



**AfCAP**  
Africa Community Access Partnership



## Long Term Pavement Performance Monitoring of Trial Sections in Mozambique incorporating Capacity Building of Road Research Centre Personnel

Site Visit Report: 2<sup>nd</sup> to 12<sup>th</sup> May 2017



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Cover Image:      Scenes from the site work

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## ReCAP Completion Report Template

ReCAP Database Details: Economic Growth through Effective Road Asset Management			
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Visual Road Condition Surveys, Visual Assessment Index

## **Acronyms, Units and Currencies**

\$	United States Dollars
AFCAP	Africa Community Access Partnership
ANE	Administração Nacional de Estradas; National Road Administration
ASCAP	Asia Community Access Partnership
CDS	Civil Design Solutions
CSIR	Council for Scientific and Industrial Research
DFID	Department for Further International Development
EU	European Union
FWD	Falling Weight Deflectometer
GPS	Global Positioning System
LEM	Engineering Laboratory for Mozambique
LVR	Low Volume Road
PMU	Project Management Unit
RAI	Rural Access Index
ReCAP	Research for Community Access Partnership
UK	United Kingdom (of Great Britain and Northern Ireland)
UKAid	United Kingdom Aid (Department for International Development, UK)
VAI	Visual Assessment Index
VRCS	Visual Road Condition Survey

## **Contents**

<b>Acronyms, Units and Currencies</b> .....	<b>iii</b>
<b>Contents</b> .....	<b>iv</b>
<b>1 Introduction</b> .....	<b>1</b>
1.1 Background to the Project	1
1.2 Objectives	1
<b>2 Site Visit Activities</b> .....	<b>3</b>
2.1 Purpose of the Visit	3
2.2 Location of LTPP, Trial Experimental and Control Sections	3
2.3 Team Composition	5
2.4 Tuesday, 2 <sup>nd</sup> May 2017	5
2.5 Wednesday, 3 <sup>th</sup> May, 2017	6
2.6 Thursday, 4 <sup>th</sup> May, 2017	7
2.7 Friday, 5 <sup>th</sup> May, 2017	7
2.8 Saturday, 6 <sup>th</sup> May 2017	8
2.9 Monday, 8 <sup>th</sup> May 2017	9
2.10 Tuesday, 9 <sup>th</sup> May 2017	10
2.11 Wednesday, 10 <sup>th</sup> May 2017	12
2.12 Thursday, 11 <sup>th</sup> May 2017	13
<b>3 General Comments and Conclusions</b> .....	<b>15</b>
3.1 Next Steps for Research Activities	15
3.2 Capacity Development in the RRC	15
<b>Annex A. List of Participants at the Meetings in Maputo</b> .....	<b>17</b>
<b>Annex B. Database user interface mock-ups</b> .....	<b>18</b>

## **1 Introduction**

### **1.1 Background to the Project**

The Africa Community Access Partnership (AfCAP) is building on the programme of high quality research established under AfCAP phase 1 and taking this forward to a sustainable future. The aim is to ensure that the results of the research are adopted in practice and influence future policy in the roads sector.

As part of this initiative AfCAP is assisting the Mozambique National Roads Administration (ANE) to evaluate existing road experimental sections constructed previously in Mozambique under several programmes, including with AfCAP support. These trial sections were designed to demonstrate and verify different options in design, material utilisation and construction methods for rural roads (particularly low-volume rural roads- LVR).

Useful data have already been obtained from both old and newer trial sections and some have been monitored over time by ANE and with the support of AfCAP and TRL (UK). In order to achieve the objective of influencing future policy in the road sector, it is necessary to review the outcomes of all trial sections constructed in Mozambique and to start a process of establishing new trial sections.

As-built information and performance data are available from previous project reports but may not be consistent between the projects and over the monitoring periods. Also, the establishment of the trial sections was not always geared towards providing all of the data that will enable researchers to assess the performance of the pavements. The data needs to be consistent with regional protocols for establishing and monitoring trial sections, which are being developed with AfCAP support under a separate regional research project known as “Back-Analysis of Experimental Roads in Southern Africa” (RAF2069A).

### **1.2 Objectives**

The objectives of the project are as follows:

1. To evaluate the nature and quality of information available from the existing trial sections.
2. To refine and implement existing regional guidelines and protocols to ensure that the establishment of road trials and collection of the information is standardised across Mozambique and the African region.
3. To establish new trial sections, and to collect data on the old and new trial sections in Mozambique on a consistent and continuous basis over a number of years.

The project is also providing training and capacity building to the ANE Road Research Centre (RRC) for the development of an Electronic Data Management System (EDMS) to manage data generated from the trial sections and other research projects. Capacity building and training

of the RRC personnel will include data input, processing and archiving of research data, including implementation of the regional protocols.

## 2 Site Visit Activities

### 2.1 Purpose of the Visit

This report describes in brief the activities that were undertaken by the ANE research team and CDS in Maputo and at the site of the LTPP and Trial Sections in Maxixe, Inhambane Province in the period 2<sup>nd</sup> May to 12<sup>th</sup> May 2017. The purpose of the visit included the following:

1. Meeting the Research Centre staff at ANE to update on the progress of the LTPP research activities and present the draft Electronic Data Management System (EDMS)
2. Complete data collection started in February 2017 at the established LTPP and Trial Experimental sections in Inhambane Province

### 2.2 Location of LTPP, Trial Experimental and Control Sections

The location of the research sections is as shown in Figures 2.1, 2.2 and 2.3 below:



Figure 2.1: Location of LTPP and Experimental Sections in Inhambane Province



Figure 2.2: Trial Experimental Sections 1 (for Dabo) and 2 (for Cedrik) and Gravel Control Section (for Paulo) on Cumbane-Chacane Road

