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# Long Term Pavement Performance Monitoring of Existing Trial Sections and Implementation of Regional Guidelines for Establishing and Monitoring Trial Sections in Tanzania

## Inception Report

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Cover photo: Concrete strip demonstration section on Bago to Talawanda road in the Bagamoyo District, Tanzania

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## Abstract

AfCAP is providing support to build capacity within Local Government Infrastructure and Transport Research Centre (LoGITReC), which is under the President's Office-Regional Administration and Local Government (PO-RALG), through a mentoring programme in Tanzania. As part of the programme, the Council for Scientific and Industrial Research (CSIR) from South Africa was appointed by Cardno Emerging Markets (UK) Ltd to undertake a project on **Long Term Pavement Performance Monitoring of Existing Trial and Demonstration Sections and Implementation of Regional Guidelines for Establishing and Monitoring Trial Sections in Tanzania.** This project will provide technical assistance to the LoGITReC Research Team as well as technicians and engineers in the roads sector and academia in Tanzania, to establish, carry out the monitoring surveys and evaluation of trial sections in accordance with standardised protocols.

Thus the project is aimed at addressing all aspects of Long-Term Pavement Performance (LTPP) assessments, integrating capacity building throughout its implementation. To this end, this assignment:

- Conducts a review of the two trial sections located on the Bago to Talawanda road in the Bagamoyo District and on the Lawate to Kibongoto road in the Siha District in Tanzania, to evaluate the nature and quality of information available from these road trials;
- Refines and implements the existing regional protocols for establishment and monitoring of road trial sections during implementation of monitoring surveys to ensure that the establishment of road trials and collection of the information is standardised;
- Conducts field surveys on the two selected demonstration/trial sections in order to collect performance data in accordance with the monitoring processes provided in the refined guidelines/protocols
- Provides in-service training to the LoGITReC research staff on practical implementation of the harmonised protocols/guidelines.

This Inception Report highlights the progress of work at the inception phase and indicates how subsequent tasks/activities will be undertaken to achieve the objectives of the project. A revised programme plan is also provided in this report to guide the project team on the implementation of the project.

## Key words

Low volume roads, materials, long-term monitoring, pavement performance, trial section.

## AFRICA COMMUNITY ACCESS PARTNERSHIP (AfCAP)

***Safe and sustainable transport for rural communities***

AfCAP is a research programme, funded by UK Aid, with the aim of promoting safe and sustainable transport for rural communities in Africa. The AfCAP partnership supports knowledge sharing between participating countries in order to enhance the uptake of low cost, proven solutions for rural access that maximise the use of local resources. AfCAP is brought together with the Asia Community Access Partnership (AsCAP) under the Research for Community Access Partnership (ReCAP), managed by Cardno Emerging Markets (UK) Ltd.

**See www.afcap.org**

## Acronyms

| | | |
|---|---|---|
| AfCAP | : | Africa Community Access Partnership |
| CSIR | : | Council for Scientific and Industrial Research |
| LGA | : | Local Government Authority |
| LoGITReC | : | Local Government Infrastructure and Transportation Research Centre |
| LTPP | : | Long-term pavement performance |
| PO-RALG | : | President's Office, Regional Administration and Local Government |
| ReCAP | : | Research for Community Access Partnership |
| DFID | : | Department for International Development (UK) |

# Contents

# 1 Introduction

## 1.1 Background

Africa Community Access Partnership (AfCAP), a programme of research and knowledge dissemination funded by the UK government through the Department for International Development (DFID), supported the construction of a number of road trials in response to the request from the then Prime Minister's Office Regional Administration and Local Government (PMO-RALG) in 2009. The oversight of regional administration of Local Government Authority (LGA) has since been transferred to the President's Office and henceforth reference shall be made to PO-RALG.

For this project, the focus is on the two trial sections that were constructed on the Bago to Talawanda road in the Bagamoyo District of the Pwani Region (20.48 km) and on the Lawate to Kibongoto road in the Siha District of the Kilimanjaro Region (13.48km). The construction of these trial sections was a strategic initiative to improve provision of district roads in Tanzania and therefore provide sustainable access to economic and social opportunities for poor rural communities. The sections were designed to demonstrate and verify different options in design, material utilisation (for both pavement and surfacing) and construction methods for low-volume roads[1]. Since the road trials have been monitored over several years, they should provide information that can be used to assess the performance of different options in design, material utilisation and construction methods.

All sections on the Bago and Talawanda road, but the concrete geocells were completed by September 2011; these were then monitored in September/October 2011. The concrete geocells were completed in January 2012 and first monitored in February 2012, with subsequent monitoring visits carried out in April 2012, September 2012 and April 2013. The construction of sections at Siha begun in March 2012 and was completed in September 2012. The baseline data for this section were collected in January 2013, with one monitoring visit carried out in April 2013. Further project background information is that the subsequent set of performance data has not yet been analysed. The inconsistency, especially in the monitoring of trial sections over time has been identified as a recurring problem in several countries, on projects supported by AfCAP. A systematic evaluation of the trial sections is needed, including the methods for collecting data and quality of monitoring data, compared to standard protocol requirements.

The ultimate goal of the current project is therefore, to carry out a review of the trial sections from the two selected sites; refine and implement the existing regional protocols to ensure that data collected from existing and new sections are consistent with the harmonised for establishment and monitoring of road trial sections during implementation of monitoring surveys while incorporating structured capacity building.

## 1.2 Project context

While good road infrastructure is acknowledged to be a key component to warrant accessibility at all times to health, education and other essential services as well as links between rural areas and the

[1] **Design Report**, Africa Community Access Programme, Research Consultant to Support the Design, Construction and Monitoring of Demonstration Sites for District Road Improvement in Tanzania, Contract Reference AFCAP/TAN/008. November 2010.

main road network, a great proportion of rural population remain inadequately connected to the national transport network. It is no surprise that social and economic benefits will be realised in communities as a result of provision of all-weather access to markets and other service delivery centres within and between communities. As the main economic activity in Tanzania is agriculture, poor rural road infrastructure will undermine economic growth of the country. It is therefore important to find solutions that will ensure the provision of reliable road infrastructure for good connectivity and sustainable access to the rural areas. In this way, the size of local road network to improve access to areas of economic importance and access to social and economic services for rural communities can be accelerated.

