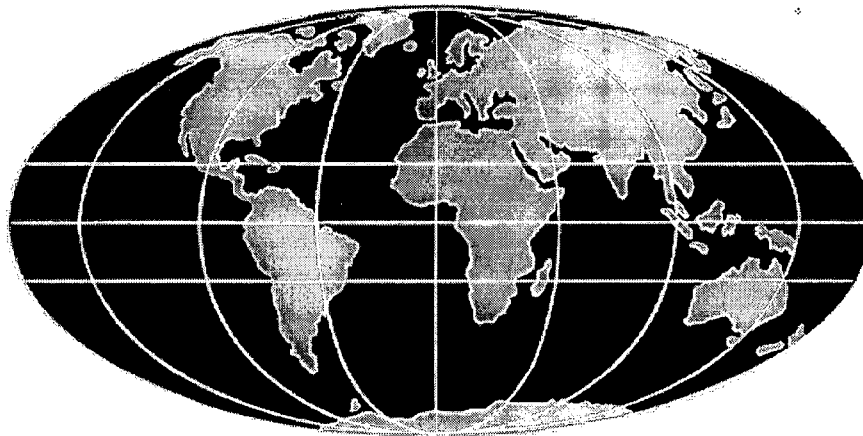




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**MAINTENANCE OF MINOR ROADS USING
THE LENGTHMAN CONTRACTOR SYSTEM**

by

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FIFTH INTERNATIONAL CONFERENCE ON LOW VOLUME ROADS

PAPER: MAINTENANCE OF MINOR ROADS USING THE LENGTHMAN CONTRACTOR SYSTEM

by

Dr T E JONES* and R C PETTS**

ABSTRACT

This paper describes current development and research activities on the Minor Roads Programme in Kenya.

The relatively rapid deterioration of unpaved roads compared to paved roads demands that maintenance is programmed rather than responsive to changes in surface condition. Road maintenance in developing countries is normally organised on a district or regional basis using ministry teams or contractors. However, the use of lengthmen to undertake routine and possibly recurrent maintenance activities may result in more rapid and cost effective correction of deficiencies and an improved level of service in some circumstances.

The Minor Roads Programme is a labour-based improvement and maintenance programme for low and medium trafficked roads in 28 districts of Kenya with a high agricultural potential. The programme commenced in 1986 and is projected to improve 4500 km of roads to gravel all-weather standard over a five year period and establish maintenance systems. The programme will also maintain some 8000 km of roads constructed under the previous labour-based Rural Access Roads Programme.

People living alongside the roads are utilised on a casual basis to carry out all improvements and maintenance supported by simple agricultural equipment for certain operations, particularly on the higher trafficked roads.

Routine maintenance on the roads is carried out using a Lengthman system. An ex-construction worker is appointed to each section; typically 1.5 - 2.0 km in length. He is provided with the necessary handtools and is paid for working 3 days per week on the road. This allows him time to continue to work on his land on other days.

The principal aim of the research reported in this paper was to establish productivity standards for a range of routine and recurrent maintenance activities carried out by lengthmen using mostly hand tools. The current research will evaluate the influence of geometry, climate, traffic and materials on the amount of maintenance required and define optimum lengths of road relative to labour inputs for these variables

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SYNOPSIS

A network of more than 8000 km of Rural Access and Minor roads has been constructed and maintained in Kenya using labour-based methods. Routine maintenance of these roads is carried out using individual lengthmen contractors.

This Paper describes current research work designed to establish maintenance needs and productivity standards. The results of the research will permit improved planning, implementation and monitoring of labour-based road maintenance.

1. INTRODUCTION

The use of individual contractors or lengthmen to undertake routine maintenance over specified lengths of road has been a recognised management technique for many years. However, the effectiveness of the technique over a long period has seldom been monitored in detail.

The Kenyan Rural Access Road Programme (RARP) was started in 1974. It's primary objective was to construct farm-to-market access roads using a labour-based method in districts with high agricultural potential. By the end of 1986 approximately 8000 km of Rural Access Roads had been completed in 26 districts and the majority of them gravelled and maintained by individual lengthmen contractors.

Following the success of the RARP in constructing roads at low cost and with high

utilisation of local resources, the Government of Kenya decided to apply the same labour-based methods to the improvement and maintenance of selected D and E roads, see Table 1, which are categorised as Minor Roads(1). During the period 1986-1992 the Minor Roads Programme (MRP) is projected to improve 4500 km of Minor Roads and to include them in Kenya's overall maintenance strategy.

The research described in this Paper is concerned with the initial establishment of maintenance productivity standards in the Minor Roads Programme and the determination of the routine maintenance needs of Rural Access and Minor Roads.

For the Minor Roads Programme, routine maintenance is defined as all work required within the road margin capable of being carried out by an individual lengthmen contractor. Periodic maintenance of the roads includes regravelling and repairs to structures and this is carried out by special units or contracting companies. Occasionally, urgent work is carried out under various arrangements when the scope is beyond the capabilities of the lengthman contractor.

2. DEVELOPMENT OF THE MAINTENANCE SYSTEM

Various methods were originally considered for the routine maintenance of Rural Access Roads. For the chosen lengthman system an ex-construction worker was appointed on a contract basis to each section of road, typically 1.5-2.0km in length. He was provided with hand tools and supervised once a month by an overseer to monitor the condition of the road and to authorise payments for satisfactory work. The payment was based on the

contractor carrying out 12 days of work per month on days of his choice. The contractor could be replaced if he consistently performed badly.

The contractor lived adjacent to the road and would therefore not require government accommodation or transport which consume considerable resources in a traditional equipment-based maintenance system.

A principal attraction of the system is the comparatively low level of equipment required and consequently lessened support problems. This is coupled with a low foreign exchange component which in 1981 was estimated to be only 10 per cent(1). This compares with a typical foreign exchange component for equipment-based routine maintenance systems of 50 per cent(2).

The lengthman system also creates productive paid employment in rural areas where there are few opportunities for such work. The contractor is able to live at home with his family and the part-time terms give him the opportunity to work on his own land as well.

