



AfCAP
Africa Community Access Partnership



Agricultural Sector Wide Approach Support Project (ASWAP-SP)

Mid-term Technical Audit Report

D387 Nsangwe-Dolo – Chikwawa District

S135 Mwanza-Kunenekude – Mwanza District

S134 Kasinje-Kandeu – Ntcheu District



J. Hongve and E. Mukandila

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ReCAP Project Management Unit
Cardno Emerging Market (UK) Ltd
Oxford House, Oxford Road
Thame
OX9 2AH
United Kingdom



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.

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Acronyms, Units and Currencies

AASHTO	American Association of State Highway and Transportation Officials
AfCAP	Africa Community Access Partnership
ASWAP-SP	Agriculture Sector Wide Approach – Support Project
BS	British Standard
DCP	Dynamic Cone Penetrometer
DN	DCP Number (mm/blow)
km	Kilometre
LVSr	Low Volume Sealed Road(s)
M	Metre
mm	Millimetre
MDD	Maximum Dry Density
Mod	Modified
OMC	Optimum Moisture Content
RA	Roads Authority
RFA	Roads Fund Administration
SATCC	Southern Africa Transport Communications Commission
TA	Technical Audit
UK	United Kingdom (of Great Britain and Northern Ireland)
UKAid	United Kingdom Aid (Department for International Development, UK)

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1. Executive summary

The World Bank financed ASWAP-SP project involves design of a total of 40 km of Low Volume Sealed Roads (LVSR) in five different locations spread out from the northern to the southern end of Malawi. Through a competitive tendering process, the Design and Supervision for the five upgrading projects was awarded to a locally based firm, Royal Associates who had no prior experience with the use of the DCP-DN Design Method.

This project, AfCAP MAL 2007, was formulated to support the Design and Supervision Consultant (DSC) and the Contractors carrying out the works as well as to the Roads Authority (RA) and the Road Fund Administration (RFA) for the oversight and administration of the projects.

The project is carried out in phases. Phase 1 including training of the DSC and RA staff, a review of the design and contract documents and Technical Audit exercise. The first phase of the audit exercise was undertaken in August/September 2015 and, amongst other activities, included the auditing of two of the project roads, D11 Kalenge Bridge – Misuku at Chitipa and T357 Parachute Battalion – Lifuwu at Salima. Phase 2 started with the mid-term Technical Audit in June 2016 of the three remaining projects, namely D387 Nsangwe – Dolo in Chikwawa District, S135 Mwanza - Kunenekude in Mwanza District and S134 Kasinje - Kandeu in Ntcheu District.

The audit exercise has identified a number of shortcomings pertaining to the contract documentation, execution and supervision which are detailed in the report and summarised below.

Category	Item	Degree of Concern	Priority
Works Contract	Design of Cape Seal surfacing	Significant	2
	Road safety	Significant	2
	Road marking	Minor	3
	Specifications	Serious	1
	New Contract Document Template	Significant	2
Project staff	Supervising Engineer's staff	Serious	1
Site Issues – D387 Nsangwe – Dolo Fargo Ltd	Quality Assurance System/Plan	Serious	1
	Road levels / Drainage plan	Serious	1
	Quality control of layer works using the DCP	Significant	1
	Construction of Cold Mix Asphalt	Significant	3
Site issues – S135 Mwanza – Kunenekude Hema Construction	Quality Assurance System/Plan	Serious	1
	Borrow pit material for base layer	Serious	1
	Road levels / Drainage Plan	Significant	1
	Quality control of layer works using the DCP	Significant	1
	Construction of Cape Seal surfacing	Significant	1
	Contractor's Site staff	Serious	1
Site issues – S134 Kasinje – Kandeu Fargo Ltd	Quality Assurance System/Plan	Serious	1
	Road levels / Drainage Plan	Serious	1
	Approval of new borrow pit	Significant	1
	Quality control of layer works using the DCP	Significant	1
	Construction of Cape Seal surfacing	Significant	1

Many of the issues identified during this audit were also identified during the first audit in September 2015 and were still unresolved or not adequately addressed by the project. A full summary of findings from both audits is presented under Section 6, page 26.

Recommendations have been made to the Roads Authority for procedural action to be taken to correct the most significant shortcomings so as to avoid jeopardising the project.

2. INTRODUCTION

2.1 Project Background and Context

The World Bank financed ASWAP-SP project involves design of a total of 40 km of Low Volume Sealed Roads (LVSr) in five different locations spread out from the northern to the southern end of Malawi as shown in Figure 1.



Figure 1: ASWAP-SP project locations

Through a competitive tendering process, the Design and Supervision for the five upgrading projects was awarded to a locally based firm, Royal Associates.

With Malawi being in the forefront in the adoption of the DCP-DN Design Method for LVSr and so far the only country with a formally recognised DCP-DN Design Manual, the RA and ASWAP-SP decided that the five projects should be designed using the DCP-DN Design Method.

