Updating of Manual of Work Norms and Specifications for Low Volume Rural Roads in Mozambique

AFCAP/MOZ/001/H

Literature Review

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This project was funded by the Africa Community Access Programme (AFCAP) which promotes safe and sustainable access to markets, healthcare, education, employment and social and political networks for rural communities in Africa.

Launched in June 2008 and managed by Crown Agents, the five year-long, UK government (DFID) funded project, supports research and knowledge sharing between participating countries to enhance the uptake of low cost, proven solutions for rural access that maximise the use of local resources.

The programme is currently active in Ethiopia, Kenya, Ghana, Malawi, Mozambique, Tanzania, Zambia, South Africa, Democratic Republic of Congo and South Sudan and is developing relationships with a number of other countries and regional organisations across Africa.

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Preface

This report covers the Inception Phase of the Updating of the Mozambique Low Volume Roads Manual, the Normas de Execucao. The Inception Phase of the project included the setting up of the project teams, the Technical Steering Committee and the literature review.

A launch meeting was carried out on the 30th of October 2013 and through it benchmarks for the project activities and milestones were set out.

The literature review has been completed and the report gives details of the findings of the literature survey paving the way for the commencement of the drafting process for the manual.
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1 Introduction

This report covers work carried out during the Inception Phase of the project focusing mainly on the review of available literature which will be useful in the drafting of the Updated Manual of Specifications and Work Norms for Low Volume Roads in Mozambique (Normas de Execucao). The contents of the manual will include the following sections:

1. Preliminaries and general.
2. Planning.
3. Design specifications and methodologies including:
   a. Geometric design.
   b. Materials design.
   c. Pavement design (including DCP Design Method).
   d. Road safety.
4. Construction methods (work norms)
   a. Work procedures.
   b. Works inspection.
5. Maintenance
   a. Planning.
   b. Execution.
   c. Evaluation.
6. Quality assurance
   a. Quality control.
   b. Approval systems including approval forms.

The main aspects of the report include:

1. Review of research knowledge and information.
2. Gaps and shortcomings in the current manual.
3. Relevant literature and documents that will be useful in the drafting of the updated manual.
4. Brief on possible key additions.
5. Proposed possible structure and presentation of the manual.

The review of literature pertinent to this assignment is an iterative process that will continue during the drafting of the manual. At this stage the review has mainly focussed on where relevant information will be sourced from for the main components of the manual. Information is also provided for the sections which will be the main focus during drafting.

It is hoped that this report will give the global picture of the assignment and that it will be used as a discussion platform for future collaboration amongst the stakeholders i.e. the consultant, the Technical Steering committee (TSC), and the ANE Directorate.

The report also covers other work that has been carried out during the Inception Phase of the project including the launch meetings and the resolutions that were reached by the main parties to the project. Minutes of the meeting are also attached for completeness.

The report also covers issues arising from the work carried out during the Inception Phase of the project which the team feel will have a significant bearing on the progress and successful completion...
of the assignment. These include issues relating to the source material, translation and coordination of project activities.

The report gives a proposed way forward for the next phase which is the main component of the assignment, the drafting of the updated manual. ANE, who are the main beneficiaries of the objective have attached great value to this project taking cognisance of its long term contribution to the road sector in Mozambique, particularly the rural road network. AFCAP also recognise that this project marks the fruition of all the research work that has been carried out in Mozambique under the AFCAP programme. The updated manual should, to a great extent, lead to the infusion of innovation and best practice in the mainstream of rural road provision.
2 Review of research knowledge and information

The project is being carried out at a time when there is an increase in rural road provision in Mozambique. There has been a protracted effort to resolve the issues relating to rural road provision in Mozambique through research and innovation and there have been many challenges and achievements to this effect.

2.1 Previous non-AFCAP/RRIP research

A lot of research work was carried out through AFCAP support, and previously through the DFID funded Knowledge and Research (KaR) programme, and other IDA funded programmes. It therefore follows that a great deal of knowledge has been accumulated and it needs to be put into practice. This research includes:

1. *Spot Improvement Manual for Mozambique*. The project involved network assessment and identification of bottlenecks including their severity and location on roads and road sections. The objective was to develop cost effective sustainable solutions at bottlenecks for improved accessibility. The project culminated in a Spot Improvement Manual which was targeted at low to very low volume roads in Mozambique. The main objective was to set out guidelines, specifications and methodologies for a staged approach to upgrading low volume roads targeting bottlenecks and using low cost and sustainable solutions.

2. *Engineering Standards and Life-Cycle Costing for Low Volume Unpaved Roads*. This was a very important project for Mozambique because of the challenges posed by the poorly performing unpaved roads and the critical shortage of good road building materials. It was increasingly apparent that unpaved roads were draining too much of the limited resources available due to high maintenance demands. The project was aimed at determining the performance of unpaved roads and to develop performance based specifications for materials plus guidelines for the work ‘norms’ for the delivery of work activities. The project outputs included the *Guideline on Quality Assurance Specifications for Unpaved Roads* and the *Life – Cycle Costing Calculator*.

2.2 AFCAP Research work

This section gives details for the research work that was carried out under the AFCAP/RRIP Projects in Mozambique, AFCAP/RRIP Phase 1 to 3 and the Back Analysis Project. This has been an extended research programme where innovative designs, specifications and work norms were trialled and investigated, see Table 2-1 and Table 2-2.

2.2.1 Road bases and wearing courses

This section covers research work carried out on materials and road bases, summarised in Table 2.1.
Table 2-1 Research work on materials and road bases

