

Prepared for ILO ASIST

by

Simon Tembo & Frans Blokhuis



International Labour Office (ILO)

Advisory Support, Information Services and Training (ASIST)

MANUAL FOR SUPERVISION OF LABOUR BASED ROAD REHABILITATION WORKS

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Foreword

This manual was developed based on the experiences of the GRZ, UNCDF and UNDP supported Feeder Roads Project (FRP) in Eastern Province, Zambia, during the period 1996 to 2001, and the GTZ, UNCDF and UNDP supported District & Feeder Roads Project (DFRP) as part of the Support to Decentralization Programme in Mwanza Region, Tanzania, during the period 1999 to 2003.

The labour-based Feeder Roads Project in Zambia was designed and delivered with technical support of the International Labour Organization and the Roads Training School in Lusaka. The delivery modality included training of District Council Works Departments, private contractors and consultants in labour based works implementation and supervision.

The experience of both FRP's has demonstrated the viability and long term benefits of labour-based methods. With the increased capacity in both public and private sector labour-based methods continue to be a preferred option for implementation of road works by District Councils in Eastern Province in Zambia and Mwanza Region in Tanzania. In implementing contracts using labour-based methods, the private sector leaves behind residual road work skills in the communities through on the job training of the labour it employs. These skills can be tapped in future road works. The labour-based road works also leave behind income in form of

wages, bolstering the local economies whilst contributing directly to poverty reduction.

All the above highlight the intrinsic value of labour-based road works. In the same vein, they highlight the value of this manual as both a practitioner's guide and a training instrument for labour-based road supervisors, whether employed by District Council or the private sector.

This is the first version of the Manual for Labour Based Road Rehabilitation Works, and as developments and improvements continue, it may be updated from time to time.

All correspondence concerning the contents of this manual should be directed to ILO ASIST, Harare, Zimbabwe.

Purpose of this manual and how to use it.

The purpose of this manual is to provide supervisors of labour-based road construction works with an easy step by step guide, which at the end, will ensure that the road works are carried out to the specified standards, not only in respect of quality of works, but also in respect of construction methodology used.

The manual is based on experiences from the FRP's in Zambia and Tanzania and is specifically developed for use in Zambia and Tanzania. Target groups, which this manual aims to reach, are road works supervisors employed by the District Councils and road works supervisors employed by private contractors or consultants.

The aim of this manual is NOT to provide another guide on labour-based road construction techniques, but it aims at highlighting important aspects of Labour Based Technology, which should be remembered by the technician or engineer, who is responsible for or engaged in the supervision of the construction of a road built by labour-based technology.

The Manual is designed in a manner that makes it easy to use for training and as a reference book. It is comprehensively illustrated with drawings and pictures to allow easy visualization with brief text to explain an activity.

The technical sections in part II of the manual follow the same sequence as the items in the standard Bill of Quantities for Labour-based road rehabilitation, which was introduced and used on both FRP's in Zambia and Tanzania. The manual makes frequent references to the technical specifications of the standard labour-based rehabilitation contracts, which were also introduced and used on both FRP's in Zambia and Tanzania, and to relevant sections of the Labour-based Technical Manual introduced in Zambia by the Roads Training School in Lusaka.

However, many aspects of supervision are not country specific and it is hoped that supervisors of labour-based contracts in other countries will find this manual useful as well.

Acknowledgements

This Supervision Manual is based on the experiences from the labour based Feeder Roads Projects in Zambia and Tanzania. For the development of this manual, credit must be paid to all people who were involved in the implementation of these projects, such as the Labour Based Contractors, Local Consultants, Local Authorities and Project Staff, all of whom have greatly contributed to the success of the two projects, and who have shown keen interest in promoting Labour Based Technology as a viable option for district and feeder roads construction and maintenance.

The Roads Training School in Lusaka and the staff of Norconsult A.S., Kenya must be specially mentioned for their important contribution to the training of the Labour Based Contractors and Local Consultants, whose unstoppable energy and commitment resulted in over 800 kilometres of high quality feeder roads in Zambia and Tanzania and two million workerdays of employment in the rural areas.

Special thanks should go out to Tomas Stenstrom of ILO/ASIST in Harare and Dave Jennings of IT Transport in UK for providing invaluable comments to the draft of this manual.

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39, 40, 41, 42

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Source of Pictures

All pictures contained in this manual are made by F. Blokhuis.

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List of Abbreviations

ASIST Advisory Support, Information Services and Training

AWD Actual Work Done

BoQ Bill of Quantities

CL Centre Line

Cm Centimetre

Cum Cubic metre

DES Director of Engineering Services

DFRP District & Feeder Roads Project

DIP Detailed Improvement Plan

DLP Defects Liability Period

DoW Director of Works

ETL Excavation to Level

FIDIC Fédération Internationale de Ingénieurs-Conseils

FRP Feeder Roads Project

GRZ Government of Zambia

GTZ Government of Tanzania

ILO International Labour Organization

IPC Interim Payment Certificate

Km Kilometre

LBT Labour Based Technology

LHS Left Hand Side

MBC Measured Before Construction

NRB National Roads Board

NS Non-Standard

NSSF National Social Security Fund

O&M Operation & Maintenance

OMC Optimum Moisture Content

PC Project Coordinator

PM Project Manager

QOP Quarry Organization Plan

RES Reshaping

RHS Right Hand Side

SBO Side Borrow

ToR Terms of Reference

UNCDF United Nations Capital Development Fund

UNDP United Nations Development Programme

USD United States Dollar

WD Worker Day

ZK Zambian Kwacha

For definitions of technical terms, the reader is referred to the Zambian Technical Manual for Labour Based Road Rehabilitation Works (reference 1).

All documents mentioned at page (ix) under 'References' can be obtained through ILO/ASIST, Harare or the Roads Training Centres in Zambia (RTS, Lusaka) and Tanzania (ATU, Dar es Salaam).

Introduction

Labour based road construction involves breaking down various components of road construction into small and simple activities that are easily carried out by hand such as vegetation control, earthworks and graveling activities, whereas intermediate equipment, like tractors, light trucks and compaction rollers are used for haulage and compaction activities. The separate operations or activities follow each other in a logical sequence.

Further, since large labour-forces have to be employed on a temporary basis, these have to be recruited from within the vicinity of the road to avoid the problems and costs of setting up a site camp. Workers should be able to walk from their homes to the site.

A high level of site supervision by the client staff is required to ensure that works carried out on site are in conformity to contractual specifications given in a contract.

The road supervisor should ensure that the employment process is not discriminatory and that workers are employed under decent working conditions. This is a major contract management task that must not be neglected by the labour-based road contractor or those supervising the contract.

This Manual, therefore, is prepared to supplement the provisions in the 'Specifications' by giving simple guidelines on the role and tasks of the Supervising Consultant on how to supervise a contract to ensure that the Contractor complies with the technical specifications.

PART 1

CONTRACT ADMINISTRATION

The Project Management Team

Following the award and successful signing of the contract with the Contractor, one of the major tasks of the Client is to appoint a Project Management Team that should oversee the implementation of the Contract to its completion.

This function is important and must be dealt with decisively before the contractor is given possession of site if future problems are to be avoided.

The Composition of the Project Management Team

The Project Management Team typically comprises the Project Manager from the Client, the Supervising Consulting Engineer and the Site Agent from the Contractor. The Director of Works or Director of Engineering (DES) usually assumes the role of Project Manager. This team is responsible for planning, implementation and controlling all aspects of the project. Their roles differ but contribute to effective implementation of the Project.

The Role of the Director of Works (DoW) 1)

The DoW plays two major roles during implementation of labour based road rehabilitation projects. These are Project Coordinator and Project Manager and are discussed briefly on the following page.

^{1)} DOW* also refers to Director Engineering Services for Municipal Councils

The DoW as Project Coordinator

In agreements signed between the Consultant and Council at procurement stage, the Council Secretary who is the Client's representative, designates the DoW as Project Coordinator (PC). As PC the DoW coordinates all activities relating to procurement of consultants and contractors involved in road projects.

During the Construction stage, the DoW also coordinates and supervises activities of the appointed *Supervising Consultant*. He has to ensure that the consultant performs according to the terms of reference and that all reports are submitted in scheduled time to assist the Client use them to make decisions. He represents the Client's interests all the time in these agreements.

The DoW as Project Manager

The DoW's other major role is to supervise and monitor the implementation of road rehabilitation by the contractor. The Supervising Consultant is therefore the DoW's representative on site.

As PM, the DoW's major role will be to lead the project management team through the construction phase. He is directly responsible for supervising and monitoring of the road rehabilitation contract.

Under FIDIC conditions the PM is usually also the first line of arbitration between the Client and Contractor.

Some of the major tasks of the DoW as Project Manager are to visit construction sites at least once per month, to attend and chair the site meetings, to review progress of works and approve interim payment certificates certified by the Supervising Consultant.

The Role of the Supervising Consultant

During the Construction stage, the consultant is required to carry out supervision of the works and ensure that the works are carried out to the required standards as specified in the contract. Failure by the consultant in this stage may lead to inferior workmanship and quality of work and no value for money.

The role of the contractor is to directly control the construction Works according to provisions of the Contract. He assembles and organizes the necessary resources of labour, materials and plant and equipment. He is guided by Conditions of the Contract and Specifications provided in the Contract Document. He is supervised by the Supervising Consultant through site visits and site meetings.

Site Possession

Following the successful submission of the relevant securities by the contractor, the Consultant and the District Engineering Staff should arrange to facilitate the handing over of the site to the Contractor.

Reconnaissance surveys

Prior to the handing over, the Supervising Consultant and the DoW should first familiarize themselves with the site conditions by visiting the site to identify key features that will be shown to the contractor during the site hand-over ceremony.

Handing-over the Site.

In most circumstances the site possession date comes before the commencement date. During this exercise, the contractor should be issued with the *certificate of site possession*. Further, the DoW and the Supervising Consultant should arrange for a *joint site visit* to show the contractor key features of the site.

During the site visit the contractor must be shown the following features:

Reference marks

Kilometre pegs, Permanent and Temporary Benchmarks

Culvert locations

Culvert positions should be identified and any adjustments must be marked in the Contractor's and Consultant's Detailed Improvement Plan (DIP)

Gravel, Stone & Sand Sources

Selected Quarry areas and test pits should be located

Water points

Contractor should be shown both drinking and construction water points

Works Inspection & Approval

Once the contractor has started to implement the works the supervising consultant should regularly visit the site to inspect the quality of works and give approvals before the contractor can proceed with certain critical activities such as gravelling and concrete works.

The Supervising Consultant should maintain an accurate record of inspected and certified works.

Works Inspection and Approval

The major responsibility of the Supervising Consultant is to ensure that the contractor's workmanship always complies with the technical specifications provided in the contract document.

The Supervising Consultant should maintain a daily record of inspected and certified works. For this purpose, sample 'Works Inspection Forms' are given in Annex D2.

Annex D2, forms 7 and 8 provide sample forms for recording results of inspections of Mitre and Catch water drains.

It should be noted, however, that final approval and acceptance of the works is only possible at final completion inspection following the "Defects Liability Period" (see page 24).

Quality Control Aids

The Supervising Consultant should ensure that the Contractor has a full set of quality control aids *on site* for checking works during and at the end of each worker's task. These should include the *line and spirit levels, strings, measuring tapes, profile boards, travellers, ditch and slope templates and camber boards.* During works inspections, the Supervising Consultant must also use these quality control aids to check the works.

Site Instructions, Day Works & Variation Orders

Communication in contract administration is key to smooth management of any contract. Means of communication must be clearly understood by all stakeholders in the implementation process of a road contract. The Supervising Consultant should expeditiously respond to requests of Site Instructions or extra works that a Contractor may have noticed. This will minimize delays in implementation of the contract.

Site Instructions

Communication between the Supervising Consultant and the Contractor on site usually starts with the Contractor submitting a Site Request in which he may request certain information from the Project Manager.

In response to Site Requests, the Supervising Consultant issues Site Instructions providing the necessary information requested by the contractor.

It is important that both parties *in writing* issue these Site Requests and Site Instructions and that records of signed copies, which are acknowledged by the other party, are kept on site for future reference.

Purpose of Site Instructions

Site Instructions are used to amplify, correct or make minor amendments to the details of the work *within Project Manager's delegated authority* and *to order the use of provisional items* required to carry out the works as required.

A contractor may be instructed to:

- remove improper work or materials,
- expose work which has been covered up without permission,
- re-execute unsatisfactory workmanship, and in general,
- > carry out the requirement of the contract.

None of these are variations and the contractor's site agent or supervisors must be left in no doubt on that score. The instruction should contain a reference to the clause from which the Project Manager draws the authority, to exclude the possibility that the contractor's site agent/supervisors might mistake it for a variation.

Good communication requires not only speed and clarity but also definite channels through which information and instructions can flow.

Contractor's staff must direct requests for information or for approval of completed work to the appropriate member of the supervisory team either directly or leaving a clear message. The Project Manager must ensure that the team members can be easily contacted or if absent from site have their duties temporarily reassigned.

Instructions or other contractual directions are never given to labourers, machine operators or other members of the work force. It is improper for instructions to be issued to employees of the contractor who are in no position to judge the effect or importance of what they are being told particularly when, as often is the case, extra work, delay or other consequences likely results in extra costs.

However in a site situation where responsible contractor's staff cannot be found and work is going on which will have to be rejected, the rule of thumb is to inform whoever is involved that the work should stop and confirm it with the foreman or the assistant foreman as soon as they can be contacted.

If additional, new or changed work is required, instructions may only be issued to the contractor or the foreman. *A contractor* should however not be instructed on the method they are to use to realize their objective.

Format of issuing instructions

All site instructions are *prepared in triplicate using standard formats*. Similar forms may be issued to site staff in the form of books or blank forms printed in sets of three. It is suggested that the first copy is given to the contractor while the second is for the Supervising Consultant's record and the last copy is retained in the site file. Attached in Annex D2 is a sample format for Site Instructions (form 6), used for NRB funded contracts in Zambia.

Clarity of instructions

Site instructions must be completely explicit, and where necessary should be accompanied by sketches or drawings uniquely crossreferenced to the instruction. There must be no room for arguments as to the precise nature of the works that have been ordered.

Checklist

A valid Instruction:

- ☑ Is issued in accordance with contract provision and confirmed in writing.
- **☑** Does not exceed the authority of the issuing officer.
- ✓ Is served on the contractor's authorized staff.
- ☑ Should include reference to a clause allowing for the Instruction

Site instructions must not be issued which instruct additional work of a value in excess of the Supervisor's delegated authority. If this is the case and unless instructed otherwise, the *Client's approval must be obtained prior to authorization of any variation*.

Day Works and Variation Orders

Apart from handling requests that may only require permissions to use certain materials, adjust working hours, carry out tests on completed works or locations of structures such as culverts, scour checks, etc., the contractor may also request for variations in the scope of works. In dealing with these requests, the Supervising Consultant must discern whether these may be treated as either Day Works or Variation Orders.

Day Works

Day Works usually involve a few extra worker days or machine hours to carryout a specific task that may not be covered by the Bill Items. They hardly affect the Contract Sum.

The Day Work rates are usually provided in the Schedule of Day Work Rates.

NOTE: The scope, worker days, material quantities or machine hours must be agreed and recorded in the Day Works Request Form prior to commencement of the task.

Variation Orders

are issued where extra works significantly affect the Contract Sum. These may involve omissions or additions to the Contract Sum.

Variation Orders may be approved by the Project Manager within his authority as provided in the Conditions of Contract. However, most Variation Orders must be approved by the Client and accepted by the Contractor. The Contingency Sum or funds saved by rearrangement of bill items, may cover the cost of Variation Orders, or extra funding may be requested from the Client.

As for Day Works, Approval of the Variation Order must be granted before the extra works may commence.

Variations to the Quality or Quantity of the Works

These types of Variations are common features of construction contracts and most of the standard forms of contract recognize and make provision for this by including "Variation Clauses".

Such Clauses empower the Project Manager to amend the specifications and extent of the works and bind the contractor to carry them out.

The Project Manager also has power to order any variation that, in his opinion is desirable for the satisfactory completion and functioning of the works. Such variations include:

- Additions
- Omissions
- Substitutions
- Alterations
- Changes in quantity, form, character or kind
- Changes in position, dimensions, level or line.

Site Meetings & Progress Reporting

Monitoring of progress and handling of site problems is one of the major responsibilities of the Project Manager and the Supervising Consultant.

Site Meetings and progress meetings provide a formal arrangement for checking contractor's performance against the work programme and providing on spot solutions to site problems.

Reporting requirements are important as a management tool to monitor progress and take corrective action in case deviation from the programme are noticed

Site meetings

Site meetings are usually conducted to review progress of Works in a month. It also affords the Contractor opportunity to seek the Project Manager's decision on some matters that may affect progress of Works on site. Therefore, the Supervising Consultant must ensure that invitation letters to parties are sent early and confirmation sought for attendance. Before the site meeting, representatives from the Client, Contractor and Supervising Consultant first jointly visit the site and check progress before sitting to conduct a site meeting. The Client's representative as Project Manager chairs the site meeting while the Supervising Consultant records the minutes. Minutes should be recorded in a standard format (a sample of which is shown in Annex D2, form 1) and distributed to all relevant stakeholders. The Supervising Consultant should also follow

up with those given responsibilities for certain actions and decisions.

Monthly Progress Reports

On a monthly, quarterly and yearly basis, the consultant prepares progress reports to document and record activities, decisions, and any deviations from the original contract. Such information is particularly useful as a monitoring tool as well as settling future legal disputes.

Progress reports contain among other things;

- Contract Details
- Summary of Important Dates
- Schedules of Plant, Personnel and Materials on Site
- Work quantities completed during the Period under review
- Materials Reports,
- Programme versus Actual Progress
- > Financial Progress and,
- Cash flow Forecast

Measurements & Payments

Measurement and valuation is clearly a prerequisite to certification and payment of works. Most contracts are of the bill of quantities type (ad measurement contracts) and their measurement and valuation are governed by the conditions of contract.

Introduction

The contract agreement, conditions of contract and specifications always specify the procedures for payment to include timing of payment, measurement guidelines, unit of measurements, who is to check and certify the certificates, etc.

Advance Payment

Advance payments as stipulated in the Conditions of Contract may be paid to the contractor upon submission to the Employer of a Bank guarantee or if acceptable, an Insurance guarantee. These funds assist the contractor in the initial stages of implementation of Works such as payment of wages for the first month and mobilization of plant and materials. The Supervising Consultant should ensure that the Advance is repaid in accordance with the provisions of the contract.

Measurements for Interim Payment Certificates

At agreed intervals usually monthly, the Contractor jointly with the

Supervising Consultant must carry out measurements of completed Works. A record of these measurements and derived quantities must be kept by both the contractor and the Supervising Consultant on site to form a basis for preparation of the Interim Payment Certificates.

Interim Payment Certificates

At monthly intervals, the contractor must submit to the Supervising Consultant a statement or valuation based on the agreed measurements. The valuation must show the estimated value of the measured works executed up to the end of the previous period as well as the estimated value of work completed during the month in question. The valuation once checked and amended by the Supervising Consultant, where necessary, is used by the Supervising Consultant to prepare the Interim Payment Certificate. Interim Payment Certificates are useful in maintaining liquidity for the contractor. Therefore, the Supervising Consultant must not unnecessarily reject whole sections of works claimed by the Contractor, but make amendments for unsatisfactory works.

Timely Payments

The Contractor will be paid monthly, following approval of a payment certificate submitted to the Project Manager, based on the accepted measurements.

Most Conditions of Contract provide that within 28 days of ap-

proval of the payment certificate, the Employer should effect payment to the contractor.

Usually delays are experienced between submission of the valuation from the contractor and the payment of the Interim Payment Certificate. These delays are very disturbing for the contractor, who in most cases relies on the interim payments to pay the wages to the labourers and to procure fuel and materials. In order to avoid such delays, the contractor should develop a more disciplined behaviour in his spending and carry out better financial planning. At the same time, the Supervising Consultant and the Client should carry out their part in the payment process with promptness and diligence.

Final Payment Certificate

As soon as the works are substantially completed or upon termination of the Contract (at an earlier stage), the Supervising Consultant and the Contractor must conduct a joint inspection and take final measurements of the completed works. Guidelines for conducting such Final Inspection are given in Section 5 of Part II of this Manual. Based on the final measurements and As-Built Drawings a Final Payment Certificate is prepared by the contractor and agreed with the Supervising Consultant. The Final Payment Certificate shall be computed as the total value of work executed under the contract less any previous payments and all amounts such as Advances, and cost of tools and equipment supplied by the Project Manager. The Supervising Officer must also ascertain that all out-

standing labour wages are settled and no other amounts are due to suppliers in the project area. These could include rental charges for site accommodation, food catering charges, charges for use of water sources, gravel sources and rental charges for equipment hired by the contractor.

If the works are approved by the Supervising Consultant, it is customary that 50% of the Retention is paid back to the contractor and that the Performance Bond is released, so that the Contractor has means to engage in new contracts.

The remaining 50% of the Retention forms the only source of security for the Project Manager to cover the Contractor's liability during the Defects Liability Period.

Management of Disputes

In a contractual relationship, disputes can arise as a result of disagreement about issues related to quality, quantity, payment or programme of the work. Parties are advised to settle disputes amicably.

A contractual dispute occurs when the contractor does not agree with the final decision by the Client and should be resolved in accordance with procedures specified in the Conditions of Contract. The resolution of a contractual dispute may be a costly and time consuming affair for both parties. All efforts should therefore be taken to reach an amicable settlement. Failing this, a procedure in two steps is normally recommended and specified in the contract before the matter may eventually be brought before the court. For both parties in a contractual dispute it is important to be aware of the formal requirements:

- Time limits for rejection of decisions and referral of the dispute to a higher level;
- All communication to be in writing and with notice to the other party.

Failure to comply with these formal requirements will in itself result in a lost case and the decision to be declared "final and binding" on both parties.

Adjudication

The parties may appoint an Adjudicator (or Conciliator), by common agreement, the particulars of whom must be specified in the Contract Data. The Adjudicator can be any person who is regarded by both parties as being neutral and having the required knowledge and experience to make a fair decision for the resolution of the dispute. The services of the Adjudicator are not free of charge and the payment is to be specified in the Contract Data. However, if the dispute can be resolved at this level, the cost to both parties in monetary terms as well as in time and effort will be relatively limited. Adjudication is normally conducted by means of negotiations whereby the Adjudicator attempts to bring the parties to agreement after having studied the relevant facts and hearing each party's arguments. Either party can bring the dispute to the attention of the Adjudicator and likewise choose to accept or reject the Adjudicators' decision. When a decision is rejected, the dispute is referred to arbitration.

Arbitration

The arbitration procedure is laid down in the Conditions of Contract, usually by reference to a law or Arbitration Act. Arbitration is a more formal and comprehensive procedure than adjudication. If the parties still fail to reach an agreement as a result of arbitration, they may refer the matter to the court.

The Defects Liability Period & Final Completion

Once the Works are substantially complete they are further observed for a period stated in the Conditions of Contract to ensure that any defects noticed are corrected. This period starts with the issuance of a Certificate of Substantial Completion.

Introduction

The Defects Liability Period starts a day after the Completion Date and ends on the expiry date stipulated in the Conditions of Contract. Substantial Completion refers to the situation where the contractor may have completed the major works that are key to functioning of the road but only minor works are outstanding. The outstanding works are then completed during the DLP and therefore do not affect contractor's demobilization of major equipment from site.

Depending on the Contract signed, the DLP last one year or shorter. For example, the DLP could be linked to the end of the rain season. The principle behind determination of the period of the DLP is to allow the critical sections of the completed Works to be tested by the worst weather conditions.

Final Inspections

Prior to start of the Defects Liability Period, the Supervising Consultant and the Contractor conduct a joint inspection, to ensure that completed works meet the specifications given in the contract document. They also identify any outstanding works, the so-called "Snag List", that on mutual agreement are completed during the Defect Liability Period. The steps to follow at this stage are fully described in Section 6 of Part II of this manual.

Notification of Defects to Contractor

During the whole period of the DLP at regular intervals the Supervising Consultant must inspect the works to identify any defects. Any defects noticed during the inspections should be communicated to the contractor in writing. The Supervising Consultant should distinguish between normal wear and a defect. Temptation to issue variation orders for new works should also be avoided. *Variation orders for new works are not allowed during the defects liability period!*

Payment for Defects

Defects that are attributed to poor workmanship, are supposed to be paid for by the contractor. However, where the contractor fails to correct the defects despite being notified, the Project Manager may use the Retention to cover the cost of these repairs carried out by someone else.

Defects that are not as a result of contractor's poor workmanship may be paid for as a separate negotiated contract and not as variation orders.

Before the end of the DLP, the contractor and the Supervising Consultant carry out another detailed inspection jointly, to ascertain that no defects exist. During this inspection the team must concentrate on the performance and condition of drainage structures and pavement layers.

Final Completion Certificate

Once all defects are corrected, the contractor must be issued a Final Completion Certificate. This is usually preceded by a ceremony at which the contractor hands over the completed Works to the Client. At this stage, the performance bond is also released.

Closing of Project Account

After the joint site inspection referred to under above paragraph 'Payment for Defects', the contractor prepares a claim for repayment of Retention, which must be agreed with the Project Manager. The Project Manager will then settle the claim with the Contractor and closes the Project Account.

Enforcement of Labour Standards

Labour based road works usually involve high labour recruitment and management. Special attention is expected from the Supervising Consultant and the project management team to ensure that the contractor is complying with the labour standards of employment.

The Supervising Consultant must also be acquainted with the local labour laws and standards.

Minimum Age

The Supervising Consultant should ensure that no under aged persons are employed by the contractor.

The minimum employable age is stipulated in the labour laws. The minimum age in Zambia for example is 15 years for non hazardous work.

Non-Discrimination

The Supervising Consultant should check that recruitment is fair and transparent and that the contractor does not discriminate on the basis of gender. Regardless of gender, the contractor should pay equal wages for work of equal value. He should advise the contractor in preparation of recruitment adverts that are neutral. In areas where strong cultural barriers exist, contractors should be assisted by the Client with sensitization meetings to explain the nature of the work and the recruitment process.

Reasonableness of Task Rates

One of the responsibilities of the Supervising Consultant is to check and advise the contractor on appropriate task rates. The rule of thumb is 'A reasonable task will allow the worker to complete it within 5 to 6 hours of moderate hard work. The Supervising Consultant should also ensure that workers are paid equal amount for work of equal value.

Safety and Health

The Supervising Consultant must ensure that the contractor observes all statutory obligations regarding safety standards for workers on site and the community at large.

Minimum Wage Rates

The minimum wage is always stipulated in the labour laws. The Supervising Consultant must ensure that the contractor does not under pay the workers. A regular check of contractor's record of pay sheets is necessary.

Falsification of pay sheets is a major method of covering up corrupt practices at all levels. The Supervising Consultant should also routinely make spot checks with a number of individual different labourers to confirm amounts received, any deductions made and their identities.

PART II

SUPERVISION GUIDELINES

Introduction

The labour based feeder roads programmes in Zambia and Tanzania used a standard Bill of Quantities (BoQ), developed for labour based road works by Norconsult A.S., Nairobi, Kenya.

The BoQ comprises of 7 bills:

- 1 Setting out, Site Clearance and Quarry Preparation
- 2 Reshaping of Road to Feeder Road Standard
- 3 Drainage Structures
- 4 (Re) Gravelling
- 5 Equipment Based ActivitiesNon Standard Items
- 6 Preliminary and General Items

Standard item descriptions of each bill are given on the following pages. The order of the items in the bills follows as much as possible the sequence of construction activities on the site.

To facilitate a clear link between the standard Bill of Quantities and this Supervision Manual, the paragraphs in sections 1 to 4 follow the same sequence and numbering as in the Bill of Quantities.

Bill 1	Setting out, Site Clearance and Quarry Preparation							
ltem	Description	Unit						
No.								
1.1	Setting out alignment & chainage pegs							
1.11	For reshaping	m						
1.12	New construction	m						
1.13	Embankment	m						
1.2	Bush Clearing							
1.21	Cross section	m2						
1.22	Cross section	m2						
1.23	Cross section	m2						
1.3	Grass Cutting							
1.31	Cross section	m2						
1.32	Cross section	m2						
1.33	Cross section	m2						
1.4	Grubbing							
1.41	Cross section	m2						
1.42	Cross section	m2						
1.43	Cross section	m2						
1.5	Tree and stump removal							
1.51	Cross section	m2						
1.52	Cross section	m2						
1.53	Cross section	m2						
1.6	Clearance of quarry site							
1.61	Quarry No.: 1 sparse	m2						
1.62	Quarry No.: 1 medium	m2						
1.63	Quarry No.: 1 dense	m2						
1.7	Make quarry access incl. maintenance							
1.71	Quarry No.: 1 light	km						
1.72	Quarry No.: 1 medium	km						
1.73	Quarry No.: 1 difficult	km						
1.8	Excavation overburden, incl. stocking							
1.81	Quarry No.: 1 soft	m3 (insitu)						
1.82	Quarry No.: 1 medium	m3 (insitu)						
1.82	Quarry No.: 1 hard	m3 (insitu)						
1.90	Dayworks	workday						

Bill 2	Reshaping of road to Feeder Roads S	Standard
Item No.	Description	Unit
2.1	Cutting of slots and setting of profiles	
2.11	For reshaping	m
2.12	New construction	m
2.13	Embankment	m
2.2	Excavation to level or side borrow	
2.21	Height of cut < m 0.25	m3 (insitu)
2.22	Height of cut > m 0.25	m3 (insitu)
2.23	Embankment	m3 (insitu)
2.3	Ditching and spreading	
2.31	Cross section	m3 (insitu)
2.32	Cross section	m3 (insitu)
2.33	Cross section	m3 (insitu)
2.4	Backsloping and spreading	
2.41	Cross section	m3 (insitu)
2.42	Cross section	m3 (insitu)
2.43	Cross section	m3 (insitu)
2.5	Sloping	
2.51	Cross section	m3 (insitu)
2.52	Cross section	m3 (insitu)
2.53	Cross section	m3 (insitu)
2.6	Camber formation	
2.61	Cross section	m2
2.62	Cross section	m2
2.63	Cross section	m2
2.7	Haulage by wheelbarrow	
2.71	10 - 50 m	m3 (loose)
2.72	50 - 100 m	m3 (loose)
2.73	100 - 200 m	m3 (loose)
2.8	Haulage by (animal) carts	
2.81	range 1	m3 (loose)
2.82	range 2	m3 (loose)
2.83	range 3	m3 (loose)
2.90	Dayworks	workday

Bill 3	Drainage Structures	
Item No.	Description	Unit
3.1	Excavation of other drainages	
3.11	Outside road formation	m3 (insitu)
3.12	within road formation	m3 (insitu)
3.13	Desilting of culverts	m3 (insitu)
3.2	Provide and build scour-checks	
3.21	Using hard core	No.
3.22	Using stakes	No.
3.23	Using stone Masonry	No.
3.3	Supply of plain concrete pipes	
3.31	Ø 450 mm	m
3.32	Ø 600 mm	m
3.33	Ø 900 mm	m
3.4	Installation of concrete pipes, full lines	
3.41	Ø 450 mm >5m	m
3.42	Ø 600 mm >5m	m
3.43	Ø 900 mm >5m	m
3.5	Installation of concrete pipes, partial lines	
3.51	Ø 450 mm <5m	m
3.52	Ø 600 mm <5m	m
3.53	Ø 900 mm <5m	m
3.6	Provide & build masonry structures in	
3.61	Dry handpacked stone masonry	m3
3.62	Stone masonry	m3
3.63	Concrete blocks	m3
3.7	Provide and build	
3.71	Gabion boxes	m2
3.72	Rockfill for gabion boxes	m3
3.73	Grouted stone pitching 150mm	m3
3.8	Concrete works	
3.81	Lean (1:4:8) Lean	m3
3.82	Class 15 (1:3:6) CL.15	m3
3.83	Class 20 (1:2:4) CL.20	m3
3.90	Dayworks	workday

Bill 4	(Re-) Gravelling						
Item No.	Description		Unit				
4.1	Excavation and stocking of grave	el					
4.11	Quarry No.:	soft	m3 (insitu)				
4.12	Quarry No.:	medium	m3 (insitu)				
4.13	Quarry No.:	hard	m3 (insitu)				
4.2	Removal of boulders						
4.21	Size < 0.025 m3		m3 (loose)				
4.22	Size 0.025 to 0.25 m3		m3 (loose)				
4.23	Size > 0.25 m3		m3 (loose)				
4.3	Loading of gravel						
4.31	Quarry No.:	easy	m3 (loose)				
4.32	Quarry No.:	medium	m3 (loose)				
4.33	Quarry No.:	hard	m3 (loose)				
4.4	Off-loading of gravel						
4.41	Quarry No.:	easy	m3 (loose)				
4.42	Quarry No.:	medium	m3 (loose)				
4.43	Quarry No.:	hard	m3 (loose)				
4.5	Spreading of gravel to camber						
4.51	Quarry No.:	easy	m3 (loose)				
4.52	Quarry No.:	medium	m3 (loose)				
4.53	Quarry No.:	m3 (loose)					
4.6	Crushing of stones						
4.61	Quarry No.:	fine	m3 (loose)				
4.62	Quarry No.:	medium	m3 (loose)				
4.63	Quarry No.:	coarse	m3 (loose)				
4.7	Maintenance of gravel road						
4.71	During construction		km				
4.72	During defects liability period	km					
4.73							
4.8	Backfill and leveling of quarry						
4.81	Quarry No.:	minor	m3 (loose)				
4.82	Quarry No.:	partial	m3 (loose)				
4.83	Quarry No.:	full	m3 (loose)				
4.90	Dayworks		workday				

Bill 5	Equipment Based Activities	
Item No.	Description	Unit
5.1	Haulage of gravel quarry No. 1	
5.11	0 - 1 km	km x m3
5.12	1 - 3 km	km x m3
5.13	over 3 km	km x m3
5.2	Haulage of gravel quarry No. 2	
5.21	0 - 1 km	km x m3
5.22	1 - 3 km	km x m3
5.23	over 3 km	km x m3
5.3	Haulage of gravel quarry No. 3	
5.31	0 - 1 km	km x m3
5.32	1 - 3 km	km x m3
5.33	over 3 km	km x m3
5.4	Haulage of gravel quarry No. 4	
5.41	0 - 1 km	km x m3
5.42	1 - 3 km	km x m3
5.43	over 3 km	km x m3
5.5	Haulage of gravel quarry No. 5	
5.51	0 - 1 km	km x m3
5.52	1 - 3 km	km x m3
5.53	over 3 km	km x m3
5.6	Haulage of gravel quarry No. 6	
5.61	0 - 1 km	km x m3
5.62	1 - 3 km	km x m3
5.63	over 3 km	km x m3
5.7	Compaction to % MDD	
5.71	Of earthworks 95%	m3 (comp)
5.72	Of side drain material 95%	m3 (comp)
5.73	Of gravel material 95%	m3 (comp)
5.8	Compaction per area	
5.81	Of earthwork and drain material	m2
5.82	Of gravel material	m2
5.83	Watering compaction area	m2
5.90	Dayworks	workday

	Bill NS	Non Standard Items	
	Item No.	Description	Unit
		Bill No. 1	
	1.01		
	1.02		
	1.03		
•	1.04		
	1.05		
	1.06		
,		Bill No. 2	
	2.01		
•	2.02		
	2.03		
•	2.04		
	2.05		
ľ	2.06		
,		Bill No.3	
•	3.01 3.02		
•	3.03		
	0.00		
	3.04		
	3.05		
	3.06		
•	4.01	Bill No.4	
•	4.01		
•	4.03		
		Bill No. 5	
	5.01		
	5.02		
	5.03		

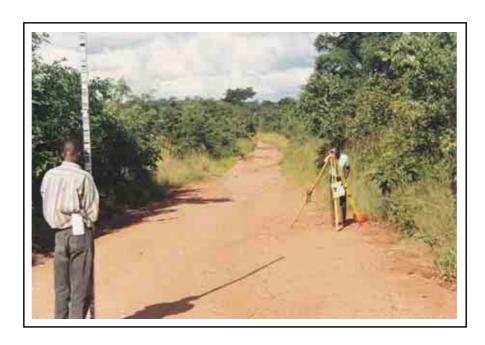
CALC	ULATION OF PRELIMINARY AND GE	NERAL ITEMS	
6.1	Site Camp incl. O&M during construction	10	
272	Construction of temporary camp per 10km @: O&M of camp during construction period @:	900,000 per camp 100,000 per month <i>Total</i> :	990,000 733,000 <i>1,723,000</i>
6.2	Insurances and Bonds (reimbursable)		
	Provisional sum @:	100,000 per month	733,000
6.3	Mobilization and demobilization		
	Mobilization transport from base to site by tipper @ Demobilization transport from site to base by tipper @ (with a minimum of 2 tipper days each)	4 trips 4 trips Total:	445,275 445,275 <i>891,000</i>
6.4	Density & gravel thickness tests after co	ompletion .	
	Density and gravel thickness tests to be carried out by an independent laboratory at a frequency of 3 tests per kilometer, each @	20,000 per test	660,000
6.5	Billboard/Signboard		
	Erection of Bill board as per standard drawing in the contract at both ends of the road, each @	100,000 per bill board	200,000
6.6	Supervision Transport during Construction	ол	
	Supervision visits from Contractor's base to site at the rate of (with a minimum of: 5 pick-up days per month)	5 visits/month @	373,736
	Total	I during construction period:	2,741,000
6.7	Supervision Transport during Maintenan	rce	
	Supervision visits from Contractor's base to site at the rate of (with a minimum of: 1 pick-up day per month)	1 visit/month @	74,747
	Totai	during maintenance period:	897,000
6.8	NSSF Contribution (reimbursable)		
	Provisional sum @:	150,000 per month	1,100,000
6.9	Other:		
		per month	
	Total for Prelimina	ary & General Items:	8,945,000

Sample summary page of the Bill of Quantities

Ril	I of Quantities	District:	Sengerema	ı		
	1 Of Qualitities	Road name:	Nyamahona	a - Chifunfu Sec. 3		
	Grand Sum	ST	STC Fixed Rates			
Bill No	Description	Standard Items	Non- Standard Items	Total Bill Amount		
			Tshs	Tshs	Tshs	
1	Setting out, Site Clearance and (Quarry Preparation	3,421,852		3,421,852	
2	Reshaping of Road to Feeder Ro	oad Standard	7,886,687		7,886,687	
3	Drainage Structures		15,921,527	420,000	16,341,527	
4	(Re) Gravelling		7,643,692		7,643,692	
5	Equipment Based Activities		16,324,450	21,000	16,345,450	
		Sub-total (1)	51,198,207	441,000	51,639,207	
6	Preliminary and General Items	s:				
6.1	Establishment of Site Camp	and O&M of camp during	n construction		450,000	
6.2	Insurances and Bonds (rei		g construction		600,000	
6.3	Mobilization and demobiliza	,			600,000	
6.4	Quality control tests (densit	y tests after completion)			400,000	
6.5	Billboard/Signboard	, ,			150,000	
6.6	Supervision Transport durin	g Construction			1,600,000	
6.7	Supervision Transport durin	-	eriod		400,000	
6.8	NSSF Contribution (reimbur				1,500,000	
6.9	VETA Contribution (reimbu				300,000	
		Total Preliminary & Ge	eneral Items		6,000,000	
		\$	Sub-total (2)		57,639,207	
	Add percentage of	2.02% of sub-total	(2) for W.T.		1,164,312	
		\$	Sub-total (3)		58,803,519	
	Add provisional sum of	10% of sub-total	(3)		5,880,352	
	for contingencies to be expend	led only with the express a	approval			
	of the District Council of :	Sengerema				
	on the recommendation of :	The District Enginee	r			
	and for price variation in accorda	Contract.				
	Total cost of Rehabilitation funded by DFR Project:	Works, TZS 63,	245,240			
	Total cost of 1st Year Main Works, funded by The Dist Council :		38,631			
	Contrac	t Sum, forward to Form	of Agreement		64,683,871	
		,	_		,, 1	

SECTION 1. SITE CLEARANCE AND QUARRY PREPARATIONS

Section 1 covers the activities of Bill 1 of the standard BoQ for labour based road construction, which all relate to initial setting out, clearing of vegetation and preparation of quarries. Most of the activities under Bill 1 and 2 are MBC items, which mean that they are **M**easured **B**efore **C**onstruction. At signing the contract document, the contractor has agreed to the respective quantities in the BoQ in order to achieve certain standards of work. The main task for the supervising officer is to check, that those standards are met.



<u>Picture 1:</u> Setting out of centerline at Eastern Dairy – Madzimoyo road, Eastern Province, Zambia

Item 1.1: Setting out alignment & chainage pegs Setting out of centre line.

