The Rural Access Roads Programme

by J.J. de Veen

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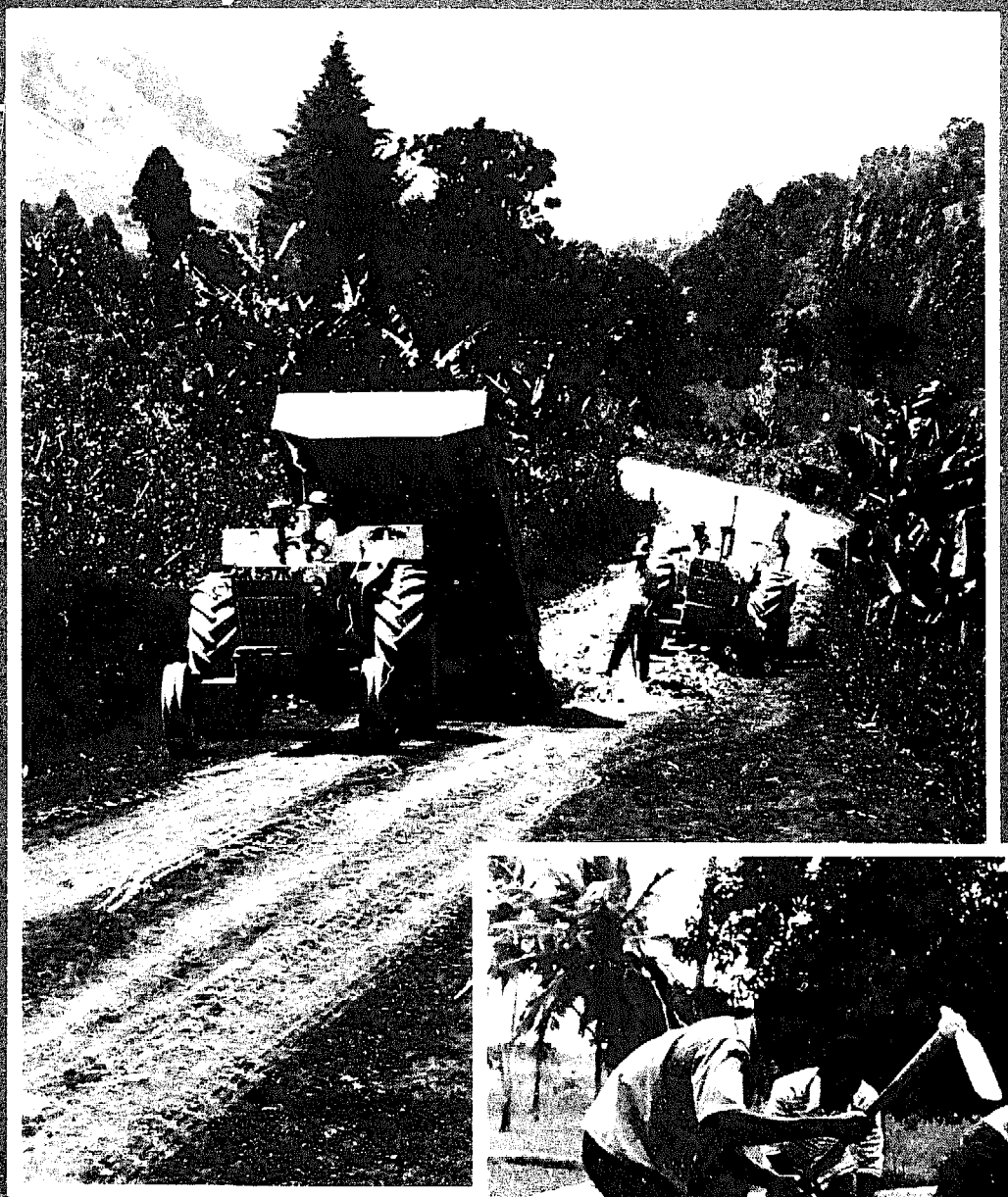
Appropriate technology in Kenya



A WEP study

International Labour Office Geneva

The World Employment Programme (WEP) was launched by the International Labour Organisation in 1969, as the ILO's main contribution to the International Development Strategy for the Second United Nations Development Decade.

The means of action adopted by the WEP have included the following:

- short-term high-level advisory missions;
- longer-term national or regional employment teams; and
- a wide-ranging research programme.

Through these activities the ILO has been able to help national decision-makers to reshape their policies and plans with the aim of eradicating mass poverty and unemployment.

A landmark in the development of the WEP was the World Employment Conference of 1976, which proclaimed inter alia that "strategies and national development plans should include as a priority objective the promotion of employment and the satisfaction of the basic needs of each country's population". The Declaration of Principles and Programme of Action adopted by the Conference will remain the cornerstone of WEP technical assistance and research activities during the 1980s.

This publication is the outcome of a WEP project.

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PREFACE

In 1974 the Ministry of Works of Kenya initiated a major rural road-building programme. The Rural Access Roads Programme (RARP), as it was called, was intended to provide all-year farm-to-market access throughout Kenya. The 14,000 km of road to be built would increase by 25 per cent the length of road in Kenya. Whilst the Programme was a major undertaking in itself, it was the manner of its execution that was to be particularly novel and significant. The construction methods were to be "as labour-intensive as is commensurate with technical and economic efficiency". This was not, therefore, to be merely an employment-creation scheme. It was in fact the first real attempt to implement the use of labour-based methods as an effective alternative to the use of equipment.

Since its inception the Programme has attracted a great deal of financial and technical support. The latter has been provided in the belief that this kind of programme would be implemented elsewhere and that the RARP could serve as a model for implementation.

By 1979 the Programme was running efficiently. The ILO, who as part of its programme on appropriate construction technology had been providing technical assistance to the RARP since its inception, decided it could be useful to detail the major aspects of the Programme. This book is a result of that decision.

The book describes the systems and procedures developed for the Programme and shows how problems were overcome. It does not, however, provide an analytical evaluation of the Programme or attempt to assess its costs and benefits. What, we feel, it does do is to present basic reference material for the growing number of

engineers and planners in developing countries interested in setting up programmes of this nature.

This book is part of a series of publications on appropriate construction technology prepared by the Technology and Employment Branch of the ILO. It was written by Ing. J.J. de Veen under the over-all direction of Dr. G.A. Edmonds.

INTRODUCTION

The RARP was initiated in 1974 to respond to concepts of employment creation and rural development embodied in the 1974/78 Development Plan for Kenya. The Development Plan stipulated that major emphasis should be placed upon the improvement of secondary and minor roads in the rural areas, especially in those areas with a high agricultural potential and an inadequate existing road network. The standards of the roads to be constructed were to be related directly to the anticipated traffic volumes.

This has meant that the design of the minor access roads under the RARP, which were expected to carry low traffic volumes,[1] could be adapted to the use of labour-intensive construction methods. It was decided to use these methods in the belief that they would be technically and economically justifiable. Consequently, the RARP has become the first road-construction programme in Africa where labour-intensive construction methods are implemented on a large scale. In the event this faith in labour-intensive construction methods has been justified. By constructing good-quality roads at low costs the RARP has proved that labour-intensive construction methods are economically and technically viable, provided that organisation and management techniques are adapted to their use. Furthermore, the Programme has shown that this type of construction technology is eminently suited to the socio-economic environment of many developing countries.

This statement merits some elaboration. In Kenya, as well as in most other developing countries, labour is relatively abundant and cheap, while capital is scarce. Nevertheless, capital-intensive

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[1] Less than 30 vehicles per day.

and labour-saving technologies from the developed world are usually transplanted to developing countries without having been adapted to the prevailing conditions in these countries.

The use of alternative technologies more adapted to these conditions was generally ignored, mainly because of the belief that more labour-based technologies are backward and inferior in terms of quality and productivity. In addition to this negative attitude a number of institutional constraints should be mentioned. First, there is usually a serious shortage of local technicians. Moreover, because the educational systems and syllabi have been taken over from the developed world, the few technicians that are available are only conversant with capital-intensive technology. Second, the administrative systems, e.g. personnel, procurement, in the construction industry are geared to the use of capital-intensive methods. Third, research on the improvement of traditional technologies has hardly been done, which is reflected in the fact that tools and equipment are not suited to heavy construction work, and organisation and management techniques have hardly been adapted to the use of labour-intensive methods. Finally, financial assistance to development programmes is often tied to the purchase of foreign technology.

The ILO was requested to provide advisory services on the design, planning, programming and organisational aspects of the RARP. The ILO was approached because its Technology and Employment Branch had for a number of years carried out research on the identification of alternative technologies which are technically and

economically viable, and a part of this research had concentrated upon road construction.[1]

The initiation of the Rural Access Roads Programme meant a major breakthrough, because it provided the opportunity to test the results of ILO and World Bank research on a large scale and to prove that labour-based technologies are not inferior.

In the RARP the development of local resources is emphasised. There is a high involvement of local personnel. The training of the supervisory personnel is specifically related to the management of large numbers of workers.

Furthermore, new planning, programming and organisational procedures have been developed. Research was carried out on tools and equipment to improve their quality.

Decentralisation of planning was realised by delegating the responsibilities of the initial screening and selection of the access roads in their respective areas to "District Development Committees".[2] Consequently, the rural communities at the grass-roots level have been involved in the identification of the roads to be constructed. The selection of these roads was done in accordance with guidelines established by the Roads Department of the Ministry of Works.

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[1] See, for instance, D. Lal, "Men or Machines": a study of labour capital substitution in road construction in the Philippines, ILO, Geneva, 1978. M. Allal and G.A. Edmonds, Manual on the Planning of Labour-Intensive Road Construction, ILO, Geneva, 1977. IBRD: Substitution of Labour and Equipment in Civil Construction, Phase I report, 1972, and Phase II report, 1974.

[2] A District Development Committee comprises representatives of the various ministries, the local administration and members of parliament of the district.

The Programme has a very low foreign exchange element. Because the roads have been constructed using mainly local resources, the foreign exchange component has been as low as 25 per cent, whereas the foreign exchange component in equipment-intensive projects of this kind commonly exceeds 50 per cent. Staff wages accounted for 12 per cent and casual wages for 47 per cent of the total expenditure.

The book is subdivided into two parts: text and appendices. The text discusses the most important aspects of the RARP in a general fashion and refers to the appendices for more detailed technical information. It should be kept in mind that the descriptions, data and figures used in the text and appendices are related to the existing environment in Kenya. Furthermore, it should be reiterated that the book describes the existing systems and procedures as developed during the course of implementation of the Programme. It is felt that a detailed analysis of these systems and procedures is outside the scope of this book.

Section 1 of the text describes the inception and implementation of the Programme and the scope of the technical and financial assistance given to the RARP.

The organisational structure of the Programme is discussed in section 2.

A description of the work of the Technology Unit[1] is given in section 3. Section 4 describes the selection and technical aspects of the access roads constructed under the RARP. The planning,

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[1] The Technology Unit, financed by the World Bank, was a multi-disciplinary group which advised the Ministry of Works on the implementation of the Programme from January 1976 to August 1978. Their work was a natural consequence of the work carried out under the MOW/ILO/NORAD study.

organisation and management of a large-scale labour-intensive project, both at headquarters and at site level, are crucial and are described and evaluated in sections 5 and 6.

Section 7 discusses recruitment procedures and motivation of the workers and refers to the payment systems used in the RARP. A description of the site arrangements and construction activities can be found in section 8. Section 9 shows how the training of personnel was planned, organised and executed. In this section the recruitment of supervisory personnel and the contents of the various courses are also briefly discussed. In section 10 a description is given of the organisation of road maintenance, which is carried out making use of some of the workers who had been employed to construct the road. Finally, in section 11, the effects of the RARP on employment and agriculture are described. This section also defines the relevance of the RARP to other developing countries and indicates in which areas future research would be useful.

The appendices with their detailed descriptions of the design standards, the construction activities, the average task rates, the expenditure control procedures and the administrative systems as applied in the RARP will be of particular interest to those officials who will be involved in the actual execution of similar labour-intensive construction works.

The text will provide useful information on an alternative way of road construction to planners and chief executives in developing countries, who are interested to apply employment-generating indigenous technologies, provided these can be implemented efficiently and effectively, i.e. without adversely affecting cost and quality of the product.

Further, it may be a useful source of information for officials of donor agencies who in principle might be interested in

the possibility of financing labour-intensive construction programmes, but would like to have more information on how a large-scale labour-intensive road-construction project can be implemented.

It is hoped that this document will contribute to a reorientation towards the use of appropriate technology, i.e. a fair judgement in each particular case - taking into account all the relevant parameters - of the optimum mix of labour and equipment, a mix that will be different for each country and possibly even for each region in a particular country.

1. INCEPTION AND OBJECTIVES OF THE RURAL ACCESS ROADS PROGRAMME

1.1 Inception and implementation

In March 1974 a loan application for the RARP was prepared for submission to the World Bank and the Swedish International Development Authority (SIDA) who had both indicated their interest to finance such a programme.

At this time the International Labour Office (ILO), in collaboration with the Kenyan Ministry of Works (MOW), had initiated a detailed study into the feasibility of the implementation of labour-intensive techniques in Kenya.[2] This study was financed by the Norwegian Agency for International Development (NORAD). Since the British Government had agreed to finance the first three rural access roads construction units[1] to open up the Programme on a pilot scale, the ILO study team could focus its activities on the first rural access roads unit. The team was thus enabled to monitor the progress of on-going projects and at the same time carry out experiments in the planning, management and organisation of labour-intensive projects.[2]

In the beginning of 1975 the Government of Kenya requested further UNDP/ILO technical assistance to advise and assist the MOW in the planning and supervision of the RARP at headquarters and in the setting up and operation of the first RAR Units in the field.

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[1] A rural access road unit comprises a workforce of approximately 270 labourers plus administrative and supervisory staff. The organisational structure of such a unit is described in section 2 and Appendix 1.

[2] ILO: "The implementation of appropriate road-construction technology in Kenya", report of the MOW/ILO/NORAD study, ILO, Geneva, Nov. 1976.

The UNDP/ILO assistance at this stage included the services of one senior engineer at headquarters and two field engineers. The United Kingdom agreed to provide the services of another two field engineers under a bilateral technical assistance agreement.

In September 1975 the World Bank together with representatives of other potential financing agencies carried out an appraisal of the Programme, which led to the signing of a loan agreement in July 1976. The Programme expanded steadily and, in May 1978, 13 rural access road "units" were operational and funds had been obtained to finance another 14 units. These funds were sufficient to finance the operation of these 27 units for 84 unit years, while at the same time an agreement for the provision of funds to equip and operate another 25 units for a period of 47 unit years was expected to be concluded. The donors involved in the Programme were: the World Bank, NORAD, DANIDA, USAID, the United Kingdom and the Netherlands.

Although a number of Kenyan engineers had been assigned to the RARP at this stage, the lack of skilled technical manpower still constituted a problem and technical assistance was still required. During the course of implementation of the Programme more donor agencies had become involved and by the middle of 1978 technical assistance agreements had been signed with UNDP/ILO, the United Kingdom, the Netherlands, Switzerland, DANIDA and NORAD. The bilateral agreements covered the financing of 14 field engineer posts and one equipment engineer. UNDP financed two headquarter posts, occupied by ILO engineers, while the ILO further provided two associate experts for the RARP headquarters under the associate expert scheme. The ILO headquarters continued to be involved throughout the implementation of the Programme, not only by the provision of technical assistance personnel but also by the rendering of advisory services and the co-ordination of annual

(review and evaluation) meetings of MOW, UNDP and donor agencies. The World Bank and the UK Ministry of Overseas Development (ODM) provided funds for continued research (see section 3) in addition to financing a number of RAR Units. The involvement of the World Bank and ILO also ensured that this research could draw upon the results of and experience gained in the studies and projects previously carried out by these agencies.

By the end of March 1979, 28 construction units were operative and agreements had been concluded with the six agencies mentioned above to finance the establishment and operation of 42 construction units. This number was considered to be optimal and would not be exceeded.

1.2 Targets and objectives

The target of the RARP was to produce approximately 14,000 km of "all-weather" access roads, partly new construction and partly upgrading of existing tracks, in 23 districts[1] in the period 1975-82, providing over that period an average of approximately 600 km of road per district. This target had to be reconsidered in the beginning of 1978 due to the fact that the build-up of the Programme had been slower than expected. It seems likely that the duration of the Programme will now be extended beyond 1982. It is envisaged that by the middle of 1982 approximately 7,000 km of road will have been completed.

The immediate objectives of the Programme are:

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[1] Kenya is divided into seven provinces. Each province is subdivided into a number of districts. The total number of districts in Kenya is 39.

(i) to provide all-weather access between high-potential farming areas and market centres;

(ii) to provide meaningful employment opportunities to the people in whose areas the Programme is implemented.

Indirectly the Programme is expected to have the following impact on the rural economy:

(i) shifts in land use by production diversification towards cashcrops and livestock activities (the extent to which this is achieved depends to a large extent on follow-up activities such as extension services by officials of the Ministry of Agriculture);

(ii) an improvement of the quality of rural life by making social and administrative services accessible on a year-round basis.

For several reasons a programme such as the RARP cannot cover the whole country. First, the availability of labour is crucial if roads are to be constructed with labour-based methods; second, the planning, administrative and supervisory staff requirements are considerable; and third, the funds likely to become available are limited. As regards the RARP, it was therefore decided to impose some order of priorities and to make a selection of a number of districts based on socio-economic criteria such as population density and increase, percentage of area in high- and medium-agricultural land, agricultural ouput and kilometres of existing "all-weather" roads.

1.3 Results

By 31 March 1979, 1,235 km of earth roads were constructed of which 213 km had been gravelled. At that time the average rate of construction of earth roads for all units since the start of the Programme was 37 km per year. The average costs per kilometre of road built up to 31 March 1979 were 2,090 Kenyan pounds (US$5,600). This figure includes all "overhead costs", such as costs of engineering supervision and headquarters.

On average 1,600 man-days were required to construct one kilometre of rural access road. Of course this figure varies considerably with the type of terrain where the roads are constructed. Furthermore, as mentioned above, many of the roads were not yet gravelled. However, due to the introduction of improved organisation and management techniques there is a definite downward trend in the number of man-days used in the construction of "an average kilometre of rural access road". It is very encouraging that most of the new units show lower figures than the country-wide average. It is evident that, in areas with average terrain conditions, the origiral target of 45 km/unit/year can be achieved with a labour force of 270 workers.[1]

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[1] Assuming 250 working days per year.

2. ORGANISATIONAL STRUCTURE[1]

The RARP was a new type of prgramme for Kenya and for the Ministry of Works (MOW), the executing ministry, in particular. It was therefore recognised at an early stage that, for a large-scale programme such as this, a new branch within the MOW would be required to ensure a flexible approach inside the existing structure.

Consequently, the Special Projects Branch was established at the beginning of 1975. This branch was to be responsible for the planning, management and organisation of the RARP and the "Gravelling Programme", a major gravelling exercise, designed to improve the standard of the secondary road network.

The branch is headed by a Chief Superintending Engineer (CSE), who is responsible to the Chief Engineer (Roads). It has functional links with the Staff Training Department (section 10) and the Roads Department, Planning Section. Early 1979 the managerial staff of the RARP at headquarters, responsible for the execution of the works carried out under the Programme, consisted of a team of five civil engineers, one mechanical engineer and one construction superintendent. Most of these posts were filled by expatriate staff, provided under a GOK/UNDP/ILO technical assistance agreement. In this period, however, it was the intention to revise the organisational structure to a decentralised version. Both the centralised and decentralised structures are described in Appendix 1. This reorganisation was intended to provide a more effective supervision in the field. The reorganisation could be implemented

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[1] Appendix 1 shows how the RARP headquarters and field organisation are structured and describes in detail the responsibilities of the various categories of managerial and supervisory staff.

at this time because the administrative systems, developed and tested by the technical assistance specialists, were functioning adequately and were suited to the requirements of the RARP. Various manuals and guidelines were available for Unit Engineers and technical and administrative staff who implemented them satisfactorily. In other words, the design and experimental phases were over and the time had come to concentrate on the improvement of the efficiency. It was recognised that the measure of success of the use of labour-based methods primarily depends on the level of supervision and it was felt that a decentralised organisation would be more effective in this respect.

There was, however, another important reason to decentralise the Programme structure. It had always been the intention that the RARP would continue in another fashion once the construction period had finished. Since labour-based construction and maintenance methods had proved to be viable and effective, the MOW had decided that the RARP should be gradually transformed into betterment and maintenance programme. Moreover, the use of labour-based methods would be extended to include the maintenance of the classified minor road network.

The reorganisation of the Programme would provide a basis to implement this policy on a provincial level.

The existing administrative organisation at headquarters in respect of accounts, procurement and personnel matters would be maintained. In the field, 18 RAR Engineers/Field Supervisors under the over-all supervision of initally four and at a later stage six "Divisional" Engineers would be responsible for the running of 42 Units. It was expected that, as soon as the reorganisation had been carried through, the RAR engineer posts could be gradually taken

over by "field supervisors" with the responsibility for two units only. These field supervisors could be lower qualified, e.g. having a diploma from the Kenya Polytechnic.

The day-to-day running of the individual RAR Units is the responsibility of "Officers in Charge" (OIC), the most senior level of supervisory staff.

Depending on the circumstances, a centralised or decentralised system is used in the field. In a centralised system the units under the charge of an engineer/field supervisor share storage, office and culvert manufacturing facilities. In a decentralised system these responsibilities are delegated to the OIC.

Transport costs will be greatly reduced and it will take less time and effort to solve small administrative problems at unit level if a decentralised system is used. Furthermore, there will be a clear dividing line between the units in terms of the responsibility for administration, planning and execution of the construction works and project management. Each officer in charge will have his own responsibilities without any possible confusion.

In a centralised system, however, the engineer/field supervisor in charge has a far greater opportunity to supervise, manage and control the ongoing activities. It would appear that the extent to which the system can be decentralised depends on the geographical situation of the Units, the abilities of the officers in charge and the availability of vital resources in a particular area. In the RARP it has become apparent that in most cases OICs need a certain period of experience in their jobs before responsibilities for store management and logistics can be handed over.

3. THE TECHNOLOGY UNIT[1]

During the initial stages of the Programme, studies were carried out to analyse, monitor and advise on the most important aspects of the construction work. These studies were initiated by the ILO in conjunction with the MOW and financed by NORAD.[2] It was realised that an extension and expansion of these studies would be extremely useful and consequently MOW/Kenya, the World Bank and the UK Ministry of Overseas Development (ODM) decided to provide the necessary funds to set up a Technology Unit. The objectives of the Technology Unit have been to assist the special projects branch with the implementation of the RARP and to conduct research aimed at rendering the execution of labour-based road construction work more effective in Kenya and elsewhere. Its main activities have related to on the following topics:[3]

(a) Implementation at the site level. This has involved research and advice on the implementation of work techniques at the site level in regard to all aspects of labour-based road construction, i.e. planning, reporting, site organisation and maintenance. Further work has been done on the monitoring of ongoing construction projects to provide the basis for cost and productivity analyses and the production of a technical manual covering all the above-mentioned activities.

(b) Research and development of tools and light equipment. Work in this area has concentrated on the development of better-quality tools; the comparison of better-quality tools with the

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[1] See figure 3.1.

[2] See MOW/ILO/NORAD report, op. cit.

[3] Appendix 11 lists all reports produced by the TU up to September 1978.

existing tools in the field in order to prove the economy of the procurement of good, more expensive, tools. Furthermore, proposals have been made for the organisation and equipment needed for tool maintenance and repair and guidelines have been established on how to use different handtools.

(c) The improvement of procurement and marketing of local tools and equipment. A consultant was appointed to assess how the procurement of good-quality handtools, handles and light equipment (wheelbarrows, tractor-drawn trailers) could best be organised and to examine the possibilities to manufacture these items locally. He also investigated whether there were any potential markets for the above-mentioned items outside the RARP and how government assistance could be utilised in relation to procurement and the promotion of local manufacture.

(d) Labour supply and demand. This involved an investigation of issues related to the economics of casual labour with special emphasis on the labour availability, its geographical and seasonal fluctuations and the opportunity cost of the labour to be employed in the RARP.

One of the main purposes of this study was to obtain more information on the effects of the implementation of a large-scale labour-intensive programme on the environment. Interviews with RARP workers have been carried out for one-and-a-half years to establish their economic and social conditions. Other sources of information on labour demand, income opportunities, small farm holdings, etc., were the Central Bureau of Statistics and the Ministry of Agriculture.

The study has highlighted the general labour availability for the RARP. It also showed the relationship between RARP wage levels

and alternative wage levels, so that it would be possible to establish an appropriate wage level for the RARP in order to avoid a situation where other sectors in the economy would be adversely affected by its implementation. Another objective of this study was to determine the average geographical area from which labour could be recruited under different relative wage levels.

(e) Organisation and management procedures. Since it had been envisaged that the RARP would function within the existing structure of the Ministry of Works, it was advisable to make use of the existing administrative procedures as much as would be feasible, provided that these procedures would not interfere with the smooth running of the RARP.

Work has therefore concentrated on the following areas:

(i) the organisation of the RARP headquarters;

(ii) the setting up of an accounting system, that would suit the requirements of the Ministry of Works as well as those of the donor agencies.

(iii) the design of a practical pay system suitable for large numbers of casual labour;

(iv) the investigation of problems in the field of logistics;

(v) the setting up of a suitable system for the procurement and distribution of stores;

(vi) the investigation of labour issues such as recruitment, dismissal, promotion, discipline, etc., and the advising on the standardisation for the RARP of these issues.