Ideally, the solutions should be to keep the roads in good condition, safe and passable throughout the year. The key lies in the use of research to develop solutions in the provision of environmentally sustainable rural roads with significant cost saving. AfCAP as a research programme is promoting safe and sustainable rural access in Africa through research and has therefore created an awareness of the role of research. The support provided by AfCAP to design and construct trial sections was carried out under Phase 1 of AfCAP. Phase 2 of AfCAP, under the overall Research for Community Access Partnership (ReCAP) umbrella, is to build on the programme of the research established under AfCAP Phase 1, and responds to the need for effective consolidation and management of the knowledge acquired over the years from the research projects. Thus the current project on *Long Term Pavement Performance Monitoring of Existing Trial Sections and Implementation of Regional Guidelines for Establishing and Monitoring Trial Sections in Tanzania* is appropriately supported under ReCAP as it will build on the research undertaken on the selected trial sections in Bagamoyo and Siha districts.

## 1.3 Project concept

### 1.3.1 Standardisation of guidelines for LTPP establishment and monitoring

The gathering of information from a long term pavement performance monitoring programme of trial sections is influenced by the initial objectives of the project and the envisaged outcome of the programme. The pavement structures of the sections may also be designed based on different methods, for example catalogue method, design charts from design manuals or the Dynamic Cone Penetrometer (DCP-DN) method. The potential therefore exists that the available data may not always provide the information that is needed to assess the impact of an array of factors in a consistent manner to assist in conclusively demonstrating the effectiveness of different options in design, material utilisation and construction methods. Standardisation of protocols for establishment and monitoring the long-term performance of demonstration sections is needed to harmonise the various approaches being adopted and to address the inconsistencies as observed on the two demonstration projects and projects in other countries supported by AfCAP.

This project is to be closely linked to an AfCAP regional project[2]. The expected outcome of the second task of the project is standardised regional guidelines/protocols for the establishment of road trials and information collection from established road trials. The protocols/guidelines to be developed are aimed at supporting the future establishment of LTPP sections not only for Tanzania, but also for other sub-Saharan African countries. The project concept is therefore geared towards regional harmonisation of the practice.

[2] **Development of Guidelines and Specifications for Low Volume Sealed Roads through Back Analysis.** Africa Community Access Programme. Contract Reference: AfCAP RAF2069A.

### 1.3.2 Capacity building

The capacity building strategy, through incorporating a mentorship programme in the project, should assist in accelerating skills development for LTPP monitoring within Local Government Infrastructure and Transportation Research Centre (LoGITReC). The LoGITReC was recently established in Dodoma by the Division of Infrastructure Development (DID) in the President's Office - Regional Administration and Local Government (PO-RALG).

LoGITReC is to provide laboratory and field testing in support of the research agenda of DID. As a new establishment, there is a need to establish institutional mechanism for appropriate skills development in the design, construction and performance monitoring of trial sections against accepted regional protocols, including the appropriate management of the collected data. However, the capacity building and training programme is to be broad-based, also involving engineers from TANROADS Central Materials Laboratory (CML) and other partners that have been identified. Through the detailed assessment of the existing trial sections, building of such capacity is to be incorporated throughout the execution of this project, to ensure that better quality data are collected on both the old and new trial sections in a consistent manner, during the monitoring period.

# 2 Project Terms of Reference

AfCAP has agreed to support the research agenda of DID in response to the request by PO-RALG through the project on ***Long Term Pavement Performance Monitoring of Existing Trial Sections and Implementation of Regional Guidelines for Establishing and Monitoring Trial Sections in Tanzania.***

The assignment requires that all aspects of long-term performance assessments of experimental/trial sections, inclusive of: the planning, design and construction of sections; the setting up of a monitoring programme; the establishment of baseline data; performance monitoring of the sections (including the capturing of traffic and environmental data); data management (including capturing, validation and storage of data in a fit-for-purpose database); data processing and analysis; and reporting formats, be addressed through a review of the trial sections in the Bagamoyo District and the Siha District and refinement and implementation of the existing regional protocols. During the project implementation, knowledge and expertise should be transferred to engineers from PO-RALG, CML and especially staff from LoGITReC.

## 2.1 Objectives

With regard to the terms of reference, the assignment seeks to:

- Conduct a review of the existing trial sections located on the Bago to Talawanda road in the Bagamoyo District and on the Lawate to Kibongoto road in the Siha District in order to evaluate the nature and quality of information available from these road trials;

  In light of the outcome of the review, refine and implement the existing regional protocols for establishment and monitoring of road trial sections during implementation of monitoring surveys to ensure that the establishment of road trials and collection of the information is standardised;

- Conduct field surveys on the two selected demonstration/trial sections in order to collect performance data in accordance with the monitoring processes provided in the refined guidelines/protocols;

- Provide in-service training to build capacity within LoGITReC and other stakeholder institutions on practical implementation of the harmonised protocols/guidelines and maximizing the uptake and utilisation of the project outcomes.

# 3 Scope of work

## 3.1 Key tasks

The scope of work comprises three main tasks that are to be undertaken in order to achieve the overall aim of the project:

1. Review of existing trial sections;
2. Review and implementation of existing regional guidelines/protocols for establishing and monitoring trial sections;
3. Ongoing monitoring of trial sections.

## 3.2 Key activities to be carried out

This section describes the key activities through which milestones are to be achieved. The project team has completed activities relating to project planning and mobilisation, including some relating to Task 1. The description of the key activities to be carried out under the key tasks will include a summary of the outcome for those activities that have been completed.

### 3.2.1 Initiate project

The first meeting was held on 6 February 2017 at the CSIR Campus in Pretoria with the Team Leader's Delegate, Mr Nkululeko Leta, following the Expert Group Meeting on ReCAP's Back-Analysis project (AfCAP RAF2069A). Mr Nkululeko Leta provided the background information to the project and clarified the Client's project expectations, which included, potential contact key persons in Bagamoyo and Siha, importance of capacity building, the key expectation regarding the linkage of the database to be developed for this project, to the regional database being developed under the ReCAP's Back-Analysis project.

### 3.2.2 Identify project information sources

The Project Leader met with the District Engineer, Mr H Shauri and Engineer C Philip at Bagamoyo District offices on 13 February 2017 and Engineer P G Kawishe and Mr V Kimaro, a Road Technician on 17 February 2017 at the Siha District Council Offices. The meetings were facilitated by Engineer Dr. Fikiri Magafu, Assistant Director, PO-RALG at LoGITReC. Deliberations were held followed by site visits. During the course of the deliberations a number of issues were discussed including available documents regarding the trial sections in the respective districts. Available documents included, materials testing records, site meetings records, monitoring method report, contract documents for routine maintenance of the sections and failure investigation reports. A number of project reports were further identified on the basis of the information gathered during the course of the deliberations. A detailed review of the documentation is on-going.