In the FRP of Zambia and Tanzania, the Supervising Consultant assisted the contractor in setting out the centreline of the road, to ensure that the alignment, as it was designed by the design engineer, will be followed. The design engineer left centre pegs behind at 25 meters interval, which should be used by the supervisor to reestablish the centreline. After re-establishment of centreline, ranging rods or strings must be used to check for the straightness and smoothness of curves.

	RE-ESTABLISH CENTERLINE
Who:	Consultant Supervisor.
Why:	To ensure that the road is built along the alignment envisaged by the design engineer.
When:	Before start of any works.
What:	Check that correct centre pegs are identified by the contractor and other bench marks left behind by the design engineer and that the centreline is set out correctly by placing new pegs.
Tools:	Use level instrument, ranging rods, strings, tape measures (30m and 50m), measuring wheel, bush pegs, panga and water proof marker.

Setting out of chainage pegs:

The design features of the road are described in the **D**etailed **I**mprovement **P**lan (DIP) at intervals of 25 meters. It is very important that an accurate correlation is established and maintained between the design in the contract document and the actual site in the field. This can only be established by placement of permanent *chainage pegs* along the road at the same intervals as used in the



<u>Picture 2:</u> Timber chainage peg placed at 100m interval, and clearly marked with black on white oil-paint.

document. Works quantities include placing of 1"x2" timber pegs, bedded in a concrete footing at 100m interval. Intermediate bush pegs placed at 25m interval. It is the task of the contractor to maintain the chainage pegs throughout the construction period. In many rural areas, people tend to vandalize the pegs, because they don't understand their use and impor-Therefore, it is essentance.

tial to sensitize the workers and the local community on this. As loss of some pegs may be unavoidable, it is advisable to establish additional natural occurring chainage benchmarks such as rocks, big trees, walls of houses or fences, etc.

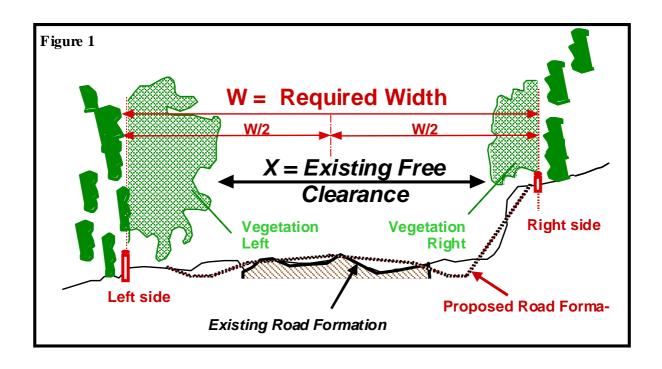
The supervising officer must check the following issues to ensure that the placement of chainage pegs is carried out to the required standards:

- The permanent 100m spaced pegs should be made of timber (at least 1"x2"), treated against ants and placed in a concrete footing as specified in the contract.
- The pegs should be placed firmly in the ground and the readings should be consistent without jumping figures.
- All chainage pegs should be placed at one side of the road.
- Oil paint should be used to write the chainages, preferably black letters on a white background, to ensure good visibility and readability at 10 to 15 meters distance.

	CHECK CHAINAGE PEGS
Who:	Consultant Supervisor.
Why:	To ensure that longitudinal measurement of the road is set out correctly and that a correlation exists with the detailed improvement plan in the contract document.
When:	After establishment of centreline and before start of any works.
What:	Start at chainage 0+000 to check the correct distance between the chainage pegs, the correct sequence of numbers and firmness of placing.
Tools:	Use tape measures (30m and 50m) or measuring wheel.

Site Clearance

In labour-based road construction, clearing of vegetation and removal of topsoil is split into 4 sub-activities (bush clearing, grass cutting, stripping and grubbing and tree and stump removal), in accordance with the steps used in the execution of the works. The assessment of works quantities is done by measuring the free clearance from the left to the right side of the road. Another activity associated with clearing, is boulder removal, however, this activity is included in Bill 4 of the BoQ (item 4.2). As all these activities (except boulder removal) are MBC items, it is not required to check quantities of works done, but rather the quality of the clearing works carried out and whether the established free clearance width is in accordance with the **required width**. For the measurements of the required width, reference should be made to the *Measure-ment Guidelines* in volume 2 of the contract document.



Items 1.2, 1.3 and 1.5: Bush clearing, Grass cutting and Tree and stump removal

For the activities mentioned above, the supervising officer should check whether the work is carried out according to the specifications in the Technical Manual. The cleared areas should be measured at regular intervals of approximately 25 meters and the supervising officer should check whether the required width is cleared at both sides of the centreline. Other important aspects to check are that:

- All bushes are removed out of the required width as specified and that the contractor does not use fire to clear the bush.
- > If fire has to be used to destroy the material it should only be done in controlled heaps to reduce the danger of fire spreading to the adjoining land.



Picture 3:

Stump removal at Eastern Dairy – Madzimoyo road, Eastern Province, Zambia

Item 1.4: Grubbing and stripping of topsoil.

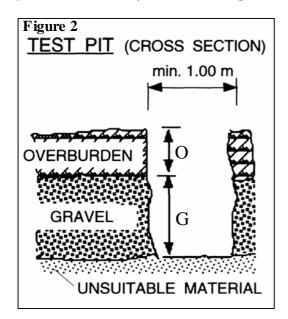
Grubbing is an activity whereby all roots of grasses, bushes and other vegetation is removed from the cleared width. If the topsoil contains much organic material, it will also be required to strip the topsoil. Following are important issues to remember when checking for this activity.

- Check the width of the stripped and grubbed area
- Check that all grass, upper grass roots and other vegetation remaining after bush clearing within the specified section has been removed (conserve trees where possible)
- Check also for the removal of top soil within the section.

	CHECK VEGETATION REMOVAL AND GRUBBING
Who:	Consultant Supervisor.
Why:	To ensure that all vegetation is removed in the required width according to the <i>measurement guidelines</i> and that the topsoil is free of roots and organic material.
When:	Before the start of Earth Works.
What:	Establish the required width from the tables in the measurement guidelines and check, that the required width is clear of vegetation, roots and organic materials at both sides of the centreline.
Tools:	Use a tape measure of 30m.

Quantity of Gravel

As part of the design and tender document preparations, the consultant, with the help of the local authorities, identifies the quarries from which the contractor will extract the material to gravel the road. The consultant, as part of his Terms of Reference, makes an assessment of quality and available quantity of gravel in the proposed source by establishing a number of test pits, which he analy-



ses by calculating the so-called "Gravel – Overburden Ratio". It is economical to develop the quarry if the gravel thickness is twice the thickness of overburden (G/O-ratio > 2.0). The results of the assessment are contained in the "Quarry Organization Plan", a sample of which is

given in Figure 3 on the following page. By mapping the selected test pits with ratio > 2.0 in a plan, the consultant determines as a first assessment, which part of the total area must be selected for excavation. At this point it must be stressed that it is the obligation of the contractor upon the start of contract implementation, to dig additional test pits at smaller intervals, to confirm the consultant's findings, *before* he starts with costly operations such as overburden removal.

Figure 3

F 1g Qua		Organiza	tion Plar	n Ro	ad No.:	RD-554		District:	Mumby	va Distric	et .	PAGE:	8
Test		Thickness	se (m)	Gravel m	atorial	Selec-	Ouerry n		O1 Situr	nbeko turn	off		
	Pit No. Over- Gr /OB		ted pit	Quarry name: Q1 Situ			ibeko turr	-011					
		burden	Gravel	Туре	ratio	(yes/no)	Quarry lo	cation:	At Chain	age 3+500	LHS		
1 0.20 0.80 4.0		yes			Access re	oad 500 me	eters						
2		0.20	0.80		4.0	yes	Owner:		Mr. Temb				
3 4		0.70 0.20	0.30 0.40		0.4 2.0	no	(Name an address)	ıd	Farm 405				
5		0.20	0.40		2.0	yes yes	audi ess)		Mumbwa				
6		0.50	0.50		1.0	no							
7		0.30	0.70		2.3	yes				Whole	quarry	Selected are	ea
8		0.20	0.40		2.0	yes	•						
9 10		0.80 0.90	0.20 0.20		0.3 0.2	no no	Quarry a	ea len volume	•	6,400 2,340		4,200 m ² 980 m ³	
11		0.60	0.40		0.2	no	Gravel vo		-	3,460		2,740 m ³	
12		0.30	0.60		2.0	yes		ge layer	Overb.	0.37		0.23 m	
13		0.20	0.90		4.5	yes	thick	ness	Gravel	0.54		0.65 m	
14		0.40	0.50		1.3	yes	Gravel / 0	Overburde	n ratio	1	.5	2.8	
15 16		0.30 0.10	0.30 0.60		1.0 6.0	no yes							
17		0.10	0.80		4.0	yes	Vegetatio	on					
18		0.40	0.60		1.5	yes							
00		Indicates	the test pits	s to be ope	ned by the	contractor p	orior to the I	removal of	overburden				
		_	-			80	0.0			>			
			10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0			
1	10.0												
	*			3	_	2		3	-	4			
	10.0												
	10.0	1											
	10.0	-	5		6		7		8		9		
80.0	-												
œ	10.0												
	¥												
	۹ و			10		25		12		13			
	10.0												
	_ 												
	10.0	_											
	10.0		14		15		16		17		18		
Lego	•				***		*6		*************************************		18		
		Surveyed	l quarry are	ea		<		Quarry a	ccess	 12	Test pit (sampled)	
Overburden deposit					Land bou	ındaries	00 12	Test pit (not sampled)				
F	〓		-		a	I	 	ı					
Loading bay / Gravel stockpile					Survey grid <<< Future quarry extension								

Quality of Gravel

The quality of the gravel is checked by the design consultant as part of his ToR in the contract preparation phase. However, during implementation of the contract, new quarries may be identified, and in that case, the supervising officer may be required

Figure 4

GRADING REQUIREMENT AFTER COMPACTION			
SIEVE (mm)	% BY WEIGHT PASSING <150 VPD	% BY WEIGHT PASSING > 150 VPD	
40 28 20 14 10 5 2 1 0.425 0.075	100 95 -100 85 - 100 65 - 100 55 - 100 35 - 92 23 - 77 18 - 62 14 - 50 10 - 40	100 100 95 -100 80 - 100 65 - 100 45 - 85 30 - 68 25 - 56 18 - 44 12 - 32	

Traffic category (vehicles/day	< 150	> 150
CLIMATIC CATEGORY	WET	DRY
Liquid limit (%):LL Plasticity Index (%):PI Plasticity Modulus 4 day soaked CBR (%) DCP Equivalent (mm/blow)		

 In dry areas, Pls tend to higher values, however in wet areas, Pl values are not allowed to exceed 15%.

NOTES

MECHANICAL STABILISATION

If suitable natural gravel is not available, it may be possible to achieve the above requirements by mixing or mechanical stabilisation of different materials.

The requirements will apply to mixtures of natural gravel and sand or up to 30% of stone (crushed or not)

- California Bearing Ratio (CBR) AT 95% Maximum Dry Density (MDD), Modified AASHTO, and 4 days soak.
- Dynamic Cone Penetrometer (DCP) using 60° cone.
- The lower quality material (CBR 15) may be accepted if no better material can be economically found.

Manual provides the quality standards for gravel wearing course (pages C17-C18), which are shown in Figure 4 above. If the supervising officer can not readily rely on laboratory services, simple field tests, as described on pages J4 to J9 of the Technical Manual, may provide a good indication of the quality of the material.

The following three field tests should be carried out on the gravel samples obtained from the trial pits when laboratory testing is not possible:

Visual test

Take a dry sample of the material and crumble it in your hands. There should be a significant proportion by volume (about half) of particles larger than 2 mm in diameter. Try to crumble the large particles in your hand or by tapping LIGHTLY with a hammer. If the lumps disintegrate completely into sand size particles it will not be suitable for gravelling as the same disintegration will occur under traffic.

Cohesion test

Take a handful of damp sample and mould it into a ball to check for the presence of cohesive fine material, which is required to bind the larger gravel particles together. If cohesive fines are present the material will stick together when gently placed on a flat surface. Silts and clays will also stain the hands.

Particle size distribution

For this test, two alternatives can be used: the 'settlement test' and the 'vibration test'. Both tests are described and illustrated on the following pages, and further details can be found in the Technical Manual on pages J4 to J9:

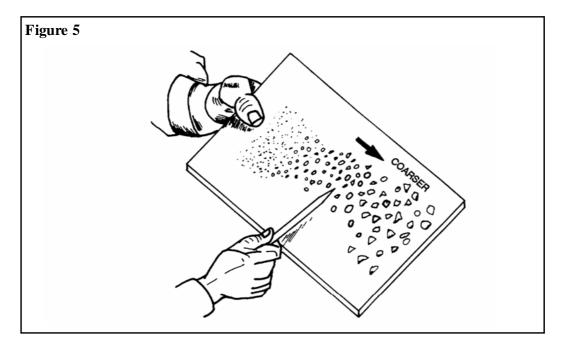
Good gravel should have a mixture of stones, sand and clay in roughly the following proportions:

- Stone (> 2 mm): 50%

- Sand (0.06 - 2mm): 40%

- Clay & Silt (<0.06mm): 10%

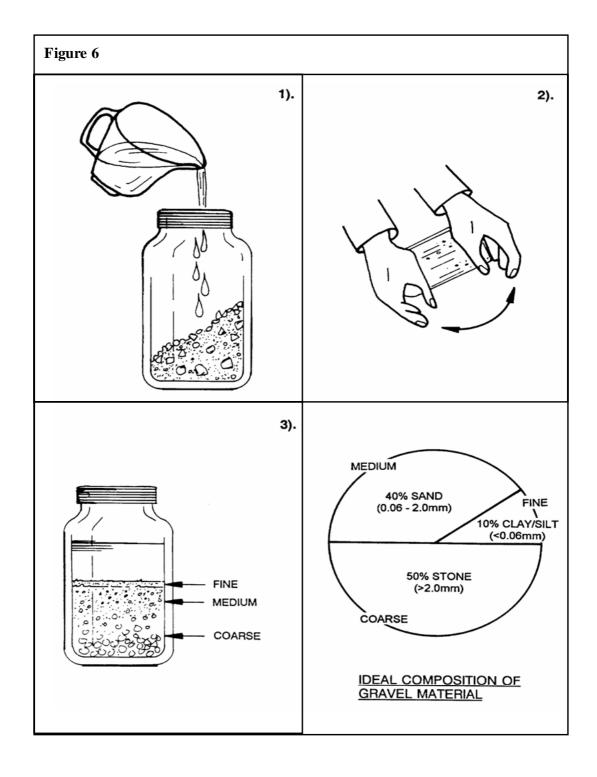
For the Vibration test, a dried sample is placed on a board or piece of stiff card. By holding the card at a slope and tapping lightly with a pencil or stick, the finer material will move up the slope or remain in place, while coarser material will move down the slope. If there are a lot of different sizes between the largest and smallest particles, the sample is well graded, i.e. it will compact well. If only



a few sizes can be seen, then the sample is single-size or poorly graded.

With the settlement test, a sample is placed in a medicine bottle or a glass jar with straight sides. Put in some water, shake vigorously and then let it stand to allow the soil to settle. Gravel and coarse sand will settle immediately, while fine sand and coarse silt settle more slowly, taking about 30 seconds.

The approximate quantities of each size can be seen as layers in the sample; the finer material usually being of a different colour.



Preparation of Quarry Sites

Gravelling is an activity on the Critical Path of the planning cycle. In order to ensure that the gravelling operation can be started as soon as possible and continue without delay, the preparation of the quarry is included in Bill 1 of the BoQ. The preparation of a quarry consists of three sub-activities:

- Clearance of quarry site.
- Establishment of access to the quarry.
- Removal of overburden.

Before the contractor starts these activities, the supervising officer must check, if the quarry is set out according to the Quarry Organization Plan in the contract. The contractor must be instructed to dig additional test pits at a minimum grid of 10 meters incl. extension area, to ascertain that gravel is available as planned by the design engineer.

Item 1.6: Clearance of quarry site

After the extent of the quarry has been correctly set out, which should be checked by the supervising officer, the contractor can start with the clearing of vegetation and grubbing of the quarry site. If large trees are situated inside the quarry area, then the contractor must be cautioned not to disturb an area within a radius of 3 me-

tres around each tree. Make sure that the entire quarry area is cleared and grubbed.

Item 1.7: Establishment of access to the quarry.

For the establishment of an access road from the quarry to the road under construction, the contractor should think of accessibility during dry and wet season. In some cases a minimum input is required, but in other cases considerable inputs may be required to establish a reliable access to the quarry, including provision of temporary culverts and a laterite finishing of the surface. A good and smooth access to the quarry will pay off later when the haulage equipment is passing the route up to fifty times a day.

	CHECK ON CLEARING OF QUARRY AREA AND ESTABLISHMENT OF ACCESS TO QUARRY
Who:	Consultant Supervisor.
Why:	To ensure that quarry area is set out according to the plan, entirely cleared and grubbed, and that a reliable and all-weather access exists.
When:	Before the start of overburden removal.
What:	Check that the actual lay-out and extra test pits, dug by the contractor are conform the quarry organization plan (QOP) in the document.
Tools:	Measuring wheel and tape measure of 5 meters.

Item 1.8: Excavation and removal of Overburden

Once it has been established that sufficient and good quality laterite is available in the quarry, the operation of overburden removal can start. It is very important that the supervising officer insists that the overburden of the entire quarry area is removed and stockpiled at the appropriate place, before any laterite excavation starts. Part or non-removal of overburden will result in mixture of remaining overburden with excavated laterite. Stocking of overburden at wrong areas may result in double handling of the same material when extension of the quarry is required. Picture 4 shows a labourer excavating overburden, while others excavate and stockpile gravel on top of an area where the overburden is not yet removed. Situations like this are bound to cause organizational difficulties, and also result in poor quality work and associated disputes.



Picture 4:

Labourer
excavating
overburden
in quarry
along
Mwamanyili-Badugu
road, Magu
District,
Tanzania.

The total volume of overburden in the quarry is estimated in the contract document by measuring the actual overburden of the initial test pits and multiplying the average height by the area of the quarry. In actual case this quantity can be considerably less or more. Therefore, it is essential to measure the actual quantity of overburden removed from the quarry. The measurement of removed overburden should be carried out together with the contractor in order to avoid disagreements in the claiming process. There are several options to determine the removed overburden:

- 1. Simply follow the overburden estimates from the quarry plan. With this option, the supervising officer must ensure that all overburden is removed from the complete quarry area according to the plan. However, since the estimates are based on test pit results at large intervals, the estimated quantity may differ substantially from the actual work done.
- 2. Measure the stockpiles of overburden after they have been removed and placed in the stockpile area. With this method, it must be ensured beforehand, that the deposit area is cleared and reasonably levelled and that the overburden is stockpiled in a systematic manner.
- 3. Take actual levels of the entire quarry area before and after the excavation of overburden. With the last option, the supervising officer measures the average level of the quarry with a levelling instrument and a staff. This method can be accurate if the levels are measured at small intervals (say 2 to 5 meters

depending on the roughness and gradient of the quarry area). For a quarry area of 50 x 40 meters, between 80 and 500 readings are required, depending on the intervals used. Also a fixed bench mark has to be selected and used to compare the measurement results before and after excavation. If well implemented, the third method is the most accurate one, and requires least supervision during the removal of overburden. This method is applicable where the quarry area is relatively flat, and the level instrument does not have to be moved too many times.

Whichever method is selected, it is very important that the supervising officer ensures and insists that the overburden is removed *from the total quarry area* **BEFORE excavation of laterite starts**. Task rates for preparatory activities in the quarry are given in Figure 7 below, and the supervising officer must ensure that labourers are not exploited and daily work tasks are set correctly.

Figure 7 ACTIVITY	TASK RATE						
RESHAPING ROAD	20 - 50	m/MANDAY					
CLEARING BUSH	200 - 1000) m²/MANDAY					
EXCAVATING OVERBURDEN + LOADING ONTO WHEELBARROW IF NECESSARY	2 - 4 m³/MANDAY						
HAULING OVERBURDEN BY WHEELBARROW *	QUANTITY	NO OF TRIPS/DAY					
0 - 40m 40 - 60m 60 - 80m 80 - 100m	10.5 m ³ /MANDAY 8.0 m ³ /MANDAY 6.5 m ³ /MANDAY 5.5 m ³ /MANDAY	210 160 130 110					

NOTES:

- Task rate for hauling and tipping only: excludes loading and spreading.
- Assuming wheelbarrow volume equivalent to 0.05cum of compacted/insitu material (0.07cum loose) when struck level with top of bodywork.
- 2 wheelbarrows assigned to each hauling labourer.
- Good haul route (Reduce tasks for poor haul route).

The task of the supervising officer during the operation of quarry preparation can be summarized as follows:

	CHECK QUARRY PREPARATION.						
Who:	Consultant Supervisor.						
Why:	To ensure that gravel sources are established at correct locations and according to the Quarry Plan, and the material is in sufficient quantity and of acceptable quality.						
When:	Before the start of excavation of laterite.						
What:	 Check correct location of gravel source as per Quarry Plan and that the contractor clears the quarry within the specified area. Check availability of gravel by analyzing more test pits, dug by the contractor. Check quality and thus suitability of gravel, either by laboratory test or field tests. Check that correct task rates are set. Check that overburden has been placed at the correct location, and not there where the quarry may have to be extended. Check that ALL overburden is removed from the quarry area BEFORE excavation starts. Check actual quantity of removed overburden and verify for payment. Check that the quarry has good possibilities for drainage during the rainy season. 						
Tools:	Levelling instrument, staff and 50m measure tape.						

Item 1.9: Tree and Stump removal (larger than Ø-20cm).

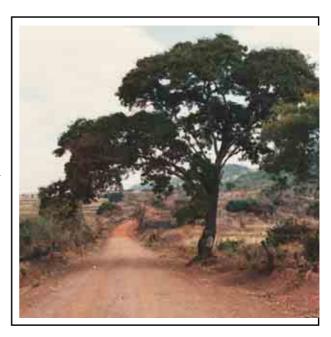
Trees and stumps smaller than \varnothing -20cm are covered under item 1.5 of the contract document; however, larger trees and stumps are removed on the basis of workerdays spent. The contractor is required to submit to the supervising officer a *Day Works Request*, which specifies the amount of work and an estimation of the inputs required in terms of worker days. A day works request is not submitted for each single tree larger than 20cm, but the contractor submits one request for all trees within a specified section of the road (e.g. one kilometre). It is the task of the supervising officer to ascertain the necessity for cutting big trees. Table 1 below gives a guideline on the workerdays required to remove trees and stumps of different diameter, measured at 1 meter above ground level, which will be paid for under item 1.9 of the standard BoQ.

Table 1: Worker days required for tree and stump removal

Ø in cm	Girth in cm	Wd per tree
0 – 20	0 - 63	MBC
20 - 30	63 – 94	0.50
30 – 40	94 – 126	1.00
40 – 50	126 – 157	1.50
50 - 60	157 – 188	2.00
60 – 70	188 – 220	3.00
70 – 80	220 – 251	4.00
80 – 90	251 – 283	6.00
90 – 100	283 – 314	8.00

The supervising officer must ensure the following:

- ✓ Investigate any technical possible solution in order to avoid cutting of a large tree.
- Before removal of big trees starts, check and agree on required worker days.
- ☑ Check that all trees and stumps have been re-



<u>Picture 5:</u> Large tree saved by construction of a mitre drain just before the tree, at Chiparambe Loop, EP – Zambia.

moved within the previously cleared area and that stumps have been uprooted and disposed off outside the cleared width.

	CHECK AND MEASURE LARGE TREES AND STUMP REMOVAL
Who:	Consultant Supervisor.
Why:	To ensure that no big trees are cut unnecessarily, and avoid if technically possible.
When:	Before the start of Earth Works.
What:	If required, agree first on workerdays input required with the contractor. After that make sure that tree, stump and debris is disposed off outside required cleared width.
Tools:	Measuring tape (5m), WD-input table

SECTION 2. EARTH WORKS

This section deals with the activities covered in Bill 2 of the contract document. After carrying out these activities, the rehabilitated road should be (re-) shaped to the road standard specified in the contract. The Detailed Improvement Plan (DIP), as shown in Table 2 below, provides all technical details and instructions to the contractor on quantities and standards of work to be achieved, such as the type of cross-section. As with clearing of vegetation, also the earth works quantities are MBC-items, which are agreed by the contractor at the signing of the contract. It is the task of the supervising officer to ascertain, that the required standards of work are achieved and correct methods and procedures are followed, rather than checking on quantities of work.

Table 2: Section of Detailed Improvement Plan (DIP)

Detai	led Im	provement Plan	Ro	oad	No	.:	Cł	ifu	nfu	2	Di	stri	ct:		Se	eng	еге	ma					Fr
Cha		(kilometres)	4				4				4				4				4				4
Chain-age		(metres)	+ 0				+ 100				+ 200				+ 300				+ 400				+ 500
Road form.		Subgrade	SS	88	SS	SS	SS	80	S	SO	SO	SO	S	SO	SO	S	80	80	SO	SO	SO	SO	SO
n.		Cross section	A3	స్ట	23	A3	АЗ	$\stackrel{\lambda}{\omega}$	E3	EЗ	E3	В	В	В	E3	В	В	ЕЗ	E3	В	ЕЗ	EЗ	띪
Earth- works		Method	SBO	SBO	OBS	SBO	SBO	OBS	ETL	TT3	ETL	TIJ	ETL	TIJ	RES	RES	RES	RES	RES	ETL	TT3	LTL	ETL
ks th		Volume (m3/m)	0.2	0.2	0.2	0.2	0.2	0.2															
Gra- wel		Thickness (cm,comp.)	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
<u> </u>		Source (quarry No.)	-	-	1	1	1	_	1	1	1	_	_	-	1	_	_	1	1	-	1	1	-
	Lon	gitudinal gradient (in %)	۵	۵	-6	-4	-3	-2	-2	-2	-2	\pm	<u>-</u>	<u>-</u>	-2	ώ	0	-1	-1	<u>-</u>	-	-1	<u>-</u>
Mitre drains	Total	Number left =	L				1	-	1														
ins	38	Number right =					1	1	1	1	1	1	_	_	1	_	1	1	1	1	1	1	_
Catch water	Total	Length of drain left =	Γ					25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
ter_	675	Length of drain right =	25	25	25	25	25																

There are three different methods of earthworks distinguished in the DIP, and the design engineer has determined which method is to be used per 25 meter section. The three methods are:

- RES = Reshaping
- ETL = Excavation to Level
- SBO = Side Borrow

Reshaping is used on sections of road, where the road embankment has a reasonable shape and where side drains exist, but need to be desilted.

Excavation to Level is the most common method in road rehabilitation and requires the contractor to build the road embankment from a level platform, which first has to be prepared by balancing cut and fill over the cross section of the road.

Side Borrow is used where the road needs to be raised, and where the material from the side drains will not be sufficient to establish this. In this case, material needs to be borrowed from further distance.

All methodologies to carry out earthworks are described in the Technical Manual. It is a major challenge for the contractor, the gang leaders and supervisors to set out the works correctly,

organize the labourers, assign fair tasks to them, and see to it that the end result will be a feeder road built to the standards required.

The consultant supervisor's job should be confined to carry out some simple inspection measurements after the road has been built, however, intermediate checks and corrections can help to avoid major problems at the end of the works.

Item 2.1: Slotting

Slotting is the first activity of Bill 2, and according to the specifications, the contractor is required to prepare slots at 10 meters interval, covering the free-clearance width specified in the contract. The slots visualize the amount of cut and fill over the cross-section



<u>Picture 6:</u> Slotting and Excavation to Level at Mwamanyili – Badugu road, Magu District, Tanzania.

of the road, and provide a clear guidance to the labourers on how to prepare a level platform from left to right. The slots should be established in such a way that the area of cut equals the area of fill. At this stage, it is also important that the slots balance in longitudinal direction. Methods to set out vertical alignments are extensively explained in section F-5 (pages F24 to F34) of the Technical Manual.

If 3 sequential slots are out of vertical alignment by more than 10cm, which must be checked using boning rods, then the slots should be adjusted by transporting material between adjacent slots as shown on Figure 8 on following page.

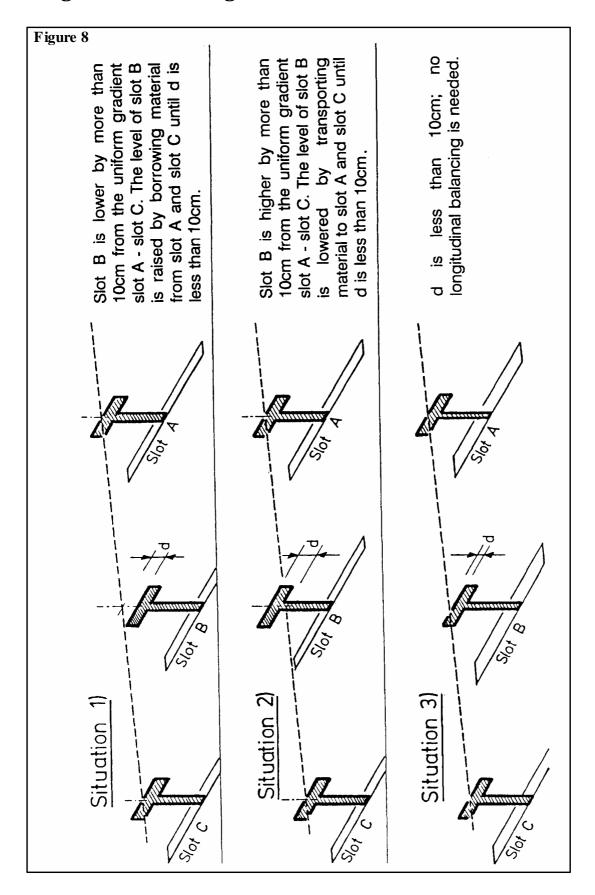
Transport of soil for longitudinal balancing is included in the rate under Item 2, 'Excavation to Level or Side Borrow' up to a haul distance of 10 metres. For longer haul distances, the contractor can claim the haulage of soil under item 2.7, 'Haulage by Wheel barrow', which is provided for in 3 different ranges (see table 3):

Table 3: Haulage by Wheel barrow

<u>Haulage by</u>	Wheel barro	w:
10 – 50	metres	5 m³ loose per day
50 – 100	metres	4 m³ loose per day
100 – 200	metres	3 m³ loose per day

Above task rates for 'Haulage by Wheel barrow' include loading, hauling and tipping.

Longitudinal Balancing.



Item 2.21 or 2.22: Excavation to Level (ETL)

ETL is the first and basic activity of the construction of the road embankment.

With ETL a level platform is created from left to right over the entire grubbed width. If the ETL is not done correctly, e.g. there are differences in level from left to right, it will be very difficult, to construct a correct final cross-section. Ditches will end up being at a different level, and it will be hard to achieve the same camber at both sides of the road. Expensive correction works may have to be ordered to the contractor. In order to avoid this, the contractor should take good care that ETL is carried out to the correct standards.



<u>Picture 7:</u> Excavation to Level at Yitwimila – Ijitu road, Magu District, Tanzania.



<u>Picture 8:</u> Excavation to Level at Mwamanyili - Badugu road, Magu District, Tanzania.

As shown in Picture 8, the gang leader can use a straight edge and a spirit level to quickly check whether a level platform has been achieved. Before the levels are finally checked with a set of boning rods, line level and a traveller for intermediate levels, the platform should be compacted to the required standards as specified in the contract. It is the role of the supervising officer to point out to the contractor where balancing is required in longitudinal direction.

The supervising officer should carry out control checks on ETL, compaction and longitudinal balancing, but these checks should not delay the contractor from continuing with the next activities. Excessive control procedures on site will not be sustainable and will cause delays in the progress of the works.

Picture 9:

Compaction of ETL at Yitwimila - Ihale road, Magu District, Tanzania.

It is better to provide clear guidelines on



standards, acceptable levels of deviation, and schedules of penalties (e.g. deductions), when certain standards are not met. Special attention should be given to the compaction of ETL. Especially where deep ruts were filled with borrow material, care must be taken to compact in sufficient thin layers so that uneven settlement at a later stage will be avoided.

	CHECK THE QUALITY OF ETL ON A REGULAR BASIS AND TAKE CORRECTIVE MEASURES IF REQUIRED.
Who:	Consultant Supervisor.
Why:	To ensure that ETL is carried out correctly.
When:	Before the start of ditch excavation.
What:	Supervisor should carry out following checks: 1. Uniform levels over cross-section 2. Smooth gradients in longitudinal direction 3. Width of platform is conform specifications 4. Platform is properly compacted
Tools:	Boning rods, line level and a 25m tape measure.



<u>Picture 10:</u> Side-borrow from widened side drain at Chiparamba Loop road, Chipata District, Zambia.

Item 2.23: Side Borrow and Embankment construction

Side borrow is any material required to build or repair the road embankment, over and above the material, which is excavated from the side drains. This will be the case when deep ruts or potholes must be filled at ETL stage, or when the road embankment needs to be raised. In labour-based road construction, side borrow is taken from enlarged or widened side drains, therefore the name *side borrow*. In certain cases, when the road leads through a village, a forest or through area's with poor sandy soils, the borrow material may have to be imported from a further distance. A haulage distance of 0 - 10 meters by wheel barrow is deemed to be included in item 2.2 of the BoQ, '*Excavation to level or Side borrow*'.

Within a distance of 200 meters, item 2.7 of the BoQ, 'Haulage by wheel barrow' takes care of the required transport. If the borrow material has to come from any further distance, alternative transport methods have to be used and a 'Non-standard item' has to be taken up in the BoQ.

The Detailed Improvement Plan (DIP) gives a clear guideline to the contractor, where side borrow has to be used to assist building the road embankment. Table 2 on page 60 shows requirement of side borrow (SBO) between chainage 4+000 to 4+150 of 0.2 cubic meters per meter length of road. The standard ditch of 60cm wide by 35cm deep, should be widened by app. 30cm on each side to provide for this extra quantity of soil.

In general, following formula can be drawn up to calculate the required ditch widening for a certain extra required quantity of fill:

If the required extra volume is large, so that the extended side drain falls outside the cleared and grubbed width, the contractor should be paid extra man days for clearing and grubbing of the extra area.

For side-borrow of 0.5 cum/m, the side drains on both sides must be more then doubled.

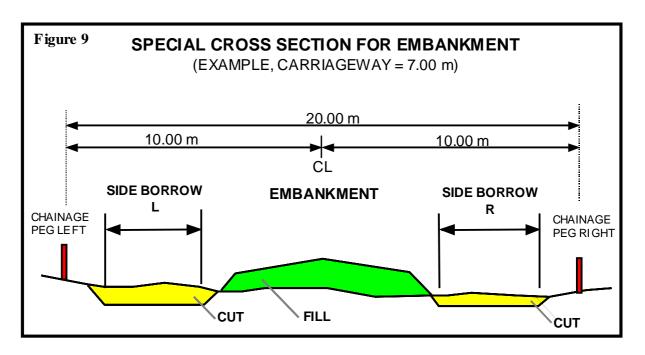


<u>Picture 11:</u> Side-borrow from widened side drain at Ilula - Manea road, Kwimba District, Tanzania.

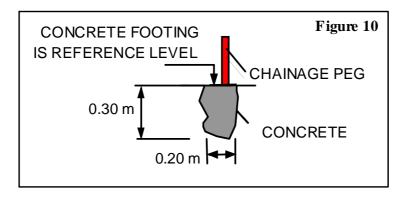
From the widened side drains, the supervising officer can easily check whether side borrow has actually been carried out. If widening of side drains is not possible, the supervising officer should insist that material is borrowed from orderly and well-established pits, rather than borrowing a bit of soil from here and there.

Special attention should be given to sections where the road must be raised to such an extent that a side drain is not required anymore. This will be the case when a marsh (dambo) area must be crossed, and an extra wide cross-section should be specified.

A special cross-section for embankment will be specified as shown in Figure 9 on the following page.



In order to accurately calculate the amount of work done by the contractor, the supervising officer must establish semi-permanent benchmarks and take cross-sections before and after the work at a minimum of 25 meters interval.



The best method is to place chainage posts in a concrete footing, and use the top of the concrete as a benchmark for

the cross-section at that specific chainage (see Figure 10). In this way, clear instructions can be issued to the contractor as to how far above the reference level, the embankment needs to be built up.

Regarding side-borrow, a number of issues are to be checked by the supervising officer, and they include:

- Check the quality of materials used. It should be as specified or better quality material e.g. the soil should be free from vegetation material like roots, grass or top soils. If possible red soil or any other firm soils can be used.
- Check that the compaction is done, and that it has been done properly in layers, with the soil at its optimum moisture content.
- In case of minor raises of the standard road embankment, check the increased size of the side drains, and compare with the required raise.
- In case of full embankment sections, issue the contractor with level references and check the setting out. Make sure that high embankments are built and compacted in layers not exceeding 15 centimetres.
- Check the levels of completed fill and compare with the specified levels as instructed in the contract document, especially for those sections, where embankments are raised considerably.
- For high embankments, check actual side borrow done by measuring cross-sections before and after construction.

To summarize, the supervising officer should carry out following checks in respect of the application of Side Borrow:

	CHECK QUALITY AND QUANTITY OF SIDE BORROW.
Who:	Consultant Supervisor.
Why:	To ensure that side borrow is carried out according to the design in the DIP.
When:	Before the start of gravelling.
What:	Supervisor should carry out following checks: 1. SBO material does not contain vegetation 2. SBO is compacted according to standards 3. SBO is carried out according to design 4. Actual SBO is measured on embankments
Tools:	Levelling instrument, boning rods, line level, 25m tape measure, ditch template.

Formation of the road

After Excavation to Level is completed, the contractor must start building up the road formation. The DIP specifies the standard cross-section to be used per section of 25 meters.

Five different cross-section types can be distinguished:

Cross section A: Standard cross section

Cross section B: Reduced cross section

Cross section C: Super elevation cross section

Cross section D: Embankment cross section

Cross section E: Black cotton soil cross section

Each of the cross sections has their own design measurements, and under each category there are sub-designs, to take account of different traffic volume conditions. Drawings of all standard cross-sections are provided in Annex C1. The most common cross-section used for feeder roads in Zambia is cross-section A3, which is shown in Figure 11 on following page.

The main characteristics of this cross-section are:

Table 4: Road characteristics of X-section A

Carriage width: 5.50 meters

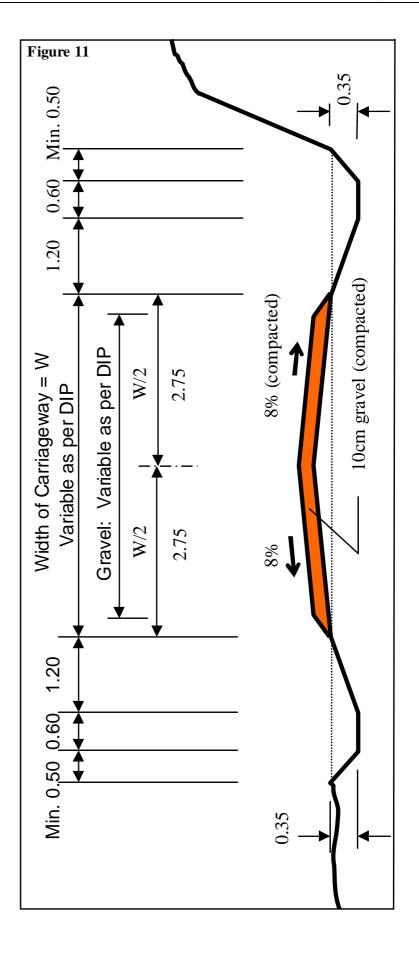
Side slope: 1.20 meters

Ditch: 0.60 m wide, 0.35 m deep

Camber: 8% compacted

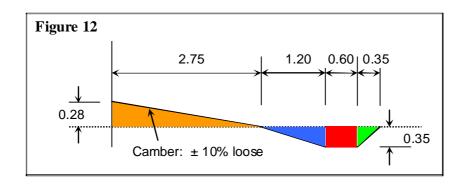
Minimum gravel: 10 cm compacted

Standard Coss Section A3



In labour based road construction, the formation of the road is built up in four steps, which are all to be carried out separately. That is why the four steps are also contained in Bill 2 of the BoQ as separate items (refer to Figure 12 below):

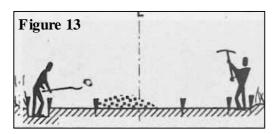
- 2.3 Ditching and spreading (red square)
- 2.4 Back sloping and spreading (green triangle)
- 2.5 (Fore) sloping (blue triangle)
- 2.6 Camber formation, final shaping, (brown triangle)

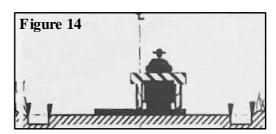


Of the four steps listed above, the first step *Ditching* is the most important one and needs to be carried out and checked by the consultant on a regular basis. The reason why is, that the size of the ditch (red square) will also determine the quantity of soil coming from the back slope (green triangle) and the fore slope (blue triangle), and all three together comprise the required material for the formation (brown triangle). If the ditch is dug to shallow, the material from the back- and fore slope will also be less, which will result in a formation which is not high enough.