(f) Health and nutrition. In 1976 an assessment was made of the nutritional and health status of workers involved in the RARP construction projects. It was found that many of the workers were under-nourished and/or suffered from various diseases. It was also established that a clear relationship exists between malnutrition and low productivity. Further studies started in 1978 to investigate (i) whether a cheap, nutritional supplement to the workers' ordinary diet will result not only in improved nutritional status but also in improved work productivity and (ii) how these food supplements could be distributed efficiently and economically.

(g) Road design and performance. The British Transport and Road Research Laboratory (TRRL) was requested to investigate road design and performance aspects for the RARP. This work has been set up as an independent study in liaison with the Technology Unit. The main objective of this study was to quantify the level of service and reliability which may be achieved on road running surfaces formed with the locally available materials under different conditions of climate, traffic, construction and maintenance.

Initially an inventory was made of the rural access roads already built and their performance was studied particularly in relation to the costs of their construction and maintenance. At a later stage a detailed condition study of selected lengths of road was made. A number of rural access roads were selected for performance monitoring in order to obtain performance histories over a longer period, so that the effects of climate, traffic and maintenance could be analysed.

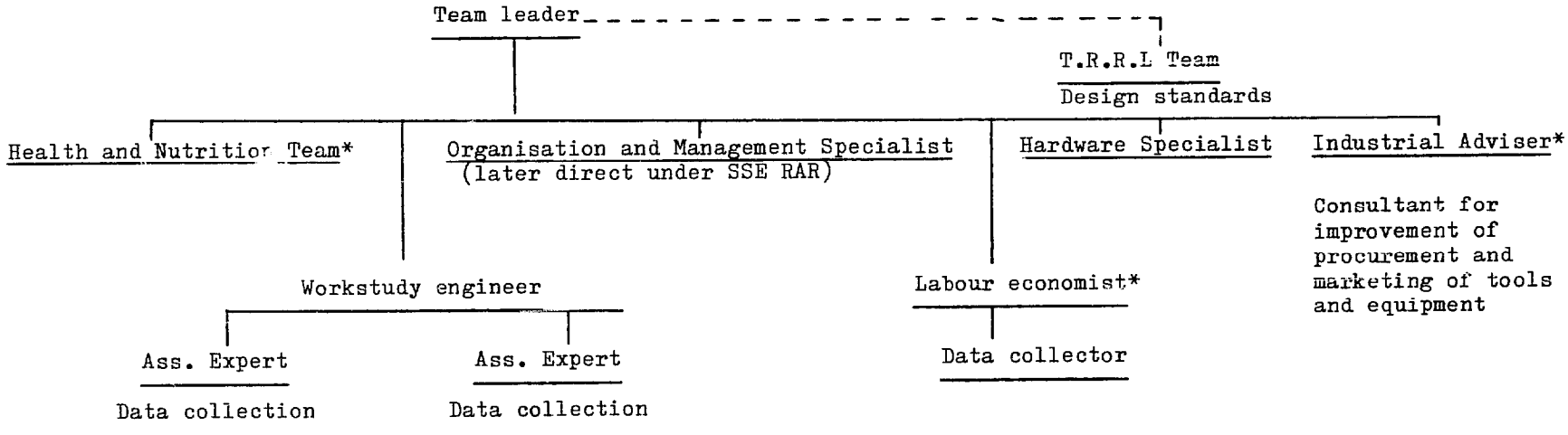
In addition to more conventional techniques a photographic monitoring technique has been used whereby a photograph is taken at approximately 30 metre intervals along the complete length of each

test road. In this way areas of deterioration could be spotted which would not necessarily be monitored during the normal survey procedure. Moreover, any areas of interest could be monitored separately and in more detail. To determine which compaction methods should be used compaction trials were carried out. The preliminary conclusions as regards the compaction of rural access roads are described in Appendix 6(k).

The results of the TRRL work has been a clear definition of the design standards for the RARP.

TECHNOLOGY UNIT R.A.R.P.

Figure 3.1



* short-term assignments.

4. SELECTION CRITERIA AND DESIGN STANDARDS

The selection of roads to be constructed in each district is carried out by the District Development Committee, which is a project planning and implementation committee at the district level, with advice and assistance from the Planning Section of the Ministry of Works. Proposals for roads to be constructed originate from the local people who notify the District Development Officer through their assistant chiefs and chiefs which roads they would like to see constructed. The District Development Committee, which comprises the heads of each government department at the district level, elected county councillors and members of parliament, is responsible for the initial screening of the proposals.

The following guidelines have been issued by the Ministry of Works to be used for this initial screening:

(a) Development criteria

(i) The roads should provide access to areas of high agricultural potential or areas where possibilities for a changeover from subsistence to cash crop farming exist.

(ii) Priority should be given to areas where other development programmes are either on-going or planned for the immediate future.

(iii) Access should be facilitated to marketing and urban centres and social services facilities.

(b) Technical criteria

(i) The roads should either be unclassified (i.e. no funds are made available from the MOW regular budget for their maintenance), earthtracks or presently non-existent.

(ii) The design standards should be such so as to make labour-intensive methods feasible. In practice this means that the route should avoid areas where big fills over long distances would be required and stretches which are either extremely rocky or have sustained lengths of gradients exceeding 10 per cent.

(iii) The road length should not be more than 10 kilometres, except where the existing road network is inadequate and constitutes a bottleneck to development.

(iv) The alignment should avoid areas which will require the construction of expensive structures.

The screening in accordance with the technical criteria is normally done by the RAR engineer.

(c) Access-extension criteria

(i) The roads must connect into classified (MOW-maintained) roads of a good standard.

(ii) Where roads have qualified in terms of the criteria described above, but connect into classified roads which in themselves are impassable, consideration should be given to carrying out improvements on these roads first under the programme.

Roads which qualify in respect of all above-mentioned criteria might still be rejected if they are too close to the existing road network, which would result in a very limited impact on agricultural development. Another important factor is that compensation is only paid for demolished crops. This means that a number of farmers in the area have to surrender land for the "right of way" of the proposed road. Usually the affected farmers gladly gave up a certain acreage of their land, since they were being provided with access to the all-weather road network. However, in some cases the farmers did not agree to these terms, which meant that the construction of a particular road had to be cancelled.

After the initial screening of the proposals has been done by the District Development Committee in accordance with the criteria described above, a final list of roads recommended to be constructed under the RARP is compiled by the District Development Officer in conjunction with the District Agricultural Officer and the Rural Access Roads Engineer. The selected roads are depicted on 1:50,000-scale topographical maps. The approved list of recommended roads together with the maps is then forwarded to the Planning Section of the MOW Roads Department, where a pre-construction evaluation report is prepared for a package of roads.

First an estimate is made of the increased value of agricultural production induced by the construction of the road. This estimate is based on data provided by the District Agricultural Officer. The technical viability of the roads and the agricultural data provided are verified during field visits made by planning engineers from the MOW Planning Section in liaison with members of the DDC.

The next step is the calculation of an access indicator. This provides a measure of the relative importance of each road in the provision of access to major social service facilities such as hospitals, health centres, market centres and divisional headquarters.

This access indicator is calculated as follows: each social facility is given a weighting according to the importance attached to that facility. This is then multiplied by the distance from the zone of influence[1] of the proposed road and by the population living in the zone of influence, i.e. the people who are going to obtain access to the social facility. The figure arrived at gives an indication of the importance of access to that particular facility. The access indicator is the total of the figures for all facilities. The need for access to a particular area can be related to the value of the access indicator. Thus, the higher the access indicator, the greater is the expected future utilisation of the facilities by people in the area under consideration and the more urgent the need for access.

In respect of the design standards of rural access roads, the Ministry of Works specified that the roads should be of "all-weather" quality, i.e. that they will be passable during all seasons in all types of weather. Consequently the critical issues to be considered were the quality of the road surface and the adequacy of the drainage system.

The horizontal and vertical geometric standards were not considered to be critical, since the volumes of traffic were expected to be low.

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[1] An area surrounding the proposed road, generally delineated by physical boundaries, which would be influenced by the provision of the access road.

Appendix 2 lists the design standards of rural access roads and shows the various cross-sections which have been implemented in the RARP. These cross-sections are adapted to the use of labour-intensive construction methods in different environmental circumstances.

5. PLANNING, REPORTING, CONTROL AND PROCUREMENT AT RARP HEADQUARTERS

5.1 Centralised planning, reporting and control

The systems used in RARP for planning, reporting, expenditure control and procurement have been adapted to the existing structures within the Ministry of Works. These systems would have to be adjusted for each different country to suit the structure of the Public Works Department there. The systems have changed during the course of the Programme in the light of the lessons learnt and the recommendations made by the MOW/ILO/NORAD study and the World Bank/ODM-sponsored Technology Unit.

As the Programme was financed by a variety of donors, it was necessary to set up an effective centralised system of physical and financial planning as soon as possible. A basic planning system was required in order to effectively control the large number of RAR units. This would ensure that each unit would receive its requisite supply of tools, equipment, materials, trained personnel and money. Furthermore, it would enable RARP HQ to control the technical and financial situation of each unit and to produce plans of critical steps, staffing and resource requirements.

For the smooth working of the planning system[1] it was necessary that targets in terms of required output of kilometres of road were established. This would ensure that the supply of resources could be calculated and organised well in advance. Another prerequisite was a good system for planning and reporting at site level so that a continuous flow of data from the units to

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[1] See section 6 and Appendix 5 for a detailed description.

headquarters could be established. This would enable headquarters to adjust quickly to different situations. For example, it might become necessary to provide more gravelling equipment to units operating in a certain area to keep up with the gravelling targets or to adjust output targets for units operating predominantly in a certain type of terrain.

There is no doubt that some of the problems encountered by the staff of the Rural Access Roads Programme were due to the fact that management and control systems had to be developed while the programme was being implemented. The lesson to be learnt here is that any programme of an innovative nature should establish management and control systems prior to programme implementation by executing a small-scale pilot project. The data and results of this pilot project should then be evaluated so that the full-scale project can be more effectively implemented.

5.2 Expenditure control at headquarters

The RARP is financed by a number of donor agencies, who all require individual justifications and statements of account before they agree to reimburse expenditures. (Initially the funds are provided by the Government of Kenya.) Also each agency has its own set of rules regarding the reimbursement of expenditure. One agency will reimburse a fixed amount per kilometre of road produced; others will reimburse for the cost of a Unit; however, some will pay for one thing and not for another; for example, expenditures incurred for the provision of (semi) permanent base camps are usually not reimbursable. The RARP accounting system, therefore, had to be designed to suit the donor requirements. Appendix 3 describes the workings of this system in detail.

5.3 Procurement of tools and equipment

Procurement of hand tools for the RARP had been arranged through the existing procurement system of the Ministry of Works. Orders were made in advance to the Supplies Branch of the Ministry. If the tools were not available tenders were called and submitted to the Central Tender Board for contract awarding. Unfortunately, during the first phase of implementation, purchases for the RARP were normally made on the basis of price only, while other factors such as quality and design were hardly considered. Although this approach might be quite practical and justified under normal circumstances, it was not suited to the specific requirements of the RARP, since tools for labour-intensive road construction are used intensively and in difficult conditions. It was clear that the procurement system had to be adapted in order to ensure that tools would be bought on the basis of acceptable and approved specifications rather than on the basis of price only. It was felt that, even though the unit cost would be higher, the purchase of well-designed heavy-duty good-quality tools would reduce the overall cost to the RARP not only as a result of greater life expectancy but also as a result of improved productivity.

The Central Tender Board recognised that the Ministry of Works recommendations on this issue were sound: it has been possible to procure tools of the desired quality and design since the beginning of 1978, based on specifications prepared by the MOW.[1]

During the growth of the Programme a number of lessons have been learnt in respect of procurement. It is crucial not only that sufficient quantities of tools and equipment are available well in

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[1] These specifications covered wheelbarrows, shovels, hoes, forked hoes, bushknives, crowbars, axes, mattocks, and handles for shovels, hoes, and pickaxes.

advance but also that appropriate tools of good design and quality are provided.

To determine the types of tools to be ordered, it is a prerequisite to consider the function, use and user of the tools. What will be the function of the tool (digging, loading, spreading)? On which type of soil will the tool normally be used? What will be the physique of the average user? (This is of importance as it will determine characteristics such as length of handle and weight of blade.) A proper handle is of utmost importance as it influences the productivity of a tool. Not only because a tool with an "appropriate" well-designed handle is easier to use but also because its breakdown time will be reduced. "Appropriate" in this context means that the handle should be adapted to the function of the tool. The handle of a striking tool, such as an axe for example, will need to be of a different shape and material than the handle of a digging tool such as a jembe or the handle of a loading tool such as a shovel.

In respect of manufacture and procurement, the following general issues need to be considered:

(i) The quantities of tools required.

(ii) The existing capacity for local manufacture of the recommended tools, in terms of technical and financial capabilities of local manufacturers to produce the required quantities of good-quality tools.

(iii) The scope of increasing the existing capacity for the local manufacture of tools.

(iv) How is the procurement of tools presently organised and will it be possible to use this existing procurement

system? If not, should it be adapted to suit the specific requirements of a large labour-based programme?

(v) Will it be feasible to adjust this system in such a manner that good-quality tools in sufficient quantities can be obtained from local sources?

Appendix 4 describes how the procurement of tools and light equipment for and within the RARP is organised and lists the tool requirements for a RAR Unit.

6. PLANNING AND SURVEY AT UNIT LEVEL

6.1 Introduction

The RAR engineer works within a framework of guidelines set by the RAR HQ. These guidelines cover such issues as personnel matters, accounts, procurement, equipment and accommodation. The RARP management has tried to standardise all the above aspects as much as possible, which is reflected in the standardisation of RARP accommodation, offices and stores.

In addition to the more specific issues mentioned above, general guidelines have been established in respect of compensation, public relations, communications, theft, and handover of responsibilities.

6.2 Planning of construction projects - the initial survey

The planning system of the RARP is based on the assumption that it should always be possible to specify the resources required for each unit six months in advance. This means that the construction projects scheduled to be carried out in the next six-month period by a particular unit are identified in terms of name, length, and the estimated required man-days and finance required. In order to achieve this, the RAR engineers are required to submit a priority list and a construction programme for a period of 12 months which should be updated regularly. The surveying and preparation of road construction projects are done six months in advance. Specific information on the roads proposed to be constructed in a particular district are available in the evaluation reports for rural access roads. As described in section 4, these

are prepared for each district by Ministry of Works Planning Engineers, based at HQ, in conjunction with the Rural Access Roads Engineer, the District Development Officer and the District Agricultural Officer. This report gives information on agricultural potential, population in the zone of influence and access. In addition to this, each road is briefly described, comments are made on soil types, river crossings and problems to be expected. Alignments are mapped on 1:50,000 scale maps. This road survey will normally have been done by the RAR engineer or his officer in charge.

As the area covered by an RAR unit is usually quite large, a zone of first priority for construction has to be selected by the District Development Committee. This is important because the construction sites should be kept as close as possible together in order to minimise transport and communication costs and to ensure that supervision can be carried out efficiently. Naturally, when it is evident that not enough labour is available to carry out several projects simultaneously in a certain area it is unavoidable to disperse the projects over a bigger area.

Further important issues to be dealt with before detailed project planning is started are the right of way and compensation. As explained earlier, only crop compensation for crops which have to be destroyed to allow the road through is paid in Kenya. This means that meetings with the local administration and the farmers concerned have to be organised where these issues are explained very clearly. When farmers insist upon land compensation and an alternative route is not practical, construction of that particular road will be postponed or even totally cancelled.

Appendix 5 shows the existing planning, programming and reporting arrangements within the RARP and describes how the overseer, after work targets have been established by the engineer, prepares his work programmes and organises his labour force. Finally, it discusses how the data on input and output are processed from the site through Unit headquarters to the RARP headquarters.

7. RECRUITMENT AND MOTIVATION

7.1 Recruitment procedures for RARP personnel

Within the establishment of the RARP there are three categories of labour: head office paid, works paid and casual employees.

(a) Head-office-paid MOW employees

These officials are paid from the MOW head office regular budget and are permanently employed. Usually they are qualified supervisory staff. They are not recruited by the RARP management but by the MOW head office. A number of this type of staff were temporarily posted to the RARP to assist with the implementation of the programme and to alleviate the urgent need for higher-qualified personnel, especially when the programme had just been initiated.

(b) Works-paid employees

These officials are paid monthly, but are not employed on a permanent basis. They can be dismissed at one month's notice, although this rarely happens in practice. Most MOW staff fall into this category: clerical personnel, supervisory personnel, drivers, plant operators, etc. They enjoy social benefits as stipulated in the "Code of Regulations" for Kenyan civil servants.

Works-paid staff have been transferred from the MOW establishment to the RARP in much the same manner as head-office-paid staff. However, the RAR engineer can also recruit his works-paid personnel from outside the MOW. The candidates can be employed if they are qualified to hold the position for which they apply.

Senior works-paid staff will normally be recruited by RAR HQ since they must be recruited through a body called the "Public Service Commission", who examine their experience and qualifications. A problem with the recruitment of senior works-paid staff has been that many candidates who had the necessary abilities, willingness and experience did not have the educational background and academic qualifications required by the civil service. They could therefore not be recruited. Although probably unavoidable this is unfortunate since the required attributes for personnel within the RARP are more related to man-management abilities, the ability to work without supervision and with common sense than to academic qualifications.

In the field it has fortunately been possible to fill most of the supervisor posts with young enthusiastic former headmen who could be employed at a salary scale below the senior works-paid salary scale.

All works-paid employees recruited from outside the Ministry of Works are recruited on probation for a period of three months. During this period their performance can be assessed and the employment can be terminated without the one month's notice applicable to regular works-paid employees.

(c) Casual employees

These are employees locally recruited for the execution of the construction works. Their wages are calculated on a daily basis, i.e. they will be paid only for the days on which they actually worked. They enjoy no social benefits and can be laid off when they are no longer required.

Casual labour is recruited on or very near the road which will be constructed. The conditions of employment are explained and the workers are required to sign a contract of employment when they are recruited. By signing the document the employee agrees that he has understood and accepted the conditions of work. When the persons applying for work outnumber the jobs available, workers are selected on a random basis to avoid charges of corruption and favouritism. Two systems have been used for selection:

(i) Each candidate is given a numbered ticket. If 400 candidates were present each candidate would have a number between 0 and 400. The duplicates of these tickets are placed in a container from which they are drawn one by one. The number of the duplicate is called out and the holder of the original will be recruited. The recruitment continues until all available vacancies have been filled. It is also possible to continue after the recruitment has been completed in order to list the remainder of the applicants on a reserve roll, so that they can be called by the local administration when required. However, it is often more practical to organise another recruitment day.

(ii) The number of applicants is counted and tickets are prepared with "yes" and "no" inscriptions. The total number of the "yes" and "no" tickets equals the number of applicants, while the number of "yes" tickets represents the available vacancies. Each applicant is then asked to pick one ticket out of the container in which the tickets are placed. Special care has to be taken that the details (name, age and name of chief) of the successful applicants are noted as soon as he receives his "yes" ticket and that the ticket is returned to the clerk immediately. This is necessary to prevent the

successful applicant from selling his ticket to somebody who had not been so lucky.

The second method is a lot quicker than the first and is therefore easier to use, especially when large numbers of people are involved. However, for the reasons described above, the recruitment has to be strictly controlled in order to avoid abuse.

Recruitment is done with the assistance of the local administration. The chiefs and subchiefs are usually enlisted to arrange the preparation for, and to assist with, the execution of the recruitment. Their assistance in the preparation consists of spreading the word that recruitment for a certain project will take place on a pre-arranged date. On the recruitment day they assist in the explanation of the conditions of work and help to ensure that the applicants come from within the vicinity of the road on which they will be working. This is especially important because the workers will be expected to walk to the site, no transportation being provided.

It is recommended that the worker be provided, after the project has been completed, with a statement of the number of days he worked, his earnings and a written explanation of deductions made. This avoids disputes at the end of the construction period. Moreover, each worker has a right to receive this type of information, which may serve as a reference for future jobs.

7.2 Motivation

Motivation of the labour is essential if a labour-based programme is to be successful. ILO studies have clearly indicated that workers paid on a piece- or taskrate system produce a much higher output than daily-paid workers. In the early stages of the

implementation of the RARP the labourers worked under a daily-paid system. After enough data had been assembled, taskwork was gradually introduced and has since then been implemented on most of the construction activities.

The daily payment system should only be used when no productivity data for the major operations in road construction are available. Daily workers are paid a fixed sum for a certain number of hours of work. But, whilst a reasonable output can be achieved, provided that supervision and work organisation are excellent, productivity will always be low because the workers have no incentive to increase production.

With the taskwork system a fixed daily wage is given in return for a fixed quantity of work. This means that workers are free to go home as soon as the given quantity of work has been done. The head man in charge of the worker ensures that the work has been completed satisfactorily, before the worker is allowed to leave the site.

Taskwork can be given to individuals (bush clearing, top-soil removal, ditching, etc.) or to groups (especially suitable for large quantities of excavation). If taskwork is given to a group of workers care should be taken that the workers are not in each other's way and have enough room to work. The workers should not be released before they have finished their task (even if this means that they have to continue after normal hours of work) unless unforeseen difficulties have arisen (like hard roots, rocks, bad weather, etc.).

Tasks will have to be adjusted when it is obvious that for some reason an average taskrate is not applicable any longer. It is easier to adjust taskrates by increasing or decreasing the number of

labourers doing a certain job rather than by increasing or decreasing quantities of work.

If a task is correctly set a good worker should be able to finish it in approximately 75 per cent of the nominal working time. Taskwork is most effective if the worker can go home every day to work for his own purposes or to spend leisure time at home. Imported labour may not be motivated by getting extra leisure time since it can be spent only in the labour camp or immediate surroundings.

Piecework is a system in which the worker is paid a fixed sum per unit of output, e.g. $1 per cubic metre of hard soil excavated. The worker himself decides how much he will produce and consequently earn. The payment per unit of output has to be determined very carefully and should be introduced only after enough reliable productivity data have been collected. To avoid exploitation of the workers, rates should be set in such a way that an average worker with a good motivation (with this system he is usually well motivated because production is related to financial reward) can earn a daily wage which is higher than the wage he would get for working the same number of hours (but less motivated) under the daily-paid system.

The advantages of this system are that the unit costs (payment per unit of output) are lower than the unit costs achieved with taskwork and that productivity is high.

It has not been possible to introduce the piecework system in the RARP because of administrative problems. A non-fixed monthly wage is usually not acceptable to a government agency. Furthermore, there is greater scope for corruption because the money is not provided by the persons who are measuring the output. These are

therefore not financially interested to ensure that measurements are made in a correct and fair manner.

Whatever system is used it is imperative that payment of wages is made on time and, if at all possible, not in arrears. Delayed payments reflect bad organisation and cause dissatisfaction among the workers. It may not always be easy to avoid delayed payment when workers are only paid for days worked. This is because payrolls have to be prepared in advance in order to allow the administration time to check them and to release the money. This problem may be overcome however by devising an efficient deduction system and by minimising the time between payroll preparation and payment as much as possible. (Two pay systems which have been used in the RARP are described in Appendix 9.)

Finally, the importance of issues such as workers-management relations, occupational safety, general working conditions and welfare facilities should not be overlooked. It is essential that the site management does everything possible to establish good relations between workers and management and amongst workers themselves. It should always be possible for individuals or groups of workers to air their problems. The management should always explain decisions. They should also encourage group activities such as sports and recreation. Weekly site meetings by Engineer/OIC, overseer and headmen can contribute enormously to the establishemnt of good relations and will prevent the aggravation and in many cases the occurrence of problems on the site.

To ensure the occupational safety of the workers, it has been common practice to avoid the concentration of large numbers of workers in a small area by measuring out individual tasks in a specific area for each worker. First-aid kits containing the

necessary items to treat injuries are always available in the site camps. In case of the occurrence of more serious injuries, transport to health centres or hospitals is provided after the Office in Charge has been notified.

As regards general working conditions, the workers should be able to finish their tasks in a reasonable time. It has been a good custom in many RAR projects to allow the workers to start work very early in the mornings, so that tasks could be finished before noon and consequently working during the hottest hours of the day could be avoided. The workers can determine their own pace of work, providing they finish their daily tasks. Since the workers employed for a particular RAR project always come from villages in the immediate vicinity of the site, housing facilities do not have to be provided. The management ensures that a supply of drinking water is always available on the site and frequently local women can be seen at the place of work selling various types of food to the workers.

8. PREPARATION AND IMPLEMENTATION OF THE WORKS

8.1 Preparation for the works

A small camp will be required at each construction site consisting of accommodation, sanitary facilities and storage facilities. A typical site camp as used in the RARP consists of:

(a) a 20' x 10' prefabricated corrugated iron hut for the overseer in charge. In some cases different sizes have also been used, depending on the rank of the overseer and customary Ministry of Works provisions in a certain area;

(b) a 10' x 10' corrugated iron store for tools, light equipment and cement. In many cases the storekeeper will use this store as accommodation and then a dividing wall may be provided;

(c) a 4' x 4' corrugated iron latrine;) in some areas 2' x 6'
) structures were
(d) a 4' x 4' corrugated iron bathroom;) provided

(e) a tent where required, especially useful for the survey team.

All the corrugated iron structures are constructed in such a way that they can be transported easily from one site to another. They normally consist of a number of panels, bolted together so that assembling and dismantling is possible in a short period and can be done by unskilled labour.

After the camp has been set up the overseer in charge of the construction site is provided with facilities for the storage of drinking water, stationery, simple survey equipment and tools and wheelbarrows sufficient for the labour force to be employed. On some construction sites it has been found useful to provide the overseer with simple transport, e.g. a bicycle.

8.2 Construction activities

The actual road construction can be broken down into a series of activities, which may again be subdivided as required by the circumstances. In the RARP road construction is usually broken down into two categories of activities, one group which can be carried out by taskwork, the other which cannot. The first group comprises:

(a) bush-clearing;

(b) tree and stump removal;

(c) grubbing;

(d) boulder removal or rock excavation;

(e) excavation to fill and to spoil;

(f) loading;

(g) ditching;

(h) sloping;

(i) camber formation;

(j) culvert laying;

(k) construction of scour checks;

(l) compaction.