Contact was established with Engineer John Malisa from CML/TANROADS in Dar es Salaam, who was one of the two research students that undertook part-time MSc research programmes at the University of Dar es Salaam on the AFCAP project in Bagamoyo and Siha. Eng. Malisa participated in all monitoring activities, and has therefore immense knowledge on the trial sections. The project team will consult him for information that might not be readily available at PO-RALG. All other individuals who have been involved in the two demonstration sites are to be identified.

### 3.2.3 Compile and synthesise information on current practice

The key aspect to consider during the information compilation phase is to establish relevant information on design, construction and the monitoring procedures adopted for the trial sections. Under this project, the pavement sections are represented by several combinations of surfacing: concrete paving blocks, concrete slab, flexible geotextile, concrete strips, double surface dressing, bituminous penetration macadam and gravel wearing course. The documentation on the methods used by the service provider that monitored the trial sections in Bagamoyo and Siha, has been acquired. The team has collected international guidelines on establishment and monitoring of experimental sections, including the draft Guideline for the Monitoring of Experimental and LTPP Sections in Mozambique, recently prepared under an AfCAP supported project[3], was made available by the Team Leader's Delegate, Mr Nkululeko Leta. The review of relevant guidelines is on-going. Verification of as-built data as well as collected performance data is to be undertaken to evaluate information consistency.

### 3.2.4 Visit demonstration sites

In addition to the review of relevant documentation on the trial sections, knowledge of the condition status of the trial sections is required. Fact-finding site visits were undertaken as part of the project mobilisation to better understand the project set up. The site visits, were also aimed at gathering necessary information for the purpose of planning the field information compilation process.

During the site visits, Engineer C Philip based at Bagamoyo District offices and Road Technician, Mr V Kimaro, based at Siha District Council Offices, were identified as the people with the longest institutional memory regarding demonstration sites in their respective districts. They were able to share essential information, for example, details on problems encountered during construction on some sections, which have impacted on the performance of the sections. Another example was about a section on the Lawate to Kibongoto road in the Siha District. The section post-mark indicates Lightly Reinforced Concrete Slab, but according to Mr Kimaro a portion of the section is unreinforced. Difference in performance is obvious. Having someone who is familiar with the project from the early stages is therefore invaluable.

There is a difference in the level of maintenance between the two demonstration sites. The state of road sections on the Lawate to Kibongoto road, show that they are being maintained, compared to the sections in Bagamoyo District, where there were more areas with deterioration. Typical forms of deterioration include, severely eroded engineered natural surface, eroded concrete strips, erosion between hand-packed stone with some stones completely dislodged, resulting in increased roughness that causes motorists to avoid the section. The sections in Bagamoyo have post marks giving the details of the type of surfacing and Chainage. Some illustration photos are presented in Appendix

[3] Long Term Pavement Performance Monitoring of Trial Sections in Mozambique incorporating Capacity Building of Road Research Centre Personnel. AfCAP Contract Project MOZ2093A

### 3.2.5 Identify how historic data is stored

An important aspect of the research component of the project is the analysis of the existing data and development of a database. The database is to be closely linked to the regional database, which is to combine data from different projects. All data elements should be properly examined to evaluate the historic data and further inform appropriate variables that should be captured. The purpose is to enhance the list of appropriate variables to be considered in the database schema and also to provide as much information as possible for uploading to the regional database.

An in-depth desktop study is to be carried out to review the available data. The collected reports on demonstration site selection, design and monitoring, currently under review, should provide additional required data. The reports by the consultants of the project (ie Roughton International) indicate availability of a CD Rom for monitoring activities. The project team is to get possession of the monitoring data during April 2017 in-country visit. The data collected during the last monitoring exercise of the trial sections, reportedly undertaken in 2015, has yet to be located.

### 3.2.6 Prepare training programme and implementation of capacity building

The matching of required level of knowledge and skills transfer is to be achieved by assessing the existing technical competency gaps with respect to the management of trial section monitoring, including materials testing and data & knowledge management. A skills/knowledge gap analysis of all LoGITReC and CML staff, including others from stakeholder institutions is necessary to ensure that they are well equipped with the right skills, knowledge and capabilities to meet the requirements for data capturing, as well as long-term pavement performance monitoring needs of the project.

At the inception phase, a preliminary assessment of capacity needs was conducted through engagement with the LoGITReC staff, which revealed that none of the staff has had the opportunity to work on a similar project and therefore they lack the knowledge and skills and can only play a limited role on the project without appropriate training. The project team was informed about the areas that required additional training, areas to prioritise, and how capacity building can be incorporated into LoGITReC current and future strategies. This is to be taken into account during the execution of the training programme

At the kick-off meeting, the project team and PO-RALG agreed on the following approach and scope for the training:

- Undertake in-class and on-site training for the local technicians and engineers from PO-RALG, CML and other institutional stakeholders, presented in section 6.
- Undertake project-specific training needs assessment of PO-RALG in post construction monitoring of trial sections.
- Prepare training materials necessary for monitoring trial sections
- Organise the training in Dar es Salaam to be attended by all stakeholders (PO-RALG, CML and others).

This project primarily deals with post-construction monitoring of selected trials sections. The main objective of post construction monitoring of trial sections is usually to record the actual in-service performance of the pavement over time. In addition, any changes in the environment that may have

had an influence on the in-service performance of the road are recorded. For this project, the long term performance of the trial sections will be evaluated in relation to the baseline data collected during the construction period, the research data (post-construction), and the project reports. It is expected that the long term monitoring activities of the trial sections involves the collection of the following three important data sets:

1. Monitoring of the structural performance (in service);
2. Monitoring of climatic conditions;
3. Monitoring of economic performance indicators.

One of the main activities undertaken by the project team is a review of available reports on the two demonstration sites on the Bago to Talawanda road and Lawate to Kibongoto road. Information gained from the reports indicates that during the construction of the two trial sections some training was provided to local technicians and engineers from PO-RALG and CML on the project. Part of the evaluation specifically focused on the ability of the technicians/engineers to accurately collect data on visuals, photo logs, surface profile measurement, rut depth measurement, surface roughness, DCP, traffic counts, concrete coring, etc. However, an overall assessment of the competence of these trainees in terms of data collection techniques indicated a lack of complete understanding of data analysis and management. This implies that further training is required for future monitoring of the experimental sites on low volume roads in Tanzania.