Item 2.3: Ditching

Before ditching can start, the contractor needs to set out the extents of the ditch as per standard cross-section with ropes. The excavated ditch material needs to be placed in the central 3 meters of the road formation, spread out and compacted as a flat platform. This is called the *Plug* (see Figures 13 and 14 below). A proper organization of this activity is important.





Care must be taken with the calculation of task rates, as the ditching activity also includes spreading of the soil. It is usually organized in such a way, that for a group of 4 workers assigned to ditching, one additional worker is assigned to spreading. Many contractors may complain that the soil is too hard and that the required

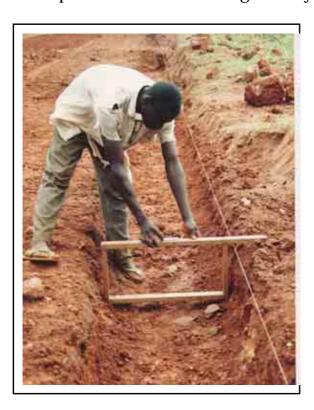


<u>Picture 12:</u> Ditching and spreading to plug at Eastern Dairy - Madzimoyo road, Chipata District, Zambia.



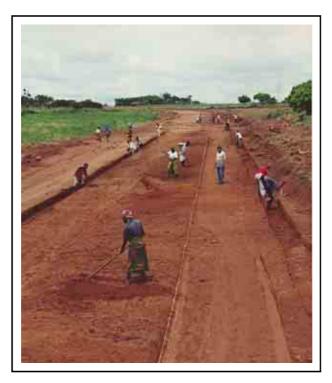
<u>Picture 13:</u> Ditching and plug formation at Mwamanyili - Baduqu road, Magu District, Tanzania.

production norm (usually $3-4~\text{m}^3$ In Situ per worker day) can not be reached. However, the contractor should be advised to alter the tasks according to the hardness of the soil. Pictures 12 to 16 give an impression of the ditching activity. Ditching is a hard job, espe-



cially in the dry season. The contractor should always be advised and encouraged to water the ditch area in the evening, before the ditching is carried out.

<u>Picture 14:</u> Control of ditch excavation with a "Ditch Template", at Ngudu - Sumve road, Kwimba District, Tanzania.



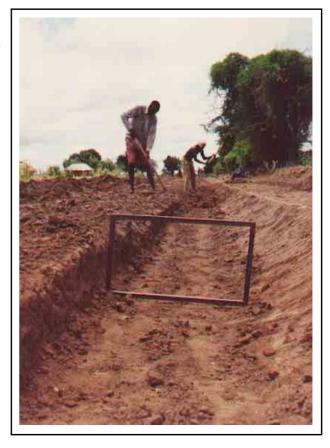
<u>Picture 15:</u> Ditching and plug formation at a well-organized site, at Kisesa - Kayenze road, Magu District, Tanzania.

In really dry conditions, the workers can excavate the first 10 centimetres of the ditch, where after water is poured into the partly excavated ditch. During

the night, the water will penetrate in the soil beneath to make it softer. Many contractors will argue that this will cost extra money, but with this extra

effort, the soil will also have sufficient moisture for compaction after it has been spread to form the plug, and hence less watering is needed for the compaction activity.

Picture 16: "Ditch Template" shows that ditch is not to required level, while back sloping is already completed, Ngudu - Sumve road, Kwimba District, Tanzania.



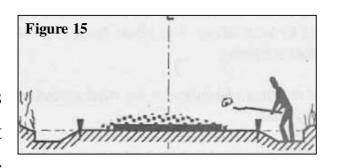
To summarize the Consultant Supervisor's role in relation to the 'Ditching' activity, following aspects have to be remembered:

- Check that ditches have been set out properly to the required sizes with pegs properly placed.
- Check that strings and ditch templates are used during excavation of the drains. These would guide the workers and also the gang leader to certify tasks.
- Check with the ditch template that the ditches have been excavated to the required width and depth.
- Check that all material is placed at the centre third of the road width and uniformly spread, watered and properly compacted.

	CHECK EXECUTION OF DITCHING.
	CITEOR EXECUTION OF DITORING.
Who:	Consultant Supervisor.
Why:	To ensure that the ditch is dug according to the measurements specified in the drawings and that the ditch material is deposited correctly to form the plug.
When:	Before the start of back- and fore sloping.
What:	Supervisor should carry out following checks:
	1. Location related to the centreline
	2. Width and depth excavated
	3. Evenly spreading of ditch material to form plug 4. Plug is compacted to specified standards
Tools:	Ditch template, 25m tape measure.

Sloping of the side drain

Sloping of the side drain is done in 2 steps. In most cases, first the back slope is

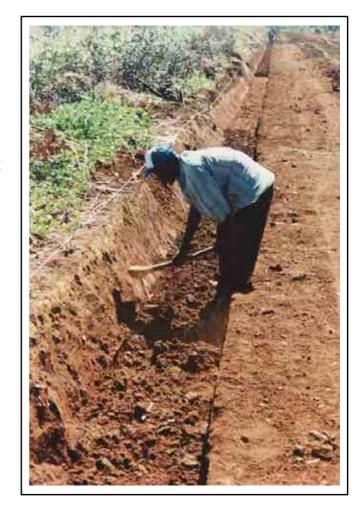


cut, and then the fore slope. The reason for this following order is that in road rehabilitation, the best material from the old road surface such as laterite is most likely to be found closer to the centre line, and this is the material, which should preferably be placed back in the top layer of the new formation.

Item 2.4: Back sloping

After ditching is completed, the back slope is cut. The loose material will fall in the ditch, but can easily by shovelled out and thrown on the centre third of the road.

<u>Picture 17:</u> Back sloping carried out on Eastern Dairy – Madzimoyo road, Chipata District, Zambia.





<u>Picture 18:</u> Back- and fore sloping at Kisesa - Kayenze road, Magu District, Tanzania. Please note the wrong placement of the material on the formation width.

Where the cut face behind the side ditch is more than 1.0 meter high, it may be easier to carry out the back sloping operation even before the ditching operation.

A very common mistake made out of convenience by the workers is, to throw the sloping material right at the edge, rather than at the middle third of the carriage way on top of the compacted plug, as shown in Picture 18 above (see arrow) and Picture 19 on the following page (also see arrow).

The formation of the camber will be extremely difficult, and the same soil needs to be handled twice, as it has to be thrown again to the centre of the road before it can be shaped to camber. Figure 15 on the previous page shows the correct procedure.



<u>Picture 19:</u> Back sloping at Kisesa - Kayenze road, Magu District, Tanzania.

Picture 20 on following page very well illustrates the problem: The female worker is busy moving the sloping material from the edge of the road to the centreline, where the existing soil is far below the guiding rope. If the material would have been thrown on the centre line immediately by the 'sloping' workers, simple raking from the centreline to both edges would have formed the camber. The convenience taken by the 'sloping' workers is causing an extra and unnecessary burden for the 'spreading' workers. Besides the double handling of the soil, also the density of the formation at the edges ends up being higher then at the centre of the formation. The road will quickly flatten out and the envisaged camber will not be there after consolidation of the formation.



<u>Picture 20:</u> Spreading of sloping material to camber at Kisesa - Kayenze road, Magu District, Tanzania.

It is the task of the supervising officer to point out to the contractor the importance of following correct procedures in order to ensure quality of work and fair treatment of all workers. The supervising officer should also check on following issues:

- Check that specified widths and slopes are properly marked with pegs and strings and that cuts are done straight to the ditch bottom and that it is done immediately after ditching.
- Check that the material is placed at the centre third of the formation width, on top of the compacted plug.
- ✓ Check that strings are used during the cutting of back slopes to ensure straight lines.

Item 2.5: Fore sloping

The second step of the sloping operation is the cutting of the fore slope. It is again important to see to it that the material is placed on the centre third of the road width.

Good organization of the workers and proper assignment of tasks, also contributes to the quality of the works. It is the task of the supervising officer to advise the contractor on these aspects. The task rates given in Annex B2 show different rates for ditching (lower, 3.0 to 4.0 cum per worker day) and sloping (3.5 to 4.5 cum per worker day) which is higher, because it is more difficult and harder to excavate a ditch then to cut down a slope.



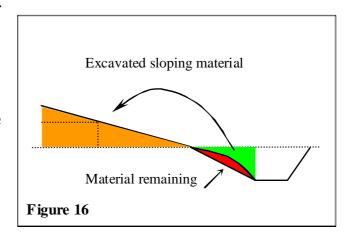
<u>Picture 21:</u> Cutting of fore slope at Kisesa - Kayenze road, Magu District, Tanzania.



<u>Picture 22:</u> Fore sloping at Ngudu - Sumve road, Kwimba District, Tanzania. Please note poor organization of workers.

Picture 22 above shows an example where 3 workers are standing directly besides each other cutting the fore slope. Not only is the risk of injuries greatly increased, but also the efficiency of the work is very much hampered. Pictures 15 and 18 show examples of a well organized labour based site organization. Another important aspect to check in the sloping operation is, that the slope is cut

straight from the edge of the carriage way down to the bottom of the ditch. This is shown in Figure 16, where the green



section depicts the material actually excavated, and the red section the material left behind, causing insufficient material to be available for formation of the required camber. The supervising officer should check with a 'Ditch-Slope Template', that the fore slope is cut straight. Regarding fore sloping, the supervising officer should check on following issues:

- ☑ Check that the slopes are properly set out to specifications and properly marked.
- ☑ Check that fair tasks are given to the workers.
- ☑ Check that strings and ditch/slope templates are used to ensure straight lines of work.
- ☑ Check on a straight cut from camber edge to ditch bottom.
- Check that material is placed at the centre third of the formation width.



<u>Picture 23:</u> Checking of ditch and foreslope with the 'Ditch-Slope Template' at Sengerema - Ngoma road, Sengerema District, Tanzania.



<u>Picture 24:</u> Formation of camber at Kisesa - Kayenze road, Magu District, Tanzania.

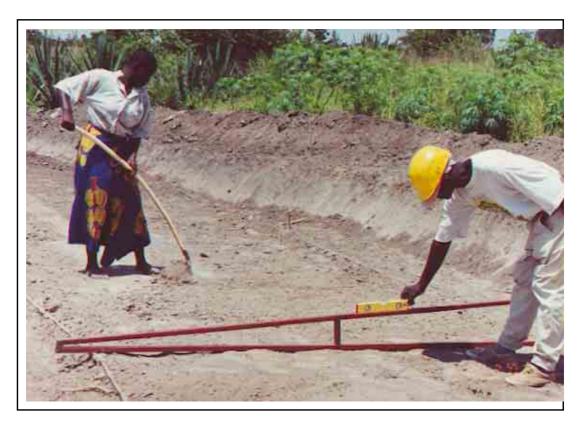
Item 2.6: Camber Formation

Camber formation is the final touch to the formation of the road embankment. If the material from back- and fore slopes are correctly placed at the centre third of the road width on top of the compacted plug, the camber can easily be formed by raking the material systematically back to both edges of the road. The best tool to use for this operation is a heavy duty and extra wide garden rake, or a special manufactured soil spreader cut out of 4mm steel sheet. The supervising officer must make sure that the workers are properly guided by ropes, set out along the centre line and the edge of the road at the correct levels.

The camber is checked with a 'Camber-board', an example of which is shown on Pictures 25 and 26. It is very important for the contractor to carry out the camber formation accurately and without major defects BEFORE the starting of the graveling operation, because making corrections with gravel is much more expensive than to correct them using earth.

Regarding the formation of camber, the supervising officer must check on following issues:

Check that the material is spread uniformly to specified width and forms a cross fall from the centreline to the edge of both sides of the road (camber) by the specified percentage,



<u>Picture 25:</u> Checking of camber cross-fall with the 'Camber-board' at Sengerema - Ngoma road, Sengerema District, Tanzania.

- so that water is allowed to flow freely to the side drains on either side.
- ☑ Check longitudinal gradients that they are gentle and not bumpy. If bumpy, the depressions should be filled or cut to balance with depressions.
- ☑ Check for proper use of strings and camber board during camber formation.
- Check for proper compaction.



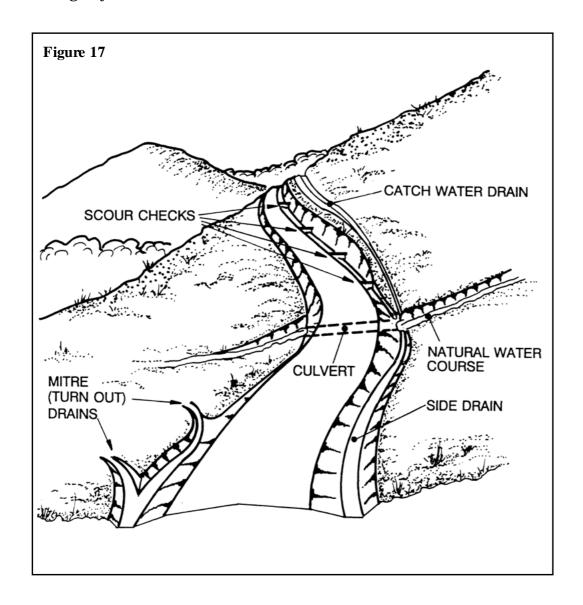
<u>Picture 26:</u> Checking of camber cross-fall with the 'Camber-board' at Ilujamate – Lubili-B road, Missungwi District, Tanzania.

After completion of the ditching, sloping and camber formation operations, the supervising officer must carry out a summary check on the quality and shape of the road formation. This check must be carried out before the graveling starts, so that required corrections can be carried out before the graveling operation.

	CHECK ROAD FORMATION IN EARTH.
Who:	Consultant Supervisor.
Why:	To ensure that the overall road formation has been constructed to the specified standards.
When:	Before the start of the graveling operation.
What:	 Supervisor should carry out following checks: Level difference between bottom of left and right side drain is nil. Width of road is as specified. Cross-fall of camber is as specified. Shape and size of side drains are as specified. Level difference between centreline and bottom of both side drains (left and right) is as specified. Formation is compacted to specified standards.
Tools:	Camber board, 25m tape measure, ditch template, boning rods, line and level.

SECTION 3. DRAINAGE AND STRUCTURE WORKS

Rain water is the biggest enemy of a road and should be led away from the road at regular intervals and at any appropriate location. Although covered only in Bill 3 of the BoQ, drainage works should be regarded as important as the actual road formation itself. Without a properly designed and constructed drainage system, the earth or gravel road, is bound to fail very soon, which is also part of the drainage system.



The drainage system is one of the most important features of the road. It consists of side drains, mitre (or turn out) drains, cross drains, catch water drains and scour checks. Cross drains may be culverts, drifts, vented drifts, fords or bridges. For an overview, see Figure 17 on previous page.

During the construction process, it is essential that the drainage features are constructed at the same time as the road formation itself, or preferably (if possible) ahead of formation works. Especially when works are carried out during the rainy season, it is important that the drainage system is functional to avoid completed road formation work from being damaged or washed away. Mitre and discharge drains will lead away unexpected rain water, and a catch water drain may prevent it from reaching the road at all.

Bill 3 of the BoQ covers all work related to the construction of drainage structures, simple as well as complicated ones. These include:

- Excavation of drainages other than side drains
- Construction of scour checks
- Supply and installation of culvert pipes
- Masonry works
- Stone pitching and gabion works
- Concrete works

Any items not covered in Bill 3, such as supply and placing of reinforcement, building of form work, etc. may be introduced as a Non-Standard item in Bill NS of the BoQ.

For the drainage design, the contractor should be guided by the Detailed Improvement Plan, which provides all details of the drainage as prepared by the design engineer (see Table 5 below).

Table 5: Section from the Detailed Improvement Plan showing details of the drainage design.

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However, in general it is the task of the supervising officer to verify the need and correctness of any design feature proposed in the Detailed Improvement Plan.

Item 3.1: Excavation of other drainages

The first item in Bill 3 comprises the excavation of other drainages, and it is subdivided in excavation of drains *outside road formation*:

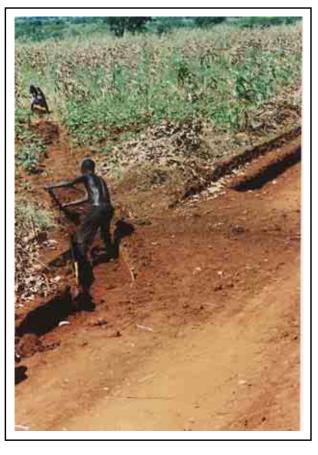
- Mitre drains
- Catch water drains
- Culvert discharge drains

and excavation of drains within road formation:

- Culvert trenches
- Excavation for culvert inlets and outlets
- Excavation for side access drifts or culverts
- Excavation for drift and bridge works.

Item 3.11a: Mitre drains

Mitre drains are in-expensive outfalls of the side drain, which should be dug at regular intervals where possible. Its function is to release the quantity of water collected in the side drain and lead it away from the road. A common error in the construction sequence of the drainage is, that first the entire side drains are dug to standard, and after that, the locations for mitre drains are set out for construction. This sequence causes double work in that the mitre bank in the side drain has to be replaced and compacted.



<u>Picture 27:</u> Excavation of mitre drain at Eastern Dairy - Madzimoyo road, Chipata District, Zambia.

It is far better in terms of quality and cost-effectiveness, to set out the locations for the mitres BEFORE the start of ditching, and instruct the workers to skip a section of 2 meters, which later will serve as the mitre bank. The soil excavated from the

mitre drain can be used to replace the soil, which is omitted from the side drain. Besides the fact, that the quality of the mitre bank is

better as it is formed with in situ soil rather than compacted soil, the cost savings are also considerable:



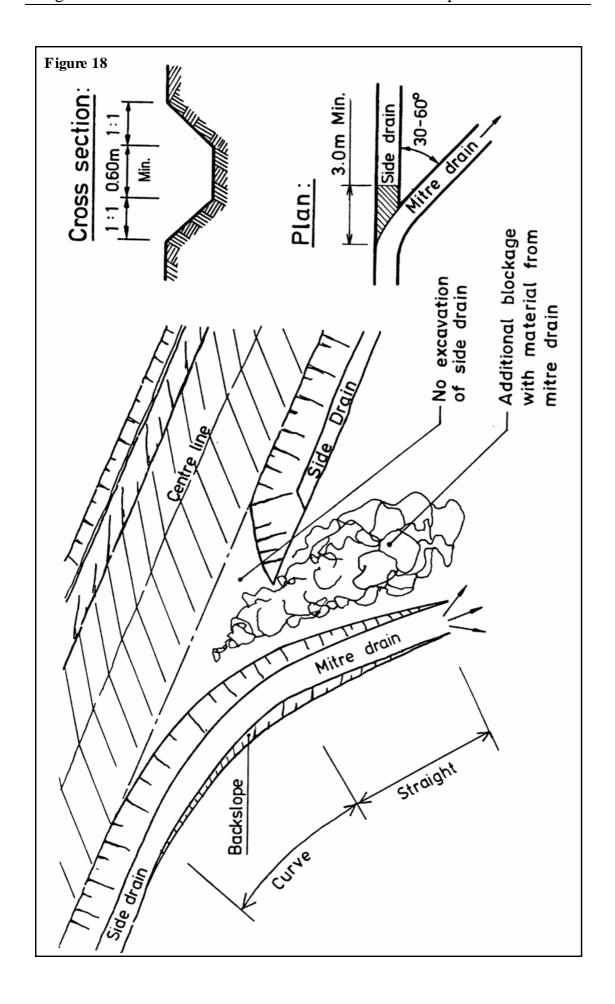
<u>Picture 28:</u> Well-functioning mitre drain at Eastern Dairy – Madzimoyo road, Chipata District, Zambia.

Assuming 30 mitre drains per kilometre, 60 meters of side drain excavation can be omitted, which is 30 cubic meters of excavation. Besides that, compaction of constructed mitre banks (also 30 cubic meters), is not required. This constitutes a saving of app. USD 50.-per kilometre. See Figure 18 on the following page for an overview of the construction method.

There are a number of issues, which the supervising officer must check in relation to the excavation of mitre drains:

- ☑ Check that mitres are set out at the correct locations where they can freely drain water away from side drains.
- ☑ Check that the cleared width is about 4m to allow space for spreading spoil material from the drain.
- Check that a diversion bund of in situ soil of app. 2 meters is left during excavation of the ditch.
- ☑ Check that the mitre is constructed to specified cross section.

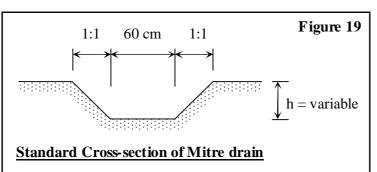
 Check bottom width and the gradients of the back sloped sides.
- ☑ Check that the mitre is excavated to a discharge point, from where the drain can freely discharge water from the side drain.
- Check that the spoil material is spread out to the sides, to avoid spilling back and causing blockage of the drain.
- ✓ Take cross-section measurements at app. 5 meters interval to calculate actual quantities of excavated soil.





<u>Picture 29:</u> Sample of failing mitre drain, because mitre bank is washed away, at Eastern Dairy - Madzomoyo road, Chipata District, Zambia.

The standard cross-section for a mitre drain is shown in Figure 19 below. In most cases, the depth (h) starts at 35 cm, which is the standard depth of the side drain, and then it gradually reduces to zero at the discharge point. Actual measurements of excavations are carried out by the supervising officer with a representative of the contractor, by measuring cross-section area's at regular intervals (say 5 meters), and multiply them with the distance between measurement points. A special form should be used, which is given in Annex D2-F7. A sample calculation is given in Figure 20 on the following page. This form is not only to be used for measurement



of mitre drains, but also for the measurement of quantity of excavation for

Figure 20

Item 3.11: Cal	lculation of	Excavation C	Outside road	formation	Culver	Culvert outlet / Mitre drain / Catchwater drain				Left /	Right
Chainage	1	2	3	4	5	6	7	8	9	10	
0+880	Invert				Discharge						Total
Chainage (m)	0.00	5.00	10.00	15.00	20.00						
Bottom (m)	1.00	1.00	1.00	0.90	0.90						
Top (m)	2.00	1.70	1.60	1.40	0.90						
Depth (m)	1.20	1.00	0.80	0.40	0.00						
Area (m2)	1.80	1.35	1.04	0.46	0.00						
Volume (m3)		7.88	5.98	3.75	1.15						18.75

catch water drains and culvert discharge drains. The results of measurements of each individual drain are entered in a summary form, which is attached to the monthly works claim submitted by the contractor. A sample of this form is shown in Figure 21 below, and the form itself is provided in Annex D2-F8. Again this 'Drainage Summary Form' is to be used for all drains excavated outside road formation.

Figure 2	1	DIST	RICT & FEE	EDER ROADS F	PROJECT	
				SPECTION F		
	Mitre,	Catch-	water and	l Discharge	Drains (M/C	/ D)
Contractor:			Rd nar	ne:	District:	
Chainages	Type of drain	L/R	Measured volume of excavation	Date inspected/approv ed	Signature	Remarks
0+150	D	L	24.5	07-03-03		
0+475	D	L	45.6	07-03-03		
1+300	M	R	15.6	07-03-03		
1+350	М	R	6.3	07-03-03		
2+650	D	L	45.1	07-03-03		
2+700	М	L	12.3	07-03-03		
3+100 to 3+850	С	R	265.4	07-03-03		
Tota	l volume (B	F):	414.8	Signa	ture of Contractor:	

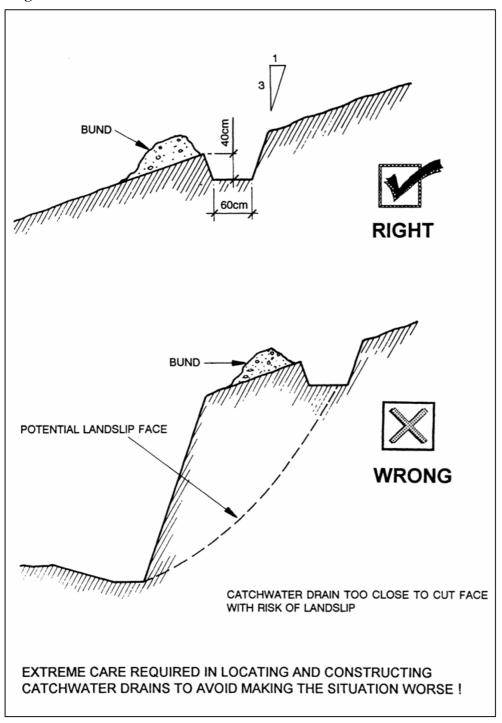
Item 3.11b Catch Water Drains

Where the road is situated on a hillside a significant amount of rainwater may flow down the hill towards the road. This may cause damage to the cut face of the road and even cause land slips. Where this danger exists a catch water drain should be installed to intercept this surface water and carry it to a safe point of discharge, usually a natural watercourse also coming from uphill, which needs to cross the road through a cross-drain or culvert. In any case, the catch water drain should be discharged at least every 200 - 300 metres through a cross drain to avoid that the accumulated water volume becomes too high. The supervising officer should check on the following in relation to catch water drains:

- If applicable, check that the land-owner's co-operation is obtained to construct and maintain the catch water drain.
- ☑ Check that the gradient in the catch water drain throughout its length is at least 2%.
- Check that the measurements are in accordance with the specified ones as shown in the diagram on following page (minimum 0.60m wide, 0.40m deep with sides back sloped at 3:1).
- ☑ Check that water flows freely and directly into a cross drain.
- Check that the drain, depending on prevailing soil conditions and height of cut face, is not constructed too close to the cut face, where it may increase the danger of a land slip.
- ☑ Check that scour checks are used if gradients in the drain are too steep.

Check that the material excavated to form the drain is placed on the downhill side to form a bund and that vegetation covers the sloping sides of the catch water drain and bund to prevent erosion.

Figure 22

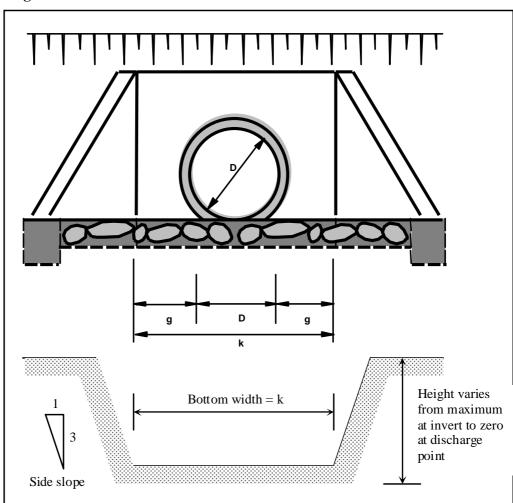


Item 3.11c Discharge or Outfall Drains

The excavation of discharge or outfall drains as part of smaller or bigger structures is also covered under the first item of Bill 3.

The cross-section of the discharge drain depends on the size of the cross drainage structure. Figure 23 below shows that the bottom width of the drain is related to the culvert designs, which are provided in Volume 2 of the Contract Document. The depth of the drain varies from maximum height at the invert to zero at the discharge point. The only fixed measurement is the slope, which should not be steeper than 1:3. In case of double or triple culvert

Figure 23



lines, the bottom width of the discharge drain alters accordingly. The volume of excavated soil from the discharge drain can reach considerable proportions, and it is very often left at the edge along the drain. An example is shown in Picture 30 below. This practice must be avoided as the soil will end up in the drain again, for what ever reason. It should either be spread out to both sides, or alternatively, it could be used for building up a ramp over the culvert, which would be required in many cases.

With regards to discharge drains, similar issues as with mitre and catch water drains must be checked however, special attention should be given to the following issues:

Avoid long discharge drains, as it will be difficult to maintain



<u>Picture 30:</u> Sample of culvert discharge drain, where excavated material is left at the edge, at Mbarika - Ilujamate road, Missungwi District, Tanzania.

- them. Try to restrict to a maximum length of 20 to 40 meters.
- Make sure that a proper minimum gradient is maintained of 2% from invert to discharge point.
- Check that excavated soil is not left at the edge, but removed or spread out to the adjacent field.
- ☑ Check that the side slopes of the drain have a minimum slope of 1:3.
- ☑ Take cross-section measurements at app. 5 meters interval to calculate actual quantities of excavated soil.

Item 3.12: Excavation of drains within road formation.

As presented before, excavation of drains *within road formation* consist of:

- Culvert trenches
- Excavation for culvert inlets and outlets
- Excavation for side access drifts or culverts
- Excavation for drift and bridge works.

The excavation of culvert trenches and culvert in- and outlets are the most common under this item, however, quantities for excavation differ, depending on the height of installation of the culvert pipe, which in turn depends on where the discharge point of the outfall is projected. The correct sequence of work is excavation of discharge drain, excavation of trench and installation of the culvert pipes.



Picture 31: Culvert trench and in- and outlet excavation, at Kijuka - Nyamahona road, Sengerema District, Tanzania.

The correct sequence is very important, especially in rather flat terrain where the length of the discharge drain should be set to a maximum of 20 to 40 metres. It is

best to start excavation at the predetermined discharge point, and work towards the trench. In this way, the danger of installing the culvert too deep will be avoided. Also the risk of flooding of the trench during rains will be eliminated. The supervising officer must check that the trench is excavated wide enough to allow for compaction of the backfill by a vibrating plate compactor, if the contractor so wishes. The supervising officer must also check that the foundations of head- and wing walls are accurately excavated below the level of the apron bottom, as per specifications, because in most cases, concrete for foundation of head- and wing walls and concrete for apron are poured together.

Where the role of the supervising officer regarding excavation of drains other than side drains is, to carry out random checks during the construction process as described in above paragraphs, a minimum of checks must be carried out upon completion of the drains:

	CHECK ALL DRAINAGE EXCAVATIONS
	OTHER THAN SIDE DRAINS.
Who:	Consultant Supervisor.
Why:	To ensure that mitre drains, catch water drains, discharge drains and excavations within road formation have been carried out to the specified standards.
When:	Drains outside road formation: At regular (monthly) intervals.
	Excavations within road formation: Before the installation of receiving structures.
What:	Supervisor should carry out following checks:
	 Cross-section of drains is dimensioned correctly. Longitudinal gradient of drains is at least 2%. Drains discharge freely
	 4. Spoil material is spread out or used elsewhere. 5. Excavated foundations have correct measurements. 6. Excavations are accurately measured and processed for payment.
Tools:	Levelling instrument, 25m tape measure, boning rods, line and level, straight edge, ranging rods.

Item 3.2: Construction of scour checks.

Scour checks are defined as small structures constructed in a drainage channel, which prevent erosion of the channel due to the impact of the fast running water on the soil. If drainage channels are constructed in sloping or steep terrain and have few outflows, the rain water can reach high velocities, which will cause the soil to be washed away, especially in poor, easy erodible soils. The deepening and widening of the drain thus caused is called erosion or scouring. In order to prevent the scouring effect of the fast running water, scour checks or check dams are constructed in the drain at certain intervals depending on the actual gradient of the drain and the quality of the soil (refer to table 6 below for recommended scour check spacing). Sandy and silty soils are poor soils which are easy erodible, requiring shorter spacing of scour checks.

Table 6: Scour check spacing

GRADIENT OF ROAD	ING ACC	IECK SPAC- ORDING TO NDITIONS	GRADIENT OF ROAD	SPACING ING TO SC	CHECK ACCORD- DIL CONDI- DNS
	GOOD	POOR		GOOD	POOR
2%	None	None	8%	7.5m	4m
3%	None	20m	9%	6m	3m
4%	None	15m	10%	5m	2.5m
5%	20m	10m	12%	4m	Lining with
6%	15m	7.5m			masonry
7%	10m	5m	15%	Lining with masonry	Lining with masonry

Different materials can be used for the construction of scour checks, such as stakes, loose packed stones or stone masonry. Especially in areas where trees are scarce, the use of stakes is not recommended, because of further negative effects on the environment. Another problem with the use of stakes is the risk of damage of the structure by termites, requiring frequent reconstruction. If loose packed stones are used, the construction must be properly carried out. The stones must be tightly packed and grass turfs must be placed around the stones to prevent disintegration of the stones by people or cattle walking over them. The FRP's in Zambia and Tanzania successfully introduced stone masonry scour checks, as shown in Picture 32, 35 and 36. Stones and sand are generally



available locally, and only cement needs to be added. If properly built, the result will be a long lasting and strong structure. With the excavation of the foundation of the scour check, care must be taken.

Picture 32: Scour check built of stone masonry along Eastern Dairy - Madzimoyo road, Chipata District, Zambia.

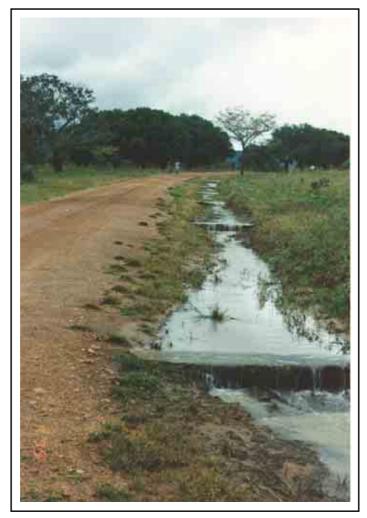


<u>Picture 33:</u> Excavation of foundation of a scour check, at Lundazi – Mwase road. Lundazi District. Zambia.

that the excavation is sufficiently extended into bottom, fore- and back slope of the side drain so that the scour check is well slotted in the ground, avoiding undermining by storm water flow. For further installation details see Technical Manual (page F56).



<u>Picture 34:</u> Construction of masonry scour check, at Nansio - Kigala road. Ukerewe District. Tanzania.



Picture 35:

Scour checks built of stone masonry along T4 – Chinkombe road, Katete District, Zambia.

Note the horizontal top surface, which will cause storm waters to by-pass the structure.

An important aspect of the role of the supervising officer is to check the correct locations and spacing of the scour checks.

Where ever possible, mitre drains should be constructed to reduce the amount of water in the side drain as much as possible. If there is no chance for mitre drains, the next intervention is the installation of scour checks. The role of supervising officer regarding installation of scour checks may be summarized as follows:

- ☑ Check that they are located at the correct locations according to the design or additional instructions of the Engineer.
- ☑ Check that the side drains are in good shape before setting out and construction starts.

- Check that the foundations are excavated in accordance with the measurements specified and that they are extended in the firm part of the fore- and back slope.
- Check the quality of the stones, sand and cement being used. The stones should be strong and clean so that they can bind with the mortar, which should be made of clean sand and fresh cement.
- Check that the workmanship of the finished structure is proper and in accordance with specifications.
- Make sure that abundant and left-over materials are removed



by the contractor and that the site is handed over clean and tidy.

Picture 36: Series of scour checks built of stone masonry along Eastern Dairy - Madzimoyo road, Chipata District, Zambia.

Item 3.3: Supply (manufacturing) of culvert pipes.

Cross drainage structures made of concrete culvert pipes are the most commonly used drainage structures on district and feeder roads. Depending on the terrain, an average of 3 to 5 culvert lines per kilometre is normal. As the name already indicates, the pipes should ensure that water can cross the road there where it is required.

The required capacity of the cross drainage structure depends on the amount of water, which is expected to cross in the worst circumstances. The size (diameter) of the rings and the number of lines is specified in the contract document on the Detailed Improvement Plan of the road (see Table 5, page 94 for a sample DIP). However, if after a rainy season the initial design capacity proves to be insufficient, in rural road construction it is fairly easy to increase the capacity of a drainage structure by constructing additional line(s) adjacent to the initial one. Such an instruction should be given to the Contractor through a Variation Order.

The first step in the construction of culverts is the manufacturing of the rings itself. The contractor has the choice to procure the rings from a specialized manufacturer. Most of the time, this is a more expensive solution, because the manufacturer would be working for a profit also. There is also a higher risk of breakage, which can occur during long transport over bad roads and handling during loading and off-loading operations.

The most preferable option for the contractor is, to manufacture the concrete rings at site under the contractor's own management. The contractor will be in control of the manufacturing process and is able to plan the production according to the work plan.

In the manufacturing process, the role of the supervising officer is to ensure that the conditions for proper concreting procedures are in place and that proper standards regarding concrete technology are adhered to:

- Basic materials such as cement, aggregates, sand and water must be clean and stockpiles must be properly stored.
- The casting floor (preferably a concrete floor) must be level and firm.
- The moulds must have no damages and deformations.
- A gauge box must be at the site to allow measurement of the ingredients by volume.
- > For curing, a shed is recommended and the use of sacks, which can be frequently dampened with water.

Figure 24 on the following page show design measurements of a gauge box for batching by volume of ONE bag of cement with the required number of boxes of the other ingredients. Table 7 on the next page shows the nominal mix designs by volume.

Figure 24 Gauge box to control mix proportions

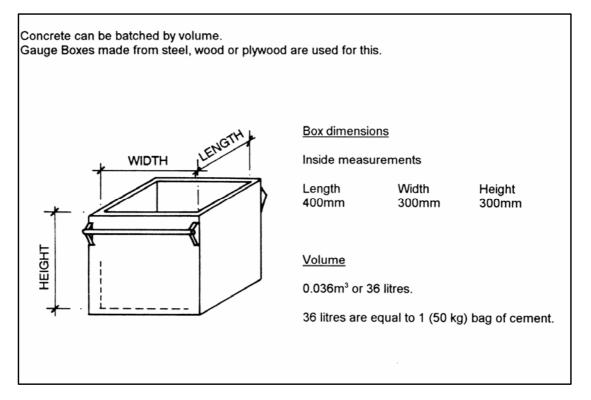
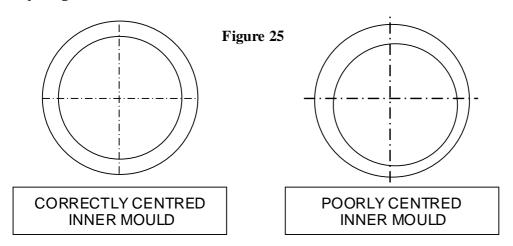


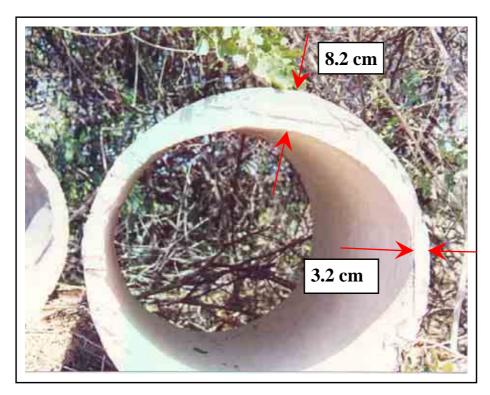
Table 7: Concrete mix proportions in Batching by Volume

		Batch w	ith 1 bag of	cement	Mater	ial requir	ed for
Concrete	Mix design cement	No. of gau	uge boxes	Approx.		oic meter hed conc	
Class	Sand aggregates (max. size of aggr.)	Sand	Aggregates	yield per batch	Cement in bags (kg)	Fine (m³)	Coarse (m³)
P	1:4:8 (40mm)	4	8	0.30 m ³	3.3 (166 kg)	0.47	0.94
Q	1:3:6 (50mm)	3	6	0.24 m³	4.3 (215 kg)	0.46	0.92
20	1:2:4 (20mm)	2	4	0.16 m ³	6 (300 kg)	0.42	0.84
25	1:1.5:3 (20mm)	1.5	3	0.14 m³	7.3 (365 kg)	0.38	0.76

In order to obtain good quality pipes, much attention should be given to the casting process. The most common error is the use of deformed culvert moulds, or that the moulds are not set up properly, e.g. the inner mould is not centred in the outer mould:



Pipes as shown on Picture 37 below must immediately be rejected by the supervising officer and removed from site or destroyed.



<u>Picture 37:</u> Bad culvert: Use of deformed inner mould to cast concrete rings at Kasama - Bulela road, Geita District, Tanzania.