<table>
<thead>
<tr>
<th>Bases/wearing courses</th>
<th>Research aspects</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blended wearing course:</td>
<td>Marracuene Macaneta Project (mixed clay and fine greyish whitish coastal sand). Both materials on their own made the road impassable. The fine sand was too loose during the dry season and such sections were impassable when the sand was dry. The other sections with clay (black cotton soils) were impassable during the wet season because they became too soft, boggy and slippery. The two poor materials were blended using a blending design devised in the laboratory and with the 70:30 proportions for sand and clay respectively. The road became all-weather passable and the rate of material loss on the resultant blended wearing is very low. The sections have withstood the floods experienced in the three years since construction.</td>
<td>Satisfactory Performance</td>
</tr>
<tr>
<td>Blended wearing course:</td>
<td>Cumbana Chacane Project (blended plastic calcrete and red sand (50:50)). The wearing course was trafficked for 2 years without the need for maintenance grading. The rate of gravel loss is also very low. The mix design for the blend was based on the performance-based specifications developed through the Engineering Standards Project.</td>
<td>Satisfactory Performance</td>
</tr>
<tr>
<td>Blended bases</td>
<td>Cumbana Chacane Project (mixed plastic calcrete and red sand). The calcrete was too plastic for use as road base and the red sand, as wearing course, only lasted one season. These were blended together through laboratory design procedures. A 50:50 blend was best. The base was strong and met the minimum requirement for bases of 40% soaked CBR. After five years the base is performing very well with no sign of deformation or excessive rutting.</td>
<td>Satisfactory Performance</td>
</tr>
<tr>
<td>Armoured base</td>
<td>Cumbana Chacane Project. This involved the construction of neat sand base capped with a layer of aggregate, which formed the armouring, hammered into the base with heavy steel rollers. The design was aimed at strengthening the base course and also solving delamination problem at the interface of the sand base and the surfacing. The section is performing very well. The base is carrying many heavily loaded medium trucks carrying aggregate from quarries which is used for building construction in Inhambane and Maxixe Towns. So the base has been put to the test. There was also a control section of 50m without the armouring and it failed within weeks showing the effectiveness of the armouring.</td>
<td>Satisfactory Performance</td>
</tr>
<tr>
<td>Neat sand base</td>
<td>Cumbana Chacane Project. On this project penetration macadam was constructed on a compacted sand base layer. The research was mainly focused on the possibility of using the abundant red sand for road base without stabilisation. This section is performing very well and there is no sign of deformation and deep rutting. Though it is research in progress, the resistance to premature deformation is pointing in the direction of good performance. Monitoring will continue in order to gather evidence on the medium to long term performance.</td>
<td>Research in progress</td>
</tr>
<tr>
<td>----------------</td>
<td>---------------------------------------------------------------------------------------------------</td>
<td>----------------------</td>
</tr>
<tr>
<td>Emulsion treated bases</td>
<td>Marracuene Macaneta Project. This was an existing road with a red sand wearing course. During recent years traffic had increased significantly due to increase in tourism at the Macaneta Resort. The sand wearing course was wearing away quickly and there was high maintenance demand on this section. The section was upgraded using an emulsion treated base (ETB) and a slurry seal surfacing. Non-standard sand, one which did not meet specifications for ETB because it was too fine (100% passing 2mm sieve) was used. The section is being monitored and it is performing well.</td>
<td>Satisfactory Performance</td>
</tr>
<tr>
<td>Cement stabilised base</td>
<td>Manjacaze Malahise. Cement stabilisation is the most common solution in Mozambique. It works but it is expensive and the extensive block cracking caused by the use of high cement contents, which are necessary for such fine soils, is a problem.</td>
<td>Satisfactory Performance</td>
</tr>
</tbody>
</table>

The research was focussed on the development of design solutions for road bases using locally available materials. The major challenge was that the most abundantly available road bases are of marginal to poor quality and are, in most cases, not suitable for use in the construction of road bases without modification. The research has yielded important results which have provided the evidence necessary for specifications to be modified.

The blending of bases is now common in some provinces in Mozambique. The development of a new manual with proper specifications, blending design methodologies and construction procedures for these innovations will help to move from research output to implementation thus increasing the benefits to the road sector.

### 2.2.2 Surfacings

This section covers research work carried out on surfacings during the AFCAP/RRIP Projects, summarised in Table 2.2.
Table 2-2 Research work on surfacings

<table>
<thead>
<tr>
<th>Surfacings</th>
<th>Research aspects</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Otta Seals</td>
<td>Zero Mopeia, Inhacufera Machaze, Cumbana Chacane and Manjacaze Malahise Projects. Trials were carried out on several projects using different aggregate types and binder application rates to find out which options were more appropriate for low volume roads. The standard specifications were used for some of the sections and alternative specifications were used on other sections. The sections with fine aggregate (nominal maximum size of 13mm) cured well while the coarse aggregate (19mm maximum size) cured poorly and not completely on some sections. This resulted in poor Otta seal surfacing which did not perform well. The specifications for aggregate for low to very low volume roads were modified for the nominal maximum of 13mm and binder application of 1.6L/m$^2$ to 1.8L/m$^2$.</td>
<td>Satisfactory Performance but only for Otta seals with finer aggregate</td>
</tr>
<tr>
<td>Otta seal using emulsion SS60</td>
<td>Cumbana Chacane Project. This is an Otta seal constructed using emulsion, in this case SS60. There has been debate as to whether it is possible to construct Otta seal surfacing using emulsion. The verdict of the ‘experts’ is that it is impossible to build Otta seals with emulsion. However, a section was trialled on the Cumbana Chacane Project and the Otta seal was successfully constructed using emulsion. This comes with a lot of advantages such as using the labour based methods of construction without the use of hot bitumen.</td>
<td>Satisfactory Performance but it still is research in progress</td>
</tr>
<tr>
<td>Slurry seals</td>
<td>These are not commonly used in Mozambique but they are nevertheless an option to consider for low volume roads. The sealed section on Marracuene Macaneta Road was sealed with slurry seal. Both a coarse and a fine aggregates were used on different sections. The slurry with coarse aggregate has performed better. Also the slurry seal was constructed to different thicknesses, not by design. There are sections were the contractor applied 10mm slurry as given in the BoQs and other sections where the contractor applied less than 5mm. The thin slurry is not performing well as expected even though the traffic is very light. The contractor was requested to correct this but did not do so for a long time.</td>
<td>Satisfactory Performance (except where the contractor applied less thickness than specified in the design)</td>
</tr>
<tr>
<td>Amalgamated</td>
<td>This is a surfacing where there is no defined plane or Satisfactory</td>
<td></td>
</tr>
<tr>
<td>Surfacing Type</td>
<td>Description</td>
<td>Performance</td>
</tr>
<tr>
<td>----------------</td>
<td>-------------</td>
<td>-------------</td>
</tr>
<tr>
<td>Sand Seal Surfacings</td>
<td>Interface between the surfacing and the base. This prevents stripping and delamination of the surfacing from the base. It means the surfacing is amalgamated with the base course and this extends the life of the surfacing significantly. On the Cumbana Chacane Project the sand seal was applied using very fine sand (100% passing 2mm sieve) which is not suitable forsurfacing at all but as an amalgamated surfacing it has performed well. The control section has the same sand seal but without the amalgamation and it failed within 2 weeks of opening to traffic.</td>
<td>Satisfactory Performance so far. Surfacing is recent and is research in progress.</td>
</tr>
<tr>
<td>Penetration Macadam</td>
<td>The aim of the research was to develop work ‘norms’ and specifications for leaner penetration macadam using non-standard aggregate. Penetration macadam was constructed on untreated or neat sand on the Cumbana Chacane Project. Non-standard aggregate was used; calcrete for the first layer and limestone for the second layer. Emulsion SS60 was used at different application rates of the binder. This surfacing is still being monitored.</td>
<td>Satisfactory Performance</td>
</tr>
<tr>
<td>Single Surface Dressing with Fog Spray on Top</td>
<td>Single surface dressing used to be popular on low volume roads and was the genesis of low cost surfacing, particularly on narrow mats. The materials and quality of construction was good in the past but nowadays there have been bad experiences. A trial section was built on the Xitaxi Moeda Project using labour based methods and the section suffered from aggregate stripping. The problem was arrested by fog spraying the areas that were stripping and also on new sections. The tentative conclusion was that single seals can work if the application of the binder is split to provide the tack coat and fog spray as a construction procedure.</td>
<td>Satisfactory Performance</td>
</tr>
<tr>
<td>Double Surface Dressing</td>
<td>This surfacing is very common in Mozambique. The application of the seal coat immediately after the rolling of the first layer reduces the effective content of bitumen for the second layer because the binder flows into the deep interspaces in the first layer and therefore there is not enough binder on the surface of the first layer to hold the aggregate, thereby leading to stripping. The second layer should not be applied until traffic has moulded the first layer into a tight and relatively flat matrix.</td>
<td>Satisfactory Performance</td>
</tr>
<tr>
<td>Concrete Slabs</td>
<td>The trials for concrete slabs on ramps had mixed outcomes. The trials were meant to determine the most cost effective design for concrete slabs for low volume roads. Variations were included in the design and they included, 200mm slabs with reinforcement at mid-depth, 150mm slabs with reinforcement at one third depth and 100mm, 150mm and 200mm slab. Most slabs have performed well except the</td>
<td>Satisfactory Performance (except where there are geotechnical problems – mass soil)</td>
</tr>
</tbody>
</table>
ones on the steepest part of the ramp (22% gradient) where geotechnical problems affected the slabs because of mass ground movement.