The second group are the non-taskwork activities:

(a) work at camp;

(b) carrying of water (potable water for the workers);

(c) setting out.

Additionally, there are the structural activities such as drift and bridge construction.

A short description of each activity is presented in Appendix 6. This appendix also describes which tools were found to be best suited for the work in the RARP and average taskrates found to be applicable in Kenya. It should be emphasised that these taskrates are only valid for specific conditions found in Kenya and should be adjusted when work is executed elsewhere in different circumstances.

A good assessment of productivity is possible only when enough data has been collected on the site, where construction takes place. Nevertheless, the data shows the output per man-day as achieved by average workers in average conditions in Kenya. They can therefore serve as a basis for assessment of productivity in reasonable circumstances.

8.3 Gravelling[1]

A basic target of the Programme is that, for each unit, 4 km of road should be surfaced every month. The surface layer consists of gravel 4 m wide and 10 cm thick when compacted. This requires 400 m^3 compacted gravel (500 m^3 loose) per km of road. Assuming 20 construction days per month, this means that a total of 34 trailer loads of gravel have to be dumped and spread per construction day if the target of 4 km is to be achieved. Up to the end of 1977 only 20 per cent of the newly constructed rural access roads had been

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[1] The actual execution of the gravelling is described in Appendix 7.

gravelled. There were a number of factors that contributed to this discouraging figure:[1]

(a) the delivery of tractors and trailers used for gravelling was severely delayed;

(b) the average hauling distance from gravel quarry to the site generally exceeded 8 km, the figure upon which the estimates were based;

(c) the equipment was underutilised, mainly due to unavailability of spares and welding equipment. Even when these items were available at provincial headquarters they had to be moved to the site or the tractor had to be moved to the workshop thus causing considerable delays;

(d) inexperience of the operators, especially with regard to the technique of reversing a tractor/trailer combination;

(e) insufficient quarry organisation.

To overcome the problems mentioned under (b) and (c) it has been decided to provide the RAR units with six (45 hp) tractors instead of four (75 hp) as originally supplied to the first units. This will ensure (a) that even with longer hauling distances the target number of loads can be achieved and (b) that a minimum of four tractors will always be operational.

It has been found that the original tractor-trailer combination (75 hp tractors pulling trailers of 5 tonnes payload) was not well matched. Trials under extreme conditions with 45 hp tractors indicated that these tractors are suitable for hauling 5

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[1] Appendix 8 contains examples of RARP report forms for gravelling.

tonne trailers under the average RAR hauling conditions. It was considered that trailers with a payload capacity of over 5 tonnes would not be suitable for handloading and manoeuvring on narrow roads.

Since tractors and trailers have to match not only in respect of engine power and payload but also in respect of optimum load transfer, hydraulic pressure and fluid capacity, eye, hook and couplings, all these aspects should be carefully considered before the purchase is made in order to ensure that the equipment is well matched. Another measure taken to reduce the breakdown time has been to provide the field engineers with a full range of essential spares. It is also intended that each unit will have its own mechanics to carry out minor repairs and maintenance.

Courses are organised (i) for tractor drivers, in order to ensure that they handle and maintain their equipment in a better way and (ii) for gravelling overseers, so that the quarry organisation will be improved. Naturally, on-the-job training of overseers by engineers or officers-in-charge remains vital if a well-organised gravel operation is to result.

The Transport and Road Research Laboratory have agreed to provide a materials engineer and to train a Kenyan materials engineer. The purpose is to identify sources of suitable surfacing material using aerial photographs and other terrain evaluation techniques. It is expected that it will be possible to locate suitable sources of material in this manner and to supplement the information on sources of gravel that can be acquired locally from MOW maintenance personnel, local administration and local people.

The present MOW policy is to gravel all roads. However, the costs of gravelling by tractor/trailer might become prohibitive and

out of relation to the construction costs of the earth road when the hauling distance becomes too great. In this case there is a choice between the following alternatives:

(a) use other hauling methods;

(b) use other sources of material (i.e. introduce (mobile) rock-crushing equipment to crush rock to aggregate). In this way a very good-quality gravel with a proper particle size distribution can be obtained.

(c) provide a gravel surface only where appropriate, depending on the suitability of the in situ material, the standard of the classified road linking to the rural access road, and the disruption to anticipated traffic if gravelling is not done;

(d) do not construct a particular road if it is obvious that gravelling will be too expensive although it is necessary for technical reasons.

Personnel

Since the gravelling operation is the most equipment-intensive and costly operation of the construction of the rural access road its organisation merits particular attention. The overseer in charge of gravelling is not only in charge of a gang of casual labourers but also of plant operators with their tractors and trailers. The administration and organisation of the gravelling demands much more of the person in charge in respect of initiative, flexibility, leadership and administrative and organisational abilities and this implies that this person should be selected with care.

Plant operators should be skilled and motivated to ensure optimal utilisation of equipment. If plant operators are engaged from outside the Ministry of Works establishment it is essential that they are thoroughly tested before they are employed. The Staff Training Department (see section 9) organises courses for tractor operators to familiarise them with the tractor and routine maintenance procedures to be followed.

The motivation of plant operators is more difficult to influence. It has been found that operators who have been engaged at lower levels and have consequently more chance to be promoted are considerably more motivated than their higher ranked colleagues. Of course it may not always be possible to find suitably qualified personnel at these lower levels and this incentive will only last until they have reached the upper levels. If it is possible to introduce bonus payments for good maintenance and general performance this should certainly be considered.

The gravelling operation is particularly suitable for group taskwork or piecework.[1] Although the workers can be motivated easily this way it is essential to motivate the operators as well before either of the systems can be implemented successfully.

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[1] See section 7.

9. TRAINING OF RARP PERSONNEL

9.1 Planning of training

The Ministry of Works has its own Staff Training Department which has been particularly concerned with the training of supervisory personnel, equipment operators and mechanical personnel for the execution of its road maintenance programme. In 1975, a study was carried out by the Ministry of Works to assess what training facilities were required by the Ministry of Works in the period 1975-80. This study assessed the additional demands placed upon the Staff Training Department by the Gravelling Programme and the Rural Access Roads Programme.

Inter alia, the study discussed the following aspects:

(i) the number, categories and levels of additional personnel to be trained during the period 1975-80;

(ii) adequate training courses and methods;

(iii) the number and qualification of required instructors;

(iv) the extension of the existing facilities of the Staff Training Department;

(v) sources of suitable trainees.

9.2 Organisation and content of the training courses

The schedule below gives an outline of the type, duration and content of the courses given by the Staff Training Department.

Category of staff	Duration of course	Number of staff/course
Officers in charge of construction units	6 weeks	8
Overseers in charge of construction	13 weeks	10
Overseers in charge of gravelling	3 weeks	8
Plant operators (tractor)	2 weeks	8
Landrover drivers[1]	1 week	-
Lorry drivers[1]	1 week	-

[1] At the time of writing these courses were proposed but had not yet started. The required annual output per year of trained overseers (gravelling), landrover drivers and truck drivers was intended to be 16-18.

The training schedule is established in relation to the demand for supervisory staff generated by the schedule of implementation of RAR units. Each unit has a supervisory staff establishment of one officer-in-charge, three construction overseers and one gravelling overseer. Additionally, there is a drivers' establishment of six plant operators, one landrover driver, one lorry driver and one spare driver.

In order to be able to provide practical training to overseers, the Staff Training Department is responsible for one RAR unit, under the nominal control of an RAR engineer. Each overseer trainee receives practical training of nine weeks in the field, supervising on-going construction projects.

The training unit is stationed in a district with a varied landscape (flat and hilly) and where sufficient gravel is available so that a gravelling team can operate continuously. Construction is carried out on a minimum of two road projects, each with a labour force of 100 workers.

An officer-in-charge is attached to the unit. He is responsible for the preparation of new projects, unit administration, and the supply of materials to the sites. This enables the STD instructors to spend their time on training. The courses for officers-in-charge, plant operators, drivers and the theoretical part of the course for overseers are run within the existing facilities of the STD in Nairobi.

The technical content of the OIC courses is a repetition of the overseer course with additional information on surveying and structures.

The courses for gravelling overseers were set up in recognition of the importance of the gravelling operation.

The courses for drivers and operators cover maintenance aspects and driving techniques. Special attention is given to the difficult matter of reversing a tractor/trailer combination.

9.3 Recruitment of suitable trainees

One of the major differences between capital- and labour-intensive construction methods lies in the type and quantity of supervisory staff required. The handling and administration of large numbers of casual labourers requires a different approach to organisation and management. It also requires different attitudes from the supervisory staff - from engineer to overseer - who are responsible for the efficient use of a number of machines and the large labour force. Man-management and leadership abilities become very important, especially for officers-in-charge and overseers who have to work with the labour force in the field. Engineers need to be reoriented towards the specific problems of labour-intensive road

construction so as to become more aware of the possible alternatives in respect of planning, design and techniques to be used.

The Kenyan Government has recognised the importance of a proper training at every level. Several young graduate Kenyan engineers have been and are running rural access roads units.

For officers in charge of units there have been three different sources of recruitment. Many good candidates for officer in charge could be found from the ranks of overseers. The problem with a number of these persons has been that promotion to a rank, suited to an official carrying so much responsibility, has been difficult in many cases. Problems arise because the persons involved do not have the educational qualifications required by the Government for a particular rank.

It has been decided, therefore, to try and recruit suitable candidates who do have the required qualifications from the Kenya Polytechnic. These "inspector roads trainees" would be given a more thorough practical training in labour-intensive construction techniques, so that they can be prepared to take over as officers in charge of RAR units. Officers in charge with required qualifications have also been provided by various volunteer organisations. To obtain the necessary background knowledge and experience these volunteers have a familiarisation period in one of the on-going units where they study the available technical manuals and course manuals for officers in charge and overseers.

Overseer trainees have generally been recruited from the ranks of headmen within the ongoing units of the RARP, staff already employed by the Ministry of Works Maintenance Organisation and/or the "National Youth Service".

Before a headman can be selected to attend a RAR overseer course he has to have had a minimum practical experience of one year. Selection depends on the results of a technical and language test and the recommendations of the officer in charge and engineer. Candidates from the National Youth Service or the Ministry of Works Maintenance Organisation, who show the correct attitude towards the RARP, have to have an experience of at least three months working in an on-going unit before they are considered for participation in a RAR supervisor course.

Plant operators and drivers, who should already possess a valid driving licence, are nominated by the rural access roads engineers to come for training at the Staff Training Department.

10. MAINTENANCE OF RURAL ACCESS ROADS

The maintenance system that has been adopted for the roads constructed under the RARP is particularly interesting in that it relies on labour-based methods. Contracts are given to individual workers to maintain a certain section of road for a fixed amount of money. The contract stipulates that payments can only be made if the section is in a good state of maintenance and if it is clear that regular maintenance has been carried out.

The workers are contracted immediately after the road, or a section of the road, has been completed. In general, the workers are former employees of the RAR construction unit. It is ensured that they live in the immediate vicinity of the section of the road they are to maintain. Consequently, no transport is required and they have a knowledge of road construction and of the standard to which the road has to be maintained. Moreover, it will be possible, since the workers are known to RAR supervisory staff, to offer the contracts to those workers who have shown both responsibility and diligence during the construction period. An additional and perhaps most important advantage is that it is known in the surroundings which worker is responsible for the maintenance of a particular section of road. In this way, he is likely to come under social pressure if he fails to maintair this section.

This maintenance work should be carried out as and when required. Major repairs, however, such as the replacement of broken culverts or the repair of washouts, are carried out by a special taskforce organised by the officer-in-charge or the RAR engineer. If such major repairs should be necessary it is the duty of the maintenance worker to inform the local authorities, who in their turn are expected to inform the RARP maintenance staff. According

to the requirements of his section, each maintenance worker is issued with a selection of the following tools and light equipment: hoe, shovel, culvert-cleaning shovel, bushknife, rake, grass-slasher, handrammer, file and wheelbarrow.

The length of each section of road allocated to one worker for maintenance varies according to the amount of work required to maintain it properly but is based on the assumption that the contract for maintenance requires approximately 12 man-days of work per month. This enables the worker to spend the rest of his time on his own farm.

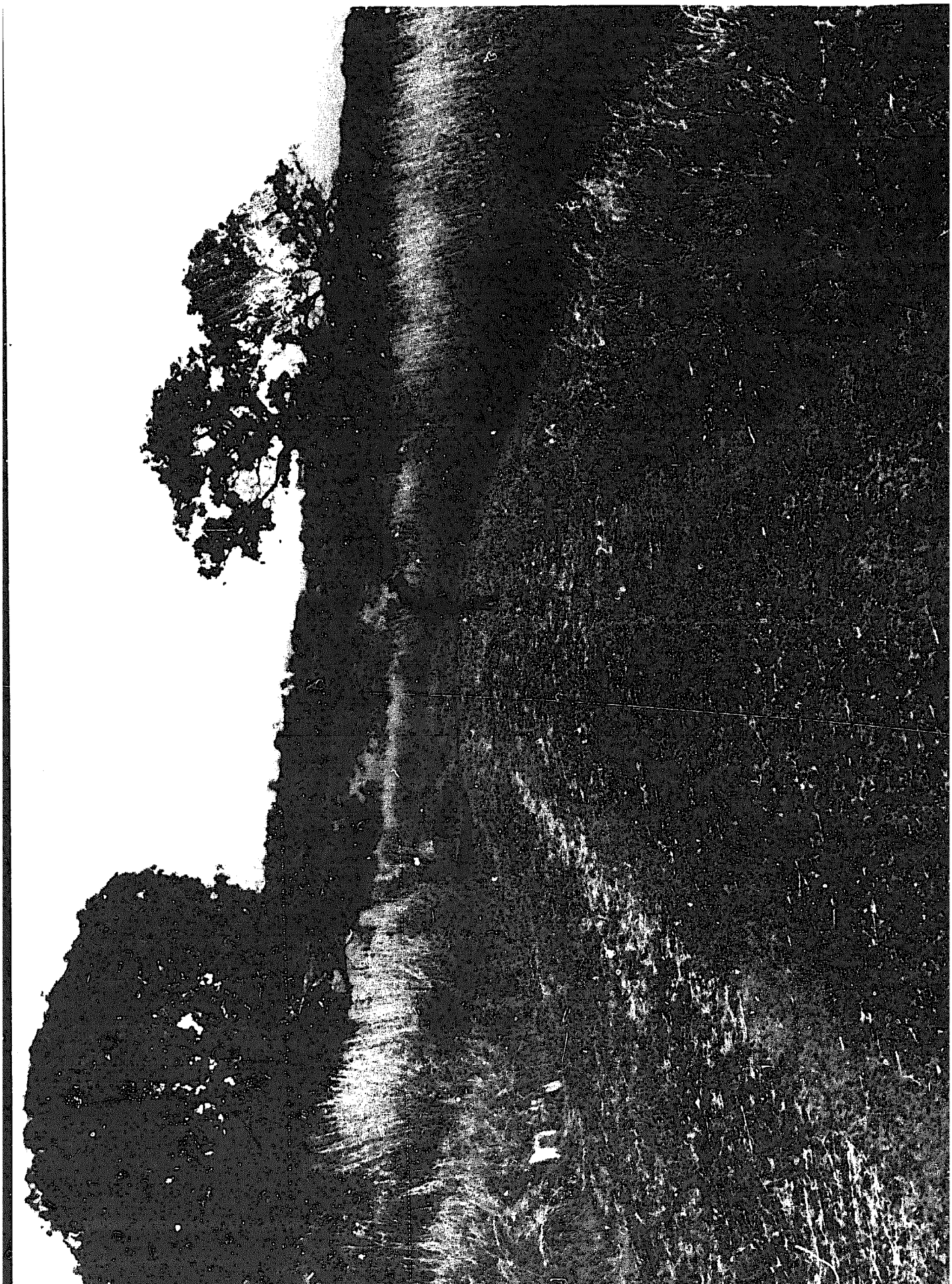
The workers are paid a fixed monthly salary of 12 working days at the current RARP rate for casual labour. If the road is in an unsatisfactory condition due to neglect by the worker payment is withheld until the deficiencies are rectified.

The inspection of the roads and supervision and payment of the workers is the responsibility of a maintenance inspector or officer-in-charge, who under normal circumstances should be able to supervise the maintenance of approximately 300 kilometres of road, depending on the average distance of his base camp from the roads. He is assisted by a clerk who handles the administrative work required (payrolls, etc.) and is provided with a landrover and driver.

An example of a maintenance inspection report can be found in Appendix 8.

At the time of writing this paper, this maintenance system is well suited to, and had been adequate for, the proper maintenance of the completed rural access roads. The system can also be adapted to future demands, in relation to increased traffic volumes. It would

be possible, for instance, to reduce the length of road to be maintained by one worker in case of an increase of traffic. Frequent inspection tours, good supervision and a strict control of standards are, however, essential if this maintenance system is to be successful.



11. CONCLUSIONS

11.1 Effects of the RARP on employment and agriculture in the rural areas where the programme is implemented

Employment creation

For the construction and maintenance of the rural access roads the RARP makes use of the local under- and unemployed rural labour force. The table below provides details of the employment created by the programme up to 31 March 1979.

Year[1]	Number of Units operating	Total labour employed (man-years)	Number of km constructed	Number of supervisors employed (man-years)
1974-75	1	270	25	5
1975-76	3	810	79	15
1976-77	6	1 620	271	30
1977-78	17	4 590	671	85
1978-79	28	7 000	1 235	140

[1] From 1 July to 30 June.

In addition, one contractor per approximately 1.5 km of road is engaged on a permanent basis to carry out routine maintenance activities (see section 10 for a detailed description of the system). By early 1979 some 7,000 labourers were employed in the construction units, while 525 individual maintenance contractors were maintaining the completed roads. When the Programme is fully operative (42 units) it will provide employment to some 12,000 workers, 250 supervisors, 150 masons and carpenters and approximately 300 drivers and tractor operators. Most of the skilled staff will be needed for the maintenance of the completed

rural access roads and also the classified "minor" roads, once the RARP has been transformed into a betterment and maintenance programme (section 2).

The growth rate of the rural labour force in Kenya between 1970 and 1990 is estimated to be about 2.7 per cent (the rural labour force is defined as 95 per cent of the males and 45 per cent of the females between the ages of 15 and 59 years).[1] This means that, with an annual growth of the rural population between the ages 15 to 59 years of 113,000, the average annual casual labour requirement of a fully operative RARP will represent approximately 15 per cent of the average annual increase of the rural labour force.

In 1980 the 12,000 workers would represent 0.4 per cent of the total rural labour force.

Naturally, the impact of the RARP labour recruitment at the local level should be considered within the context of other rural employment opportunities. The sample survey of the RAR workers carried out by the labour supply study staff showed inter alia that some 60 per cent of the interviewed RARP workers had previously worked off the farms. Moreover, most of those who had not previously worked were youngsters who had recently joined the labour force. The most recent employment of approximately 37 per cent of the workers had been in agriculture. The remainder had been employed in various urban or non-agricultural activities. Approximately 55 per cent of the RAR workers interviewed intended to return to their smallholdings when their RAR employment ceased. Most of the remainder intended to look for new jobs.

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[1] The figures used here are derived from the "RAR labour supply study" and originate from the Central Bureau of Statistics, Ministry of Finance and Planning, Government of Kenya.

As regards the effect of the RARP on the agricultural activities in the areas where the Programme is operative, a detailed examination of the labour supply of 13 road sites revealed that in 12 of the cases less than 10 per cent or less of the total male labour force available within 2 km of the road applied for RAR employment. At five of the sites, the numbers of applicants from within this 2 km area represented 5 per cent or less of the total male labour force. At only one site was the 10 per cent figure exceeded. The workers coming from within this 2 km area represented about 30 per cent of the RAR labour force.

The RAR workers travelling more than 2 km are drawn from a much larger area and represent therefore a much smaller proportion of the total labour force available in this larger area.

One can conclude from the evidence, therefore, that it is unlikely that the RARP would cause severe labour shortages for other economic activities. It is more likely, and indeed this has occurred already in several cash crop farm areas, that the labour requirement for agriculture will limit the supply of labour for the RARP.

Characteristics of RAR workers

The RAR workers fall within five main categories:

1. Workers from families with smallholdings where no hired labour is employed and where the worker has had no off-farm employment during the last 24 months (45 per cent of the RAR labour force).

2. Workers from families with smallholdings, who have held off-farm employment during the last 24 months (35 per cent of the labour force).

3. Farm owners and employers of hired labour who do not search for off-farm employment (11 per cent of the labour force).

4. Farm owners and employers of hired labour who search for off-farm employment (3.5 per cent of the labour force).

5. Landless workers (5.5 per cent of the labour force).

For 36 per cent of the workers in the first category, it appeared that in their smallholdings the family labour availability was over twice the labour requirement. Therefore, it may be concluded that the loss of their contribution to the farm output would be very low. The second category was assumed to comprise of seekers of off-farm employment. For this category as well, the loss of agricultural production was estimated to be low. The third and fourth categories find it worth while to hire labour which implies that the agricultural output produced by these workers must be higher than the hired workers' wage rate. It is unlikely in this case that substantial losses in agricultural production will occur because these categories of workers have taken up employment with the RARP.

For the last category of workers the RARP simply constitutes an additional employment opportunity within the existing rural labour market. Moreover, the small number of landless labourers working on the project means that those who will derive the most benefit from the roads, the small farmer, are also most involved in their construction.

Summarising, the evidence of the study clearly suggested that the loss in agricultural production, even within very limited areas around the road site, would be small. Furthermore, the projected upward trend in the size of the national labour force and population

suggest that labour availability for off-farm employment in rural areas will increase in the future without conflicting with agricultural production to a great degree. Moreover, the RARP requires labour in a locality for a relatively short period, so that its effect on the local labour market is short-lived.

To limit adverse effects on agricultural production and to ensure that the road construction benefits those who live close to the road, two policy measures have been adopted: first, the use of migrant labour is discouraged; second, the wage rates are kept sensibly low. This means that when a labour shortage occurs the project is postponed. If it is not possible to obtain the numbers of workers required even when agricultural requirements are low, the project is abandoned. These shortages of labour have, however, occurred in very few areas, implying that in most areas the problem is under-employment of labour. In this respect, it should be noted that the availability of labour and the degree of community interest in a particular project is, to the extent possible, assessed at an early stage in the project selection. It may be concluded that, since the RARP offers "half-time" employment within the locality, it provides an excellent additional employment opportunity to the people living in the small rural localities.

11.2 Relevance of the RARP to labour-based road construction projects elsewhere

The previous sections have shown the methods which have been employed within the RARP to overcome its administrative, organisational and management problems and have described the types of technical assistance provided to the Government of Kenya. The appendices describe, in more detail, the various systems and procedures developed during the course of implementation of the

Programme. It should be recognised, however, that the successful implementation of this large-scale road construction programme could not have been realised without the commitment and support of the Government of Kenya and, in particular, the Ministry of Works, which is responsible for its execution.

It was always felt that the knowledge and experience gained in the implementation of the RARP could be applied in similar projects elsewhere. The relevance of the Programme in this respect was particularly demonstrated when, in November 1978, the ILO in collaboration with MOW organised a study tour for African and Indonesian engineers and economists. Eleven participants from seven countries took part in this study tour. In addition to six senior engineers from Botswana, Ethiopia, Gambia, Sudan, Togo and Zambia, whose participation was financed under the ILO/NORAD Programme of Technical Co-operation between Developing Countries, a second Ethiopian and four Indonesian government officials attended, financed by the Ethiopian Government and UNDP Indonesia respectively.

The participants had the opportunity of visiting on-going projects in selected areas in the field and to discuss practical problems of organisation and administration with the field engineers and supervisory staff. At the Programme's headquarters in Nairobi, various papers were presented describing the inception, development and progress of the RARP and discussing its methods of training, maintenance, management and organisation. At the end of the study tour the participants appraised the Programme in a brief evaluation report and discussed the possibilities of implementation of similar projects in their own countries. Summarising these reports, it may be said that the participants were impressed by the scope and organisation of the Programme and by its results in respect of

output, productivity and quality of the completed roads. It also appeared that the lack of skilled supervisory staff and the negative attitudes of engineers in public works ministries were considered to be the major impediments to the introduction of labour-intensive methods in road construction.

This last point particularly demonstrated the usefuless of the study tour, since many engineers (including some of the participants prior to having seen the programme at work) are convinced, unless shown otherwise, that labour-intensive methods are inferior in terms of quality and productivity. High wage rates and the non-availability of labour in some areas were identified as constraints in some of the reports, although it was realised that the implementation of appropriate technology does not mean that labour-intensive construction methods should be used at all costs, but only when their use is economically and technically justified. There was a general feeling that the use of labour-intensive construction methods can be very advantageous to developing countries provided good organisational, administrative and training systems are established. The RARP had demonstrated convincingly that, in Kenya, it had been possible to construct low-cost, good quality rural roads using these methods. It had also shown that the use of this alternative technology had led to a considerable reduction of foreign exchange costs and an optimal utilisation of local resources. Finally, it was indicated in several of the reports that the right type of technical assistance, aiming at the provision of the infrastructural requirements necessary for an effective implementation of labour-intensive methods, would be most welcome.

In 1979, the ILO will provide technical assistance in the implementation of labour-based rural road construction and maintenance projects to the Governments of Ethiopia, Botswana and

Mozambique. Naturally, it will not be possible to transplant the methodologies practised within the RARP without adapting these to the conditions prevailing in these countries. Nevertheless, the Kenyan experience has provided an extremely valuable background to which country specific approaches can be related.