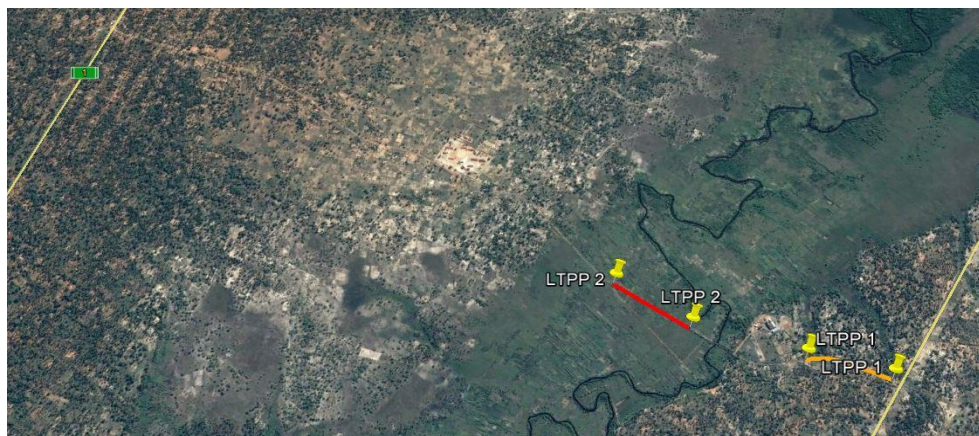


Figure 2.3: LTPP Experimental Section 1 (for Carlos) and 2 (for Dzimba) on Agostinho Neto Road

The pavement structure and surfacing on the Experimental Sections is as follows:

- Section 1: Sand seal on an armoured red sand base.
- Section 2: Penetration macadam on a red sand base.

The “Control Section” is a gravel road.

The pavement structure on the Agostinho Neto Road includes:

- Sub base: Red sand
- Base: Blended red sand and calcrete (50/50)
- Surfacing: Otto seal + Sand seal + Slurry seal<sup>1</sup>

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<sup>1</sup> The slurry seal was laid after premature failure of the original Otta Seal/Sand Seal.

### **2.3 Team Composition**

Mr Fernando Dabo, Road Research Centre, ANE  
Mr Carlos Cumbane, Engineering Laboratory of Mozambique (LEM)  
Mr Moises Dzimba, Delegation Representative, Gaza Province, ANE  
Mr Cedric Nambureta, Delegation Representative, Inhambane Province, ANE  
Mr Paulo Guicuane, Materials Technician, Maxixe, ANE  
Mr Adilson Vilinga, Assistant Team Leader

### **2.4 Tuesday, 2<sup>nd</sup> May 2017**

The CDS team met in Maputo with ANE/LEM representatives including the Director of DIMAN. The list of participants that attended the meeting is included in Appendix 1.

The purpose of the meeting was to update the Director on the project research activities, demonstrate the Electronic Data Management System (EDMS) being developed under the project, and to plan the site visit activities in Inhambane.

The main points of discussion were:

1. The database was presented to those present including a live run. Key features of the database are:
  - Currently the database is hosted by the CDS Database Expert. ANE may continue with this arrangement after the end of the project (recommended as support software is continuously upgraded and backups are made daily) or may wish to administer it themselves (not recommended). There will be a fee payable by ANE if the future hosting of the database is outsourced.
  - The database is a web-based application and valid ANE users will have full access through a web browser from any location.
  - Users of the database may have different levels of access; e.g. administrator, researcher, etc.
  - At the outset of the data entry, a road and road section are defined.
  - Under a road section (either for LTPP or Trial Experimental) research data is entered and stored for a particular date or data collection event.
  - Data can be accessed and edited when needed.
  - The research team was encouraged to use the database and provide feedback on issues that still needed to be refined to improve its operation.
  - CDS will conduct a training course in ANE on the use of the database once it is close to a final version.
  - Eng Fernando Dabo is the person in ANE responsible for management of the database.
  - (Mock-ups showing the structure of the database are included in Annex 2).

2. The purpose and logistical aspects of the mission to Maxixe were discussed. It was reported that during the previous mission in February 2017, it was not possible to complete the data collection on all sections due to time constraints as there was unfavourable weather (the cyclone and many rainy days). It was for example learnt that most of the data collection on the gravel control section was not undertaken after the team had left site. It was also agreed that some additions to the final version of the Monitoring Protocol necessitated remarking of the test sections. The remarking will require collection of a new set of some of the data.
3. The Team Leader emphasized the need for the research participants to be more engaged in the research work being undertaken so that they can move it forward on their own when the current project comes to an end. They need to clearly define their research objectives. The review of the researchers' reports from the last mission found many inconsistencies as they did not clearly define the objectives and some of the reports contained little analysis.
4. It was reported that the Protocol is being translated into Portuguese and is expected to be ready in three weeks<sup>2</sup>. Participants felt that their input into the research will improve once the Protocol is translated.
5. The researcher team needs to identify and prepare a research paper to be published from the work carried out on the project. Research topics may include the development of the Protocol and the EDMS. Other topics may include the data the researchers have so far collected, but it was noted that there is unlikely to be significant analysis for a technical research paper by the end of 2017.
6. It was reiterated that the AfCAP funds for the project do not include provision for the purchase of testing equipment. ANE is to arrange procurement of equipment required in the research projects. For example, there is a need for a Light Weight Deflectometer (LWD) for deflection measurements. Funds are available to ANE from the World Bank for the procurement of equipment.
7. The AfCAP funding includes a provisional sum of GBP 13,000 for "External Training". Suggestions for the use of these funds included a study visit to CSIR, Tanzania and/or Ethiopia. It was also suggested that participants could participate in a SARF<sup>3</sup> training course on Low Volume Roads scheduled for July 2017. CDS agreed to obtain further information. ANE will provide further feedback on the kind of training envisaged for participants with the resources available.