Approximately 80 per cent of the direct costs of the system were estimated to be paid directly to the contractors in 1982. The system also enables maintenance to be achieved throughout the year on each section of road. The responsibility for the maintenance of each road section lies completely with one person who requires minimal logistic support.

Unfortunately, the establishment of the maintenance system did not attract the same amount of research and development effort as the construction aspects of the programme.

It was erroneously assumed that the local administration and people would bring pressure to bear on the contractors to maintain the roads to a good standard. The contractor's appreciation of the maintenance requirements was taken for granted. The need for training and supervision was underestimated and mechanical problems associated with the supervision vehicles had an adverse effect.

It is now realised that the development of effective maintenance systems requires as much, if not more, effort than construction or road improvement systems. In recognition of these problems a Study of Maintenance of Rural Access Roads was commissioned in early 1985(3). The report showed the lengthman system to be quite effective. However, it indicated a significant potential for improvement and the need for better direction and control of the contractors. Extensive discussion of the maintenance issues has enabled the principal problems to be identified and appropriate strategies developed for tackling them.

In particular there was a need to more accurately determine the maintenance requirements of Rural Access Roads and Minor Roads under various conditions of rainfall, alignment, pavement/soil type and traffic. Rural Access Roads have a 4 m wide gravelled running surface whereas the Minor Road standard is 5.4 metres. See Figs 1 and 2.

Methods of determining required maintenance resources and their deployment, direction and control needed to be developed. Arrangements for dealing with urgent works such as washouts and culvert breakages should be formalised. The methods of identifying spot regravelling and full regravelling required to be developed and the various options for carrying out this work eg by animal-drawn haulage and casual labour

or small scale contractors, needed to be investigated. There was an urgent requirement to ease the supervision burden of the maintenance overseers because of the minimal time that they could allocate to each contractor and the mechanical problems that will always exist to a degree, even with the low equipment component of the system. The scope for the use of headmen, responsible for a small number of contractors, needed to be developed as well as the methods of training, directing and monitoring them. On the technical side there was the problem of maintaining a satisfactory longitudinal profile especially for the wider, more heavily trafficked Minor Roads. There was also the question of safety for lengthmen working on the carriageway of the more heavily trafficked roads (>50 Vehicles per day). Consideration had to be given to the use of simple tractor-drawn mechanical graders or drags for maintaining the running surface in these circumstances; with pothole patching support and all off-carriageway work by the lengthmen.

The lengthman concept has been adopted for the maintenance of Rural Access and Minor Roads under the new programme. However a number of major improvements to the system have been initiated or planned. Studies of particular maintenance aspects are being carried out as part of this process.

The main areas of improvement to the maintenance system are as follows:

1. The setting of fair contract lengths for the lengthmen including objective consideration of the factors influencing the amount of maintenance required.
2. The supervision of lengthmen activities and concentration on one routine maintenance activity at a time.
3. Arranging for the lengthmen to work progressively from one end of a section to the other on a specified activity, easing supervision and control.
4. The establishment of realistic task rates for routine maintenance activities.
5. The setting of priorities for routine maintenance activities according to season.
6. The establishment of reference stations on each lengthman's section for control and reporting purposes.
7. The introduction of both working and non-working headmen in appropriate situations to control work between Overseer's visits.
8. The introduction of control aids for headmen.
9. The introduction of an objective assessment of routine maintenance performance

incorporated in an annual inspection system. This system will also allow periodic maintenance work to be identified and monitored.

10. A training programme including formal and on-the-job training, and demonstration sites in each district.
11. Allocation of the highest priority to the provision, servicing and repair of routine maintenance overseer's motorcycles.

Items 1 and 4 are the subject of the current study described in this Paper. Other initiatives are being taken to bring about the other improvements.

Phase I of the study has already established routine maintenance productivity standards (task rates).

Phase II of the study will monitor the maintenance requirements of Rural Access Roads and Minor Roads under the range of principal influential factors experienced; namely rainfall, gradient, traffic and surface characteristics. Figure 3 depicts the flow diagram for the study. Whilst Fig 4 details the proposed district structure for the established maintenance organisation.

3. PHASE I: ESTABLISHMENT OF MAINTENANCE PRODUCTIVITY STANDARDS

3.1 Objective

Phase I of the study concentrated on the following objective:

Establish productivity standards for a range of routine maintenance activities utilising hand tools.

The following activities in Table 2 were identified as the principal routine maintenance operations for Rural Access and Minor roads for which productivity levels were established in the study. Some of the operations are illustrated in Plates 1 to 8.

3.2 Methodology

Phase I of the study was conducted in Kisii and South Nyanza districts between October 1988 and March 1989, a period which conveniently overlapped wet and dry seasons in both districts.

Kisii is a high rainfall district with generally cohesive 'red coffee' soils at approximately 1800m elevation and has an annual rainfall of between 1500 and 2000 mm. South Nyanza is a drier district with predominantly sandy and 'black cotton' soils at approximately 1100m elevation; annual rainfall there being between 1000 and 1500 mm. Programme districts are

illustrated in Fig 5.

The two districts are considered to be typical of many MRP districts so that the productivity data derived may be applicable across the programme.

Three overseers were seconded to the study team each supervising up to 14 maintenance contractors with the assistance of 2 'non-working' headmen. This contrasts to the supervision ratio planned for the MRP which would typically be one overseer to 8 headmen to 80 lengthmen. In some areas 'working headmen' have their own maintenance section as well as supervision responsibilities over other lengthmen.

The contractors were generally working on their own separate sections prior to the study. However, during the study they were brought together in small groups of seven under each non-working headman for ease of supervision. Prior to the commencement of data collection the contractors and headmen were given approximately 2 weeks of training by the overseers.

The lengthmen were given individual daily tasks on various maintenance activities along a short section of road. Tasks were set daily by the overseers and monitored throughout the day by both the overseers and headmen. The starting and finishing times were carefully recorded for each task.

During the study the contractors were retained for approximately 7 hours if tasks were not completed. However they were released earlier, normally after 5 hours, if they finished their work satisfactorily. Individuals were rotated between activities on successive days.

