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BAY REGION AGRICULTURAL
DEVELOPMENT PROJECT, SOMALIA

MID TERM REVIEW

CONSTRUCTION EQUIPMENT
SPECIALIST REPORT

by
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1.0 TERMS OF REFERENCE

- 1.1 The original terms of reference from Hunting Technical Services for this report were:-

To provide specialist advice on the following aspects of the Access Roads component of the Bay Region Agricultural Development Project (BRADP) within the overall terms of reference of the BRADP Mid Term Review.

- a) The suitability of the project construction vehicles and equipment for the implementation of alternative road rehabilitation, construction and maintenance proposals; specifying any additional equipment required.
- b) The operation and control of vehicles and equipment currently engaged in road construction and the principal reasons for the current levels of utilisation and productivity.
- c) The proper disposition, operation and control of the existing fleet of vehicles, equipment and personnel in order to improve utilisation and productivity.
- d) The establishment of an effective regional road maintenance unit.

After discussions with the Team Leader, it was agreed that para. 1.1c should be expanded to include logistic support for the project equipment.

1.2 Summary

- 1.2.1 The Bay Region Agricultural Development Project is a multi disciplinary Somali Government Project, covering improvements to livestock, agriculture, water supply and access roads in the Bay Region. The work is funded by four Agencies including the World Bank, and expected to take six years. Hunting Technical Services are carrying out a Mid Term Review and requested specialist advice as listed above.
- 1.2.1 A visit to Somalia was made from 14th to 26th September by Mr. R.B. Downs of Taylor Woodrow International Planning Department. Discussions were held with a number of the Project Management staff, and road construction work, both completed and in progress, was inspected. Diary and personalities are given in Annex G.
- 1.2.3 It was found that there is very little proper supervision of the construction work by qualified Civil Engineers. The supervision of the work has been left to junior and inexperienced Somali Staff. Consequently the work is slow and of poor quality because too

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much material of the wrong type is being used, and this material is being handled either by the wrong machines or by too many machines. Although new construction is going ahead, no maintenance work is being undertaken and existing roads are deteriorating badly.

1.2.4 Recommendations

In the short term output and quality can be improved easily by the proper supervision of qualified staff. Various recommendations are made in this report (para. 4.2).

In the long term the organisation and control of both new work and maintenance will require reorganisation of the current plant into separate Road Construction and Road Maintenance Units. New buildings for Workshops and Support Services will also be required. The organisation of these units and methods of road construction are discussed and recommendations made in this report (para. 4.3).

2.0 INTRODUCTION

2.1 History

Four Agencies are jointly funding the Somali Government's Bay Region Agricultural Development Project. These Agencies are the World Bank, African Development Fund, International Fund for Agricultural Development and USAID. The Project started in 1980 with an expected 6 year period to complete the scope of work agreed by these Agencies. A mid term review was commissioned by the World Bank to be prepared by Hunting Technical Services, and this report to Hunting Technical Services will be used by them in the preparation of their report.

2.2 Project Description

The Bay Region Agricultural Development Project is a multi-disciplinary Project covering improvements to Livestock, Agriculture, Water Supply and Access Roads in the area. The Project is run by a Project Manager appointed by the Somali Government, whose job is to integrate the work of the various experts in each discipline. Some of these experts come from other Government departments and others come as Technical Assistance provided through one of the Development Agencies. Equipment generally is funded by one of the Development Agencies.

2.3 Access Roads

2.3.1 The construction of the Access Roads is being carried out by a Direct Labour Team employed by the Somali Government under the overall direction of the Project Manager. The Somali Government has employed under contract from FINTECS of Cairo, a team of four engineers (Civil and Mechanical) to provide line management of the access roads work under the Project

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Manager. These Engineers are also expected to train Somali Staff on the ground, though the Somali Government is also sending potential Somali Engineers to University in U.S.A.

- 2.3.2 The work involved for the access roads is new gravel road construction to Class 2 (6 metre nominal roadway) and Class 3 (4 metre nominal roadway) together with rehabilitation and upgrading of existing roads. The actual scope of work has been changed in the past three years, and the construction plant purchased is not entirely the same as that recommended in the original World Bank project report. These facts led to the Mid Term Review Team requesting specialist advice as shown in para. 1.1a.
- 2.3.3 During this review the team also found that road construction was much slower than calculated by the original World Bank report consequently specialist advice as shown in para 1.1b and 1.1c was requested.
- 2.3.4 Although the original World Bank report recognised the need for maintenance, in that it recommended setting up two Road Construction Units and one Road Maintenance Unit, the plant purchased was formed into two Road Construction Units only. Consequently specialist advice as shown in para. 1.1d was requested.
- 2.3.5 In order to advise the Mid Term Review Team a visit to Somalia was arranged for Mr. R.B. Downs of Taylor Woodrow International. A diary and a list of people interviewed is in Annex G.

3.0 OPERATION OF EXISTING PLANT AND CONTROL OF WORK

3.1 Geography

The Bay Region area is shown in the map at Annex 'A'. There are two access roads under construction now. Road Construction Unit 1 is building a Class 2 road from Goof Guduud to Qansaxdheere. Road Construction Unit No. 2 is building a sub-standard Class 3 road from Qansaxdheere to the Juba River. The details of construction for these roads are discussed in paras. 3.4 and 3.5 below.

3.2 Organisation

3.2.1 Staff

The road construction plant has been organised into two separate Road Construction Units under the overall direction of the Project Manager at Baidoa. The line management of the Construction Units is contractually the responsibility of the Fintecs Civil Engineer. In practice responsibility appears to be divided between him and the Director Access Roads who is a Somali

3.2.1 Staff (continued)

Government staff member appointed by the Project Manager. The maintenance and repair of the Construction Equipment is the contractual responsibility of the Fintecs Mechanical Engineer who is assisted by his Fintecs Plant Superintendents. There do not appear to be Somali Government staff at the Mechanical Engineer's level under-studying the Fintecs Mechanical Engineer. The provision of fuel, oil, lubricants and administrative matters such as pay are handled directly by the Project Manager and are not the concern of the Fintecs staff. An outline organisation is at Annexure 'B'. However, this is to some extent conjectural as the Fintecs Civil Engineer was on leave, the Director Access Roads was in Mogadishu, and the Project Manager was only available for a short time for discussions. The major technical contact was with the Fintecs Mechanical Engineer.

3.2.2 Plant Organisation

All the plant purchased with World Bank funds has been organised into two Road Construction Units. The current distribution of Plant between the units is given in Annex C.

3.3 Scope of Work

The scope of work required for the construction of new gravelled roads to the specification given, is:-

- a) Rip suitable gravel beds, doze into stock piles.
- b) Load stockpiles and move up to 20 Kms to road head.
- c) Construct low ($\frac{1}{2}$ metre) embankment from in-situ material on road alignment, including compaction.
- d) Spread, shape and compact gravel surface.
- e) Construct ditches and culverts/causeways as appropriate.

The scope is similar whether the roads are Class 2 (nominal 6m roadway) or Class 3 (nominal 4m roadway). The variation is in the quantities needed. The roads generally are intended to improve access to villages and therefore run mainly through areas of black cotton soil. In these areas embankment construction is easy, but the nearest gravel pits are in lateritic areas and gravel has to be carried many kilometres. Between the fertile settled areas the roads run over lateritic type soils where embankment construction will normally need some ripping work, but gravel pits are much nearer the road. Overall construction speeds should therefore be similar whatever the in-situ soil.

3.4 Work of RCU1 - Goof Guduud to Qarsaxdheere Road

3.4.1 The working site of No. 1 RCU was visited on 21st September at Km 13 on the Goof Guduud to Qarsaxdheere road. The site had just received an allocation of fuel after being stopped for several days. The method of working was:-

- a) Clear of a thin topsoil layer of the black cotton soil by grader to provide road formation.
- b) Build up an embankment with a dozer working at right angles to the centreline pushing up the black cotton soil. This is then levelled by a grader and compacted.
- c) One dozer in the quarry rips and heaps up gravel, which is loaded by one front end loader into tippers which carry to the road.
- d) The tippers dump each load into 15m³ piles on the embankment.
- e) A bulldozer breaks down the heap to enable the grader to spread and level the gravel, which is sometimes watered and then compacted.