## **2.5 Wednesday, 3<sup>th</sup> May, 2017**

The CDS Assistant Team Leader travelled to Maxixe. The ANE/LEM team was delayed leaving Maputo and arrived in Maxixe on the following day.

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<sup>2</sup> The first draft of the translation is expected at the end of May 2017.

<sup>3</sup> South Africa Road Federation.

## **2.6 Thursday, 4<sup>th</sup> May, 2017**

The RRC Team arrived in Maxixe in the afternoon. After 15:00hrs the Assistant Team Leader convened a planning meeting at Farmar's Hotel with the following in attendance: Mr Carlos Cumbane, Cedrik Nambureta, Fernando Dabo and Paulo Guicuane. Moises Dzimba arrived much later in the night. Points discussed in the planning meeting included:

1. Capacity building on data collection and storage: team members were to try using the draft Electronic Data Management System (EDMS) on Thursday, 11<sup>th</sup> May.
2. Cedrick was to make available all forms for the work planned, including setting out, visual road condition survey, roughness, rutting, traffic counts, etc.
3. Team members to gather all information on their experimental sections including design data, construction data, weather data etc.
4. The differences in the objectives of the research of the Trial experimental sections and LTPP experimental sections were discussed. The relationship of the Control and Trial experimental sections was also made clear. The team responsible for the Trial sections initially assumed that the Control section was not their responsibility.
5. Traffic counts were to be conducted for three days and 12 hours (0600 to 1800) from Tuesday to Thursday, at one location on each of the two roads (Agostinho Neto and Cumbane-Chacane). This was mainly due to logistical reasons to complete the traffic counts when the team members were on site.
6. The team was to work together to complete the work set out in the next few days. This was mainly due to limited resources in terms of equipment.
7. The various monitoring activities were to be conducted periodically in future as follows:
  - a. Visual Road Condition Surveys – every six months (control section every 3 months)
  - b. Gravel loss on Control Section – every three months
  - c. DCPs – every six months
  - d. Rutting – every six months
  - e. Roughness (with MERLIN) – every six months
  - f. FWD (when available) – every six months
  - g. Density and Moisture Content – every six months
  - h. Axle load measurements and Traffic Counts – base year and whenever there is a significant change in traffic in terms of composition and numbers.

## **2.7 Friday, 5<sup>th</sup> May, 2017**

The plan was to be on site early but due to logistical issues the team was only on site at 15:00h. The team jointly carried out surveys on the 77No. points on the Control section on the Cumbane-Chacane road. This was to establish the gravel loss since the last measurement in February. The concrete permanent benchmarks were first checked for any movements before the survey of all the points was carried out.

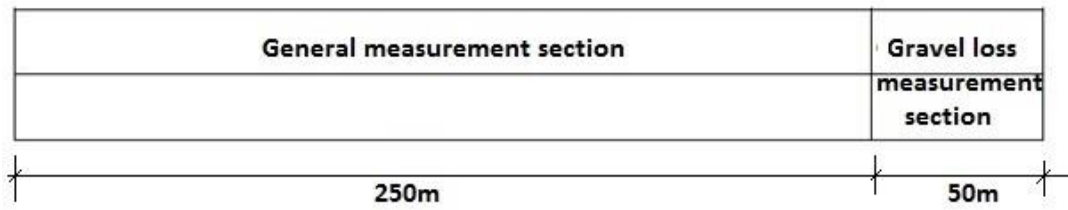


Figure 2.4: Layout of Gravel Control Section

## 2.8 Saturday, 6<sup>th</sup> May 2017

To recover on lost time, the team decided to undertake fieldwork on Saturday. Again, due to logistical problems the team could only get to site by 12:00 noon. The initial plan was to complete the measurements on the Control section, however, Paulo who was responsible for the Control section was not present as he was attending to some emergency official work at the Delegation. The team decided to work on Trial Experimental Section No. 2 under Cedrik on the Cumbane-Chacane Road.

The following activities were carried out:

1. Detailed remarking to conform to the additional detail in the protocol (as shown in Figure 2.5). This was also to establish semi-permanent retraceable markers in paint for the measurement of rutting on this mission and in future.
2. A permanent steel peg marker in concrete 3m away from the edge of the road was installed. This was done to establish the starting point of the Trial section in case the paint wears off.
3. Roughness measurements using the MERLIN were carried out on the left-hand side in the outer wheel path to verify high IRI values obtained in February in this section. In February, the IRI value for the section was found to be on average 7.6m/km. Preliminary calculations indicate a high value again, confirming the findings in February.
4. Visual Road Condition survey was carried out by the full team. This should have been carried out after a further three months, but was necessitated to increase the understanding on collection of the Visual Road Condition information for the benefit of some members of the team who still needed additional orientation.
5. Rutting measurements carried out using the 3m long straight edge and wedge on the newly marked locations.

