms, rakes.	Aggregate Bituminous binder

Method of Measurement:

Work shall be measured and paid for on the basis of the area of completed surface dressing.

Unit: m^2

Approved Work Method:

1. Place warning signs and safety devices in accordance with clause 907 of the MOTC Standard Specification for Road and Bridge Construction or as directed by the Engineer.
2. Clean the road surface so that it is dry and free of dirt or dust.
3. Check, test and adjust the binder distributor to confirm the speed of travel.
4. Place paper strips transversely at the start and finish of each pass. The pass length to be determined by the capacity of the tipper lorries.
5. When gritter lorries, roller and distributor are all ready, distribution of the binder can start.
6. Distribute the aggregate over the spread bitumen by reversing the gritting lorries maintaining approximately 30 m between the distributor and the spread aggregate or use a chipspreader.
7. Add additional aggregate by hand to ensure the surface is completely covered.
8. Use brooms to maintain an even spread of aggregate and to keep the untreated carriageway free of aggregate.
9. Roll the aggregate making a number of passes over the complete surface.
10. Tidy site.
11. Measure site and record the square metres of surface dressing completed.
12. Leave 50 km/h "speed limit" sign and "loose chippings" sign in place but remove other

FEATURE	PAVED ROAD CARRIAGEWAY	
ACTIVITY SPECIFICATION	Activity No: 15-80-004	Activity Name: SURFACE DRESSING

warning signs and safety devices.

13. During the following 5 days, excess chippings shall be removed with a mechanical broom or brushing by hand.
14. When the surface is free of loose chippings, the remaining traffic signs shall be removed

Technical Specifications

Work shall be in accordance with Ministry of Roads and Public Works, Materials Branch Report 339.

Table 11.43

FEATURE	PAVED ROAD CARRIAGEWAY	
ACTIVITY SPECIFICATION	Activity No: 15-80-005	Activity Name: SANDING
Classification:	Routine Maintenance	

Description and Purpose:

For treating a bitumen road surface where excess binder appears on the surface of the pavement.

Performance and Scheduling Considerations:

Work should be scheduled as soon as possible after this defect is found to avoid unnecessary problems for vehicles and pedestrians using the road.

Typical Personnel:	Basic Equipment:	Approved Material:
Foreman Tractor operator Labourers	1 tractor and trailer Handtools: Shovels Brooms	Coarse sand

Method of Measurement:

Work is to be measured and paid for on the basis of the area of road surface sanded.

Unit: m^2

Approved Work Method:

1. Place warning signs and safety devices in accordance with Clause 907 of the MOTC Standard Specification for Road and Bridge Construction or as directed by the Engineer.
2. Sand is scattered by shovel over the affected area from a truck or trailer.
3. The sand should be spread out with a broom so that the excess binder is completely covered and the sand surface is even.
4. Measure and record the area of road surface sanded.
5. Remove all warning signs and safety devices.

Technical Specifications:

1. The affected area of the surface course shall be covered completely with sand.
2. The thickness of the scattered sand shall be enough to absorb flushed bitumen.

Table 11.44

FEATURE	ROAD FURNITURE	
ACTIVITY SPECIFICATION	Activity No: 20-50-003	Activity Name: SIGN CLEANING AND PAINTING
Classification:	Routine Maintenance	

Description and Purpose:

The cleaning of road signs, reflectors and guideposts and painting of sign supporting structures, rear panels of signs, kilometre posts and culvert markers.

Performance and Scheduling Considerations:

This activity should be scheduled after the seasonal rains and if painting, should be scheduled for a dry period.
Activity should be co-ordinated with works under activity 20-50-004.

Typical Personnel:	Basic Equipment:	Approved Material:
Foreman Labourer	Washing cloths, brushes or squeegee Steel brush scrapers Bristle brush Paint brush or roller Ladder or hoist	Ammonia base detergent Paint Clean water Paint brush cleaner

Method of Measurement:

Work will be measured and paid for on the basis of the number of signs, reflectors, or guideposts cleaned or cleaned and painted. The Contractor is deemed to have taken account of the fact that the sign face areas vary and so the amount of cleaning or painting per sign will vary.

Unit: No

Approved Work Method:

1. Place warning signs and safety devices in accordance with Clause 907 of the MOTC Standard Specification for Road and Bridge Construction or as directed by the Engineer.
2. Prepare detergent solution
3. Wash sign face using a cloth, water and detergent solution. Take care not to scratch the surface or damage a reflective paint surface.
4. After washing, remove all traces of detergent with a cloth and soft brush and rinse with water.
5. Clean the back of the sign and the supporting structure using water and a cloth. Use a hand brush to remove dirt from corners of fittings.
6. Where signs or reflectors are contaminated with bitumen or oil streaks, use kerosene for cleaning and then wash down with water.

Table 11.44

FEATURE	ROAD FURNITURE	
ACTIVITY SPECIFICATION	**Activity No: 20-50-003**	**Activity Name: SIGN CLEANING AND PAINTING**

IF PAINTING IS INSTRUCTED

7. Do not paint the front face of the sign.
8. Prepare surfaces to be painted by steel brushing, scraping or sandpapering to remove oxidation and scale.
9. Scrub with clean water using a bristle brush and allow to dry.
10. Apply undercoat and finishing coat in accordance with manufacturer's recommendations.