3.4.2 The output on this site is slow because:-

- a) No control over line and level by the supervisors means that excessive amounts of both fill and gravel are brought in. It is estimated that 20 - 50% excess material is being used.
- b) In the black cotton soil it is wasteful to build the embankment by dozer and grader. A grader alone can build the necessary bank by V ditch cutting outside the formation and spreading the windrows into the bank. This was demonstrated to Project Staff, who said they would look at the system and try to get the grader operator trained. It is probable that this system will be slower to start with until the grader operator gets experience. It is strongly recommended that it is tried for at least a few kilometres, as it will definitely be quicker and cheaper in the long run.

- c) The tippers persist in dumping 15m³ heaps, which means a dozer is standing by permanently in addition to the one building the embankment. If the trucks would tip in 3 or 4 small heaps the grader alone could spread and level. It was suggested to the Project Mechanical Engineer that it might be useful to make up an improvised pusher to fix on the front of the grader to help level the piles. Ideally a grader with a pusher blade would be best.
- d) Time is wasted by grader operators turning the machines round at the end of each run. It is far quicker to reverse in top gear and this can appreciably increase output.
- e) The 7 Km haul road has only been graded once when the track from the quarry was improved. The track is now rough and Project Staff were advised to grade it about every week. This grading would speed gravel delivery and so increase output.

3.4.3 Apart from the slowness of work, the quality of construction is poor. Some elementary alignment has been done but line and level have been put in by eye. Consequently the required camber is virtually non-existent and although longitudinal alignment is a little better, it is still subject to unexpected irregularities. No pegging of edges appears to have been done and no "boning" to check levels. The completed road is already rutting and corrugating although it has only been built a few months. This is partly due to the lack of water but also points to insufficient rolling during compaction. The standards on this site suggest insufficient supervision of work by the Engineering Staff of Fintecs.

3.5 Work of RCU2 - Qansaxdheere - Buur Dhubo Road

- 3.5.1 The working site of no. 2 RCU at km 50 on the Qansaxdheere to Buur Dhubo road was visited on 20th September. The unit had very little fuel left and expected to run out that day. The diagrammatic site layout was:-

No less than 3 dozers were working in the quarry and were getting so much in each others way that output was very low. Loading by a 66C FEL was into 2 tippers which were running on the formation or embankment already laid. The formation was 50 cms deep in silty dust, and no effort to water or compact the formation was being made. The gravel was being dumped straight into the dust in 15m³ heaps, which meant that periodically a dozer had to come to level the heaps sufficiently for a grader to spread the gravel for completion by a single roller. The heaps were being put so close together that at least 70 cms thickness had to be used to spread the gravel over a reasonable width. Of the remainder of the RCU plant one S/F roller was being serviced by the fitter, 2 tippers and 1 FEL were U/S with punctures.

3.5.2 The work on this site was slow and standard of construction poor because:-

- a) It was clear that because plant was available, it was being used. Consequently there was much idle time, particularly for the bulldozers.
- b) Lack of water and poor compaction of the formation has caused tremendous dusting, and unnecessarily severeworking conditions for the plant and men.
- c) The complete absence of control of line and level by Fintecs or other qualified staff and allowing tippers to put their whole load in one place instead of a number of small heaps, has led to a gross excess of material being put down. It is estimated that 300% of the true requirement is being placed which is uneconomic, wasteful and inevitably slows the work.
- d) The complete absence of water and the excessive thickness of the gravel mean that compaction is ineffective and consequently although there is more gravel in the road than is needed the road is worse, not better, because this is loose gravel.

3.5.3 Further inspection of the remainder of the road showed that the description given by the Project Manager that they were building a sub-standard Class 3 all weather track was not correct. In fact as far as KM 30 this is a dry weather access track only, and is already in poor condition. In areas of good subsoil, much of the track is simply a bulldozer scrape after

clearing scrub. There is no drainage, and the track is below ground level, so will inevitably become a watercourse when it rains. On poor subsoil a slot is cut which is 200-300 mms deep, and then gravel is dumped in the slot. There is no attempt to produce a camber and no drainage. Since this road surface is also below ground in many places these sections also will become watercourses. Where stone has been put down no real effort to level and compact properly has been made and the road surface is already bad after only five months. There appears to be no adequate supervision of the work and it will not survive the first rainy season. From Km 30 to Km 50 the road gang seem to have forgotten their brief. There is still no preparation of the formation but as much as 70 cms of stone have been dumped on the ground and shaped roughly over about 6 metres width. Shape and compaction are poor and no attention has been paid to drainage.

3.6 Maintenance and Repair of Plant

3.6.1 Maintenance and Repair. The current maintenance and repair system was explained by Mr. Achmed Zohdi, the Technical Assistance Officer filling the post of Mechanical Engineer. He is fully aware of the need to set up a Maintenance System, with central control of the records and direction of the work but with permanently attached fitters to each RCU, and has implemented such a system. His plant superintendents not only supervise the maintenance but work with the fitters on the job. Maintenance manuals in English are available and the Mechanical Engineer is teaming up English speaking young fitters with older more experienced, but non English speaking fitters. Certainly the plant on site seems to have been regularly greased, cleaned in the essential areas to enable maintenance to be done, and so far as is possible with the current spares situation, kept on the road in good order. The necessary record systems to forecast and check maintenance have been set up. There is still a requirement to integrate the fuel and lubricant records with the remainder of the plant documents. This is difficult as fuel supply and documentation is not under the direct control of the Mechanical Superintendent. However, he has recommended a system and is trying to get it implemented now. There is no doubt that Mr. Achmed Zohdi has worked and is continuing to work extremely hard at ensuring that the plant is properly maintained and repaired. The systems he is setting up are good, and should be supported.

3.6.2 The original World Bank report recommended construction of several sets of buildings including workshops, stores, offices and laboratories

for the Access Roads element of the project. Until the buildings are constructed there are no facilities available for major repairs. All that can be tackled are field repairs under primitive conditions.

3.7 Logistics

3.7.1 There are three main aspects of logistics to be considered for the support of the Access Roads programme.

- a) Fuel oil and lubricants
- b) Spare parts
- c) Supporting services such as operator training space, office and store accommodation, and soils laboratories.

3.7.2 Fuel. There appears to be a suitable government system for the supply of fuel and lubricants which is established and well known. There are however two points to be borne in mind. First the present system of issuing small quantities of fuel daily to the plant greatly increases the condensation problem and increases the risk of dirt in the injectors. It would be much better to fill the fuel tanks of the construction plant each night to reduce the problems. If fuel theft is considered to be a problem, then locking caps could be fitted. Secondly, the oil is generally re-cycled so that oil and filter changes should be more frequent than usual.

3.7.3 Spares. The provision of spare parts is not satisfactory, mainly because there is no procurement system. Only 10% initial spares were purchased, and of these some have still not come (Hanomag), some are incomplete, (Mercedes) and some are wrong (Galion and Pettibone oil filters). However, the Mechanical Engineer has now properly stored the items which are available, has started a proper bin card system, and is generally controlling the stores on site although he still cannot cost anything as spares costs have not been passed to him. The present procurement system between the site and the manufacturer is long and complicated and can be summarised as:-

- a) List spares required - by Mechanical Engineers
- b) Obtain Proforma invoices from Manufacturers
- c) Go to Donor for permission to purchase
- d) If the Donor approves, go to the Somali Government for import licence.
- e) When import licence is granted obtain insurance from a Somali firm

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- f) Take import licence and insurance to Somali Central Bank and get letter of credit opened
- g) Send Letter of Credit to Donor to get guarantee
- h) When supplier is informed through normal commercial banking channels that Letter of Credit is valid, he can ship
- j) Supplier ships to Somalia, BRADP clear through docks and forward to site

Stages 'a' to 'h' can take 4 months normally and could go longer. Stage j can take 3-4 weeks from Europe and 3-4 months from USA to the Port, and 1-3 weeks from port to the site. Spares can thus take 5 months from ordering, and may take as long as 9 months from the USA if everything does not go exactly to plan.

- 3.7.4 Supporting Services These are at present only small offices for the Engineering Staff, and small store for spare parts which is inadequate in size. There is no space for training operators or other staff, and no laboratory to advise on selection of quarries, compaction methods or watering requirements for the fill and gravel. Such accommodation is included in the future building programme.

4.0 PROPOSED FUTURE OPERATION OF PLANT AND CONTROL OF WORK

4.1 It is necessary to divide proposals into short term and long term proposals. The short term covers the period until the completion of the Goof Guduud - Qansaxdheere and the Qansaxdheere - Buuz Dhubo road. The long term covers the period after the completion of these roads.