| Stone paving with concrete screed | This project was aimed at resolving passability problems on a very steep ramp using locally available stone. The design involved excavation and laying of large stones which were then smoothed with a ribbed concrete screed. On some sections wire mesh was placed to prevent or minimise shrinkage cracking. Stone paving is appropriate for interventions on short segments of road. | Satisfactory Performance (minor cracks on concrete screed) |

The research on surfacings was critical for the following reasons:

1. The performance of roads is mostly affected by the failure or premature failure of surfacings.
2. The bulk of the cost for the construction of low volume roads is usually in the surfacings.
3. The greatest contribution to life-cycle costs is from the maintenance of surfacings.

In order for low volume roads to be truly low cost, innovation in design and construction which leads to improved performance and reduction in costs is critical. To this effect the research was aimed at the following:

1. Developing designs for non-standard materials which were locally available so that they could be used successfully for surfacing.
2. Developing designs which led to reduction in costs. The performance was then monitored to ensure that the resultant anticipated service life of the surfacings made the surfacing options viable.
3. Developing work methods or work norms which were appropriate for the non-standard materials.

The successful research outputs provide a good opportunity for improvement of specifications and work norms for different surfacing options and will be included in the manual where appropriate.
3 Review of available documents

There is a considerable amount of literature available on low volume roads. Some of it is very relevant to the Mozambique situation and some may need adaptation. The review is critical but does not represent an exhaustive list at this early stage of the project. It is anticipated that authors of the manual will concentrate on specific technical aspects and refer to existing research as an evidence base for each chapter, as it is compiled. This section will help to focus on the main documents to be referenced.

<table>
<thead>
<tr>
<th>Document</th>
<th>Relevant sections</th>
<th>Relevant Information</th>
</tr>
</thead>
</table>
| Manual-Normas de Execucao    | This is the main document that will be updated through this project. The document consists of preliminaries and general information which are primarily administrative and organisational. This part will remain very much as it is unless stakeholders decide to change any of the items in it. | Series 100 Preliminaries and General – requires minor improvements on site establishment and quality control.  
Series 200 Drainage – requires substantial improvement including drawings, photos, subsurface drainage, climate resilient structures, etc.  
Series 300 Earthworks (subbase and bases) – this section covers the common work procedures but lacks on the specifications and design aspects and illustrations of work procedures. Improvements can also be made through additions on the work procedures that have been developed for the non-standard materials and related construction procedures e.g. use of neat sands for road bases, armouring, blending, etc.  
Series 400 Asphalt pavements and surfacings – this section covers the construction processes and some specifications. Improvements can be made through the research work and good practice developed through research in Mozambique and elsewhere. Improved specifications for Otta seals, Otta seals using SS60, amalgamated surfacings, etc. |
| Spot Improvement Manual      | This document covers the procedures and specifications for low cost targeted interventions on low volume roads. Though the emphasis is on the lower end of the low volume of traffic (50 vpd or less), the principles are applicable to the upper end (up to 300 vpd). | The major contributions could be on the drainage design and the diagrammatic illustrations of the drainage structures. Passability was the key focus and that is the reason why drainage was a critical component. Incorporation of the diagrammatic illustration would be of significant value. Some of the guidance on the choice of surfacings for all-weather passability could also be very useful. There are some drawings included in the document that could be included in the updated Normas de |
| Guideline for Quality Assurance Procedure for Road Works | This document was prepared by TRL and published by ILO in 2006. It covers adequately the specifications and work norms for low volume unpaved roads. It also covers adequately aspects related to quality assurance and approval processes and specifications. | Its contribution to the drafting of the manual would be on a number of engineering aspects:  
The performance based specifications for the selection of good quality wearing course materials or the modifications of the poor materials for improved performance.  
The labour based construction procedures.  
The method specification type of quality assurance which stipulates the specifications for construction required to meet the minimum quality standards thus minimising the need for laboratory based quality control particularly for remote projects.  
The approval processes i.e.  
Part A: Approval of Materials  
Part B: Approval of Works  
Part C: Planning, Design and Life Cycle Costing  
Note: Part C enhances designs by incorporating future maintenance as a design parameter and use of the life cycle costing calculator for maintenance planning and investment prioritisation.  
An important addition is the approval forms which can be included in the updated Normas de Execucao to enhance quality control on site through standardisation of approval procedures. |
| Guideline on Specifications and Work Norms for LVRs in Mozambique | This document was produced as an output of the AFCAP/RRIP Research Project (Phases 1 to 3). The Guideline was prepared in anticipation of using the contents for the development of the Manual of Specifications and Work Norms for Low Volume Roads in Mozambique. Some of the contents can be transferred to the Normas de Execucao with minimal modifications.  
The Guideline was designed to be self-contained which will be the main attribute of the updated Normas de Execucao and covers most of the engineering aspects from start to finish. | The major contributions to the drafting of the updated Normas de Execucao will include:  
Chapter 1: Project Planning – this would be an important addition to the manual. Project planning is crucial to the successful execution of any project. This aspect is seriously lacking on projects being carried out in Mozambique currently. This would cover all the materials investigation, route planning, etc.  
Chapter 2: Road Pavement Evaluation – this aspect is also lacking in practice. No proper evaluation of the existing road is being carried out and it means the existing strength is not being taken into account in the design of the pavements. The use of the DCP method of evaluation is both low cost and versatile. The DCP Design Method is key to this and involves the design charts based on the resistance to penetration, DN (mm/blow). |
Chapter 3: Geometric Design - The current manual lacks detail on geometric design and the Guideline does provide the framework for this though some enhancing may be required.

Chapter 4: Drainage Design – the Normas is reasonably comprehensive on this but lacks on sub-surface drainage which is covered by the Guideline.

Chapter 5: Pavement Materials, Design and Work Norms – this section is based mainly on EOD and Overseas Road Note 31 (ORN 31) specifications but some of the specifications have been superseded by more recent developments in terms of material specifications for some of the non-standard materials like pedogenic materials (laterites, calcretes). It is recommended that the drafting process considers the DCP Design Method which is good for consolidated, existing roads where existing alignment is followed closely and for the conventional CBR method with reduced specifications for roads built on virgin land or existing roads with minimal consolidation of the existing pavement. Design based on a point-by-point rehabilitation design analysis made possible by using the DCP (a design method developed by Dr. John Rolt and Kenneth Mukura) should be considered for this. The methods give leaner and more efficient pavements particularly for low volume roads.