The proposed scope of training for this project therefore, focuses on monitoring and data analysis of pre- and post-construction structural performance, climatic conditions and economic performance indicators of the trial sections. The following is to be incorporated in the training programme in order to capacitate participants in aspects of long-term performance assessments of experimental/trial sections:

- Visual inspection of roads, identification of defects, methods of recording and taking photographs of defects;
- Measurement of pavement distress as recorded in the form of rutting, cracking, ravelling, bleeding, potholes etc. This should include methods and equipment required for taking rut depth measurements, the types of surface that the measurements are taken on, how changes in rut depth over time can be monitored and what are the possible causes of increases in average rut depths;
- Purpose of surface profile measurements, methods of carrying out surface profile measurements, advantages/disadvantages of each profile method, the intervals at which measurements are taken, etc.;
- Methods of traffic counting, the importance of including different days in the week in order to capture weekly variations and the importance of assessing changes in traffic over time;
- Equipment used to measure surface roughness, at which point on the road should the measurements be taken, and how the International Roughness Index (IRI), is calculated from the data that is collected;
- Purpose of taking asphalt and concrete cores, the methods of taking cores and the laboratory tests to be undertaken following extraction of the cores;
- Measurements/monitoring of temperature and rainfall data;

- Measurement and evaluation of pavement deflection parameters.

Thus the training is to be provided to capacitate researchers, engineers and technicians on specific elements to address competency gaps, including data collection and extracting of relevant information as input to performance analysis they will be conducting.

The methodology to be implemented for achieving the objectives and outcomes of the task on capacity building is based on an integrated and hands-on approach to ensure effectiveness of the capability development, including a combination of workshops and mentoring. Project implementation requirements are that PO-RALG will provide resources for training, while the project team will provide the training services. The scope of training programme is provided in Table 1 below, revised from that presented in the project proposal, following discussions during the project inception meeting.

As shown in Table 1, the training programme follows a block-release format, thus the presentation of the modules is to be spread over the project execution period. Problem-based learning (PBL) approach is to be implemented, in that knowledge and skills transfer is to take place through the project activities.

PBL is to be used as an instructional method using activities related to trial section establishment and monitoring as a context for learning skills and in addition acquire necessary knowledge related to low volume access roads. This is to involve associated mentoring of some of the personnel on the project. The researchers and technicians are to spend specific periods of time with the key project experts on site. The timing of the training programme, including workshops/seminars to be conducted is subject to approval by LoGITReC to ensure that it fits well with LoGITReC's capacity building needs and implementation plans. The implementation schedule in Table 1 is therefore indicative and is to be finalised in April 2017. The dates are to be confirmed by LoGITReC.

A training evaluation sheet is to be developed which will be completed by the participants to serve as a record of knowledge transfer and capacity building and for monitoring and evaluation purposes by AfCAP.

Table 1: Training programme

| Session | TRAINING BLOCK | | | |
|---|---|---|---|---|
| | **August 2017** | **November 2017** | **January 2018** | **March 2018** |
| **1** | **Module1:**<br>Experimental Design/Experiential Matrix<br>***Main objective*:**<br>To understand how the experimental plan is developed for design, construction and monitoring of trial sections. | **Module 5:**<br>Monitoring and Research after the Construction Phase<br>***Main objective:***<br>To understand post-construction monitoring processes, and materials properties to be determined at this phase. | **Module 9:**<br>Drainage of the road surface, pavement layers<br>***Main objective:***<br>To know the effect of different types of drainage structures on the performance of the road. | **Module 13:**<br>Materials sampling, field and laboratory measurements<br>***Main objective:***<br>To develop skills in sampling and evaluation of construction materials for low volume roads. |
| | | | | |
| **2** | **Module 2:**<br>Setting up test sections – control section<br>***Main objective:***<br>To understand the differences between trial and test sections in terms of the setting up criteria and expected data from these sections | **Module 6:**<br>Monitoring of Economic Performance Indicators<br>***Main objective:***<br>To understand impact of traffic volume and axle loads on in-service performance of trial sections. | **Module 10:**<br>Analysis of the Physical Performance of Road Sections<br>***Main objective*:**<br>To know how the monitoring data are collected, interpreted and analysed during baseline studies and post construction studies. | **Module 14:**<br>Data collection and management & Linkage to pavement design<br>***Main objective:***<br>To develop skill in procedures for data collection and management as well as link of material properties to pavement design. |
| | | | | |
| **3** | **Module 3:**<br>Background to Research Planning and Reporting<br>***Main objective*:**<br>To understand the various research objectives, activities and stages that are expected to be undertaken during construction and monitoring stages as well as reporting results of the monitoring | **Module 7:**<br>**Monitoring of climatic conditions**<br>***Main objective:***<br>To understand how rainfall and temperature are monitored over time and related to the performance of trial sections. | **Module 11:**<br>Evaluation of Appropriate Construction Methods<br>***Main objective:***<br>To know the various construction techniques used for monitoring and their associated costs. | **Module 15:**<br>Individual presentation<br>***Main objective:***<br>To encourage full participation, and also to enhance participant's skill in presentation**.** |
| | | | | |
| **4** | **Module 4:**<br>Monitoring and Research During the Construction Phase<br>***Main objective:***<br>To understand how baseline data is collected during and immediately after construction characteristics and materials properties to be determined for experimental sections. | **Module 8:**<br>Monitoring of In-Service Pavement Performance<br>***Main objective*:**<br>To know how performance parameters such as rutting, cracking, etc. are measured during the assessment period**.** | **Module 12:**<br>Economic Analysis (life-cycle cost analysis)<br>***Main objective*:**<br>To compare the life-cycle costs of the various pavement options based on records of the construction and maintenance costs. | **Module 16:**<br>Feedback<br>***Main objective:***<br>To assist the project team in assessing the training programme in terms of the overall presentation, training materials and whether or not it was beneficial to participants and PO-RALG. |
| | Evaluation | Evaluation | Evaluation | Evaluation |

### 3.2.7 Review existing guidelines for establishment and monitoring trial sections

The project team is conducting a review of technical reports and accessible guidelines from both international and regional sources to assess adequacy and extent of existing information on the establishment and monitoring of trial sections. The review should provide background information about the state of the practice and recent developments that have taken place in the establishment and monitoring of trial sections. This activity was carried out with information from LoGITREC and CML on the construction of the trial sections. The information was particularly important because it gave the project team some insight into what had transpired during construction of the two trial sections.