Various levels of difficulty were defined for each maintenance activity and some of the activities had to be broken into two component operations for ease of control or measurement.

Forms were developed to record the relevant technical and personnel data for each day's task. This included name, sex and age of individuals. Reports were thoroughly checked before entering on the microcomputer database, using dBase III Plus software.

Productivities were calculated in terms of quantity of work completed per hour. These values were then adjusted to represent the quantity of work that could be expected for a standard 5 hour closely supervised workday. This was adopted as the basis for development of daily productivity standards. In the normal situation the lengthman is subjected to a lower level of supervision. He/she is nominally paid for 8 hours of work and the 5 hour supervised standard was considered to be an appropriate target for the MRP.

From the data gathered, comparisons were made between performance related to age groups, sex and districts, and whether the set tasks were successfully completed or not.

3.3 Phase I Study Results

A total of 1960 task-days of data was collected. Of the eleven originally planned activities (see Table 2) five were sub divided into two operations; in effect making 16 activities to be monitored, see Table 3. For each activity up to 4 degrees of difficulty were defined and observations made based on these divisions. As many as 47 observations were made on an

individual activity (Activity R3). Records were unobtainable for only one combination of activity-difficulty. For only 4 activity-difficulty combinations were 5 or less observations made. The lack of data on these combinations reflects their low occurrence in general RAR/MR maintenance operations.

The observations were taken on seven road sites two of which were constructed to Minor Road cross section standards. From the observations taken it was not possible to detect a difference in productivity between Rural Access Roads and Minor Roads.

Little difference was observed in productivities between age groups, districts or sexes. The most significant observation was that contractors who completed their tasks, and thus left work early, worked significantly harder (by up to 30%) than those who failed to do so. This trend shows up fairly consistently throughout the results and is (i) an indication of the quality of the data gathered and (ii) a strong argument for establishing a task based system with fair and achievable targets.

The standard deviation for each data set was calculated and used to define the representative range of productivity for the task around the mean of the observations. These ranges were then used for the final comparisons and are shown in Table 4 (Kisii District) and Table 5 (South Nyanza District).

The productivity results shown in these tables can be used as standards for the MRP. However it should be appreciated that these results were obtained under most favourable supervision conditions with trained lengthmen and motivated overseers. They should be

treated as reference points to strive for by MRP personnel.

4. PHASE II. THE IDENTIFICATION OF ROUTINE MAINTENANCE REQUIREMENTS

4.1 Objectives

The Principal objectives of Phase II of the study are:-

- a) To determine the influence of geometry, climate, traffic and pavement materials on the amount of routine maintenance required expressed in terms of the 16 standard activities.
- b) To determine optimum maintainable lengths of road relative to labour inputs under various soil, topographic, climatic and traffic conditions.

4.2 Methodology

In order to achieve these objectives detailed observations will be taken over a period of 12 months on existing sections of Rural Access and Minor Roads which are already under routine maintenance.

4.3 Selection of Road Sections and Preparation Work

The Kenyan Rural Access and Minor Roads have been constructed over a wide range of climates, vertical gradients, soil types and traffic levels. Traffic currently using these roads varies from less than 10 to over 100 vehicles per day. Selection will be made of suitable sections of existing roads encompassing as many of these variables as possible.

The most important variables considered to affect the performance of the roads are classified as follows:-

- (1) Traffic <20, 20-50, and >50 vpd
- (2) Annual Rainfall <500mm, 500-1500mm, >1500mm
- (3) Vertical Gradients <4%, 4-8%, >8%
- (4) Surface Materials: Gravelled and ungravelled.

In addition, the following parameters will also be recorded at the beginning and end of the study:-

- (a) width of carriageway
- (b) average crossfall
- (c) length of section maintained
- (d) frequency of supervision
- (e) thickness of gravel

As a "control" some sections will be selected on which no maintenance (other than emergency repairs) will be carried out during the study.

Minor Roads Programme (MRP) personnel will be responsible for the initial identification of roads suitable for inclusion in the study. A total of about 50 sections of roads will be required to cover all the principal variables (however some sections may be on the same road). Each section will be of a length maintainable by one individual contractor ie 1-2km approximately.

The study roads will mainly be concentrated in 3 areas, Nakuru/Naivasha, South Nyanza and Kisii, to cover a wider range of variables, some road sections may be located outside these areas.

Each road will be inspected by a supervising engineer to confirm its suitability and to carry out a detailed condition survey. This will include identifying maintenance defects and preparing a schedule of repairs.

The supervising engineer will also be responsible for the final demarcation of the road sections to be included in the study, and will also ensure that each road section is clearly marked with a signboard indicating the section reference number. This initial survey will record the relevant details of soil/gravel type, mean gradient, gravel thickness, road width, etc for each contractor's section.

MRP personnel will be responsible for carrying out the repairs to bring the road to an acceptable and maintainable standard within a reasonable period of time to suit the study programme. A check inspection on completion of the repair works will be carried out by the supervising engineer.

Prior to the commencement of the study and at the end of the study manual traffic counts will be taken over 7 consecutive days and 2 nights on each road and thereafter on 1 day per month.

Rainfall gauges will be established in the vicinity of each road to monitor daily rainfall and surface roughness measurement will be carried out on each road section using the MRP vehicle mounted bump integrator on a monthly basis.

4.4 Study data collection

The study will be carried out over a period of 12 consecutive months on each road section with an additional 1 month's trial data collection at the commencement of the study.

Every month an MRP inspector, under the direction of the supervising engineer, will visit each road and record and assess the previous month's work. He will also survey the road and locate, quantify and record all defects or outstanding maintenance requirements. He will inform the overseer supervising the road of the maintenance programme for the following month based on the productivity norms established by the MRP under "Maintenance Study II Phase I Productivity Standards" which was completed in early 1989(4).

Each month the schedule for each contractor will show:-

- (a) Maintenance work achieved
- (b) Outstanding work required

If the maintenance contractor is falling behind with the work then he will be given additional time to ensure that the road condition is satisfactorily maintained (provided the delays are not due to inefficiency on the part of the contractor). In certain cases additional personnel may be temporarily employed to help catch up on any backlog of work.