4.2 Short Term Proposals

The work of both Road Construction Units can be improved both in speed and quality by improving the supervision of work by qualified personnel. The supply of spare parts could also be improved in the short term by standardising the supply system. These proposals are discussed in paras. 4.2.1 below.

4.2.1 Road Construction Unit No. 1

4.2.1.1 It is recommended that the work and organisation of this unit be amended as below in order to improve output quality.

- (a) The construction sequence should be amended slightly as follows:-
- (i) Clear Right of Way with grader in black cotton soil, and dozer in scrub covered country.
 - (ii) Form embankment with grader, assisted by the dozer ripping in gravelly soils.
 - (iii) Compact embankment with vibrating rollers.
 - (iv) Win gravel with dozer, F/E Loader and tippers.
 - (v) Tip gravel on formation in small heaps, and spread with grader.
 - (vi) Water and compact gravel.
- (b) Remove one bulldozer (D6) and one F/E loader from No.1 RCU and add one tipper from No. 2 RCU. This will improve the gravel output, and remove the temptation to use machines simply because they are available. The D6 bulldozer should go back to agriculture, and the F/E loader to reserve. See Annex C.
- (c) Start control of line and level by pegging the edges of the formation and using camber and boning rods. If the site staff cannot use these simple equipments get the Fintec Civil Engineers staff to teach them. Until they are taught there should be a Fintecs man on site permanently acting as Line Manager and teaching the others.
- (d) Ensure that quarry site and material selection is made by competent supervisory staff.

4.2.1.2 The main requirement to improve output and quality is to have competent staff on site with the knowledge and authority to improve that knowledge. Short visits, even daily are no substitute for long term teaching and supervision. Until Somali staff are trained in this supervision it is essential that the Fintecs Technical Assistance Team do spend most of their time on site.

4.2.2 Road Construction Unit 2

Although it is stated by the Project Manager that this unit is building an all weather track, the design chosen will only produce a sub standard dry weather track. If an all weather track is needed then it is recommended that:-

- (a) The present construction sequence be slightly amended as under:-
- (i) Clearing scrub with dozer
 - (ii) Rough levelling formation with dozer/ grader in places
 - (iii) Excavating gravel with ripper/dozer, loading with FEL, transport by tipper
 - (iv) Instead of dumping full loads, dump small loads from tippers
 - (v) Spread water and compact gravel
 - (vi) When grader time is available maintain formation/haul road, and water when possible.
- (b) Ensure that Fintecs staff are on site both as line managers and instructing site staff. In particular they should ensure proper line and level is maintained, and that proper material and quarry locations are selected.
- (c) By reducing the quantity of gravel, the quantity of excavation in the quarry and the number of tipper trips is reduced. To avoid machines being unnecessarily used simply because they are there, withdraw one bulldozer, one FEL and two tippers from RCU 2. Send one tipper to RCU I and the other plant to form a reserve pool. Proposals are shown in Annex C. One of the Fintecs staff should be on site all the time until the Foremen have been instructed in the use of boning rods, tapes and camber boards. Once instructed they should be ordered to use them and not rely on the eye of the grader operator. This should keep the quantities of gravel within reason and increase speed of output.
- (d) Every effort should be made to keep the formation graded and in good condition and as much water as possible should be used for all compaction purposes.

- (e) Priority be given to getting all four graders back on the road as soon as possible. This would greatly help in ensuring the formation and haul roads were kept in good condition by allowing two graders per RCU.

4.2.3 Plant Maintenance, Repairs and Logistics

- 4.2.3.1 The plant maintenance system in the short term needs no improvement, but only continued application.
- 4.2.3.2 The repair system cannot be improved in the short term.
- 4.2.3.3 The logistics system needs urgent improvement of spares supplies as soon as possible. The main problem is the delay between deciding a spare should be ordered and its arrival on site. There are two areas where time might be saved:-

- (a) Since all funding is external, and since a cif quote from a supplier would also ensure that insurance money paid is external, then a general waiver of Import Licence and Somali insurance would save time on individual applications.
- (b) An annual spares budget would save time by eliminating the need to go to the Donor each time to get approval. A suitable amount would be the following percentages of the capital cost of the plant for the expected 7 year life of the plant:-

Year 1	-	6½%
2	-	7%
3	-	8½%
4	-	11%
5	-	14½%
6	-	19%
7	-	24½%

- 4.2.3.4 Whatever system is used it is essential that the full details are published and passed to the Mechanical Engineer and his stores staff. They can then annotate their bincards with appropriate reorder levels, and adjust their spares ordering system to take account of the procurement system, whichever system is set up.

4.3 Long Term Proposals

4.3.1 New Road Construction

4.3.1.1 Whilst it is essential to start road maintenance as soon as possible, it is also essential to continue with new road construction. The proposals given in Section 4.2 will not only improve the speed and quality in the short term, but if new construction is concentrated into one Road Construction Unit it will enable new Class 2 all weather roads to be built at the rate of 1 Km per week.

4.3.1.2 Calculations to show plant usage and scheduling to achieve this are given in Annex 'D'. The current system of work uses bulldozers extensively partly because they are there, and partly because the supervisors do not seem to realise the potentialities of the grader. The Fintecs Civil Engineer has ignored all other plant and calculated that 1 Km of Class II road requires 145 bulldozer hours. By more efficient management of the dozers and including more use of the graders as described in Annex 'D' appendix 1, it is possible to cut the bulldozer usage to 66 hours. If, however, graders do go unserviceable it is still possible to continue road construction using bulldozers, albeit more slowly and less efficiently. In annex D, Appdx 2 is a possible plant configuration making maximum use of dozers.

4.3.1.3 From these calculations it is possible to propose a single Road Construction Unit to replace the two existing units and this is given in Annex E. But it is emphasised that all the points brought out in the short term proposals must continue to be applied. In summary it is essential that:-

- (a) The work on site be directed by a responsible engineer. Until Somali staff are trained, this means the Fintecs staff supplied as technical assistance. Their job is to ensure:-
 - (i) Proper line and level is maintained to give both a good running surface and to minimise unnecessary work
 - (ii) Proper direction of the operators is given to ensure the correct machines are used in the correct way to maximise output

- (iii) Proper selection of materials for embankment and gravel is made to make best use of available resources and proper supervision to ensure that full compaction is obtained.
- (b) The maintenance and repair system with its accompanying records now being set up by the Fintecs Mechanical Engineer be fully adopted and expanded to include full tracking of fuel usage.
- (c) The suggested logistic supply system be rapidly started to ensure that spare parts in particular are available when they are needed. This system must not work in isolation, but be integrated with the stores system being set up by the Fintecs Mechanical Engineer now.

4.3.2 Road Maintenance

4.3.2.1 There is an urgent need to start maintenance both on existing roads and on the current new construction. In order to start maintenance and still keep within the budget it is necessary to examine the maintenance operations and plant requirements, improve them with a balanced fleet to enable new construction to continue, and from this data to make recommendations.

4.3.2.2 Background

In any road construction programme there must be a balance between new construction costs and maintenance costs, which is always affected by the volume of traffic. A low cost road built with local materials and minimum quality control will always require considerable maintenance. The maintenance requirements will increase with traffic quantity. A higher cost road, using good quality gravel imported from several kilometres and with good quality control on compaction and levelling will require less maintenance (or be able to take more traffic with the same maintenance as the low cost road).

However all roads must be maintained. If they are not maintained, traffic in dry weather will take to the adjacent land rather than use a rough road surface, and this can, if unchecked, lead to serious loss of useful land. Such tracking has already taken place on the new Goof Guduud to Qansasxdheere road even though it is only a few months old. The establishment of a road maintenance unit is therefore urgent.

4.3.2.3 Scope of Maintenance Work

The scope of work can be divided into 4 main headings, and the requirements are examined in detail below.

- (a) Regular grading. Loose stone, longitudinal ruts and corrugations develop fairly quickly under traffic. Their effect is to slow traffic in dry weather and to hold water on the road (with consequent rapid deterioration of the road surface) in wet weather. Whilst it is possible to use agricultural tractors with improvised drags, the most efficient tool is a grader taking very light smoothing cuts along the road. This needs to be done about every 3 to 6 months depending on traffic and the standard of road construction. It ought to be done in dry weather the full length of every road. The grader will need to be accompanied by a 7T truck for moving labour, fuel etc.
- (b) Repair of culverts and causeways. Culverts and causeways need regular inspection during wet weather to ensure that they are kept clear, otherwise serious damage can occur to the road. It must be remembered that blockages are often deliberately caused by farmers and herdsmen who want to form water reservoirs. This must be discouraged. Apart from inspection in the wet season, there needs to be a regular repair programme in the dry season, particularly to causeways to replace washed out stones. A small team of masons and labourers with a 7 tonne truck to carry sand, cement and tools, together with a small water trailer is all that is needed for the repair work. In the wet season the same truck can be used for inspection.