During the course of discussions, at the meeting of Group of Experts on ReCAP's project: *Development of Guidelines and Specifications for Low Volume Sealed Roads through Back Analysis,* held on 6 February 2017 at the CSIR, it was agreed that the draft Guideline for the Monitoring of Experimental and LTPP Sections in Mozambique, prepared under AfCAP Contract Project MOZ2093A should be the basis of the revised guideline. This document is therefore providing the team the necessary perspective in the process of identifying the gaps for the preparation of a harmonised guideline. It is possible that some of the outcomes of this project can be incorporated in the current guidelines to accommodate Tanzania conditions.

The review of relevant guidelines is on-going, with emphasis on the principles and criteria for establishing and monitoring trial sections obtained from the different sub-Saharan African countries (i.e. Ethiopia, Malawi, Mozambique, etc.) as well as other overseas countries (Australia and the United States). In-depth discussions with all individuals who were involved with the construction and monitoring of the trial sections forms part of the review process to ensure that a true reflection of experiences on all aspects of establishing and monitoring trial sections are taken into account.

### 3.2.8 Evaluate data collection methods

Collected data is to form the basis for the review of the guideline and it is essential that the collected data are accurate, consistent and appropriate. The information contained in the reports should be validated in order to generate evidence-based recommendations for data collection methods to be incorporated in the guideline.

The methods of monitoring the demonstration sites are as follows:

- Visual inspection;
- Photographic logging;
- Surface profile measurement between beacons;
- Surface rut measurement using a standard straight edge;
- Surface roughness using a MERLIN apparatus;
- Surface texture measurement using sand patch testing;
- Dynamic Cone Penetrometer (DCP) testing;
- Classified traffic counts;
- GPS Monitoring;

To ensure that data collection is referenced to the same point during the monitoring phases, beacons were installed at regular intervals along the different pavement options to provide a fixed location for each of the data collection methods. Project reports show that the data collection frequency was at 6 month intervals, with the exception of DCP testing and GPS monitoring, which are at yearly interval.

The monitoring is to continue for a period of ten years following construction completion date. According to the original contract with AfCAP, the consultant, Roughton International, was to monitor the sections for one year following construction completion, which was until April 2013. However, an additional year of monitoring was carried out by the consultant, as an extension to the original contract. This means that, a further eight years of monitoring and data collection is the responsibility of the District Engineer and staff under the direction of LoGITReC. PO-RALG and TANROADS-CML, with the involvement of District engineers, have carried out one additional monitoring visit to both demonstration sites. However, the latest set of performance data has not yet been analysed. The data is yet to be made available to the project team.

### 3.2.9 Establish knowledge database of existing trial sections

The difficulties being experienced to locate the data for the last monitoring phase, is evidence of the need to establish a centrally accessible research orientated database for LoGITReC, that is populated with relevant secondary data of trial sections as well as the design and as-built data that was generated. The recorded data from the existing trial sections are to be stored into a formal database. The centralized knowledge database should be for capturing, storage and dissemination of findings and knowledge of research undertakings. It will be a tool for assessing the quality, utilisation and performance of non-conventional materials used in trial sections, leading to improvements to standards and specifications as well as road construction techniques

As pointed out earlier, the database is to closely be linked to the reginal database under AfCAP's regional project: *Development of Guidelines and Specifications for Low Volume Sealed Roads through Back Analysis*. During the Group of Expert meeting, held on 6 February 2017 at the CSIR Campus in Pretoria, the proposed regional database was demonstrated to the project team. It became clear that a better understanding of the perceived uses/value of the database and terminology used will be required. Any future activities in terms of data collection on projects will be influenced by changes to the proposed database.

Linked to but not dependent on the final database is the research data management. This includes the way that the data is captured, stored and managed. In order to establish a feasible procedure the following are planned:

- Obtaining and analysing copies of existing procedures as foundation for any suggested procedures.
- Developing an understanding of the following based on questionnaires:
    - Understanding of existing/current equipment used, especially regarding the format(s) in which the data is generated, used and stored.
    - Understanding of known challenges and issues influencing adherence to existing procedures.

  - Understanding of the file sizes that are generated in terms of storage needs.
  - Determining of access requirements in relation to roles and responsibilities.
  - Compatibility between systems must be determined.
  - Determining the need and feasibility for the migration of proprietary data formats to open standard formats to ensure long term preservation needs.
  - Understanding of the existing ICT infrastructure and planned improvements and relevant phases both within President's Office-Regional Administration and Local Government (PO-RALG), relevant laboratories, e.g. LoGITReC, and Tanzania as such.
  - The establishment of a procedure to link calibration records of equipment with relevant project data as part of the validation of results.
  - Establishment of procedures in terms of skill development in the use of specific equipment and specialised tools in order to proof qualified/skilled usage of equipment.
- Harvesting of data and the development of an integrated system with limited human intervention will be investigated and to increase productivity.
- The development of a 'check-list' approach will be used to verify that all relevant information has been submitted in terms of a project file.

The use of cloud storage as an alternative to self-hosted storage will be investigated and a decision based on existing legislation and policies will be submitted. On-site uploading of data to the proposed database will be a major consideration in all planned activities. However, this is dependent on an adequate ICT infrastructure, to be assessed during the April 2017 in-country visit.

As part of the change management process, implementation of systems and procedures will follow hands-on, in-depth and timely training sessions based on customised training materials.

### 3.2.10 Monitor existing trial sections and identify new trial sections

The transfer of knowledge and expertise to local staff, especially at LoGITReC, is key to this project. The technical assistance is aimed at addressing the need for adequate staff with the capability to monitor the trial sections and analyse the collected data at regular intervals. Experiences recorded in the reports point to the need for dedicated staff for the long term monitoring of demonstration sections.

The current proposal is that three local researchers, who are individuals fully employed by LoGITReC and CML will undertake the work, supported by at least two technicians. The combination of which is to be ascertained. While a capacity building programme can be implemented, the level of operationalization of LoGITReC as a newly established research entity is crucial and should be taken into account to provide direction on the level of staff that will be dedicated for monitoring of demonstration sites. Under this scenario, District Engineer's staff is to play a complimentary role but their availability is also critical. The current staff composition for LoGITReC is shown in Table 2. From the table, there are three people designated as researchers, including the Assistant Director. This means that LoGITReC is in a position to effectively provide two researchers. However, one of the two researchers, Engineer Lwanda is the Laboratory Manager, which may affect his availability for the monitoring work. While TANROADS-CML will provide additional expertise, it is still apparent that LoGITReC will require at least an additional researcher.