All survey data including the regular monitoring of rainfall, roughness and traffic will be input to a micro-computer data base and analysed to establish relationships between the extent of each maintenance operation required and the monitored characteristics of the road section.

5. PROJECT OUTPUT

The two phases of the study should enable the labour based maintenance of Rural Access and Minor Roads to be significantly improved.

The research in Phases I and II will result in:

1. A rational basis for implementing routine maintenance using the 'lengthman' principle over the range of site conditions experienced in Kenya.
2. Identification of any shortcomings in the lengthman system.
3. The provision of data to prepare realistic estimates of resources and costs for routine maintenance.

4. More realistic productivity standards for use in the TRRL guide to maintenance management for District Engineers(5).

These results will permit more effective planning, execution and monitoring of gravel roads maintenance particularly where lengthmen contractors are used.

6. OTHER INITIATIVES

In addition to the Phase I and Phase II studies described in this paper the Ministry of Public Works has taken a number of other initiatives to improve the lengthman maintenance system.

The improvements identified and described in Section 2 have been adopted as policy for the MRP. Pending the results of the two study phases, including finalisation of productivity standards and maintenance needs, other improvements will be introduced, through a planned programme of training, and demonstration sites.

In recent TRRL studies, research on unpaved roads has often concentrated on comparisons between motorised graders and tractor drawn graders(6).

The maintenance project in Kenya has afforded the opportunity of evaluating maintenance strategies incorporating a 'mix' of towed graders and contract lengthmen. The intention is to investigate a mix of low cost equipment and labour based maintenance during Phase II of the project. This strategy will be used only on the higher trafficked roads (> 50 vpd) of the

Minor Roads Programme. It is intended that the towed grader will only lightly grade the running surface, with pothole patching and all side drainage and off-carriageway work being carried out by the lengthmen.

The results from this additional research will provide new and valuable information on the most appropriate maintenance strategies utilising low cost techniques for gravel roads in developing countries.

7. RECOMMENDATIONS FROM THE PHASE I INVESTIGATION

The results of Phase I of the study are summarised in Tables 4 and 5. For the guidelines to be applicable in each district of Kenya some allowance, based on previous experience, will be required to adjust the separate task rates for the particular workforce involved.

The subdivision of five of the maintenance activities permits better control and measurement of these tasks and has been recommended for incorporation into the present reporting system.

The guidelines themselves have been established under virtually ideal supervisory conditions with a well trained workforce under the control of motivated overseers. As such, the guidelines represent the best overall productivities that can be expected under conditions in Kisii and South Nyanza districts. They should be treated as realistic targets which can be strived for as the management of routine maintenance is improved. More importantly perhaps, the guidelines provide a reference against which the performance of contractors can

be assessed.

The maintenance activities are not directly comparable to those of construction and improvement work. A number of activities are of a similar nature although there are differences in scale of work and method of working and measurement. Where a broad comparison is possible the productivities achieved for maintenance activities are somewhat below the RARP/MRP construction productivity standards. This reflects the generally smaller scale and dispersed nature of the maintenance work.

At the commencement of Phase I it was found that many contractors and headmen did not fully appreciate what the various maintenance tasks were, how they should be carried out and controlled, and the methods to be used for measuring them. There was an obvious need for training particularly since, if the task system is to work effectively, the headmen must take on a much stricter supervisory function than they have in the past. Besides their direct supervisory function, headmen must also become fully conversant with the methods for measuring each activity so that they can assist the overseers in their overall management role.

It will be important to introduce the experience gained from Phase I, and in due course Phase II into the training and maintenance operations of the MRP.

The lengthmen, headmen and overseers should have a clear understanding of the reasons for and methods of desilting. It is just as important that they appreciate when it is not required due to established vegetation and good drainage conditions.

Recommendations include updating of the planning and reporting system and introduction of the new productivity standards.

Training material, manuals and courses will also be necessary.

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Table 1. Kenya Road Network Under the Responsibility of the Ministry of Public Works: (Km)

CATEGORY	BITUMEN	EARTH/GRAVEL	TOTAL
A. INTERNATIONAL TRUNK ROADS (1)	2,608	971	3,579
B. NATIONAL TRUNK ROADS (1)	1,308	1,443	2,751
C. PRIMARY ROADS (1)	2,293	5,476	7,769
D. SECONDARY ROADS (1)	1,041	10,074	11,115
E. MINOR ROADS (1)	512	25,754	26,266
SPECIAL PURPOSE ROADS (1)	166	2,931	3,097
RURAL ACCESS ROADS (2)	15	7,962	7,977
TOTAL	7,943	54,611	62,554

NOTE (1): Network at September 1990.
(2): Network at June 1990.

Table 2. Maintenance Activity

Activity Code	Description
R1	Inspection and remove obstructions
R2	Clean culverts and inlets/outlets
R3	Repair culvert headwalls
R4	Clean mitre drains
R5	Clean side drains
R6	Repair scour checks and side drain erosion
R7	Repair erosion on shoulders
R8	Fill potholes in carriageway
R9	Grub edge and reshape carriageway
R10	Cut grass in the side drains
R11	Clear bush

Table 3. Revised activity schedule

Activity Code	Maintained Activity
R1	Inspection and Removal of Obstructions
R2A	Clean Culverts and Inlets
R2B	Clean Culvert Outfalls
R3	Repair Culvert Headwalls
R4	Clean Mitre Drains
R5	Clean Side Drains
R6A	Repair Scour Checks
R6B	Repair Side Drain Erosion
R7A	Repair Shoulder Erosion
R7B	Grass Planting
R8A	Fill Potholes in Carriageway
R8B	Fill Ruts in Carriageway
R9A	Grub Edge of Carriageway
R9B	Reshape Carriageway
R10	Grass Cutting
R11	Bush Clearing

R1 : Inspection
1.5 km/day

Table 4. PRODUCTIVITY RANGES FOR ROUTINE MAINTENANCE
WET HIGHLAND AREAS (KISII DISTRICT)