11. Tidy up the site.
12. Record the number of road signs cleaned/painted.
13. Remove all warning signs and safety devices.

Technical Specifications:

Only approved detergents and paints shall be used. The manufacturers' instructions shall be followed.

Table 11.45

FEATURE	ROAD FURNITURE	
ACTIVITY SPECIFICATION	Activity No: 20-50-004	Activity Name: SIGN REPAIR/REPLACEMENT
Classification:	Routine or Periodic Maintenance	

Description and Purpose:

For the repair or replacement of a damaged road sign or support structure.

Performance and Scheduling Considerations:

Where the damaged sign is a hazard to traffic, schedule as emergency maintenance to make it safe and as soon as possible schedule a full repair or replacement.

Typical Personnel:	Basic Equipment:	Approved Material:
Foreman Labourers Paint sprayer	Panel beating tools Wire brushes Paint brushes, rollers or spraying equipment Shovels, picks Concrete breaker Tractor and trailer or pick-up Hand rammer	Automotive body filler Paint Retro – reflective material Bolts, washers and nuts Cement Sand Aggregate Water

Method of Measurement:

The works shall be measured and paid on the basis of the number of signs repaired or replaced. The Contractor is deemed to have taken into account which signs are to be repaired and which are to be fully or partially replaced. The Contractor is also deemed to have taken into account that the sign face areas vary and so the supporting structures will also vary.

Unit: No

Approved Work Method:

1. Place warning signs and safety devices in accordance with clause 907 of the MOTC Standard Specification for Road and Bridge Construction or as directed by the Engineer.

DAMAGED OR WORN SIGN

2. Remove the sign from the supporting structure and transport to a suitable workshop.
3. Panel beat slightly damaged areas.
4. Remove old retro-reflective material, scale or oxidized paint.
5. Apply automotive body filler to panel-beaten area and sand down to flush finish.
6. Paint or spray undercoat and finish coat on sign face and reverse side.
7. Cut retro-reflective material and affix to sign face.
8. Replace sign on supporting structure (if appropriate).

FEATURE	ROAD FURNITURE	
ACTIVITY SPECIFICATION	Activity No: 20-50-004	Activity Name: SIGN REPAIR/REPLACEMENT

IF SUPPORTING STRUCTURE IS DAMAGED

9. Locate the replacement sign as close as possible to the old one in the correct position and orientation.
10. Excavate new post foundation and trim the sides vertical.
11. For concrete backfill prepare a mix 1 cement: 3 sand: 6 stone adding only enough water to obtain a workable mix.
12. Erect new post in middle of foundation. Use temporary struts to hold in position and check for alignment and orientation. The sign must be slightly turned away from the road to avoid headlight reflection.
13. Pour concrete around posts and compact with a hand rammer or place and compact soil in 100 mm layers.
14. Smooth the concrete to a slight slope downwards away from the post.
15. Clean sign face.
16. Paint sign support.
17. Replace sign.
18. Tidy up site
19. Record the number of signs repaired or replaced.
20. Remove all warning signs or safety devices.

Technical Specifications:

Works shall comply with the Ministry of Transport and Communications Standard Specification for Road and Bridge Construction, Clause 2004.

Table 11.46

FEATURE	ROAD FURNITURE	
ACTIVITY SPECIFICATION	Activity No: 20-50-005	Activity Name: REPLACE GUIDE/MARKER POSTS
Classification:	Routine Maintenance	

Description and Purpose:

To replace damaged or missing guide/marker posts on drifts and causeways.

Performance and Scheduling Considerations:

Schedule as soon as possible after notification of the missing guide posts to maintain the level of traffic safety.

Typical Personnel:	Basic Equipment:	Approved Material:
Foreman Labourer	Handtools: Shovels Hammer Chisels	Guide posts Cement Sand water

Method of Measurement:

Work to be measured and paid for on the basis of the number of guide/marker posts replaced.

Unit: No

Approved Work Method:

1. Place warning signs and safety devices in accordance with Clause 907 of the MOTC Standard Specification for Road and Bridge Construction or as directed by the Engineer.
2. Remove any damaged post from the post socket.
3. Remove any water, sand and loose mortar from the socket.
4. Check that the socket depth is at least 150 mm and enlarge or deepen the hole as necessary.
5. Place the guide post in the socket.
6. Fill the socket with mortar (1 cement: 3 sand) tamping to compact the mortar.
7. Clean up the work site.
8. Count and record the number of guide posts replaced.
9. Remove all signs and warning devices.

Technical Specifications:

1. Socket depth shall be at least 150 mm.
2. Mixing ratio of mortar for filling socket shall be 1 cement: 3 sand.

Table 11.47

FEATURE	ROAD FURNITURE	
ACTIVITY SPECIFICATION	Activity No: 20-60-002	Activity Name: ROAD MARKING (MECHANICAL)
Classification:	Routine or Periodic Maintenance	

Description and Purpose:

The renewal of faded or missing road markings by mechanised methods.

Performance and Scheduling Considerations:

Schedule this activity after seasonal rains and in a dry, warm season. This activity should be scheduled after activities under Items 15 and 50 that may have destroyed the existing road markings.