The equipment currently being used to monitor the condition of the existing trial sections is deemed adequate and for consistency is to be used for future monitoring. While the limitation of the manually operated MERLIN, as pointed out in the draft Guideline for the Monitoring of Experimental and LTPP Sections in Mozambique, is that it may not identify longer wave-length deformation such as low frequency corrugations, undulations, its use is to continue as the type of equipment used, has an influence on the type of data collected and therefore type of parameters recorded.

**Table 2: LoGITReC staff composition as at 1 March 2017**

| No. | Name | Gender | Qualification | Job Title | Designation (Researcher/ Technician) | Years of experience |
|---|---|---|---|---|---|---|
| 1 | Eng. Dr. Fikiri Magafu | Male | PhD | ADPR | Researcher | 17 |
| 2 | Vincent Lwanda | Male | BSc | Laboratory Manager | Researcher | 18 |
| 3 | Jacob Manguye | Male | Certificate | Principal Technician | Technician | 37 |
| 4 | Asante Kamba | Female | Full Technician Certificate | Senior Technician | Technician | 14 |
| 5 | Peter Mkumbo | Male | Full Technician Certificate | Senior Technician | Technician | 9 |
| 6 | Geofrey Mbunda | Male | Diploma | Senior Technician | Technician | 8 |
| 7 | Nassoro S. Juma | Male | Diploma | Technician II | Technician | 3 |
| 8 | Charles Athman | Male | Certificate | - | Driver | 9 |
| 9 | Francis Lukindo | Male | Certificate | - | Driver | 20 |
| 10 | Joseline Kagombora | Female | BSc | Engineer II | Research | 3 |

During the two monitoring rounds, planned for under this project, the level of competence of the newly trained researchers and the technicians will be assessed. The LoGITReC research team and others from stakeholder institutions are to accompany the project team on its visits to the two sites during each round of monitoring and will be required to write individual reports in order to develop skills for reporting results of the monitoring based on the revised regional guideline.

Through the process of establishing new long-term pavement performance trial sections the opportunity is to be provided for the LoGITReC researchers and technicians to gain knowledge, experience and understanding on how to carry out the monitoring surveys and evaluation in

accordance with the revised guideline. This is to include development of proposed implementation methodology, including drafting of programme for field surveys, design and construction.

As part of establishing new trial sections, construction and maintenance costs should be compiled to facilitate computation of life-cycle costs for the sections, in order to compare with conventional low volume roads. Workshops are to be held for the purpose of knowledge sharing/dissemination, additional training and final project evaluation.

### 3.2.11 Disseminate information

An important key element of this project is knowledge transfer. As such a presentation of the findings and recommendations to Roads Research Steering Committee is scheduled as part of the project execution. The lessons learned from this project should be properly communicated to other stakeholder institutions. Uptake of research results is usually constrained by political, institutional, technical and financial factors. The inclusion of other stakeholder institutions is deemed an effective way to achieve greater uptake of the output of this project. Stakeholder institutions have been identified.

A further strategy is the introduction of PBL at one of the academic institutions as a modality for enhancing research results utilisation. The ultimate goal is to create a learning environment at institutions designed to ensure knowledge sharing on road research results, broaden road research communication and dissemination, promote uptake of appropriate solutions for local road infrastructure and enhance creation of new research ideas and thus build more research capacity.

Other means of dissemination will include publication of an article in high quality technical journal, linkage with the ReCAP website/portal and presentations at specific conferences on low-volume roads regionally or other international conferences (e.g. Transportation Research Board Annual Meetings). The articles are to be prepared by the local researchers under supervision of the project team.

# 4 Work plan, programme and deliverables

## 4.1 Work plan

No major changes to the work plan are anticipated. Revisions in activities will be made as and when it is necessary. Any such revisions will be discussed and agreed with the AfCAP PMU and the PO-RALG. The project milestone and their target dates are shown below:

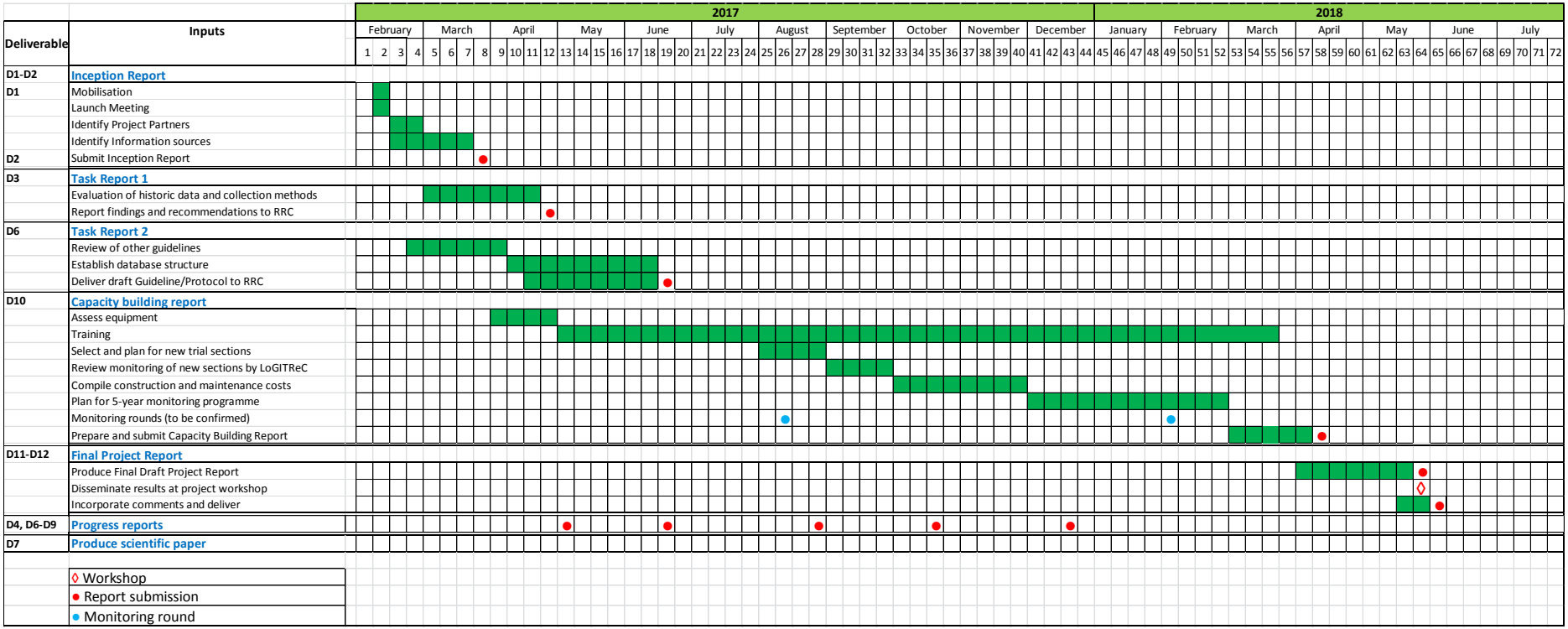
**Table 3: Project Milestones and Targets**