ACTIVITY	UNIT	TASK DIFFICULTY				NOTES
		1	2	3	4	
R2A : Clean Culvert+ Inlet	As shown	2-5 Culverts/day	1-14 Days/Culvert	14-3 Days/Culvert	3-5 Days/Culvert	Difficulty - Silt depth in culvert. 1. Up to 1/4 2. 1/4 to 1/2 3. 1/2 to 3/4 4. Over 3/4
R2B : Clean Culvert Outfalls	m/day	45-60	30-45	15-30		Difficulty - Silt depth 1. Up to 10cm 2. 10 to 20cm 3. Over 20cm
R3 : Repair Culvert Headwalls	No/day	5-10	3-5			Difficulty - Type of repair 1. Minor repairs 2. Major repairs
R4 : Clean Mitre Drains	m/day	50-65	35-50	25-35		Difficulty - Silt depth 1. Up to 10cm 2. 10 to 15cm 3. Over 15cm
R5 : Clean Side Drains	m/day	55-75	35-55	25-35		Difficulty - Silt depth 1. Up to 10cm 2. 10 to 15cm 3. Over 15cm
R6A : Repair Scour Checks	No/day	3-8	5-9			Difficulty - Type of scour check 1. Wood 2. Stone
R6B : Repair Side Drain Erosion	m/day	90-110	70-90	50-70		Difficulty - Depth of erosion 1. Up to 15cm 2. 15 to 30cm 3. Over 30cm
R7A : Repair Shoulder Erosion	m/day	85-110	60-85	40-60		Difficulty - Depth of erosion 1. Up to 10cm 2. 10 to 15cm 3. Over 15cm
R7B : Grass Planting	m/day	90-110	70-90	60-70		Difficulty - Planting width 1. Up to 0.5m 2. 0.5 to 1.0m 3. Over 1.0m
R8A : Fill Potholes in Carriageway	w.bags/day	23-30	16-23	11-16	7-11	Difficulty - Hauling distance 1. No Haul 2. Up to 100m 3. 100m to 200m 4. Over 200m
R8B : Fill Ruts in Carriageway	m/day	60-80	40-60	30-40	10-20	Difficulty - Hauling distance 1. No haul 2. Up to 100m 3. 100 to 200m 4. Over 200m
R9A : Grub Edge of Carriageway	m/day	230-300	160-230	100-160		Difficulty - Width of grubbing 1. Up to 0.5m 2. 0.5 to 1.0m 3. Over 1.0m
R9B : Reshape Carriageway	m/day	55-80	40-55			Difficulty - Type of reshaping 1. Light (Up to 75mm) 2. Heavy (Over 75mm)
R10 Grass Cutting	Light m/day	400-450	220-300	150-220		Difficulty - Width of grass cutting 1. Up to 1.0m 2. 1.0 to 2.0m 3. Over 2.0m
	Dense m/day	275-350	200-275	150-200		
R11 Bush Cutting	Light m/day	400-450	220-300	150-220		Difficulty - Width of bush 1. Up to 1.0m 2. 1.0 to 2.0m 3. Over 2.0m
	Dense m/day	250-300	200-250	150-200		

* All tasks except reshaping are measured along one side of the road only.

R1 : Inspection
1.5 km/day

Table 5. PRODUCTIVITY RANGES FOR ROUTINE MAINTENANCE
DRY LOWLAND AREAS (S NYANZA DISTRICT)

ACTIVITY	UNIT	TASK DIFFICULTY				NOTES
		1	2	3	4	
R2A : Clean Culvert+ Inlet	As shown	2-5 Culverts/day	1-14 Days/Culvert	14-3 Days/Culvert	3-5 Days/Culvert	Difficulty - Silt depth in culvert. 1. Up to 1/4 2. 1/4 to 4 3. 4 to 3/4 4. Over 3/4 Tasks for 600 dia culverts with 7 rings
R2B : Clean Culvert Outfalls	m/day	45-60	30-45	15-30		Difficulty - Silt depth 1. Up to 10cm 2. 10 to 20cm 3. Over 20cm
R3 : Repair Culvert Headwalls	No/day	5-10	3-5			Difficulty - Type of repair 1. Minor repairs 2. Major repairs
R4 : Clean Mitre Drains	m/day	50-65	35-50	25-35		Difficulty - Silt depth 1. Up to 10cm 2. 10 to 15cm 3. Over 15cm
R5 : Clean Side Drains	m/day	soft 45-60 hard 25-35	soft 35-45 hard 20-25	soft 25-35 hard 20-25		Difficulty - Silt depth 1. Up to 10cm 2. 10 to 15cm 3. Over 15cm
R6A : Repair Scour Checks	No/day	3-8	5-9			Difficulty - Type of scour check 1. Wood 2. Stone
R6B : Repair Side Drain Erosion	m/day	75-100	40-75	20-40		Difficulty - Depth of erosion 1. Up to 15cm 2. 15 to 30cm 3. Over 30cm
R7A : Repair Shoulder Erosion	m/day	85-110	60-85	40-60		Difficulty - Depth of erosion 1. Up to 10cm 2. 10 to 15cm 3. Over 15cm
R7B : Grass Planting	m/day	90-110	70-90	60-70		Difficulty - Planting width 1. Up to 0.5m 2. 0.5 to 1.0m 3. Over 1.0m
R8A : Fill Potholes in Carriageway	w.brws/day	20-30	14-20	10-14	7-10	Difficulty - Hauling distance 1. No Haul 2. Up to 100m 3. 100m to 200m 4. Over 200m
R8B : Fill Ruts in Carriageway	m/day	40-60	20-40	10-20	5-10	Difficulty - Hauling distance 1. No haul 2. Up to 100m 3. 100 to 200m 4. Over 200m
R9A : Grub Edge of Carriageway	m/day	150-220	80-150	50-80		Difficulty - Width of grubbing 1. Up to 0.5m 2. 0.5 to 1.0m 3. Over 1.0m
R9B : Reshape Carriageway	m/day	55-80	40-55			Difficulty - Type of reshaping 1. Light (Up to 75mm) 2. Heavy (Over 75mm)
R10 Grass Cutting	Light	m/day	275-350	200-275	150-200	Difficulty - Width of grass cutting 1. Up to 1.0m 2. 1.0 to 2.0m 3. Over 2.0m
	Dense	m/day	275-350	200-275	150-200	
R11 Bush Cutting	Light	m/day	400-450	220-300	150-220	Difficulty - Width of bush 1. Up to 1.0m 2. 1.0 to 2.0m 3. Over 2.0m
	Dense	m/day	250-300	200-250	150-200	

* All tasks except reshaping are measured along one side of the road only.