Typical Personnel:	Basic Equipment:	Approved Material:
Foreman Operator Labourers	Road marking machine Air compressor and airline sweeping brush or mechanical sweeper.	Paint or thermoplastic material.

Method of Measurement:

Work shall be measured and paid for on the basis of the area of road marking applied. The marking widths may vary and this is deemed to have been taken into account in preparing a unit rate.

Unit: m^2

Approved Work Method:

1. Place warning signs and safety devices in accordance with clause 907 of the MOTC Standard Specification for Road and Bridge Construction or as directed by the Engineer.
2. The road surface to be marked shall be thoroughly cleared removing all dust and debris and the road surface shall be completely dry.
3. The markings required shall be marked on the road surface as guide to the machine operator.
4. Paint or thermoplastic material shall be applied by machine to the road surface.
5. Tidy up the site.
6. Measure and record the length of completed road marking.
7. Allow the material to dry in accordance with the manufacturers instructions.
8. Remove all warning signs and safety devices.

Technical Specifications:

Work shall comply with the Ministry of Transport and Communications Standard Specification for Road and Bridge Construction, Clause 2005.

Table 11.48

FEATURE	ROAD FURNITURE	
ACTIVITY SPECIFICATION	Activity No: 20-60-003	Activity Name: ROAD MARKING (MANUAL)
Classification:	Routine or Periodic Maintenance	

Description and Purpose:

The renewal of faded or missing road markings by manual methods.

Performance and Scheduling Considerations:

Schedule this activity after seasonal rains and in a dry, warm season. This activity should be scheduled after activities under Items 15 and 50 that may have destroyed the existing road markings.

Typical Personnel:	Basic Equipment:	Approved Material:
Foreman Labourers	Air compressor and airline Sweeping brush or mechanical sweeper. Paint brush Former Paint pourer	Paint or thermoplastic material.

Method of Measurement:

Work shall be measured and paid for on the basis of the area of road marking applied. The marking widths may vary and this is deemed to have been taken into account in preparing a unit rate.

Unit: m^2

Approved Work Method:

1. Place warning signs and safety devices in accordance with Clause 907 of the MOTC Standard Specification for Road and Bridge Construction or as directed by the Engineer.
2. The road surface to be marked shall be thoroughly cleaned removing all dust and debris and the road surface shall be completely dry.
3. The markings required shall be marked on the road surface.
4. Paint shall be applied to the road surface by brush or by pouring paint into a former.
5. Tidy up the site.
6. Measure and record the length of completed road marking.
7. Allow the material to dry in accordance with the manufacturers instructions.
8. Remove all warning signs and safety devices.

Technical Specifications:

Work shall comply with the Ministry of Transport and Communications Standard Specification for Road and Bridge Construction, Clause 2005.

Table 11.49

FEATURE	ROAD FURNITURE	
ACTIVITY SPECIFICATION	Activity No: 20-70-001	Activity Name: GUARD RAIL REPAIR/REPLACEMENT
Classification:	Routine, Periodic or Emergency Maintenance	

Description and Purpose:

The repair or replacement of damaged sections of guardrail.

Performance and Scheduling Considerations:

Where the guardrail is hazardous to traffic, emergency maintenance should be planned to make it safe. The permanent repair or replacement should be scheduled as soon as possible and should be no later than 10 days after the occurrence of the damage.

Typical Personnel:	Basic Equipment:	Approved Material:
Foreman Labourers	Hand tools: pickaxe, shovel spanners Tractor and trailer or pick-up	Galvanised guardrails Guardrail posts Bolts, washers and nuts Concrete

Method of Measurement:

Work shall be measured and paid for on the basis of the length of guardrail repaired or replaced.

Unit: m

Approved Work Method:

1. Place warning signs and safety devices in accordance with clause 907 of the MOTC Standard Specification for Road and Bridge Construction or as directed by the Engineer.
2. Remove section of guardrail to be replaced.
3. Remove posts from holes and clean out post holes
4. Re-install posts into holes.
5. Lift guardrail into position and bolt to post with overlap in the direction of the traffic.
6. Backfill half the post hole with concrete around the post and compact. Tighten nuts and bolts and check the horizontal and vertical alignment.
7. Backfill with concrete and compact remainder of the post hole.
8. Tidy up the site.
9. Measure and record the linear metres of guardrail repaired or replaced.
10. Remove all warning signs and safety devices.

Technical Specifications:

Works shall be in accordance with the Ministry of Transport and Communications Standard Specification for Road and Bridge Construction clause 2006.

Table 11.50

FEATURE	PAVED ROAD CARRIAGEWAY	
ACTIVITY SPECIFICATION	Activity No: 50-50-002	Activity Name: CRACK SEALING
Classification:	Routine Maintenance	

Description and Purpose:

For the Repair of transverse or longitudinal cracking on carriageway or shoulder paved with cement concrete.

Performance and Scheduling Considerations:

Schedule to complete before seasonal rains to prevent water penetration into the pavement which may cause early failure.

Typical Personnel:	Basic Equipment:	Approved Material:
Foreman Labourers	Wire brush Air compressor and hose Brush Sprayer Sealant dispenser (hand lance or watering can)	Primer Crack sealant Low viscosity latex or epoxy resin

Method of Measurement:

Work shall be measured and paid on the basis of length of crack sealed.