Another common mistake in the casting process, which also affects the quality of the end product, is that the moulds are not properly cleaned during and after use. Deposits of dry concrete build up in edges and around hinges and lockers, which will result in deformations of the pipe, and eventually cause the mould to be unusable. The supervising officer must check that the date of casting is indicated on the ring. The date is usually engraved in the top edge of the ring while the concrete is still moist. The date indication on the ring allows the contractor to monitor the required *curing time of 28 days*, before the pipe can be installed in the road. The supervising officer must ensure that the contractor keeps proper records of the manufacturing and curing process, quantity of materials used, and the daily labour input. In respect of the culvert manufacturing process, the role of the supervising officer should include regular site inspections to ensure that:

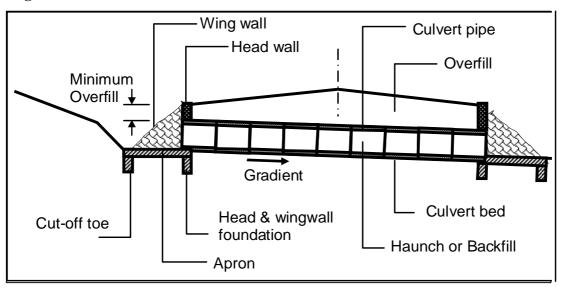
- All required materials are sufficiently available
- Aggregates and sand are clean and have the correct size
- Clean water is used in the production process
- The casting floor is level and firm
- The moulds are clean and oiled before every use
- The moulds are not damaged or deformed
- Concrete ingredients are properly measured with a gauge box
- Casting and compaction is done correctly
- Curing and storing is done correctly

Item 3.4: Installation of culvert pipes and other structures

The correct installation of culvert lines is crucial for a well functioning drainage design. The basic drainage design should be provided in the Detailed Improvement Plan, an example of which is shown in Table 5 of this chapter. However, it is the role of the supervising officer to check that the design features are appropriate and that the structure will be installed at the correct location. It is very common for several reasons that the chainages specified in the DIP do not coincide with the chainages physically set out on the road, and therefore, corrections are necessary. Also the choice of type of inlet structure may have to be changed according to the physical features of the location. Although the contractor is not responsible for location and design of a structure, he should not start the installation of a culvert until he has received a written confirmation from the supervising officer regarding its correct location and principal design.

Figure 26

Main Features of a Culvert



Considerations regarding construction sequence are also important at this stage. If culverts are installed after the road formation works are completed, a lot of extra and double work and corrections may be required, which cost the contractor extra input of labour and equipment resources. Therefore, in most cases it is better to install and construct culverts in advance of the road formation works. Once the exact location for a culvert has been determined, the contractor can start installation after the right of way has been cleared and ETL (excavation to level) at the location of the culvert has been established.

In most cases, where the side terrain has sufficient cross fall (at least 5%), a culvert can be installed at standard installation depth measurements. For these cases, step by step procedures for installation are given on page H-32 of the Technical Manual.

If the cross fall is not sufficient, the supervising officer must determine how much the culvert needs to be raised, taking into consideration the gradient of the pipe and the discharge drain, and the maximum distance from culvert outlet to free discharge point.



Picture 38:

Setting out of culvert line along T4 - Chinkhombe road, Katete District, Zambia.

The procedure for setting out culvert excavations in flat terrain, are given on page H-34 of the Technical Manual. It should be noted that for maintenance considerations, it is not advisable to allow for a discharge drain with a length in excess of 20 meters however, in certain conditions it may be practical to allow for a longer discharge drain. In summary, the steps to follow, to set out a culvert in flat (cross fall <5%) terrain are following:

- 1. Determine correct location of culvert.
- 2. Determine point of discharge and mark with peg A.
- 3. Determine culvert outlet point and mark with peg B.
- 4. Determine culvert inlet point and mark with peg C.
- 5. Measure level differences between A, B and C.
- 6. Measure distances between A, B and C
- 7. Decide on slope in discharge drain and culvert barrel.
- 8. Calculate depth of excavation at B and C

Start excavation of discharge drain and trench from A (discharge point) via B (outlet point) to C (inlet point) by using boning rods and a traveller and a discharge drain template. The actual depth of the culvert trench from road edge level (ETL) at the inlet point C, will determine whether a ramp is required. The standard excavation depth at C should be 117cm for \varnothing -60 cm culverts, and 175cm for \varnothing -90 cm culverts. If the calculated depth at C is less, then a ramp should be constructed over the culvert to compensate for the required shortfall in depth.

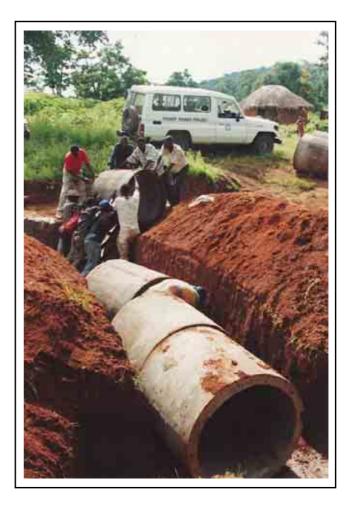


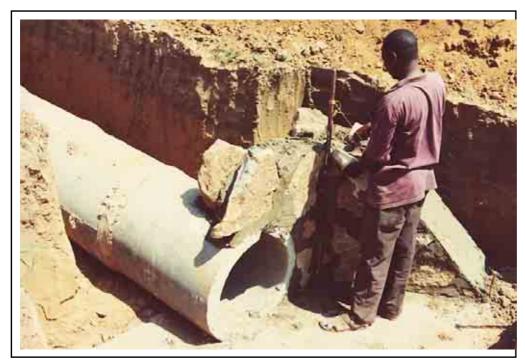
<u>Picture 39:</u> Excavation of trench and discharge drain at Kijiku - Nyamahona road, Sengerema District, Tanzania.

Especially in the rainy season it is very important that the discharge drain is excavated before the trench so that rain water cannot be trapped in the trench causing concrete and masonry works to be delayed.

It is also important that sufficient labourers are engaged to handle the heavy concrete pipes in the trench as to avoid cracks and other damages, resulting in extra costs for the contractor.

Picture 40: Installation of 90 cm concrete rings at T4 -Minga road, Petauke District, Zambia.





<u>Picture 41:</u> Construction of masonry head and wing walls at Kijuka – Nyamahona road, Sengerema District, Tanzania.

Culvert installation and head- and wing wall construction: The above culvert (Picture 41) is installed at standard depth. The culvert below (Picture 42) is installed in flat terrain, requiring a ramp.



<u>Picture 42:</u> Finishing of culvert masonry work at Tamanda Loop road, Chipata District, Zambia.

During installation of culvert lines, it is very important that the supervising officer is involved frequently and checks all stages of construction, because many things can go wrong. For example, the picture below (Picture 43) shows a section of a completed culvert with masonry head and wing wall. During final inspection it was discovered that the concrete foundation was absent and masonry head wall was not properly enclosing the concrete pipe. This situation may have caused erosion and washout of the culvert during the rainy season. Tight supervision and adherence to quality standards is required by both the contractor and the supervising officer. Another common mistake in the installation of culverts is poor compaction of back fill of the culvert trench after the masonry work is completed. Especially in cases where the trench is exca-



<u>Picture 43:</u> Bad quality masonry work and absence of concrete foundation footing for head wall, discovered during inspection at *lluiamata-Lubili B road*, Missungwi District, Tanzania.



<u>Picture 44:</u> Washed out culvert trench after rainwater flooded over the road at Mwamanyili – Badugu road, Magu District, Tanzania.

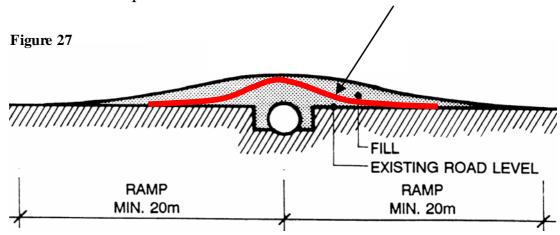
vated in finished road formation, some contractors do not adhere to correct compaction procedures. A sample of what can happen is shown in Picture 44, where the rain water, due to poor design and under sizing of the culvert, flooded over the road and washed away the poorly or non-compacted backfill material. It is an important task of the supervising officer to check that proper procedures are used in backfilling of culvert trenches. The backfill must be compacted in layers of 10 to 15 cm depending on the compaction device used, with the soil having its optimum moisture content.

In flat terrain, culverts can usually not be installed at standard depth and have to be raised to allow for proper discharge. As a consequence, the road also needs to be raised and a 'ramp' must be



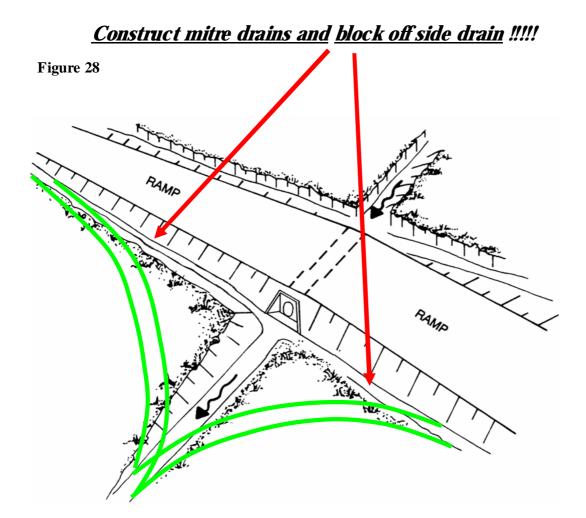
<u>Picture 45:</u> Full concrete surround over double line culvert at Sengerema – Ngoma road, Sengerema District, Tanzania.

constructed, in order to achieve the required coverage or overfill over the culvert. The vertical alignment of such ramps should be checked using the method described in the Technical Manual, Module F, Figure F-17. Often, not sufficient efforts are made to construct ramps to the required standards: they are too short, and insufficient soil is used to establish smooth gradients on the approaching slopes. This is shown in Figure 27 below, where the red line depicts actual practice and the grey area the desired cross section of the ramp.



Yet another mistake often made in the installation of culverts and associated drainage channels is, that the side drains on the down stream side are excavated until they reach the outlet structure, after which the water is expected to make a 90°-turn into the culvert discharge drain, as shown in Figure 28 below. The water flowing through the culvert pipe, and the water accumulated in the down stream side drains, will come together at the outlet of the culvert, causing flow turbulence and as a result, unnecessary erosion and scouring.

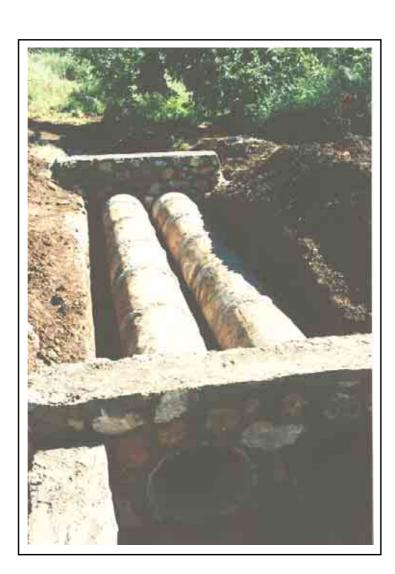
A better and safer option is to excavate mitre drains just 10 to 15 meters before the outlet structure and divert the water from the side drain into the culvert discharge drain.



To summarize the role of the supervising officer during the process of culvert installation and construction, there are a number of issues which must be carefully checked:

- ☑ Check that the proposed chainage for culvert location is correct before setting out starts
- ✓ Check that the setting out is done correctly
- Check that the culvert pipes are not cracked and are of the correct shape and size as specified.
- Check that proper measures are taken to divert the traffic from the construction site.
- ☑ Check that the culvert trench and head & wing wall foundation trenches are excavated to specifications.
- The bed must be stable. Wet, soft or organic materials should be excavated and replaced with compacted gravel.
- ✓ The bed should be checked with a bedding template.
- Check the gradients using boning rods.
- Check that concrete is of the specified mix design.
- Check that the culvert pipes are correctly laid with joints properly sealed inside and outside of the ring.
- Ensure that the head & wing walls are constructed before the start of back filling.
- ✓ Check the quality of the stones, sand and cement being used. The stones should be strong and clean and able to bind with mortar, clean sand and fresh cement.

- ☑ Back fill material should be at optimum moisture content and compacted in layers of not more than 15 cm.
- Check that the inlet structure, intake channels and discharge drain are properly shaped according to specifications and that sharp curves are avoided to allow free and smooth flow of water into the culvert and discharge drain.
- Check that the backfill over the culvert pipe at inlet structure has a minimum height of ¾ of the culvert diameter.
- Check that the ramp, if required, is constructed according to the specifications and that it is properly compacted.



Picture 46:

Double line of 60 cm concrete rings ready for back fill at Eastern Dairy - Madzimoyo road, Chipata District, Zambia.

Note the proper sealing of joints between the rings and completion of inlet and outlet structure before start of backfilling.

The supervision tasks during culvert construction and installation are substantial and require a lot of time input by the supervising officer, especially when the number of culverts to be installed is many. However, the majority of supervision tasks should be carried out by the contractor. The supervising officer should limit his input to random checks during construction and an accurate final inspection of each installed culvert line. However, regular inspection of the works during construction avoids expensive and unnecessary excessive correction works at the final stage of contract implementation. Therefore, during the construction of culverts a 'Works Inspection Form for Culverts' should be kept up to date. On this form, the supervising officer should indicate approval of the works at different stages of construction:

- After location and design has been checked,
- > After culvert trench, discharge drain and head & wing wall foundations have been dug,
- After foundation, optional bedding and apron concrete has been poured,
- After pipe has been placed and head & wing wall has been completed,
- After optional concrete surround has been poured,
- After the back fill has been completed, and
- After the ramp has been constructed.

A sample form as used in the FRP is given in Annex D2-F9.

During final inspection some important features of the culvert must be measured and recorded in a final inspection report, which should include:

- Diameter of rings and number of lines;
- Level difference between head walls, which must be nil;
- Gradient in the barrel, which must be 2-5 %;
- Haunch profile, if applied;
- Height of fill over the culvert, which depends on culvert diameter and application of concrete surround or haunch;

After handing-over of the road to the responsible authorities, the regular maintenance of the road and its structures is a major task. For management purposes, it will be beneficial when culverts along the road are marked with appropriate KM-chainage identification.



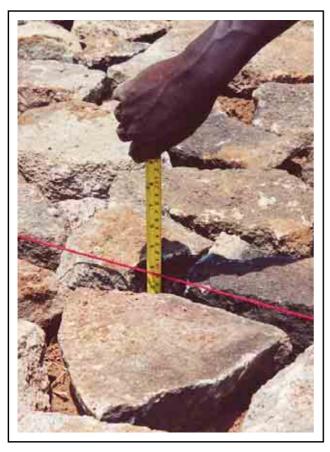
<u>Picture 47:</u> Culvert head wall with KM – chainage identification for future maintenance management at Mbarika - Ilujamata road, Missungwi District, Tanzania.



Picture 48:
Culvert Drop
Inlet, applied to
relief a side
drain with
steep gradient
at Eastern
Dairy - Madzimoyo road,
Chipata District, Zambia.

Note how upstream rain water is trapped in the inlet structure and led away through the pipe, not allowing it continue to flow down the side drain.

Drop inlets such as shown in Picture 48 above, may constitute a safety hazard to cyclists, pedestrians and animals walking along the road. Limits need to be set to the depth of such inlets in order to regulate the requirement of a top slab or surround wall to prevent people (or traffic) from falling in. The importance of a well-functioning drainage system for the life of a gravel road cannot be over-emphasized, and proper engineering design and good supervision arrangements are a pre-requisite to achieve this. However, this requires preparedness by the road funding agents to set aside sufficient funds to carry out proper design and supervision, rather than accepting un-technical and amateurish approaches and methods.



Picture 49: Stone pitching for side access drift at Ilujamate – Lubili B road, Missungwi District, Tanzania. Note that stones are laid in soil rather than embedded in first layer of mortar as it should be.

The last aspect to be covered under drainage structures is stone pitching, which is used for side access drifts, cattle crossings, slope protection and aprons. The supervising

officer must ensure that the specified thickness is applied by checking the depth of the excavated area where the stone pitching will be constructed, and that the stones are well embedded in mortar.



<u>Picture 50:</u> Cattle crossing constructed in 15 cm stone pitching at Mwamanyili – Badugu road, Magu District, Tanzania.



<u>Picture 51:</u> Side access drift constructed along Kamena - Bukoli road, Geita District, Tanzania.

Side accesses are a frequent requirement in the design of feeder roads. They give access to schools, clinics, go-downs, community roads and side tracks. When the longitudinal gradient of the road is not sufficient, an access culvert with diameter 60 cm may not be feasible because of drainage problems, and the only option is to built an access drift and "pave" part of the side drain to provide a reliable access. To accommodate the light traffic passing over these side accesses, they can be built with stone pitching, rather then concrete, which is more expensive. A principal design for different cross sections and widths is given in Annex C5.

During construction of drainage structures, the role of the supervising officer is to check on several issues as described above however, upon completion of each single structure, some checks must be carried out before the structure can be certified for payment:

	CHECK DRAINAGE STRUCTURES.	
Who:	Consultant Supervisor.	
Why:	To ensure that scour checks and culverts are installed at the required locations and constructed to specified standards.	
When:	Regularly during construction and after a structure has been completed and forwarded for payment.	
What:	 Supervisor should carry out following checks: Location of all structures and spacing of scour checks in particular. General appearance and workmanship of masonry work, concrete work and plastering. Tidiness of the site, no left over materials. Approaches of intake channels are properly integrated and allow smooth flow of water. Head walls at in- and outlet are at same level. Gradient of the barrel is according to design. Coverage or fill over the barrel is sufficient. Ramp gradients are within the design limits. Discharge drain allows for free discharge. Road chainage of culvert location is marked (painted or engraved) on the head wall. Stone pitch is well embedded in mortar. 	
Tools:	Levelling instrument, 25m tape measure, boning rods, line and level, straight edge, ranging rods.	

SECTION 4

GRAVELLING WORK

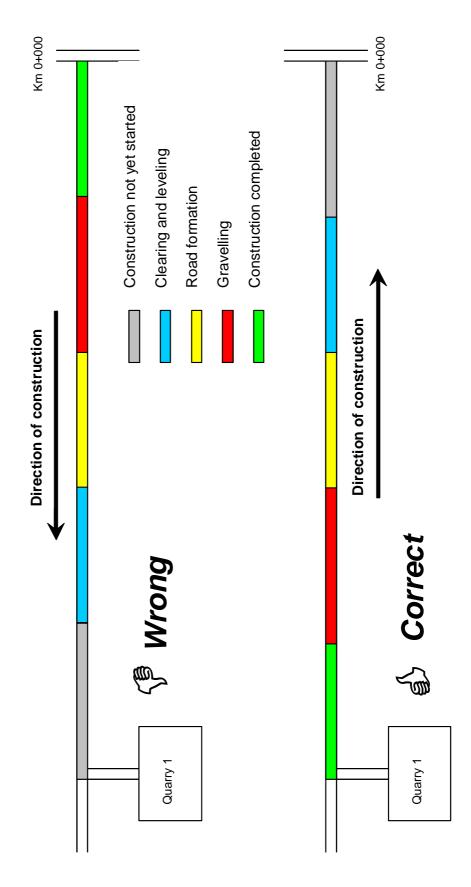
Gravelling work is the most expensive part of district & feeder road rehabilitation. Typically it comprises 30 % – 50 % of the total contract cost, depending on the haulage distance from gravel sources to the road. Unless proper funding is available, it will be difficult to plan for full gravelling on district & feeder roads and careful prioritization and planning of works is required. In the planning of gravelling work, it is essential and a golden rule, to keep haulage distances short, therefore, to identify as many gravel sources as possible along the road under construction. In this guide, gravel and laterite means 'naturally occurring gravel' and a quarry is the source, where the gravel or laterite is found. The whole of gravelling work can be divided in a number of distinct operations, which are separated by different bills in the BoQ:

- 1. Quarry preparation (Bill 1)
- 2. Excavation, stock piling, loading and spreading of gravel (Bill 4)
- 3. Haulage, and compaction of gravel (Bill 5)

As mentioned before, gravelling work is expensive. This is mainly because of the equipment input required. Therefore, it is important to make proper work planning and minimize interruptions for the equipment. The organization of the labour force is very important, and several options are possible. The contractor may employ a large gang of labourers working on individual daily tasks. This requires much organization, setting out of tasks and supervision by

the contractor. Another option is to make an arrangement with a gang of labourers for each sub-operation (excavation, loading, offloading and spreading) and simply pay them according to the number of trailer/truck loads delivered to site. This kind of group task arrangement can be implemented in a number of variations. The latter option is most convenient for the contractor as long as he pays sufficient for the labour input given, and it requires the contractor to undertake less supervision and control. Another important cost-saving aspect is proper organization of the main work operations (road formation work and gravelling work) in such a way that they do not interfere with each other. For this reason it is important, that the construction and gravelling of the road starts from the point where the quarry access joins the road. Haulage times will be reduced and compaction will be improved. Required daily labour output will start high and gradually reduce, which psychologically is better for the work gangs than the other way round. Also the gravelling work must closely follow the formation work. This will avoid road formation from being damaged before the start of gravelling work, necessitating the contractor to carry out repairs and correction works, which normally are not paid for. Figure 29 on following page shows both alternatives. The correct plan of implementation should be the bottom one, where haulage equipment can deliver gravel to the finished road section without disturbing clearing, levelling and formation work. Another advantage is that the haulage equipment assists in compaction, and that graveling can continue, even during the rainy season.

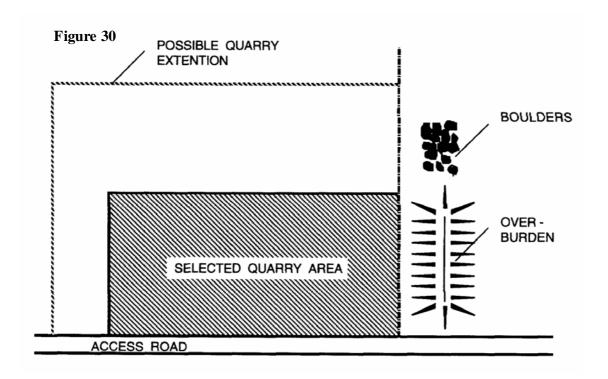
Figure 29



4.0 Planning lay-out of the quany

A good planning of the overall lay-out of the quarry is essential for a smooth and cost-effective gravelling operation. Bad planning of the quarry may result in costly double handling of materials and inefficient movement of the equipment. The Quarry Organization Plan (QOP) in the contract document (see Figure 3 on page 47 for a sample) specifies how the quarry should basically be planned, and an important task of the supervising officer is to ensure that the contractor adheres to this plan. A number of important issues must be considered in the planning of a quarry site:

The overburden is stockpiled so that it will not hinder future extension, and that it can eventually be used to reinstate the quarry;

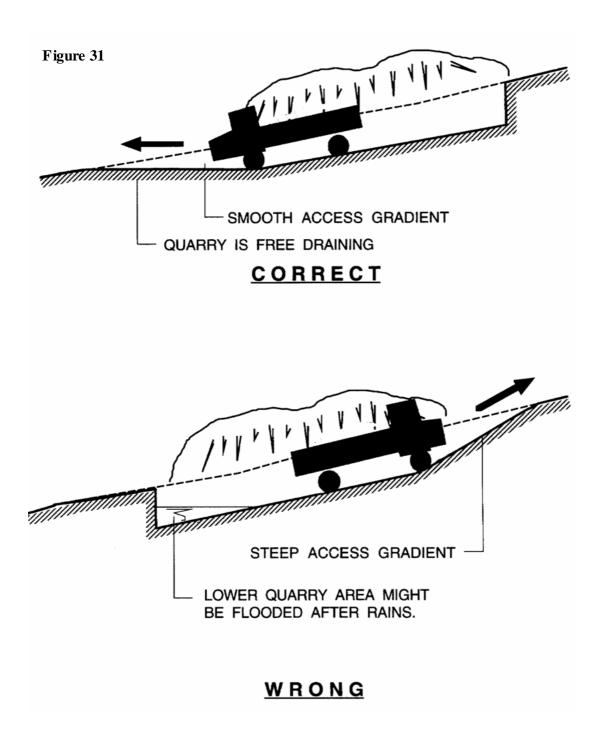




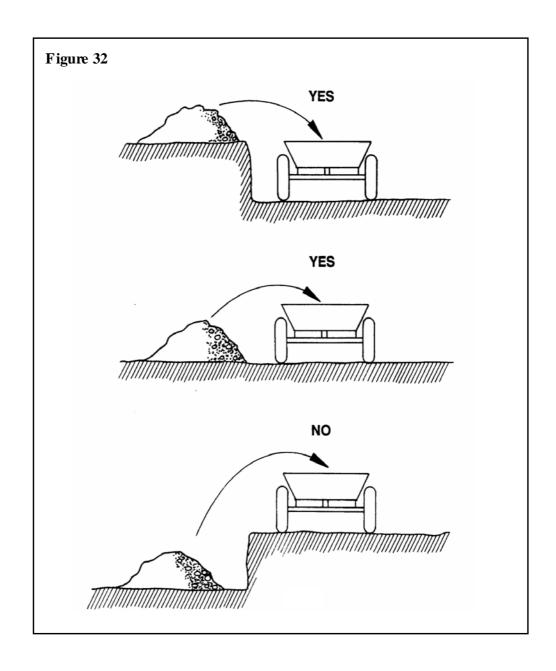
<u>Picture 52:</u> Laterite quarry established at a hill side along Eastern Dairy - Madzimoyo road, Chipata District, Zambia.

- tractor/trailers and/or trucks can enter and leave without disturbing each other;
- > The quarry can be exploited fully with removal of the maximum amount of gravel;
- Environmental damage by drainage and erosion is minimized both during and after exploitation of the quarry;
- The best material is taken in cases where gravel quality is variable within the quarry.
- The quarry is developed so that it drains effectively when it rains during the execution of the works.

Figure 31 below illustrates this last point and Picture 52 on the previous page shows a quarry on a hillside, where the drainage has yet to be established in order to avoid water being trapped during the rains.

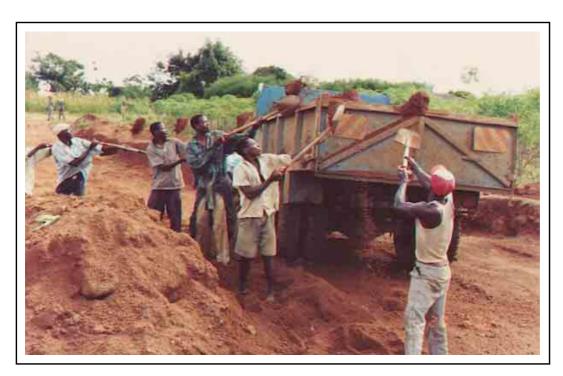


After the overburden has been removed and stockpiled at the correct location, the contractor must set out 'loading bays' beside which the gravel can be stockpiled. The loading bays can be used for parking the trailer or truck and in this way, the loading of the gravel is done by throwing it down, or from the same height into the trailers or trucks. Pages J28 to J31of the Technical Manual show different methods and techniques for establishment of loading bays, suitable for both tractor – trailers and tipper trucks.



The main principles in the development of the quarry are that:

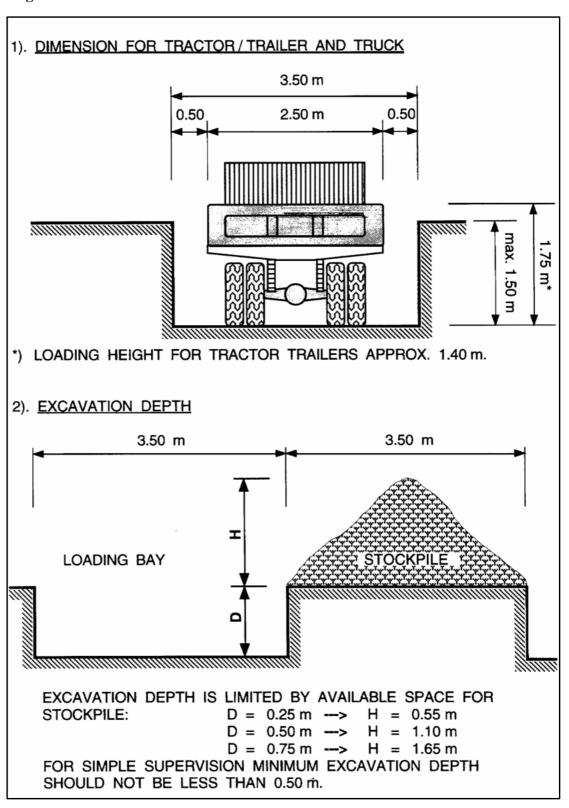
- > Situations where the gravel is stockpiled below the equipment should be avoided as this makes loading difficult. (A sample of bad practice can be seen on Picture 53 below).
- Labourers must have enough room to work safely and comfortably, and the equipment must have enough room to manoeuvre. Standard measurements of loading bays as shown in Figure 33 on the next page allow for this.
- Trucks or trailers should be loaded from both sides whenever possible. Also in this respect, Picture 53 below shows bad practice, where 6 labourers are loading from one side only.



<u>Picture 53:</u> Loading of tipper truck in quarry at Yitwimila –ljitu road, Magu District, Tanzania. Note the absence of loading bays The labouers are loading from one side only and from a position which is too low. Loading times of half an hour are not exceptional.

Development of Loading Bays in the Quarry.

Figure 33



Items 4.1 and 4.3: Excavation and stock piling of gravel and loading of gravel

Once the quarry is established and prepared, the excavation of the gravel can start. Depending on the target production during a day, less or more labourers are required in the quarry, which can range from 15 to 100 labourers. With so many labourers congested in a relative small area, it is important that this operation is wellorganized, otherwise it could end up being a source of loss to the On pages J-24 to J-39 of the Technical Manual a contractor. wealth of information is provided on organizational techniques to use in order to carry out these activities in the most efficient and profitable way. The role of the contractor's supervisor is challenging as he must be in control of the efficient utilization of labourers and smooth movements of equipment in the quarry. The role of the supervising officer is to ensure that the quality of the gravel is good and not being mixed with overburden. He should also ensure that labourers are not exploited with too high task rates.



Picture 54:
Labourers
excavating
and stock
piling gravel
in a well organized
manner in
quarry along
MwamanyiliBadugu road,
Magu District, Tanzania.

Especially when group work is used, a rate may be agreed with the labourers for excavation and loading per full trailer leaving the quarry. This rate should be checked against the task rates given in Table 8 below:

Table 8: Gravelling task rates

ACTIVITY	TASK RATE/ PERSON
EXCAVATING GRAVEL	1.6 - 2.4 m³/MANDAY (INSITU) 2 - 3 m³/MANDAY (LOOSE)
LOADING GRAVEL ONTO TRAILER	8 - 10 m³/MANDAY (LOOSE)
LOADING GRAVEL ONTO TRUCKS	5 – 7.5 m³/MANDAY (LOOSE)
OFF LOADING AND SPREADING	12 - 16 m ³ /MANDAY (LOOSE)

Contrary to a fixed daily task arrangement, the workers have the opportunity and may be willing to produce more, and as a result, also the equipment will achieve a higher rate of utilization.

Using above task rates, a trailer capacity of 3.5 m^3 and a daily wage of ZK 7,000 (at 1 USD = 5,000 ZK), the combined rate for excavation and loading should not be less than:

$$(3.5/2.5 + 3.5/9)*7,000 = ZK 12,522.- per trailer load$$

Group work arrangements give the labourers opportunity to produce and therefore earn more than in a normal daily task arrangement. However, the negative side is, that the contractor tends to neglect proper organization in the quarry and leaves it to the labourers to organize themselves. This may lead to poorly organized quarries, samples of which are shown on Pictures 53 and 55.



<u>Picture 55:</u> Loading of tractor - trailer in quarry at Kijuka – Nyamahona road, Sengerema District, Tanzania. Note absence of proper loading bays and labourers loading from one side only!!

It is an important task of the supervising officer to ensure that in the quarry proper organizational techniques are used, whatever the employment arrangements are. This is for the benefit of all parties.

Gravelling involves expensive haulage and compaction equipment, which should not be left idle unnecessarily. Therefore, it is very important that the activities prior to gravelling (vegetation control, road formation and quarry work) are properly organized and continue without delays. If road formation slows down, also gravelling is bound to slow down, and that may be costly for the contractor. He should organize the work in such a manner to ensure that gravelling can start as soon as possible, and continue without delay and disturbance until final completion of the contract.



<u>Picture 56:</u> Well-organized loading of tipper truck in quarry, Tanga – Pangani road, Tanga Region, Tanzania. Loading bays are developed in such a way that the truck can be loaded from above by preloaded wheel barrows, which are tipped from a ramp, running from left to right. A total of **40 labourers** were involved to achieve loading times of 7 to 10 minutes.



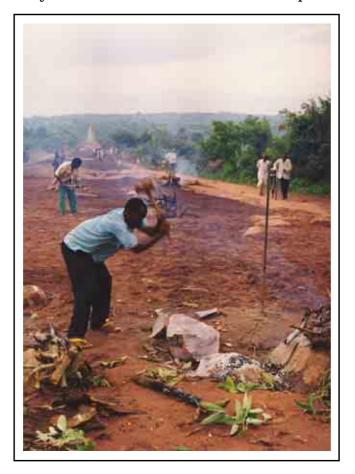
Picture 57:
Well established loading bays in quarry along Pangani – Muheza road, Tanga Region, Tanzania.

Although the main supervisory task in this operation lies on the shoulder of the contractor's supervisor, the task of the supervising officer during the operation of gravel excavation, stock piling and loading, can be summarized as follows:

	CHECKS ON EXCAVATION, STOCK PILING AND LOADING OF LATERITE.	
Who:	Consultant Supervisor.	
Why:	To ensure that proper Labour Based-Technical procedures are used.	
When:	At random during excavation and loading of laterite.	
What:	 Supervisor should carry out following checks: Check that a proper excavation plan for the quarry is implemented, allowing smooth flow of traffic. Check that the excavated gravel is not mixed with overburden. Check that the labourers engaged in the excavation and loading operation, have payment conditions related to fair daily task rates. Check that the haulage equipment, depending on the quality of the haul route, is loaded to its correct capacity. Check that at the end of the day, at least one daily production of gravel is stock piled in the quarry. Advise contractors on labour allocation in the quarries. 	
Tools:	No specific tools required.	

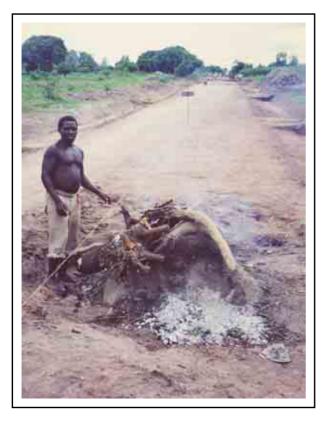
Item 4.2: Boulder Removal

As indicated before, boulder removal is an item contained in Bill 4 of the BoQ, however, it is preferably executed during clearing activities to avoid interferences with other construction activities. The quantity provided in the BoQ is only a rough estimate as it is difficult to determine what is below the ground level. Therefore, this item is an **AWD**-item, which stands for Actual Work Done. Boulder removal is a difficult and heavy job and above all it is a risky job. The risk of injuries among workers is high. The supervising officer should insist that the contractor provides protective gear such as safety glasses, gloves and preferably shoes or boots with a steel nose in order to reduce this risk. Furthermore, it is very often observed that the tools provided to the workers are too



light, inappropriate and of poor quality. Some of these shortcomings are visible on Picture 58. The supervising officer should see to it, that sledge hammers with good handles, heavy

<u>Picture 58:</u> Boulder removal and clearing activities at Kasama – Bulela road, Geita District, Tanzania.



<u>Picture 59:</u> Splitting of boulders using heat at Yitwimila - Ihale road, Magu District, Tanzania.

crow-bars, chisel and feathers, etc. are available to the workers for boulder removal. Techniques to remove boulders are described in the Technical Manual. A successful and safe method, which requires a lot of patience, is the use of fire and

water to quickly cool down the rock. As an effect of this, the rock will crack (see Picture 59). In order to avoid environmental damage, it is recommended to use bush and timber from the clearing activity as fuel wood. The BoQ provides three sub-items for boulder removal according to different sizes, because relatively small boulders can be removed quickly without additional expenses, while bedrock must be removed with special techniques and tools, requiring a higher worker day input. Consequently, for the payment of boulder removal, three different rates are used per unit of cubic meter. Rather than measuring each boulder separately for payment, the contractor should be instructed to remove all boulders along a certain section of the road (say 1 kilometre).



<u>Picture 60:</u> Stack of removed boulders for verification and measurement at Mbarika - Lubili road, Missungwi District, Tanzania.

The removed boulders should be piled up in measurable rectangular heaps for certification and payment. The formula used to calculate the quantity (cubic meters) of boulders in a stack can be expressed as follows:

(Area of bottom + Area of top) * Height of stack * ½

If the boulders can be used for masonry works (e.g. in head- and wing walls of culverts), the boulders may be handed over to the contractor, by deducting an appropriate rate for purchase and transport of an equal quantity of stones, which should be agreed in advance.

To summarize, the Supervising officer should carry out following checks in respect of boulder removal:

	CHECK ON BOULDER REMOVAL AND MEASUREMENT OF QUANTITY
Who:	Consultant Supervisor.
Why:	To ensure that all boulders and rocks are removed from the road and drains in a safe and correct manner and that the removed quantities are properly measured.
When:	Before the start of Earth Works.
What:	1. Check that workers have protective gear and use appropriate tools.
	2. Instruct contractor to heap removed boulders outside the cleared width in measurable stacks for certification.
Tools:	Measuring tape (5m)

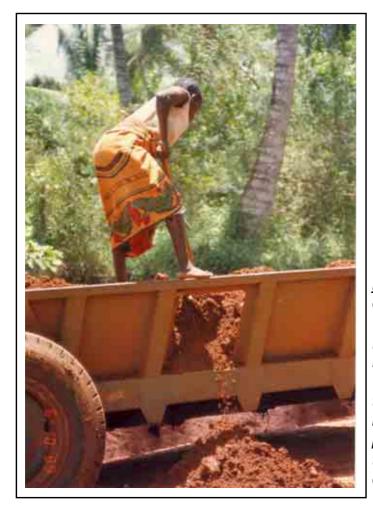
Item 4.4: Off-loading of gravel

The off-loading and spreading of gravel is done by one separate gang on the road. Employment arrangements for this gang may also be based on group work, and a rate can be established and agreed for each load off-loaded and spread on the road. However, the productivity of this gang is depending on the productivity of the gang in the quarry, and of course on the haulage productivity. Contrary to what happens in the quarry, the trailers will during off-loading not be detached from the tractor, so it is important that the trailers are off-loaded as quick as possible in order to reduce idle time of the tractor as much as possible.



<u>Picture 61:</u> Off-loading laterite from a tractor drawn trailer at Ilujamate – Lubili B road, Missungwi District, Tanzania. Note the use of side doors on the trailer to reduce off-loading time.

The off-loading, including manoeuvring time should not take more than 8 minutes. Trailers for Labour Based road construction are often equipped with side doors to increase the speed of off-loading. Another advantage is that the gravel is already somehow distributed over the off-loading area before the spreading starts. Self tipping trailers, one would say, are ideal for this purpose, but wide experience has shown that the hydraulics of self-tipping trailers are the first thing to break down. Moreover, hydraulic self-tipping trailers are much higher, which makes the loading more difficult.



Picture 62: Another example of a trailer with side doors at Pangani – Muheza road, Tanga Region, Tanzania. Off-loading times were recorded to be 50% less as compared to those from trailers without side doors.

Item 4.5: Spreading of gravel

The material from one trailer is unloaded and spread within a "box" marked by pegs and sisal twine. The box has the width of the road running-surface (app. 0.25 metre less then the edge to edge width of the road) and a length calculated to ensure the correct thickness of loose material.

The box length can be calculated with the formula as given below:



<u>Picture 63:</u> Setting out "off-loading boxes" before gravel arrives, in order to control thickness of the gravel layer at Kisesa – Kayenze road, Magu District, Tanzania.

The site agent must determine the box length by completing this calculation. The supervising officer should check at random, whether the trailer or truck is actually loaded to the assumed capacity. If for any reason full loading is not possible, because of haul route conditions or the condition of the haulage equipment itself, then the box length has to be adjusted accordingly. Tables 9 and 10 on the following page, box lengths are given for 3 m³ trailers and 5 m³ tipper trucks for different standard cross-sections. Box dimensions for trailers and trucks with different capacities must be calculated separately.



<u>Picture 64:</u> Spreading and compaction of gravel at Kisesa – Kayenze road, Magu District, Tanzania. Note the use of rods and strings to set out the off-loading box, and the use of a camber board to check cross fall on the finished surface of the road.

Table 9: Box dimensions for unloading of gravel by trailers

Unloading gravel: "BOX" DIMENSIONS for 3m3 TRAILERS

ROAD TYPE (CROSS SECTION)	GRAVEL WIDTH (AVERAGE) (m)	GRAVEL THICKNESS (COMPACTED) (m)	GRAVEL THICKNESS (LOOSE) (m)	BOX LENGTH (3m³ TRAILER)
STANDARD (A1) } EMBANKMENT (E) }	5.25 5.25	0.12 0.20	0.15 0.25	3.80 4.60*
STANDARD (A2)	4.75 4.75	0.12 0.20	0.15 0.25	4.20 5.10*
REDUCED CS (B)	3.75	0.10	0.125	6.20
MOUNTAIN (C)	3.25	0.10	0.125	7.40
BLACK COTTON (D)	6.00	0.20	0.25	4.00*

^{*} Gravel to be laid in two separated layers of 0.125m thickness using these box dimensions.