Another important feature of the Programme is that it has shown in which areas further research is still required. For example, it has become clear that traditional tools and equipment mainly used for agricultural activities are often not suited to the different requirements of heavy construction work, where they are used extensively and under difficult conditions. However, in order to justify the higher purchase costs of well-designed good-quality handtools and equipment, it will be necessary to determine the extent to which the productivity of labour is influenced by their use and to quantify the greater durability of these tools.

The successful use of tractors and trailers in the gravelling operations has demonstrated that this form of "intermediate" equipment can be eminently suited to this type of work, provided that their design is adapted to their use in road construction operations. It would seem that there is great scope for the introduction of other forms of intermediate equipment in road construction, using either human, animal or engine power. The use of such devices may well lead to a further increase of productivity and thereby further increase the competitiveness of labour against machinery.

It may be concluded from the above that the potential for the development of an alternative, more appropriate, technology in road construction is great and that there exists a considerable interest in other developing countries to implement such a technology.

Many obstacles still have to be overcome before labour-based construction methods are accepted as a potentially viable alternative by those concerned with the planning and execution of road construction works in developing countries. Political commitment at the highest level for the implementation of the most appropriate technology is indispensable. Furthermore, it will be necessary to create an awareness among planners and engineers that alternative technologies exist, and that a choice of the most appropriate technology in the planning design stages of construction projects is a prerequisite, if these projects are to have a maximum impact on the environment where they are executed. To produce this awareness, educational curriculae in technical schools and universities will need to be adjusted to reflect the merits of the use of labour-based road construction methods.

At the same time, it is essential to recognise - and this is an important lesson learnt from the RARP - that the choice of technology has implications for all phases of the construction process. When the use of labour-based construction methods is considered, the design and the systems of planning, management, training and administration will have to be modified and related to the employment of large numbers of men rather than to construction with a limited number of machines. When an integrated mix of labour-based and equipment-intensive methods is considered to be the most appropriate approach, the working techniques and administrative systems will have to be orientated towards the use of this "mixed" technology.

Of paramount importance is the training of a cadre of supervisory staff familiar with the concepts of labour-based road construction projects. Man management and leadership abilities as well as the capacity to programme, organise and monitor the

construction activities are essential and training programmes should emphasise these aspects.

Summarising, it is clear that the implementation of more appropriate technologies in the road construction sector will require support from the highest level and a flexible approach to seemingly familiar problems. More information and a different approach in education and training of engineers and planners are needed to produce a change of attitude towards the use of alternative technologies. Fortunately, the RARP has contributed much in this area by providing the evidence that labour-based construction methods can be viable and competitive.

APPENDICES

APPENDIX 1

STRUCTURE OF THE RARP HEADQUARTERS AND FIELD ORGANISATION[1]

1.1 The centralised structure

The actual execution of the works carried out under the RARP is the responsibility of a senior superintending engineer who is assisted by two superintending engineers, based at headquarters, who are responsible for the units operating in East and West Kenya respectively.

The superintending engineers form the link between the RARP headquarters and the field staff. They are responsible - within their particular region - for the implementation of the planning, technical, administrative and reporting standards of the RARP. They monitor and co-ordinate the work of the RAR engineers and inspect the ongoing construction works during inspection tours. Their specific duties are the following:

(a) to ensure that the design and construction standards of RARP are implemented on a programme-wide basis;

(b) to monitor the effective use of planning and reporting systems for the RARP;

(c) to ensure that the systems of procurement and the supply of resources to the RARP field units work effectively;

(d) to provide assistance and advice to the RARP field engineers on the implementation of the Programme.

One of the superintending engineers, in collaboration with the senior superintending engineer, is also responsible for the

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[1] Charts visualising the structure of the RARP headquarters and field organisation are attached to this appendix.

preparation of quarterly reports to donors relating to the disbursement of funds. Each of the superintending engineers is assisted in his duties by an assistant construction engineer who has been made available to the RARP under the ILO associate expert scheme.

The senior superintending engineer is responsible for the co-ordination of the efforts of the superintending engineers, has the over-all responsibility for the proper implementation of the financial and procurement procedures related to the Programme, and liaises with the chief superintending engineer and the chief engineer (roads) in all matters of policy.

The day-to-day running of the RARP head office, accounts section and stores section of the RARP is the responsibility of an executive officer, an accounts assistant and a supplies officer respectively who report directly to the senior superintending engineer.

The executive officer is responsible for the handling of personnel matters for staff employed at head office and the recruiting and discharging of staff in liaison with the personnel section of the Ministry of Works and the senior superintending engineer. His other duties consist of supervising head office staff and ensuring that registry, filing and handling of correspondence are done properly and that Government of Kenya regulations are being adhered to. The accounting and procurement systems are discussed in detail in Appendices 3 and 4.

In addition to the managerial and administrative staff mentioned above, a mechanical engineer, based at RAR headquarters, is responsible for the introduction of effective vehicle and plant servicing procedures in order to maximise vehicle and plant

availability. In this context he is expected to determine the service life of parts such as fan belts, brake linings, etc. so that these can be replaced during planned servicing rather than after failure. Furthermore, he co-ordinates the maintenance and repair of the RARP equipment.[1]

In the field, the Rural Access Roads (RAR) engineer is responsible for the usual duties of financial administration, planning, programming, approval of alignments, procurement and the preparation of monthly progress and finance reports. Moreover, he is also responsible for the technical evaluation of the proposed roads, the design of small structures, on-the-job training of supervisory personnel and the implementation and organisation of an efficient maintenance system. In short, he is working as a contractor, consultant, instructor and accountant. Since all the above-mentioned aspects are of equal importance and the use of labour-intensive construction methods is still relatively strange to many civil engineers, it follows that the RAR engineer needs to be a person who is not rigid in his attitudes but can approach the above-mentioned facets of the work in a flexible manner.

Officer in charge (OIC)

The day-to-day running of the units is the responsibility of an officer in charge (OIC).[2]

In practice, most OICs have been recruited from the overseer ranks after recommendations by their respective engineers.

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[1] The average equipment holding per RAR Unit is: 1 Landrover, 6 tractors, 8 trailers, 1 flat lorry and 1 pedestrian vibrating roller.

[2] The most senior level of supervisory staff.

Special courses for officers in charge have been organised by the Staff Training Department of the Ministry of Works (see section 9).

The officer in charge is expected, without engineering supervision, to deal with the survey, the employment of casual personnel,[1] the procurement and administration of stores, the programming control and reporting of construction works, and the efficient organisation of logistics.

He should also be able to advise the gravelling overseer on the suitability of gravel materials to be used and on other matters related to soil technology. He submits a detailed monthly progress report[2] on all the above issues to the engineer.

Overseers

The overseer in charge of a construction site should be able to manage, with only a limited amount of supervision by the OIC, a labour force of approximately 80 casual labourers with the assistance of one headman per 20 labourers. He is also responsible for the preparation of daily work programmes and site reports and for the administration of personnel and stores under his charge. Examples of the standard forms used in the RARP for the above can be found in Appendix 1.

Headmen

The overseer is assisted by a number of "gang leaders" or "headmen", normally one per 15 labourers. These headmen supervise the work of their particular gang in respect of output and

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[1] In some cases this will be done by the engineer.

[2] An example of such a monthly report can be found in Appendix 8 (RAR form 6).

standards. They are expected to execute the daily work programme as prepared by the overseer, to report the daily progress and to manage their group of workers without favouritism.

In addition to the supervisory staff, each unit has one general storekeeper, three or four casual storekeepers, one carpenter, one mechanic and at least one mason.

The general storekeeper handles the issues and receipts of the unit main store, while the casual storekeepers deal with the stores on the separate construction sites.

The mechanic takes care of small repairs and maintenance of the equipment.

The casting of concrete culverts is carried out away from the construction site. A mason with a number of casual labourers is responsible for this operation. In some cases the engineer may decide to have one centrally located site with facilities such as running water where all culverts for his units are cast.

1.2 The decentralised structure

In section 2 it was noted that the organisation of the RARP would be decentralised in order to:

(i) provide the basis for the implementation of the betterment and maintenance programme which the RARP will eventually become;

(ii) provide a more effective supervision to increase the efficiency of the field units.

In this situation the headquarters staff would comprise one programme co-ordinator and one construction engineer. The

responsibility for the co-ordination of the RARP at the provincial level would be delegated to "Divisional Engineers". Six such posts would be established at the various Provincial Engineers' Offices. The posts would be filled by experienced RAR engineers of proven ability. The Divisional Engineer would initially be responsible for the RAR construction and maintenance work as well as the field administration in his division. Gradually, with the augmentation of the length of completed roads, the Divisional Engineer would set up a maintenance organisation, independent of the field engineers. These would, from then onwards, be solely responsible for construction activities instead of for maintenance as well as construction activities, as had been the case since the start of the programme. This maintenance organisation would initially concentrate on the maintenance of completed Rural Access Roads but could by degrees be enlarged to include the maintenance of the classified minor road network.

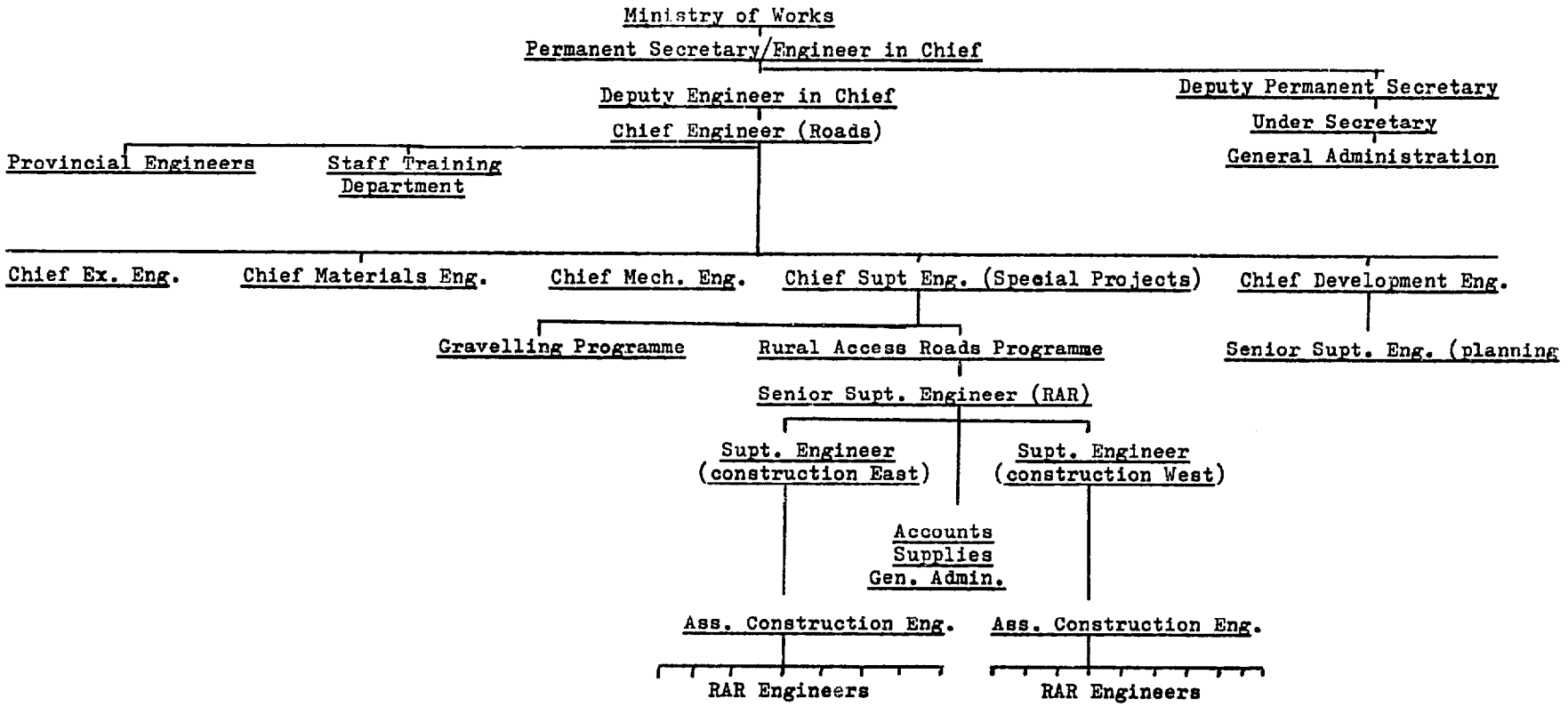
Each Divisional Engineer would have the following staff at his disposal:

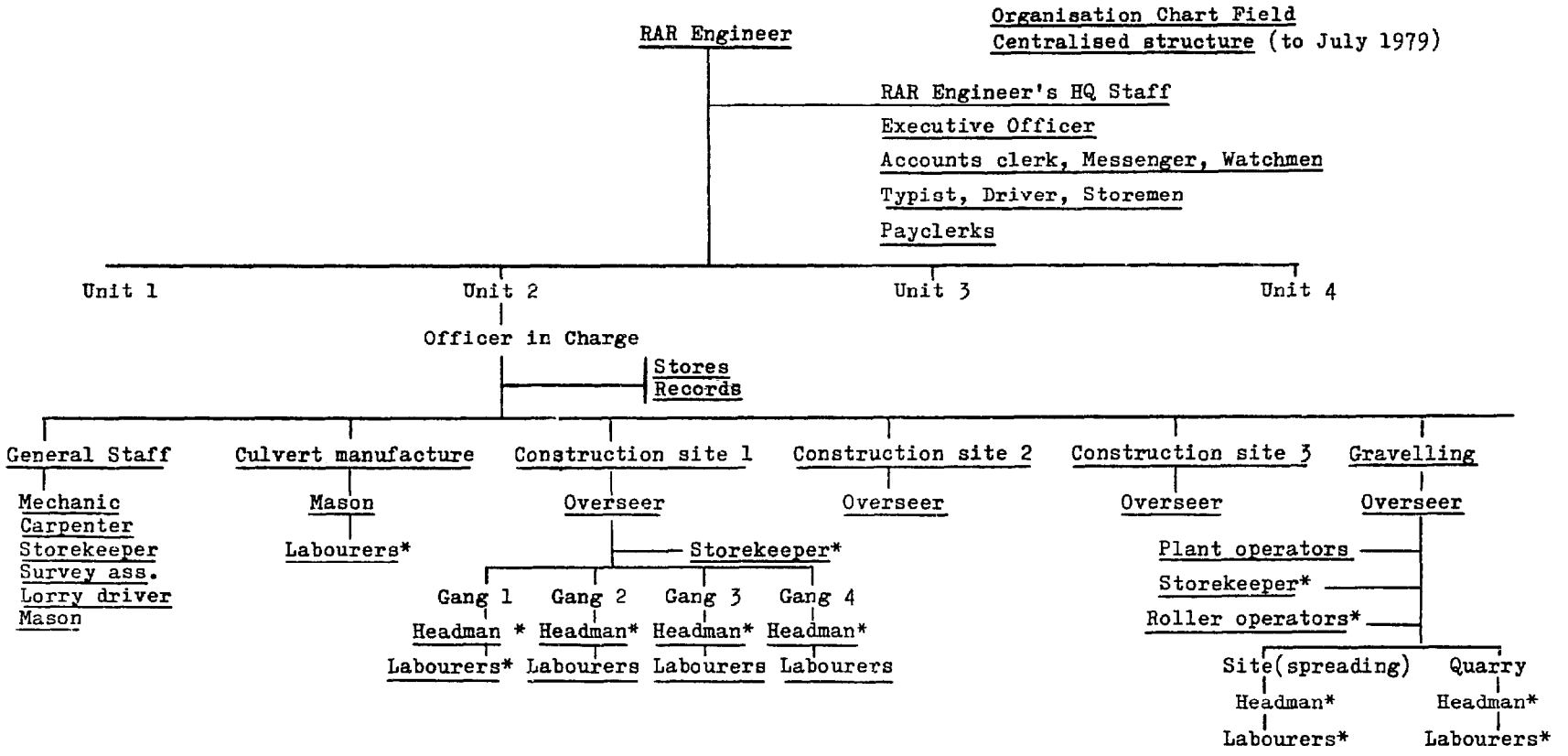
(i) an inspector mechanic in charge of a service team of several mechanics;

(ii) administrative staff to handle the accounts, records and stores at the provincial level.

The length of time that the "field supervisor" posts would still be occupied by expatriate engineers would depend on the availability of suitable candidates either from the Kenya Polytechnic or from the University of Nairobi. At unit level (from OIC downwards) the organisation remains similar to the organisation described above (see "centralised structure").

Organisation Chart Headquarters
Centralised Structure (to July 1979)



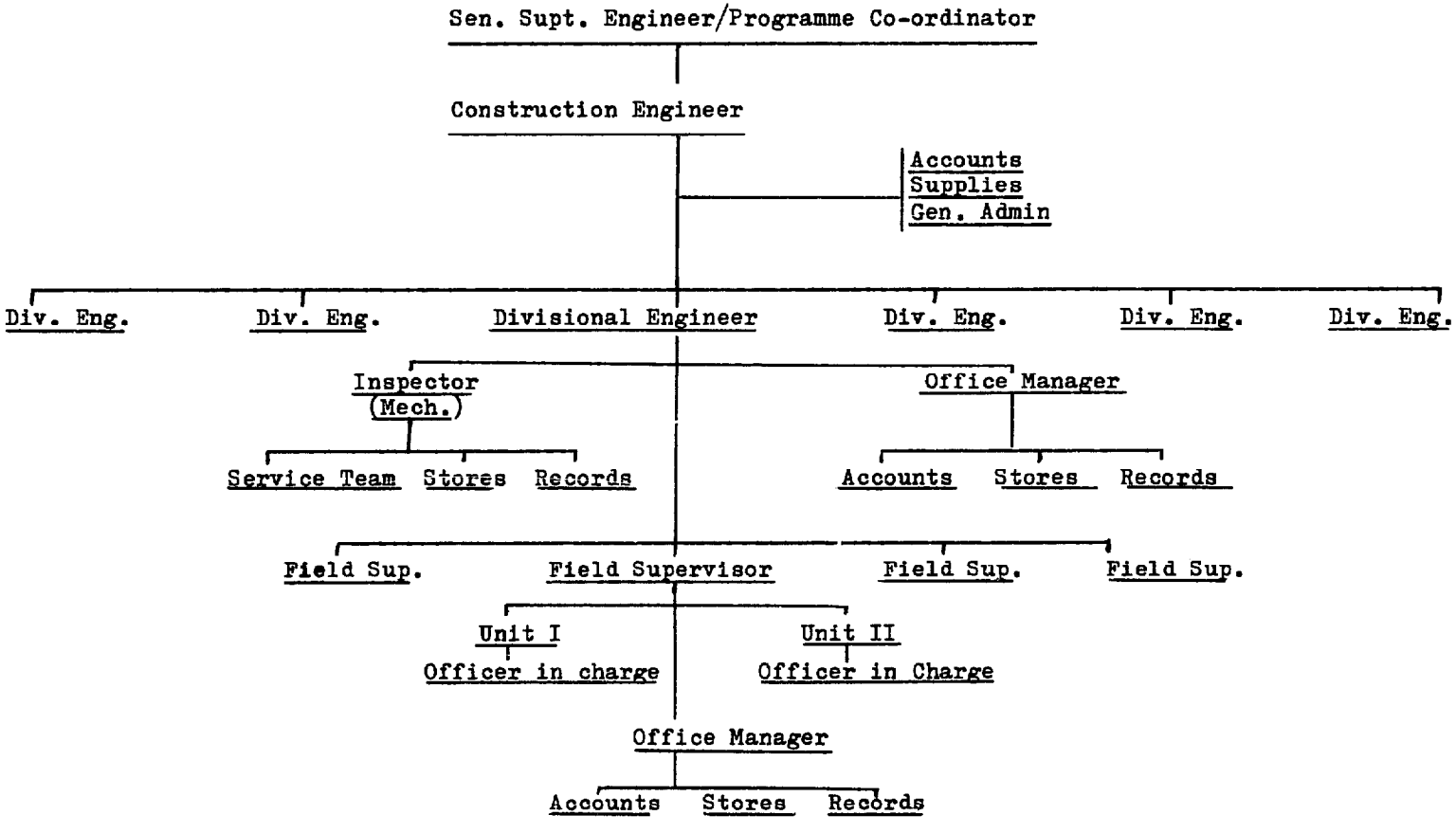


Note : 1) Labour will be employed as required, but the total number of casual labourers per unit should not exceed 300
2) At the RAR Engineers' HQ normally one payclerk and one storeman per unit is employed.

*Casual

Organisation chart II RARP

Decentralised Structure (to be effective from July 1979)



APPENDIX 2

DESIGN STANDARDS OF RURAL ACCESS ROADS

Guidelines prepared by the MOW in respect of design of rural access roads stipulate that a gradient of 11 per cent should not be exceeded and that where a gradient of 11 per cent is considered necessary this gradient should not be exceeded for more than 100 metres continuously.

The minimum radius of horizontal curvature is 15 metres and the minimum desirable radius of horizontal curvature is 30 metres.

The design standards in respect of formation and drainage are shown in table 1, and standard cross-sections of the rural access roads appear as figure 2.1 to 2.6 of this appendix. Side drains steeper than 5 per cent should be provided with scour checks and frequently-placed mitre drains or culverts according to the terrain and gradient.

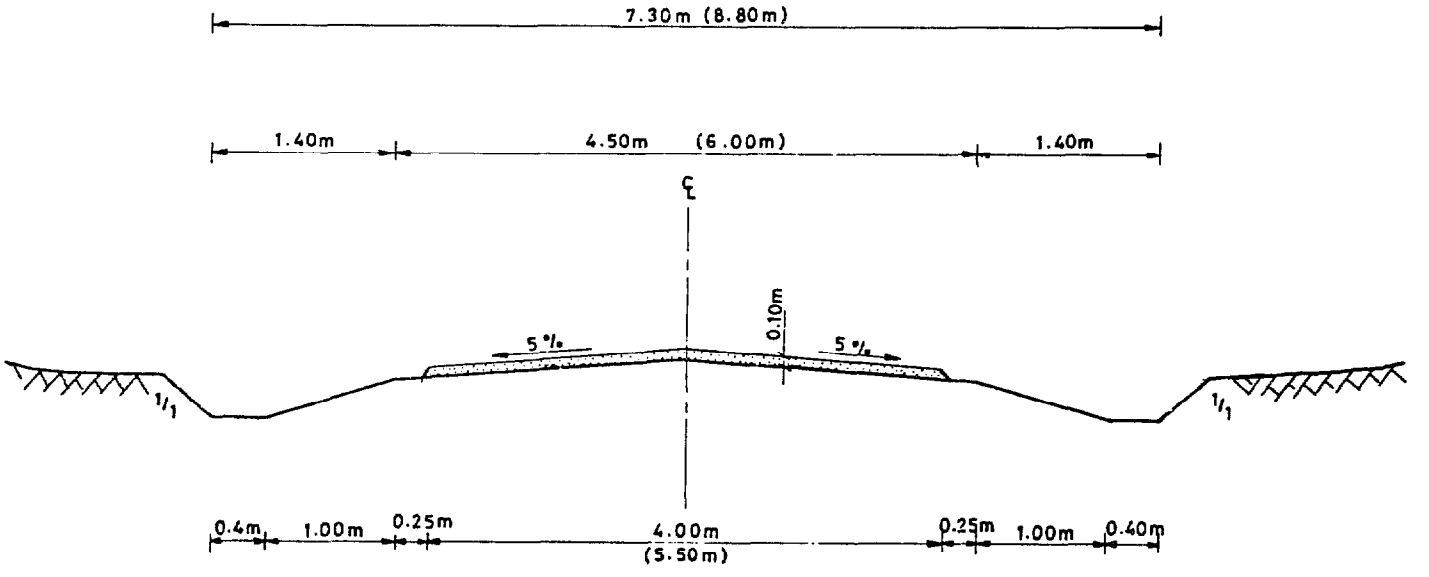
For less than 30 vehicles per day the width of the earth-road formation is 4.50 metres as shown in the attached cross-section. If however the traffic is expected to be more than 30 vehicles per day a wider formation of 6 metres is considered justified. In mountainous terrain where cuts are greater than 2 metres the earthworks are minimised by the reducing of the formation width to 3.5 metres (see cross-section III). Passing bays will be provided within sight distance of each other and the length of these sections constructed according to this cross-section is kept limited.

Table 1: Design standards of rural access roads

Standard formation	4.50 m)
Sidecut	4.50 m) shoulder included
Embankment	6.00 m)
Side drain	2 x 1.40 m
Side drain in sidecut	1 x 1.40 m
Formation width	
Standard	7.3 m
Sidecuts	5.9 m
Embankment	6.0 m
Deep cut (height over 2 m)	3.5 m
Camber of running surface	5-7%
Width of gravel course	4.0 m
Depth of gravel (compacted)[1]	10-15 cm
Depth of side drain below horizontal excavated level	30 cm
Depth of side drain below crown of road	45 cm
Minimum diameter of culvert pipes	45 cm
Minimum gradient of culvert pipes	2.5%
Maximum gradient of culvert pipes	5.0%

[1] While the normal gravel thickness is 10 cm compacted, on very poor natural soils this thickness may be doubled to 20 cm.