- (c) Reshaping. Whilst dragging can eliminate smaller faults, it will sometimes be necessary to adopt more drastic measures and reshape the road. Provided that not too much surfacing has been lost, it is possible to use a grader to scarify the surface, then reshape it, add water if necessary and recompact it. This work needs a grader with a scarifier, a roller and sometimes a water tanker. In the absence of a scarifier it will be necessary to transport one of the tracked dozers with a ripper to site, but this is a very uneconomic way of working. A 7 tonne truck and small water trailer are also needed so that essential repairs to structures can be carried out at the same time by the regravelling unit. Reshaping is generally only required over relatively short lengths of road and is a repair operation which could be carried out by the regravelling unit.
- (d) Regravelling. It is inevitable that traffic, dragging and weather will cause loss of surface material on the road, and this must be replaced. The work required is to first reshape the existing road as in para (c) above. Then new surface material is obtained from suitable quarries, moved to site, dumped, spread, shaped and compacted. Thus the plant needed is dozers with rippers in the quarries; front end loader with large tipper trucks, graders with light dozer blades on the road to spread and shape, and vibrating rollers and water tankers to compact the surface. Regravelling is needed about every 3-6 years depending on quality of new construction and the quantity of traffic. If a programme to regravell 20% of the roads in an area per year is set up, this will probably be suitable.

4.3.2.4 Organisation

Whilst it is essential that there is a central road construction management, it is also essential that at working level new construction teams and maintenance teams are separate entities. If they have dual functions, maintenance will be neglected. Similarly although central management is essential, the road maintenance units should be based in the areas in which they work and not all based centrally. Bearing in mind the limitation of plant, the choices of one depot at Baidoa and one at Dinsoor now, to be followed by one at Buur Hakara later would suit maintenance of all project roads. However, it must be borne in mind that there are inter regional roads passing through the project area and project roads going outside the project boundaries. Whilst it is essential to set up at least 1 and preferably 2 Road Maintenance Units now, it may be more economic to set up an agency agreement with the Ministry of Public Works to avoid the need for a third depot in the future.

4.3.2.5 Composition of the RMU

From the analysis of the work required and the proposed organisation, it is possible to list the plant required for the Road Maintenance Unit in Annex E. The Unit will be divided into 5 sections based at two locations. The Regravelling Section with one Grading Section and one Works Section should be based in Baidoa, whilst one Grading Section and one Works Section should be based at Diroos. If found necessary in the future, and if funds become available, a third grading section and Works section could be based at Biuir Harbour.

4.3.3 Plant Maintenance, Repair and Logistics

4.3.3.1 Maintenance

In the long term it is essential that the system now being implemented is continued and supported.

4.3.3.2 Repair

It is essential that a central repair workshop is set up. A proposed design has been made by European Consultants for the Project Manager and this design has been examined. The existing drawings show the workshop should be built in the Project Management Compound on the outskirts of Baidoa. However, it is understood from the Project Manager that it is intended to move the workshop elsewhere in Baidoa. This move should not affect the comments made below:-

- (a) It is assumed that this workshop will be used not only by the plant fleet but by all the vehicles in the Development Project. Thus, there will be 70+ items of equipment from the plant fleet plus at least 30 Chevrolet pick ups plus some other tractors and trucks. The present workshop design is too small in the stores area and in the servicing area for the plant fleet and much too small for the total fleet.
- (b) It is assumed that repairs will be limited to major assembly changes as the upper limit. Major rebuilds of engines, gearboxes etc. will not be undertaken. It is felt that this assumption must be made as setting up specialist equipment for reboring cylinders etc. cannot be economically justified for the relatively small fleet being used.
- (c) On the basis of the first two assumptions the following detailed comments are made:-
 - (i) The central store is much too small. It probably needs to be at least quadrupled in size for normal spare parts and a second store of about the same size is needed for tyres.
 - (ii) There is a requirement for 3 or 4 offices. These are one for the workshop and stores supervisors, one for stores records,

one for plant and vehicle servicing schedules and spare parts documents, and a general office for costing and accounting.

- (iii) There should be at least 3 and preferably 4 servicing bays and at least 2 pits one of which should be suitable for landrover and pickups.
- (iv) The carpenters shop must be separated from the battery maintenance shop. The latter must be properly equipped to remove hydrogen and acid fumes.
- (v) The Injection testing and Hydraulic testing rooms should be sealed and airconditioned.

It is strongly recommended that the workshop designed layout is re-examined before tenders are requested, or at least variation orders produced before work actually starts.

4.3.3.3

Logistics

Provided the short term proposals for fuel and spares supply are carried out, then there should be no further long term alterations in these fields.

Major deficiencies, at present, are support of training and support of the Construction Units with soils information and advice. In the long term these must be improved and the proposed building programme will provide both a soils laboratory and a classroom. However, the shape of the classroom is bad for teaching, being long and narrow, and there seems to be insufficient facilities in the soils laboratory. It is recommended that the use of the facilities be further examined by the appropriate specialists.

5.0 SUITABILITY OF PROJECT CONSTRUCTION VEHICLES

- 5.1 The existing holdings of project vehicles for the Access Road element are listed in Annex F. Whilst the plant originally provided is generally suitable for new construction work, there are a number of deficiencies and anomalies discussed below. The major deficiency is the lack of small vehicles for maintenance.

5.1.1 Bulldozers

All the bulldozers have been equipped with rippers, and the sizes chosen are suitable for the work required.

5.1.2 Wheeled Front End Loaders

The 3M³ size machines have plenty of power, and the height reach of the bucket seems suitable for use with the large Mercedes tippers. When a Road Maintenance Unit is set up with smaller tippers (see Section 8 and Annex E) it may be desirable to purchase some smaller FEL to match these tippers.

5.1.3 Graders

For new construction work, as part of a Plant Team the graders purchased are satisfactory. However, for use in repair and regravelling the graders would need other plant with them, which would be uneconomic. It is recommended that 2 or 3 graders are fitted with scarifier attachments and light dozer blades. Each grader can then work on its own, scarifying the existing road, reshaping it, knocking down heaps of gravel dumped by tippers, spreading and reshaping the gravel.

5.1.4 Rollers

There is no doubt that vibrating rollers are the best type for the soils of this area, particularly when much work has to be undertaken with materials at less than optimum moisture content. In the dry weather there is no requirement for the sheep-foot rollers, though they can be used provided the final rolling is carried out with the double drum smooth wheel rollers. The sheepfoot rollers may be useful in the wet weather periods on some soils, but until soil tests and practical rolling trials are carried out in the wet weather their effectiveness is uncertain. The present two rollers should be retained until trials can be made, but it is recommended that further sheepfoot rollers should not be bought. When a plant workshop is set up, it may be economical to buy new smooth rolls and install these instead of the sheepfoot.

5.1.5 Tippers

The large 25 tonne Mercedes Tippers are ideal for new construction work, and large scale regravelling projects. However, they are much too big for minor repair work and patching. When a Road Maintenance unit is set up some smaller tippers will be essential.

5.1.6 Stone Crusher

The Parker 50m³/hr stone crusher is ideal for producing stone for grouted or pre mixed macadam. For low cost access development roads it is unnecessary, and it is suggested that this should be disposed of to some other organisation. It would be desirable to exchange it, if some form of swopping can be arranged, for more useful plant such as small front end loaders and tippers.

5.1.7 Compressors

These are large compressors about 9m³/min., ordered with rock breakers, but delivered with rock drills. They were intended to be used in conjunction with the crusher. They are not required for that purpose, and without breakers are not much use on the sites. Their principal use now is for plant cleaning in the absence of water, and they are good if uneconomic for this. If they can be swopped for two smaller compressors this would be more economic, but if this is not possible they should be retained.

5.1.8 Generators

These are useful for camp lighting and should be retained.

5.1.9 Mobile Workshop Trailers

These are essential and very worthwhile.

5.1.10 Logistics Vehicles

The fuel, water and low loader trailers for the Mercedes Benz tractors, together with the Land Rover pick up, are all essential and suitable.