Table 10: Box dimensions for unloading of gravel by tippers

Unloading gravel: "BOX" DIMENSIONS for 5m3 TRUCKS

ROAD TYPE (CROSS SECTION)	GRAVEL WIDTH (AVERAGE)	GRAVEL THICKNESS (COMPACTED)	GRAVEL THICKNESS (LOOSE)	BOX LENGTH (5m³ TRUCK)
	(m)	(m)	(m)	(m)
STANDARD (A1) } EMBANKMENT (E) }	5.25 5.25	0.12 0.20	0.15 0.25	6.30 7.60*
STANDARD (A2)	4.75 4.75	0.12 0.20	0.15 0.25	7.00 8.40*
REDUCED CS (B)	3.75	0.10	0.125	10.70
MOUNTAIN (C)	3.25	0.10	0.125	12.30
BLACK COTTON (D)	6.00	0.20	0.25	6.70*
* Gravel to be laid in two separated layers of 0.125m thickness using these box dimensions.				

The pegs should be set at the centre line and edge of the box and sisal rope or twine should be tied between the pegs at a height equal to the loose gravel thickness (refer tables 9 and 10 on previous page) to ensure the correct thickness, even spreading and a satisfactory cross fall of 8%. Picture 64 shows a sample of good practice. If the gravel consists of any gravel lumps or stones larger than 63mm, they should be broken down using sledge hammers.

Tipper trucks should be unloaded into the box with the vehicle moving slowly forward to distribute the material as far as possible along the length of the box. Flat bed trucks should be unloaded by



hand, as for trailers. Gravel dumps lined up on the road as shown in Picture 65, may be the correct practice for a Machine Based implemented contract, but is bad practice for a Labour Based implemented contract for following reasons:

<u>Picture 65:</u> Gravel dumps on the road at Nyamahona – Chifunfu road, Sengerema District, Tanzania.

- The gravel is dumped at the side of the road, rolling into the drain, which will be a major extra task for labour to remove.
- The gravel stacks, after some time, increase in density, which will cause extra work for labour to loosen it, before it is spread.
- The gravel at the bottom of the stack will remain where it is, and because of its higher density, the quantity of gravel over the full width of the road will be uneven, resulting in a variable thickness and therefore an uneven final surface.
- The opportunity for the haulage equipment to assist in the compaction of the gravel layer is lost.

The best practice for a Labour Based site is shown on Picture 64, where gravel, once dumped, is spread and compacted immediately.



<u>Picture 66:</u> Spreading of gravel at Mwamanyili – Badugu road, Magu District, Tanzania. Note the practice of gravelling first one side of the road and than the other one, which can be a good solution in situations where traffic is rather heavy.

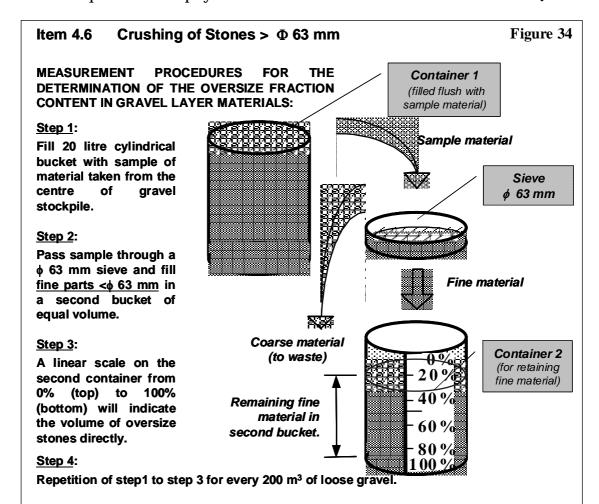
Item 4.6: Crushing of stones

A certain proportion of the gravel consists of stones larger than the maximum size suitable for road gravel. Therefore, Item 4.5, 'Spreading of gravel to camber' includes the crushing of up to 10% of the material retained on a 63 mm sieve. If the quantity of oversized material is more than the 10% margin, the crushing of that will be paid under item 4.6. Gravel lumps or stones $> \emptyset$ 63 mm should be broken down to sizes smaller than 63 mm by using sledge hammers. Oversized material, which cannot be broken down to required smaller size must be removed to a spoil dump. In order to make a fair assessment of the quantity of material eligible for payment under item 4.6, the supervising officer must follow the procedure described in Figure 34 on the next page.



<u>Picture 67:</u> Oversized material is separated for crushing or permanent removal at Eastern Dairy – Madzimoyo road, Chipata District, Zambia.

Procedure to determine quantity of oversized material in gravel, which qualifies for payment under item 4.6 of the standard BoQ.



EXAMPLE:

The second bucket of four samples taken for the full gravelling of a 1.0km long section
of Feeder Road Cross Section Type A3 can be filled with fine material up to the 17%,
45%, 37% and 29% marks respectively.

Subsequently:

- · The second bucket can be filled in average up to the 32% mark;
- 100 % is the total volume of the sample;
- 68 % has passed the sieve, is therefore < ♦ 63 mm and does not require crushing;
- 32 % has <u>not</u> passed the sieve, is > φ 63 mm and needs to be crushed (total oversize volume);
- The Specification for <u>Item 4.6 "Crushing of Stones < √ 63 mm"</u> stipulate a payable quantity which <u>exceeds 10% of volume Item 4.5 "Spreading of Gravel to Required Camber"</u> as a certain amount of large stones can be expected in any type of natural gravel material.
- The payable percentage is therefore: 32% 10% = 22% (of Item 4.5)
- The payable quantity for Item 4.6 "Crushing of Stones <φ 63 mm" for 1.0 km of Feeder Road Cross Section A1 is now calculated as follow:

$$V = \frac{5.50 \text{m x } 0.15 \text{m x } 1,000 \text{m x } 22\%}{100\%} = 181.50 \text{ m}^3 \text{ say } \frac{180 \text{ m}^3/\text{km}}{100\%}$$

Item 4.8: Backfill and levelling of quarry site

Before a quarry is backfilled and levelled, consultations should take place with the community regarding their specific wishes and needs. Most important is to cut steep sides to acceptable slopes in order to avoid accidents. Refer to pages J43 and J44 of the Technical Manual for details on backfill and levelling of quarries.

	CHECKS ON OFF-LOADING, SPREADING OF GRAVEL AND LEVELLING OF QUARRY.
Who:	Consultant Supervisor.
Why:	To ensure that a gravel layer is provided according to specifications.
When:	At random during off-loading and spreading of gravel and during final inspection of the contract.
What:	 Supervisor should carry out following checks: Check that camber of the road formation is correct before gravel is off-loaded and spread. Check at random that 'off-loading' boxes are properly set out before the gravel is dumped, and that their length is in correct relation to the quantity of gravel loaded on trucks or trailers. Check that labourers engaged in off-loading and spreading, are paid fair daily task rates. Check at random that oversized material (> 63mm) is crushed with a sledge hammer. Check that gravel from one trip is evenly spread within "the box" and compacted immediately. Check that the quarry is left behind in a manner satisfactory to the community.
Tools:	Camber board and spirit level, measuring tape (5m)

SECTION 5

EQUIPMENT BASED ACTIVITIES

In Labour Based operations, haulage and compaction of gravel are the main two activities requiring equipment inputs. In order not to waste financial resources, the right choice of equipment is essential to avoid it being idle or under-utilized. The choice of equipment type to be used on a labour based construction site should match the output of the labour force engaged on the site. For example, the use of 20 ton dumper trucks is not appropriate because it would take too much time to get it loaded with labour. A 10-ton self-propelled compactor would be idle for most of the day, because its normal daily output far exceeds the output of an average labour based gravelling gang. In exceptional circumstances where large numbers of labourers are engaged on a single site, the input of heavier plant may be justified.

For haulage basically two options are appropriate and widely available:

- Tractor trailer combination
- 7-ton tipper truck.

For compaction the use of one or more pedestrian double-drum vibrating rollers and/or a tractor-drawn steel drum rollers are an appropriate choice for a small scale labour based operation.

Item 5.1 to 5.6: Haulage of gravel

In order to monitor compliance with the gravelling plan provided in the contract document, Bill 5 has 6 items for 'haulage of gravel', each of them covering the haulage from a different quarry.

The choice whether to use tractor-trailer combinations or tipper trucks as haulage equipment depends on the haul distance which needs to be covered. The maximum economic haul distance for gravelling by tractor/trailer combination is 4 to 5 km. Trucks may be economic for any distance above 5 km. An upper range of 15 to 20 kilometres is normally used, above which gravelling becomes extremely expensive and in most cases hard to justify. In that case alternative surfacing options should be explored.



<u>Picture 68:</u> Tractor-trailer combination, Mwanza Region, Tanzania. The twin-wheel design gives good suspension properties and greatly reduces the jumping of the trailer on bad roads. The small tale-gate allows for better utilization of the loading capacity of the trailer.

Table 11

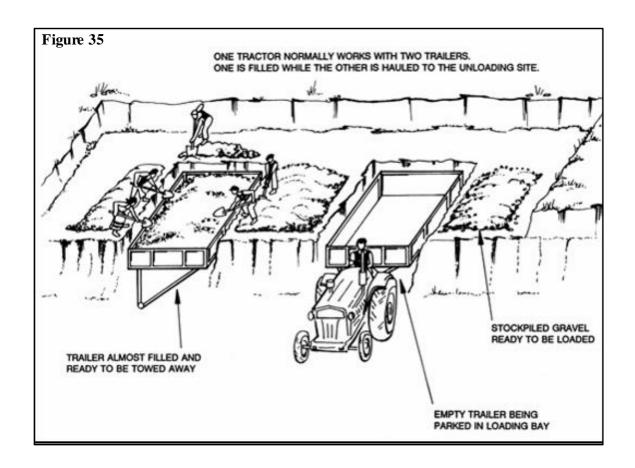
EQUIPME	NT INPUT	: TRAC	TOR and to	wo TRAILE	RS combin	nation		Page:	10
CYCLE PAR	RAMETERS	FOR TRANS	SPORT OF L	ATERITE, SAI	ND, AGGRE	GATES, etc.	Select type of	trailer: (place	a cross)
Hire rate per Loading cap Loading time Haul speed Off-loading ti Return spee Working time	e ime d	,	(ADHR) (LC) (LT) (HS) (OT) (RS) (WT)	3.3 5 20 8 30	(Tsh/day) (M3) (MIN) (KM/H) (MIN) (KM/H) (KM/H) (HOURS/DAY)		X	_	vheel trailer (SW) eel trailer (TW)
CONTRACT	TOR ALLOV	VANCES:			[Haula	age rates	
						0 - 1 km	=	2,544	Tshs / m3*km
			Overhead:	15%		1 - 3 km	=	979	Tshs / m3*km
			Profit:	10%		> 3 km	=	574	Tshs / m3*km
		ILY TARGE							
HAUL	LOADING		OFF-LOADING	RETURNING	CYCLE	TARGET	VOLUME	BASIC RATE	
DISTANCE	(MIN) b=LT	(MIN)	(MIN)	(MIN)	(MIN)	(TRIPS/DAY)	HAULED/DAY	(Tsh/m3)	(Tsh/(m3-km)
		c=(aver.a/HS)x60	d=OT	e=(aver.a /RS)x60	f=b+c+d+e	g=(WTx60)/f	h=LCxg	i=ADHR/h	HR=i/Aver.a 2.544
а		2	0	4	10	24			
a 0 - 1	5	2	8	1	16 21	31	102	1,272	
a 0 - 1 1 - 2	5 5	5	8	3	21	23	77	1,682	1,122
a 0 - 1 1 1 - 2 2 2 - 3	5 5 5	5 8	8	3 5	21 26	23 19	77 62	1,682 2,093	1,122 837
a 0 - 1 1 - 2 2 - 3 3 - 4	5 5 5 5	5 8 11	8 8	3 5 7	21 26 31	23 19 16	77 62 52	1,682 2,093 2,503	1,122 837 715
a 0 - 1 1 - 2 2 - 3 3 - 4 4 - 5	5 5 5 5 5	5 8 11 14	8 8 8	3 5 7 9	21 26 31 36	23 19 16 14	77 62 52 45	1,682 2,093 2,503 2,914	1,122 837 715 647
a 0 - 1 1 - 2 2 - 3 3 - 4 4 - 5	5 5 5 5 5	5 8 11 14 17	8 8	3 5 7 9	21 26 31 36 41	23 19 16 14 12	77 62 52 45 39	1,682 2,093 2,503 2,914 3,324	1,122 837 715 647 604
a 0 - 1 1 1 - 2 2 - 3 3 - 4 4 - 5 5 - 6	5 5 5 5 5	5 8 11 14	8 8 8	3 5 7 9	21 26 31 36	23 19 16 14	77 62 52 45	1,682 2,093 2,503 2,914 3,324 3,734	1,122 837 715 647
a 0 - 1 1 1 - 2 2 2 - 3 3 - 4 4 4 - 5 5 - 6 6 - 7	5 5 5 5 5	5 8 11 14 17 20	8 8 8 8	3 5 7 9 11	21 26 31 36 41 46	23 19 16 14 12 11	77 62 52 45 39 35	1,682 2,093 2,503 2,914 3,324	1,122 837 715 647 604 574
a 0 - 1 1 1 - 2 2 - 3 3 - 4 4 - 5 5 - 6 6 - 7 7 - 8	5 5 5 5 5 5	5 8 11 14 17 20 23	8 8 8 8 8	3 5 7 9 11 13	21 26 31 36 41 46 51	23 19 16 14 12 11	77 62 52 45 39 35 31	1,682 2,093 2,503 2,914 3,324 3,734 4,145	1,122 837 715 647 604 574 553
a 0 - 1 1 1 - 2 2 - 3 3 - 4 4 - 5 5 - 6 6 6 - 7 7 7 - 8 8 - 9	5 5 5 5 5 5 5 5	5 8 11 14 17 20 23 26	8 8 8 8 8 8	3 5 7 9 11 13 15	21 26 31 36 41 46 51 56	23 19 16 14 12 11 10 9	77 62 52 45 39 35 31 29	1,682 2,093 2,503 2,914 3,324 3,734 4,145 4,555	1,122 837 715 647 604 574 553 536

Tables 11 and 12 show sample calculations to establish haulage rates for both tractor/trailer combinations and tipper trucks.

EQUIPME	NT INPUT	: 7-Ton	TIPPER T	RUCK				Page:	13
CYCLE PARAMETERS FOR TRANSPORT OF LATERITE, SAND, AGGREGATES, etc.:						<u>:</u>	Table	12	
Hire rate per	day (incl. fue	el & driver)	(ADHR)	130,000	(Tsh/day)				
Loading cap	• •	,	(LC)		(M3)				
Loading time			(LT)		(MIN)				
Haul speed			(HS)		(KM/H)				
Off-loading ti	mo		(OT)		(MIN)				
Return speed			. ,						
			(RS)		(KM/H)				
Working time	9		(WT)	8	(HOURS/DAY)				
CONTRACT	OR ALLOV	VANCES:			ı		Hauli	age rates	
						0 - 1 km	=	4.280	Tshs / m3*km
			Overhead:	15%		1 - 3 km	=	1,258	Tshs / m3*km
			Profit:	10%		> 3 km	=	475	Tshs / m3*km
		ILY TARGE							
HAUL	LOADING		OFF-LOADING	RETURNING	CYCLE	TARGET	VOLUME	BASIC RATE	HAULAGE RA
	(MIN)		(MIN)	/BAINI)		(TDIDO (DANA)	HAULED/DAY	(Tsh/m3)	
DISTANCE		(MIN)		(MIN)	(MIN)				
а	b=LT	c=(aver.a/HS)x60	d=OT	e=(aver.a /RS)x60	f=b+c+d+e	g=(WTx60)/f	h=LCxg	i=ADHR/h	HR=i/Aver.a
a 0 - 1	b=LT 30	c=(aver.a/HS)x60	d=OT 5	e=(aver.a /RS)x60 1	f=b+c+d+e 36	g=(WTx60)/f 13	h=LCxg 61	i=ADHR/h 2,140	4,280
a 0 - 1 1 - 2	b=LT 30 30	c=(aver.a/HS)x60 1 2	d=OT 5 5	e=(aver.a /RS)x60 1 2	f=b+c+d+e 36 39	g=(WTx60)/f 13 12	h=LCxg 61 57	i=ADHR/h 2,140 2,299	HR=i/Aver.a 4,280 1,533
a 0 - 1 1 1 - 2 2 - 3	b=LT 30 30 30	c=(aver.a/HS)x60 1 2 4	d=OT 5 5 5	e=(aver.a /RS)x60 1 2 3	f=b+c+d+e 36 39 42	g=(WTx60)/f 13 12 11	h=LCxg 61 57 53	i=ADHR/h 2,140 2,299 2,458	HR=i/Aver.a 4,280 1,533 983
a 0 - 1 1 1 - 2 2 - 3 3 - 4	b=LT 30 30 30 30 30	c=(aver.a/HS)x60 1 2 4 5	d=OT 5 5 5 5	e=(aver.a /RS)x60 1 2 3 4	f=b+c+d+e 36 39 42 44	g=(WTx60)/f 13 12 11 11	h=LCxg 61 57 53 50	i=ADHR/h 2,140 2,299 2,458 2,617	HR=i/Aver.a 4,280 1,533 983 748
a 0 - 1 1 - 2 2 2 - 3 3 - 4 4 - 5	b=LT 30 30 30 30 30 30	c=(aver.a/HS)x60 1 2 4 5	d=OT 5 5 5 5 5	e=(aver.a /RS)x60 1 2 3 4 5	f=b+c+d+e 36 39 42 44 47	g=(WTx60)/f 13 12 11 11 10	h=LCxg 61 57 53 50 47	i=ADHR/h 2,140 2,299 2,458 2,617 2,776	HR=i/Aver.a 4,280 1,533 983 748 617
a 0 - 1 1 1 - 2 2 - 3 3 - 4 4 - 5 5 - 6	b=LT 30 30 30 30 30 30 30	c=(aver.a/HS)x60 1 2 4 5 7	d=OT 5 5 5 5 5 5	e=(aver.a /RS)x60 1 2 3 4 5	f=b+c+d+e 36 39 42 44 47 50	g=(WTx60)/f 13 12 11 11 10 10	h=LCxg 61 57 53 50 47 44	i=ADHR/h 2,140 2,299 2,458 2,617 2,776 2,935	HR=VAver.a 4,280 1,533 983 748 617 534
a 0 - 1 1 1 - 2 2 2 - 3 3 - 4 4 - 5 5 - 6 6 - 7	b=LT 30 30 30 30 30 30 30 30 30	c=(aver.a/HS)x60 1 2 4 5 7 8	d=OT 5 5 5 5 5 5 5	e=(aver.a /RS)x60 1 2 3 4 5 7	f=b+c+d+e 36 39 42 44 47 50 53	g=(WTx60)/f 13 12 11 11 11 10 9	h=LCxg 61 57 53 50 47 44 42	i=ADHR/h 2,140 2,299 2,458 2,617 2,776 2,935 3,094	HR=i/Aver.a 4,280 1,533 983 748 617 534 476
a 0 - 1 1 1 - 2 2 2 - 3 3 - 4 4 - 5 5 - 6 6 - 7 7 - 8	b=LT 30 30 30 30 30 30 30 30 30 30 30	c=(aver.a/HS)x60 1 2 4 5 7 8 10	d=OT 5 5 5 5 5 5 5 5	e=(aver.a /RS)x60 1 2 3 4 5 7 8 9	f=b+c+d+e 36 39 42 44 47 50 53	g=(WTx60)/f 13 12 11 11 11 10 10 9	h=LCxg 61 57 53 50 47 44 42 40	i=ADHR/h 2,140 2,299 2,458 2,617 2,776 2,935 3,094 3,253	HR=VAver.a 4,280 1,533 983 748 617 534 476 434
a 0 - 1 1 1 - 2 2 2 - 3 3 - 4 4 4 - 5 5 5 - 6 6 6 - 7 7 7 - 8	b=LT 30 30 30 30 30 30 30 30 30	c=(aver.a/HS)x60 1 2 4 5 7 8 10 11	d=OT 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	e=(aver.a /RS)x60 1 2 3 4 5 7 8 9	f=b+c+d+e 36 39 42 44 47 50 53	g=(WTx60)/f 13 12 11 11 11 10 9	h=LCxg 61 57 53 50 47 44 42 40 38	i=ADHR/h 2,140 2,299 2,458 2,617 2,776 2,935 3,094 3,253 3,412	HR=VAver.a 4,280 1,533 983 748 617 534 476 434 401
a 0 - 1 1 1 - 2 2 - 3 3 - 4 4 - 5 5 - 6 6 6 - 7 7 7 - 8 8 - 9	b=LT 30 30 30 30 30 30 30 30 30 30 30 30	c=(aver.a/HS)x60 1 2 4 5 7 8 10	d=OT 5 5 5 5 5 5 5 5	e=(aver.a /RS)x60 1 2 3 4 5 7 8 9	f=b+c+d+e 36 39 42 44 47 50 53 55 58	g=(WTx60)/f 13 12 11 11 10 9 9 8	h=LCxg 61 57 53 50 47 44 42 40	i=ADHR/h 2,140 2,299 2,458 2,617 2,776 2,935 3,094 3,253	HR=#Aver.a 4,280 1,533 983 748 617 534 476 434

Tables 11 and 12 on the previous page, show sample calculations of cycle times, and how parameters such as speed, loading and off-loading time can influence the haulage cost. Depending on the haul distance, the number of target trips per day can be calculated and this should be used by the contractor to determine the labour input required for excavation, loading, off-loading and spreading of gravel.

With the use of a tractor – trailer combination, *each tractor normally works with two trailers* (see Figure 35 below). If only one trailer is used per tractor, it will be idle in the quarry while it is being loaded. In that case the size of the loading gang could be increased to reduce the loading time. For short haul distances the most efficient combination would be to have each tractor working





<u>Picture 69:</u> Loaded tractor- trailer combination Eastern Province, Zambia.

with 3 trailers. Tractor – trailer combinations quickly lose their economic advantage, especially in environments, where tipper trucks can be obtained fairly cheap. The calculated samples in Tables 11 and 12 show that the 7 ton tipper truck becomes cheaper to use on haul distances above 4 kilometres. This picture may quickly change if the parameters in the yellow fields are changed, or the hire rate of the equipment is altered.

Table 13 on the following page show sample daily hire rate calculations. If the contractor uses his own equipment, he should carry out these calculations in order to determine his own hire rates. This can be done by filling the yellow fields according to his personal situation. He will then be able to make a sound judgement as to what haulage equipment he should use.

Table 13: Sample Calculation of Daily Hire Rates for Haulage Equipment

	Equipme	ent Daily I	Hire Ra	ate	Calculations, C	ctober 20	001	
							Trailer	
	ltem	Unit			Formula	Tractor-4WD	twin wheel	Tipper, 7 ton
1	USD-Exchange rate	Tshs	UN-rate		966.38	966.38	966.38	966.38
2	Purchase price	Tshs	Р			30,020,254	6,626,857	30,000,000
2a	Supplier					27,992,017	4,590,250	30,000,000
2b	Extra accessories					1,215,066		
2c	Export				•	274,955	274,955	
2d	Transport					238,400	238,400	
2e	Import					199,816	199,816	
2f	Duty					nil	nil	
2g	Tax					nil	1,223,436	
2h	Registration					100,000	100,000	
3	Tire cost	Tshs	cT		complete set	1,832,256	479,131	1,164,353
3a	Front				market price	224	124	201
3b	Rear				market price	724	124	201
4	Tyre life	hour, km	TL		assumed	3,000	2,500	30,000
5	Salvage value	fraction of P	S		assumed	0.10	0.05	0.10
6	Depreciable cost	Tshs	D	=	P-T-S	25,185,972	5,816,383	25,835,647
7	Interest rate	fraction of 100	i		as per bank loan	0.095	0.095	0.210
8	Pay-back period	year	n		as per bank loan	3.0	3.0	9.0
9	Capital Recovery Factor	factor	CRF	=	[i(1+i) ⁿ]/[(1+i) ⁿ -1]	0.40	0.40	0.26
10	Economic life	hour, km	EL		assumed	15,000	12,500	350,000
11	Available Time	hour, km/year	AT		WD * nd * t	1,664	1,664	40,000
11a	Working days		WD	=	365 - LT	260	260	260
11b	Nominal day	hour/day	nd		by law	8	8	8
11c	Lost time factor	factor	t		assumed	0.80	0.80	0.80
12	Operating life	year	OL	=	EL / AT	9.0	7.5	8.8
13	Non-working days	105	LT	=	s+p+r+m+o			
13a	Sundays		S		actual			
13b	Public holidays		р		actual			
13c	Rainy days		Г		assumed			
13d	Maintenance		m		assumed			
13e	Other reasons		0		assumed			
14	Fuel price	Tshs	pF		actual	590		590
15	Fuel consumption	Ltrs/hour	cF		assumed	4		4
16	Lubricants	% of F	cL		assumed	10		10
17	Maintenance cost during OL	fraction of D	fm		assumed	1.00	0.50	1.00
18	Driver/Operator	Tshs/month	sD		actual	80,000		80000
19	Turnboy	Tshs/month	sT		actual	50,000		50000
20	License	Tshs/year	Li		actual	38,000	38000	38000
21	Insurance	Tshs/year	In		actual	1,329,600	216,000	1,329,600
22	Tyre cost	Tshs/day	tc		(cT/TL) * nd * t	3,909	1,227	5,971
23	Fuel cost	Tshs/day	fc		(AT/WD)*cF*(1+cL)*pF	16,614	-	16,614
24	Driver's cost	Tshs/day	dc		(sD+sT) / (WD/12)	6,000	-	6,000
	B 11 1	T 1 /1	D.0		(ODE + D) (14/D	20.042	0.047	05.440
25	Depreciation charge	Tshs/day	DC		(CRF * D) / WD	38,610	8,917	25,443
26	Maintenance charge	Tshs/day	MC		(fm * D) / (OL * WD)	10,746	1,489	11,356
27	Operating charge	Tshs/day	OC	}	tc + fc + dc	26,523	1,227	28,585
28	Insurance & License	Tshs/day	IC	=	(Li + In) / WD	5,260	977	5,260
29	Daily Hire Rate	Tshs/day	DHR	=	DC+MC+OC+IC	81,139	12,609	70,645
	Contractor Allowances							
30	Overhead	% of DHR	Ov	=	15%	12,171	1,891	10,597
31	Profit	% of DHR	Pr	=	10%	8,114	1,261	7,065
32	All-in Daily Hire Rate:		ADHR	=	DHR * (1+(Ov+Pr)/100)	101,424	15,761	88,307

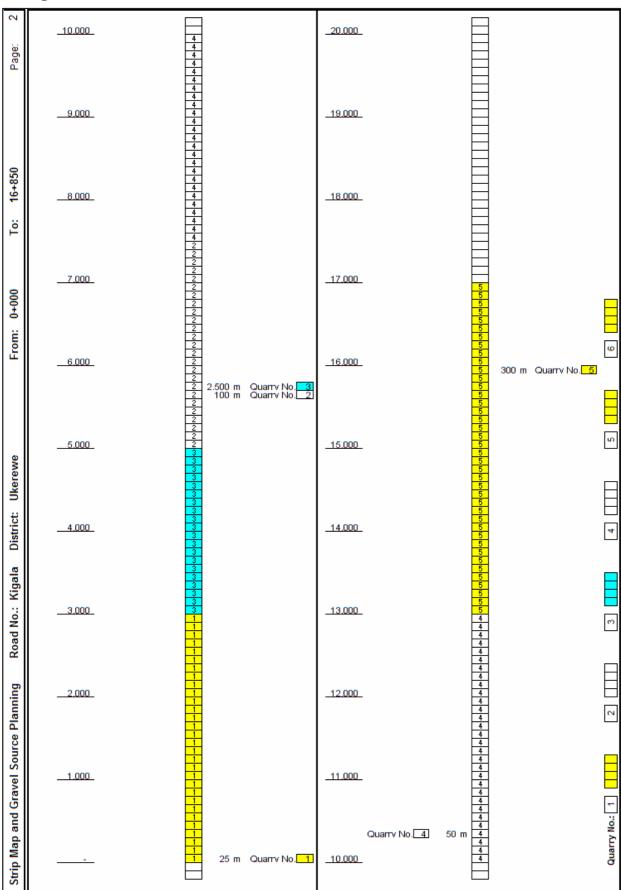
Whatever haulage equipment is used, it is important that the supervising officer ensures that the gravelling plan is implemented as provided in the contract document, unless more cost effective options become available during the course of implementation. Figure 36 on the following page shows a sample of a gravelling plan. In preparing the gravelling plan, the aim must be to reduce on haulage as much as possible. This is simply achieved by determining the cut-off chainage between two quarries from where gravelling from one quarry should stop and gravelling from the next quarry should start. Provided that sufficient gravel is available in the quarries to cover the road sections to be gravelled, this cut-off chainage must always be in the middle between two quarries. Fig-

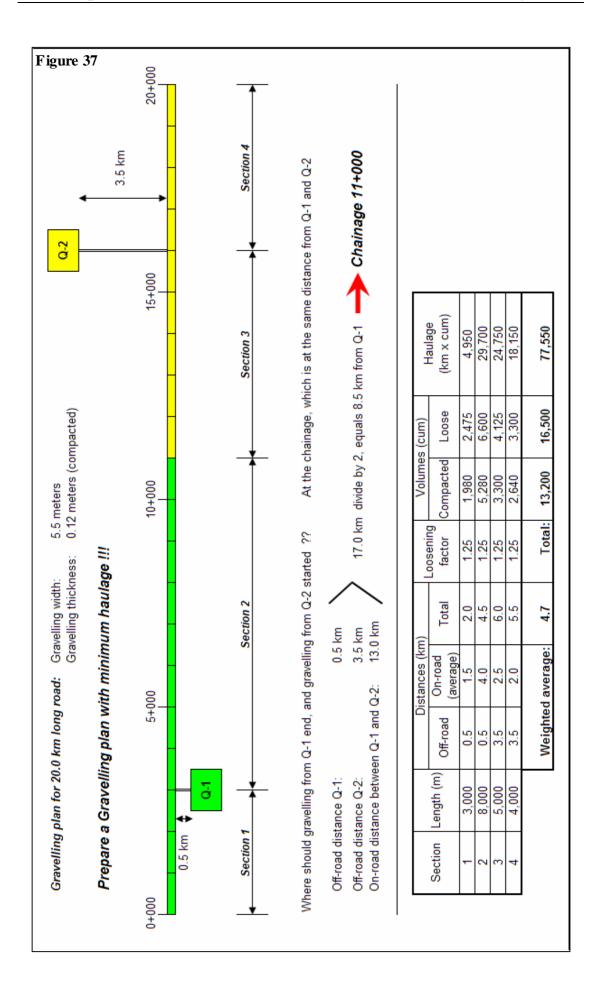
In practice it often happens that additional quarries are identified by the contractor, which could reduce the haulage cost. On the other hand, opening up a new quarry would increase the costs on quarry preparations. Therefore, it always requires careful analyses in respect of quality of material and cost, before the contractor should be given a go ahead to open new quarries.

ure 37 after the following page gives a sample calculation.

Another typical challenge the supervising officer will face, are the contractor's complaints that the material is too hard. The supervising officer should look at this kind of issues in all fairness, and deal with them within the scope and possibilities of the contract. Fairness should go to both sides: the contractor and the client.

Figure 36





Compaction

The contract document requires that road formation, gravel surface layers and backfill of culvert trenches are compacted. Compaction is required to improve the properties of the soil, because it:

- reduces hollow spaces in the soil
- increases bearing capacity of the soil
- reduces settlement of the soil
- reduces permeability of the soil, and
- increases the shearing strength.

A road which has been compacted can stand erosion and traffic better than a loose embankment. Compaction results in a dense surface which can carry substantial loads without getting depressions. It also helps to ensure that rainwater cannot penetrate the layer and soften the gravel or the base. In simple terms, compaction is pressing soil together to make it denser, by getting the air out. In this way the soil becomes stronger and more particles touch each other. Soil consists of three components, solid particles, water and air. The air does not contribute to strength and must be removed by compaction.

Water acts as a lubricant to pack the soil particles and allow them to settle in a dense mass. However, water should not be too much, and also not too little. Each soil has a certain "Optimum Moisture Content" (OMC), which varies between 8% and 10% of the total volume. If the soil has already some moisture, less water need to be added. If the soil is wet, e.g. after a heavy rain, the soil needs to be left to dry before compaction starts.

The requirements regarding the moisture content of soil at the time of compaction are described in the specifications as follows:

"The moisture content at the time of compaction shall be within the range of +/-2 % of the optimum moisture content. If necessary the moisture content of the material shall be adjusted by either drying up or mixing in water".

A simple field test can give a fair indication whether the soil has the correct 'optimum' moisture content for compaction:

Take a sample of the soil to be compacted and squeeze it as tightly as possible in the hand. After opening your hand, one of 3 possible results should be visible:

- 1. The material disintegrates easily and collapses into small pieces: *The soil is too dry*.
- 2. The material sticks together, with no visible sign of free water on the surface of the lump: The soil has the correct moisture content.
- 3. The material sticks to the hand or free water is ejected: *The soil is too wet*

In order to compact a road or a trench, certain equipment is required. In labour based road construction, the use of tractor towed smooth steel drum rollers and pedestrian double drum vibrating rollers are very common. For compaction of backfill in trenches, hand rammers are most commonly used, as well as vibrating plate compactors. The contract specifies the degree of compaction which must be achieved. This is expressed in a percentage relative to a laboratory compaction test of the same soil. For example,

compaction to 95% means that the dry density of samples taken in the field should be 95% of the dry density obtained in specified laboratory compaction tests. Laboratory compaction tests are carried on multiple samples of the same soil according to specified procedures using standard equipment.

The next question is: How can the specified standard of 95% be achieved? The first requirement is, as discussed before, that the soil must have its optimum moisture content at the time of compaction. After that, it depends on the equipment used (size and weight) how much effort is required to compact the soil and get the air out. The required effort is normally expressed in "number of passes". With a heavy machine, less passes are required to reach 95%, with light machines more passes are required. Again, with vibrating machines results are achieved quicker. Another important factor is the thickness of the soil layer being compacted. Usually, a layer thickness of 20 cm is the maximum which can be compacted to the required standards. Table 14 below gives an indication of the no. of passes required for different soils and equipment.

Table 14: Compaction equipment and recommended No. of passes

Type of	Category mass	No. of passes for layer not greater than:					
Compaction equipment	per metre width of roller:	Earthw	ork/fill	Gra	vel		
		100mm	150mm	110mm	150mm		
Vibrating roller	700kg to 1300kg	12	16	16	Unsuitable		
(smooth wheeled)	1300kg to 1800kg	8	10	6	16		
Dead weight roller	Over 2500kg	6	8	16	Unsuitable		



<u>Picture 70:</u> Pedestrian double drum vibrating roller used for gravel compaction on Sengerema – Ngoma road, Sengerema District, Tanzania

Note the use of protective gear (dust mask) by the operator !!!.

Items 5.7 and 5.8: Compaction and watering of gravel

For compaction equipment, there is the choice between pedestrian double drum vibrating rollers, tractor drawn smooth steel drum rollers, or a combination of both.

Experience has shown that a combination of both pieces of equipment has most advantages. In the gravelling operation the double drum vibrating roller is an excellent piece of equipment, which can be used to immediately compact a load of fresh and moist gravel after it has been spread. A tractor drawn steel drum roller is more effective on longer stretches of road. This is the case in road formation, where a labour gang at the end of the day may have completed a section of 100 meters of road. A pedestrian vi-

brating roller would take too long to compact such a long section at the end of the working day. An important advantage of the tractor-drawn steel drum roller is, that it can be locally manufactured, that it is in-expensive (app. 1/3 to 1/4 of the price of a pedestrian vibrating roller), and that it is almost maintenance free. However, a tractor is required to pull the roller, which is expensive and requires intensive maintenance in order to keep it in good running condition. Since the tractor is also used for other activities on site, e.g. gravel haulage and watering, proper work planning for the tractor will be a challenge.

Table 15 on following page gives a sample calculation, as it was done on the FRP programme in Tanzania, for the rate of compaction including watering using pedestrian vibrating rollers.



<u>Picture 71:</u> Watering before compaction using a tractor drawn water browser trailer at llujamate – Lubili B road, Missungwi District, Tanzania.

Table 15: Rate built-up for compaction, including watering

Calculation of Rate fo			-	F 70
	Item	5.71 Earth works	5.72 Drain material	5.73 Gravel material
Calculation of rate for Compaction:	Unit	WOIKS	material	material
Actual width of roller	m	0.75	0.75	0.75
Overlap allowance	m	0.10	0.10	0.10
Effective width	m	0.10	0.10	0.10
Speed (1st gear):	m/hour	1,500	1,500	1,500
Working hours per day	hour	6.0	6.0	6.0
Total length per day	m	9,000	9.000	9,000
Total m2 per day	m2	5,850	5,850	5,850
Thickness layer (compacted)		0.15	0.10	0.10
	m No.	0.15	0.10 5	5
No. of passes required		110	117	117
Productivity (output) per day Daily rate for Pedestrian roller:	m3/day Tshs	23,155	23,155	23,155
Daily rate for Pedestrian folier:	ISNS	23,155	23,155	23,155
Rate for Compaction:	Tshs/m3	211	198	198
Calculation of rate for Watering:				
Average water required	ltr/m3	60	60	60
Total water required per day	ltr/day	6,581	7,020	7,020
Capacity of bowser	ltr	4,500	4,500	4,500
No. of trips required	trips/day	1.5	1.6	1.6
Hire rate tractor	Tshs/day	101,424	101,424	101,424
Working hours per day	hours/day	8.0	8.0	8.0
Average distance to water source	km	10.0	10.0	10.0
Speed empty	km/hr	30	30	30
Loading water time	min	20	20	20
Speed full	km/hr	20	20	20
Water distribution time	min	25	25	25
Trip cycle time	hour	1.6	1.6	1.6
Cost of tractor for total water requirement	Tshs	29,358	31,315	31,315
Daily hire rate bowser-trailer + pump	Tshs	21,667	21,667	21,667
Rate per ltr.	Tshs/ltr	7.75	7.55	7.55
Rate for Watering:	Tshs/m3	465	453	453
Extra labour requirements:				
Extra labour for compacting	1 md	2,505	2,505	2,505
Total labour		2,505	2,505	2,505
Rate for extra labour input:	Tshs/m3	23	21	21
Total compaction rate:	Tshs/m3	700	670	670
Labour input for use of tractor		0.6	0.6	0.6
Roller operator		1.0	1.0	1.0
Labour input for use of waterbowser		0.3	0.3	0.3
Extra labour for compacting		1.0	1.0	1.0
			2.9	2.9
Total:		2.9	2.3	2.3

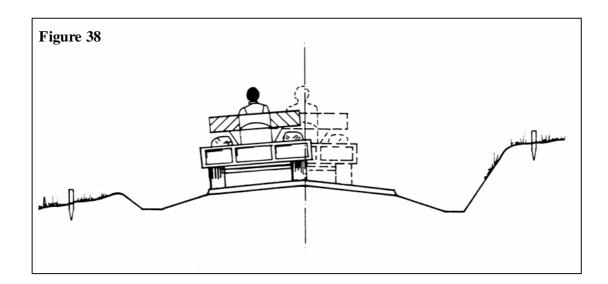
As discussed before, it is very important to obtain the correct moisture (Optimum Moisture Content) before the start of compaction. Watering the soil or gravel must be well organized and done at the right time, with minimum of disturbance to other operations. For the earth works, it is most practical that the tractor – water browser combination is used to water the completed formation works in the afternoon after the labourers have knocked off. Overnight the water can be left to penetrate and distribute in the soil, where after in the morning compaction can be carried out. The gravel, which is compacted immediately after spreading, contains a certain level of moisture for the initial compaction. The stretch of 50 to 100 metres gravel can be watered in the afternoon before the roller makes its final passes during the first hours of the next morning.



<u>Picture 72:</u> Watering before compaction using a tractor drawn water browser trailer at llujamate – Lubili B road, Missungwi District, Tanzania. A well-functioning spray bar is essential for a good distribution of the water over the area.

If the stock piles of gravel in the quarry are dry, the contractor may opt to water them the day before they are loaded, to ensure that the gravel has sufficient moisture for immediate compaction after it has been spread on the road.