Unit: m

Approved Work Method:

1. Place warning signs and safety devices in accordance with Clause 907 or the MOTC Standard Specification for Road and Bridge Construction or as directed by the Engineer.
2. Use wire brush or compressed air to clean crack and remove all loose particles.
3. Sweep away all dust and loose particles from alongside crack.
4. Ensure that the area is completely dry.
5. Apply primer with sprayer. For progressive cracks as same above in width, to be cut the pavement along the crack previously.
6. Heat crack sealant to the specified temperature.
7. Fill sealant into the cracks following the crack pattern. Hold the nozzle of the dispenser as close as possible to the road surface and keep the width of spread to as small as possible.
8. Check flatness of the pavement surface. If the sealer is projected, scrape and reshape. If the sealer is hollowed, fill with same material.
9. Tidy up work area.
10. Measure and record length of longitudinal and transverse cracks sealed.
11. Remove all warning signs and safety devices.

Technical Specifications:

1. For non-progressive cracks less than 0.5 mm in width, it is applicable low viscosity latex or low viscosity epoxy resin.
2. If the base course is deteriorated, re-construction of base course shall be considered as directed in the No.15-70-005.
3. Temperature of heat sealant is about 170 - 220 degree in general.

Table 11.51

FEATURE	SLOPE PROTECTION	
ACTIVITY SPECIFICATION	Activity No: 60-50-002	Activity Name: RECUT SLOPE/BENCHING
Classification:	Routine and Periodic Maintenance	

Description and Purpose:

The treatment of unstable slopes by cutting to a flatter gradient or the creation of benches (or berms).
Work can be equipment-based or labour-based as appropriate.

Performance and Scheduling Considerations:

Where there is a danger of collapse of the slope, the work should be programmed as emergency maintenance.
Where possible, work should be completed before the seasonal rains.

Typical Personnel:	Basic Equipment:	Approved Material:
Foreman Operator Labourers	1 excavator/dozer Handtools: shovels	N/A

Method of Measurement:

Work to be measured and paid for on the basis of the volume of material excavated. Rate is deemed to include excavation and disposal of surplus material.

Unit: m^3

Approved Work Method:

1. Place warning sign and safety devices in accordance with Clause 907 of the MOTC Standard Specification for Road and Bridge Construction or as directed by the Engineer.
2. Remove all loose or unstable material.

RECUTTING
3. Set out slope as shown on the drawings or as directed by the Engineer.
4. Cut slope by hand or machine to the new slope angle.
5. Remove all surplus material from site.

BENCHING
6. Cut benches as shown on the drawings or as directed by the Engineer.
7. Remove all surplus material from site.
8. Remove warning signs and other safety devices.

Technical Specifications:

Works shall be in accordance with MOTC Standard Specification for Road and Bridge Construction, Section 5.

Table 11.52

FEATURE	SLOPE PROTECTION	
ACTIVITY SPECIFICATION	Activity No: 60-50-003	Activity Name: GRASSING/SEEDING OF SLOPES
Classification:	Routine and Periodic Maintenance	

Description and Purpose:

The establishment of grass on slopes to reduce erosion of the soil and to improve stability.

Performance and Scheduling Considerations:

This activity should only be carried out when the climate and soil conditions are favourable. Advice should be obtained from the local department of agriculture.

Typical Personnel:	Basic Equipment:	Approved Material:
Foreman Labourers	Tractor and trailer Handtools: Shovel Rake Hoe Hand tamper or roller	Turf Grass seed Topsoil Fertiliser Water

Method of Measurement:

The work to be measured and paid for on the basis of the area of completed turfing or seeding.

Unit: m^2

Approved Work Method:

1. Place warning signs and safety devices in accordance with Clause 907 of the MOTC Standard Specification for Road and Bridge Construction or as directed by the Engineer.
2. Prepare area to be turfed to required levels and slopes.

TURFING (Grass sodding)

3. Where no topsoil is present, spread evenly to a depth of not less than 50 mm and water as required.
4. Cover the area with freshly cut turfs (sods) without weeds. Turfs are to have thickly matted roots which should not have dried out.
5. Tamp sods with a tamper or use a hand roller.
6. On slopes, stakes may be used if necessary to hold turfs in position.
7. Water turfs at intervals until the grass takes hold.

FEATURE	SLOPE PROTECTION	
ACTIVITY SPECIFICATION	**Activity No: 60-50-003**	**Activity Name: GRASSING/SEEDING OF SLOPES**

SEEDING

8. Loosen the soil to a depth of 100 mm using handtools.
9. Spread topsoil to a depth of at least 50 mm.
10. Water the area to be seeded.
11. Apply fertiliser in accordance with the manufacturer's instructions.
12. Apply ground limestone at the specified rate and mix into the topsoil.
13. Apply grass seed by hand at the specified rate.
14. Lightly roll the seeded area within 24 hours using a hand roller (only roll if the soil does not stick to the roller).
15. The seeded area should be watered as required until the grass has taken hold.
16. Tidy up the site.
17. Measure and record the area of turfing or seeding completed.
18. Remove all signs and warning devices.