5.1.11 Maintenance Equipment

The problem of lack of scarifiers and push blades for the graders is discussed in para 5.1.3 above. There is also the problem of supply of gravel, cement, sand and water, together with the movement of labour and hand tools for repairs of culverts

5.3

and patching of the roads. The Mercedes Benz tippers and water trailers are far too big for this work. To be effective some general purpose tippers of about 5-7 tonnes are required with 3-5000 litre water trailers. The requirement is covered in detail in Section 4.3.2.

6.0 PROPOSED DRAFT SECTIONS FOR THE MID TERM REVIEW TEAM REPORT

6.1 A first draft of the Access Road element of the Mid Term Review Team's Report was seen in Somalia. Based on that draft, the information given in this Construction Specialists Visit Report has been summarised below as extensions to that draft.

6.2 9.2 iii a. Additional sentences at end of para.
The quality of construction is poor principally because of very poor supervision of the works by the Fintecs Civil Engineering Staff. The main faults are:-

1. There is no control over line and level, and all work is put in by eye. Consequently the correct crosssections are not maintained and 20-30% excess material is being used, with consequent slowing of the work.
2. There has been very little water used for compaction, and no control over the material used as gravel.
3. Because of lack of direction, incorrect machines have been used for some operations, leading to a reduction in output.
4. Because of the poor construction highlighted in para 1&2 above, the road is already rutted longitudinally, corrugated laterally and potholed. Even though it has only been built a few months the road is already being by passed by traffic running alongside the road in the cleared right of way.

6.3 9.2 iii c. Delete from "Construction has currently reached KM 54" to the end of para, and substitute:-

"The quality of construction does not accord with an "all weather track". For the first 30 Kms there is a maximum of 250mm of gravel laid in a slot in the black cotton soil varying to a minimum of zero in some areas of

gravel. Most of this section is below ground level, will become a watercourse in the rain, and will not survive the first rainy season. From Km 30 to about Km 50 the gravel has been dumped on the ground as much as 700mms thick. But due to the lack of water it has proved impossible to compact this thickness and this section of the track is already starting to break up. Because of its poor shape and bad compaction and the poor quality of imported gravel it will not stand traffic in the rainy season.

- 6.4 Fig 9.3 Delete cycle time (mins) Insert travel time (mins).
- 6.5 Para 9.3 (f) Delete and renumber 9.3 g. New Para 9.3 (f).
- 9.3(f) Air Compressors. It was intended to use these, with rock breakers to split large boulders for the crusher. Quite apart from the fact that the crusher is not required, the compressors came with drills. Since water is short the Mechanical department is using these compressors to clean off machines for maintenance. Unless some smaller machines are readily available it is recommended that these compressors are retained. The drills should be sold.
- 9.3(g) Logistic Support. The continued operation of the plant demands logistic support in the three main areas of fuel oil and lubricants, repair and maintenance and supply of spare parts.
- (i) The supply chain for Fuel, oil and lubricants is well established and the procedures known. There have been nationwide shortages of fuel, but the supply has normally been satisfactory. It should be remembered, however, that oil is generally recycled. This means that oil and filter changes will need to be more frequent than usual.
- (ii) The Fintecs Mechanical Engineer is fully aware of the need for a fully documented system for regular maintenance and the need for rapid field repairs. A working system is in operation for maintenance and keeping of records has started. Since fuel is not under his control the maintenance

and fuel records are not yet integrated. To gain the maximum information to ensure economic use of the plant the present maintenance system should be supported in every way. Repair is limited by both lack of proper facilities and lack of spare parts. But wherever possible field repairs have been expeditiously made and plant kept on the road.

- (iii) The provision of spare parts and handling them when they arrive are two separate problems. The spares handling is now satisfactory with the parts in a reasonable store and a bin card system started. The system needs expanding and developing in the future, but a good start has been made. There is no well established system for the supply of spare parts. Problems have been etc. (Insert here Mr Ward's paragraph on spare parts and consumable stores). It is essential that a proper procurement system is set up for all materials required by the project and this system is clearly explained to the users.

6.6 9.3 (iii) Road Construction. Although the road construction has been in progress for some 9-10 months, progress has been very slow and the quality of construction has been poor. In particular the following shortcomings have been noted.

- a) Lack of effective supervision, site control and training of Somali staff by Fintecs Civil Engineer. This has led to lack of camber, poor compaction, excessive volume of materials being used for construction. The first two faults lead to increased maintenance and the third slows down construction.
- b) Low outputs by plant caused partly by operator inexperience, but mostly by lack of guidance from Fintecs Civ. Eng. staff causing wrong machines to be used for specific tasks or too many machines being used in a limited area simply because they are available. Both factors reduce total output per machine.
- c) Because water is short, in practice little effort has been made to use what is available, thus contributing to the poor compaction problem.

- d) No quality control by Fintecs Civil Eng. staff in selecting fill material, which has contributed to the poor compaction, irregular levels and will cause greatly increased maintenance.
- e) No drainage ditches have been put in alongside the roads and causeways have not been paved. Unless this work is done before the rain starts, there will be major reconstruction needed after the rains.
- f) No planning of the alignment. This has caused extra costs for payment for standing crops, and unless the alignment is pegged out well ahead of construction there will continue to be similar payments.
- g) No records of materials used, machine hours, alignment, or labour used have been kept. Without these records no useful future planning can be achieved.

In mitigation it must be stated that most of these shortcomings could be rectified if the existing supervisory and technical inputs can be significantly increased. This is discussed in the next section.

- 6.7 Para 9.3 (iv) Delete sentence "In the field of Plant maintenance" insert:-

In the field of plant maintenance there has been considerable progress. The Mechanical Engineer has set up a maintenance system, his plant superintendent works with the fitters, and young English speaking fitters are teamed with more experienced non English speakers to obtain maximum value from the English repair manuals. Clearly much remains to be done but since early '83 progress in training has been made and a degree of line management is being assumed by the Mechanical Engineers. In the case of road construction (i.e. civil engineering activity) the prospect appears less encouraging. There appears to be etc.

- Para 9.4 (ii) Add new paragraphs at the end.

The Road Construction Unit staffing has been based on the assumption that the Improved methods of operation costed in figures ?? will be used, that adequate supervision will be available, and that adequate spare parts do become available.

The reserve pool of plant and vehicles is created mainly to ensure that plant is readily available to replace unserviceable machines quickly. This plant must be kept under central control, but provided that there is adequate site supervision it could be stored with the RCU and RMU plant. It is essential that this reserve is not used on site simply because it is there, but is kept to replace U/S plant in genuine emergencies. The reserve pool should be cycled through the Units to equalise wear on all the machines.

Outline Organisation of Access Roads Component
Bay Region Agricultural Development Project

Project Manager (Mohamed Wassame Duale)

Civil Engineer's Dept.
(Responsible for Plant
Operation)

Mechanical Engineers Dept.
(Responsible for Plant
Maintenance and Repair)

Admin. Dept.
(Fuel, oil, lubricants,
staff pay, etc.
(handled by Project
Managers Office direct))

Civ. Engr. Achmed Rammou - Fintecs under contract
Dir Access Roads Abdul Khadir - Somali Government
Civ Engr. Fahir - Somali Government

- Achmed Zohdi Mechanical Engr.

Foreman
No. 1 RCU
Local Plant Ops

Somali
Government

Foreman
No. 2 RCU
Local Plant
Ops

Plant Supt. (Fintecs
No. 1 RCU under
contract)

Plant Supt.
No. 2 RCU

Local Fitters

Local Fitters

Current Distribution of Plant and Future Short Term
Redistribution Proposals

	Now	Short Term Future
<u>Road Construction Unit 1</u>		
Hanomag D700	1	1
Hanomag D600	1	1
Caterpillar D6	1	- (e)
Hanomag T66C	2	1
Galion T600C	2 (a)	2
Pettibone C44 S/W	3	2
Pettibone C44 S/F	1	-
Mercedes Benz Tractors	6 (b)	7
Tipper Bodies	3	4
Watertank Bodies	3	3
Fuel Tank Bodies	2	2
Mobil Workshops	1	1
Mobile Generators	1	1
Air Compressor	1	1
<u>Road Construction Unit 2</u>		
Hanomag D700	1	1
Hanomag D600	2	1
Hanomag T66C	2	1
Galion T600C	2	2
Pettibone C44 S/W	1	2
Pettibone C44 S/F	1	-
Mercedes Benz Tractors	5 (b)	4
Tipper Bodies	4	2
Water Tank Bodies	2	2
Fuel Tank Bodies	2	2
Mobile Workshops	1	1
Mobile Generators	1	1
Air Compressor	1	1

	Now	Short Term Future
<u>Reserve /Pool</u>		
Hanomag D600	-	1
Hanomag T66C	-	2
Mercedes Benz Tractors	1 (b)	1 (b)
Tipper Body	1 (b)	2 (b)
Fuel Tank Body	1 (b)	1 (b)
Low Loader Trailer	1	1
Pettibone C44 S/W	1 (c)	1 (c)
C44 S/F	-	2
Stone Crusher	1 (d)	-
Mobile Generators	2	2
Land Rover Pick-up	9	9
Station Wagon	3	3

- Notes (a) 1 grader unserviceable
 (b) Distribution tractors, fuel and water tanks arbitrary, and vary depending on fuel supply position. 1 Tipper body U/S
 (c) Loaned to another project and unserviceable there
 (d) Not required - for disposal
 (e) Cat D6 to be returned to Agricultural element of project

CONSTRUCTION OF 1KM ROAD IN 1 WEEK

1. These calculations are based on the construction of 1 km of Class II Road on poor subsoil, using the cross sections supplied by the Roads Engineer of the Mid Term Review Team.