As mentioned in the beginning of this chapter, it is important that gravelling works should start from the point where the access road to the quarry joins the road to be gravelled. Besides other advantages already mentioned before, the haulage equipment can greatly contribute to the compaction efforts required under the contract, if the tractor operator carries out the haulage according to a disciplined procedure: The tractors and trailers will be driving over the fresh gravel layer giving a certain amount of initial compaction. To ensure an even compaction of the running surface, the tractor drivers should be instructed not to follow one track along the road, but they should start driving on one side of the road and move across to the centre of the road with each subsequent pass of the loaded trailers. This procedure should be repeated for the other side of the road (see Figure 38 below).



The contractor should be well in control of all aspects of the haulage and compaction operations. However, the task of the supervising officer during these operations can be summarized as follows:

	CHECKS ON HAULAGE AND COMPACTION OF LATERITE.
Who:	Consultant Supervisor.
Why:	To ensure that proper Labour Based-Technical procedures are used and that the gravel layer is compacted according to the specifications.
When:	At random during haulage, and during and after compaction of the gravel.
What:	 Supervisor should carry out following checks: Check before haulage that the gravelling plan is appropriate as to minimize haulage and that it is adhered to. Check that gravel is compacted immediately after it has been spread. Check that the gravel has correct moisture for compaction. Check that the loose layer thickness does not exceed 20 cm. Check at random that the required number of passes is made with the compaction equipment. Ensure that upon completion of the contract an independent laboratory takes a minimum of 3 samples per kilometre at random locations for testing of dry density and thickness of the gravel layer.
Tools:	5m measuring tape.

SECTION 6

FINAL INSPECTION

The final inspection is carried out as part of the procedures for handing over the completed road (or part of it) to the client. Once the contractor has completed the entire contract, or an agreed part of it, he should notify the supervising officer and request for a final inspection. In the final inspection a number of key measurements are carried out in order to check whether the road has finally been constructed to the specified standards. The results of the final inspection measurements should be compiled in a *Final Inspection Report.* The key measurements carried out during the final inspection are related to:

- 1. the road formation
- 2. the gravel layer
- 3. structures (mainly culverts)

6.1 Key measurements on road formation

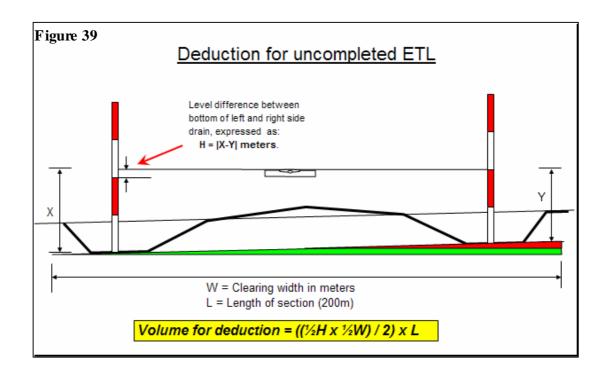
The Excavation to Level is a pre-measured item of work, for which the contractor received 100% payment. However, very often it happens that the ETL is not carried out to correct standards, which is visible in a level difference between the bottom of left and right side drains. Therefore, in the final inspection, this measurement is carried out on 25 meter intervals. The average of the differences



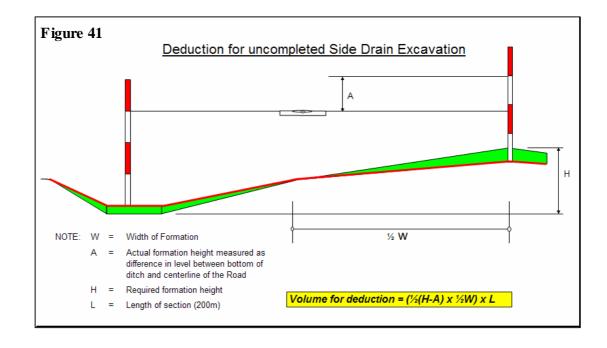
<u>Picture 73:</u> Final check on ETL standards: Measurement of level difference between ditch on left and right side of the road during final inspection on Kakunguli – Bukindo road, Ukerewe

over a section of 200 meters is then calculated. If the average difference is within a margin of 5 cm, the work should be approved. If the average difference is more than 5 cm but less than 20 cm, the contractor will face a deduction on ETL-payments already received in earlier IPC's. If the average difference is more than 20 cm, the contractor should be ordered to carry out corrections.

The contractor should be well aware of the fact that these measurements will be carried out during the final inspection. In order to avoid deductions, it will be an extra motivation for the contractor to carry out the works to specified standards right from the start. At the same time, the supervising consultant should not wait informing the contractor about short comings in the quality of the work until the end of the contract, but rather carry out interim checks (at every IPC inspection). As such, the contractor has the opportunity to carry out corrections while the work is still ongoing.



X-section type	Width of ETL	Height of Earth Formation	Gravel thickness	Required Formation	Figure 40
туре	(W) in m.	in m.	(G) in m.	Height (H) in m.	
A1	10.9	0.52	0.12	0.64	If SIDE-BORROW is specified, add
A2	9.6	0.45	0.12	0.57	the thickness (in m) to the height of earth formation !!!
В	8.0	0.41	0.10	0.51	
С	6.7	0.39	0.10	0.49	
D	13.5	0.71	0.20	0.91	





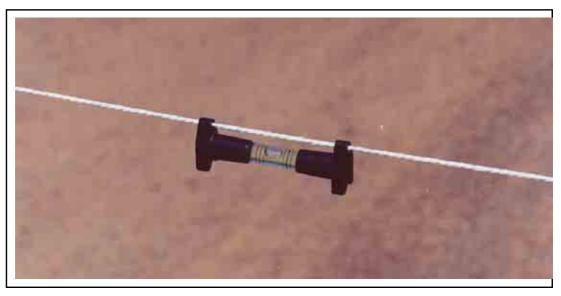
<u>Picture 74:</u> Measurement of level difference between ditch and center line during final inspection on Kakunguli – Bukindo road, Ukerewe District, Tanzania

Another pre-measured item of work is the excavation of side drains (ditching, back- and fore sloping) for which the contractor has also received 100% payment. If the drains are dug to the required standards, depending on the constructed cross section, a difference in level should have been achieved between bottom of side drains and centre line of the road. If this has not been achieved, similarly, deductions should be calculated or corrections should be ordered to the contractor. These measurements will mainly be carried out, where standard cross sections were specified. The achieved standards on embankment sections and sections where side-borrow is specified, must be evaluated separately. The standards for these measurements and related calculations are shown in Figures 39, 40 and 41 on the previous page.



<u>Picture 75:</u> Final inspection on achieved camber, which should be 8%; Kakunguli – Bukindo road, Ukerewe District, Tanzania

Other measurements on road formation during final inspection comprise the width of the road from edge to edge, and camber achieved on both sides, which must be 8%. Also the shape of the side drain is checked with a Ditch-Foreslope template.



<u>Picture 76:</u> Line and level: A frequently used instrument to carry out level measurements.

The results of these measurements are entered in a spreadsheet, where (if applicable) deductions are calculated. Also directions to the contractor for corrections to be carried out should be provided.

6.2 Key measurements on gravel layer

Inspection measurements on the gravel layer should not be carried out by the supervising officer, but by an independent laboratory. The laboratory should carry out *3 random tests per kilometre* to determine achieved gravel thickness and density. The test results must be included in the final inspection report, including corrective



measures to be ordered to the contractor. These may be instructions to re-gravel or to recompact. If the gravel thickness proves to be less than specified, but within appropriate limits, deductions may be made instead.

<u>Picture 77:</u> Adjustable boning rod is standard measurement equipment for the road supervisor.

6.3 Key measurements on installed structures

With an average of 3 to 4 culvert lines per kilometre, typical for feeder roads, the installation of structures is a major investment and constitutes an important part of the total rehabilitation cost. A comprehensive and thorough final inspection of the installed structures is therefore not a luxury. The final inspection should include following features:

- Location (chainage) and type of culvert,
- Diameter and length of the culvert,
- Number of lines.
- Type of inlet and outlet structure,
- Haunch profile, if constructed,
- Ramp quality, if constructed,
- Extra constructed additions to standard design,
- Gradient from inlet to outlet,
- Gradient and discharge capabilities of run-off drain,
- > Level difference between the LHS and RHS headwalls, which should be nil.
- Level difference between inlet apron and centreline of the road, to check whether there is sufficient coverage,
- Paid quantities of pipes, masonry and concrete.

All measurements and observations are to be entered in a couple of spreadsheets, and will form part of the final inspection report (Annex D3) as an "AS BUILT" record of the drainage design of the road.



<u>Picture 78:</u> Final inspection to check that headwalls are constructed to same level; Kakunguli – Bukindo road, Ukerewe District, Tanzania

Most of the measurements and checks should be carried out at the time of an IPC-inspection, when the contractor submits a claim for specific culverts for payment. If not completed to the required standards, the culvert should not be approved for payment. The final check on all structures at the end of the contract is merely to compile all information and assure that payments have been made in accordance with what has actually been built.

One important final check is on the coverage over the culvert. Especially where culverts are raised, and a ramp is built, the minimum coverage is often not achieved, and the contractor must be instructed to go back and rectify the situation. The measurement guideline for this inspection is given on following two pages. Another aspect to be inspected is the quality of the ramp itself, which is often too steep, causing the effect of a speed bump. (see Figure 27) Also here the contractor should rectify the situation.



<u>Picture 79:</u> Final inspection to check whether sufficient cover has been achieved over the culvert; Kakunguli – Bukindo road, Ukerewe District, Tanzania

The required difference in level between the centreline of the road and the inlet apron can be calculated by adding following measurements:

- Thickness of compacted gravel layer
- Height of camber at centreline:
- > ¾ of the pipe diameter
- Thickness of pipe wall
- Diameter of pipe

The measurements for different X-sections and pipe diameters are given in Table 16 on the following page:

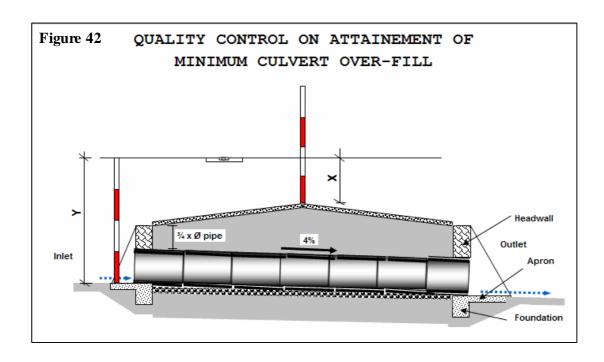


Table 16: Required fill over concrete culvert pipes

X-section type	Pipe diameter (m)	Gravel thickness (m)	Camber (8%) at CL (m)	Overfill %4 of Ø of pipe (m)	Pipe thickness (m)	Required Level difference (m)
A1	0.60	0.12	0.22	0.45	0.07	1.46
A2	0.60	0.12	0.20	0.45	0.07	1.44
В	0.60	0.10	0.16	0.45	0.07	1.38
С	0.60	0.10	0.14	0.45	0.07	1.36
D	0.60	0.20	0.22	0.45	0.07	1.54
A1	0.90	0.12	0.22	0.68	0.10	2.02
A2	0.90	0.12	0.20	0.68	0.10	2.00
В	0.90	0.10	0.16	0.68	0.10	1.94
С	0.90	0.10	0.14	0.68	0.10	1.92
D	0.90	0.20	0.22	0.68	0.10	2.10

If HAUNCH PROFILE III or IV is applied, take 1/2 of the Ø of the pipe for overfill !!!

The Final Inspection must be carried out by the supervising officer, in the presence of the contractor and the DoW's representative.

	EINIAI INICHECTIONI OF THE WORKS
	FINAL INSPECTION OF THE WORKS.
Who:	Consultant Supervisor.
Why:	To ensure that the works are carried out according to the specifications and the quantities in the contract.
When:	After substantial completion of the works.
What:	Supervisor should carry out following inspections:
	1. Check full length of the completed road.
	2. Arrange for laboratory technician to take 3 ran-
	dom tests per kilometre to check gravel thickness and density.
	3. Measure achieved width and camber at an inter-
	val of 200m and check shape of side drains.
	4. Check whether mitre and catch water drains are
	discharging.
	5. Check achieved road formation by measuring at
	intervals of 25m the level difference between LHS
	and RHS side drains, and between the side
	drains and centreline.
	6. Check correct installation of culverts and ramps
	by measuring level difference between inlet apron
	and centreline, gradient in the pipe and discharge capability of run-off drains.
	7. Check the number of structures installed and
	quantities paid for materials against the actual.
	8. Check that all labour wages are paid, and that the
	contractor has no outstanding debts to other
	suppliers of services and goods in the rural area.
Tools:	Camber board and spirit level, 25m measuring tape,
1 0013.	ranging rods, boning rods, line level.

ANNEX A

SPECIAL CONDITIONS FOR LBT WORKS

The FRP programmes in Zambia and Tanzania, used the *FIDIC SHORT FORM of CONTRACT* as the standard contract form for labour based road construction works. The standard contract form comprises of:

- The Agreement
- General Conditions
- Rules for Adjudication
- Notes for Guidance

In the management of Labour Based works where this contract form is used, the supervising officer is advised to have a copy at hand for reference.

Specifically for use on the Labour Based contracts, special conditions were included in the standard contract. These special conditions are given in this annex.

ANNEX A: **Special Conditions for LBT Works**

Clause 4.

THE CONTRACTOR

4.1

General Obligations: Add eleven new Paragraphs under this

Sub-Clause

4.1.1

Labour-based

Methods

labour-based methods.

4.1.2

Methods

Equipment-based Equipment support may be required to carry out some specific type of roadwork activities e.g. haulage of gravel material and compaction. The Contractor is expected to use tractors, trailers, water bowsers, light rollers (self-propelled and/or tractor

The works shall generally be carried out using

drawn) and/or light trucks for this purpose.

4.1.3

Approval of Equipment

The Contractor will supply the Employer within seven days prior to the commencement date with a list of equipment, which he intends to use on site for the latter's approval. He shall further notify the Employer prior to bringing in or removing any equipment from site.

Use of heavy equipment will not be allowed except

with the written consent of the Employer.

4.1.4

Equipment Ownership

The equipment can either be owned by the Contractor, rented from private contractors, leased from leasing companies, or rented / leased through arrangements facilitated by the Employer.

4.1.5

Recruitment of Labour

All general workers employed by the Contractor or Subcontractor must be recruited from amongst the surrounding population. There shall be no discrimination in recruitment because of tribe, religion, political affiliations, gender etc.

The contractor shall apply fair and transparent procedures in selecting the labour for employment. He shall further notify the Employer at least one week ahead of any major recruitment. The notification shall state venue, date and time the enrolment will take place.

4.1.6

Employment of Young Persons and Children

In accordance with the Employment Act Ordinance CAP 366 concerning the Employment of Young Persons and Children, the Contractor is free to employ any person of sixteen years and older.

Under certain conditions, persons younger than sixteen years but not younger than fourteen years (children) may be employed (see Annex 1 for extracts from these sections of the Law).

4.1.7

Conditions of Employment of Labour

In view of the large labour force the Contractor shall observe and fulfil particularly the following conditions in respect of all persons employed by him in the execution of the Contract:-

- The Contractor will be expected to employ labour on a daily task or piecework basis. The size of the daily task shall be what can reasonably be expected of a worker during a normal working day (8 hours).
- The level of the task will vary depending upon the terrain and ground conditions and the Contractor will be expected to agree the task level and payment system with the Employer from time to time.

- The wages paid to workpersons, foremen or other labour including housing and working conditions shall be in accordance with any statute, and rule or act as shall be applicable.
- In absence of any rates of wages or conditions of the labour so established, the Contractor shall pay rates of wages and observe conditions of labour considered adequate for the project area. They shall not be less favourable than the general level of wages and conditions observed by other employers whose general circumstances in the trade or industry in which the contractor is engaged are similar.
- The Employer may further stipulate a minimum labour wage rate per workday on productivity related output (task work). The applicable labour wage rate is to be at least equivalent to the basic rate as defined in Sub-Clause 11.1.1 a)(ii).

4.1.8

Reporting Requirements

During the contract the Contractor shall keep fully detailed muster rolls in English showing wages paid to all personnel employed on the Contract, and shall be bound to produce at any time such muster rolls for inspection by any person authorised by the Employer.

The Contractor shall further keep daily records of all information and data related to labourers such as classes of labour, numbers employed each day, output per head, distribution between gangs etc. Other information are gender breakdown, wage rate, machine output etc.

The records for each calendar month during construction shall be made available to the Employer during the first week of the following month, together with the monthly Interim Payment Certificate (ICP) claim.

4.1.9

Non-payment of Wages by Contractor

Any dispute between the Contractor and labourers, regarding delayed payment or default in payment of fair wages, if not resolved immediately may force the Employer to intervene.

The Employer may, upon the Contractor defaulting payment, pay the monies due to labourers not honoured in time, out of any moneys due or which may become due to the contractor under the Contract.

In such events, the Contractor is bound to cooperate with the Employer in processing the payment of the correct amounts of monies due to the labour force by submitting the relevant musterrolls, workday reports and pay-sheets, and be represented during the payments.

Direct payment to labourers by the Employer will attract a penalty as mentioned in the Appendix, Section C-2 to cover expenses incurred in the administration of such labour payments.

4.1.10

Working Hours

The Contractor shall not carry out any work outside normal working hours unless authority to do so has been obtained in writing from the Employer or his Representative.

4.1.11

Provision of Handtools

The Contractor shall provide his labour force with handtools of adequate quality, sufficient in numbers and make the necessary provisions to maintain the tools in good and safe working conditions.

Detailed minimum requirements on handtools standards are given in Section E, Specifications.

4.2

Contractor's Representative:

Add one new Paragraph under this Sub-Clause

4.2.1

Contractor's Superintendence

Labour based Construction methods require a high input of supervisory and administrative personnel with relevant background and experience. The Contractor will be required to show that he has sufficient competent staff available to ensure proper supervision by submitting the relevant CV's within seven days prior to the commencement date.

The supervisory staff must have adequate technical education and sufficient previous exposure to labour based methods as per Appendix Section C-2.

Clause 7.

TIME FOR COMPLETION

7.1

Execution of the Works: Add two new Paragraphs under this Sub-Clause

7.1.1

Progress Review Meetings

Regular progress review meetings between the Employer and the Contractor shall be held once in every two weeks at a time agreed to by both parties.

The purpose of this meeting will be to discuss the progress being made, review the plans for the remaining works, and deal with any problems that have a direct bearing on the immediate to short – term work activities.

Clause 7. Time for Completion (continued)

7.1.2

Minutes of Progress Review Meetings

The Employer shall record the proceedings of progress review meetings and shall provide copies of these records to those attending the meeting

within seven calendar days.

Agreements reached, and instructions and orders given during the meetings shall be considered as site instructions.

7.2

Programme:

Add three new Paragraphs under this Sub-Clause

7.2.1

Intended Construction Procedures, Order, and Methods The Contractor will be required to show the procedure, order and methods proposed in carrying out the works with specific emphasis on the labour requirements, equipment utilisation and productivity.

7.2.2

Productive Construction Period

When compiling his programme the Contractor shall make adequate allowances for any public and religious holidays, weather and conditions, which are normal and expected during the period of the Contract.

7.2.3

Up-date of Programme

Within the intervals stated in the Appendix, Section C-2, the Contractor shall submit up-dated programmes of the Works.

Clause 9.

REMEDYING DEFECTS

9.1

Remedying Defects: Add one new Paragraph under this Sub-Clause

9.1.1

RoutineDuring the period for notifying defects, the Maintenance
Contractor shall carry out normal routine

maintenance to the works, payable under the

Contract on a quarterly basis.

Clause 10.

VARIATIONS AND CLAIMS

10.4

Right to Claim: Add two new Paragraphs under this Sub-Clause

10.4.1

Variation in Quantity

Clause 11 together with the Appendix and Section F of the Tender Document provide detailed guidance in measuring quantities and single out Works, which qualify for re-measurement after construction.

Work items not identified for re-measurement shall be Measured Before Construction (MBC) and will here below be referred to as a MBC Item.

Variation in quantity will not apply to works classified under a MBC Item, except for events where the Employer has changed the Scope of Works.

Clause 10. Variations and Claims (continued)

10.4.2

Reduction in Scope of Work due to Slow Progress In case the Contractor's execution of the Contract is too slow to ensure completion within the prescribed completion date, the Employer may reduce the Scope of Works in accordance with Sub-Clause 10.1 above to ensure that all works within the reduced scope are completed before the set completion date.

Such reduction will not entitle the Contractor to any revision of rates or claims arising out of such a variation.

Clause 11.

CONTRACT PRICE AND PAYMENT

11.1

Valuation of the Works: Add five new Paragraphs under this Sub-Clause

11.1.1

Single method of calculating offer

Appendix, Section C-2 will define, if applicable, <u>one</u> of the following five possible options to be used in calculating the offer:

- (a) Lump sum price
- (b) Lump sum price with schedule of rates
- (c) Lump sum price with bill of quantities
- (d) Re-measurement with bill of quantities
- (e) Cost reimbursable

11.1.2

Combined method of calculating offer

The nature of labour-based road works may require that offers be calculated by applying more than one of the five possible options as per Paragraph 11.1.1.

Clause 11. Contract Price and Payment (continued)

11.1.3

Price Adjustment

Adjustments to the Contract Price shall be made in respect of rise or fall in the cost of local labour and specified materials as set out in this Sub-Clause.

a) Local Workpersons

For the purpose of this Sub-Clause:

- (i) "Local Workpersons" means skilled, semiskilled workers of all trades engaged by the Contractor on the Site for the purpose of or in connection with the Contract or engaged full time by the Contractor off the Site for the purpose of or in connection with the Contract (by way of illustration but not limitation: workers engaged full time in any office, store, workshop or quarry).
- (ii) "Basic Rate" means the applicable basic minimum wage rate prevailing on the date 28 days prior to the latest date for submission of tenders by reason of any National or State Statute, Ordinance.
- (iii) "Current Rate" means the applicable basic minimum wage rate for Local Workers by reason of any National or State Statute or Ordinance, prevailing on any date subsequent to the date 28 days prior to the latest date set for submission of tenders.

b) Specified Materials

For the purpose of this Sub-Clause:

(i) "Specified Materials" means the materials stated in Schedule II of the Tender Document required on the Site for the execution and completion of works.

Clause 11. Contract Price and Payment (continued)

(i) "Basic Prices" means the current prices for the specified materials prevailing on the date 28 days prior to the latest date for submission of tenders.

a) Overheads and Profits Excluded

In determining the amount of any adjustment to the Contract Price pursuant to this Sub-Clause no account shall be taken of any overheads or profits.

11.1.4

Schedule of Basic Prices

It shall be a condition of application of this clause that the Contractor submits the completed schedule of Basic Rate of Labour, Equipment and Materials for executing additional work of any kind necessary for the completion of the Works.

Prices shall be listed for all materials, fuel or power, which the Contractor proposed to use on site in the execution of the Contract. Original written quotations from the Contractor's suppliers in respect of price ruling at the time when developing the rates shall be the basic prices, subject to approval by the Employer.

11.1.5

Exclusion of Price Adjustment for Late Completion of Works In the event of the Contractor failing to complete the work within the Time for Completion as defined under Clause 7, the provisions of Clause 11 shall cease to apply.

Any part of the Works executed after the expiry of the time for completion shall be valued at a price level prevailing at the contractual date of completion.

Clause 11. Contract Price and Payment (continued)

11.3

Interim Payments: Add three new Paragraphs under this

Sub-Clause

11.3.1

Advance Payment on Mobilisation

An advance payment may be provided to the Contractor for mobilisation on application after signing of the contract.

The Contractor will be required to submit a guarantee in the equivalent amount from a source approved by the Employer.

This advance will be used for payment of the first month' labour wages, the provision of tools and equipment, and the erection of camp facilities.

11.3.2

Deductions for Re-payment of Mobilisation Advance

The Mobilisation Advance as per Paragraph 11.3.1 shall be repaid according to the schedule as specified in the Appendix, Section C-2.

No account shall be taken of the Advance Payment or its repayment in assessing value of work done, variations, price adjustments claims, or liquidated damages.

11.3.3

Deductions for Lease / Hire of Equipment

If equipment is leased or rented through an arrangement facilitated by the Employer as per Paragraph 4.1.4, lease or renting costs shall be recovered from the Interim Payments due to the Contractor directly.

The Employer shall therefore be authorised to effect the necessary deductions from the Interim Payment Certificates according to the schedule spelt out in the relevant equipment lease or renting agreement.

ANNEX B

TASK RATES for Labour Based Road Works

ANNEX B1: Linear Task Rates based on Daily Task Rates per

Unit for different X-sections.

ANNEX B2: Daily Task Rates used to calculate Unit Rates for

Labour Based Bill of Quantity Items.

ANNEX B1: Linear Task Rates based on Daily Task Rates per Unit for different X-sections.

TABLE - TASK RATES	RATES	LINE	AR PRO	LINEAR PRODUCTIVITY IN METRES PER MANDAY	IN METRE	S PER MAI	NDAY	REMARKS
				CROSS SECTION TYPE	CTION TY	ñ		md = manday;
ACTIVITY	TASK RATE	A1	A2	ω	ပ	۵	ш	volumes measureu insitu.
Bush clearing	300 - 800 m²/md	60 - 160 m	67 - 178 m	n 75 - 200 m	86 - 229 m	55 - 145 m	55 - 145 m	Quantity measured on
Stripping & grubbing	100 - 200 m²/md	20 - 40 m	22 - 44 m	п 25 - 50 m	29 - 57 m	18 - 36 m	18 - 36 m	area covereu ny vegetation only.
Tree & stump removal	150 - 250 m²/md	30 - 50 m	33 - 56 m	п 38 - 63 m	43 - 71 m	27 - 45 m	27 - 45 m	Small stumps task rate
Boulder removal	300 - 800 m³/md							per mz. Drg ones by No.
Slotting	3 - 4 slots/md	30 - 40 m	33 - 44 m	n 43 - 57 m	50 - 67 m	25 - 33 m	25 - 33 m	Task rate to be
Excavation to level	3.0 - 4.0 m³/md	2 - 3 m	3 - 4 n	m 3 - 5 m	4 - 5 m	2 - 3 m	0.4 - 1 m	terrain.
Ditching	2.0 - 3.5 m³/md	3 - 6 m	5 - 9 m	n 8 - 14 m	8 - 14 m	2 - 4 m	N/A	Ditching, backsloping and sloping to be
Spreading	10 - 20 m³/md							given as combined activities together with
Backsloping	2.5 - 4.0 m³/md	17 - 27 m	20 - 32 m	n 20 - 32 m	33 - 53 m	8 - 13 m	W/A	spreading; Linear Productivity includes
Sloping	2.5 - 4.0 m ³ /md	7 - 11 m	10 - 16 m	n 10 - 16 m	13 - 20 m	ш 6 - 9 ш	W/A	drain on both sides of the road.
Camber formation	100 - 200 m²/md	18 - 36 m	20 - 40	m 25 - 50 m	29 - 57 m	17 - 33 m	14 - 29 m	
Mitre drains	3.0 - 4.0 m³/md							
Scour checks	1.0 - 2.0 No./md							Including collection of stones and pegs.
Culvert laying	1.0 - 2.0 m/md							Group task
Catch water drains	3.0 - 4.0 m ³ /md							
Hauling	4.5 - 9.0 m³/md							
Masonry work	0.3 - 0.5 m³/md							

ANNEX B2: Daily Task Rates used to calculate Unit Rates for Labour Based Bill of Quantity Items.

	Bill of Quantity Ite	ems		Task Rates
ltem	Description		Unit	Agreed rates (units/mo
No.	Description		Onic	Agreed rates (units/inc
1.1	(Re) establishment of alignment an setting of chainage including placi permanent markers			
1.11	For reshaping	RES	m	75
1.12	New construction	ETL	m	75
1.13	Embankment	SBO	m	75
1.2	Bush Clearing			
1.21	Cross section		m2	
1.22	Cross section		m2	300
1.23	Cross section		m2	
1.3	Grass Cutting			
1.31	Cross section		m2	
1.32	Cross section		m2	800
1.33	Cross section		m2	
1.4	Grubbing			
1.41	Cross section		m2	
1.42	Cross section		m2	110
1.43	Cross section		m2	
1.5	Tree and stump removal			
1.51	Cross section		m2	
1.52	Cross section		m2	200
1.53	Cross section		m2	
1.6	Clearance of quarry site			
1.61	Quarry No.: 1 s	parse	m2	150
1.62	Quarry No.: 1 m	edium	m2	100
1.63	Quarry No.: 1	lense	m2	50
1.7	Establishment of access to quarry including maintenance throughout whole construction period			
1.71	Quarry No.: 1	light	km	0.050
1.72	Quarry No.: 1 m	edium	km	0.035
1.73	Quarry No.: 1 di	ifficult	km	0.020
1.8	Excavation of overburden, includi loading, hauling and stocking with 100m	- 1		
1.81	Quarry No.: 1	soft	m3 (insitu)	3.5
1.82	Quarry No.: 1 m	edium	m3 (insitu)	3.0
1.82	Quarry No.: 1	hard	m3 (insitu)	2.5

	Bill of Quantity	Items		Task Rates
Item	Description		Unit	Agreed rates (units/md)
No.	 			
2.1	Cutting of slots and setting of			
2.11	For reshaping	RES	m	35
2.12	New construction	ETL	m	30
2.13	Embankment	SBO	m	25
2.2	Excavation to level or side bor	rrow		
2.21	Height of cut <m< td=""><td>0.25</td><td>m3 (insitu)</td><td>3.0</td></m<>	0.25	m3 (insitu)	3.0
2.22	Height of cut>m	0.25	m3 (insitu)	3.0
2.23	Embankment		m3 (insitu)	3.0
2.3	Ditching and spreading			
2.31	Cross section		m3 (insitu)	
2.32	Cross section		m3 (insitu)	3.0
2.33	Cross section		m3 (insitu)	
2.4	Backsloping and spreading			
2.41	Cross section		m3 (insitu)	
2.42	Cross section		m3 (insitu)	3.5
2.43	Cross section		m3 (insitu)	
2.5	Sloping			
2.51	Cross section		m3 (insitu)	
2.52	Cross section		m3 (insitu)	3.5
2.53	Cross section		m3 (insitu)	
2.6	Camber formation			
2.61	Cross section		m2	
2.62	Cross section		m2	100
2.63	Cross section		m2	
2.7	Haulage by wheelbarrow			
2.71	10 - 50 m		m3 (loose)	5.0
2.72	50 - 100 m		m3 (loose)	4.0
2.73	100 - 200 m		m3 (loose)	3.0

	Bill of Quantity	/ Items		Task Rates
ltem	Description		Unit	Agreed rates (units/md)
No.	Description		Oiiit	Agreed rates (dilits/illd)
3.1	Excavation of other drainage	es		
3.11	Outside road formation		m3 (insitu)	3.5
3.12	within road formation		m3 (insitu)	3.0
3.13	Desilting of culverts		m3 (insitu)	2.0
4.1	Excavation and stocking of	gravel		
4.11		soft	m3 (insitu)	3.0
4.12	Quarry No.: 1 3	medium	m3 (insitu)	2.5
4.13	Quarry No.: 2	hard	m3 (insitu)	2.0
4.2	Removal of boulders			
4.21	Size 0.025 to 0.25 m3		m3 (loose)	0.8
4.22	Size 0.25 to 0.5 m3		m3 (loose)	0.8
4.23	Size > 0.5 m3		m3 (loose)	0.8
4.3	Loading of gravel			
4.31		easy	m3 (loose)	7.0
4.32	Quarry No.: 123	medium	m3 (loose)	6.0
4.33		hard	m3 (loose)	5.0
4.4	Off-loading of gravel			
4.41		easy	m3 (loose)	15
4.42	Quarry No.: 123	medium	m3 (loose)	14
4.43		hard	m3 (loose)	12
4.5	Spreading of gravel to camb	er		
4.51		easy	m3 (loose)	15
4.52	Quarry No.: 123	medium	m3 (loose)	14
4.53		hard	m3 (loose)	12
4.6	Crushing of stones			
4.61	Quarry No.: 4	fine	m3 (loose)	3.0
4.62	Quarry No.: 1 3	medium	m3 (loose)	2.5
4.63	Quarry No.: 2	coarse	m3 (loose)	2.0
4.7	Maintenance of gravel road			
4.71	During construction		km	0.065
4.72	During defects liability peri	iod	km	0.013
4.8	Backfill and leveling of quar	ry		
4.81	Quarry No.: 23	minor	m3 (loose)	4.0
4.82	Quarry No.: 1	partial	m3 (loose)	4.0
4.83		full	m3 (loose)	4.0

ANNEX C

STANDARD DRAWINGS FOR LBT WORKS

ANNEX C1: Standard Cross Sections

ANNEX C2: Standard drawings of culverts & haunch profiles

ANNEX C3: Tables for Standard Masonry & Concrete Quan-

tities in Head-wall and Wing-wall Construction

ANNEX C4: Standard Drawing of Ramp Construction

ANNEX C5: Standard Access Drift

ANNEX C6: Standard Main Drift

ANNEX C7: Main Traffic Signs

ANNEX C8: Standard Bill Board Design

ANNEX C1: Standard Cross-sections

The Technical Manual distinguishes seven types of cross sections. The application of each cross section is implied by its description.

A1: Standard, as per MWS specification, for flat or undulating terrain:

The basic cross section "A1" is the standard section for earth and gravel roads specified by the MWS, but adapted to suit labour-based construction and maintenance. This cross section is used in most situations. The measurements of the side ditches have been chosen to enable a constructed camber cross fall of 8% to be achieved after compaction and consolidation, whether there are one or two side ditches (10% before compaction, in loose condition).

A2: Standard, as per MLGH specification, for flat or undulating terrain:

The cross section "A2" is the standard section for earth and gravel roads specified by the MLGH. The differences between cross sections "A1" and "A2" are marginal and are normally used for roads in similar site conditions.

B: Reduced cross section, for very low traffic volumes in flat or undulating terrain

Cross section "B" may be used in flat or undulating terrain when traffic levels in the coming 5-year period are not expected to exceed 10 vpd.

C: Mountain road cross section, for severe terrain and very low traffic volumes

Cross section "C" is applicable if formation of the road to cross section "A1" or "A2" would necessitate the excavation of large quantities of earth. An expected total labour requirement for the entire rehabilitation in excess of approximately 4,000 workdays / km could be given as an upper limit for lowering the cross section standard to type "C".

The other three cross sections are for limited use in specific situations:

D: Black cotton soil

Cross section "D" is applicable for sites where road levels are to be raised due to poor in situ soil conditions such as black cotton, etc.

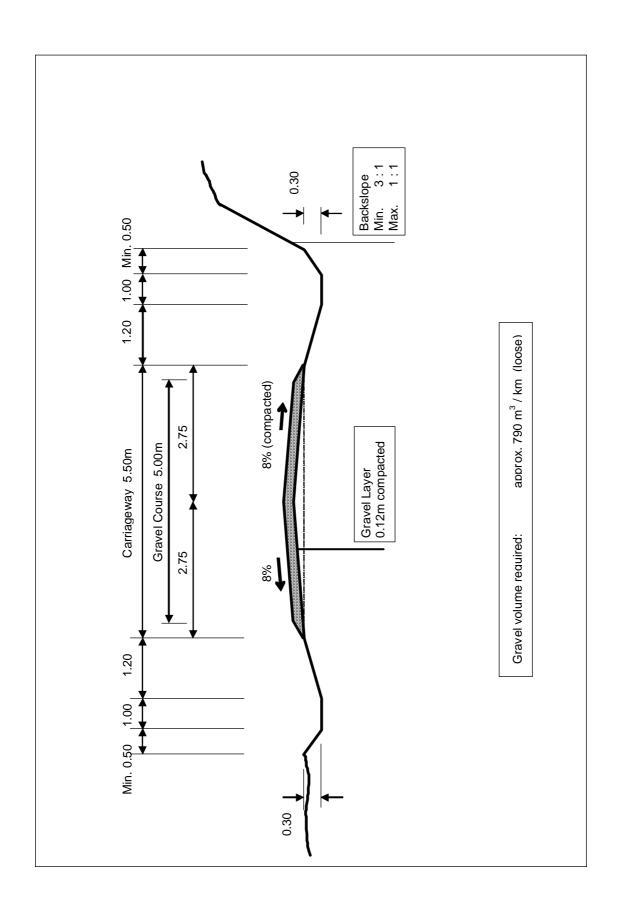
E: Embankment

Cross section "E" is used adjacent to structures and over ground liable to flooding (dambo crossings).

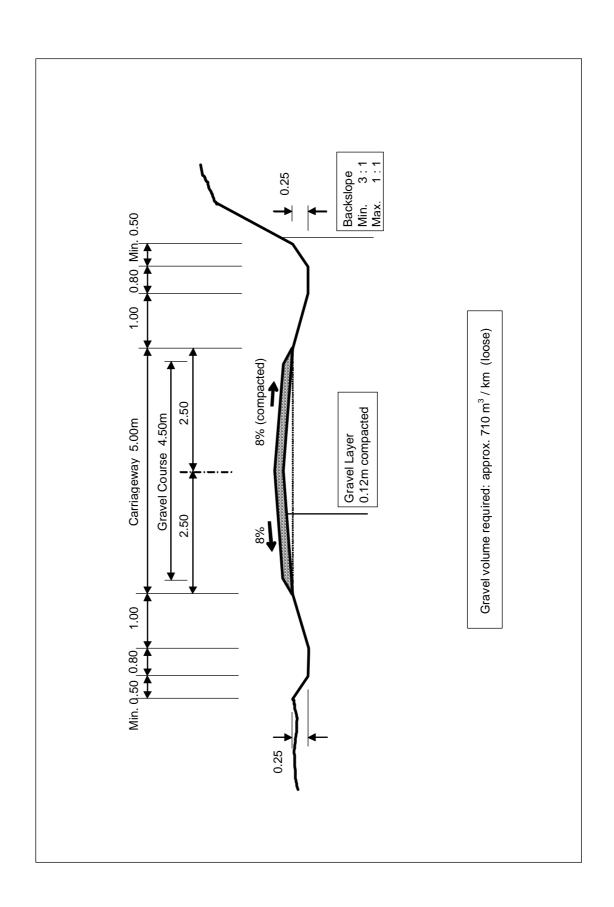
F: Super elevation

Cross section "F" is applicable for hairpin bends and/or for curves with a radius of less than 100m.