AFCAP/RRIP Consolidated Construction Report

This is a very important report for this assignment. It was prepared as part of the outputs of the research work carried out under AFCAP/RRIP. The report covers the construction activities carried out during the implementation of construction works for the trial sections that were carried out during Phases 1 to 3 of AFCAP/RRIP.

The main contents of the report related to the lessons learnt during the process and this includes how to do things and how not to do things.

The main contributions to the drafting process will include the following:

Chapter 4: Phase 1 Projects – the section covers the construction procedures for concrete slabs, water structures (causeways and culverts), earthworks including labour based cement stabilisation of road base, labour based surfacing, construction of stone paving with concrete screed, single Otta seals, block paving, etc.

Chapter 5: Phase 2 Projects – this section covers the construction procedures of blended wearing courses, blended bases, emulsion treated bases, Otta seals using both coarse and fine aggregate natural aggregate including non-standard materials, slurry seals (coarse and fine), etc.

Chapter 6: Phase 3 Projects: the section covers the construction procedures for blended bases, armoured bases on sand and plastic materials, untreated sand bases, coarse gravels with boulder
<table>
<thead>
<tr>
<th>Back Analysis of Previously Constructed Low Volume Sealed Roads in Mozambique Project Final Report</th>
<th>This report was produced as the main output for the Back Analysis Project and it covers the performance evaluation of LVSR built using reduced specifications and non-standard materials. The evaluations shed light into the performance of the roads and the observations, measurements and test results have led to the development of evidence necessary for modifications of specifications for bases and surfacings.</th>
<th>The major contributions to the drafting of the manual will include the following: Materials: Specifications for materials for road bases for low volume roads and surfacings – the performance of the different test sections with the different materials. The unstabilised bases yielded important information on the possible specification limits for the materials. This information is particularly important because it is based on long term performance. Drainage – the results showed that it is not necessary in most circumstances to meet the minimum requirement for crown height (750mm from EOD) and this will help to reduce the cost of earthworks. In flat areas it is possible to mitre the water into sumps especially in areas where the road is at or below ground level. This also helps to minimise costs. Bituminous surfacing – the results showed that there are problems related to the durability of the bitumen, i.e. in-service the bitumen is deteriorating fast (two times faster than the anticipated rate). This means that the specifications for the binders and type of surfacings need to be tailored to suit the Mozambique environment (hot climate). Traffic loading – the results showed that the roads were able to carry much higher traffic than the maximum of 1 MESA. It follows that specifications can be reduced further for roads that have lower traffic.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Manual for Low Volume Sealed Roads</td>
<td>This manual was prepared recently as the main output of the research on carried out under AFCAP in Malawi. The research involved the back analysis of the performance of low volume roads in Malawi. The main technical output was the DCP</td>
<td>Major contributions to the drafting of the manual will include the following: Section B2 – Preliminary Road Evaluation: this section covers the evaluation of the pavement structure on an existing road. This is the basic principle of low volume road design particularly when it involves the upgrading of existing unpaved...</td>
</tr>
</tbody>
</table>
The section gives a step by step approach to the DCP field tests and analysis of the results (Step 1 through to Step 5).

Section B3 – Traffic: design is incomplete without the analysis of the traffic loading. This section also has a step by step approach to estimation of traffic loading. This includes estimation of AADT at the start, ESAs per traffic class including the power factor (n), cumulative traffic loading MESAs per lane for the design life of the road, determination of design traffic classes for pavement design.

Section B5 – Pavement Design: this section covers the basic aspects of pavement design through steps 1 to 10 or 11 depending on the how the measured strength and the required design strength compare regarding the decision on whether to strength or simply apply a seal. This also includes the layer strength profiles and the use of the DCP Design Catalogue.

Section B6 - Materials: the manual offers a different approach to materials investigation and evaluation using the DCP test results. It also involves the evaluation of moisture sensitivities of the different materials and how this approach can be used to select suitable materials for the different pavement layers.

Section B7 – Surfacings: this section covers all the common surfacing types and their durability. The strength of the section in terms of its anticipated contribution to the drafting of the Mozambique LVRs manual is in the non-bituminous surfacings including cobble stone, concrete bricks, unreinforced concrete slabs. The guidance given in Table 7-2 Suitability of various surfacings for use on low volume roads.

| Ethiopia Geometric Design Manual | This manual was prepared as part of the AFCAP Project on the development of manuals for the Ethiopian Roads Authority (ERA). The manual was developed to address the gaps in geometric design for LVRs in Ethiopia.
What makes this manual special is that it is tailor made for the Ethiopian environment which has both flat and one of the most challenging mountainous terrains. |
|---|---|
| The major contribution to the drafting of the Mozambique LVRs manual, Normas de Execucuo, will be in the following areas.
Chapter 2 Summary of Standards and Departures from the Standards: this section is important as the geometric design of LVRs takes a very different approach because the traffic volume is much less than the high volume roads. Table 2-1 Road Classification, AADT, Carriageway Widths and Design Speeds provides the necessary deviation from standards that have been adopted for LVRs where design speeds of less than 100km/h can be used for |
bordering the Rift Valley. It thus covers both extremes in terrain and high monsoon rainfall.

the geometric design of LVRs. Table 2-2 Shoulder Width on Each Side of the Carriageway provides guidance on the choices of shoulder width which relates to the functionality of the road, the traffic mix and terrain constraints. Mozambique has all of these factors though at different magnitudes of complexity. Tables 2-9 to 2-16 provide specifications for the different categories of traffic for both paved and unpaved roads. These include AADT 300-1000, 150-300, 75-150, 25-75 and <25vpd. These will be very useful in the drafting of geometric designs for LVRs in Mozambique.

Chapter 4 Survey Requirements: this section gives detailed guidance on the survey that needs to be carried out and how. These include GPS and CADD and the generation of the Digital Terrain Model (DTM) with the data obtained.

Chapter 7 Design Speed and Sight Distances: this is a critical element of geometric design because it has a bearing on the alignment which then translates into costs and this is where it matters most for LVRs. The stopping sight distances also border on road safety which is also a crucial element in geometric design. The critical elements include the design speed and the design speed can be selected on the basis of terrain, traffic and safety factors.

Chapter 8 Horizontal Alignment: Curvature is a critical element of road safety. Some specifications of acceptable and safe road curvature are given in Tables 8-1 Minimum Radii for Horizontal Curves for Paved Roads. Table 8-5 Super-elevation Rates and Length of Run-off with maximum super elevation of 8%.

Chapter 9: Vertical Alignment: This is all to do with gradients and safe crest and sag curves at given design speeds. The information that would be useful in the drafting of the manual is given in Table 9-1; Minimum Values for Crest Vertical Curves, ranges of K values, Stopping Sight and Passing Sight Distances. Table 9-2 Minimum Values for Crest Vertical Curves for Unpaved Roads, Table 9-3 Minimum Values of K for Sag Curves.