Technical Specifications:

TURFING (Grass sodding)

1. Topsoil shall be spread evenly to a depth of not less than 50mm and water as required.

SEEDING

1. Soil shall be loosened to a depth of 100mm.
2. Topsoil shall be spread to a depth of at least 50mm.
3. Seeded area shall be lightly rolled within 24 hours by hand roller.

Table 11.53

FEATURE	SLOPE PROTECTION	
ACTIVITY SPECIFICATION	Activity No: 60-60-001	Activity Name: SLOPE STABILISATION-SHOTCRETE
Classification:	Routine and Periodic Maintenance	

Description and Purpose:

The application of sprayed concrete to unstable slopes to provide temporary or permanent stability.

Performance and Scheduling Considerations:

Schedule to avoid strong winds and heavy rain.

Typical Personnel:	Basic Equipment:	Approved Material:
Foreman Operator Labourers	Compressor and air hose Concrete spraying equipment	Diamond-shaped wire netting (2 mm x 50 mm) 50 mm diameter PVC pipe. Spray quality concrete Anchor pins.

Method of Measurement

Work to be measured and paid for based on the volume of shotcrete used. The rate is deemed to be inclusive of all materials and labour required.

Unit: m^3

Approved Work Method:

1. Place warning signs and safety devices in accordance with Clause 907 of the MOTC Standard Specification for Road and Bridge Construction or as directed by the Engineer.
2. Remove all unstable rock and dust using pressurised water or air.
3. Attach diamond-shaped steel wire netting (2 mm x 50 mm) to the slope to be treated.
4. Place 50 mm diameter PVC pipe for every 3 square metres to provide weep holes.
5. Where the area to be covered is large, place a vertical expansion joint every 20 metres to prevent the spread of shrinkage cracking.
6. Spray concrete in a continuous process until a vertical expansion joint is reached. The depth of shotcrete should be 100 mm to 150 mm as indicated on the drawings or as directed by the Engineer.
7. Tidy up the site.
8. Record the volume of shotcrete.
9. Remove all warning signs and safety devices.

Technical Specifications:

Concrete to have a mix ratio by weight of 1:3:2 for cement: sand: gravel with a water cement ratio of 45%.
Additives may be used to enhance the spraying characteristics of the concrete provided prior written approval is given by the Engineer.

Table 11.54

FEATURE	SLOPE PROTECTION	
ACTIVITY SPECIFICATION	Activity No: **60-60-002**	Activity Name: **GABION INSTALLATION**
Classification:	Routine and Periodic Maintenance	

Description and Purpose:

The placing of gabions to act as a retaining structure after stabilising the slope.

Performance and Scheduling Considerations:

Work should be completed before seasonal rains.
Where there is a danger of a collapse, work should be scheduled as emergency maintenance.

Typical Personnel:	Basic Equipment:	Approved Material:
Foreman Operator Labourers		Gabion mesh or boxes. Selected rock Filter material (if necessary) Binder wire

Method of Measurement:

Work shall be measured and paid for on the basis of the area of the gabion mesh and the volume of the filled rock used for the gabions placed. The rate is deemed to include for all excavation and disposal of material, mesh, rock and filter fabric (if required).

Unit: m^2/m^3

Approved Work Method:

1. Place warning signs and safety devices in accordance with Clause 907 of the MOTC Standard Specification for Road and Bridge Construction or as directed by the Engineer.
2. Remove all loose or unstable material.
3. Trim slope to line and level.
4. Compact the surface upon which gabions are to be laid.
5. Place gabions as shown on the drawings or as directed on site.
6. Adjacent gabions shall be stitched together with binder wire along all touching edges.
7. If gabion boxes are used, they should be laid with a broken bond to avoid continuous joints.
8. If shown on the drawings or where instructed by the Engineer, filter material shall be placed behind the gabion face to be in contact with existing or back filled ground.
9. Where shown on the drawings or instructed by the Engineer, soil should be back filled behind the gabions and compacted.
10. Tidy the site.
11. Measure and record the area of the gabion mesh and the volume of the filled rock.
12. Remove warning signs and other safety devices.

Technical Specifications:
Works shall be carried out in accordance with MOTC Standard Specification for Road and Bridge Construction, Clauses 711 and 713.

Table 11.55

FEATURE	SLOPE PROTECTION	
ACTIVITY SPECIFICATION	Activity No: 60-60-004	Activity Name: RETAINING WALL CONSTRUCTION
Classification:	Periodic Maintenance	

Description and Purpose:

The construction of a retaining wall to support unstable slopes.

Performance and Scheduling Considerations:

Typical Personnel:	Basic Equipment:	Approved Material:
Foreman Operator Labourers	Excavator (if required) Tractor and Trailer Hand tools: shovels, pickaxe	

Method of Measurement:

Work to be measured and paid for on the basis of volume of material used.

Unit: m^3

Approved Work Method:

1. Place warning signs and safety devices in accordance with Clause 907 of the MOTC Standard Specification for Road and Bridge Construction or as directed by Engineer.
2. Excavate foundation in accordance with the drawings.
3. Prepare level foundation bed and compact until firm.
4. Spread 50 mm of mortar (1 cement: 6 sand) or concrete blinding (1 cement: 4 sand: 8 stone) to provide a clean working area and let this set.
5. Construct retaining wall in stone masonry, mass concrete or reinforced concrete as shown on the drawings.
6. Install weep holes as shown on the drawings.
7. Backfill in layers behind the wall using gravel, broken stone, quarry waste or other free draining material.
8. Backfill with soil compacting in layers.
9. Tidy the site.
10. Record the volume of materials used.
11. Remove all signs and warning devices.