| No | Milestone Deliverable | Content | Due Date |
|---|---|---|---|
| 1 | Mobilisation | Report to cover team mobilisation, start-up meeting held with PMU | 24 February 2017 |
| 2 | Inception Report | Report to cover the preparatory activities; detailed methodology and programme for conducting the assignment including proposed time inputs for the experts; brief descriptions of trial sections to be assessed. | 27 March 2017 |
| 3 | Task 1 Report | Findings and recommendations for presentation to Roads Research Steering Committee. | 24 April 2017 |
| 4 | Technical progress report 1 | Brief report, including historic data storage | 15 May 2017 |
| 5 | Task 2 Report | Review report, including draft guidelines / | 19 June 2017 |

| | | | |
|---|---|---|---|
| | | protocols | |
| 6 | Technical progress report 2 | Brief report, including training programme preparation | 30 June 2017 |
| 7 | Technical progress report 3 | Brief report, including training Block 1 | 21 August 2017 |
| 8 | Technical progress report 4 | Brief report, including training Block 2 | 13 October 2017 |
| 9 | Technical Progress report 5 | Brief report, including training Block 3 and 4 . | 11 December 2017 |
| 10 | Capacity Building and Skills Development Report | This report will provide detailed information on the training of RRC personnel and an assessment of competence/capacity levels of each researcher in specific areas and aspects requiring further training. This report will be submitted at the end of the assignment. | 16 April 2018 |
| 11 | Draft Final Report | Includes study findings and recommendations for presentation at final dissemination workshop | 21 May 2018 |
| 12 | Final Report and at least 1 technical paper | The final report, incorporating valid stakeholder comments emanating from workshop. The technical paper(s) will be submitted at the end of the assignment. | 28 May 2018 |

## 4.2 Programme

The following is the revised programme



### 4.3 Project kick-off meeting

The project kick-off meeting was held on 15 February 2017 in Dodoma at PO-RALG offices. The meeting was chaired by Engineer Dr. Magafu, Assistant Director, PO-RALG at LoGITReC. The consultant then made the presentation as outlined below.

#### 4.3.1 Presentation

The presentation covered the following:

- Introduction of the service provider project team;
- Explanation of the role of each on the project;
- Presentation and explanation of the important project milestones in the work plan, presentation of the programme;
- Explanation of the important project responsibilities of the service provider and the project partner.

The presentation is contained in the Project Mobilisation report. The list of attendees is provided in Appendix A.

Following the presentation, discussions focused on clarification of the training and expected project outcomes. The list of partner institutions was confirmed and Engineer Dr. Magafu will seek confirmation of participation in the project from each institution. Key highlights of discussions during the meeting are included in the project mobilisation report (project milestone deliverable) that was submitted to AfCAP on 24 February 2017.

### 4.4 Visit to LoGITReC Central Materials Research Laboratory (LoGITReC-CMRL)

A visit was made to newly established LoGITReC-CMRL, for the project team to familiarise itself with available infrastructure and equipment. The laboratory will play a critical role on the project, in terms of data collection and materials testing.

Currently, LoGITReC-CMRL does not have a laboratory inventory management system (LIMS) in place. However, through another AfCAP supported project (TAN2095A), they will be acquiring one, and it is expected to be installed by end of April 2017. The database to be developed under the current project will add value to the institutional development in data management.

## 5 List of documents to be reviewed

The following documents have so far been compiled for review:

- **A Guideline for the establishment and monitoring of sections on the road network to measure Long Term Pavement Performance (LTPP).** Development of Pavement Design Standards for Low Volume Roads in Ethiopia. CPR1851 Contract Reference: AFCAP/ETH/005/A. A. Otto &P.A.K. Greening and A.A. Endale, TRL , July 2014;

- **Bagamoyo Final Monitoring Report.** Design, construction and monitoring of demonstration sites for district road improvement in Tanzania. Prime Minister's Office – Regional Administration and Local Government (PMO-RALG) under the African Community Access Programme (AFCAP/TAN/008). June 2013. Roughton International;

- **Comparison of the US and Australian Long Term Pavement Performance (LTPP) Data on Asphalt Pavements**. February 2009. Austroads Project No. AT1064. Austroads Publication No. AP–T128/09;

- **Design Report**: Research Consultant to Support the Design, Construction and Monitoring of Demonstration Sites for District Road Improvements in Tanzania Prime Minister's Office - Regional Administration and Local Government (PMO -RALG). (1) Lawate - Kibongoto - Siha District - Kilimanjaro Region (2) Bago - Talawanda- Bagamoyo District - Pwani Region. Project Reference: AFCAP/TAN/008. November 2010. Roughton International;

- **Guideline for the Monitoring of Experimental and LTPP Sections in Mozambique**. (First Draft) Project Reference: MOZ2093A. January 2016. P. Paige-Green:

- **Inception Report - Site Selection:** Research Consultant to Support the Design, Construction and Monitoring of Demonstration Sites for District Road Improvements in Tanzania Prime Minister's Office - Regional Administration and Local Government (PMO -RALG) Project Reference: AFCAP/TAN/008. November 2009. Roughton International;

- **Long-Term Pavement Performance Inventory Data Collection Guide**. Publication No.: FHWA-HRT-06-066. March 2006;

- **Low Volume Rural Road Surfacing and Pavements:** A Guide to Good Practice. J R Cook, R C Petts and J Rolt. OTB Engineering UK LLP. June 2013;

- **Siha Final Monitoring Report.** Design**,** construction and monitoring of demonstration sites for district road improvement in Tanzania. Prime Minister's Office – Regional Administration and Local Government (PMO-RALG) under the African Community Access Programme (AFCAP/TAN/008). June 2013. Roughton International.