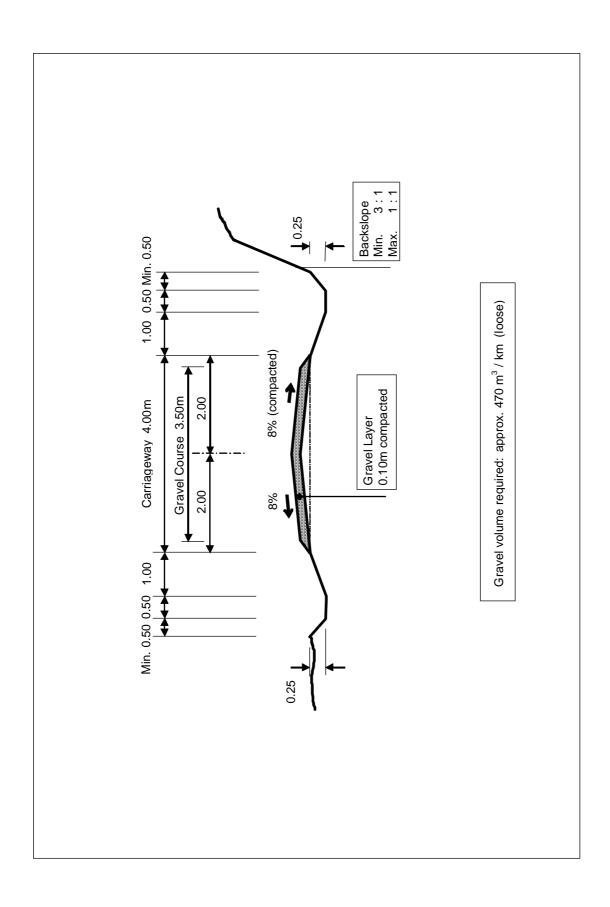
Standard cross section A1, as per MWS specification



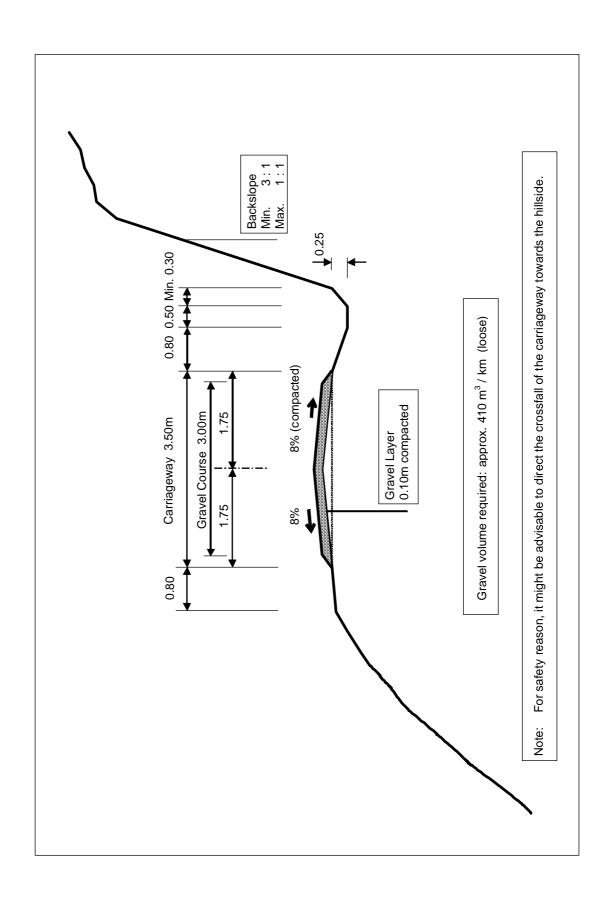
Standard cross section A2, as per MLGH specification



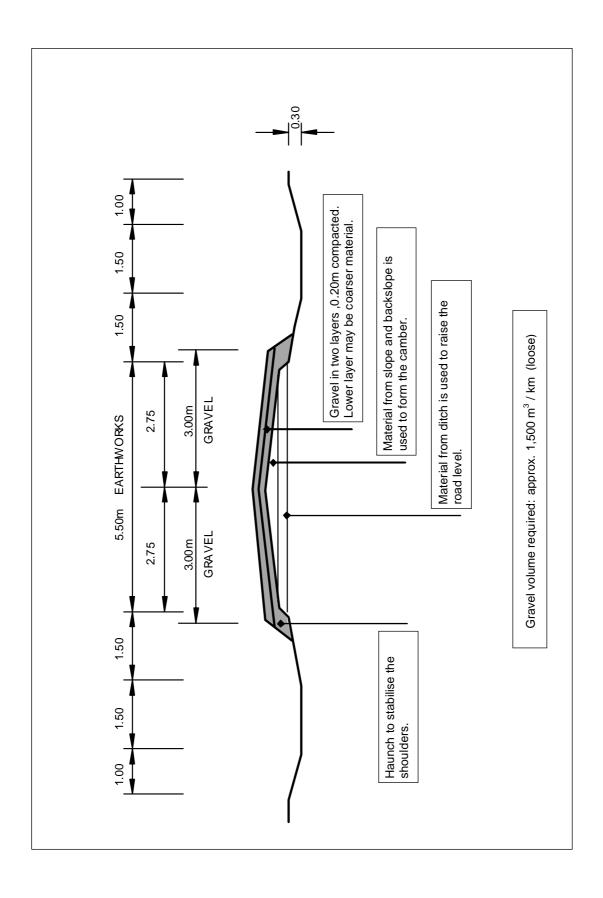
Standard cross section B, Reduced cross section



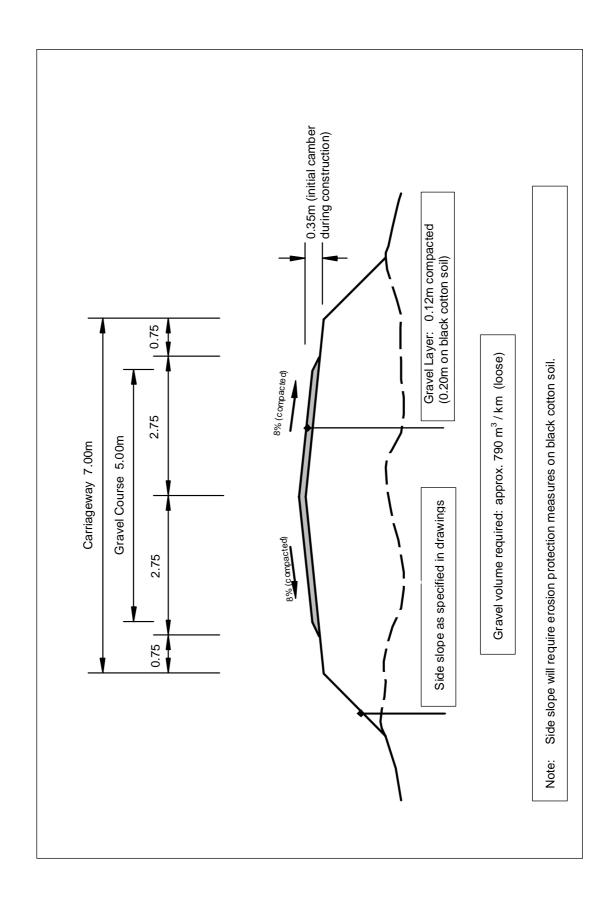
Standard cross section C, mountain road cross section



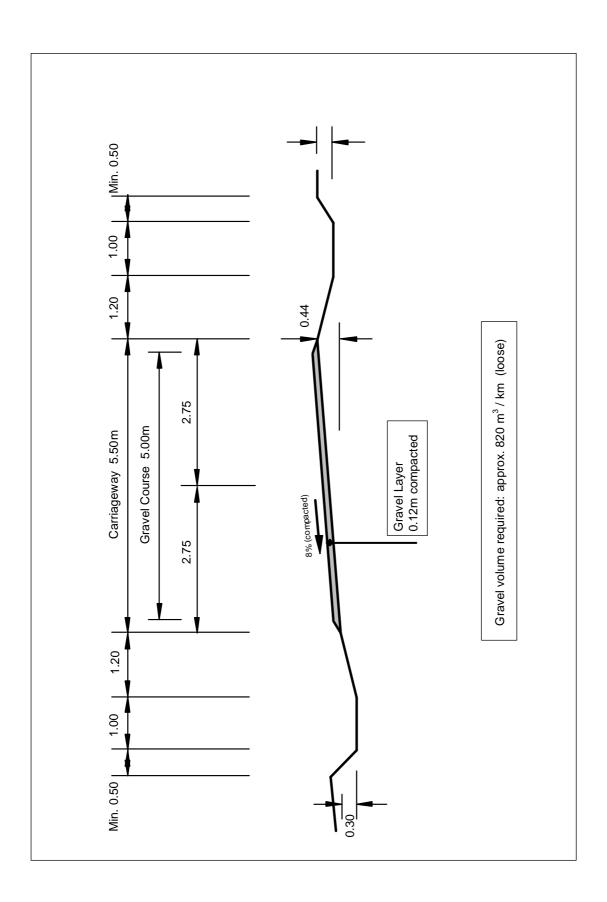
Standard cross section D, black cotton soil



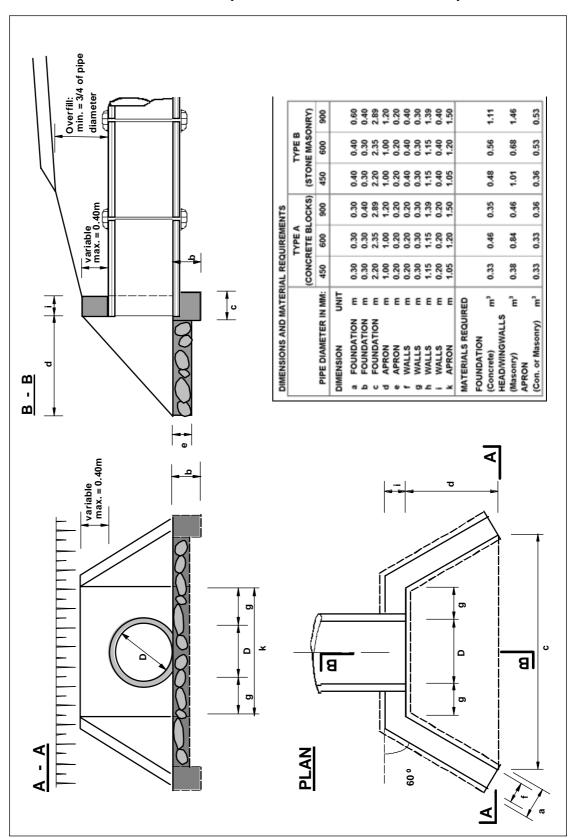
Standard cross section E, embankment



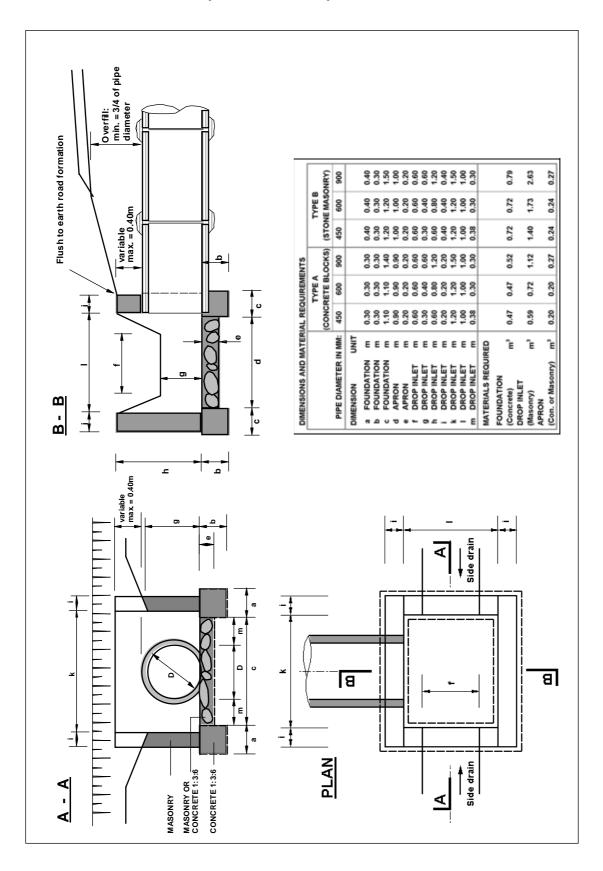
Standard cross section F, super elevation



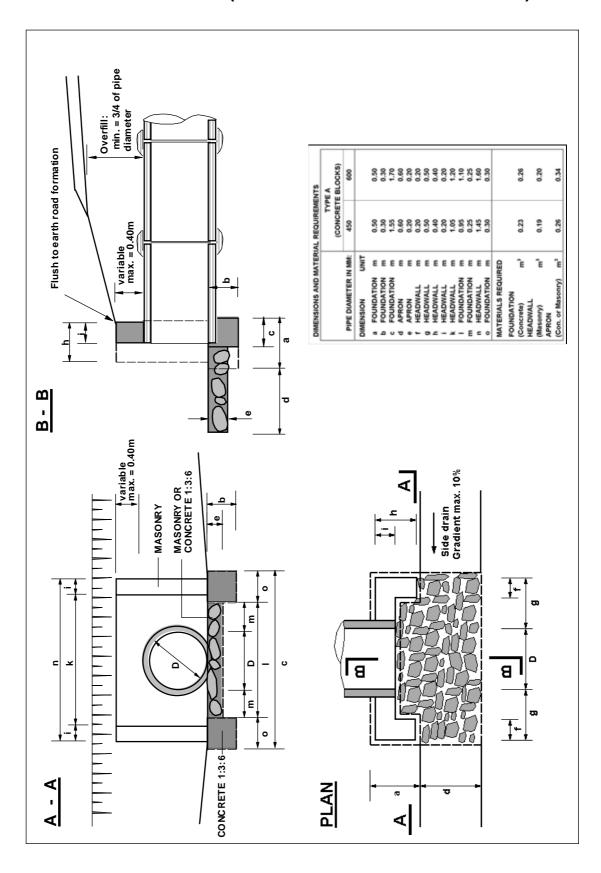
ANNEX C2: Standard drawings of culverts, haunch profiles
HEADWALL TYPE 1 (HEAD AND WINGWALLS)



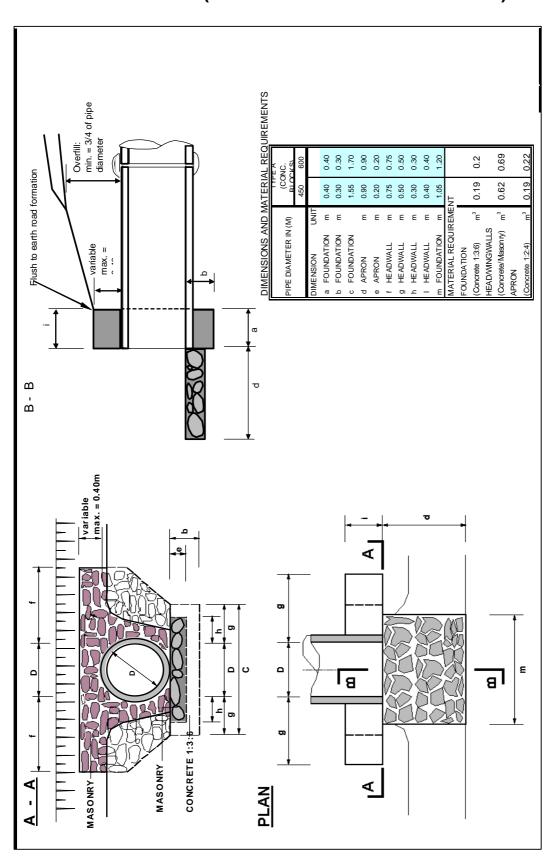
HEADWALL TYPE 2 (DROP INLET)



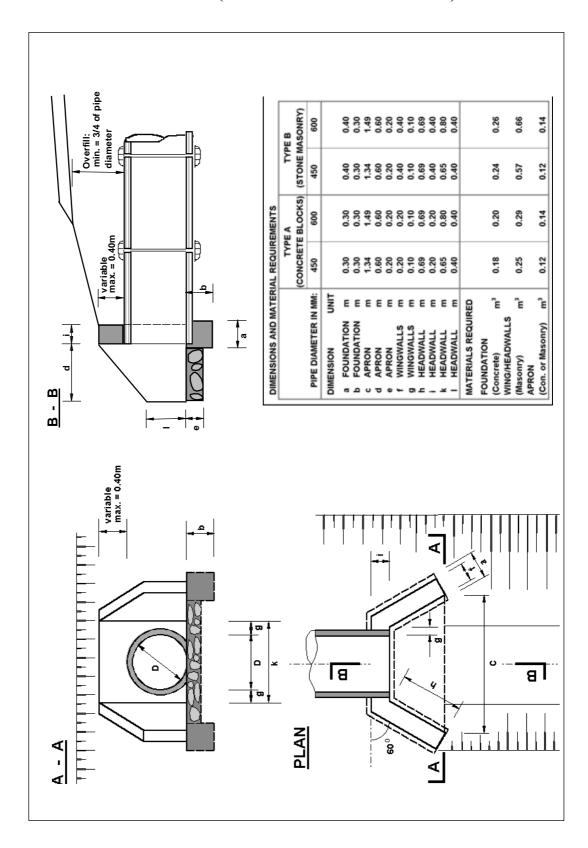
HEADWALL TYPE 3A (CONCETE BLOCK HEADWALLS)



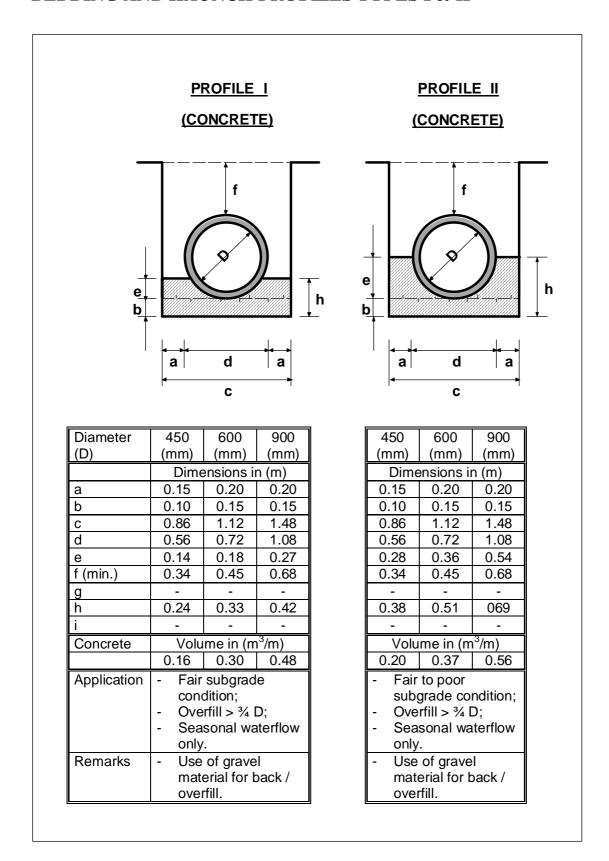
HEADWALL TYPE 3B (STONE MASONRY HEADWALLS)



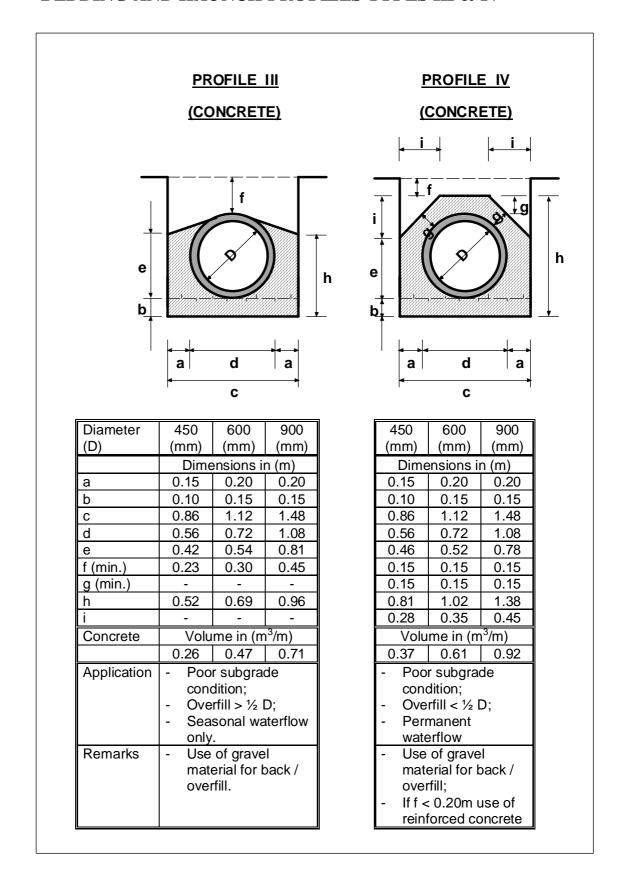
HEADWALL TYPE 4 (FOR ACCESS CULVERTS)



BEDDING AND HAUNCH PROFILES TYPES I & II

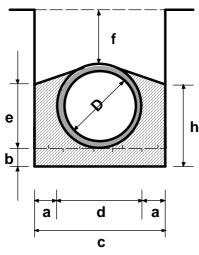


BEDDING AND HAUNCH PROFILES TYPES III & IV



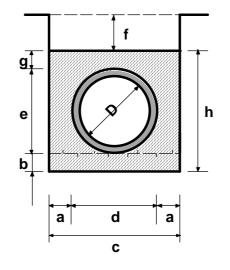
BEDDING AND HAUNCH PROFILES TYPES V & VI





Diameter	450	600	900
(D)	(mm)	(mm)	(mm)
	Dime	ensions i	n (m)
а	0.15	0.20	0.20
b	0.10	0.15	0.15
С	0.86	1.12	1.48
d	0.56	0.72	1.08
е	0.42	0.54	0.81
f (min.)	0.34	0.45	0.68
g (min.)	-	-	-
h	0.52	0.69	0.96
i	-	-	-
Stabilised			
Laterite	Volu	me in (m	1 ³ /m)
	0.26	0.47	0.71
Application	cond - Ove	subgrad dition; rfill > ¾ I sonal wa	D;
Remarks		of grave erial for b fill.	

PROFILE VI (CEMENT STABILISED LATERITE)

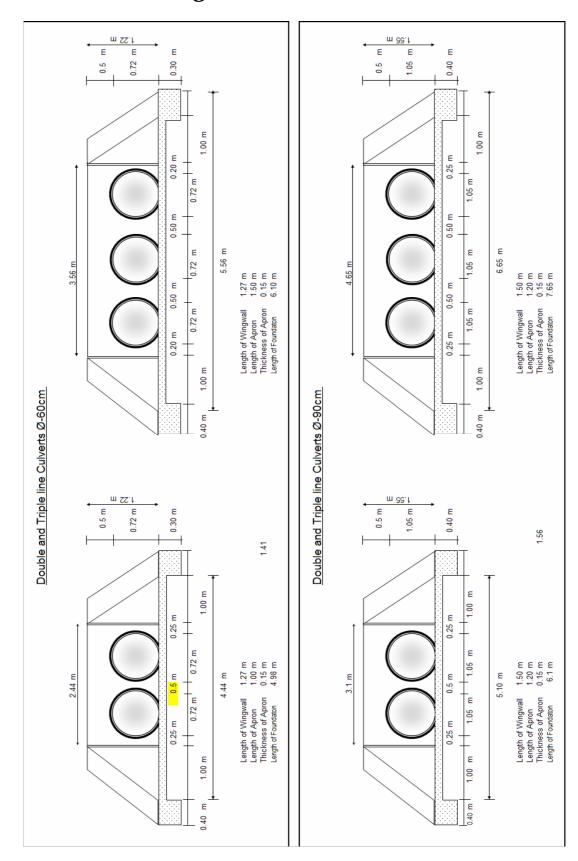


450	600	900
(mm)	(mm)	(mm)
Dime	ensions i	n (m)
0.15	0.20	0.20
0.10	0.15	0.15
0.86	1.12	1.48
0.56	0.72	1.08
0.56	0.72	1.08
0.23	0.30	0.45
0.11	0.15	0.23
0.77	1.02	1.46
-	-	1
	·	·

Volume in (m³/m) 0.42 0.73 1.25

- Poor subgrade condition;
- Overfill > ¾ D;
- Seasonal waterflow only.
- Use of gravel material for back / overfill.

ANNEX C3: Table Masonry and Concrete Quantities for Head-wall and Wing-wall Construction



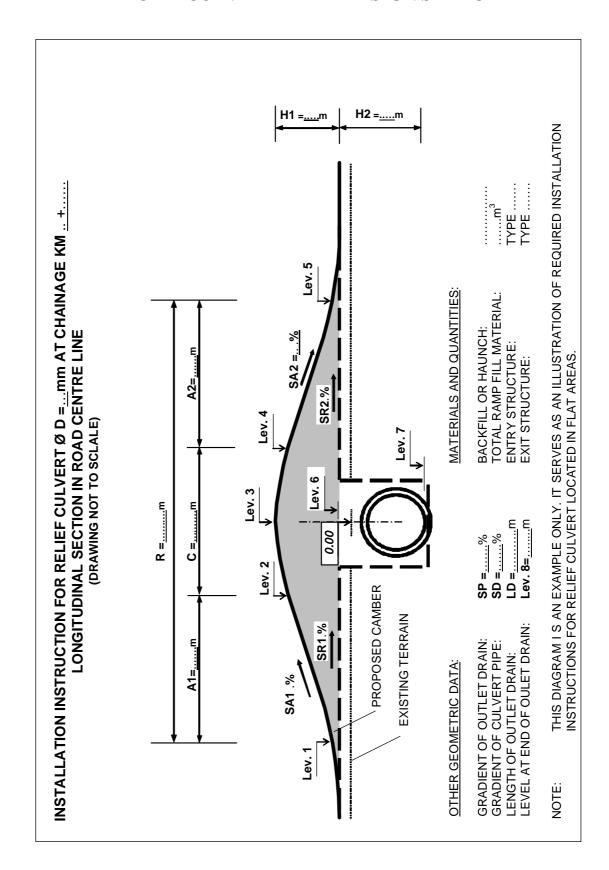
Standard quantities for masonry and concrete in culvert construction

Masonry & Concrete Quantity	Diameter	Material		Inlet/Outlet Type	et Type		Ξ	Haunching concrete		*)
	(mm)	type	B1	B2	B3	B4	l- d	ll - d	ll - d	P-IV
	009	Masonry	0.94	1.53	0.22	99.0	-	-	-	•
Single line		Concrete	0.84	96.0	0.96	0.40	2.10	2.59	3.29	4.69
	006	Masonry	1.33	2.48			-	-	-	•
		Concrete	1.29	1.09	-	-	3.36	3.92	4.97	6.44
	009	Masonry	1.48	2.55		1.09	-	-	-	•
Double lines		Concrete	1.11	1.58	-	0.73	4.20	5.18	6.58	9.38
	006	Masonry	2.16	3.05	,	•	-	-	,	•
		Concrete	1.71	1.83	-	•	6.72	7.84	9.94	12.88
	009	Masonry	1.87	3.32		1.47	-	-	-	•
Triple lines		Concrete	1.76	2.05	-	1.67	6.30	7.77	9.87	14.07
	006	Masonry	2.77	3.53	,	•	-	•	,	•
		Concrete	2.24	2.44	,		10.08	11.76	14.91	19.32

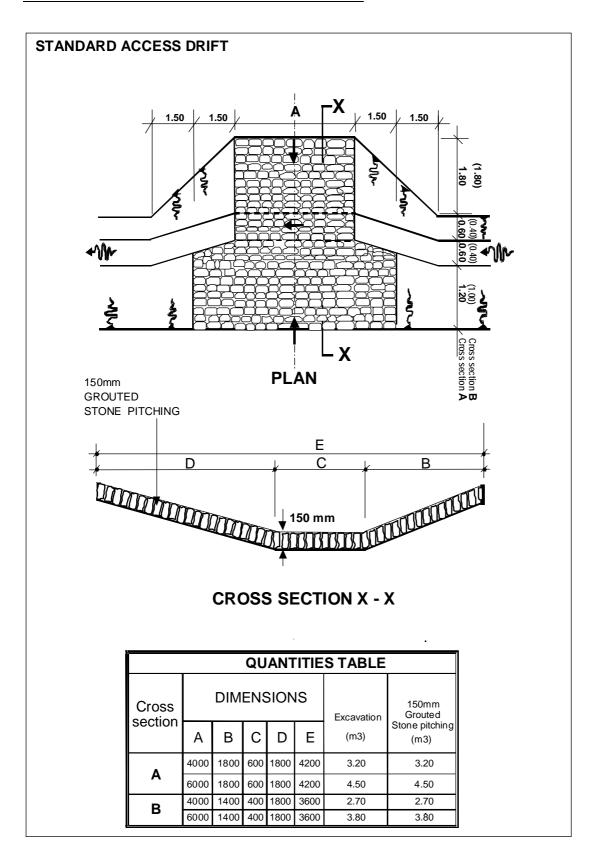
*) Installation length is assumed to be 7.00 meters.

⁾ Apron is assumed to be constructed with concrete

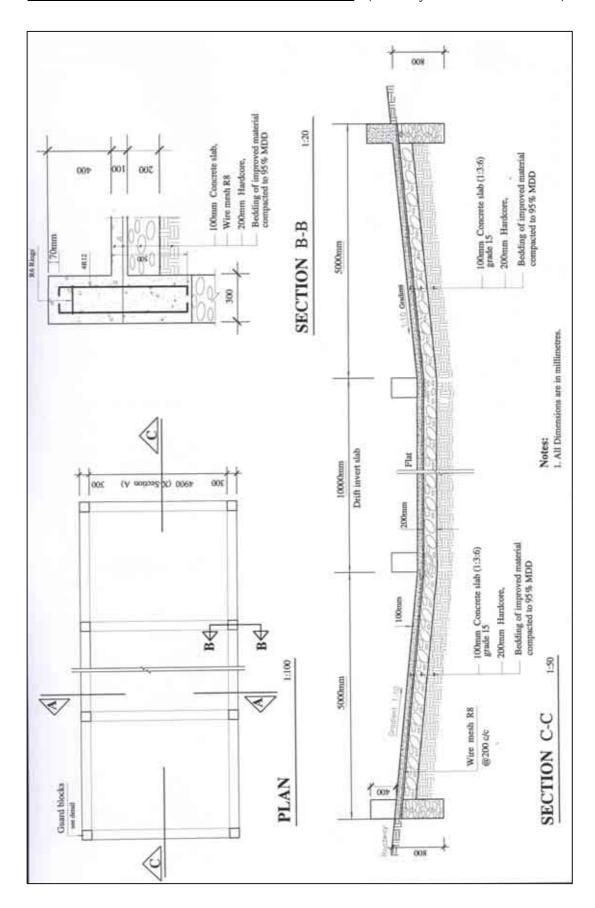
ANNEX C4: Standard Drawing of Ramp Construction EXAMPLE OF A CULVERT RAMP DESIGN SKETCH

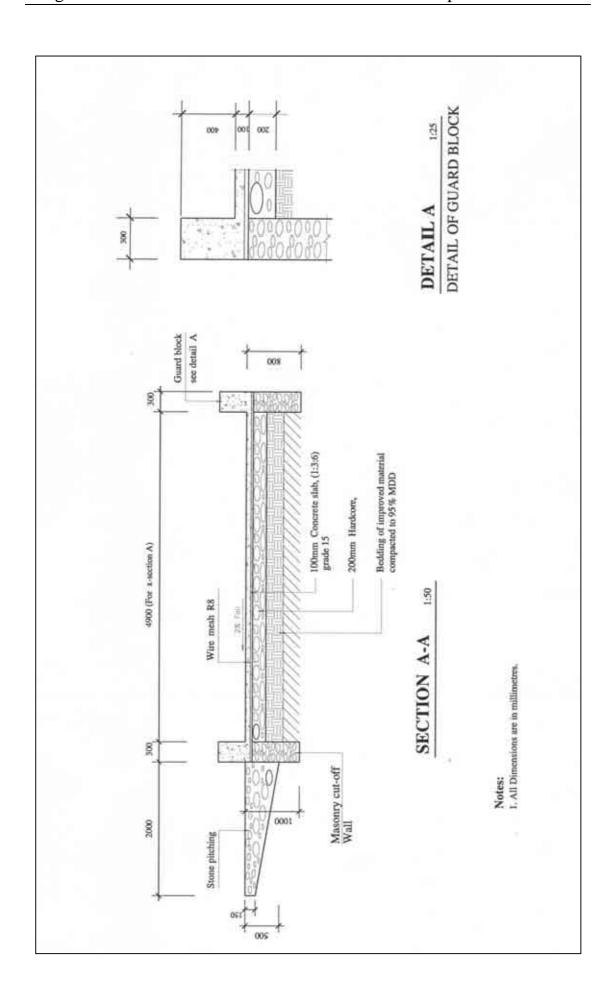


ANNEX C5: Standard Access Drift



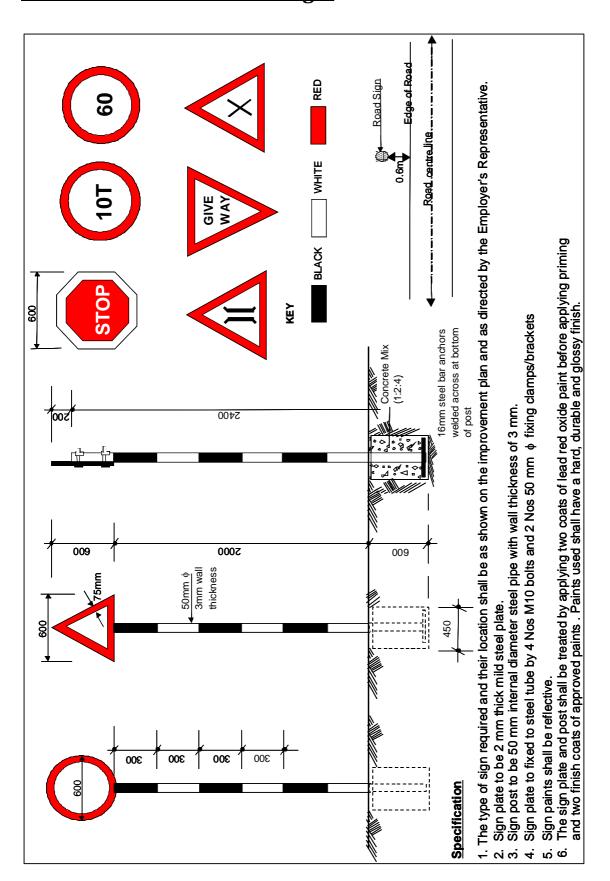
ANNEX C6: ...Standard Main Drift (drawn by Crown Tech, Tanzania)



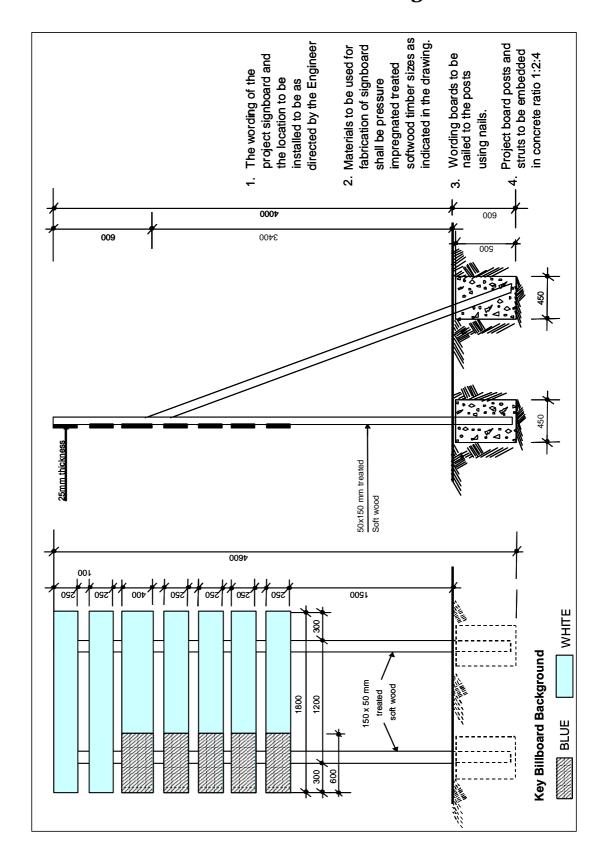


	Materials needed for construction of concrete drifts	d fo	r const	ruction	of con	crete d	rifts	
Bill 3	Drainage Structure		Required	BoQ qua	ntities for	a variety o	Required BoQ quantities for a variety of drift lengths	gths
]	Description	I bit	Quantity	Quantity	Quantity	Quantity	Quantity	Quantity
No.			15mx5.5m	20mx5.5m	25mx5.5m	30mx5.5m	35mx5.5m	40mx5.5m
	Excavation of other drainages							
3.11	Outside Road formation	m3	50	80	100	120	150	164
3.12	Within Road Formation	m3	99	73	06	107	125	142
	Masonry Works							
3.62	Masonry in drainage structure	m3	10	13	15	17	20	22
	Provide Materials and build							
3.72	Hardcore (Stones)	m3	14	19	24	29	34	39
3.73	Grouted Stone Pitching	m3	11	14	18	21	25	28
	Concrete Works							
3.82	Conc. in drainage struct.class 15	m3	7	10	12	15	17	19
	Non-standard Items							
3.01	Backfill for drainage structure	m3	5	9	7	8	6	10
3.02	Supply & place Wire Mesh	m2	71	96	120	144	169	193
3.03	Supply & place Mild Steel R12	kg	16	16	16	16	16	16
3.04	Supply & place Mild Steel R6	kg	10	10	10	10	10	10

ANNEX C7: Main Traffic Signs



ANNEX C8: Standard Bill Board Design



ANNEX D

CONTRACT MANAGEMENT FORMS

ANNEX D1: Contractor's Site Management Forms

ANNEX D2: Contract Supervision Forms

ANNEX D3: Final Inspection Report Format

ANNEX D1

Contractor's Site Management Forms

- 1. Form for Village Notice for Recruitment of Labourers
- 2. Form for Employment of Casual Labourers (front page)
- 3. Form for Employment of Casual Labourers (rear page)
- 4. Form for Agreement for Quarry Acquisition
- 5. Form for Muster Roll
- 6. Form for Daily Worker Days Report
- 7. Form for Labour Based Equipment on Site
- 8. Form for Tipper Trucks on Site
- 9. Form for Monthly Planning and Progress

FORM FOR VILLAGE NOTICE FOR RECRUITMENT **OF CASUAL LABOURERS**

	NT OF CASUAL LABOUR D WORKS
DISTRICT/CONTRACTOR:	
ADDRESS:	
ROAD NO:	ROAD FROM:
	то:
the time and place given below. All cit	asual workers for road construction at izens of Zambia, Men and Women, of or employment. Persons residing close ge to apply:
	inity of employment. Selection of those ballot. Please note that all applicants
PLACE OF RECRUITMENT:	
DATE OF RECRUITMENT:	TIME:
NAME OF RECRUITMENT OFFICER:	
DATE:	SIGNATURE:

FORM FOR EMPLOYMENT OF CASUAL LABOURERS (FRONT PAGE)

	L EMPLOY OR ROAD V	MENT FORM VORKS
NAME AND ADDRESS OF CONTRA		
ROAD NO:		AD FROM:
EMPLOYMENT FORM NO:	TO:	
NAME OF EMPLOYEE MR/MRS:	DAI	LY WAGE RATE:
N.C.D. N.O.		K / DAY MMENCEMENT DATE OF EMPLOYMENT:
N.C.R. NO:	COI	VIMENCEMENT DATE OF EMPLOYMENT:
CONDITIONS OF EMPLOYMEN	<u>IT:</u>	
for work and is offered employ	ment on subseque	e working day. When the employee reports ent days, the terms and conditions of this ed each day up to a maximum period of 30
2. Wages will be aggregated and page	aid over monthly pay	y periods.
Daily wages, including those for be paid on the daily rate quoted a		Saturdays, Sundays or Public Holidays will
	e. Employees comp	y pay period will be paid a bonus equivalent leting 18 or more days in any monthly pay ages quoted above.
Payment of allowances, housing above quoted daily rate.	g, leave or any othe	er types of entitlements are included in the
The replacement cost for any to payments due to the Employee.	ools or equipment lo	ost by the Employee will be deducted from
This agreement may be renew agreement and signature of the control of the co		periods not exceeding 30 days by mutual sto below.
I have read/had read to me the above I hereby accept the casual employme	ent on the terms and	conditions on this form.
Name of Employee:	Date:	Signature of Employee
Name of Employer (or Representative	e): Date:	Signature of Employer (or Representative):
Witnessed by:	Date:	Signature of Witness:

To be completed in duplicate:

Original to Employee, Duplicate to Employer

FORM FOR EMPLOYMENT OF CASUAL LABOURERS (REAR PAGE)

RENEV	VAL OF AG	REEMENT
1st Renewal I hereby accept the renewal of conditions on this form for the p		oyment as per the terms and
Name of Employee:	Date:	Signature of Employee
Name of Employer (or Representative):	Date:	Signature of Employer (or Representative):
Witnessed by:	Date:	Signature of Witness:
2nd Renewal I hereby accept the renewal of conditions on this form for the p		oyment as per the terms and
Name of Employee:	Date:	Signature of Employee
Name of Employer (or Representative):	Date:	Signature of Employer (or Representative):
Witnessed by:	Date:	Signature of Witness:
3rd Renewal I hereby accept the renewal of conditions on this form for the p		
Name of Employee:	Date:	Signature of Employee
Name of Employer (or Representative):	Date:	Signature of Employer (or Representative):
Witnessed by:	Date:	Signature of Witness:

FORM FOR AGREEMENT FOR QUARRY ACQUISITION

DISTRICT:	REPUBLIC OF ZAMBIA MINISTRY OF
ROAD NO:	
FORM OF AGREEMENT FOR QUARRY	ACQUISITION
This agreement is made on this day the between Mr/Mrs. Owner of Plot No. located in herein after referred to as the Owner, on the one han of: Project Manager on the other certifies as follows:	of
1. Mr/Mrs: is the sole and legal	owner of the above described plot.
The Owner allows the Project Manager or his appointed Conquarry located within the Plot for the purpose of gravelling transport the excavated material via the most suitable route to	g of Unpaved Rural Roads and to
3. Sketch Plan of the Plot, quarry and access road:	Maximum quarry area:ha
	Estimated thickness of the overburden:m
	Estimated thickness of the gravel:m
(If necessary sketch overleaf)	
4. The Owner will be compensated a Total Amount of K	(in figures), ue for value of crops, trees, fences,
 The Owner will allow the Project Manager or his appoin excavate and haul additional gravel material from within the of gravelling, regravelling or gravel stacking along roads, w compensation. 	agreed quarry area for the purpose
After completing excavation and hauling of gravel from the appointed Contractor(s) will level the affected area and sproverburden over the area to restore the quarry area as much	read the excavated and stockpiled
In witness whereof the parties have hereunder set hands:	
a) Owner: Witnes b) Project Manager: Witnes c) Valuation Officer:	