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FIGURE 2 Minor road. Standard cross section

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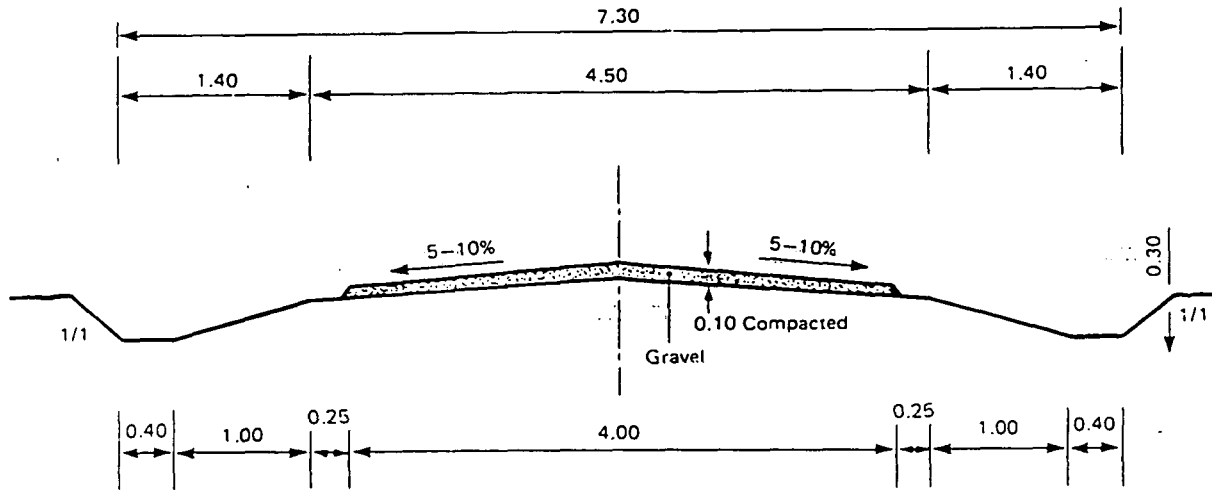


Fig.1 Rural access road. Standard cross section

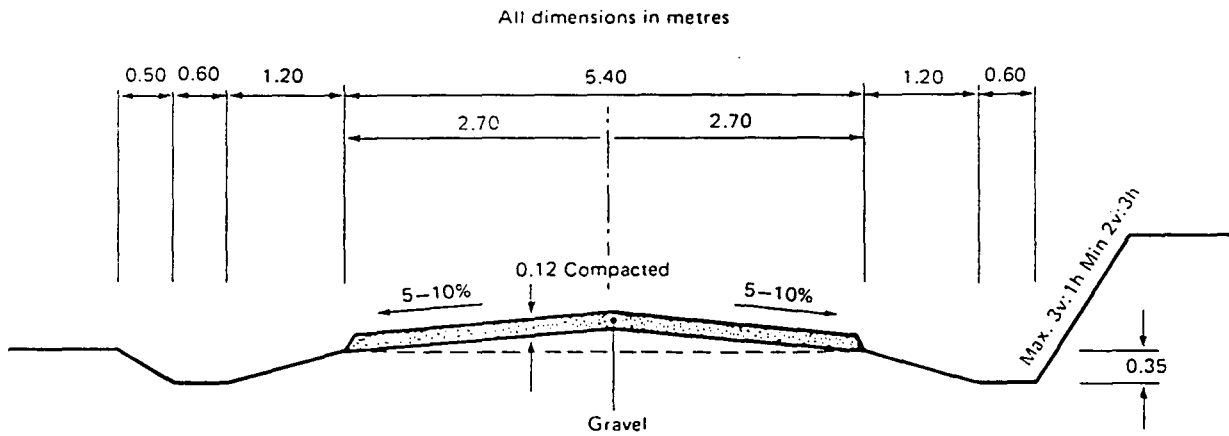


Fig.2 Minor road. Standard cross section

Notes: Camber profile depends on whether constructed from arisings of one ditch or two.
Other sections apply for Black Cotton soil, severe terrain or embankment situations