Contract documents will form part of the documents to be reviewed to establish typical costs, including costs for maintenance.

# 6 Relevant institutional partners

A number of key partners will be involved in the implementation of the project. The following were confirmed and will be invited to confirm their availability:

- Tanzania National Roads Agency (TANROADS);
- Tanzania Central Materials Laboratory (CML);
- Dar es Salaam Institute of Technology;
- Mbeya University of Science and Technology;
- National Road Fund Board;
- Private sector (engineering consultants and contractors);
- University of Dar es Salaam.

# 7 Key recommendations for way forward

In summary, the following are the key issues and recommendations that require to be addressed in order to maintain progress towards achieving the objectives of the project:

## 7.1 Need to centralise data

Currently, LoGITReC-CMRL does not have a database but will be developed under the current project. However, for the initial analysis to take place effectively data should be centralised.

**Recommendation:** LoGITReC to ensure that all historic data from the monitoring of the trial sections is collected and establish centralised storage.

## 7.2 Need to enhance staff component at LoGITReC

The current proposal for the implementation of the project, is that three local researchers, who are individuals fully employed by LoGITReC and CML will undertake the work, supported by at least two technicians. The current staff component of LoGITReC shows that there is a need to recruit additional research staff.

**Recommendation**: LoGITReC should initiate steps to recruit at least a researcher to enhance the staff component to effectively contribute on this project, particularly if more trial sections are to be established.

## 7.3 Need to acquire equipment

The equipment currently being used to monitor the condition of the existing trial sections is deemed adequate and for consistency is to be used for future monitoring of the existing trial sections. However, LoGITReC-CMRL does not currently have most of the equipment. DCP sets are available.

**Recommendation**: LoGITReC should initiate steps to acquire the equipment for measurement during monitoring of the trial sections. Potential constraint is acknowledged as there is a cost implication.

# APPENDIX A: Kick-off Meeting Attendees

| Name | Position | Organisation |
|---|---|---|
| Dr F Magafu | ADPR | PO-RALG, LoGITReC |
| Eng. R Mogeike | Engineer | PO-RALG, LoGITReC |
| Rocky Malegela | Librarian | PO-RALG, LoGITReC |
| Nasson S Juma | Lab Technician | PO-RALG, LoGITReC |
| Jacob Manguye | Lab Technician | PO-RALG, LoGITReC |
| Ahsante Kamba | Lab Technician | PO-RALG, LoGITReC |
| Geofrey Mbunda | Lab Technician | PO-RALG, LoGITReC |
| Peter Mkumbo | Lab Technician | PO-RALG, LoGITReC |
| Ally Jumanne | Civil Engineer | PO-RALG, LoGITReC |
| Isihaka A Sudi | Architect | PO-RALG, LoGITReC |
| Justin Lyatuu | Economist | PO-RALG, LoGITReC |
| Dr M B Mgangira | Consultant (Team Leader) | CSIR |
| Dr J Anochie-Boateng | Consultant (Materials Expert) | CSIR |
| Adele Van der Merwe | Consultant (Data Management Specialist) | CSIR |

# APPENDIX B: Illustrative trial section condition

**BAGO TO TALAWANDA ROAD**

The Photo A1 shows the slurry seal section. The left side is a Lime slurry seal and the right hand side is a Cement slurry seal. The section performance is evidently poor with the side with the lime slurry performing significantly worse than the cement.


**Photo A1: Slurry seal section performance**

Photo A2, shows a concrete strip section. The general observation is that the concrete strips are performing very well, but moderate to severe side erosion between the gravel shoulder and the concrete strips was noted on several spots along section, evidence of poor maintenance.

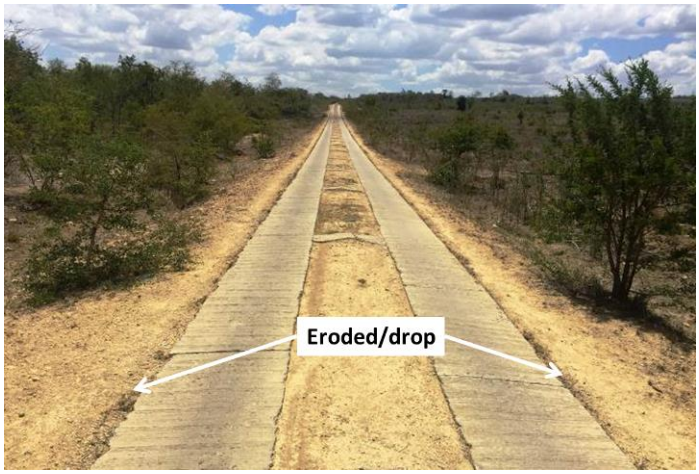



**Photo A2: Concrete strip section**

Photo 3 shows the hand-packed stone section. The performance of the section is very poor. The section is impassable. Traffic is avoiding using the section as it is very rough, with some of the stones

loose and completely dislodged. Engineer Philip pointed out that section gets flooded during the rainy season.

**Photo 3: Hand-packed stone section**

Photo A4 shows the engineered gravel section, which has deteriorated with severe and extensive erosion tracks. The condition of the section is evidence of lack of proper maintenance programme.

**Photo A4: Severely eroded engineered natural gravel**

**LAWATE TO KIBONGOTO ROAD**

Photo A5, shows the project sign board displaying details of project description and project Principals. In contrast, there was no project sign board on the Bago to Talawanda road.


**Photo A5: Project sign board**

Photo A6 shows the Gravel Wearing Course section, with a sign board at the beginning of the section displaying details of the type of surfacing and the length of the section. The drain showed presence of light sedimentation, but the section is generally in good condition, evidence that a maintenance programme has recently been implemented.


**Photo A6: Gravel Wearing Course section**

Photo A7, shows the paved block section. The section is performing very well and no major defects were observed. Shown is also typical traffic.


**Photo A7: Paved block section**

Photo A8 shows Unreinforced Concrete Slab (75 mm) section. Defects have been observed in the form of cracks, both longitudinal and transverse cracks as shown in the photo. Note vegetation growth in the crack. The cracking was noted as early as 2013 and an investigation was conducted. The cracks were attributed to shrinkage as traffic was deemed too low to cause structural cracking.

Photo A8: Defects on Unreinforced Concrete Slab section