FORM FOR MUSTER ROLL

ROAD NAME:																								Page:		10	
					DIST	DISTRICT:	22							co	CONTRACTOR	СТО	22						Fi	Month:			
No. Name	Sex			ŀ		,		9				1	1	9	9.	:	;		2	1	9	96		Total	Total	Rate/task	Total Wage
-		-	_	-	-	-	+	_	=		<u>t</u>	9	1	9	6	4	1	\$	3	0	9		5	Olaci daya	idoxo	gie!	9
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Total female days this page:	9		9			Lo	tal fer	nale 1	asks t	Total female tasks this page:														Signature:			

FORM FOR DAILY WORKER DAYS REPORT

2	MANDAYS DEDODT	DISTRI	푎	CT									ដ	CONTRACTOR:	R	ŭ	꽁								MONTH	Ē				
=		ROAD:	ë										8	CONTRACT NO:	Ϋ́	CT	2							-						
B≣ No.	Date	-	2 3	3 4	9 1	9	 00	6	10	11	12	13	14	15	16	17 1	18 1	19	20 2	21 2	22 23	23 24	4 25	5 26	3 27	28	29	30	31	Total Workerdays
,	Setting out CL, Site Clearing & Boulder Removal																													
	Quarry Preparartion																													
,	Slotting, Earthworks & Wheel Barrow Haulage																													
7	Side Drains and Camber Formation																													
	Drains outside Road formation & Scour Checks																													
က	Supply & Installation of Culverts																													
	Masonry & Concrete Works																													
	Excavation, Loading of Laterite & Quarry Backfill																													
4	Off-loading & Spreading of Laterite																													
	Maintenance during Construction & Correction Works																													
9	Haulage & Compaction (drivers, operators)																													
9	Variation orders																													
	Unproductive (Support) Staff																													
	Permanent (Supervision) Staff																													
ř	Total workerdays by day:				-																									

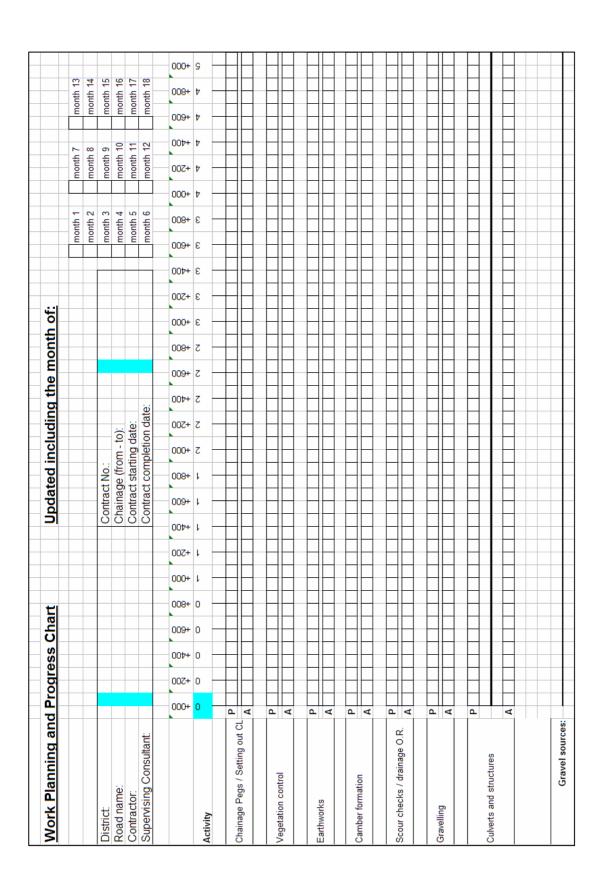
FORM FOR LABOUR BASED EQUIPMENT ON SITE

Trial Tria	EQUIPMENT, FUEL	AND		MA	IE	MATERIALS		- 1	REPORT	OR																				
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 6 27 28 29 30 31	Item				\vdash	\vdash	\vdash		L	L	Σ	ont	بز	\vdash	\vdash	\vdash	H	L											Ī	otal
10 10 10 10 10 10 10 10	Date		2	\vdash	\vdash	\vdash	\vdash	\vdash	\vdash	10		12	13	14 1										26	27	28			1	
Pule	A) No. of Tractors on Site																													
Particular Par	B) No. of Tractors																													
State Stat	C) No. of Daily Target Load	35																												
State Stat	D) No. of Trips completed																													
Tractor Trac	E) Length of Road gravelle	P																												
Tractor Trac	F) Kilometers / hours done																													
Varieth	G) Fuel filled (ltrs), Tracto	10																												
Particular Par	Vanette	0																												
Tractor Trac	Vibro-rolle	بر																												
Tractor Trac	Waterpum	д																												
terpump		1																												
terpump terpum	Vanette	m																												
Serpump	Vibro-rolle	بر																												
Total B)	Waterpum	g.																												
1	Cement (bags)																													
1	Sand (cum)																													
Total B Total CONSUMPTION = Total B Total B Total CONSUMPTION = Total B Total B Total B Total B Total CONSUMPTION = Total B	Aggregates (cum)																													
Total B Total B Total CONSUMPTION = CLt/km	Stones (cum)																													
Total B) Total B) Total A) Total D) Total D) Total CONSUMPTION = ———————————————————————————————————	Water (bowser trips)																													
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Total D) Total D) Total D) Total H) Total H) Total H) Total H) Total C) Total C)		Tota					×	000			% ї					Š –	[S]	Ä.	[-			lal I				п	(Ltt.	Km)		
= 10tal D) =		E			+	+	+	-						+	+	+	+	-	_	4	E		;							
Total C) ===== Total F)		Tota			\dashv	-	_ <u>`</u> >	-22			25			=	-8		_≦	_ <u>L</u>	_z				$_{\Xi} $			- 1	1	_[m¥		
		Tota					-	<u> </u>			. !!			1	3	-	-	-	5	_	Ë		Œ				1		_	li

FORM FOR TIPPER TRUCKS ON SITE

EQUIPMENT, FUEL	AN		MA	H	E	AL	D MATERIALS REPORT	Œ	Ž	Z																				
Item										~	Month:	<u>ä</u>		#												Н				Total
Date	1	2	8	4	5	. 9	7 8	8 9	9 10	11	12	12 13	14	15	16	17	18	19	20 ;	21 ;	22 2	23 2	24 2	25 2	26 2	27 2	28 29	9 30	31	
A) Number of Trucks on Site																														
B) Number of Trucks serviceable																														
C) Number of Daily Target Loads																														
D) Number of Trips																														
E) Length of Road gravelled																														
F) Total Mileage done (km)																														
G) Total Fuel used (Litres)																														
H) Total Oil used (Litres)																														
Cement																														
Sand																														
Aggregates																														
AVAILABILITY =	191 191	Total B) Total A)				×	× 100%		┼				FU	FUEL	8	CONSUMPTION		TE	Z		Total G) Total F)				$+ \parallel \mid + \mid$			(Ltr/km	₩	
UTILIZATION =	Total D) Total C)						100%			%			ll oil		CONSUMPTION		APT	Ŕ			Total			$+\ \cdot\ $	$+\ \cdot\ $	+ $ $ $ $ $ $ $ $	=	(Ltr/km)	<u> Î</u>	

FORM FOR MONTHLY PLANNING AND PROGRESS



ANNEX D2

Contract Supervision Forms

- 1. Sample Agenda for Site Meetings
- 2. Form for "Request for Day Works"
- 3. Form for "Submission of Claimed Works"
- 4. Form for "Issuance of Variation Order"
- 5. Form for "Issuance of Variation Order" (Alternative)
- 6. Form for "Issuance of Site Instruction"
- 7. Form for "Calculation of Volumes In Drainage Excavation
- 8. Form for "Inspection of Drainage Excavation"
- 9. Form for "Inspection of Culvert Construction"
- 10. Form for "Inspection of Road Formation and Gravelling
- 11. Form for "Inspection of Scour Checks"
- 12. Form for "Certificate of Substantial Completion"
- 13. Form for "Certificate of Final Completion"
- 14. Form for "Interim Payment Certificate
- 15. Form for "Summary of IPC Payments"

SAMPLE AGENDA FOR SITE MEETINGS

REHABILITATION AND MAINTENANCE OF ROAD T373 CHILANGA SCHOOL – JUNCTION T372 & T373

Contract No.: 5C/LL/DZ/03

Contractor: Mkaka Construction Company Ltd

PROPOSED MONTHLY SITE PROGRESS MEETINGS AGENDA

- 1. CONFIRMATION OF AGENDA
- 2. CONFIRMATION OF THE PREVIOUS SITE MEETING MINUTES
- 3. MATTERS ARISING FROM PREVIOUS MEETING
- 4. SITE PROGRESS
 - Site Progress Report and Quality of Works
 - Deviation from Approved Programme
 - Progress Target for the next Month
- 5. TECHNICAL AND CONTRACTUAL ISSUES
 - Site Instructions
 - Work Approval
 - Quality Control and Work Methods
 - Request for Additional Information
- 6. LABOUR ISSUES
 - Site Management
 - Employment and Workerdays Utilization Records
 - Site Health and Safety Issues
- 7. FINANCIAL ISSUES
 - Status of Payment Certificates
 - Variation Orders and Extra Works
- 8. TRAINING AND MENTORSHIP ISSUES
- 9. ANY OTHER BUSINESS
- 10. DATE FOR NEXT MEETING

FORM FOR "REQUEST FOR DAYWORKS"

DAYWORKS REQUEST FORM

District:		Contractor:			
Road name:		Contract no.:			
Description of works: (to	be filled by the Contractor)				
Chainage		Activity			
(to be filled by the Engineer)					
Description	of activity	Quantity	Pro	ductivity	Mandays
Dayworks approved					
Item no.	Quantity	Mandays			
		1			
Signed;				_	
for/Client		Contractor	•••••		
Date		Date			

FORM FOR "SUBMISSION OF CLAIMED WORKS"

MEASUREMENT FORM

Contractor		Sheet nu	ımber
Contract number		Date	
Item number as per bill of quantities	Measurement, including all sketches, chainages, etc.		Measured quantity
Contractor	Engin	eer	
Date	Date		

FORM FOR "ISSUANCE OF VARIATION ORDER"

С	DANIDA Road Sector Program S	upport
	Variation order no. 4	<u>4</u>
Client:	Ponds Department Vacma Distric	t Council
_	Roads Department Kaoma Distric	
Contract:	Rehabilitation of Luampa Hospita	i Road.
Contract No.	Milache Enterprises	
Contract No.:	RSPS-01	
Date of issue:	23rd January, 2003	
The requirement(s) described below, involving a chan	ge of the contract by
(v) Addition	(v) Omission	
() Alteration	() Quality	
is hereby ordered	as variation under the above contra	ict.
Description of the		
-	two additional culverts at chainage	9+050 and 18+040.
	oviding and laying gravel from 3+50	
•	hall be valued according to:	30 10 1 1 2001
	rates	
` '	s to be agreed prior to commencem	nent
	vorks rates	
	this Variation Order constitutes an I	ncrease / Decrease of
the original contra	ct sum of ZK, (in v	vords)
C	•	,
The contract durat	ion will Increase / Decrease by	working days.
The effect on cont	ract value and timing has been:	
() Assessed	by the Supervising Consultant	
() Is approv	ed by Client	
() Is approv	ed by the Technical Advisor	
Signed:		
Client	Technical Advisor	Contractor
Required Attac	hments: Justification Drawings, lav-	out cost estimates IIII

FORM FOR "ISSUANCE OF VARIATION ORDER" (alternative)

CONTR	ACTOR:	Libean C	ontr	actors Limited		
CONTR	ACT NO.	SHEMP	/FA7	/CHD/RR001		
CONTR	ACT NAME:	Manje -	Kazi	mule Road, Chad	iza District	
VARIA	TION ORDER:	No. 2				
ITEM	DESCRIPTION OF WORKS	Qty/	Unit	Rate	Variation Amount	Variation from BoQ
				(ZMK)	(ZMK)	(ZMK)
	Add:					
4.02	Supply and install single barrel x 600mm culvert		No.	2,045,000.00	8,180,000.00	
5.15	Gravelling selected sandy sections	1,000	m ³	31,500.00	31,500,000.00	
6.02	Construct new catchwater drains	300	m	350.00	105,000.00	
6.04	Stone pitching (15m x 7.9m)	119	m ³	8,700.00	1,030,950.00	
8.01	Boulder removal	25	m ³	57,500.00	1,437,500.00	
					0.00	
					42,253,450.00	42,253,450.00
	Omit:					
	Minor Reshaping (areas to be gravelled)	-2.5	km	3,500,000.00	(8,750,000.00)	
					-8,750,000.00	-8,750,000.00
					Net Value VO No. 02	33,503,450.00
					Original Value of Works	143,907,500.00
					Add Value of VO No. 01	12,770,246.63
					Revised Value of Works	190,181,196.63
				Averag	ge Cost of Works per Km	USD 2,419.22
				Prepared By		Checked By
				IEF		OCE
	We the undersigned accept Variation Order No. 2 for Gravel for Feeder Road Repairs in Chadiza District	ling of 2.5km and	boulder	removal as detailed above u	nder Contract No. SHEMP/FA7/CHE	N/RR001
				Accepted By		Approved By
				Contractor		For Client
				LIBEAN CONTRACTOR	S LTD.	PCO-SHEMP

FORM FOR "ISSUANCE OF SITE INSTRUCTION"

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FORM FOR "CALCULATION OF VOLUMES IN DRAINAGE EXCAVATION"

Item 3.11: Ca	lculation of l	Excavation C	Outside road	formation	Culve	ert outlet / M	<u>litre drain /</u>	Catchwate	r drain	Left /]	Right
Chainage	1	2	3	4	5	6	7	8	9	10	
	Invert									Discharge	Total
Chainage (m)	0										
Bottom (m)											
Top (m)											
Depth (m)											
Area (m2)											
Volume (m3)											
									<u>.</u>		
tem 3.11: Ca						ert outlet / M				Left / I	Kight
Chainage	1 Invert	2	3	4	5	6	7	8	9	10 Discharge	Total
Chainage (m)	0										
Bottom (m)											
Top (m)											
Depth (m)											
Area (m2)											
Volume (m3)											
Item 3.11: Ca	lculation of l	Excavation C	Outside road	formation	Culve	ert outlet / M	r drain	Left /]	Right		
Chainage	1	2	3	4	5	6	7	8	9	10	
C1	Invert									Discharge	Total
Chainage (m)	0										
Bottom (m)											
Top (m)											
Depth (m)											
Area (m2)											
Volume (m3)											
Item 3.11: Ca	lculation of l	Excavation (Outside road	formation	Culve	ert outlet / M	litre drain /	Catchwate	r drain	Left / l	Pight
Chainage	1	2	3	4	5	6	7	8	9	10	- Sant
	Invert									Discharge	Total
Chainage (m)	0										
Bottom (m)											
Top (m)											
Depth (m)											
Area (m2)											
Area (m2) Volume (m3)											

FORM FOR "INSPECTION OF DRAINAGE EXCAVATION"

		DIST	RICT & F	EEDER	ROADS	PROJEC	Т	
	ı				CTION F		rains	
Contractor:			. F	load name:			District:	
Chainage	Type of drain M / C / D	L/R		ate I/approved	i	volume of vation	Signature	Remarks

FORM FOR "INSPECTION OF CULVERT CONSTRUCTION

			r	
	f		Remarks	
			Discharge drain	
	District:	c	Backfill & ramp	
5		Actual construction	Haunching	
N FORI		Actual c	Pipe installation YinoseM &	
ER ROADS PRO INSPECTION For Culverts			Foundation S especiele S prongs	
FEEDER ROADS PROJECT WORKS INSPECTION FORM For Cuiverts			Excavation of discharge drain, trench & foundation	
WOR	Road name.		Construction of bypass	
	α		Revised	
	2		Наипсћ	
		Original design	Ksmp	
		Original	No. of lines and diameter	
	Contractor		Chainage	

FORM FOR "INSPECTION OF ROAD FORMATION AND GRAVELLING

			WOR	KS INS	SPECT	PROJECTION F Grave	ORM	
Contractor	-		Ro	ad name:				District:
Chainages	Chainage pegs & Setting out CL	Clearing & Stumping	ETL & First compaction	SBO, Ditching, Plug & Compaction	Sloping, Camber formation & Compaction	Preparation of Quarry & Removal of Overburden	Gravelling & Final compaction	Remarks
+200								
+400								
+600								
+800								
+000								
+200								
+400								
+600								
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+000								
+200								
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FORM FOR "INSPECTION OF SCOUR CHECKS"

				ER ROAI			· ·		
		<u> </u>		INSPE		FORM			
			•	scour c	HECKS				
Contractor:			R	oad name:			District:		
Chainages	L/R		volume of onry	Da inspected		Sign	ature	Rem	arks

FORM FOR "CERTIFICATE OF SUBSTANTIAL COMPLETION"

REPUBLIC OF ZAMBIA

MINISTRY OF WORKS & SUPPLY ROADS DEPARTMENT KAOMA DISTRICT COUNCIL



CERTIFICATE OF SUBSTANTIAL COMPLETION

DANIDA Road Sector Programme Support 104.zam. 815

ROAD REHABILITATION BY LABOUR BASED CONSTRUCTION METHODS

Client: Roads Department Kaoma DC
Road Name: Luampa Hospital access road
Contract Number: RSPS-01

Contractor: Milache Enterprises

Date of Completion: 15 March, 2004

From chainage: 0+000 to 22+500

The authorized representative of the employer has inspected the works performed under this contract and he hereby declares that the works are SUBSTANTIAL completed on the above date, as per specifications stipulated in the contract.

The contractor accepts this certificate of substantial completion and agrees to complete and/or correct any items of works contained in the original contract (including issued variations), which may be identified during the Defects Liability Period.

The Defects Liability Period will start on the above date, and will last for 12 calendar months.

Agreed:	Certified:	Certified:
Contractor	Supervising Officer	District Officer in Charge
Approved:	A	.pproved:
Technical Advisor	_	mployer

FORM FOR "CERTIFICATE OF FINAL COMPLETION"

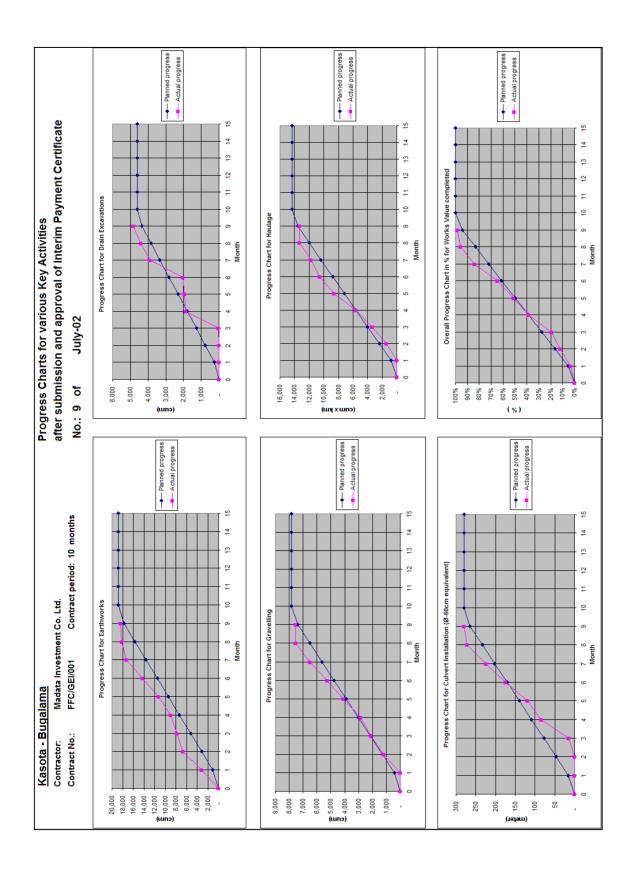


FINAL COM	PLETION CERTIFICATE
CONTRACT Name : Routin	e Maintenance of Chikumba – Kasonde (R161) Road
CONTRACT Number : ERMP	PET/01
EMPLOYER : PETAU	KE DISTRICT COUNCIL
CONSULTING ENGINEER: EASTC	ONSULT Consulting Engineers Limited
CONTRACTOR : MTON	OO BUILDING CONSTRUCTION LIMITED
IMPORTANT DATES	
COMMENCEMENT DATE : 01.10	0.2002 COMPLETION DATE : 31.12.2002
REVISED COMPLETION DATE : N/A	END OF DEFECTS LIABILITY : 30.06.2003
	r Period on 30 th June, 2003 and In accordance with Conditions of rks have been completed and that all defects have been corrected.
Certified and Issued by the Project Director, Mr. Tembo, on behalf of EASTCONSULT LTD	Simon Certificate received by Managing Director, Mr. Henry D. Zulu, on behalf of MTONDO B. C. LIMITED
Tembo, on benan of EASTCONSOLT LID	Zilia, on behalf of WITOADO B. C. LIMITED
Date: _	Date:
Mr. Simon Tembo	Mr. Henry D. Zulu
Certificate received by the Council Secretary, M Masenga, on behalf of PETAUKE DISTRICT	r. Andi. G. Witness: Director of Works, Mr. Richard Ndlovu, COUNCIL PETAUKE DISTRICT COUNCIL
	Date:
MR. ANDI. G. MASENGA	MR. RICHARD NDLOVU

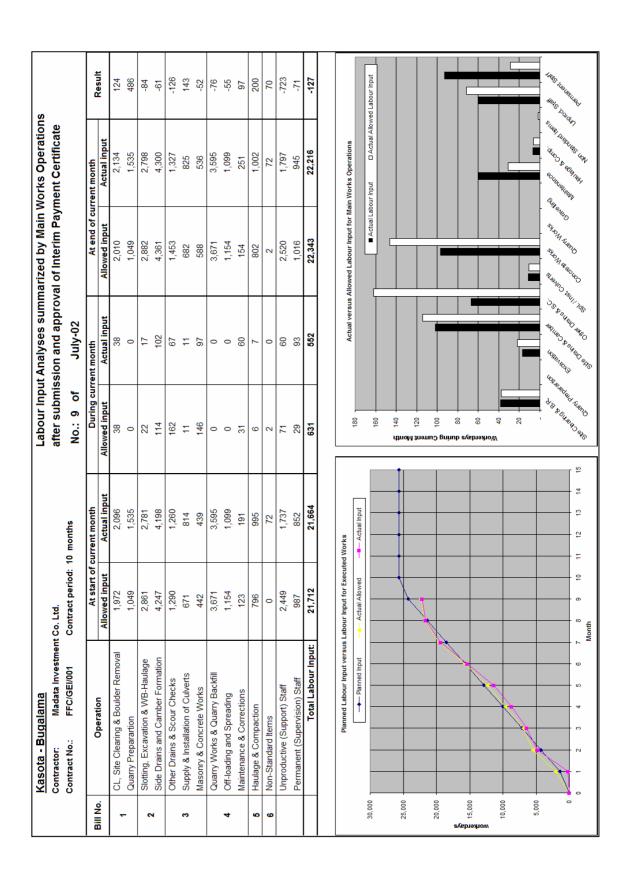
FORM FOR "INTERIM PAYMENT CERTIFICATE (1)"

United Republic of Tanzania	or Lanzania			DISTRICT & FEEDER ROADS PROJECT, SUP-INWANZA	KOADS PROJECT	SUP-IMWANZA	
Ministry of Regional Administration & Local Government Geita District Council	Iministration & Local	l Government		Road rehabilitation and gravelling by labour based methods Kasota - Bugalama	າ and gravellinເ າ	by labour based	methods
		Contract No.: File No.:	FFC/GEI/001 F.12.7.8.10			Madata Investment Co. Ltd.	ĘĘ
Interim Payment Certificate	t Certificate	No.:	6	July-02	D-Consultant: S-Consultant:	Crown Tech Consultants Crown Tech Consultants	
Bill	:		Contract	Valu	Value of works completed		è
No.	Description of Item		Amount	Month start	This month	Total todate	%
1 Setting out, Site C	Setting out, Site Clearance and Quarry Preparation	reparation	6,955,600.00	6,921,520.00	,	6,921,520.00	100%
2 Reshaping of Roa	Reshaping of Road to Feeder Road Standard	dard	18,602,300.00	16,993,978.00	299,834.00	17,293,812.00	93%
3 Drainage Structures	res		26,970,400.00	20,511,301.39	3,710,847.77	24,222,149.16	%06
4 (Re) Gravelling			16,622,900.00	12,450,290.00	163,846.00	12,614,136.00	76%
5 Equipment Based Activities	d Activities		36,650,600.00	29,865,735.00	165,950.00	30,031,685.00	82%
NS Non-Standard Items	ms		438,000.00	•	438,000.00	438,000.00	100%
6 Preliminary and General Items	Seneral Items		12,313,000.00	5,777,234.00	718,662.00	6,495,896.00	53%
	Sub - total 2		118,552,800.00	92,520,058.39	5,497,139.77	98,017,198.16	83%
		0.00%	1				
	Sub - total 3		118,552,800.00				
	Provisional sum	9%	5,927,640.00	606,232.70	1	606,232.70	10%
	Total Contract sum:	-	124,480,440.00				
		Total valu	Total value of works executed:	93,126,291.09	5,497,139.77	98,623,430.86	%62
We certify that the sum of Tshs:	Tshs:			Total value of Work	Total value of Works approved this month:	ıth:	5,497,139.77
	4,952	4,952,282.78		Less: Advance repayment	yment		
				Hire / purchase Vib-roller	se Vib-roller		270,000.00
is due to:	Madata Investment Co. Ltd.	Co. Ltd.		Retention (5%)	(%)		274,856.99
	CRDB, Mwanza Branch, Account No.: 01J1053519300	anch, Account No.:	: 01J1053519300	Late labour por late Complet	Late labour payment (7.5% with min. 50,000) are Completion (50,000 - per day)	n. 50,000)	
This amount is due to be paid within 28 days from date of acceptance of related Claim:	aid within 28 days f related Claim:	(06-Aug-02)		' '			
						Sub-total:	4,952,282.78
Certified:	Approved:		Certified:				
				TOTAL	. PAYMENT DUE T	TOTAL PAYMENT DUE THIS CERTIFICATE:	4,952,282.78
PMA - DFRP	District Executive Director		District Engineer				
				US-Dollars equivale	nt at current UN-exc	US-Dollars equivalent at current UN-exchange rate (955.48):	5,183.03

FORM FOR "INTERIM PAYMENT CERTIFICATE (2)"



FORM FOR "INTERIM PAYMENT CERTIFICATE (3)"



FORM FOR "SUMMARY OF IPC PAYMENTS"

CONTRACT REGISTER	ER										
Contract Name			-						Start Date		
Contract Number									Site Possession Date		
Contractor									Intended Completion Date	Oate	
Contract Sum									Revised completion Date	ate	
Revised Contract Sum				•					Defects Liability Period Ends	od Ends	
Advance received				,					Funding Agency		
DETAILS OF PAYMENT CERTIFICATES	NI CERTI	FICATES	,,								
CONTRACT SUM	ZMK			1.00							
VARIATION ORDER NO.	<u>ö</u>										
VARIATION ORDER NO.	į.			•							
REVISED CONTRACT SUM	T SUM			1.00							
	CERTIFICATE	CATE			VALUE OF	% of	RETENTION	ADVANCE	AMOUNT PAID	VAT	
PERIOD Dat	Date App'd Date Paid Invoice No.	te Paid In	tvoice No.	CHQ No.	WORK DONE	sum	10%		IN ZMK	PAID	
Advance								-		,	This certificate
								•	•	•	Total to date
							•	•	•	•	This certificate
											Total to date
							•	•	•	•	This certificate
											Total to date
							•	•	•	•	This certificate
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							•	•	•	•	This certificate
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							•	•	•	•	This certificate
											Total to date
								,	•	•	This certificate
•••				-							

ANNEX D3

Final Inspection Report Format

Main Report

ANNEX A: Final Inspection Standards and Summary of Findings

ANNEX B: Culvert Construction Inspection Form

ANNEX C: Road Formation and Drain Inspection Form

ANNEX D: Materials Reconciliation Report for Constructed Structures

ANNEX E: Summary of Material Quantities Used

ANNEX F: Spreadsheet to Enter Results of Inspections and Calculate Deductions on Earthworks

Main Report

SAMPLE FINAL INSPECTION REPORT

JOINT FINAL INSPECTION REPORT FOR LABOUR BASED REHABILITATION WORKS OF BUKINDO – KAGUNGULI - BUGUZA ROAD

1. Introduction

The Contractor, M/s Gagu Investment Co. Ltd, executed works on Bukindo-Kagunguli-Buguza road from chainage 0+000 to 13+425. The contractor requested for Final Inspection on 11 November 2003, following substantial completion of the works.

Final Inspection measurements started on 15 November and were completed on 18 November.

2. Objective

The Objective of the joint final inspection is to ensure that the road has been constructed to the technical specifications as described in the contract document, before the road can be handed over to the client.

3. Inspection Team

The Joint final inspection was conducted by:

Stephano K. Mufundi, Supervising Officer. Hamza. M. Msuya, Works inspector KAPSEL

in the presence of:

Seleman Paul, District Engineer Ukerewe Reonard Stephen, Gagu Investment Co. Ltd

4. Methodology

The joint final inspection was conducted with regards to road drainage features (side drains, miter drains, catch water drains), drainage structures (culverts, side access drifts and scour checks) and road formation and gravelling. Proper inspection tools were used such as camber board, ditch-slope template, boning rods, ranging rods and line and level in order to check adherence to specified standards.

Besides the adherence to technical standards, the final inspection team also assured itself that the contractor has adhered to environmental standards (backfill of quarries), and that all outstanding labour wages are paid, including any outstanding charges to local suppliers of services and goods.

5. Results

A summary of the results of the Final Inspection is presented in ANNEX A. The contractor is ordered to carry out corrections as described in ANNEX B and C. Payment of materials will be adjusted to reflect the quantities shown in ANNEX D and E. Deductions will be applied in the Final Payment Certificate as shown in ANNEX F.

6. Corrections to be carried out by the Contractor

The road has generally been constructed to a satisfactory and acceptable standard. However, before the Certificate of Completion can be issued to the contractor, he must carry out following corrections:

- a) Additional coverage is required for culverts at chainage 8+300, 0+100, 0+200 and 0+475 [See ANNEX B for more details].
- b) Reshape, fill, water and compact the eroded fore slopes to standard specifications along chainages 0+300 to 0+400, 3+600 to 4+100, 5+600 to 5+800 and 11+600 to 11+800.
- c) Water and compact road edge from chainages 0+000 to 0+400 and 10+100 to 10+200.
- d) Repair culvert outlet and apply stone pitching on the slope before the culvert inlet at chainage 0+530.
- e) Construct access drifts to Balatogwa dispensary at chainage 6+200 and to Balatogwa Primary School at chainage 5+900.
- f) Backfill and reshape gravel pit no.1 and 5 and allow for self-drainage.
- g) Open and reshape the catch water drain from chg. 0+500 to 0+800.
- h) Open and reshape miter drains at chainages 1+200, 4+500, 6+200, 8+600 to 8+800, 10+000 and 10+400 to 10+800.
- i) Repair cracks at inlets of culverts at chainages 0+100, 9+345, 11+395 and 12+200.

The contractor is required to carry out the above mentioned corrections within 2 weeks from the date of this report. Upon completion he must notify the supervising officer and request him to verify the works on site. If carried out satisfactorily, the contractor will be issued the Certificate of Completion and the road will be handed over to the District Council.

ANNEX A: FINAL INSPECTION STANDARDS AND SUMMARY OF FINDINGS

ž	INSPECTION ITEM	SPECIFICATION REQUIREMENT	FINDINGS	REQUIRED CORRECTIONS AND/OR DEDUCTIONS
	Chainage Reference Pegs	Chainage Reference Pegs made of timber 2"x4" at 1 kilometer interval and interim bush pegs at 100 meter interval.		
5.	Road width and gravelling width	Gravel width to be as specified in the cross section constructed. Correction to be ordered where the overall width deviates more or less than 10 cm.		
ю	Gravel thickness (inspection to be carried out by laboratory)	Gravel thickness to be as specified in the DIP. With a negative deviation of 20 mm or more, the contractor should be ordered to re-gravel. A deviation of 0 – 20 mm triggers deduction on items Bill 4 and 5.		
.4	Camber	Standard camber of 8% is specified for all roads. A deviation of ±2% (i.e. range from 6% to 10%) is acceptable. Else correction should be ordered.		
5:	Fore slopes	Specification is as per standard cross section constructed. Especially in case of erosion, corrections should be ordered.		
.9	ETL	At intervals of 25m, check level difference between LHS and RHS, which must be zero. Compile average measurements at 200m interval. Average level difference up to 5 cm will be accepted. From 5 to 20 cm, deduction will be applied on ETL items Bill 2 and Bill 5. If the difference is more than 20 cm, the contractor should be ordered to correct.		

ANNEX A: FINAL INSPECTION STANDARDS SUMMARY OF FINDINGS (cont.)

INSPECTION ITEM	SPECIFICATION REQUIREMENT	FINDINGS	REQUIRED CORRECTIONS AND/OR DEDUCTIONS
7: Road formation.	Check level difference between bottom of side drains (LHS and RHS) and center line of the road. Use same intervals as under item 6. Standards as specified in section 5.1 of the Supervision Manual must be achieved. Deviations, deductions and order to correct as under item 6.		
8: Miter Drains	Standard bottom width is 60 cm and side slopes are 1:1. Check whether drain is discharging.		
9: Catch water drains	Standards: depth 40cm, bottom width 60cm, slopes H:V = 1:3. Check proper discharge into relief culverts or drains.		
10: Drainage Structure	For culverts check minimum level difference required between center line and inlet apron as specified in section 5.3 of the Supervision Manual. Check further level difference between Headwalls LHS and RHS, which must be zero. Deviation of 50mm will be allowed. Check gradient in pipe (minimum 2%). Check design and material inputs (pipes, masonry, concrete).		
11: Compaction of wearing course (inspection to be carried out by laboratory)	Compaction achieved to standards as specified in the contract (generally 95% Minimum Dry Density). Re-compaction to be ordered if not achieved. Longitudinal deformation and rutting due to bad compaction must be corrected by reshaping.		

ANNEX B: CULVERT CONSTRUCTION INSPECTION FORM

	S						
	Level difference inlet apron and CL	lsuto A					
	Level di inlet apro	Required					
CULVERT INSPECTION FORM		Level difference headwalls					
		A dditional uo bairnso					
ECTIO		Discharge gerties run-off dra					
RT INSF	dity	gamp Gua					
ULVEI	әіпо.	Наипсь рг					
S	9	Outlet type					
	lnlet type						
	Gradient of pipe						
	ր e սմքի (m)						
	No. of lines						
		mm ni Q					
		Function					
		Chainage					

ANNEX C: ROAD FORMATION AND DRAINS INSPECTION FORM

				ROAD		IATION	FORMATION AND DRAINS INSPECTION FORM	RAINS	INSPEC	TION	ORM		
		Ro	Road formation	ion		Gra	Gravel	Drain	Drains (shape and discharge properties)	and disch	arge prope	rties)	
=	((Camber (8%)	r (8%)	Fore s	Fore slopes	wearing course	course	Averag bottom	Average level difference bottom side drain and CL	erence and CL		78	
CHAINAGI	m) ni dtbNV	ЛэД	Right	Лэ́	₽ight	VV(dth	Thickness in (cm)	Required	Actual left	Actual fdgir	Miters	Catch wate	Remarks Required corrections
0+000													
0+200													
0+400													
009+0													
0+800													
1+000													
1+200													
final													

ANNEX D: MATERIALS RECONCILLIATION REPORT FOR CONSTRUCTED STRUCTURES

				Mat	eria	ls Re	SCOL	JCilli	atio	n Re	sport f	or Col	Materials Reconcilliation Report for Constructed Culverts	ed Cu	Iverts			
	Road Name: Contractor: Contract No.:	ame: or: No.:	Mareg New (FFC/U	Maregea - Nansio - Kigala Road New Century Construction Co. Ltd FFC/UKE/001	sio - P	(igala iction	Road Co. Lt	P				Project: Consultant: Road Lengt	ant: angth.:	DFRP Mwanza K & Associates 0+000 to 16+850	vanza iciates 16+850			
					sə	Hin	_	H/W-walls	alls			ð	Quantities			Sc	Scour-checks	S
N/S	Chainage	Status	Function	Diameter (mm)	niJ ĵo.oN] ssəɔɔ∀	Length	Inlet Type Outlet	Type	Haunch Profile no.	Masonry (m3)	Stone Pitching (m3)	Concrete (m3)	Reinforcement (m) R8 T12	ement) T12	Chainages (km) Fromkm to km	Chainages (km) Fromkm to km	No.:
-	060+0	z	8	009	-		7	B1	B4	2	2.82		6.75			0 km -	- 1 km	
2	0+110	z	AC	009	-		9	B4	B4		1.40	٠	0.70					
3	0+535	Z	CD	009	1		7	B1	B1	Ν	1.88	-	5.91					
4	0+744	z	CD	009	1		7	B1	B1	2	1.88	-	5.91					
48	11+075	z	CD	009	1		7	B1	B1	,	1.88		1.68			11 km	11 km - 12 km	29
49	11+475	z	CD	009	1		7	B1	B1	_	1.88	-	1.68					
90	11+900	z	AC	009	1		9	B4	B4		1.88		1.68					
51	12+095	z	AC	009	1		9	B4	B4		1.88		1.68			12 km	12 km - 13 km	1
9/			,															
77																		
	TOTAL				09	394	394				113.26	29.34	173.89	120	80			123
_	No. of lines		90	Installation	ation	II		394 m	_		Masonry	113.26 m3	m3	ŭ	Concrete =	17;	173.89 n	m3
SS	Scour-checks	123 no.				Groute	ed stor	ne pitc	hing (f	or Ace	Grouted stone pitching (for Acess Drift)	29.34 m3	m3					

ANNEX E: Summary of Material Quantities used

	FINAL QUANTITIES FOR CONSTR	UCTION OF CULVER	RTS
Item of BOQ	Description	Unit	Quantity
3.32	Supply of plain concrete pipes 600mm	m	394
3.42	Installation of concrete pipes 600mm	m	394
3.62	Provide and build masonry structure.	m3	113.26
3.82	Concrete works [class 15].	m3	173.89

ANNEX F: SAMPLE SPREADSHEET TO ENTER INSPECTION RESULTS AND CALCULATE DEDUCTIONS ON EARTHWORKS AS APPROPRIATE.

			LEV	EL DIFFER	RENCE BETW	EEN CENTRE	LINE AND	SIDE DRAII	N		
CHAINAGE	5	Surve	y Data	Calcul	ation on ETL d	eduction		Calculation d	eduction Item	2.3, 2.4, & 2.5	j.
	Cross Section	LHS [M]	RHS [M]	=C1-C2	Average depth over 200m (sum.C3)/8	ETL Deuctions (m3)	Actual formation heigh	Formation height per standard	Difference [m] [Actual - Standard]	Average over 200m	Total volume Deducted
		C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
0 + 000	АЗ	0.67	0.67	0.00			0.67	0.67	-		
0 + 025	АЗ	0.67	0.67	0.00			0.67	0.67	-		
0 + 050	АЗ	0.67	0.67	0.00			0.67	0.67	-		
0 + 075	АЗ	0.67	0.68	-0.01			0.68	0.67			
0 + 100	АЗ	0.67	0.67	0.00			0.67	0.67	-		
0 + 125	АЗ	0.67	0.67	0.00			0.67	0.67	-		
0 + 150	АЗ	0.67	0.67	0.00			0.67	0.67	-		
0 + 175	АЗ	0.67	0.67	0.00			0.67	0.67	-		
0 + 200	A 3	0.67	0.67	0.00	(0.00)	(0.14)	0.67	0.67	-	-	-
0 + 225	АЗ	0.67	0.67	0.00			0.67	0.67	-		
0 + 250	АЗ	0.67	0.67	0.00			0.67	0.67	-		
0 + 275	АЗ	0.67	0.67	0.00			0.67	0.67	-		
0 + 300	АЗ	0.58	0.69	0.11			0.64	0.67	(0.04)		
0 + 325	АЗ	0.56	0.67	0.11			0.62	0.67	(0.06)		
0 + 350	АЗ	0.50	0.68	0.18			0.59	0.67	(0.08)		
0 + 375	АЗ	0.60	0.68	0.08			0.64	0.67	(0.03)		
0 + 400	А3	0.67	0.67	0.00	0.05	6.53	0.67	0.67		(0.03)	(3.06)
0 + 950	0	0.67	0.67	0.00			0.67	0	0.67		
0 + 975	0	0.67	0.67	0.00			0.67	0	0.67		
1 + 000	0	0.68	0.58	0.10	0.01	1.36	0.63	0	0.63	0.17	20.52
Total						7.76					17.46