Technical Specifications:

1. Mixing ratio of mortar shall be 1 cement: 6 sand, if concrete blinding 1 cement: 4 sand: 8 stone.

Table 11.56

FEATURE	SLOPE & ROAD PROTECTION	
ACTIVITY SPECIFICATION	Activity No: 60-70-002	Activity Name: REMOVE UNSTABLE MATERIAL/ CLEARING SLIP MATERIAL
Classification:	Urgent Maintenance	

Description and Purpose:

The removal of unstable material from slopes and of slip material from the road to avoid danger to road users, to allow the free movement of traffic and the operation of the drainage system.

Performance and Scheduling Considerations:

This activity should be scheduled as soon as is possible after notification of the problem. Care must be taken for the safety of road users and the workforce in case slips may occur.

Typical Personnel:	Basic Equipment:	Approved Material:
Foreman Operators Labourers	1 tractor and trailer or tipper lorry Front wheel loader Wheelbarrow Handtools: Shovels Pickaxe	N/A

Method of Measurement:

Work to be measured and paid for on the basis of the volume of material removed from site.

Unit: m^3

Approved Work Method:

1. Place warning signs and safety devices in accordance with Clause 907 of the MOTC Standard Specification for Road and Bridge Construction or as directed by the Engineer.
2. Do not work under an overhanging slope.
3. Check the slope for unstable material and remove the unstable material before starting on slip clearings to ensure the stability of the slope and the safety of the workers.
4. It will generally be easier to remove unstable material down the slope by dislodging it with light equipment or hand tools. Ensure **ALL** loose material is removed.
5. Where appropriate, excavate soil to reduce the angle at the top of the slope before slip clearing.
6. After the slope is confirmed as safe, excavate all slipped material from the carriageway, shoulder and ditches by loader or by hand.
7. Load onto trucks, tractor and trailer or wheelbarrows and remove to suitable dump sites.
8. Do not excavate too deep and damage the road/shoulder surface.
9. Remove the last layer of slipped material by hand to avoid damage to the surface.
10. Clear the ditches and regrade or restore if necessary
11. Light grade the shoulder area.
12. Re-check the stability of the slope.

FEATURE	SLOPE & ROAD PROTECTION	
ACTIVITY SPECIFICATION	**Activity No: 60-70-002**	**Activity Name: REMOVE UNSTABLE MATERIAL/ CLEARING SLIP MATERIAL**

13. Tidy up the site.
14. Record the volume of material removed from site.
15. If slope is stable, remove all warning signs and safety devices.
16. If slope is unstable, leave warning signs to advise road users or if potentially hazardous to traffic, close the road until a permanent repair can be completed.

Technical Specifications:

In case of slopes where the unstable rocks or soils are much and / or found frequently, it shall be a subject to consider application of a slope stabilise method.

Table 11.57

FEATURE	SLOPE & ROAD PROTECTION	
ACTIVITY SPECIFICATION	Activity No: 60-80–001	Activity Name: INSTALLATION OF CUT-OFF DITCH
Classification:	Periodic Maintenance	

Description and Purpose:

The installation of a ditch at the top of the slope to prevent water running down the face of the slope and causing erosion

Performance and Scheduling Considerations:

Only appropriate where the adjacent ground is falling towards the road. Usually erosion gullies will be visible in the face of the slope.

Typical Personnel:	Basic Equipment:	Approved Material:
Foreman Labourers	Hand tools: Shovel Pick axe	N/A

Method of Measurement:

Work will be measured and paid for on the basis of the volume excavated.

Unit: m^3

Approved Work Method:

1. Determine the location and alignment of the ditch from local inspection.
2. The ditch should not be too close to the edge of the slope as this could encourage slip failure.
3. Excavate the ditch to 500mm below the adjacent ground following the natural contours. Check the gradient is sufficient for water flow (minimum 1.0 %) and re-excavate if necessary.
4. The ditch should be trapezoidal in shape with an invert width of 600 mm.
5. Trim the sides of the slope so that they are stable and not too steep to avoid collapse.
6. Remove excavated material from site well away from the ditch and the edge of the slope.
7. Tidy up the site.
8. Measure and record the volume excavated.

Technical Specifications:

1. The ditch shall be excavated to 500mm below the adjacent ground following the natural contours.
2. Gradient shall be ensured at least 1.0%.
3. The ditch should be trapezoidal in shape with an invert width of 600 mm.

CHAPTER 12 SAFETY METHODS FOR EXECUTION WORKS

When work is being carried out on or close to the carriageway, it is the Maintenance Engineer's responsibility to see that adequate measures are taken to warn and protect road users and maintenance workers. He should instruct all supervisors and foremen in safety measures, including traffic control, and the use of temporary road signs.