STANDARD CROSS SECTION I

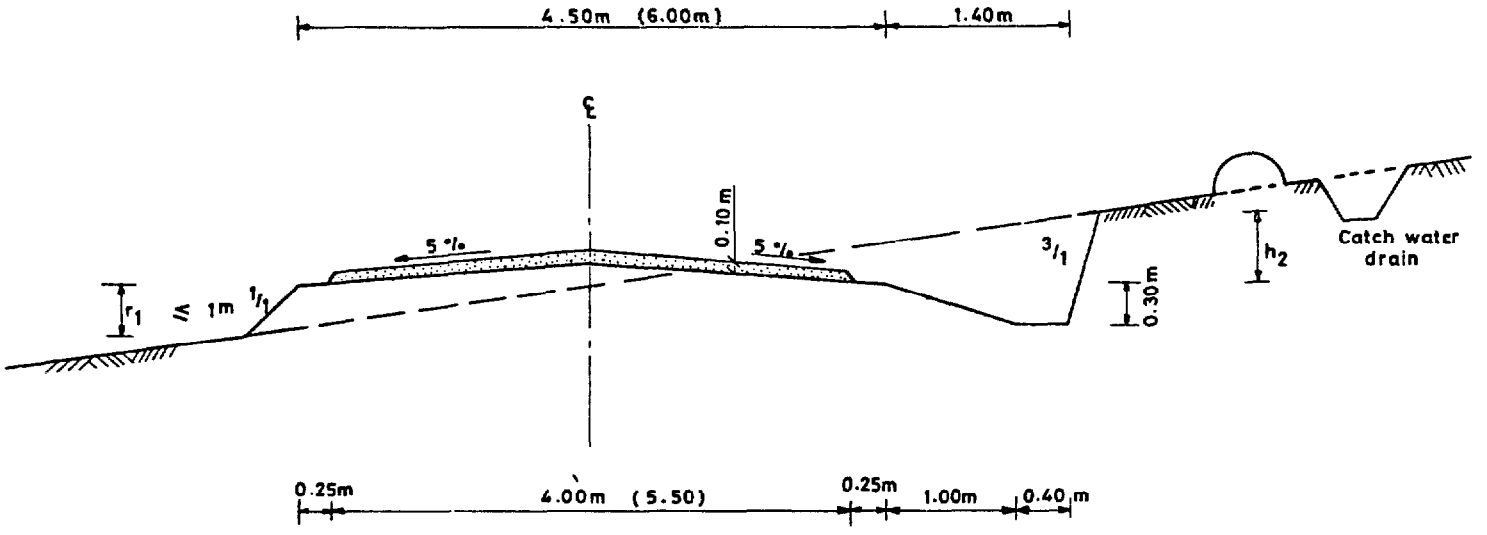


SCALE:- 1: 50

NOTES:

1. Width of earth road formation 4.50m for less than 30 vehicles per day.
   " " " " " 6.00m " more " " " " " .

STANDARD CROSS SECTION II
CUT AND FILL



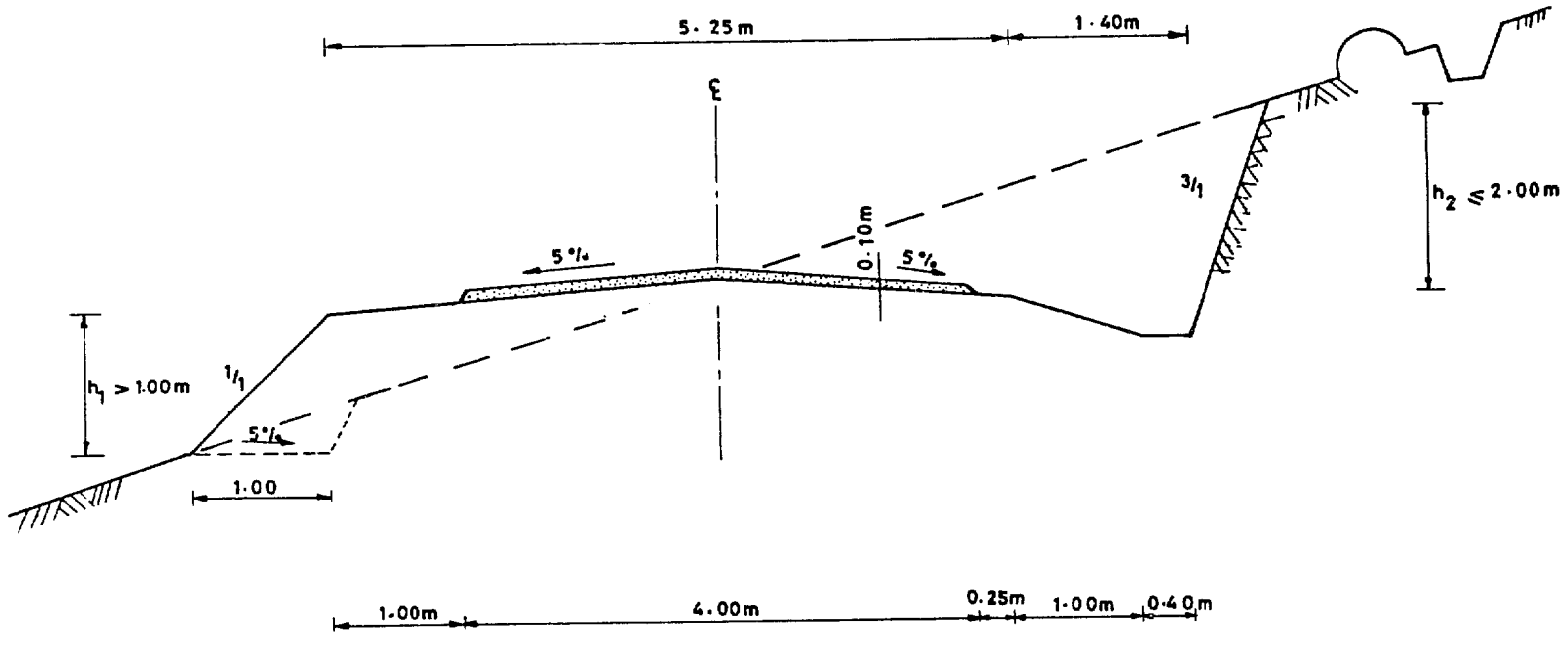
SCALE :- 1:50

NOTES:

1. Width of earth road formation 4·50m for less than 30 vehicles per day.
   " " " " " 6.00m " more " " " " "
2. Height of fill less than or equal to 1·00m.
3. H_2 height of cut.

STANDARD CROSS SECTION III

CUT & FILL

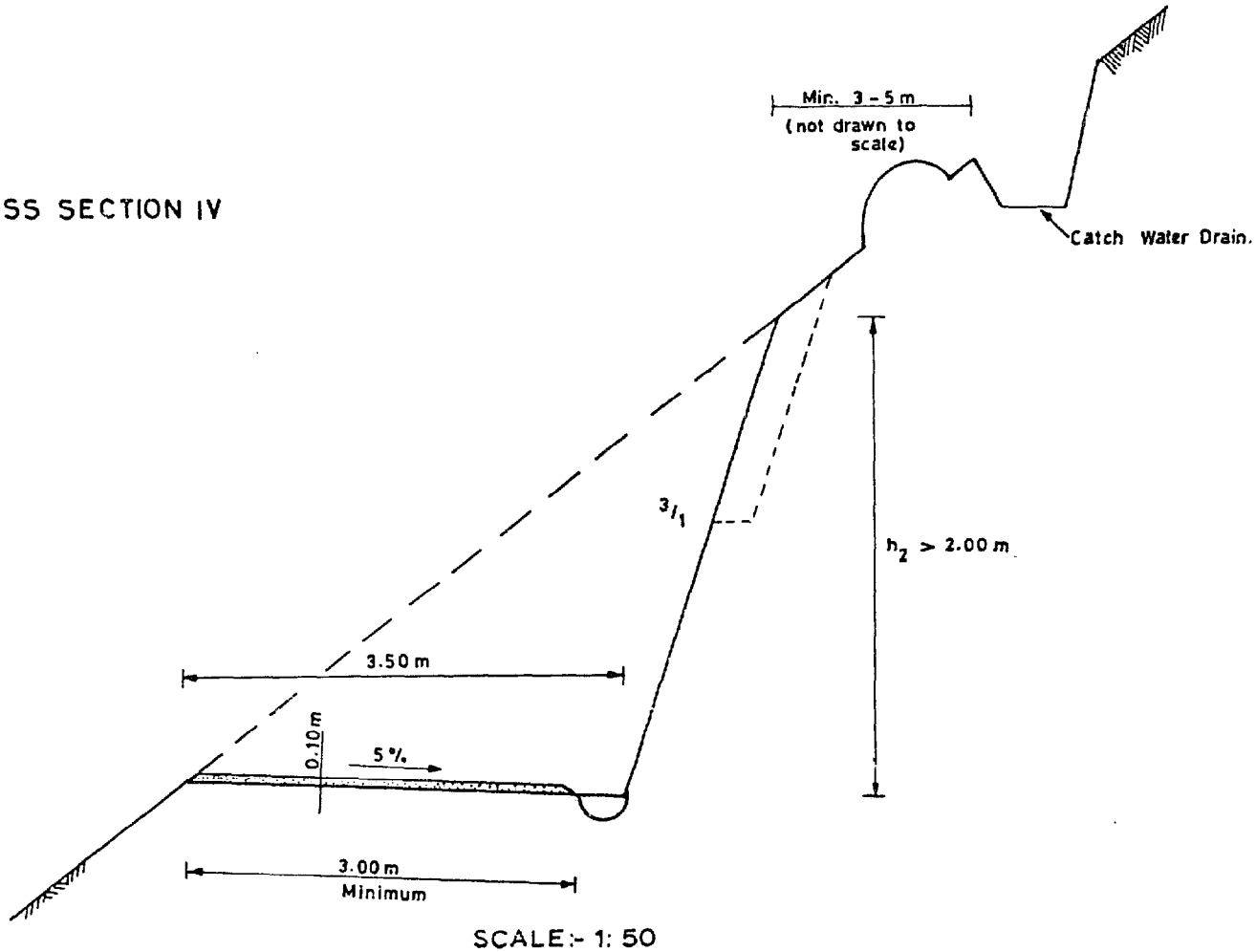


SCALE :- 1:50

NOTES:

1. Width of earth road formation 5·25 m for less than 30 vehicles per day.
2. Height of cut less than or equal to 2·00 m.
3. Height of fill more than 1·00 m.

STANDARD CROSS SECTION IV
DEEP CUT

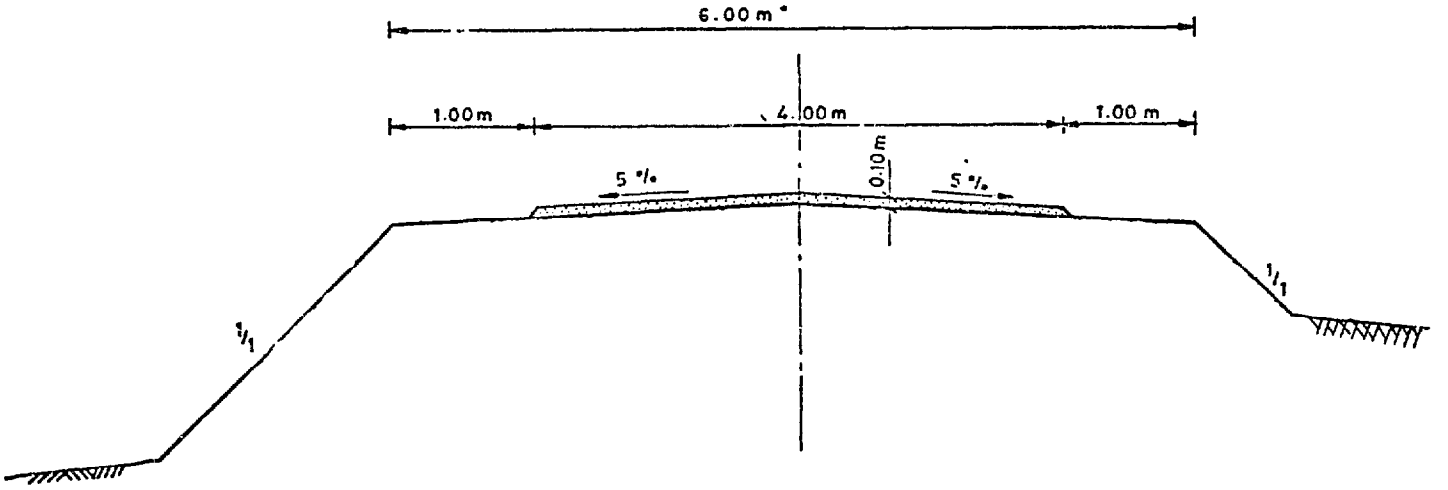


SCALE:- 1: 50

NOTES:

1. Width of earth road formation 3·50m with passing bays within sight distance of each other.
2. Height of cut more than 2·00 m.
3. Drain: 1/2 culvert or trapezoidal drain.

STANDARD CROSS SECTION V.
EMBANKMENT

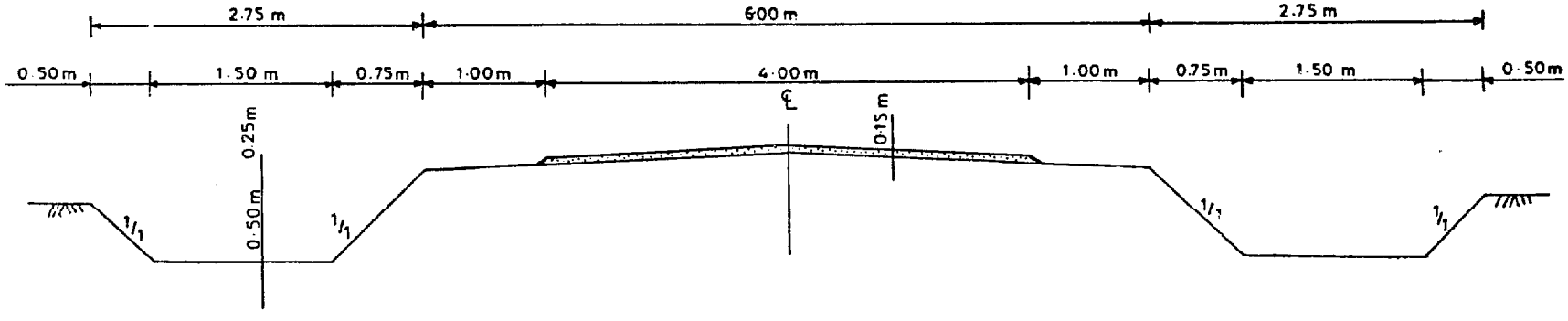


SCALE :- 1: 50

NOTES:

1. Width of earth road formation 6.00m.
2. Fill higher than 1.00 m.

STANDARD CROSS SECTION VI
BLACK COTTON SOIL



SCALE :- 1 : 50

NOTES:

1. Width of earth road formation 6.00m
2. Fill height is 0.25m

APPENDIX 3

EXPENDITURE CONTROL AND REIMBURSEMENT PROCEDURES

Funds for the construction of roads in a particular province are issued by the chief roads engineer to the provincial engineer[1] in the form of an "Authority to Incure Expenditure". The provincial engineer then issues the funds destined for the construction of rural access roads in his province to the RAR engineer concerned in the form of a "Departmental Expenditure Authority".

The Departmental Expenditure Authority is intended to cover all unit running costs with the exception of the purchase of tools, plant and vehicles. These items are purchased by RAR headquarters and delivered to the units. Funds are normally issued quarterly to each unit. Only in very special circumstances will additional funds be issued, e.g. when a base camp is being constructed or a major structure is required. In these cases, approval from headquarters must be obtained before the construction work is initiated.

In order to exercise control over the expenditure of the allocated funds, the RAR engineer maintains a record of all liabilities and expenditures incurred in an approved form of vote book. This vote book is written in duplicate on a monthly basis with a separate record for each account number (each unit has its own account number for construction activities and another for maintenance activities). At the end of the month, the total of the outstanding liabilities and the total of expenditures incurred are calculated.

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[1] See organisation chart attached to Appendix 1.

After examination by the RAR engineer both copies are signed and the duplicate copy together with copies of all payment vouchers and invoices in respect of expenditures incurred during the month is forwarded to RAR headquarters. The information serves as a basis for the reimbursement of funds by the donors to the Kenyan Government.

A special accounting system has been adopted to provide the detailed information requested by the donors. A two-part code is used to classify all expenditure, a letter representing the financing agency and a number representing the type of expenditure. For example, the code C-4 would relate to an expenditure reimbursable by the Netherlands (C) in respect of tools (4). This expenditure code is endorsed on all payment vouchers and recorded in the expenditure ledgers which are kept at unit headquarters by the RAR engineer.

The expenditure is subdivided into nine categories: staff wages (monthly-paid employees), casual wages (daily-paid employees), equipment, tools, construction materials, accommodation materials, petrol, oil and lubricants, service and repair and miscellaneous.

Every month copies of the expenditure ledgers together with copies of all vouchers and invoices in respect of expenditures incurred during the month are sent from the units to RAR headquarters. After these documents have been checked, the headquarters accountant prepares a final expenditure ledger for each unit. This ledger shows not only the expenditures as reported by the engineer but also all expenditures incurred at headquarters for this particular unit.[1]

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[1] Normally all expenditure for tools and equipment is incurred at headquarters and not in the field.

Each unit has its own financial file at headquarters, in which all accountable documents relating to that unit are kept for reimbursement purposes. The following documents are filed quarterly:

(i) duplicate copy of the expenditure ledger prepared by the accountant, which gives a complete picture of all expenditures incurred by and for a particular unit;

(ii) the expenditure ledger prepared by the RAR engineer;

(iii) a monthly expenditure control record;

(iv) all corresponding vouchers including copies of the procurement documents used at headquarters for the procurement of tools and equipment for the unit in question during that particular quarter.

Summaries of all expenditure incurred for each unit, in which a breakdown of expenditures is given according to reimbursement codes and chargeability, are then prepared by the accountant. Whilst these summaries are accepted by most of the donor agencies as being sufficient proof and documentation of expenditures incurred, an annual audit of accounts by the Auditor General is still required. A different system is used for one agency, which reimburses a fixed amount per kilometre completed. This fixed amount is recalculated annually to reflect actual costs.

Issue of funds

The issue of funds to an RAR engineer does not relieve the provincial engineer of his responsibility for the proper control and accounting of these funds. However, whilst in respect of the maintenance organisation the provincial engineer can effectively

control his senior staff and the funds entrusted to them, this is more difficult in the case of the RARP. Although the programme functions within the MOW structure, it does have a measure of autonomy. In respect of accounts, this is demonstrated by the following:

(i) The RAR engineer reports his expenditure direct to RAR HQ with a minimum delay and forwards his own accountable documents.

(ii) A suitably adapted accounting system is used to satisfy the donor requirements.

(iii) As the RAR engineer is responsible for the maintaining of the RAR expenditure ledger and the reporting of his expenditures to headquarters, he has his own accounting personnel which is directly responsible to him.

(iv) The head office of the RAR engineer is usually not located in the same place as the provincial headquarters where all other accounts are kept.

(v) The administration and payment of large numbers of casual labour (12,000 divided over six provinces) is different from the administrative and payment procedures established for the "regular" MOW maintenance staff, mainly because the casual RAR staff is recruited and laid off within short periods and is paid only for the number of days worked.

For these reasons the provincial engineer is in a difficult position as regards administering and managing the RARP funds. It is expected, however, that the creation of the Divisional Engineer posts within the provincial engineers' offices will contribute much

to the improvement of RAR funds administration at the provincial level.

It may be concluded from the above that the implications of the implementation of a large labour-based programme are many and that it is extremely important to adapt or change existing administrative and organisational structures to suit the specific requirements of a labour-based programme prior to its initiation. However, it should also be recognised that changing existing systems can create many problems. There are usually good reasons why systems have developed in a particular way. The changes that are inevitable should be tried out in small pilot projects and time must be allowed for agreeing with the appropriate authorities how they are to be effected.

APPENDIX 4

PROCUREMENT

The procurement, storage and distribution systems for the RARP have been organised as follows: a store has been set up in Nairobi from where the supply services to the field are arranged. After tenders have been approved by the Central Tender Board, the items ordered will be supplied to this store either through the Supplies Branch of the Ministry of Works or direct from the suppliers. All items received are checked, recorded and stocked in this store until they are required in the field. A minimum stock level and a minimum re-order quantity have been established for each item. These minimum stock levels consist of the average monthly total issues multiplied by a lead time in months. The lead time for each item varies according to the time required to order and receive this particular item. Re-order quantities are at least one year's estimated requirement.

In order to avoid stocks running out it is extremely important that the above procedures are strictly applied so that tenders are advertised and orders are placed timely.

The following handtools are required to run a unit, employing approximately 300 casual labourers:

shovel	200
panga/bushknife	75
hoe	200
forked hoe	125
mattock	75
mason hammer	25

axe	25
pickaxe	75
rake/spreader	50
crowbar	25
sledgehammer	25
wheelbarrow	50
earthrammer	25

It should be noted that these figures are average requirements, based on Kenyan experience but that, depending on soil type and local customs, requirements may vary. Only the most important tools have been included above, but it will be necessary to procure small numbers of bowsaws, hacksaws, tape measures, spirit levels, buckets, uniforms, as well as a large amount of stationery.

As noted above, the central store at RARP headquarters should always contain sufficient quantities of tools to meet the requirements of the established units. During the first years of the implementation of the RARP, however, the procurement of the desired quantities and quality of tools was problematic. This has meant that in some cases the purchase of the handtools and light equipment such as wheelbarrows has been done locally by the RAR engineers when the required items could not be supplied in time. Local purchase of goods by government officials, however, is governed by very strict regulations. It is therefore not possible to purchase locally the number of tools and light equipment required to keep one or more units running throughout the year without referring to Central, Ministerial or District Tender Boards for approval. This is a lengthy process. It cannot be overemphasised, therefore, that it is essential to modify, where necessary, the existing procedures for they are often orientated towards equipment-intensive organisations or programmes. In the case of the RARP the

management has been allowed to tender for the Programme's own requirements, so that it is now responsible for its own procurement.

Stores[1] are delivered to the RAR engineers after a monthly stores demand has been submitted. This demand should reach headquarters not later than the tenth day of the month. Stores will then be issued by the RAR supply section to the units during the following 20 days either by car or by train, where this is possible. Local purchases may be made by the RAR engineer in respect of the following materials or services: ballast, sand, cement, timber, vehicle repair and other items or services after written authority from RAR HQ has been obtained. For most of the above materials and services, government contracts are awarded at the beginning of each financial year. If such a government contract is awarded to a particular supplier, the RAR engineer is obliged to obtain the materials concerned from that source. Petrol, oil and lubricants are usually obtained from existing MOW facilities. Where possible, engineers have installed bulk supplies for these items.

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[1] "Stores" comprise five categories: tools, survey equipment, building materials, stationery and general office items. A list of items available is in the possession of each RAR engineer.

APPENDIX 5

PLANNING, PROGRAMMING AND REPORTING AT SITE AND UNIT LEVEL

Planning

Before construction can be started, the quantities of work for each operation have to be known so that a project plan can be drawn up. In the RARP, two planning methods[1] have been used.

Method A. Some time before construction is to be started a small survey team, in some cases consisting of an overseer and a group of labourers, sets out the alignment of the proposed road. This survey entails initial bush clearing and a consideration of possible alternatives. After this preliminary work has been carried out, the engineer or officer in charge inspects the proposed alignment and approves it when he is convinced that there are no better alternatives. After approval of the route, the overseer sets out the final alignment in detail. The next step is the preparation of a detailed bill of quantity (Appendix 8), in which the quantities of work for each operation per 20 metres of road length (clearing, excavation, etc.) are accurately described. Where necessary, remarks are made regarding the difficulty of the work (e.g. thickness of bush, soil type, throwing distances, length of haul when big fills are required, etc.).

After data collection, a project plan is drawn up by the engineer in conjunction with the overseer/survey assistant who has prepared the bill of quantity and the overseer who will be in charge

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[1] Method A has been successfully tested in the initial period of the RARP in Kwale and Kitui districts. Method B has been introduced in a later stage of the Programme and has been established as the standard planning and programming method by the RARP management.

of the construction works (in some cases this is the same person). Productivity norms are established taking into account the parameters which are relevant for each section of road. These parameters are described in the remarks column of the bill of quantity.

Having established (a) the quantities of work, and (b) the productivity norms for each operation, the number of man-days required for each activity can be calculated by dividing (a) by (b).

The planned total number of man-days for the project can be computed after allowances for non-taskwork activities such as camp preparation and culvert laying have been made. The approximate duration of the project (number of construction days) is then reached by dividing the total number of man-days by the average size of the labour force. The average size of the labour force is determined by the availability of labour in the area, the available resources (the total number of casual labourers per unit should not exceed 300) and the size of the project.

Based on the above calculations and data, a "planning graph" can be drawn (see Appendix 8), where the planned progress of a control activity - usually camber formation - is plotted on a chart where the input in man-days is shown on the vertical (y-) axis and distances in kilometres on the horizontal (x-) axis.

This "graph" will be used for control during construction, when the actual progress and number of man-days spent can be plotted next to the planning line. The necessary data for this exercise are obtained from the monthly progress reports. The overseer in charge of the construction knows the targets to be accomplished and makes use of the bill of quantity to prepare his daily work programmes.

Method B. This method differs from the above-described system mainly because no detailed bills of quantity are prepared. The engineer estimates the required input in man-days for the construction of the road, basing this estimate on personal experience and general guidelines provided by RAR headquarters. Following previous data (project summaries and personal experience), the man-days required for each kilometre or identical part of the road are estimated for each activity (Appendix 8, RAR-1). A planning graph is then prepared in the same way as described under "Method A". Work targets are given to the overseer as: (i) the construction day when the control activity and, naturally, all preceding activities should be finished for each kilometre, (ii) the maximum of man-days to be used for this purpose (table 1).

Table 1

	km 1		km 2		km 3	
	Target	Actual	Target	Actual	Target	Actual
Construction day	18	19	28	34	38	52
Man-days	725	700	1 225	1 250	1 750	2 000

The overseer in charge of construction is expected to measure all quantities of work well ahead of construction in order to be able to prepare his daily work programme and to set his tasks in an efficient way.