Gradient is also critical in geometric design. This is particularly relevant to roads in the highlands in the western and northern parts of Mozambique. The specifications are generic and are given in Table 9-4.
### Maximum Gradients for Paved Roads, ranges 3-12%.

| Non-key documents for reference | Maximum Gradients for Paved Roads, ranges 3-12%.
|--------------------------------|----------------------------------------------------|
| **Technical Paper 2.1**  
**Behaviour of Engineered Natural Surfaced Roads - SEACAP** | This is a paper which was produced as part of the SEACAP Programme and provides details of some important aspects of strength of soils. The paper also provides an analysis of the relationship of deterioration with the material properties and environment. Major contributions to the drafting of the manual include the following:  
Chapter 4 Bearing Capacity: Bearing strength of soils is given in relation to varying moisture conditions and Figure 4-1 Bearing Capacity of Soils (by Ahlvin and Hammitt, 1976) gives relationships between passages (traffic loading) and soil strength (CBRs). This is particularly important for taking into account the variation in soils and the environment in Mozambique. The section also gives information on the effect of clay mineralogy on soil strength particularly the smectites, kaolinites and halloysites (Cook, 1997). This in addition to the work carried out by the Portuguese in Mozambique and Angola and work carried in Brazil on the material properties of the pedogenic materials particularly laterites.  
Chapter 5 Performance Trends: This involves parameters such as $G_c$, $P_l$, $P_p$, $S_p$, $I_c$. The performance relationships are important in determining the maintenance demand of wearing courses because they influence the rate of material loss and riding quality. The section also provides roughness deterioration with traffic over given time periods (HDM based analysis). |
| **Technical Paper No 2.2**  
**SEACAP 19**  
**Behaviour of Engineered Natural Surfaced Roads** | This is a paper that gives a detailed analysis of the measured performances of trial sections in relation to the material properties. Such performances provide the necessary evidence required for evaluation of appropriateness of specifications and innovations. This augments well the research carried out in Mozambique. The main contributions to the drafting of the Mozambique manual would be mainly on the unpaved roads.  
Chapter 4 Data Collection, Management and Review: This section looks at the correlations between the material properties such as $P_p$ and $S_p$ and this helps to link the specifications developed in SEACAP to those developed in Mozambique which use slightly different specifications. The cusums of the CBRs with a 50 percentile of approximately 40% conforms to the current specifications for road base materials for LVRs which is also pegged at 40% minimum CBR.  
Chapter 5: Review of Performance Data: This section covers relationships between performance and material properties. The reality being that there is no indication of good correlation between individual properties and performance. This is due to the fact that performance is affected by a combination of factors, some more than others. Of particular importance is the role of traffic loading which increases with time. |

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18 | Page
importance is the lack of correlation between performance and PP, Gc, and even crown height. This helps in the setting out of upper and lower limit specifications for the appropriate levels of serviceability in combinations rather than for individual parameters.

Technical Paper No. 5: Economic Evaluation of Rural Road Upgrading - SEACAP

This technical paper covers the necessary considerations for the economics of low volume rural road upgrading. Whatever endeavours are undertaken in rural road provision they all boil down to sustainability whose foundation is economics.

The main contribution of this paper is on the incorporation of sustainable economic analysis which in turn influences the development of appropriate specifications and standards which are sustainable.

Chapter 3 Economic Appraisal of LVRR Upgrading:
This involves optimum design and appraisal and life-cycle cost assessment. This is still lacking in Mozambique but it is very important right from project planning stage.

Chapter 4 Economic Criteria and Decision Making:
This includes the justification for upgrading, project prioritisation and making decisions on pavement options. This leads to cost effective investment in roads and drives research for increased efficiency.

Maintenance Operational Procedures for Road and Bridge Works

This document, though not completed, focuses on maintenance and it is written in a format that is commensurate with the Normas de Execucao in that it is instructive rather than text book type and provides lists of resources and a step-by-step approach to the work norms specifications and guidance. There are diagrams and photos for easier understanding.

The main contribution to the drafting of the manual is as follows:
Structure: The structure of this document is much more appropriate and should be considered for improving the structure of the Normas de Execucao because it provides for diagrammatic and photo illustrations particularly for designs and work norms.

Content: there is a step-by-step instructive text on the work procedures augmented by a proposed list of resources necessary for the activity(ies) and the checklist for the supervising engineer.

The structure conforms to the format of tender documentation which is one of the requirements of ANE Management, see minutes of launch meeting.

Rural Road Surfacing Research Vietnam SEACAP 1 Final Report

This document was prepared as part of the SEACAP programme which involved the design and construction of low cost surfaced roads in Vietnam. This information is similar and a precursor to the AFCAP projects carried out in Mozambique and other countries in Africa.

Contributions to the manual will include:
Chapter 4: Traffic loading on LVRRs. This is essential because it is the basis on which designs are formulated.

Chapter 6 & 7: LCS Options: these sections cover the surfacing options and guidance on choices depending on various factors of climate and functionality. Stabilised and unstabilised bases are also covered.
<table>
<thead>
<tr>
<th>Cambodia Low Cost Surfacing – SEACAP 8 Completion Report</th>
<th>Chapter 8: Appropriate pavement selection. This section covers materials evaluation and selection and strength profiles on the basis of soaked CBRs.</th>
</tr>
</thead>
</table>
| This document gives details of the low cost surfacing works that were carried out in Cambodia covering design and construction of pavements and low cost surfacings | The main contribution to the manual will be on the following:  
Chapter 5: provides information on overloading and ways of dealing with the problem and this is relevant to Mozambique. Information on different surfacing options is particularly important for the manual.  
Chapter 6: gives information on the work methods for non-conventional surfacings like hand packed stone, block paving which have become common in Mozambique.  
Chapter 8: Pavement Design Concept: provides information of the appropriate pavement structures relating closely to the LVRs pavement design charts which were developed through EOD study.  
Chapter 9: Provides information on the costs for the different LCS options and this is vital for Mozambique where unit rates are much high than the generally accepted values. |

This literature review has provided the main areas of sources of information for the drafting of the manual. The documents for reference were selected to cover the main disciplines given in the Normas de Execucao and included those that were perceived to be missing yet very important and necessary. This, the project team believes, will enrich the Normas de Execucao.

Note: some extracts of the information referred to in the tables is given in the Appendix.
4 Plans for the next reporting period

The next reporting period involves the drafting of the Updated Normas de Execucao which is the main activity of the assignment. The information including outputs of previous research work and the list of documents that will be key references are provided.

The following sub-activities associated with the drafting of the manual are planned:

1. The allocation of different sections of the manual for drafting to the key project team members.
2. The drafting of the sections using the references given in this report and other sources as may be deemed relevant.
3. An internal review of the contents of the drafts and improvements thereafter as may be necessary.
4. Compilation of the different sections into the manual including illustrative drawings, diagrams and photos as required.
5. Constant consultations and review meetings with the Technical Steering Committee for editing and approvals.
6. Finalisation of the first draft Normas de Execucao.