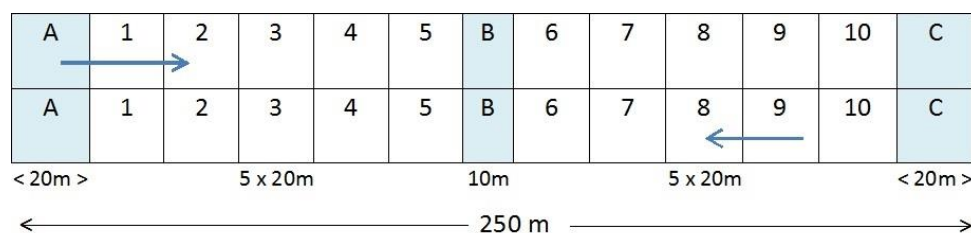


Figure 2.5: Layout of Trial Experimental sections on Cumbane-Chacane



Gravel loss measurement before grader passed on the Control section



Detailed marking on Cedrik's Trial Experimental section



Re-measurement of roughness

Figure 2.6: Team work on Cumbane-Chicane

## 2.9 Monday, 8<sup>th</sup> May 2017

The team planned to complete outstanding work on the Control section not completed the previous week due to Paulo's absence. Paulo could still not participate, nevertheless, the team decided to go ahead and complete the work jointly. After completing the work on the Control section the team moved to Eng Dabo's section (Trial Experimental Section No. 1). It was discovered that the control section was levelled by a grader the previous day (Sunday), this was not communicated to the team previously by the Delegation. The team decided that a new survey of the gravel-loss points was required to establish the new levels and compare with the levels taken on Saturday. It rained quite heavily on the day for at least an hour and half in the afternoon.

### Control Section – Gravel Wearing Course

1. Detailed Visual Road Condition survey jointly carried out. This was necessitated due to the use of the unpaved road specific forms which are different from the flexible pavement forms used on the other research sections. Previously this was not done adequately as the team did not have enough time in the last mission.
2. Permanent marker in concrete was installed at the start of the section 3m away from the edge of the road, this was to assist to identify the start of the gravel-loss measurement section. It was a challenge to identify the buried concrete markers at the start of the section this time around.
3. Measured rutting using the straight edge and wedge; wheel paths were not well defined on the road as currently traffic is channelized on the right-hand side where there is sand and a smoother surface. The measurement was carried out in the wheel path of the left-hand side which was more consistent for the whole section.
4. Insitu moisture and density measurements were carried out in the section. A test pit was excavated near the old test pit in the right outer wheel path. The density and moisture were checked in the wearing surface and subgrade layers. The insitu density was checked using the Troxler and the insitu moisture was checked with the Protimeter.



**Figure 2.7: Team work on Gravel Control Section**

### **Trial Experimental Section 1 (Armoured base + double sand seal)**

1. Detailed remarking to conform to the additional detail in the Protocol (in the same way as done in Section 2).
2. Permanent steel peg marker in concrete as in Section 2.
3. Rutting using straight edge and as done in Section 2.

#### **2.10 Tuesday, 9<sup>th</sup> May 2017**

On this day, the traffic counts on the two experimental roads were started. The team members planned to take turns in meeting logistical requirements to ensure that the enumerators were at the designated locations on time in the morning and for collecting them up in the evening. The enumerators received a quick training on how to carry out the traffic counts.

#### **Traffic Counts:**

1. The traffic counts were to be carried for a period of three days (Tuesday, Wednesday and Thursday) and for 12 hours (from 06:00 am to 06:00 pm). The count was only for three days due to limited time, however, the Protocol recommends a 7-day count to be more representative. The only traffic data available previously for the Agostinho Neto Road was a one-day 12-hour count done in 2016 by the Delegation. No previous counts were found for the Cumbane-Chacane road.
2. The counting locations were selected in such manner as to be representative of both LTPP sections on the Agostinho Neto road and for the three research sections on the Cumbane-Chacane road. The count on the Agostinho Neto road was carried out at the location of LTPP section 1 (Carlos) and on the Cumbane-Chacane road at the location of the Trial Experimental Section 1 (Dabo). The traffic count activity was completed successfully on Thursday as planned. From the preliminary estimates of the AADT, Agostinho Neto and Cumbane-Chacane roads carry approximately 620 and 80 vehicles per day respectively. On Cumbane-Chacane one heavy vehicle (ANE class F - 2 or 3 axles) was counted over the three days, whereas on Agostinho Neto a total of 8

vehicles were counted in this class. No vehicles with more than 3 axles (ANE class G) were counted on either road.

### LTPP Section 1 (Carlos's Section)

1. Detailed marking of the 500m-25-panel section in accordance with the additional guidelines in the Protocol.

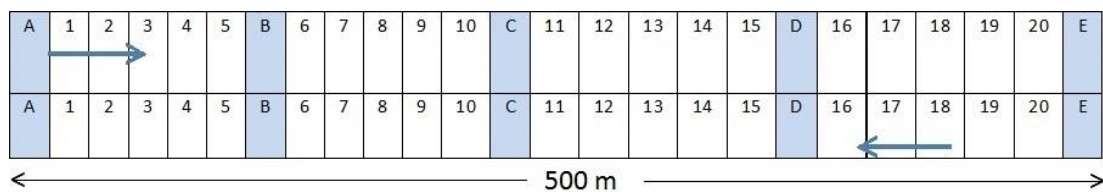


Figure 2.8: Layout of LTPP sections on Agostinho Neto

2. Rutting using the straight edge and wedge; marked at centre of each panel, tests done on outer and inner wheel paths on both lanes
3. Insitu moisture for base (red sand), subbase (red sand) and subgrade at the location of previous test pit using the Protimeter. Material samples were taken to derive insitu moisture using the gravimetric method in order to calibrate the Protimeter and ensure accurate measurements. Tests were carried out in the outer wheel path and centre on the right side in panel A and D.
4. Insitu soil density for base (red sand), subbase (red sand) and subgrade using the Troxler. Tests carried out in the outer wheel path and centre on the right-hand side in panel A and D, the same locations for the moisture tests.

### LTPP Section 2 (Dzimba's Section)

1. Section is getting poorer after the rainy season, more crocodile cracking observed, one major failure, more bleeding in the centre of the road, more signs of surface disintegration due to structural failures along most of the section.
2. Detailed marking of the 500m-25-panel section in accordance with the guidelines in the Protocol.
3. Rutting measurements carried out using the 3m long straight edge and wedge on the newly marked locations, in the outer and inner wheel paths in both lanes.
4. Visual road condition survey carried out in two uniform sections, one with kerbs at the edge of the carriageway, and the other without on the embankment section.
5. Area measurement of potholes and patching work was carried out in each panel.
6. The team member responsible for this section was requested to take notes on the location of deep ruts (due to deformations and extensive crocodile cracking) outside the pre-marked points for rut measurements.