This manual proposes the following safety methods for traffic flow:

12.1 Lane Closure on High Traffic Volume Roads

Before Works starts, warning signs, barriers and cones should be placed around the work area. Work should be carried out on one side of the road at a time, allowing traffic to pass on the other. Signs should be placed in the following order:

(a) "Men working" signs should be placed 200 m meters in front of the work area.
(b) "Road narrows" signs should be placed 100 m in front of the work area.
(c) "Speed limit" signs should be placed 100 m in front of the work area.
(d) Barriers should be placed at each end of the work area.
(e) Cones should be placed in a taper at the approaches to the work area and at a maximum spacing of 10 m along the middle of the road next to the work area.
(f) "End of restriction" signs should be placed 50 m beyond the work area.

(g) Traffic controllers should be stand next to the barriers in the center of the road to operate the reversible "Stop/Go" signs.

The controller closest to the oncoming traffic should decide when to stop the flow and allow traffic to travel in the other direction. Traffic should be stopped in both directions when works vehicles enter, leave or turn at the worksite.

Figure 12. 1 shows the basic traffic safety method.

12.2 Lane Closure on Low Traffic Volume Roads

The engineers should also consider and approve the use of a simple system of traffic control as follows:

(a) Only the "Men working" and "End of restriction" signs should be placed at roadside areas. Also, two controllers should stand at the start of the work area.
(b) When reshaping the shoulders by motor or towed grader, "Grading shoulders" signs should be placed alongside the "Men working" signs.
(c) When grass cutting with a tractor, "Mowing" signs should be placed alongside the "Men working" signs.

12.3 Edge Working and Bush Clearing

Where road works are being carried out which do not affect the carriageway, or where works such as grading, dragging or bush clearing are being carried out, sign layout shown in Figure 12.2 is proposed.

Warning signs should be placed before work starts and must be placed in the following order:

(1) "Men working" signs should be placed at the approaches to the work area.
(2) "Road clear" signs should be placed at the ends of the work area.

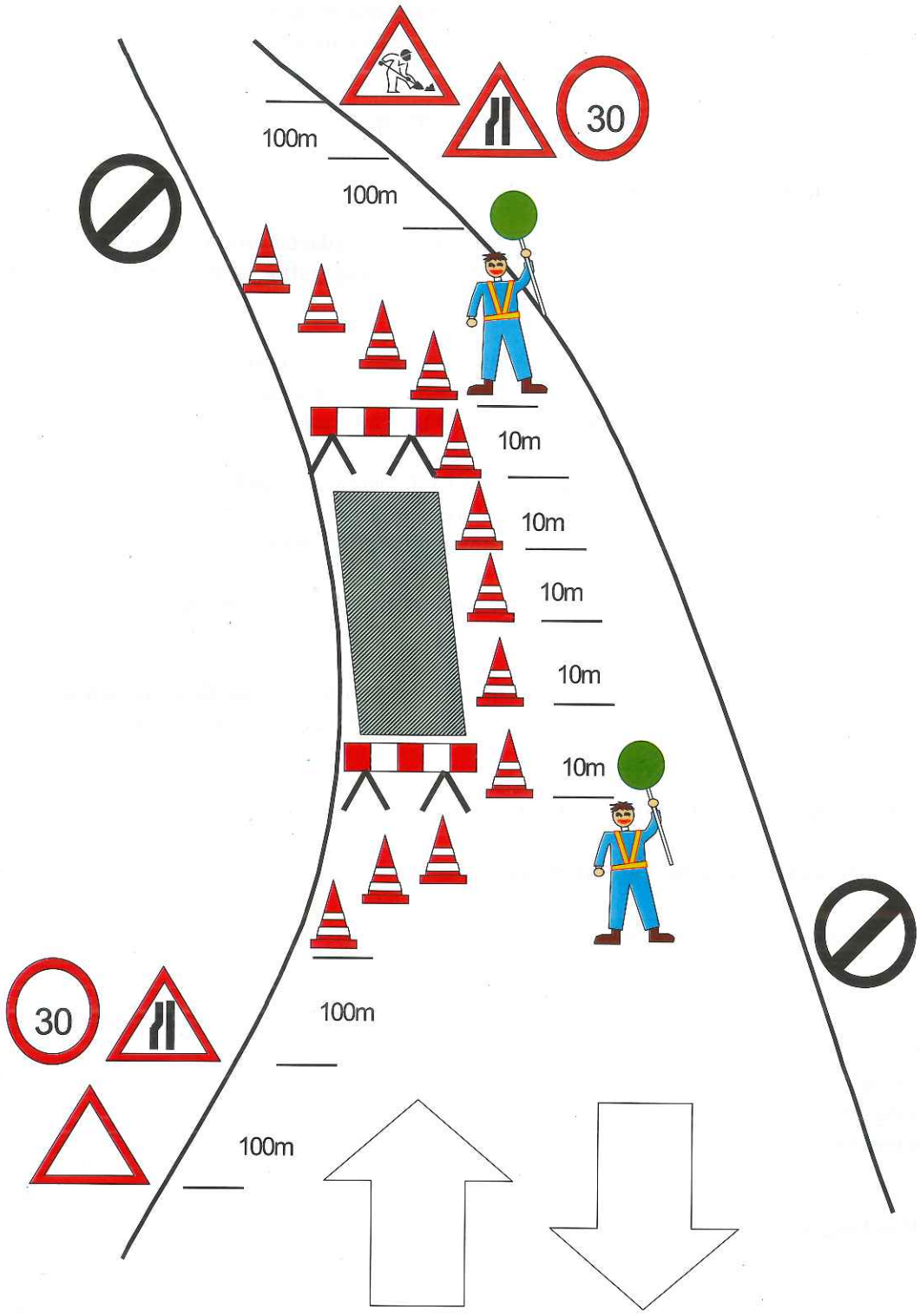


Figure 12. 1 SAFETY METHOD FOR EXECUTION WORKS (1)