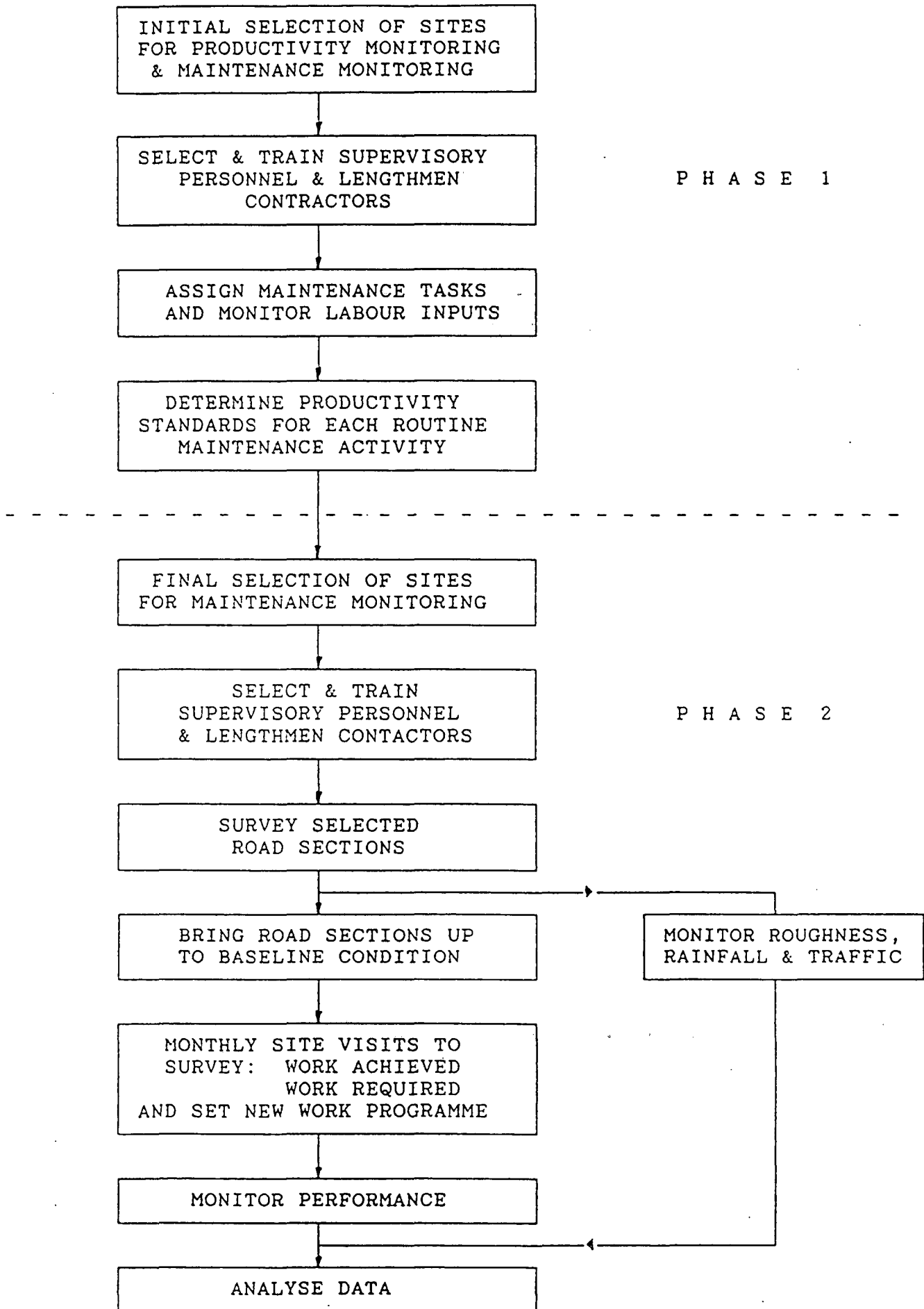
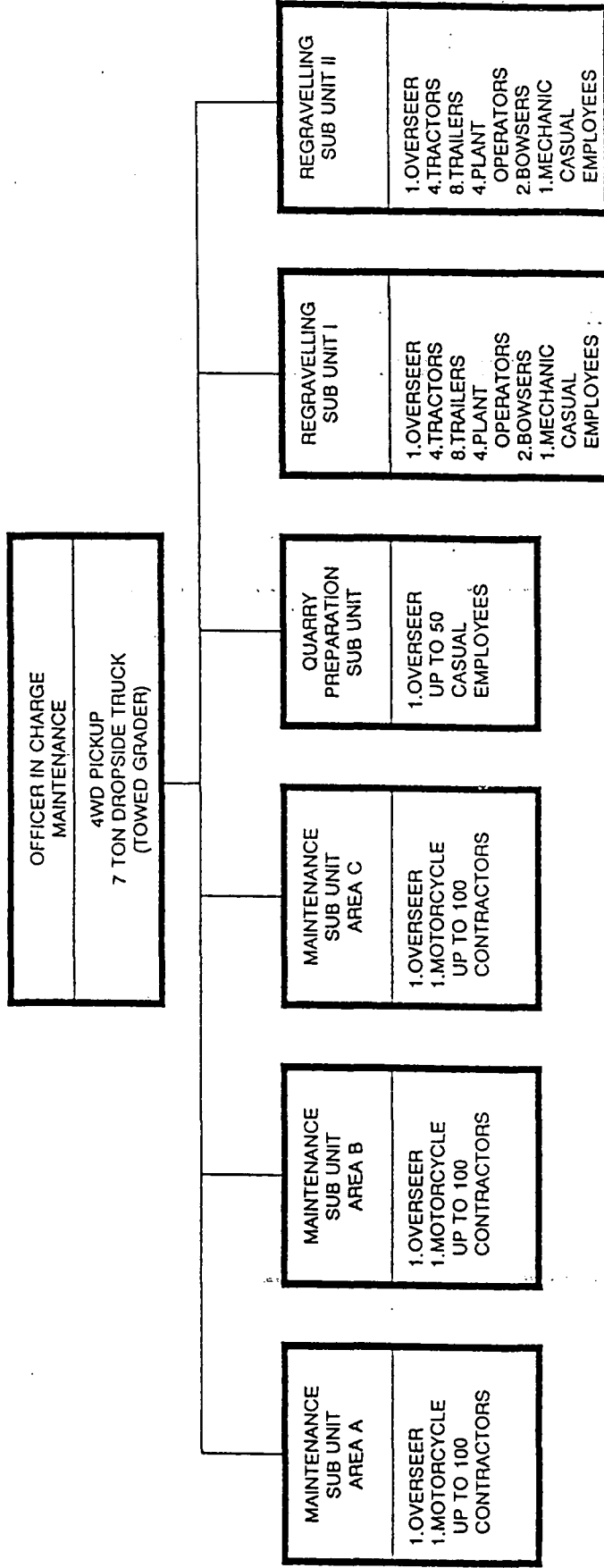


Fig 3. Flow diagram of the research programme

FIGURE 4. PROPOSED MRP DISTRICT MAINTENANCE UNIT



NOTES:

1. Maintenance sub units as required.
2. Second regravelling sub unit only if required.
3. Regravelling sub units to also replenish contractor stockpiles.
4. Regravelling resources calculated on 7500m³ of regravelling/stockpiling per sub unit year.
5. Bowsers: single axle towed, 1 fuel and 1 water per sub unit.