These activities are laid out in the activity schedule for the project given in Figure 4-1.
**Figure 4-1 Activity Schedule (updated)**

<table>
<thead>
<tr>
<th>Activity</th>
<th>Oct-13</th>
<th>Nov-13</th>
<th>Dec-13</th>
<th>Jan-14</th>
<th>Feb-14</th>
<th>Mar-14</th>
<th>Apr-14</th>
<th>May-14</th>
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<tr>
<td><strong>Preliminaries</strong></td>
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<td>Technical Review Report</td>
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<tr>
<td>Minutes of monthly meetings with TSC + Progress</td>
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<td></td>
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<tr>
<td>Training Report and Final Version of Manual</td>
<td></td>
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</tr>
</tbody>
</table>

| Inputs                                         |        |        |        |        |        |        |        |        |
| **Staffing**                                   |        |        |        |        |        |        |        |        |
| Project Manager                                |        |        |        |        |        |        |        |        |
| Senior Researcher                              |        |        |        |        |        |        |        |        |
| Assistant Author                               |        |        |        |        |        |        |        |        |
| LVR DCP specialist                             |        |        |        |        |        |        |        |        |
| In-country                                     |        |        |        |        |        |        |        |        |
| Out of country                                 |        |        |        |        |        |        |        |        |

| Project Manager                                |        |        |        |        |        |        |        |        |
| Senior Researcher                              |        |        |        |        |        |        |        |        |
| Assistant Author                               |        |        |        |        |        |        |        |        |
| LVR DCP specialist                             |        |        |        |        |        |        |        |        |
| Total                                          |        |        |        |        |        |        |        |        |

**Notes:**

- In-country
- Out of country
5 Issues

This section gives details of issues arising in the execution of the project. These issues have the potential to impact on the progression of the project.

1. The current manual, the Normas de Execução, is in Portuguese and the team needed an English version for the drafting process. ANE indicated that they had the English version but a copy of the English version that the team received is not completed and the translation from Portuguese to English is not very good. Consultations were made with the client on this matter and it has been resolved that the project team shall use the SATCC Specifications document from which the Normas de Execução was derived through translation from English to Portuguese. However, on reviewing the SATCC document it was discovered that though the main codes are similar, the Normas de Execução has codes which are different for the sub-items under the main codes. This may slow down the team as there will be need to make sure that the sub-items are sequential and that they match. Also there will be much more typing rather than mere additions and editing that was initially anticipated.

2. The team has not yet received the list of the Technical Steering Committee members as promised by ANE during the project launch meeting.

3. The planning and costing for the workshops needs to be clarified to ensure proper advance planning for this activity.

4. The current security situation in the Central Region may need to be factored into the planning for the workshops. Consultations have been made with ANE and it is safe to fly and is therefore possible to hold workshops in the towns and cities. Security problems are presently in isolated rural areas only.
6 Conclusion

The Inception Phase of the project has been completed successfully and the necessary awareness is in place. It is anticipated that the drafting of the manual will proceed well taking cognisance of the wealth of information that has been put together during the Inception Phase.

Consultations will be made with the relevant stakeholders on issues raised above and once these are resolved the project should proceed well towards the intended successful conclusion.
7 References

1. National Road Administration (ANE), 2012. *Normas de Execucao*
2. TRL, 2006. *Spot Improvement Manual for Basic Access*
Appendix A  Examples of extracts from the reference document

Geometric Parameters for Design Class DC5 Paved Ethiopia
(AADT 300-1,000)

<table>
<thead>
<tr>
<th>Design Element</th>
<th>Unit</th>
<th>Flat</th>
<th>Rolling</th>
<th>Mountain</th>
<th>Escarp’t</th>
<th>Urban Peri-Urban</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Speed</td>
<td>km/hr</td>
<td>85</td>
<td>70</td>
<td>60</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Width of Running Surface</td>
<td>m</td>
<td>7.0</td>
<td>7.0+</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Width of Shoulders</td>
<td>m</td>
<td>Table 2.2 and Table 2.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum. Stopping Sight Distance</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>g = 0%</td>
<td>m</td>
<td>155</td>
<td>110</td>
<td>85</td>
<td>65</td>
<td>65</td>
</tr>
<tr>
<td>g = 5%</td>
<td>m</td>
<td>175</td>
<td>120</td>
<td>90</td>
<td>70</td>
<td>70</td>
</tr>
<tr>
<td>g = 10%</td>
<td>m</td>
<td>205</td>
<td>140</td>
<td>105</td>
<td>75</td>
<td>75</td>
</tr>
<tr>
<td>Min. Passing Sight Distance</td>
<td>m</td>
<td>330</td>
<td>270</td>
<td>230</td>
<td>180</td>
<td>180</td>
</tr>
<tr>
<td>% Passing Opportunity</td>
<td>%</td>
<td>25</td>
<td>25</td>
<td>15</td>
<td>0</td>
<td>20</td>
</tr>
<tr>
<td>Minimum Horizontal Curve Radius</td>
<td>m</td>
<td>350</td>
<td>215</td>
<td>145</td>
<td>95</td>
<td>95</td>
</tr>
<tr>
<td>SE = 4%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>SE = 6%</td>
<td>m</td>
<td>310</td>
<td>195</td>
<td>135</td>
<td>85</td>
<td>85</td>
</tr>
<tr>
<td>SE = 8%</td>
<td>m</td>
<td>280</td>
<td>175</td>
<td>120</td>
<td>80</td>
<td>-</td>
</tr>
<tr>
<td>Transition Curves Required</td>
<td></td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Max. Gradient (desirable)</td>
<td>%</td>
<td>4</td>
<td>6</td>
<td>8</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>Max. Gradient (absolute)</td>
<td>%</td>
<td>6</td>
<td>8</td>
<td>10</td>
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<td>Minimum Gradient</td>
<td>%</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Maximum Super-elevation</td>
<td>%</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>Min. Crest Vertical Curve</td>
<td>K</td>
<td>55</td>
<td>30</td>
<td>17</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Min. Sag Vertical Curve</td>
<td>K</td>
<td>18</td>
<td>12</td>
<td>9</td>
<td>7</td>
<td>7</td>
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<tr>
<td>Normal Cross-fall</td>
<td>%</td>
<td>2.5</td>
<td>2.5</td>
<td>2.5</td>
<td>2.5</td>
<td>2.5</td>
</tr>
<tr>
<td>Shoulder Cross-fall</td>
<td>%</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Right of Way</td>
<td>m</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
</tr>
</tbody>
</table>
Design Speeds (Ethiopia)

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<thead>
<tr>
<th>Design standard</th>
<th>Design speed (km/h)</th>
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<tbody>
<tr>
<td></td>
<td>Flat</td>
</tr>
<tr>
<td>DC 8</td>
<td>120</td>
</tr>
<tr>
<td>DC 7</td>
<td>120</td>
</tr>
<tr>
<td>DC 6</td>
<td>100</td>
</tr>
<tr>
<td>DC 5</td>
<td>85</td>
</tr>
<tr>
<td>DC 4</td>
<td>70</td>
</tr>
<tr>
<td>DC 3</td>
<td>70</td>
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<td>DC 2</td>
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</tr>
<tr>
<td>DC 1</td>
<td>50</td>
</tr>
</tbody>
</table>

Note 1  The design speeds in mountainous terrain for unpaved roads has been adjusted slightly so that the minimum radii of curvature are the same for both the paved and unpaved option. This ensures that when a road is upgraded to paved standard, the existing curves are not already ‘over’ designed.