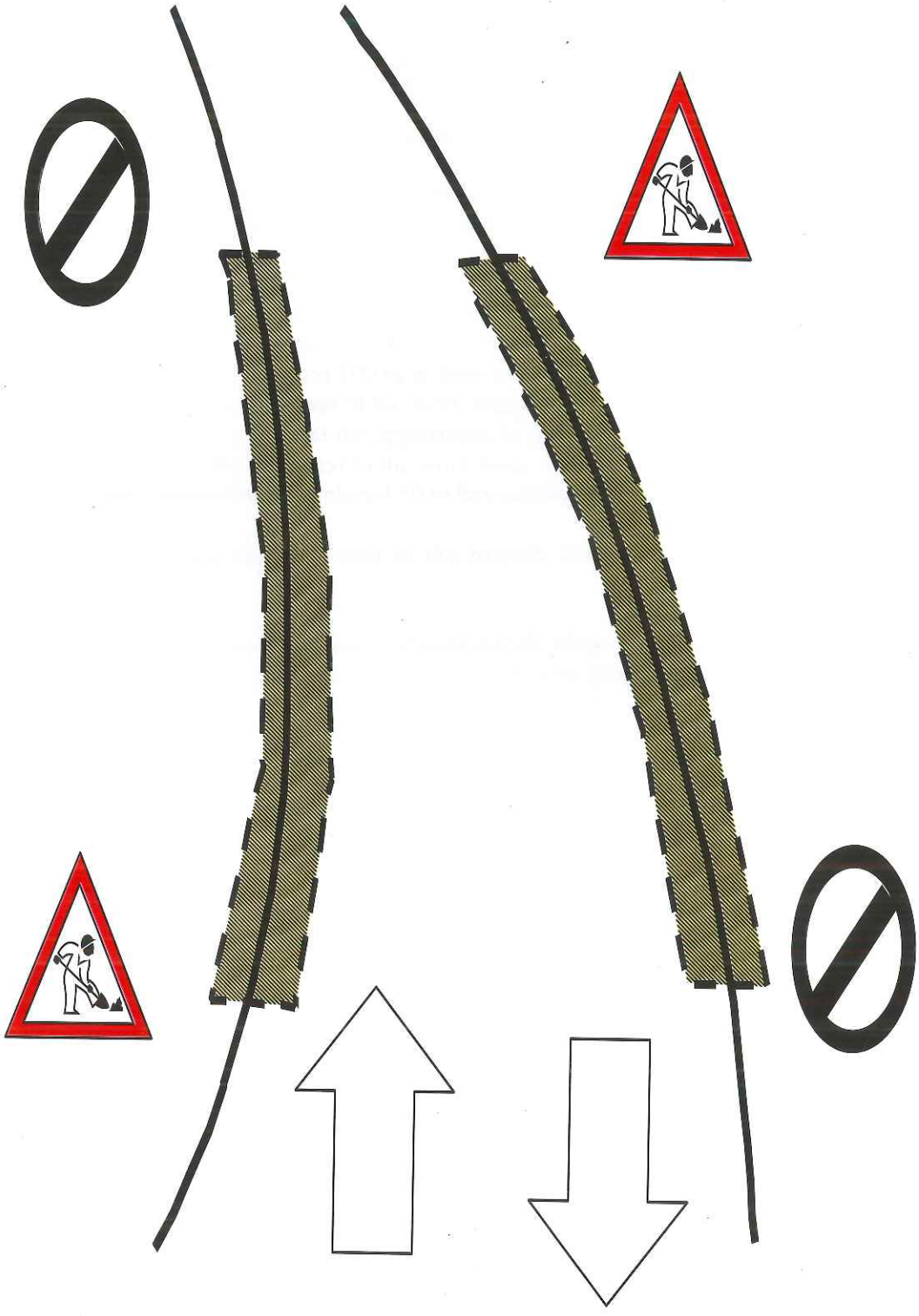


Figure 12. 2 SAFETY METHOD FOR EXECUTION WORKS (2)

APPENDIX

Member of The Working Group

Name	Organization	Position
Eng. N. N. Gekonge	MORPW	CSE, Planning
Eng. B. G. Ariga	MORPW	Principal, KIHBT
Eng. J. N. Maina	MORPW	CSE, Materials
Eng. S. K. Kogi	MORPW	SSE, Maintenance
Eng. R. M. Kimuu	MORPW	SSE, Maintenance
Eng. F. D. Karanja	MORPW	SSE, Maintenance
Mr. R. M. Waruru	MORPW	Senior Instructor, KTS
Eng. A. Gitonga	MOLG	Deputy Project Manager, KUTIP
Eng. C. M. Karani	KWS	Project Engineer (Roads)
Eng. G. N. Kamau	Nairobi City Council	ACE (Operations)
JICA Study Team	JICA	