The "planning graph" described above is a simple version of the "Time and Location Chart", which can be used effectively for production planning and control of more complex road construction projects. A description and example of such a "Time and Location Chart" is given as Appendix 10.

Programming

In order to allow the overseer to organise his labour force properly and to ensure that the workers will not be in each other's way, the latter do not all start on the same day. In accordance with the quantities of work as estimated in the bill of quantity, the size of the labour force will gradually be increased. The first group of workers hired will start work on the first activity. Two days later the next group starts with the next activity, and so on, until all labourers are at work. The size of each group will vary according to the number of man-days required for each activity. In this way, the rate of progress for each activity is approximately the same.

The overseer prepares a work programme[1] for all workers and instructs his headmen, one day in advance, of the intended work. On the work programme form he notes details for each planned activity, i.e. length of road to be completed, exact place of work, quantity of work, the taskrate and the number of men employed on this activity. In the space for remarks he notes deviations from the average taskrates (if any) and explains his reasons for adjustments.

The work should be programmed in such a way that no activity lags behind. In order to facilitate supervision the overseer should also take care that all construction activities are being carried out on a section of road that is short enough to enable him to visit all groups of workers at least three times daily. If the next morning a taskwork group is short of workers, labourers should be transferred from non-taskwork activities to the taskwork groups so that the taskwork activity can be carried out as planned. The headman should set out the tasks in the morning according to the

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[1] Appendix 8.

instructions received the previous evening. The overseer should then check as soon as possible whether his instructions have been carried out properly. In order to reduce supervision problems the number of activities planned is kept to a minimum by carrying out the construction in two phases. Phase I includes site clearance and excavation to level and phase II drainage and camber formation.

Administration

The overseer's administrative duties cover the monitoring of personnel, stores, input (man-days/activity) and output (production/activity). Although the overseer is responsible for all administration, his headmen may assist him with the administration of personnel, while the stores are being administered by the storekeeper. The overseer carries out random checks of certain items to check the work of his storekeeper. A 100 per cent check of site stores is carried out monthly, preferably immediately prior to pay day.

This system works very satisfactorily but requires storekeepers and headmen with some kind of educational background. There have always been plenty of candidates with a reasonable educational background for the white-collar job of storekeeper. However, the requirements for a headman post are different (man-management abilities and leadership are required rather than the ability to read and write), which implies that in many cases these posts are filled with workers without education. If the headmen are not capable of assisting with the administration of personnel this work will be done by the overseer, assisted by his storeman/timekeeper.

A muster-roll book is used for personnel administration. In this book the presence or absence of each worker is noted daily.

This information is kept in duplicate, as each month muster-rolls have to be collected and brought to the main office to provide the necessary information for the payrolls.

In a stores ledger-book all receipts, issues and balances of tools, materials and equipment are recorded. Daily issues are not recorded in this book, but names of workers and tools issued are noted by the storekeeper on a separate form at the beginning of the day when the tools are issued. In case of discrepancies the overseer is notified immediately and the worker will have to explain what has happened. When this explanation is not satisfactory the worker will have to pay for the tool and an appropriate amount of money will be deducted from his salary at the end of the month. Particular care should be taken by the storekeeper that the workers do not replace good-quality handtools by bad ones. This implies that the management should ensure that all tools are clearly marked.

Reporting

Reporting is done on a daily/weekly report form. The input (in man-days) to the various activities as well as the total number of workers on the muster-roll and their designation is reported on this form. At the end of each week the inputs for each activity are totalled and the stations between which work has been carried out are noted.

Based on the daily/weekly report forms, a monthly report form is filled in either by the overseer or the officer-in-charge. In any case, the officer in charge has to check the achievements of the month during a site visit in the beginning of the following month. After this inspection he then completes the monthly report by

calculating and recording the output, productivity, rates of pay and amounts.

The daily records, summarised in monthly reports, form the feedback to the engineer. The engineer then reports progress, total cost and resources used for his units to headquarters on a monthly basis. Quarterly the engineer submits a detailed breakdown of overheads to headquarters, where costs, etc. are analysed. When a project is completed, a summary is made and analysed in order to improve the planning and construction procedures.

The monthly accomplishment report (RAR-10)[1] and the monthly unit report (RAR-11)[1] give information on production and productivity, expenditure, personnel, equipment and gravelling. The quarterly engineer overheads report (RAR-12)[1] gives a detailed cost breakdown of overheads at engineer's level and contains information on maintenance. On the reverse of the form the engineer's staff is listed. The quarterly unit overheads are calculated on form RAR-13.[1] The computing of the average unit overhead costs per man-day is necessary for the analysis of the cost per km of road constructed.

The project summary form (RAR-14) describes the inputs, outputs, parameters and costs of the project.

The monthly reports are forwarded to RAR HQ before the tenth of the succeeding month, together with a copy of the expenditure ledger and copies of payment vouchers and invoices, detailing and justifying expenditure incurred during the previous month. Orders for "stores" obtainable at RARP headquarters are made at the same time.

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[1] Appendix 8.

Since the level of supervision on individual construction sites is very variable, it is important that the problems of control and supervision are made as simple as possible. Planning and reporting procedures must be self-checking. For example, the number of man-days paid in a month as shown on the payroll must equal the number of man-days worked as shown on the monthly site record.

APPENDIX 6

CONSTRUCTION ACTIVITIES: DESCRIPTION AND AVERAGE TASK RATES

(a) Bush-clearing

Bush type	Tools	M2/man-day
1. Light bush	Bushknife, brush-hook	640
2. Medium bush	Scythe, axe, bowsaw	480
3. Dense bush	Plantpuller	320

Bush-clearing is often done with traditional tools which are not very well suited for the purpose. For instance, the use of a bushknife to clear vegetation means working in a tiring, bent position and with a high risk of injury. The use of improved tools and equipment (brush-hook, plantpuller, scythe, axe with proper handle) results in increased productivity and minimises the risk of injuries.

Photograph 1 shows a site where the bush has been cleared. The man in the foreground is engaged in "grubbing" or topsoil removal.

1

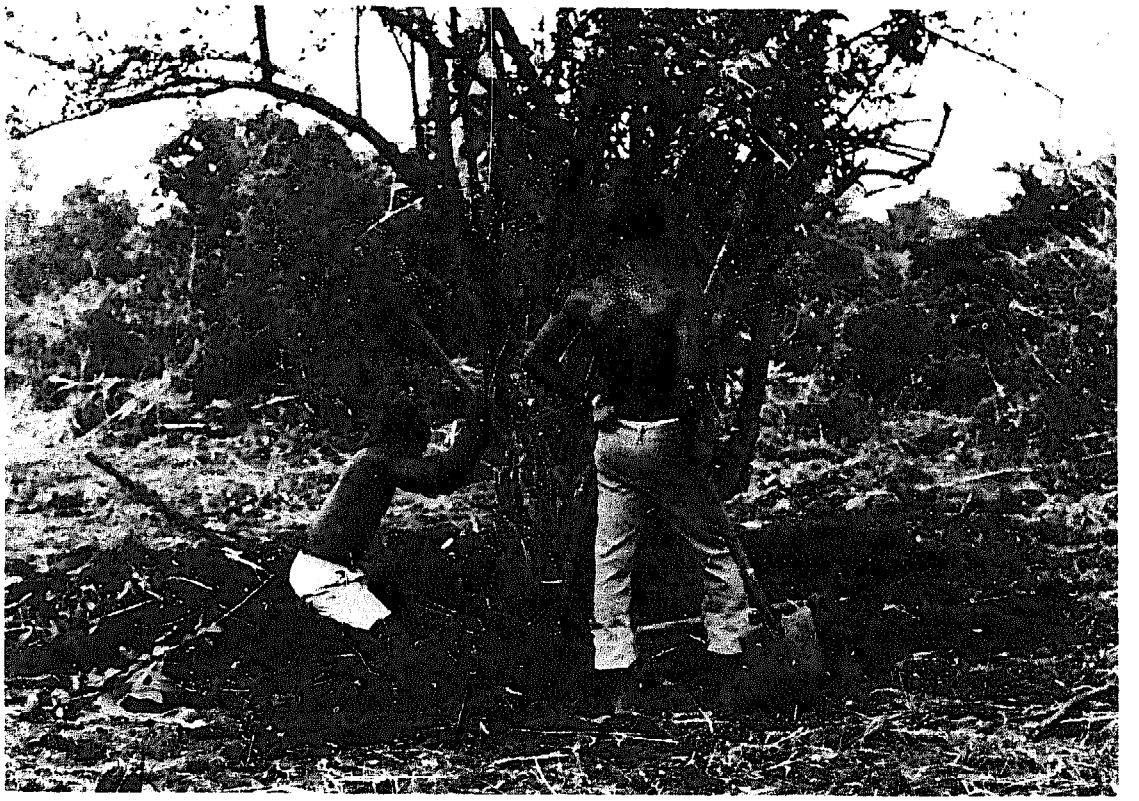
(b) Tree and stump removal

Tools used in the RARP for this purpose are: axe, bowsaw, cross-cut saw, hand-operated winch, pickaxe, hoe, spade, mattock. It has been found useful to make a grinding wheel available at the store and honing stones available on the site for the sharpening of these tools.

Photographs 2 and 3 show heavy bush, tree and stump removal.

2

3



(c) Grubbing

"Grubbing" means the removal (roots included) of vegetation and the disposal of the waste material outside the roadway (see photograph 1).

Vegetation type	Tools	Task M2/man-day
Dense vegetation in firm soil covering the whole area	Hoe, heavy duty rake shovel	100
Sparse vegetation in loose soil	Hoe, heavy duty rake shovel	250

(d) Boulder removal and rock excavation

The RARP has indicated that this activity is not very well suited to the use of labour-intensive techniques. Nevertheless, it has been possible to move or crush big stones without resorting to machines by:

(1) pulling or pushing the stone outside the roadway using winches or crowbars;

(2) digging around the stone, pushing it over (using manpower, hydraulic jacks or winches) and burying it;

(3) alternately heating and cooling the stone until it can be cracked using sledgehammers and steel wedges;

(4) drilling holes and splitting the stone using a petrol-powered or pneumatic drill and plug and feathers;

(5) drilling holes and blasting. Tools, material and equipment used: pickaxe, mattock, hoe, shovel, crowbar, winches, jacks, drills (petrol-powered or compressor-driven), sledgehammers, chisels, wedges and plug and feathers.

Photographs 4 and 5 show rock excavation and boulder removal by labour-intensive means.

4

5

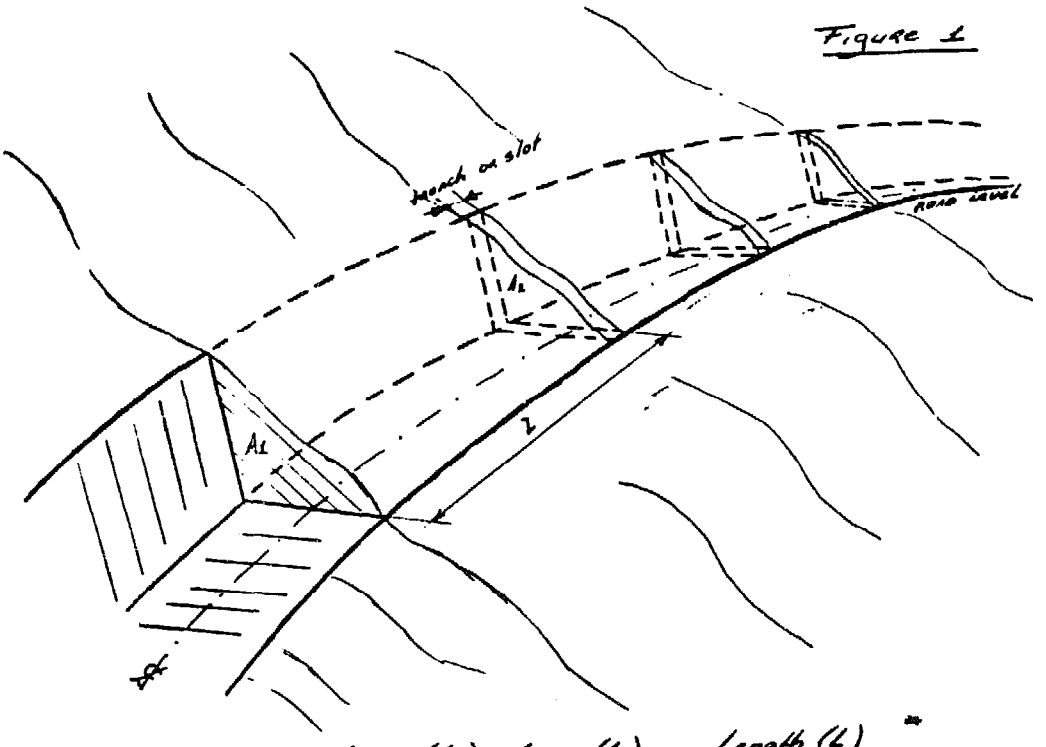
(e) Excavation

This activity consists of the excavation to level of soil to spoil or fill as directed. The productivity varies not only with the soil type but also with the throwing distance. To measure the volume to be excavated "slots" are dug (see photograph 6 and figure 1) indicating (a) the future level of the road and (b) the width of the excavation. The volume of the soil to be excavated can be calculated by measuring the exposed faces of two slots, calculating the average area and multiplying this average area by the distance between the slots (see Appendix 8 for calculation form used).

After determining the type of the soil and measuring the average throwing distance the taskrate can be found according to the table below.

Soil type	Tools	Taskrates M3/man-day Throwing distance (m)		
		0-4	4-6	6-8
Loose, not sticky soil	Shovel, jembe	5.0-6.0	4.5-5.5	3.5-4.5
Firm soil	Shovel, forkjembe	3.5-4.5	3.0-4.0	2.5-3.5
Very hard soil, hard soil mixed with stones	Pickaxe, forkjembe, shovel	2.0-3.0	1.8-2.5	1.7-2.5

6



Volume 1 = $\frac{\text{Area 1 } (A_1) + \text{Area 2 } (A_2)}{2} \times \text{Length } (L)$ *

* Page 186 RAR forms.

The workers are only released after the section between the slots has been checked with boning rods or similar simple survey equipment.

(f) Loading

Excavation combined with loading of soil can be effectively carried out by labourers up to a loading height of about 1.0 m - e.g. into headbaskets or wheelbarrows. Above that height it is preferable to have a separate group of loaders whose output must be matched with that of the excavators.

Type of soil	Tools	Taskrate M3/man-day[1]
Loose	Shovel	4.0-5.5
Firm	Shovel, hoe, forked hoe	2.5-4.0
Hard	Shovel, pickaxe, forked hoe	1.5-2.5

[1] Loading height 0-1 m.

To match the output of loaders and excavators it is also necessary to have an assessment of the output for the loading activity alone.

Soil type	Tools	Loading height	Taskrate M3/man-day
Loose	Shovel	0-1 m	12-15
Loose	Shovel	1-2 m	7-10

7

(g) Hauling of material

There is a wide variety of hauling modes from headbaskets to scrapers. The productive output varies with the hauling distance, condition of the route, site organisation, etc. In the RARP only the wheelbarrow and tractor and trailer are extensively used. It is felt however that several other methods of hauling - Chinese wheelbarrow, animal-drawn carts, two-wheeled tractors with small trailers - may very well be economically feasible and proposals to experiment with these hauling modes are under consideration.

Wheelbarrow hauling, recommended[1] tasks

Haul distance	Task[2] (m^3)		Number of men			
	In situ	Loose	Hauling	Loading	Spreading	Compaction
0-20	13.5	17	1	2	1	1
20-40	10.5	13.5	1	1.5	1	1
40-60	8.5	10.5	1	1	1	1
60-80	6.5	8	1	1	0.5	0.5
80-100	5.5	7	1	0.5	0.5	0.5

[1] Slopes ranging from 0-5 per cent, good and smooth hauling-route, more wheelbarrows than haulers so that loaded wheelbarrow is always waiting for the hauler and waiting time is minimised.

[2] These task recommendations are based on the Technology Unit studies.

These taskrates relate to a very well-organised site and on nearly flat terrain. Also the type of wheelbarrow used is very important. Specifications of "ideal" Western wheelbarrows and an example of the Chinese wheelbarrow can be found in the forthcoming ILO publication "Guide to tools and equipment for labour-based road construction".

Studies have indicated that on gradients from 5 per cent to 15 per cent (load carried down hill) productivity is higher than on flat terrain up to a hauling distance of approximately 60 metres. When the hauling distance is longer than 60 metres productivity is lower than on flat terrain, mainly because of the fact that the hauler has to brake the wheelbarrow in order not to fall and the more difficult return trip.

Experience has shown that it is better to define a task as a number of m^3 (in situ or loose) rather than a number of wheelbarrow trips. The latter seems easier but has proven to be very inaccurate for two reasons: (a) the counting of the supervisor; (b) the level of filling of the wheelbarrows. On the other hand, a volume of fill to be completed by a labour gang is an easily recognisable task, provided that it is clearly set out with pegs and strings.

Gangs have to be balanced in order to avoid waiting time either for loaders or for haulers. It is also recommended to rotate tasks within a gang, so that each worker does hauling, spreading and loading on the same working day. If at all possible there should be twice as many wheelbarrows as haulers. Of prime importance is that unloading and compaction are well organised so that (a) workers are not in each other's way, and (b) layers to be compacted have a maximum thickness of 15 cm.

Photo 8 shows excavation to fill using wheelbarrows and photo 9 shows a well-compacted fill with loading of wheelbarrows in the background.

8

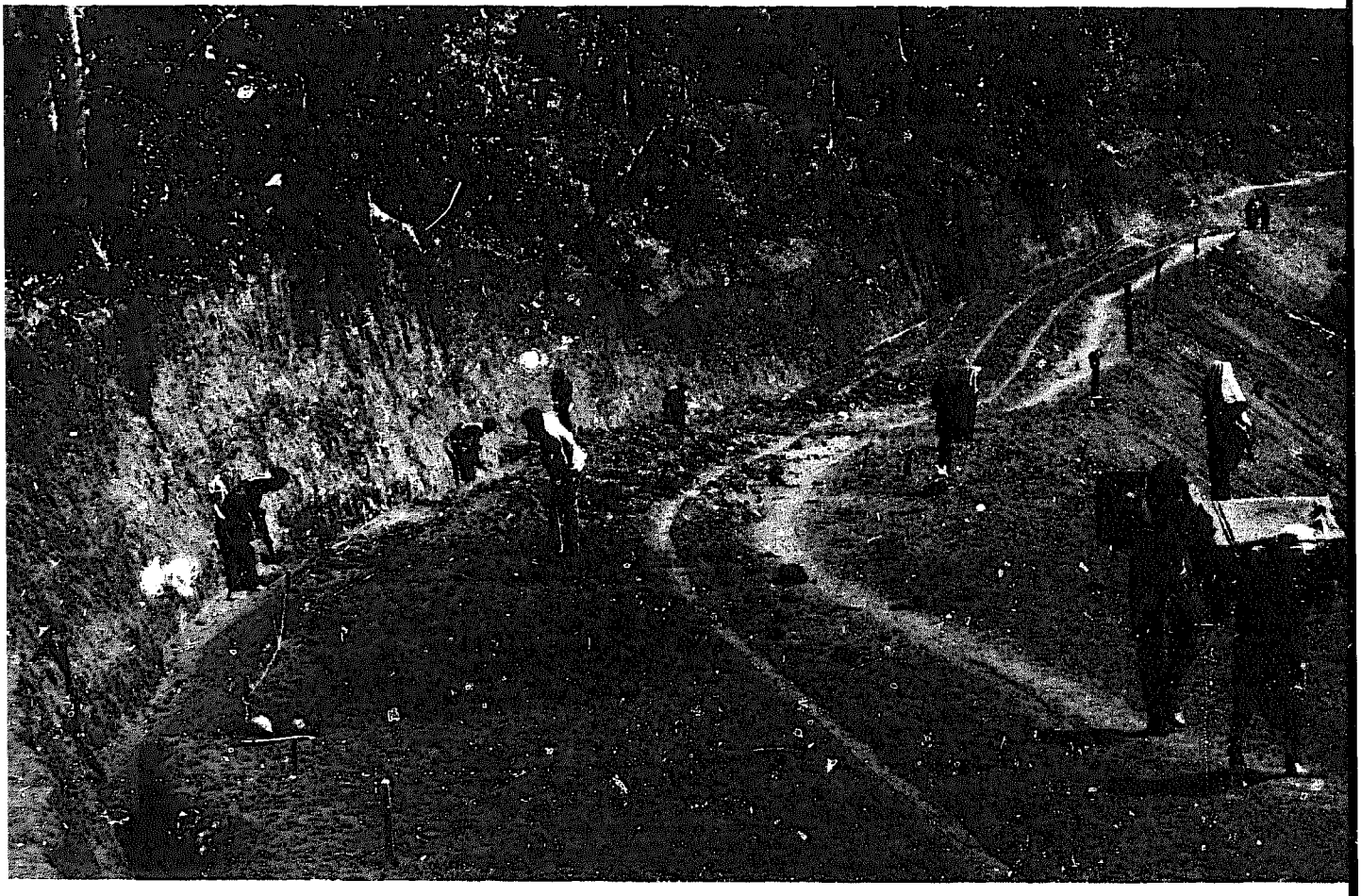
9

(h) Ditching and sloping

These activities are mentioned separately because in the RARP the worker excavates to a precise shape (see photographs 10-11) and throws the excavated material to the centre of the road.

Type of soil	Tools	Taskrate m^3/man-day
Loose	Hoe and shovel	4-5
Firm (with roots)	Hoe, forked hoe, mattock, shovel	3
Hard to very hard	Mattock, pickaxe, shovel	1-2

10



11

(i) Spreading or camber formation

This task consists of the spreading of the soil from the ditches and slopes, which has been heaped in the middle of the road, towards the sides of the road. A camberboard is used to check that the correct camber is obtained and boning rods are used to ensure that there are no holes or depressions longitudinally.

Suitable tools for spreading are hoes, forked hoes, shovels and heavy-duty rakes. The task should be approximately 12 m^3 man-day. Photograph 12 shows the road after the camber formation is completed.

12

Camber formation should be scheduled to follow shortly after ditching and sloping in order to avoid hardening of the soil heaped on the centre line of the road. Camber formation is usually used as the controlling activity (see "Time and location chart", Appendix 10).

(j) Culvert laying

This task consists of the excavation of the trench, preparing the bed, laying of culvert, backfilling and compaction. The number of man-days required varies with the volume of the excavation and the soil type. After conducting a number of studies on culvert laying recommendations have been made by the Technology Unit which are shown in the table below.

Soil type	Volume of trench (m^3)		
	< 7	7-10	10-13
	Number of man-days		
Loose to firm	6	7	see below[1]
Hard	6	see below[1]	
Very hard, stony	see below[1]	see below[1]	

[1] In these cases the work is split over two or more days. First the trench should be excavated and then the preparation of the bed, the laying, backfilling and compaction is done. Only three workers can work effectively in the excavation of the trench. Therefore the volume of the excavation has to be limited to that which three workers can excavate in one day. The following rates are then applicable: hard soil 3.5 m^3/man-day and very hard, stony soil 2 m^3/man-day. After completion of the trench approximately 3 man-days are needed to lay 8 rings, backfill and compact.

Headwalls are not included in the above-described task for culvert laying as they are constructed afterwards by a qualified mason where required.

(k) Compaction

It is possible to achieve compaction by the use of heavy and light equipment (vibrating or dead weight), handtools and indirectly, e.g. by climate and traffic.

In the RARP all the above methods have been used or experimented with.

The Transport and Road Research Laboratory (TRRL) has made an inventory of over 200 km of rural access roads and has monitored the condition of these roads in terms of deterioration of the running surface, general stability and erosion. A preliminary report on compaction for rural access roads based on this monitoring, on

experience gained in the construction of rural access roads in general and on experience gained in the construction of special modified trial sections was published in December 1977. The following observations were made in this report:

(i) Heavy compaction plant is not necessary in the construction of rural access roads. In fact the use of heavy plant is not recommended because of the problems of transport, maintenance and lack of skilled labour. The costs are high, the plant is usually underutilised, the moisture content and preparation of loose layers need to be controlled very well if effective compaction is to be achieved and the presence of the plant is a discouragement to labour.

(ii) The use of light plant or handrammers is appropriate in some circumstances. For example in deep fills where additional compaction is necessary to produce the required stability or at times of heavy rains to prevent excessive erosion and saturation of shaped formations. Although light plant and handrammers both produce acceptable compaction standards, light plant (pedestrian vibrating rollers or plates) have a higher productivity and provide a better shape. Light plant, however, suffers similar maintenance problems as heavy plant and needs skilled (although less skilled than heavy plant) operators.

(iii) Manual compaction with handrammers requires more supervision but is very flexible. For example, it is possible to compact narrow benches on a cut to fill

operation when even light equipment cannot be used. The estimated output of manual tamping is 12-15 m^3/man-day.

(iv) Compaction is necessarry at all levels of construction but it can be achieved by indirect[1] methods in conjunction with an appropriate construction schedule.

It has been found that, given a suitable period of time, roads uncompacted at the time of construction achieve densities of the same values as compacted roads. Good shape can be obtained provided that suitably adapted construction methods and scheduling are employed. It is particularly important that the final shaping of a new road is carried out after the major effects of indirect compaction have been realised.

The sensible channelling of traffic can achieve fast compaction. Thus, the period between initial construction and the time that the effects of indirect compaction have been realised is kept short. It is advisable to schedule the works in such a way that there is a considerable lapse of time between the excavation-to-level and ditching activities. This of course has to be achieved without resorting to dismissal and re-employment of casual workers.