For this cross section the insitu embankment is $4,350\text{m}^3$ bank measure, and the gravel surfacing is $2,535\text{m}^3$ bank measure = $3,295\text{m}^3$ loose measure.

2. Clearing Right of Way

Small scrub up to 5cms dia, with odd slightly bigger trees. Use D600 Bulldozer. Area to be cleared = $20 \times 1000 = 20$ Hectares With 3m cut width @ 3 Kph time to clear = $\frac{3 \times 3}{10}$ hectares/hr.

Assume 75% efficiency = .675 hectares/hr.
Total time to clear = $20/0.675 = 30$ hours

3. Forming to Embankment

Use the grader alone in black cotton soil. Use the Right of Way dozer to assist with two ripping passes in lateritic soils. The operation is to cut a V ditch each side of sufficient volume to produce the embankment. Full details of the technique (from HMSO publication Military Engineering Vol XVI Engineer Construction Plant) are attached at Appendix 1. In this case the road is 8m wide and requires $4,350\text{m}^3$ per Km of road. Ditching work is normally carried out in 2nd gear at approximately 3Km/hr. Reversing in 4th or 5th gear at 20 Km/hr. On this basis one pass of 1 Km length takes:-

Cut	20 mins.	
Reverse	3 mins.	Operator eff = 0.6
Change gear	0.5 mins.	45 minute hour = 0.75
Select new cut	1.0 mins.	Actual cycle time = 54 mins
	<u> </u>	say 1 hour

24.5 mins. cycle time

Ditch will be about 4 m wide and 1 m deep, and this will require 4 passes per side, with a further 4 passes per side to move the windrow, and 4 final grading passes after rolling. Total is then 20 passes with a 1 hour cycle time gives total production time of 20 hours.

Note that this represents 217m^3 bank measure output per hour, much better than dozing.

D.2

4. Excavation of Gravel

Rip 2,535 m³

Use Hanomag D 700 at 1 Kph (incl. slip and stall), 3 teeth with 1m between, depth of rip 0.7m, turning time 15 secs.

On 40m run, since 1 Kph = 1000/60 = 16.7m/min,

Cycle time = $\frac{40}{16.6} + 0.25 = 2.4 + 0.25 = 2.65$ minutes

On a 45 min. work hour = 15 passes per hour

Volume ripped per hour = (40 x 2 x 0.7) x 15 = 840m³/hour

Time to rip gravel = 3.01 say 3 hours

Doze into heaps - Assume 50m push, output = 250m³/hr. 2,535m³ bank measure = 1.3 x 2,220 = 3,295m³ loose measure. op eff = 0.6

Handle ripped rock = 0.8

45 min. Work tour = 0.75

Actual output = 250 x 0.75 x 0.8 x 0.6 = 90m³/hr.

Dozing time = 3,295/90 = 37 hours

Total bulldozer time for production = 40 hours

5. Load and Transport Gravel

Use Hanomag D 66C with 3m³ standard bucket

Average cycle time	0.55 min
Large lump add	0.04 min
From dozer pile add	0.01
For inconsistent opes add	<u>0.04</u>
	0.64

On 43 min. hour this gives 70 cycles per hour

D.3

Bucket fill factor	=	85%
Production per cycle	=	2.55m ³
Production per hour	=	70 x 2.55 = 178.5m ³
Time to load	=	19 hours

Also use 6 bucket loads per truck, load time = 6 x 0.64 = 3.84 mins

6. Move 3,295m³ gravel.

Assume cycle time = travel time + 10 minutes

Travel speed takes 25 Kms per hour i.e. in 40 hours each week each tipper travels 1000 Kms.

At the present time the round trip from the quarry from No. 1 RCU is about 20 Kms and it is considered this should be the average round trip length for calculation purposes. On this basis 1 truck moves 15 m³/hr or 600m³ per 40 hr week. To move 3,295m³ in one week needs 5.49 say 5 tippers since they all seem to speed at 30-40 Kph. One grader should maintain the haul roads.

7. Water gravel and fill.

Total volume bank and gravel = 4,350 + 2,535 = 6,885m³
Assume 6% water added requires 413,000 litres per week or nearly 3 x 25000 l tanker loads per day. Assume each trip is 50 Kms round trip, total mileage is 800 Kms/week.

8. Spread and grade the gravel

Assume 4 passes to cover the road width and 3 passes to each area = 12 passes. At cycle time of 1 hour (see para 3 above) time = 12 hours.

9. Compaction

- a) Embankment 4 passes to cover width, and 5 passes to each area = 20 passes at 2 Kph = 10 hours rolling
- b) Gravel 3 passes to cover width and 5 passes to each area = 15 passes @ 2 Kph = 8 hours rolling.

D.4

It is considered that 1 Km Class II road can be built in 1 week as under.

M/C	No.	Activity	0	10	20	30	40	
Dozer	1	Clear Rof W	-----					
Grader	1	Form bank	-----					
Dozer	1	Exc. gravel	-----					
FEL	1	Load gravel	-----					
Tippers	5	Move gravel	-----					
Water truck	1	Water bank/gravel	-----					
Grader	1	Spread gravel	-----					
S/W Roller	1	Compact bank/gravel	-----					
Grader	1	Maintin haul Road.	-----					

In theory even with poor operators, reasonable supervision and reasonably correct usage of plant will enable one Km of road per week to be built with:-

- 2 Bulldozers
- 2 Graders - one exclusively on haul road maintenance
- 1 Front End Loader
- 5 Tippers
- 1 Water Truck
- 1 Smooth Wheel Vibrating Roller

In view of the time lost if plant breaks down it is considered that the above figures should be increased to:-

- 3 Bulldozers
- 2 Graders
- 2 Front End Loaders
- 5 Tippers and 5 Tractor Units
- 2 Water Trucks and 1 Tractor Unit
- 2 Smooth Wheel Vibrating Rollers

In addition for logistics:-

- 1 Water Truck, 1 mobile Workshop, 2 Landrovers
- 1 Tractor + 2 Fuel Tankers, 1 Generator

Ditching and earth road construction using graders

38. There are five stages in cutting Vee ditches and using the excavated spoil to construct an earth road to its required formation level.

These stages are:

- (a) The marking cut
- (b) The ditching cuts
- (c) Moving the windrow
- (d) Levelling the windrow
- (e) The bank sloping cut

They are illustrated in Figure 61.

39. Stage 1. The marking cut (see Figure 61(a)). In order to facilitate grader control and to cut a straight ditch, a marking cut is first made. To do this the blade is tilted at a slope of 1 in 2 and, with the toe in line with the outside front wheel, a light cut 4 inches to 6 inches in depth is made along the outer edge of the ditch of the proposed road.

40. Stage 2. The ditching cuts (see Figure 61(b)). These are the first heavy cuts. The blade is maintained at a slope of 1 in 2, but the toe is set to cut so as to maintain a slope of 1 in 1 on the outside ditch bank. The heel of the blade is set to cast a windrow just inside the rear inside wheels of the grader. With the outside front wheel of the grader travelling in the marking cut, the heaviest cut is then made that soil conditions allow.

41. Stage 3. Moving the windrow (see Figure 61(c)). As soon as the windrow thrown up by Stage 2 gets too high to pass under the grader axles, it must be moved across the road. In the initial stages the shoulders are formed during this operation.