Proposed specifications (Back Analysis Project – Mozambique)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Standard Specifications</th>
<th>LVRs</th>
<th>Condition</th>
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<tbody>
<tr>
<td>Soaked CBR</td>
<td>≥ 80%</td>
<td>≥ 40%</td>
<td>Drainage conditions are good</td>
</tr>
<tr>
<td>In-situ CBR</td>
<td>≥ 120%</td>
<td>≥ 60%</td>
<td>Drainage condition are good</td>
</tr>
<tr>
<td>PI</td>
<td>0 - 6</td>
<td>0 - 14</td>
<td>Maximum PP = 460</td>
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<td>14 - 20</td>
<td>Maximum PP = 200</td>
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<td>PP</td>
<td>0 - 90</td>
<td>0 - 460</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>460 - 570</td>
<td>Semi-arid to arid</td>
</tr>
<tr>
<td>GM</td>
<td>2.05 – 2.65</td>
<td>1.6 – 2.65</td>
<td>PI is less than 9 and PP is less than 200</td>
</tr>
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<td></td>
<td></td>
<td>1.3 – 1.6</td>
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</table>
Proposed structure for the updated Normas de Execucao (Botswana)

### Maintenance Operational Procedures for Road and Bridge Works

**Labour Based Method**

<table>
<thead>
<tr>
<th>CREW</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 foreman</td>
</tr>
<tr>
<td>1 truck or tractor driver and pedestrian roller operator</td>
</tr>
<tr>
<td>4 workmen</td>
</tr>
<tr>
<td>1 driver</td>
</tr>
</tbody>
</table>

**Tools and Equipment**

- Tipper/7.5 tons flat bed truck or tractor and trailer
- A small roller
- 1 wheelbarrow
- 2 shovels
- 2 pickaxes
- 2 hand hammers
- 2 brooms
- 1 squeegee
- 1 watering can
- 1 cold emulsion single drum sprayer
- 5 paint brushes
- 1.5 m long measuring tape
- 1 pick-up vehicle

**Equipment Based Method**

<table>
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<th>CREW</th>
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</thead>
<tbody>
<tr>
<td>1 foreman</td>
</tr>
<tr>
<td>1 spray/lance/bitumen operator</td>
</tr>
<tr>
<td>1 truck or tractor driver</td>
</tr>
<tr>
<td>1 roller operator</td>
</tr>
<tr>
<td>3 workmen</td>
</tr>
<tr>
<td>1 driver</td>
</tr>
</tbody>
</table>

**Tools and Equipment**

- Bitumen hoover and distributor
- Tipper/7.5 tons flat bed truck or tractor and trailer
- 1 pick-up vehicle
- A power cutter machine
- A small pneumatic roller
- 2 wheelbarrows
- 2 shovels
- 2 brooms
- 2 watering cans
- 2 squeegees
- 1 bitumen thermometer
- 1 2 meter straight edge
- 1 metal bucket
- 10 paint brushes
- 1.5 m long measuring tape
- 1 spare jet for the spray lance
- 1 box of tools for dismantling the spray lance
Relationship between Shrinkage Product and Plasticity Product (SEACAP 19)
Appendix B: Photos for the manual

<table>
<thead>
<tr>
<th>Labour based construction of ETB</th>
<th>Mixing of ETB with disc harrow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction of concrete slabs</td>
<td>Screening of Otta seal surfacing</td>
</tr>
<tr>
<td>Construction of Otta seal (binder application)</td>
<td>Construction of Otta seal (calcrete aggregate application)</td>
</tr>
<tr>
<td>Description</td>
<td>Image</td>
</tr>
<tr>
<td>--------------------------------------------------</td>
<td>----------------------------------------------------------------------</td>
</tr>
<tr>
<td>Construction of armoured base</td>
<td><img src="image1.png" alt="Construction of armoured base" /></td>
</tr>
<tr>
<td>Amalgamated sand seal surfacing on armoured base</td>
<td><img src="image2.png" alt="Amalgamated sand seal" /></td>
</tr>
<tr>
<td>Construction of penetration macadam (second layer)</td>
<td><img src="image3.png" alt="Construction of penetration macadam" /></td>
</tr>
<tr>
<td>Rolling of penetration macadam</td>
<td><img src="image4.png" alt="Rolling of penetration macadam" /></td>
</tr>
</tbody>
</table>
Appendix C: Minutes of the Launch Meeting

Proceedings of the Launch Meeting for the Updating of the Mozambique Manual
30 October 2013

Present

ANE
Eng. Miguel Coanai  Acting General Director (Director of Planning)
Eng. Aderito Guilamba  Director of Projects
Eng. Luis Fernandes  Head of Maintenance
Eng. Adelino Serrage  Acting Director of Maintenance
Eng. Hilario Tayob  Monitoring Department

AFCAP
Eng. Leta Nkululeko  Technical Manager

TRL
Kenneth Mukura  Regional Manager for Southern Africa/Project Manager
Mike Pinard  Low Volume Roads Expert

Agenda
1. Opening by Director
2. Brief by AFCAP
3. Presentation by TRL
4. Discussion Issues
   b. English version of the Normas de Execucao.
   c. Documents for Technical Review.
   d. Programme of activities
   e. Review Workshop
   f. Translation from English to Portuguese
   g. Dissemination Workshops
   h. Logistics
   i. Printing of final version of manual
5. Any Other Business
6. Closing remarks
## Proceedings

<table>
<thead>
<tr>
<th>Items</th>
<th>Issues</th>
<th>Resolutions</th>
</tr>
</thead>
</table>
| Opening by Acting General Director | The meeting was officially opened by the Acting General Director and he touched on a number of issues relating to the history of the RRIP/AFCAP programme and ANE’s expectations  
  - ANE was facing a lot of challenges with regards to provision of roads and embarked on the Rural Road Investment Programme to try and provide sustainable solutions to these challenges.  
  - ANE has carried out research with the support of AFCAP and TRL.  
  - ANE is looking forward to the production of the updated manual which will be used by the provinces, the contractors and the consultants and will provide the necessary support. ANE’s intensions are to upgrade unpaved rural roads to pave road standards. |                                                                                          |
| AFCAP                  | AFCAP has provided support for the research work which has been undertaken over 5 years in Mozambique and other countries. AFCAP is happy for the fruition of research and that the final step has been reached where the current manual on specifications and work norms will be upgraded. |                                                                                          |
| Introduction Power point presentation by TRL | The presentation covered the consultant’s perspective of the nature of the assignment, the requirements in terms of content and activities, the information available and the strategy for the execution of the project.  
**Background information:**  
- The current manual (Normas de Execucao) is generally a direct translation of the SATCC specifications and does not deal adequately for low volume roads (LVRs).  
- There is shortage of good road building materials and the updated manual should accommodate the use of locally available materials which may be non-standard in quality. All materials are fit for purpose in an EOD context sensitive design. |                                                                                          |
There has been a lot of research carried out in Mozambique and the result will help to develop specifications and work norms which are appropriate for local conditions and resources.