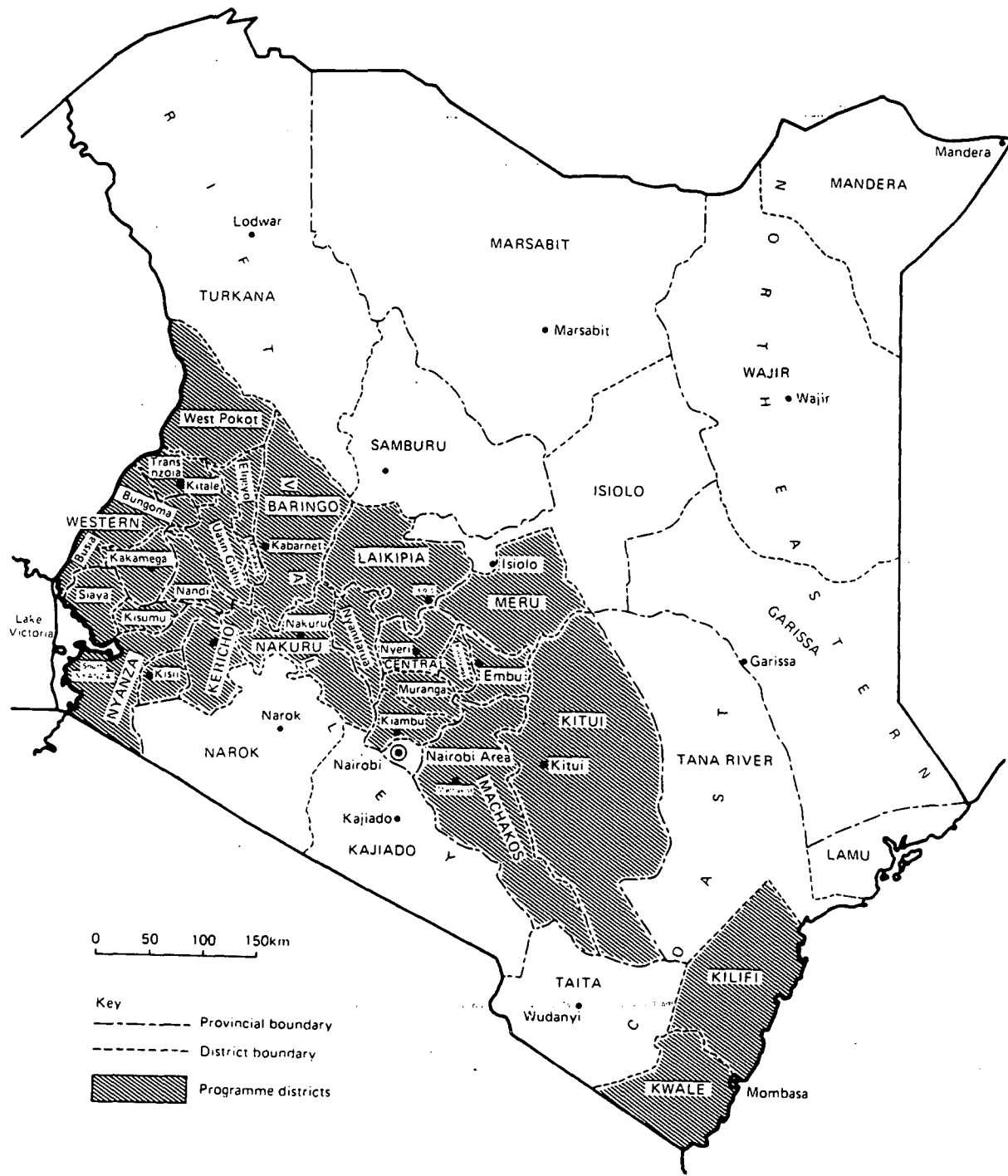


Fig.5 Kenya minor roads programme. Programme districts

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Plate 1. Lengthmen working collectively



Plate 2. Grubbing edge

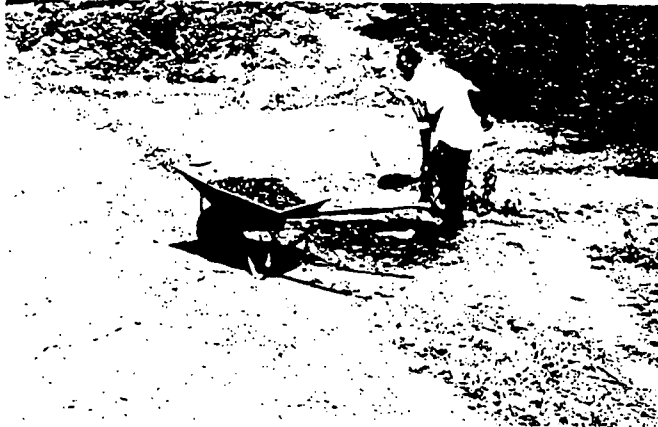


Plate 3. Excavating gravel for Patching



Plate 4. Re-shaping carriageway



Plate 5. Cleaning culvert outlet



Plate 6. Cleaning culvert inlet



Plate 7. Cleaning mitre drain

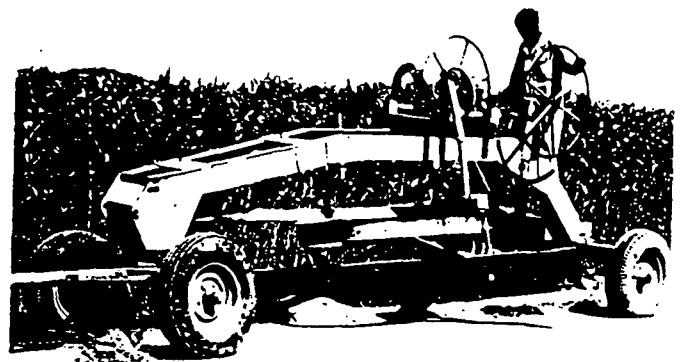


Plate 8. Towed grader under trial