LTPP Section 2 deteriorating rather quickly

Rutting measurement on LTPP Section 1 after re-marking

Measurement of insitu moisture content and density, LTPP Section 1

Figure 2.9: Team Work on Agostinho Neto

### 2.11 Wednesday, 10<sup>th</sup> May 2017

The team planned to complete all remaining activities on this day as the following day was set aside to work on the EDMS. It was however not possible to complete all the activities. Main activities carried out included the following:

#### LTPP Section 1 (Carlos)

- Visual road condition survey carried out on two uniform sections, one on the embankment section (wet section) and the other on the drier level section.

#### LTPP Section 2 (Dzimba)

- Measurement of insitu moisture content and density of the base, subbase and subgrade continued, carried out in Panel A and E. The insitu moisture content and density were measured using the Protimeter and Troxler respectively in the same manner as the previous day on the LTPP section 1.

#### Trial Experimental Section 1 (Dabo- Cumbane Chacane Road)

- Measurement of insitu moisture content and density of the base in Panel A and B carried out after similar measurements on the LTPP Section 2 were completed. The measurements in the subbase and subgrade were carried out the following day.

#### Control Section (Paulo)

Re-measurement of the 77No. survey points for gravel loss after the section was graded the previous Sunday (08.05.17).



Preparation for measurement of insitu moisture content and density on LTPP sect. 2

Potholes in the section being repaired

Control section after grader levelling

Figure 2.10: Team Work on Agostinho Neto

## **2.12 Thursday, 11<sup>th</sup> May 2017**

The team went out very early in order to complete the outstanding activities on the Trial Experimental Sections on Cumbane-Chacane road so as to return early and work with the Electronic Data Management System (EDMS). On this day, the traffic counts were also completed.

### **LTPP Section 1 (Carlos)**

Undertook DCP measurements in test panels C and D.

### **Trial Experimental Section 1 (Dabo)**

Measurement of insitu moisture content and density of the subbase and subgrade in Panel A and B. All layers were sampled for further insitu moisture content measurement through the gravimetric method.

### **Trial Experimental Section 2 (Cedrik)**

Measurement of insitu moisture content and density of the base, subbase and subgrade in Panel A and B were carried out as in Section 1. Samples were also collected for gravimetric moisture content measurement.



*Testing of insitu density and moisture content on all layers on Dabo's section*



*Test pits excavated in February yet to be properly backfilled and sealed*



*Control Section after grader blading*

**Figure 2.11: Team Work Activities**

### **Capacity Building Session on the draft Electronic Data Management System (EDMS)**

After lunch, the team met at the Farmar's Hotel. All team members opened an account in the EDMS. Team members were run through all the necessary steps starting from how to introduce a new road to the database to the more detailed steps on storing the data in the appropriate locations. Team members were encouraged to input data to have a feel of the database. Later the team members were asked to make comments on issues that could help improve the storage in the database. They could also submit their comments after having more time trying out the database from their respective home base after the end of the mission.

The following is a list of comments on the draft version of the database:

1. Change Research to Trial Experimental

2. Position of Section – to show Chainage start
3. Traffic – define unit as AADT (Annual Average Daily Traffic), should be for whole section and not per panel and should have count date included. Possibility of showing full traffic count with different traffic classes in the count will be highly desirable.
4. ID should be User-defined
5. VCI characterization – should be defined in sections 1-5, 6-10, 11-15 and 16-20
6. Include a field for 'Insitu Moisture Content'
7. Need for export button on the data
8. Data window – to have dropdown options on the base, subbase etc. as shown in the mock-up screens (Annex 2)
9. Add an option to ADD notes/comments and pictures
10. Show polyline for whole section instead of just showing the start coordinate
11. Decimal separator should be a full-stop instead of the comma
12. Show more information on the Road/Street window such as province and perhaps district
13. Chainage to be shown with a plus as separator e.g. 18+225 instead of 18.225

### **3 General Comments and Conclusions**

#### **3.1 Next Steps for Research Activities**

The following next steps were agreed with the researchers before the end of the mission.

- i. Team members were requested to clean all the data collected and insert in appropriate forms as given in the Protocol.
- ii. Each team member was to write a summary of all the activities carried out in each experimental section, indicating all the data collected in this mission. They were also to combine with data collected in February where appropriate. This should form part of the base data for the experimental sections. Other data including design, construction, maintenance, climatic, environmental for a particular experimental section was to be collected and stored where data was available from all sources.
- iii. Participants were to derive the VCI for experimental sections with a flexible pavement using the revised spreadsheet. They were also to calculate the VCI for the Control section using the Deduct Method spreadsheet.
- iv. Participants were to store all the base data collected in the EDMS (code-named RHINO) when the final version is released. Further training will be provided by CDS in the operation of the database.
- v. Participants were to return for the next round of monitoring in six months except for the gravel loss measurements which must be carried out in three months' time.

#### **3.2 Capacity Development in the RRC**

The following observations and recommendations are made concerning the development of the capacity of the RRC research team and future priorities for the project. These issues were discussed at a project meeting at ANE in Maputo on 14<sup>th</sup> June 2017.