**Previous research in Mozambique:**
- Spot improvements manual
- Engineering standards and life-cycle costing (Regional)
- AFCAP/RRIP Phases 1 to 4
- Mozambique Back Analysis Project

**Previous research work elsewhere**
- Malawi Back Analysis Project
- SEACAP Projects
- Uganda LB Surfacing
- Zimbabwe LB surfacing
- Regional Sands Guideline
- Botswana Pavement Monitoring Programme

**Key referral documents**
- Normas de Execucao – point of departure.
- Updated Guideline for Specifications and Work Norms for Low Volume Roads in Mozambique.
- Final Report for AFCAP/RRIP Phase 2
- Construction Report for AFCAP/RRIP Phases 1 to 3.
- Final Report for the Back Analysis Project

**Other documents**
- Spot improvement Manual
- Guideline for Quality Assurance Procedures for Road Works (Engineering standards project – unpaved roads)
- Malawi Low Volume Roads Manuals (DCP Design Method)
- SEACAP Reports and Ethiopia Manuals

**Proposed key additions on designs of unpaved**

Research carried out in South Africa and Brazil should also be considered.

Need to use the SATCC document in case there is no properly translated English version of the Normas de Execucao.

The Botswana manuals and reports should be considered for the format and information. Mike would provide copies.
roads:
- Performance based specifications (outputs of the Engineering Standards Project)
- High performance specs for long-life wearing courses.
- future maintenance demand as a design parameter. (e.g. procedures for blending materials for high performance wearing courses).
- Life-cycle costing calculator for investment decisions.

**Proposed additions on paved roads design:**
- Reduced but appropriate specs for LVRs.
- DCP Design Method.
- Use of neat sand for bases, blended bases, armoured bases, ETB specs for fine materials, etc.

**Proposed additions for surfacings:**
- Standards and improved specs for Otta seals for LVRs using non-standard materials.
- Std. and reduced specs for penetration macadam for LVRs. using non-standard materials
- ‘Amalgamated surfacings’
- Reduced specifications for concrete slabs for LVRs.
- Stone paving with concrete screed
- Sand seals
- Hot sand asphalt

**Proposed additions on geometric design:**
- Specs for LVRs (Ethiopia Manuals)
- Following existing alignments as much as possible (requirements of the DCP Design Method).

**Proposed additions on drainage design:**
- Specs for drainage design in flat terrain and sandy areas.
- Standard specs in undulating and mountainous areas.

It was resolved to include Road Safety and Environment in the manual.
- Surface and sub-surface drainage.
- Climate resilient drainage structures for vulnerable areas (e.g. courseways).
- Design procedures and parameters for structures in flood prone areas.

**Proposed key additions on work norms**
- Blending of materials for bases and wearing courses.
- Armouring of bases.
- Construction of ETB.
- Construction of amalgamated surfacings.
- Construction of Otta seals of LVRs.
- Etc.

**Proposed additions on quality assurance**
- Compaction judgement chart (Zimbabwe specs)
- Use of DCP (good for remote projects)
- Method Specifications (good for remote projects)
- Bitumen testing

**Proposed key additions on maintenance**
- Appropriate methods and tools for LVRs - sealed and unsealed (e.g. LCC Calculator for unpaved roads).
- Road evaluation/assessment.
- Structured maintenance for surfacings (particularly the low cost surfacings).
- Maintenance budgeting.
- Work procedures.
- Evaluation
- QA

**Proposed additions on Road safety and the Environment**
- Appropriate methods for ensuring road safety (traffic calming, catering for NMT, etc)
- Appropriate methods for safeguarding the environment (borrow pit reinstatement, etc)
<table>
<thead>
<tr>
<th><strong>Propose structure and key attributes of the updated manual</strong></th>
<th><strong>The structure of the Botswana Manuals and Reports should be considered</strong></th>
<th><strong>The manual should include diagrams and photos for illustrations</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>- User friendly (i.e. simple and concise)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Self-contained (not too many references which will be difficult to access)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Instructive (step by step approach)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Easy to update (new knowledge still being produced)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- To be in the current format of the Normas de Execucao with modifications.</td>
<td></td>
<td></td>
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<tr>
<td>- Manual will be supported by a video which is under production.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Discussion issues</strong></th>
<th><strong>ANE shall form a Technical Steering Committee (TSC)</strong></th>
<th><strong>TRL was tasked with drafting the ToR for the TSC for submission to ANE. ANE must form the TSC before the project progresses too far into implementation.</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Formation of the Technical Steering Committee (TSC)</strong></td>
<td>from within its structures which combined should cover as much as possible the disciplines to be covered in the manual. The TSC will also be tasked with organising workshops because Govt may need to be informed before-hand.</td>
<td></td>
</tr>
<tr>
<td><strong>Review Workshop</strong></td>
<td>Review workshop – this will involve the review of the first draft of the manual. Composition should not differ much from that of the Research Centre Project.</td>
<td>The English version of the manual will be used and can be presented in English to a limited audience in ANE Maputo. The majority of the participants will be from ANE.</td>
</tr>
<tr>
<td><strong>Dissemination workshops</strong></td>
<td>The ToR requires the holding of 3 workshops in the Southern, Central and Northern Regions of Mozambique. These will be attended by the practitioners some of whom are not proficient in English. The document shall be peer reviewed before the workshop</td>
<td>The documents and presentations shall be in Portuguese or presentations shall be in English with simultaneous translation. The workshops shall not include training and this shall be planned for the future.</td>
</tr>
<tr>
<td><strong>Translation of document to Portuguese</strong></td>
<td>The consultants will produce the updated manual in English and it should be translated to Portuguese for sake of the practitioners some of whom are not proficient in English. Translation shall be the responsibility of ANE and</td>
<td>The first draft shall be in English for the Review Workshop. The final draft shall be translated into Portuguese before</td>
</tr>
</tbody>
</table>
AFCAP. The company, CPG could be contacted because they did the translation for the SATCC document to Portuguese. the dissemination workshops.

| Linking the manual with practice | It is important for the manual to conform to the bidding documents in order for the specifications and work norms to be operationalised. This may include:  
- Specification for the DCP Design Method  
- Specification of the type of rollers to be used i.e appropriate equipment in general.  
- Linking the manual to the BoQs | The current manual format should be followed as much as possible because it is already linked to the BoQs and consistency will help as the provinces and the practitioners are already familiar with the format and how to incorporate parts of the manual in the BoQs. |

| Research | ANE appreciated the research that has been carried out by TRL which has provided sustainable solutions for ANE, particularly the Otta seals, blended bases, armoured bases and amalgamated surfacings. | There are trial sections which were completed recently and have not been monitored enough and these innovations should be included in the manual but as research in progress. |

| Any Other Business | | |

| AFCAP Brief on other Projects | AFCAP gave a brief on other related projects such as the Research Centre Project which have close linkages with the Updating of the Manual on Specifications and Work Norms Project. | |