The main disadvantage of indirect compaction is the level of erosion during the construction period. Extra man-days are then required to reshape the road one or more times before the required compaction standards have been achieved. However, on most of the constructed roads this effect has been quite small and the extra costs are negligible compared to the costs that would have to be made if light plant were used for initial compaction. If the construction schedule, described above, is employed the road will

---

[1] "Indirect" here means the effect of rain and traffic both human, animal and mechanical.

have settled to a certain extent between the excavation-to-level and ditching operations, so that the number of extra man-days for reshaping can be reduced even further.

One very important reason why the indirect compaction method can work within the RARP, lies in the organisation of the maintenance system (see section 11). The main strength of this system lies in the fact that there always is a man on the spot who can attend to faults before they deteriorate further.

It is evident that the condition of the rural roads after construction is much more dependent on the proper execution of the maintenance than on the standards of initial construction.

(1) Structures

To cross minor waterways the following drainage facilities are provided:

(1) culverts (photograph 13);

(2) single-span timber bridges (photograph 14);

(3) drifts (photograph 15);

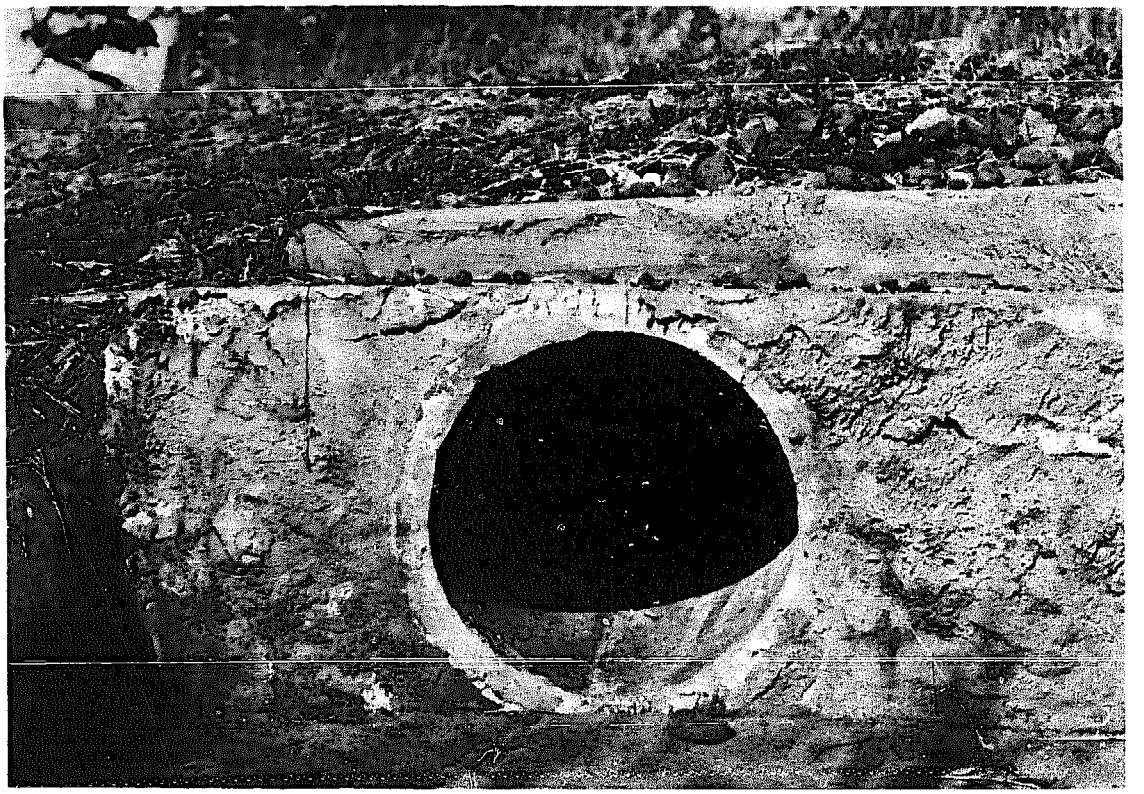
(4) culvert bridges (photograph 16).

The engineer decides which type of structure will be constructed in each particular case. Local masons are usually employed for the construction of the abutments. In some cases it has been possible to obtain the main beams from local sources, i.e. the local population was so gratified that the bridge was constructed that they supplied the required trees free of charge.

As the first objective of the RARP is to provide low-cost access centres, which major structures cannot normally be justified. The objective can normally be achieved by constructing a road from the existing network to a river (by so doing providing access to the area on that side of the river) and to construct a road from the other side of the river joining to the existing network on that side of the river.

In special situations where the engineer feels a major structure is justified, he submits his design, estimated costs and justification for the structure to RAR headquarters where the decision is taken whether or not to release additional funds. This has been especially important as several donors have stipulated that no funds will be provided for the construction of bridges in excess of 5 m span.

Concrete culverts are manufactured on a culvert-manufacturing site where running water is available. If this is not possible, a source of clear water should be near the site. Usually a shed is constructed so that manufacture can continue even with bad weather conditions.



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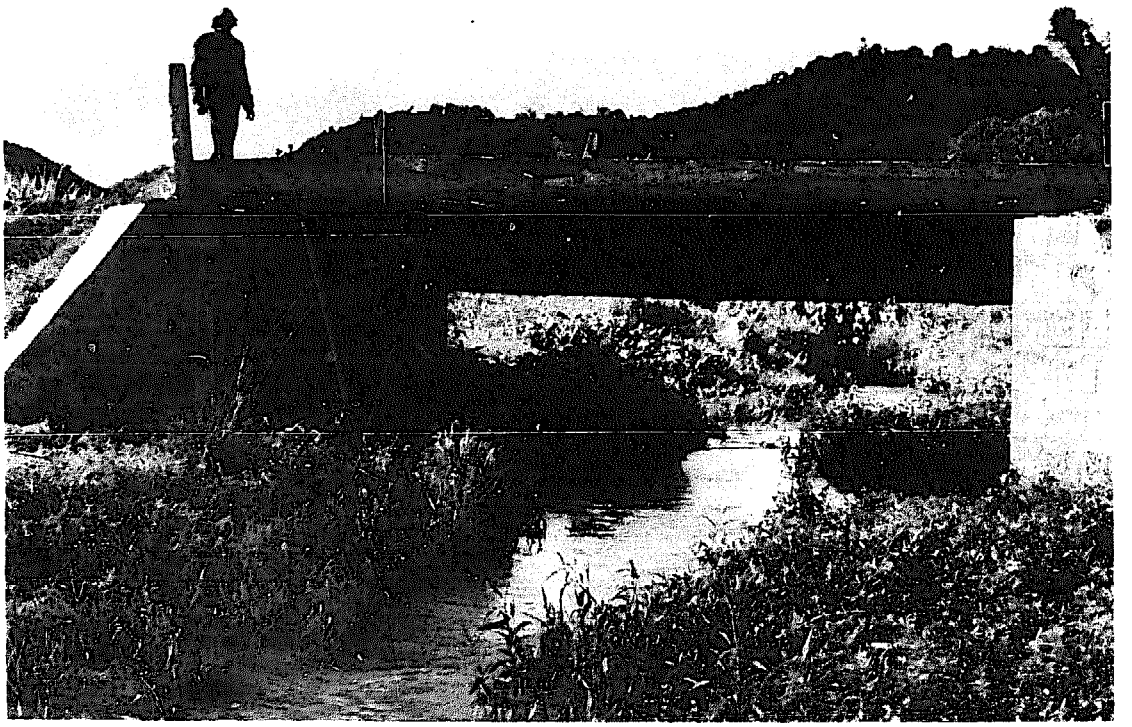

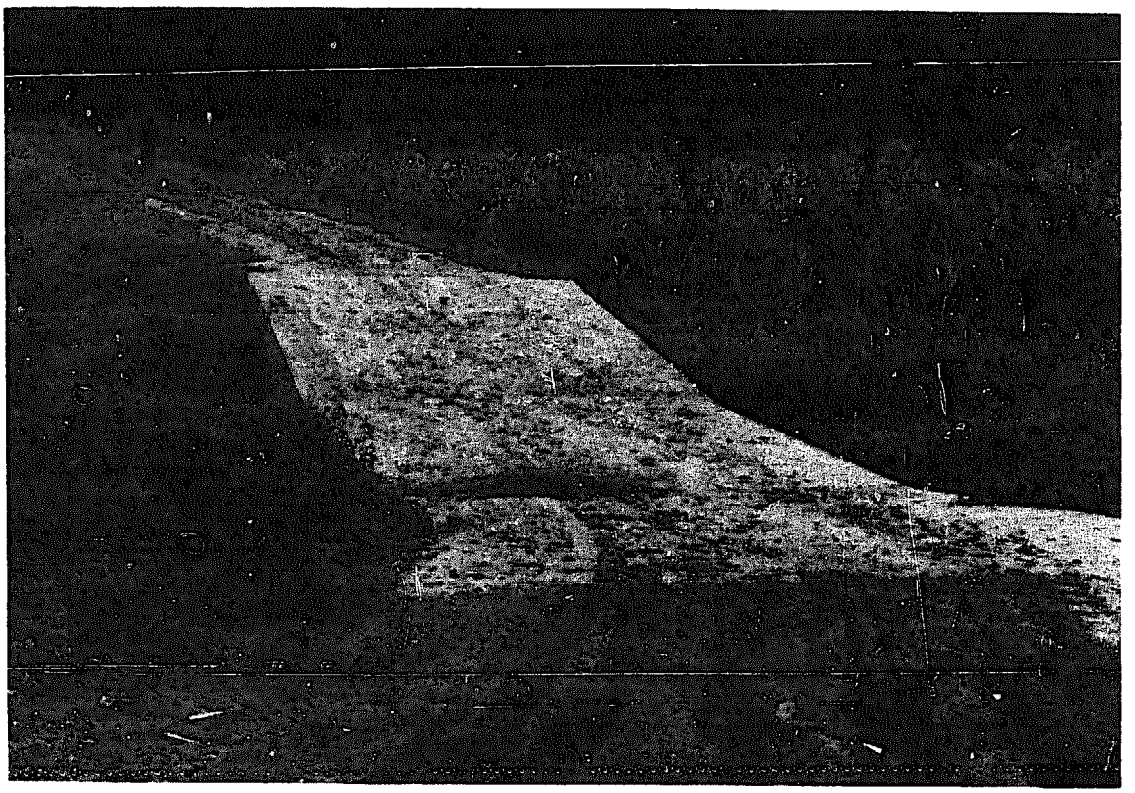

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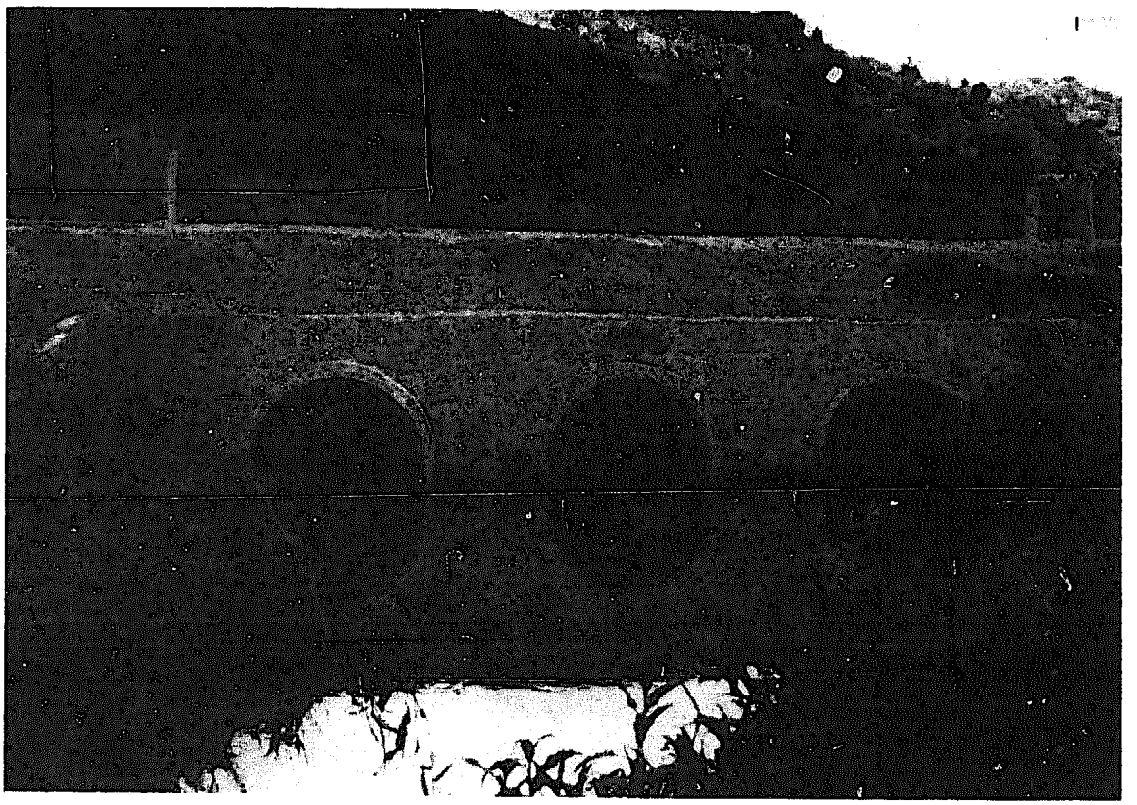

APPENDIX 7

GRAVELLING

Execution of the work

After a quarry with suitable material has been located an access road of a suitable width (or with passing bays) is constructed. The camp (stores and living quarters) is set up as close as possible to the quarry site in order to minimise non-productive use of the tractors. The quarry site is cleared of bushes, trees and topsoil. The topsoil is stockpiled to be respread after the gravelling is finished. The quarry should be big enough to provide ample room for the loading of eight trailers and the manoeuvring of the tractors. If this is not possible it is better to operate from more than one quarry than to allow tractors to stand idle. The construction of a ring road allowing the tractors to enter the quarry on one side and leave the quarry on the other is often advantageous as it reduces the space required for manoeuvring and passing. It is advisable not to select quarries in low terrain unless they can be properly drained to avoid flooding by heavy rains.

Equating the demand and supply of labour for a quarry is a difficult task. To facilitate the administration it is necessary that hiring and dismissal of labour are done in a limited number of steps. The number of labourers required increases when the hauling distance decreases. It has appeared that, towards the end of the project, the productivity tends to go down unless there is a gradual lay-off of labourers.

It is advisable, therefore, to end a project with a minimum number of labourers, i.e. when the hauling distance is greatest.

Tables 1 and 2[1] tabulate the number of labourers required for the various activities versus the hauling distance for two different average tractor speeds.

It should be noted that good quarry organisation and motivation of operators and labourers become particularly important when hauling distances are less than 3 kilometres and that the figures quoted in the table can be used only in ideal circumstances, when there is no waiting time for the tractors. In the RARP, hauling distances have usually been greater than 3 kilometres. Consequently, the shorter hauling distances have not been studied in depth. It may well be that the figures will have to be adjusted because other factors come into play which have not been considered. The figures quoted for the longer haul distances are perfectly feasible and have been achieved in practice.

The following tools are used within the RARP for gravelling (i.e. excavation, loading, spreading and crushing of oversized material):

(a) heavy-duty shovels with pointed blade and long round handles to facilitate loading of greater heights;

(b) pickaxes with heavy head with good balance and oval-shaped handle;

(c) crowbars, long, heavy and of a good-quality steel;

(d) forked hoes, suitable for excavation of loose soft gravel;

(e) heavy-duty rakes with reinforcement strips welded on. Normal garden-type rakes are not considered to be suitable.

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[1] See pp. 130-131.

(f) sledgehammers with heavy heads and long oval-shaped handles for the crushing of oversized quarry material on the site.

It has been found useful to excavate and stockpile the gravel two days ahead of loading in order to avoid delays when unforeseen difficulties occur. The excavation should be organised in such a way that the loading height is minimised, i.e. the trailer should always be positioned as low as possible, so that it can be loaded from above.

As far as the actual laying of the gravel is concerned, turning points for the tractor/trailer combination are prepared at regular intervals along the road which is to be gravelled. If at all possible these turning points should not be further apart than 100 metres. The tractor/trailer combination should turn before it has reached the dumping site and reverse to the dumping site where the gravel is dumped. This way, unnecessary waiting time and uneven compaction caused by the tractor/trailer combination passing over the freshly dumped murram, can be avoided.

On the dumping site, the width to be gravelled is set out by pegs connected with strings. The pegs along the length of the road indicate the length over which each load is to be spread. The rural access roads in Kenya are to be gravelled over a width of 4 m and with a thickness of 10 cm after compaction, so that a trailer-load of 3 loose m^3 is spread over a length of 6 m. The spreading is greatly facilitated if the tractor/trailer combination moves forward while the load is being dumped.

The headman in charge of gravel spreading ensures that the gravel is spread evenly to the correct width and length of the road section, that oversized material is crushed, and that the gravel is spread to the correct camber. Finally, he sets out the total length

expected to be surveyed during the day, so that plant operators and spreaders know what their daily task is.

Special report forms[1] are in use to record the relevant details particular to the gravelling operation. The input is recorded in terms of tractor engine hours, fuel consumption and number of man-days spent on the several activities. The output is described as the length of road gravelled and the number of trips done. On a monthly summary report details are given on the condition of the tractors and trailers and the average hauling distance.

Down time, owing to mechanical problems (lack of spares, repair facilities and skilled manpower on the site), has been high in the RARP. This is expected to be reduced considerably when each RAR engineer is provided with (a) a mechanic who can do small repairs and maintenance on the site and (b) a range of essential spares.

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[1] See Appendix 8.

Table 1: "Ordinary" haul-route

Hauling distance (km)	Trips per tractor per day	4 tractors + 8 trailers				3 tractors + 6 trailers				2 tractors + 4 trailers			
		No. of workers				No. of workers				No. of workers			
		Exc.	Load	Spr.	Total	Exc.	Load	Spr.	Total	Exc.	Load	Spr.	Total
0-1	18	-	-	-	-	-	-	-	-	36	18	9	63
1-2	14	-	-	-	-	42	21	11	64	28	14	7	49
2-3	11	44	22	11	77	33	17	8	58	22	11	6	39
3-4	9	36	18	9	63	27	14	7	48	18	9	5	32
4-5	7	28	14	7	49	21	11	6	39	14	7	4	25
5-6	6	24	12	6	42	18	9	5	32	12	6	3	21
6-7	5	20	10	5	35	15	8	4	27	10	5	3	18
7-8	4	16	8	4	28	12	6	3	21	8	4	2	14

Assumptions and conditions:

(a) One tractor + two trailers, ample room for manoeuvring and loading.
(b) Manoeuvring time: 8-20 minutes per cycle (depending on organisation).
(c) Excavation and stockpile: 2-3.5 loose m^3/man-day.
(d) Loading: 7-10 loose m^3/man-day.
(e) Spreading: 12-15 loose m^3/man-day.
(f) Volume per load: 3 loose m^3.
(g) Working time per day: 8 hours.
(h) Rest and other allowances (taskwork bonus): 40%.
(i) Tractor available time: 6 hours.
(j) Good supervision and quarry organisation.
(k) Good motivation of tractor operators and labourers.
(l) Good-quality tools.

Table 2: "Poor" haul-route

Hauling distance (km)	Trips per tractor per day	4 tractors + 8 trailers				3 tractors + 6 trailers				2 tractors + 4 trailers			
		No. of workers				No. of workers				No. of workers			
		Exc.	Load	Spr.	Total	Exc.	Load	Spr.	Total	Exc.	Load	Spr.	Total
0-1	18	-	-	-	-	-	-	-	-	36	18	9	63
1-2	12	-	-	-	-	36	18	9	63	24	12	6	42
2-3	9	36	18	9	63	27	14	7	48	18	9	5	32
3-4	7	28	14	7	49	21	11	6	39	14	7	4	25
4-5	6	24	12	6	42	18	9	5	32	12	6	3	21
5-6	5	20	10	5	35	15	8	4	27	10	5	3	18
6-7	4	16	8	4	28	12	6	3	21	8	4	2	14
7-8	3	12	6	3	21	9	4	2	15	6	3	2	11

Note: The recommended maximum number of tractors per quarry is 2 for a hauling distance of 1 km and 3 for a hauling distance of 1-2 km.

Assumptions and conditions as per table 1.

APPENDIX 8

RARP PLANNING, PROGRAMMING AND REPORT FORMS

INPUT ESTIMATE UNIT: .....

ROAD:..... NO .....

RAR-1

Station (km)										
Terrain										
Vegetation										
Soil										
ACTIVITY	MANDAYS									
Glearing + grubbing										
Excavation										
Drain + Slope										
Camberformation										
Culvert laying										
SUB TOTAL:										
Supporting activities										
TOTAL:										
Structures										
GRAND TOTAL:										
REMARKS:										

RAR-2

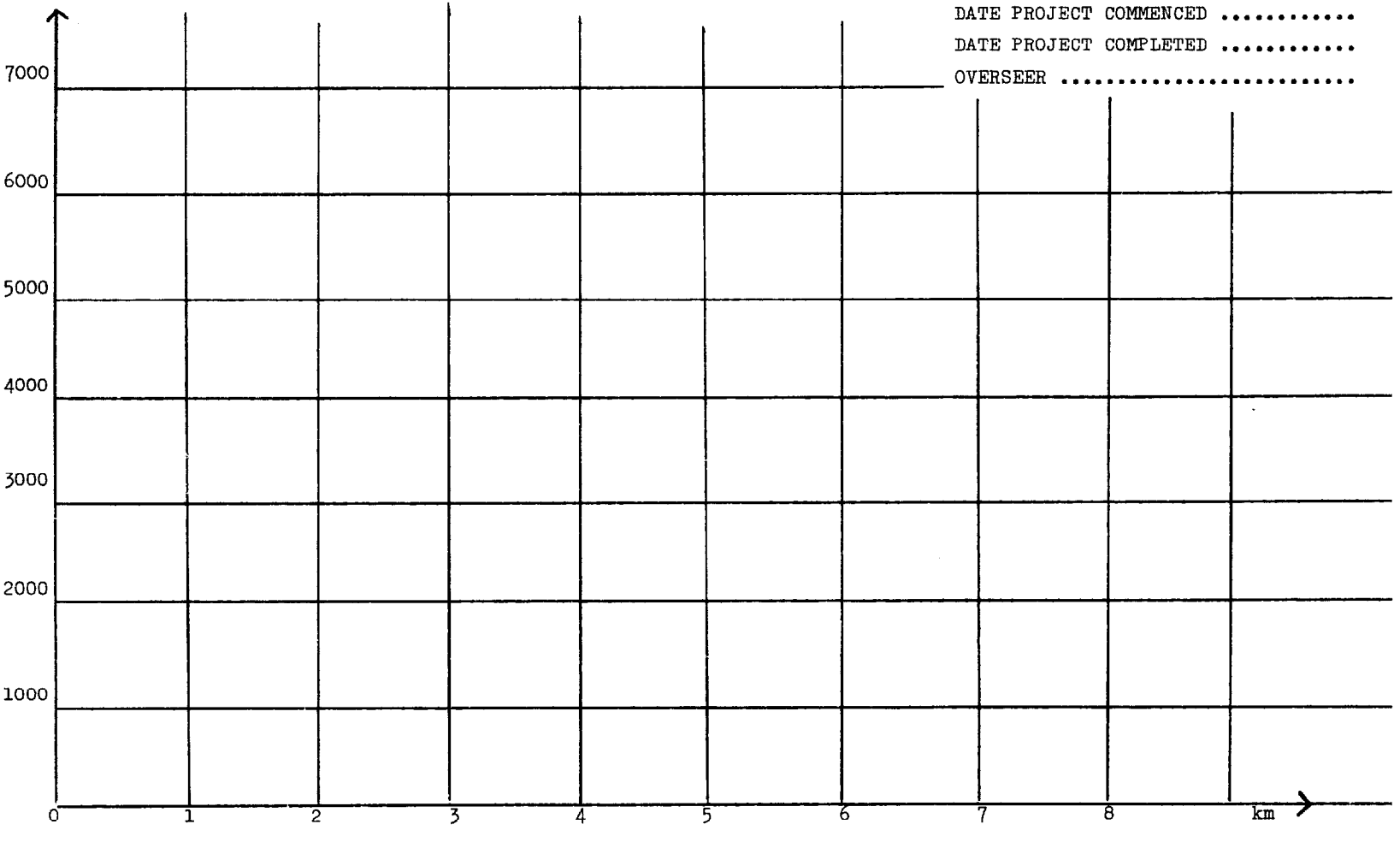
UNIT NAME .....

PROJECT NAME .....

DATE PROJECT COMMENCED .....

DATE PROJECT COMPLETED .....

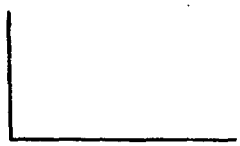
OVERSEER .....



District.....

Road number.....

Road name.....

Station number	Measurements of cross-section	Calculation
	A 	AREA A = AREA B == $\frac{\text{AREA A + AREA B}}{2}$ =
	B 	Volume = $\frac{\text{AREA A + AREA B}}{2}$)length Volume =
	C 	AREA C = $\frac{\text{AREA B + AREA C}}{2}$ = Volume =
	D 	AREA D = $\frac{\text{AREA C + AREA D}}{2}$ = Volume =
	E 	AREA E = $\frac{\text{AREA D + AREA E}}{2}$ = Volume =
	F 	AREA F = $\frac{\text{AREA E + AREA F}}{2}$ = Volume =
	G 	AREA G = $\frac{\text{AREA F + AREA G}}{2}$ = Volume =

Activity :.....

Unit of measurement :..... B/F from Page.....