- i. It is evident that the RRC researchers require additional guidance and direction in the identification and formulation of research projects. No clear objectives have been agreed for the field work in Inhambane.
- ii. There was a delay to the start of the field work due to the late arrival of the team in Inhambane and difficulty in finding accommodation in Maxixe. Future field work needs to be better planned.
- iii. The shortage of equipment remains a constraint to efficient implementation of the field work but ANE is expecting to procure equipment using a World Bank loan.
- iv. The requirement to repeat the setting out of the experimental and LTPP sections due to modifications to the Monitoring Protocol resulted in additional work for the research team and some frustration. This was due to changes in the draft Protocol, and it is not expected that similar problems will be faced in future.
- v. The lack of a Portuguese language version of the Protocol has been a barrier to the researchers' understanding the required procedures. (The initial translated version was made available to ANE/LEM by email during the meeting of 14<sup>th</sup> June. The

“official” version of the document will reside with Eng Dabo, who will be responsible for managing all revisions. Comments were requested by CDS on the quality of the translation.).

- vi. The researcher’s reports from the field work should focus on presenting the measurement data ready for entry into the database. The researchers are encouraged to independently collect any additional data they feel is necessary from their research/LTPP sections. It is not necessary to wait for CDS to arrange a field visit. The team was encouraged to complete their work before returning to their home base – it was noted that it was difficult to give time on the research work in addition to every day duties.
- vii. CDS was tasked with providing more detailed analysis on the performance of the various trial sections on the Cumbane-Chacane Road. This analysis should refer to the original TRL design reports. It was suggested that a seminar be arranged and Eng Mukura of TRL invited to present the rationale behind the design and the construction process. This seminar will be arranged for August or September 2017. It should include a session on how to clearly define research objectives and how to go about a research project. The researchers will be assisted to prepare a clear objective and methodology for their individual research work. This seminar will take place before the next field visit.
- viii. It is expected that the next field visit will include establishing monitoring sections on the Zero-Mopeia Road in Zambezia Province. This road is believed to be in good condition and is relatively easily accessed from Quelimane. Consideration also must be given to establishing monitoring sections on the Xitaxi-Mueda Road in Cabo Delgado, which included several interesting LVR pavement designs. However, field work on the Xitaxi-Mueda Road would include significant logistical challenges.

## Annex A. List of Participants at the Meetings in Maputo

### 2nd May 2017

No.	Name	Organisation	Position	Contacts
1	Irene Simões	ANE – DIMAN	Director	<a href="mailto:ilanga@ane.gov.mz">ilanga@ane.gov.mz</a> +258849225451
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6	Robert Geddes	CDS	Team Leader	<a href="mailto:rgeddes@cdsafrika.com">rgeddes@cdsafrika.com</a> +258877417709/+263712608312

### 14<sup>th</sup> May 2017

No.	Name	Organisation	Position	Contacts
1	Irene Simões	ANE – DIMAN	Director	<a href="mailto:ilanga@ane.gov.mz">ilanga@ane.gov.mz</a> +258849225451
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5	Cedrik Namburete	ANE - Inhambane	Engineer	<a href="mailto:cedrik.namburete@gmail.com">cedrik.namburete@gmail.com</a>
6	Nkululeko Leta	ReCAP PMU	Regional Technical Manager	<a href="mailto:nkululeko.leta@cardno.uk.com">nkululeko.leta@cardno.uk.com</a>
7	Alexander van Oostenrijk	CDS/Independent Software	Database Specialist	<a href="mailto:alexander@independent-software.com">alexander@independent-software.com</a> +258823042635
8	Robert Geddes	CDS	Team Leader	<a href="mailto:rgeddes@cdsafrika.com">rgeddes@cdsafrika.com</a> +258877417709/+263712608312

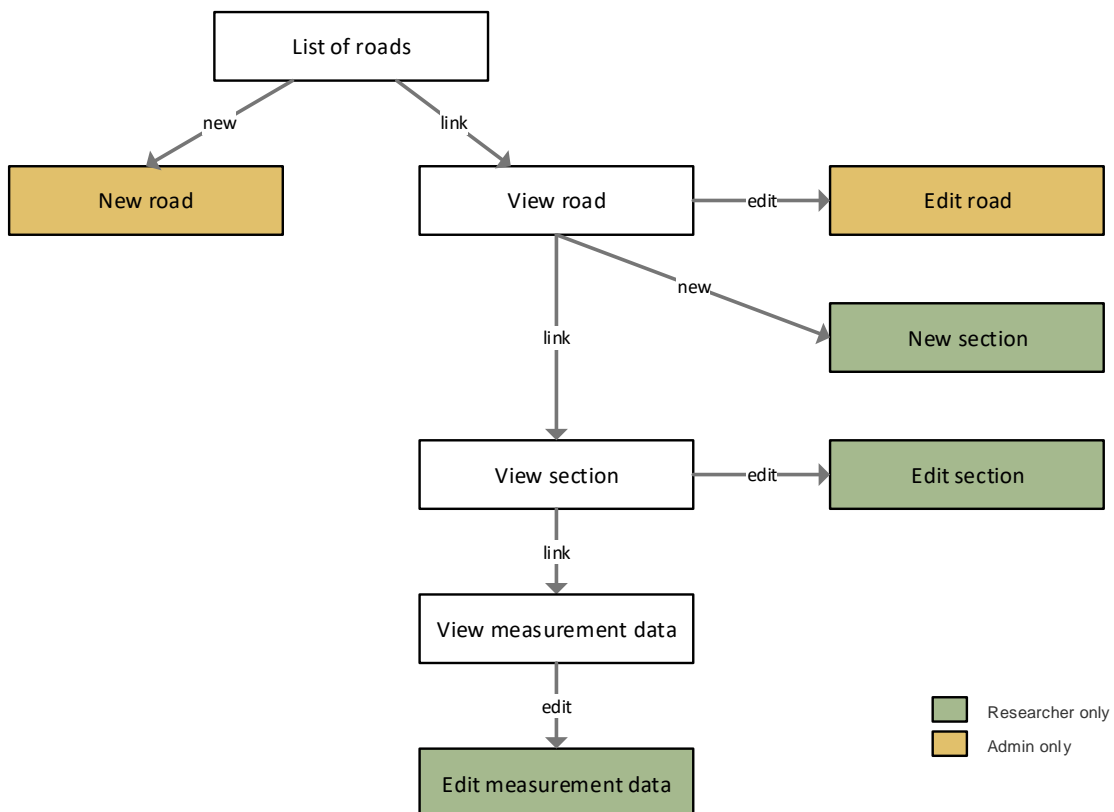
## Annex B. Database user interface mock-ups

### Structure of database screens

The database starts by showing a list of roads. From there, authenticated users can view road data, section data, and measurement data.