The heel of the blade is set a little higher than the toe (consistent with the required camber) and at an angle of 45 degrees to the axis of the grader. The grader travels with the outside front wheel just outside the windrow. In this way, the shoulders of the road are formed and the excess spoil is cast to form a windrow outside the rear wheels of the grader.

Stages 2 and 3 are repeated until this last windrow is just high enough to pass under the axles of the grader. It is then levelled to form the crown of the road.

42. Stage 4. Spreading the windrow (see Figure 61(d)). The blade is set until the heel is just higher than the toe, as in Stage 3, but nearly at right angles to the axis. The windrow is then spread, without throwing any spoil off the heel of the blade.

Stages 2, 3, 4 are repeated until the ditches have been cut to the required depth, and the spoil spread to the required camber.

The outside bank of the ditch must now be smoothed off.

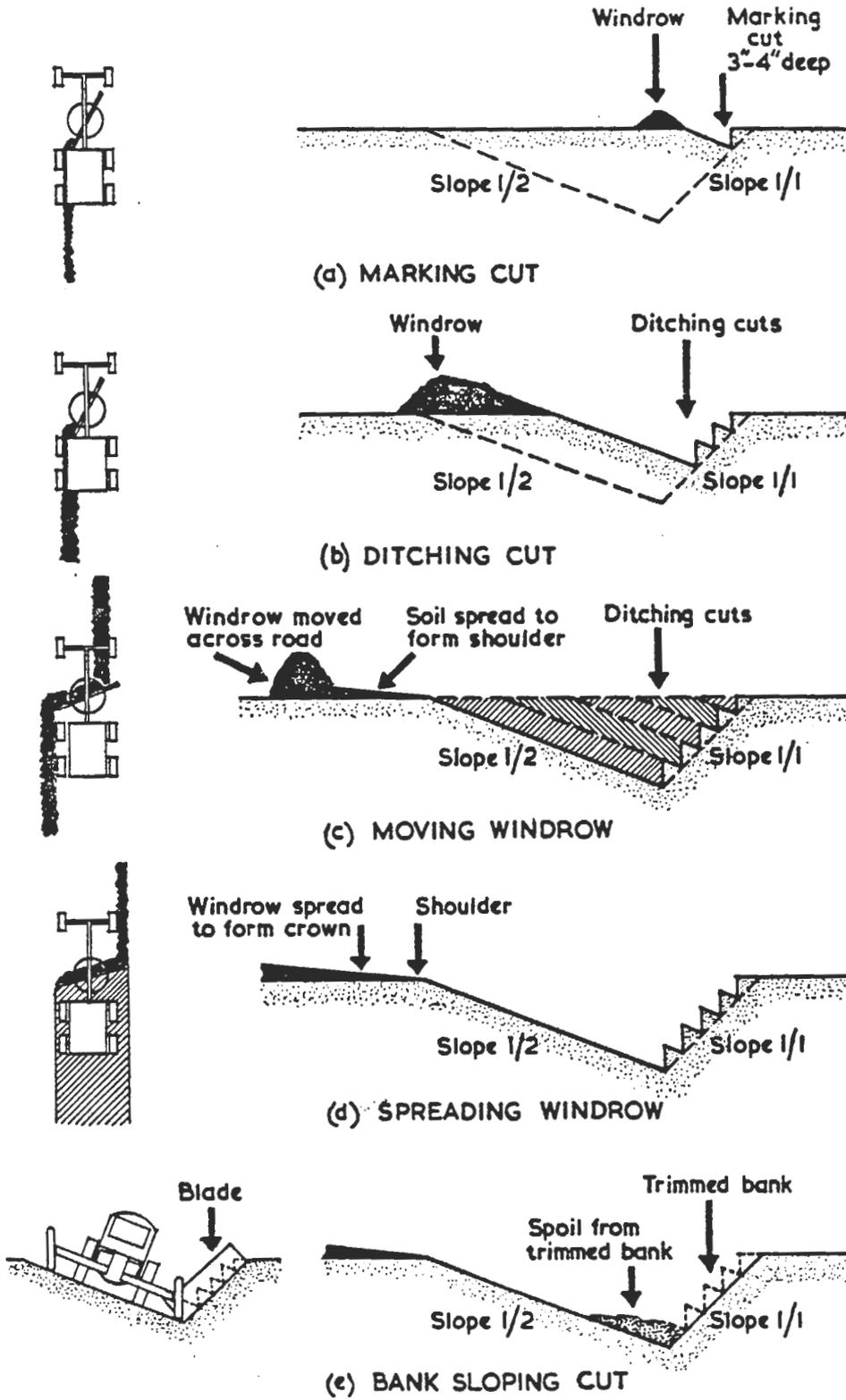


FIGURE 61. Sequence of operations in cutting a Vee ditch

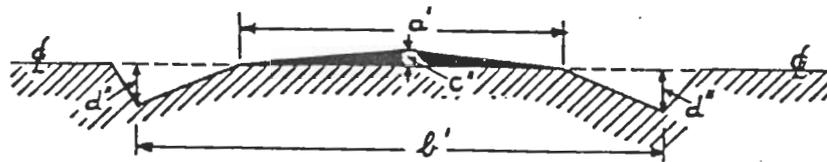
43. Stage 5. The bank sloping cut (see Figure 61(e)). The blade is swung into its verticle plane and set at an angle to trim the outside bank to a slope of 1 in 1.

The front outside wheel of the grader travels in the bottom of the ditch.

The spoil cast into the bottom of the ditch is then removed and spread by repeating Stages 2,3 and 4.

44. This method and sequence of work can be applied to the construction of various widths of earth roads, the number of passes being modified or expanded according to the required road width. In Table 28 are examples of quantities of earth to be moved and time required for various profiles of road.

TABLE 28: Earth quantities and time required for ditching and spreading to form various profiles of earth roads



Road dimensions				Quantity of earth to be moved per mile of finished road (cu yds)	Average lateral displacement of earth (ft)	Length which can be completed per hour using one motor grader (miles)
a (ft)	b (ft)	c (ins)	d (ins)			
(a)	(b)	(c)	(d)	(e)	(f)	(g)
10	18	6	9	600	6	4/10
12	20	8	12	830	6½	3/10
18	27½	8	30	2,200	8½	2/10

45. Flat bottomed ditches. To obtain greater drainage capacity it is often desirable to widen the bottom of a Vee ditch converting it into a flat bottomed ditch (see Figure 62). To do this, with the wheels on one side of the grader in the bottom of the Vee ditch, set the blade so that the leading edge is the prosed width of the bottom of the ditch from the bottom of the existing Vee. Take a series of ditching cuts until the base of the new cut is a few inches above the previous ditch invert level.

The "bottoming cut" is then made by angling and tilting the blade so that the toe is at the base of the bank slope, the heel at the base of the interior slope, and the tilt to the required slope of the bottom of the ditch. The spoil which this bottoming cut casts on to the interior slope is finally removed by a further ditching cut.

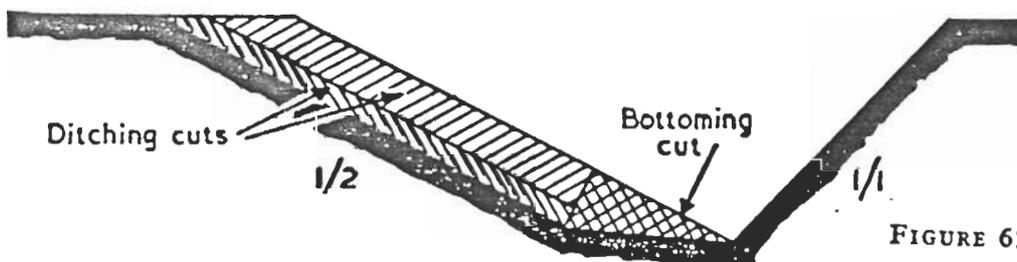


FIGURE 62. Widening a Vee ditch

Throughout the above process windrows formed on the shoulder are spread over the road surface as in paragraph 41 and 42 above.

46. Clearing existing ditches. Most ditches contain water or are soft and muddy. They should always be excavated against the fall so that water can flow to the outlet. The ditch can be converted to Vee or flat-bottomed Vee by making the bank sloping cut first, followed by a bottoming cut. The spoil is cleared and the interior slope trimmed with a ditching cut. A6 x 4 motor grader has great difficulty in working under these conditions as the wheels in the ditch cannot grip on the wet soil and traction is often lost.