Station	Rate	Quantity	Cum quantity		Station	Rate	Quantity	Cum quantity

C/F to page:

C/F to page:

RAR-4

Date of Programming: Date of work: C-day:

ACTIVITY	STATION		QTY.	Task Rate	Gang size	Actual Gang	Task* Compl.
	Start	End					
Bush clearing							
Tree & stump rem.							
Stripping & grub.							
Boulder removal							
Excavation							
Excavation							
Work on fill							
Ditching							
Sloping							
Camberformation							
Culvert laying							
Misc.-drainage							
Carry water							
Setting out							
Work at camp							
Repair & reshaping							
Misc.:							
Sub-total ROADS							
STRUCTURES							
TOTAL:							

REMARKS:

*Tick when the work has been inspected and approved

DAILY SITE RECORD

Week No. :	M	T	W	T	F	S		RAR-5	
DATE									
C-day number								Station	
ACTIVITY	M A N D A Y S						Total	Start	End
Bush clearing									
Tree & Stump removal									
Stripping & grubbing									
Boulder removal									
Excavation									
Work on fill									
Ditching									
Sloping									
Camber formation									
Culvert laying								Lines: 3	Rings: 4
Misc. drainage								Location: culverts	
Carry water									
Setting out									
Work at camp									
Repair & reshaping									
Misc. :									
Sub-total ROADS								Location: structures	
STRUCTURES									
TOTAL:									

M A N D A Y S

ON SITE MUSTER ROLL	M	T	W	T	F	S	S	Total
ROAD: Headmen								
Storekeeper								
Watchmen								
Total D.P.S.								
Labourers								
STR: Headmen								
Fundi								
Total D.P.S.								
Labourers								
TOTAL ROAD & STR.								

Monthly paid	Mdays

4

Camberformation started on C-day:				
Camberformation completed For km				
on C-day				
Acc. Mdays				

RURAL ACCESS ROADS PROGRAMME Month:..... Year:..... Unit:..... RAR-6

MONTHLY SITE REPORT C-days this month ..... Cum..... Project: ..... No:.....

1	MANDAYS							Station		This month	
ACTIVITY / WEEK						This m.	Cum.	Start	End	QTY	Prod.
Bush clearing											
Tree & Stump removal											
Stripping & grubbing											
Boulder removal											
Excavation											
Work on fill											
Ditching											
Sloping											
Camber formation								Lines:		Rings:	
Culvert laying											
Misc. drainage											
Carry water											
Setting out											
Work at Camp											
Repair & reshaping											
Misc. :											
Sub-total ROADS											
STRUCTURES											
TOTAL:											

2									CUMULATIVE	
ON SITE MUSTER ROLL	MANDAYS					Total Mdays	Rate	Amount	Mdays	Amount
ROAD: Headmen										
Storekeeper										
Watchmen										
Total D.P.S.										
Labourers										
STR: Headmen										
Fundi										
Total D.P.S.										
Labourers										
TOTAL ROAD & STR.										

3					
Monthly paid	This month			Cumulative	
	Mdays	Rate	Amount	Mdays	Amount

4					
Camberformation started on C-day:					
Camberformation finished					
For km.					
On C-day					
Acc. Mdays					

Page RAR-7

Item .... Code ....

Unit of issue .... Unit price ....

Date	Quantity			Signature	Rec. from/issued to
	Rec.	Issued	Balance		

Month: No. of days worked: Date

Day	Mandays				Cement (bags)		No. of Boxes*		Rings casted				Remarks:
	Labourers	Headmen	Craftsmen	Overseer	Issued	Returned	Used	Sand	Ballast	ϕ30 cm	ϕ45 cm	ϕ60 cm	ϕ90 cm	

* Gauge box 0.4 x 0.3 x 0.3 cm = 0.036m³

RAR-9

Materials Card for Structures.

Project:..... No:.....

Type and size of structure: Unit:..... Chainage:.....

Material	Dimension	Unit												Total
Cement	-	bags												
Sand	-													
Aggregate														
Girders		pcs												
Decking		pcs												
Runningstrips		pcs												
Kerb		pcs												
Woodpreservation		liters												
Spikes		pcs												
Nails		Kilos												
Shaped stone														
Hardcore														
Gabions		pcs												
Culvertrings		pcs												
Bolts		pcs.												

R.A.R. 9 Reverse.

Month:					Month:					Month:					
Date	Lab.	Hm.	Fundi.	OS	Date	Lab.	Hm	Fundi	O.S	Date	Lab.	Hm	Fundi	O.S	Remarks:

UNIT: ..... MONTHLY ACCOMPLISHMENT REPORT FOR: ..... 19.....

(Month) (Year)

RAR-10

ANNUAL PROGRAMME / 19 ... -30/6 19.....		LENGTH km.		EARTH ROAD CONSTRUCTION					
				STARTING MONTH		COMPLETED KM.		FINISHING MONTH	
Road No.:	NAME OF ROAD			PLANNED	ACTUAL	THIS MONTH	THIS F.Y.	PLANNED	ACTUAL

REMARKS: (e.g. charges in length, reasons for delays, "carry over" from last year .....)

MONTH: ..... YEAR .....

UNIT: .....

MONTHLY UNIT REPORT MONTH:..... RAR-11

UNIT:.....

CASUAL EMPLOYEES (this month)	Earth Rd.	Grav. Rd.
Number of casual labourers employed (on site muster roll)		
No. of other cas. empl. (headmen, watchmen, storemen, clerk etc.)		
Number of paid mandays, all casual employees		

STAFF	Established No. of posts	ACTUAL HQ-paid	ACTUAL Works-paid
Inspector/Foreman	1		
Overseer	4		
Driver/Plant Operator	9		
Mechanic	1		
Mason	1		
Payclerk	1		

FUNDS ISSUED

This F.Y. ..... Shs.

TOTAL COMMITMENT

This month ..... Shs.

This F.Y. ..... Shs.

UNCOMMITTED BALANCE

..... Shs.

VEHICLES AND PLANT					Availability % W.D.-D.O.R. / W.D. (2) x 100	Utilization % Plant: Hrs. Run / 150 x 100	Utilization % Vehicles: Km. Run / X (3) x 100
Reg. No.	Type	Km/Hrs.R	Fuel (1)	D.O.R.(1)			
	L.R.						
	TRUCK						
	TRACTOR						
	TRACTOR						
	TRACTOR						
	TRACTOR						
	TRACTOR						
	TRACTOR						
Average, all vehicles & tractors							

No. of trailers available this month:.....

Total No. of trail-workingdays this month:.....

REMARKS:

Notes: (1) D.O.R.: Days off road

(2) W.D.: No. of workingdays this month.....

(3) X = 2,500 km. for landrover

RAR-12

QUARTERLY ENGINEER OVERHEADS

STATION:..... QUARTER:.....

VEHICLES				Expenditure			TOTAL	
Reg. No.	Type	km run	Fuel(l)	P.O.L.	Depr.	Serv.& Rep.	This qter	This F.Y.
						Total		

STAFF	This qter	This F.Y.
Wages		

CAMP	This qter	This F.Y.
Depreciation		
Mainten.& Rep.		
Total		

MISCELLANEOUS	This qter	This F.Y.

SUMMARY	This qter	This F.Y.
Vehicles		
Staff		
Camp		
Miscellaneous		
Total		
Total/Unit		

MAINTENANCE

Length of earth road under maintenance :.....

Length of gravelled road under maintenance:.....

Total :.....

Number of employees:.....

Expenditure	This qter	This F.Y.
Wages		
Tools		
P.O.L.		
Service & Repair		
Miscellaneous		
Total		

REMARKS:

QUARTERLY UNIT OVERHEADS RAR-13

UNIT:..... QUARTER:.....

TRACTOR & TRAILER COSTS
(for project summary gravelling)

	This qter	Last 12 months
P.O.L.		
Service & Repair		
Depreciation		
Total Shs		

Tractor hours total.....

Cost per hour.....Shs (1)

Gravelling:.....tractorhours @.... Shs (2) = ... (3)

Other uses:.... tractorhours @.... Shs (2) = ... (4)

CALCULATION OF UNIT OVERHEADS
(for project summary construction)

	This qter	Last 12 months
Vehicles (L/R, trucks & equipment): P.O.L.		
Service & Repair		
Depreciation		
Tractors not used for gravelling (5)		
Staff wages (unit staff)		
Tools		
Accomodation: Running costs, site huts etc.		
Engineer overhead costs (6)		
Total Shs		

Total mondays all casual employees

this quarter:.....

last twelve months:.....

Unit overhead average in Shs per manday casual employee

this quarter:.....

last twelve months:..... (7)

REMARKS:

Notes: (1) Cost per hour
(2) Fill in (1)
(3) See project summary gravelling
(5) Fill in (4)
(6) See previous report RAR-12

UNIT STAFF

POST	NAME OF HOLDER	DESIGNATION	PERSONAL NO
Officer in Charge			
Site Supervisor			
Driver/Operator			
Truck			
L/Rover			
Tractor			
Tractor			
Tractor			
Tractor			
Tractor			
Tractor			
Mechanic			
Mason			
Pay Clerk			

A.

Project commenced on:.....
-"- ended on:.....
Construction days planned:.....
-"- actual:.....
Mdays planned:.....Actual.....

B. Basic measurements

Length:.....km
Culvertlines, total:.....
-"- , per km:.....
Exc. to level, total:.....
-"- , per km:.....

C. General characteristics

Terrain:.....
Soil:.....
Vegetation:.....
.....
Existing, motorable (4-WD) track.....%

D. Split-up of input to activities.

ACTIVITY	Tot. mday	Per km	Output	Prod		
Bush clearing						
Tree & Stump rem						
Stripping Grubbing						
Boulder removal						
Excavation						
Work on fill						
Ditching						
Sloping						
CAMBERFORMATION						
Culvert laying						
Misc. drainage						
Carry water						
Setting out						
Work at camp						
Repair and reshaping						
Misc.:						
Sub-total ROADS						
STRUCTURES						
TOTAL:						

E. Costs (Shs.)

ROAD	Total	Cost/km	%
Labourers			
Material			
Unit overheads			
Miscellaneous			
TOTAL ROAD			
STRUCTURES			
Labourers			
Material			
Unit overheads			
Miscellaneous			
TOTAL STRUCTURES			
TOTAL			

F. Remarks

Project:.....No....
Unit:.....

STRUCTURES REPORT RAR-15

Unit:.....

Project:.....No:.....

Bridge/Culvert/Drift

Size (span, No. lines, length):.....

INPUTS	Mdays,	Rate,	Costs	%
Materials,				
Salaries, Labour				
Salaries, Fundi				
Salaries, Supervision				

Cost/metre/line

DRAWINGS Plan:

Section:

Description and Materials RAR-15 Reverse side

Foundation/bed:

Abutments:

Wingwalls:

Girders:

Decking:

Running strips:

Materials used:

	Dimensions	No.	Price	Cost
Cement				
Sand				
Aggregate				
Girders				
Decking				
Runningstrips				
Kerb				
Woodpreserva				
Spikes				
Nails				
Shaped stone				
Hardcore				
Gabions				
Culvert rings				

Remarks:

PLANNING & PROJECT SUMMARY GRAVELLING

Unit:.....RAR-16
Project:.....No:...

Earth road construction was completed on:..... ....
Gravelling commenced on:.....Completed on.....
Work-days planned:.....Actual:.....Per km.....
Man-days cas. empl. planned:.....Actual:..... Per km.....
Tractor-days planned:.....Actual:..... Per km.....
Length gravelled.....km. Total length of road:..... km % gravelled...
Minimun Haul-Distance (H.D.):.....km Max H.D.:....km. average HD.....km
Average Haul-route standard:_____
Gravel Test: _____
Total volumes of gravel:.....m^3 (loose)

P L A N N I N G G R A V E L L I N G

HD km	Trips per Tractor per day	Number of Tractors	Number of workers EXC	LOAD	SPR	TOT.	Daily Accomplishment km	Length within HD interval km	Workdays within HD interval	Mandays within HD interval	Tractor-days within HD interval
1	2	3	4	5	6	7	8	9	10	11	12
0-1											
1-2											
2-3											
3-4											
4-5											
5-6											
6-7											
7-8											
							SUB TOTAL				
QUARRY AND ACCESS ROAD PREPARATION											
							GRAND TOTAL				

I N P U T TO ACTIVITIES

	Mandays	Lm^3/mday
Quarry preparation		
Excavation		
Loading		
Spreading		
Subtotal Cas.Lab.		
Daily paid staff		
Total Cas. Lab.		
Drivers		

C O S T S (KShs)

	Shs (total)	%
Labourers		
Tractor & Trailer		
Material		
Unit Overheads		
Miscellaneous		
TOTAL		

R E M A R K S:

SIGNATURE
RAR-ENGINEER

DAILY/MONTHLY REPORT GRAVELLING

Unit:.....RAR-17
Project:.....No:...
Month:.....

Project started:..... Project ended:.....

Date	Workday	MANDAYS							Tractors working	Haul-distance km one way	Number of loads		G.LENGTH		REMARKS
		Quarry and access road preparation	Excavation	Loading	Spreading	Other cas.empl. (H/Men,W/Men etc)	Total cas.empl.	Drivers	Trailers		Target (table I)	Actual number of loads	Per day (m)	Accumulated (m)	Hour reading when tractors leave or return to project, breakdowns, etc.....
TOTAL															
ACCUM.															

Tractor Registration No	GK	GK	GK	GK	GK	GK
Hr reading end of month						
-"- beginning -"-						
GROSS HRS.						
Less hrs not on project						
NET HRS.						

Total gross hours (all tractors)	
Total net hours (all tractors)	

G.P. 53

MUSTER ROLL FOR THE MONTH OF ..... 19.....

No.	Name	Description	DATE 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31	No. of days present	Rate of Pay	Sh.	cts.	Sh.	cts.

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RURAL ACCESS ROADS PROGRAMME
MAINTENANCE INSPECTION REPORT

ROAD No---------- ROAD NAME---------- ROAD LENGTH (Km)------ DISTRICT NAME----------

SECTION No.	LENGTH OF SECTION (Km)	STANDARD OF CONSTRUCT.		STATE OF SECTION																			INSTRUCTIONS TO MAINTENANCE CONTRACTOR
		EARTH	GRAVELED	PATCHING			RESHAPING			DITCHES AND DRAINS			CULVERTS			BRIDGES AND DRIFTS			GRASS CUTTING			
				Good	Fair	Bad	Good	Fair	Bad	Good	Fair	Bad	Good	Fair	Bad	Good	Fair	Bad	Good	Fair	Bad	
1																							
2																							
3																							
4																							
5																							
6																							

Is first payment withheld of maintenance contractor on section number? (1)----------

1st 2nd payment withheld of maintenance contractor on section number----------

Has contractor been dismissed on section number?----------

Has replacement been made on section number?----------

DESCRIPTION OF ANY MAJOR ROAD REPAIRS----------

INSPECTED BY: SIGNATURE:

APPENDIX 9

PAYMENT SYSTEMS FOR CASUAL LABOUR USED IN THE RARP

Two payment systems have been used in the RARP although preference is given to the system as described under "A". The advantages and disadvantages of each system will be briefly discussed. The main problem with the payment of casual workers - who get paid only for the days they have worked - is that payrolls cannot be prepared in advance because salaries cannot be predicted unlike the case of permanent staff.

A. Payment is made on a monthly basis but two weeks in arrears. The normal payment period is from the 16th of the previous month up to the 16th of the current month. The duplicate masterrolls are collected every 16th of the month and the payrolls for the casual workers are prepared during the next three days. The masterrolls provide all necessary information in respect of daily rates of pay and number of days worked. The payrolls are submitted to the Provincial Engineer's (MOW Maintenance) Administration where they are checked for arithmetical errors. As per the directions of the RAR engineer one or several cheques per unit are then prepared for the signature of the provincial engineer and a second signatory (not the RAR engineer). Information on payment date and a breakdown of the cash for wages is forwarded to the bank at least two days in advance, so that the paying officer will be able to collect the money with minimum of delay on the date of payment. The paying officer proceeds to the sites where the workers have been assembled and pays every worker up to the 16th of the month.

The disadvantage of this payment system is that the workers are paid in arrears, the necessity of which many of them find

difficult to understand and accept, even after lengthy explanations. It also means that workers cannot be paid on the last day of work when the construction has been completed, but will have to come back for their final wages one or two weeks afterwards. To avoid these problems payments can also be made according to system B described below.

B. The collection of the muster-rolls, preparation of the payrolls and cheques and the giving of notice to the bank is done as described under A, the difference being that the wages for the period between the date of collection of the muster-roll and the date of payment are estimated and added on the payroll. It is assumed that every worker will be present every day during this period. To avoid overpayment the paying officer will have to deduct money according to a list prepared by the overseer, indicating the number of days workers have been absent during the above-mentioned period. A column for deductions is provided on the payroll and the worker signs for the actual amount received.

It is evident that this system increases the work of the paying officer substantially (deductions have to be made on the spot, total amount deducted has to be surrendered and accounted for). This may prove to be prohibitive especially if the paying officer does not come from within the RARP and is subsequently not responsible to the RAR engineer. The administrative work for the overseer, who has to prepare monthly deduction sheets, is also increased. An important disadvantage is that there is a scope for fraud by the paying officer and by the overseer.

Although the system can work and is better for the casual workers it depends too much on the personality and character of the paying officer because of the reasons described above. It is for

this reason that the RARP management has preferred the system described under A.

APPENDIX 10

DESCRIPTION OF A TIME AND LOCATION CHART[1]

This diagram is a graphical representation of the major constituents of the road project.

(i) The plan of the road is drawn at the top of the diagram. The chainage points are marked, as are all the structures such as bridges, culverts and retaining walls.

(ii) The longitudinal section of the road is drawn under the plan, volumes of cut and fill are marked on this longitudinal sector.

(iii) The horizontal axis of the diagram represents the length of the project and is a direct projection of the longitudinal plan. The vertical axis is on a timescale and can be in construction days, weeks or months as required. Each operation is drawn on the diagram as a series of lines and each point on the line represents a point in time and location.

(iv) At the left-hand side of the diagram the resources required in terms of labour and equipment can be shown (calculated by reading across the row and adding the resources required to each operation at each point of time, e.g. week 5, 250 labs required).

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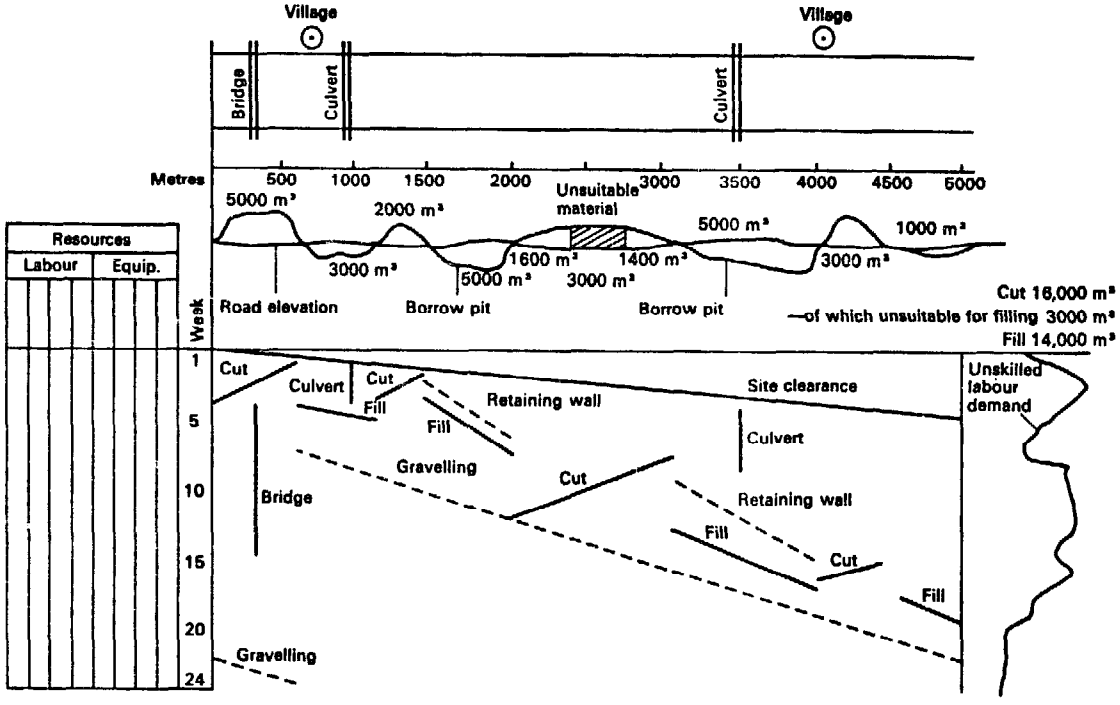
[1] For a more detailed description and explanation see "Manual on the planning of labour-intensive road construction", an ILO publication by M. Allal and G.A. Edmonds in collaboration with A.S. Bhalla.

(v) These data enable the planner to plot a labour demand curve as shown at the right-hand side of the diagram, on which the expected labour supply curve can be superimposed.

Example of a Time and Location Chart



It should be noted that this example illustrates the main elements of a critical path network without using network diagrams, e.g. the fill operation between chainage 600 and chainage 1,200 cannot be effectively executed until the culvert at chainage 900 is completed.

Since the diagram shows hauling lengths as well it is also possible to tell at a glance which hauling technique (wheelbarrows, tractor trailers, dump trucks) is the most appropriate for a particular cut to fill operation.

Ccmparing the planning graph described in Appendix 5 and this Time and Location Chart it can be seen that a lot of variations are possible and that the chart can be made as simple or detailed as the circumstances require. This is particularly important, as in labour-intensive programmes not only higher-qualified personnel deal with planning and control but also construction supervisors of a low educational level.

APPENDIX 11

REPORTS PRODUCED BY THE TECHNOLOGY UNIT,[1] MOW[2] AND ILO[3]

TECHNOLOGY UNIT

- Progress Reports Nos. 1-8;
- Final Progress Report, August 1978 (Volume I of the Final Report);
- Technical Manual for the RARP (Volume II of the Final Report);
- Final Report on Development of Tools and Equipment (Volume III of the Final Report);
- Report on Handtools and Equipment (ODM);
- Second Report on Handtools and Equipment (ODM);
- Labour Supply Study, Report No. 1 (ODM);
- Labour Supply Study, Report No. 2 (ODM);
- Labour Supply Study, Final Report (ODM);
- Final Organisation and Management Report (ODM);
- Unit Managers' Guide for Office Administration;
- A Guide to Head Office Procedures;

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[1] Available at World Bank (Transportation Department) or Ministry of Overseas Development (UK).

[2] Available at Ministry of Works, Kenya.

[3] Available at ILO, Geneva (Technology and Employment Branch).

- The Relationship of Nutrition and Health to Worker Productivity in Kenya (World Bank Technical Memorandum No. 26);
- Kenya: Health, Nutrition and Worker Productivity Studies.

TRANSPORT AND ROADS RESEARCH LABORATORY (TRRL)

- Inception Report, Study of Engineering Standards (January 1977);
- Progress Report January-October 1977 (Technology Unit's Progress Report No. 7);
- Annual Progress Report (February 1978);
- Compaction for Rural Access Roads Preliminary Report (Technological Unit's Progress Report No. 8);
- Characteristics of Rural Access Roads: An Inventory;
- TRRL/TU/MOW Co-operative Research Programme Progress Report (March-August 1978);
- A Study of Gravel Deposits in the Kerinyaga, Nyeri and Kwale Districts, Kenya, for the RARP.

MINISTRY OF WORKS

- Loan Application Submitted to the International Bank for Reconstruction and Development and Swedish International Development Authority (March 1974);
- Revised Loan Application in respect of Rural Access Roads Programme (July 1975);

- Policy paper on the selection of priority districts for the implementation of the proposed RARP (July 1976);
- Monitoring and Evaluation of the RARP through the Impact Study (revised July 1977);
- Annual Review and Evaluation Meeting, 1978, Discussion Papers, (March 1978):
  - (i) Historical Review;
  - (ii) Present and Future Financial Assistance;
  - (iii) Progress Report to 31 December 1977;
  - (iv) Report on the Development Training Programme;
  - (v) Work of the Technology Unit;
  - (vi) Maintenance of Rural Access Roads;
  - (vii) Characteristics of Rural Access Roads;
  - (viii) Compaction of Rural Access Roads;
  - (ix) Selection and Evaluation Criteria for Rural Access Roads;
- Guidelines to the District Development Committees for the Selection of Rural Access Roads (March 1978);
- Progress Report No. 2, period ending 31 December 1978 (May 1979);
- Progress Report No. 3, period ending 31 March 1979 (June 1979);

- Annual Review and Evaluation Meeting, 1979, Discussion Papers (June 1979):

  Volume I: (i) Road Maintenance;
  (ii) Training Report;
  (iii) Progress Report, TRRL Study Team;

  Volume II: (i) Equipment Maintenance and Performance;
  (ii) Planning and Reporting;
  (iii) Gravelling Report;
  (iv) Estimate of Additional Road Length by Districts;
  (v) Draft;
  (vi) Supplies;

  Volume III: Current Status on the Selection and Evaluation of Rural Access Roads and the Implementation of the Impact Study;

- Progress Report No. 4, period ending 30 June 1979 (December 1979);

- Progress Report No. 5, period ending 30 September 1979 (January 1980);

- Vehicle Maintenance Manual (May 1979).

INTERNATIONAL LABOUR OFFICE

- Implementation of appropriate road construction technology in Kenya (November 1976);

- The Kenya Rural Access Roads Programme, review meeting, January 1977, a report of the presentations and discussions;

- The Kenya Rural Access Roads Programme, report of the Joint Donors' Review and Evaluation Meeting held in March 1978;

- The Kenya Rural Access Roads Programme, report of the Joint Donors' Review and Evaluation Meeting held in June 1979.

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