- Only users with administration rights can create new roads, edit roads, and delete roads.
- New sections can be created, existing sections edited or deleted and measurement data can be edited and deleted only by users with researcher rights.

This means there are three roles: ordinary user, admin and researcher. The role names are a suggestion and can be changed.



## Screen: List of roads

### Roads

The screenshot shows the 'Roads' interface with the following elements:

- Filter:** A text input field labeled 'Filter...' with a callout: 'Type to filter roads by (part of) name'.
- Order:** A dropdown menu labeled 'Order by: Name' with a callout: 'Order by name, sections, or measurements (asc/desc)'.
- Action:** A blue button labeled 'New road' with a callout: 'admin only'.
- Table:** A table with two columns: 'Name' and 'Sections'.

Name	Sections
<a href="#">R205 – Macia to Chokwé</a>	8
<a href="#">R208 – Chokwé to Manjacaze</a>	18
<a href="#">R423 – Mapinhane to Mabote</a>	16
<a href="#">R474 – Milange to Molumbo</a>	12
- Export:** A blue button labeled 'Export to Excel'.
- Callout:** A callout pointing to the road names: 'Click to view road detail (sections)'.

### Details

The roads are shown with their names and number of sections. The list can be exported to Excel. The table can be ordered by road name, number of sections or number of measurements (ascending or descending). It is also possible to quickly find a road by typing in part of its name.

Any filtering and ordering also applies to data exported to Excel.

### Links

From this screen, clicking a road name goes to an overview of that road.

Clicking **New road** allows admins to create a new road definition.

## Screen: View a road

### View road

#### R474 – Milange to Molumbo

Click to see only sections with no measured zones

Without measurements

Type

Click to filter by Research or LTPP

Order by: ID ▼

Order by ID, chainage, length, traffic or measured zones.

admin only

New section

Section No.	Chainage	GPS	Length	Type	Traffic
1	334	-34.54, 16.51	8000	Research	(no data)
2	440	-34.53, 16.58	4000	Research	15
3	480	-34.53, 16.62	4500	Research	28
4	512	-34.51, 16.77	5000	LTPP	(no data)

Click to view section detail

Click for a Google Map

Export to Excel

Edit road

Click to edit road base data (name only) admin only

### Details

This screen shows a list of all sections on a road. The sections table can be ordered by chainage, length, type, and number of measured zones (panels). It is also possible to filter, showing only sections without any measurements, or sections of a selected type only (Research or LTPP).

### Links

From this screen, clicking a section ID goes to an overview of that section. Clicking GPS coordinates pulls up a Google Map of these coordinates.

Clicking **New section** allows admins to create a new section definition.

Clicking **Edit road** allows admins to edit the base data for this road definition (its name) or to delete the entire road.

## Screen: Edit road

### Edit road

Name  ✓

#### Details

This screen allows administrators to edit the base data for a road (its name, for now). No two roads may share the same name. The **Update** button is only available if all fields are correctly filled out and the road name does not clash with another road name.

#### Links

From this screen, the user can either update the road with a new name, delete the entire road with all its sections and measurement data (confirmation will be asked), or cancel and go back to the **View road** screen.

## Screen: New section

### New section

Road: R423 – Mapinhane to Mabote

The form contains the following fields and callouts:

- Chainage:** Input field containing '443' with a green checkmark. Callout: *Required field with visual feedback.*
- Latitude:** Empty input field. Callout: *Required field with visual feedback, not yet filled out.*
- Longitude:** Empty input field.
- Length:** Empty input field.
- Type:** Dropdown menu with 'Research' selected. Callout: *Select Research or LTPP*
- Buttons:** 'Save' (disabled), 'Save and add more' (enabled), and 'Cancel'.

Callouts for buttons:

- Save:** *Button disabled if not all required fields filled out correctly.*
- Save and add more:** *Save section, then present form again for another section*

### Details

This screen allows administrators to set the base data for a new section: its chainage, GPS coordinates, length and type (Research or LTPP). A section can only be saved after all fields have been filled out correctly, and all fields are required. The **Save** and **Save and add more** buttons are only enabled when all fields have been filled out correctly.

### Links

Clicking **Save** saves the section and takes the user back to the road view.

Clicking **Save and add more** saves the new section, then presents the same form again to allow the user to add another section.

Clicking **Cancel** takes the user back to the road view.

## Screen: View section

# View section

## R423 – Mapinhane to Mabote

### Section 4

Chainage 512 Length 5000 Type LTPP

Click to filter by side of road

Order by panel, distance, side of road, wheel path or date.

researcher only

Side ▼ Wheel path ▼

Order by: Panel ▼

New measurement

Panel	Distance	Side of road	Wheel path	Date
<a href="#">A</a>	2 m	Left	Inner	March 18, 2017
<a href="#">A</a>	6 m	Left	Inner	April 6, 2017

Export to Excel

Edit section

Edit section data (chainage, length, type) admin only

### Details

This screen allows a user to view the list of measurements for a section. The screen shows the section's base data (chainage, length, type), as well as a list of each measurement done on a position marked by panel, distance, side of road, wheel path, and date.