Section 44

POINTS TO BE WATCHED WHEN SUPERVISING WORK OF GRADERS

47. General. Has the work been properly planned so that it will be completed and the fill which has been cut placed in its final position, with the fewest number of operations?

In the case of towed graders and those motor graders which can tilt their wheels, are these wheels being correctly tilted in view of the shape of the ground and the type of cut being taken?

48. Levelling. Is the blade set at an acute enough angle to obtain proper slicing action and at a proper pitch to obtain cutting action?

Is the blader set so that the windrow either inside or outside the rear wheels of the grader? A windrow falling under the wheel causes the blade to rise and fall during travel producing a wavy surface. Wheels of a motor grader cannot get proper traction when travelling on a windrow.

49. Ditching. Is the marking cut made approximately 4 inches to 6 inches deep? Is the toe of the blade directly behind the front wheel?

Is the blade set so that the windrow falls inside the rear wheels, and is the windrow removed before it reaches the underside of the grader?

Is the bank slope step-cut?

Is the heel of the blade lowered to maintain the inside slope of the ditch?

50. Reshaping. Is maintenance performed in the least possible number of passes? Has it been planned so that the flow of traffic is not stopped?

Is the surface cut to the bottom of all holes, ruts, and undulations?

Is the material kept on the road and not spilled into the ditch?

Is the speed fast enough to maintain efficient operation, yet not so fast as to cause unevenness of surface?

51. Bank sloping. Is the toe of the blade at the bottom of the ditch?

Is the blade set to give maximum slicing action?

Is the grader working at highest possible speed consistent with its power and the operator's skill?

52. Scarifying. Are the teeth penetrating too deep, so that the subgrade is torn up and mixed with the road surface?

USE OF BULLDOZERS INSTEAD OF GRADERS1. Construction of Embankment

Assume D 600 is used.

Bank Volume = $4,350\text{m}^3$ bank measure = $1.3 \times 4,350 = 5,655\text{m}^3$ loose

With 20 m wide trace, average push 10m. Allowing for some longitudinal movement say average push is 20m.

Output = $300\text{m}^3/\text{hr}$.

Operator efficiency = 0.6
Material "dead" = 0.8
45 min. hour = 0.75

Actual output = $0.6 \times 0.8 \times 0.75 \times 300 = 108\text{m}^3/\text{hours}$

Hence time to build embankment = $5,655/108 = 52$ hours

Hence one machine cannot build the embankment in 1 week, and a further 12 hours output is needed. Since the bulldozer clearing the Right of Way is only operating 30 hours per week, this could assist.

Hence the grader for embankment construction (20 hours) can only be replaced by $1 \frac{1}{4}$ bulldozer for 40 hours for embankment construction.

2. Spreading gravel

If a bulldozer is used to spread gravel, instead of a grader, then quantity to be spread is $3,295\text{m}^3$ loose measure.

Using the same output figure as para 1 above.

Bulldozer hours = $3,295/108 = 30$ hours

Thus we replace a grader for 12 hours with a bulldozer for 30 hours.

3. The overall effect of losing 1 grader is to require 2 bulldozers to do the same work.

LONG TERM REORGANISATION OF PLANT FLEET1. Recommended Road Construction Unit

MB Tractor Unit	7	D 700 Bulldozer	1
MB Tipper	5	D 600 Bulldozer	2
MB Water Tanker	3	T 600 Grader	2
MB Fuel Tanker	2	T66C Front end loader	2
Mobile Workshop	1	C 44 Roller vib	2
Landrover PU	2	Generator	1
Compressor	1		

2. Pool Equipment

D 600 Bulldozer	1		
T 600 C Grader	2 - 1 u/s		
T 66 C F/E Loader	1		
C 44 Roller, S/F	2		
C 44 Roller S/W	1		

3. Logistic Support

MB tractors	2
Low Loader	1
25,000L water tank	1
25,000L Fuel Tank	2
Generator	2
Landrovers	8
*5000 L Water trl	1

4. Recommended Road Maintenance Unit

(a) Land Rover PU 2

(For 2 supervisors at Baidoa & Dinsoor)

(b) Regravelling Unit 1

(At Baidoa)

MB Tractor Unit	3
MB Tipper	3
MB Water Tanker Body	1
MB Fuel Tanker Body	1
Mobile Workshop	1
* 7 T Truck	1
Compressor	1

D 600 Bulldozer	1
*T600 grader & Scarifier	2
T66C F/E Loader	1
C 44 Roller Vib	2
Generator	1
*Water trailer 5000 litre	1

(c) Grading Units - 2

(At Baidoa & Dinsoor)

* 7T Truck 1

* T 600C Grader 1

(d) Works Unit 2

(At Baidoa & Dinsoor)

* 7T Truck 1

* 5000 L Water Trailer 1

* New Buys or exchange

Equipment to be purchased for Road Maintenance Units

7 T GP Tipper	5		
Grader with Scarifier and push blade, 190 HP	2	-	Exchange for crusher?
5000 litre water trailer with spraybar	4		
MB Tipper body replacement	1		
Graders	2	-	Already earmarked funds?

Bay Region Agricultural Development Project
Equipment Construction Plant

Hanomag D 700 - Bulldozer with Blade and 3 tine rippers (200 HP)	2
Hanomag D 600 - Bulldozers with Blade and 3 tine rippers(144 HP)	3
Hanomag T66C - Front end loaders with 3m ³ bucket (210HP)	4
Gallion T600C - Grader with blade (190 HP)	4
Pettibone C44 - 2 Drum vibrating roller	5
Pettibone C44 - 2 Drum vibrating (1 drum sheepsfoot) roller	2

Vehicles

Mercedes Benz Tractors	12
25 Tonne Tipper Trailers	8
Water Tank trailers with pressure spray bar	5
Fuel Tank trailer	5
Low Loader	1
Land Rover - P.U. SWB	9
- Station Wagon SWB	3

Ancilliary Equipment

Mobile workshop trailer	2
Air compressors	2
Mobile generators	4
Stone crusher C/W generator and 4 mobile conveyors (Parker Kibbutzer)	1

DIARY

- 14th September 1983 - Depart Heathrow
- 15th September 1983 - Arrive Mogadishu. Discussions with Road Engineer, Mr. M. Ward
- 16th September 1983 - a.m. Continue discussions. Depart Mogadishu - Arrive Baidoa p.m.
- 17th September 1983 - a.m. Visit worksite No. 1 RCU at Km 13 on Goof Guduud - Qansaxdheere.
- Public Holiday - Visit quarry site at Dusta - visit Crusher site at Goof Guduud. p.m. report writing
- 18th September 1983 - a.m. Visit Camp of No. 2 RCU at Km 32 on Qansaxdheere - Buur Dhobo road.
- Public Holiday - p.m. Report writing
- 19th September 1983 - a.m. Visit Project Manager and Mechanical Engineer for discussions. p.m. Report writing.
- 20th September 1983 - a.m. Visit worksite No. 2 RCU at Km 50 on Qansaxdheere Buur Dhobo road p.m. Continue visit - report writing late p.m.
- 21st September 1983 - a.m. and half p.m. - visit working of No. 1 RCU at KM 13 Goof Guduud - Qansaxdheere
- 22nd September 1983 - a.m. Final discussions with Team leader. Depart for Mogadishu. p.m. - Discussions with economic adviser to Team.
- 23rd September 1983 - Friday Holiday
- 24th September 1983 - a.m. Discussion with Financial Director. p.m. Complete the draft report
- 25th September 1983 - Depart Mogadishu
- 26th September 1983 - Arrive Heathrow

2. Personalities Visiteda) Bay Region Agricultural Development Project Staff

Project Manager	Mr. Mohamed Wassame Duale
Mechanical Engineer	Mr. Ahmed Zohdi (Fintecs Staff on contract)
Financial Director	Mr. D. Sigsworth
Civil Engineer	Mr. Fahir
Road Construction Units	Somali Foremen through unofficial interpreter

b) Hunting Technical Services Mid Term Review Team

Team Leader	Mr. M. Adams
Roads	Mr. M. Ward
Livestock	Mr. V. Clarke
Agronomy	Mr. R. Goodyear
Economy	Mr. N. Story
Hydrology	Mr. V. Bakiewicz

c) Others

Fintecs Manager in Somalia	Miss D. Russell
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3. Other personalities mentioned, but not able to be interviewed

Director Access Roads	Mr. Abdul Khadir
Civil Engineer	Mr. Ahmed Ramou (Fintecs staff on contract)