It is legal to have multiple measurements for the same panel/distance/side of road/wheel path combination, on different dates.

The table of measurements can be ordered by panel, distance, side of road, wheel path and date. The table can also be filtered by side of road (e.g. show LHS only), or wheel path (e.g. show Inner path only).

And ordering or filtering is reflected also in data exported to Excel using the **Export to Excel** button.

### Links

From this screen, clicking **New measurement** allows users with the Researcher role to input data for a new measurement.

Clicking a **panel link** in the table takes the user to the **View measurement** screen.

Administrators can click **Edit section** to edit the section's base data (chainage, length, etc.).

## Screen: Edit section

### Edit Section

Road: R423 – Mapinhane to Mabote

ID	513
Chainage	<input type="text" value="443"/> ✓
Latitude	<input type="text" value="-34.12"/> ✓
Longitude	<input type="text" value="16.48"/> ✓
Length	<input type="text" value="384"/> ✓
Type	<input type="text" value="Research"/> ▼

*Required field with visual feedback.*

*Select Research or LTPP*

*Delete section and all its measurements. Will ask for confirmation.*

#### Details

This screen allows administrators to edit a section's base data (chainage, GPS, length and type). All fields are required and the changes can only be saved when all fields have been filled out correctly.

It is also possible to delete the entire section from here (including all its measurements). This will require confirmation through a confirmation dialog.

#### Links

From here, clicking **Update** saves the section data and returns to the **View section** screen.

Clicking **Cancel** returns to the **View section** screen.

Clicking **Delete section** deletes the section (after confirmation) and returns to the **View road** screen.

## Screen: View measurement data

# Measurement data

## R423 – Mapinhane to Mabote

### Section 4

Chainage 512 Length 5000 Type LTPP

Date	May 13, 2017
Panel	A
Distance	2 m
Side of road	Left hand side
Wheel path	Inner

Base	Layer thickness	18
Sub-base	Material type	Some text
Subgrade	Liquid limit	13
Selected subgrade	Plastic limit	12
Gravel WC	Plasticity index	31
Bituminous seal	Linear shrinkage	56
Block pavement	Grading modulus	3
Riding quality	Mod MDD	18
Deflection	OMC	2
Skid resistance		
DSN800		
VCI		

Edit measurement data  
researcher only

Edit

Cancel

## **Details**

This screen shows all measurement data for a given panel, road side, wheel path, distance and date combination. Since the measurement data is comprised of many fields, it is accessed by clicking the tabs on the left-hand side of the screen. In the example, the tab “Base” is active and the data for the road base is shown.

## **Links**

Clicking **Cancel** returns the user to the **View section** screen.

Clicking **Edit** allows users with the researcher role to edit the measurement data (on the **Edit measurement** data screen).

## Screen: Edit measurement data

# Measurement data

## R423 – Mapinhane to Mabote

### Section 4

Chainage 512 Length 5000 Type LTPP

Date	<input type="text" value="2017-05-13"/>
Panel	<input type="text" value="A"/>
Distance	<input type="text" value="2"/>
Side of road	<input type="text" value="Left hand side"/>
Wheel path	<input type="text" value="Inner"/>

It is possible to have multiple measurements for the same spot, at different dates.

<b>Base</b>	<b>Layer thickness</b>	<input type="text" value="18"/>
Sub-base	<b>Material type</b>	<input type="text"/>
Subgrade	<b>Liquid limit</b>	<input type="text"/>
Selected subgrade	<b>Plastic limit</b>	<input type="text"/>
Gravel WC	<b>Plasticity index</b>	<input type="text"/>
Bituminous seal	<b>Linear shrinkage</b>	<input type="text"/>
Block pavement	<b>Grading modulus</b>	<input type="text"/>
Riding quality	<b>Mod MDD</b>	<input type="text"/>
Deflection	<b>OMC</b>	<input type="text"/>
Skid resistance		
DSN800		
VCI		

Update

Delete this entire measurement. Will ask for confirmation.

Delete measurement

Cancel

## Second sample

# Measurement data

## R423 – Mapinhane to Mabote

### Section 4

Chainage 512 Length 5000 Type LTPP

Date	<input type="text" value="2017-05-13"/>
Panel	<input type="text" value="A"/>
Distance	<input type="text" value="2"/>
Side of road	<input type="text" value="Left hand side"/>
Wheel path	<input type="text" value="Inner"/>

Base
Sub-base
Subgrade
Selected subgrade
Gravel WC
<b>Bituminous seal</b>
Block pavement
Riding quality
Deflection
Skid resistance
DSN800
VCI

Seal type	<input type="text" value="Double Otta Seal"/>
AIV (Wet)	<input type="text"/>
AIV (Dry)	<input type="text"/>
ACV (Wet)	<input type="text"/>
ACV (Dry)	<input type="text"/>
10% FACT (Wet)	<input type="text"/>
10% FACT (Dry)	<input type="text"/>
ALD	<input type="text"/>
Flakiness index	<input type="text"/>
Bitumen adhesion	<input type="text"/>

Update

Delete this entire measurement. Will ask for confirmation.

Delete measurement

Cancel

## **Details**

This screen allows researchers to add or edit measurement data. The researcher may edit the location of the measurement (date taken, panel, distance, side of road, wheel path), as well as the data itself. The data is presented through tabs as there are many fields.

In the first sample above, the data for “Base” is being edited. In the second sample, the data for “Bituminous seal” is being edited.

## **Links**

Clicking **Cancel** takes the user back to the **View section** screen.

Clicking **Update** updates the measurement data (as long as all fields contain valid values).

Clicking **Delete** deletes the entire measurement (after confirmation) and returns the user to the **View section** screen.