With these projects being the first of their kind in Sub-Saharan Africa (SSA), the importance of successful completion of the projects led to a formulation of the AfCAP project, MAL 2007, for support to the Design and Supervision Consultant (DSC) and the Contractors carrying out the works as well as to the Roads Authority (RA) and the Road Fund Administration (RFA) for the oversight and administration of the projects.

The project is carried out in two phases as follows:

- Phase 1
 - Training of the DSC and staff from RA in the DCP-DN Design Method
 - Design Review for all five legs of the ASWAP-SP project
 - Technical Audit exercise at start of construction of the two northerly projects, D11 Kalenge bridge - Misuku at Chitipa and the T357 Parachute Battalion - Lifuwu at Salima
- Phase 2
 - Mid-term Technical Audit exercise of the three southerly projects, D387 Nsangwe – Dolo in Chikwawa District, S135 Mwanza - Kunenekude in Mwanza District and S134 Kasinje - Kandeu in Ntcheu District
 - Training of more local consultants and RA staff in the DCP-DN Design Method
 - Final Technical Audit exercise of all five projects at the end of the construction period.

Phase 1 was completed in September 2015. The following reports document the project activities and their respective outcomes:

- Training Report - February 2014
- Design Review and Training Report - October 2014
- Technical Audit Report - October 2015

It should be noted that the DSC had no prior experience in the use and application of the DCP-DN Design Method when preparing the bid for the contract. The initial training that was carried out during the design stage could thus only bring the DSC staff up to an intermediate level in the understanding and application of the DCP-DN Design Method. The method differs in philosophy and approach to the traditional CBR/Density based methods of design that they were used to. Some of the shortcomings identified during the design review and subsequent Technical Auditing exercises can be attributed to this.

Different surfacing options have been specified for the projects. Three projects are constructed with Cape Seals that are commonly applied in Malawi. The D387 Nsangwe – Dolo is constructed with Cold Mix Asphalt and Slurry Bound Macadam was originally specified for S134 Kasinje – Kandeu.

Due to the latter two surfacing options being new to the contractors, a parallel project has been implemented under ASWAP-SP with no involvement of AfCAP for training of the contractors in the construction of these two surfacings. Based on his experience, particularly with Cold Mix Asphalt from Kenya and elsewhere, Jon Hongve was engaged to carry out the training. The activities and outcomes of the training are documented in the following reports:

- Training Report – December 2015 (Cold Mix Asphalt)
- Training Report – April 2016 (Slurry Bound Macadam)

The justification for choosing the Slurry Bound Macadam on S134 Kasinje - Kandeu, was the prevalence of hand-knapped stone in the communities along the road. However, the stone proved to be unsuitable for the purpose and upon successful completion of the training on the Slurry Bound Macadam using stone from a commercial crusher, it was concluded that this option would be too expensive. This project will therefore also be constructed with Cape Seal.

2.2 Project team

Due to their involvement in the development of the DCP-DN Design Method and experience with the practical application thereof, the team appointed by AfCAP to undertake the MAL2007 project consists of:

- Mike Pinard
- Jon Hongve
- Estimé Mukandila

All three were involved in the activities under Phase 1. The second Technical Audit exercise, which is the focus of this report, was carried out by J. Hongve and E. Mukandila. All three members of the team have been contracted to conduct the third and Final Technical Audit exercise which is scheduled for the end of 2016.

2.3 Motivation for Audit

The motivation for carrying out the audit exercise is to ensure that the professional services provided by consultants and contractors are carried out in an efficient and effective manner and to the highest possible standards. This is all the more important on the ASWAP-SP projects as it is the first time that such roads have been designed on the basis of the Malawi Manual for the Design of Low Volume Sealed Roads Using the DCP Design Method.

The potential benefits of the technical audit exercise carried out on the ASWAP-SP project roads include the following:

- Identifying potential problems early in the course of the project cycle – in this case at the design, tender documentation, procurement and construction stages.
- Instilling a sense of greater diligence in the attitude of all parties to the contract.
- Reducing the scope for corruption, particularly at the Contract Award and implementation stages of the project.

- Detecting misinterpretations of data, inaccurate reporting and departure from the project objectives.
- Confirming the implementation of prescribed requirements such as quality assurance, quality control and work plans.
- Minimising the risk and severity of failures that may occur as a result of design deficiencies in the road project.
- Minimising the need for re-work and physical remedial works caused by design or construction deficiencies by taking early corrective action.
- Satisfying the project financiers that the project has been well designed, documented and constructed so as to provide value for money.
- Capacity building of the road sector actors (contractors, consultants, Clients) to ensure current and future infrastructure projects are built in a cost-effective manner and provide value for money.

Technical Audits should ideally be carried out by independent auditors to ensure complete objectivity in the assessment of the performance of the parties to the contract, i.e. the Contractor, the Consultant as well as the Client. A Technical Audit Report has no legal standing in the contractual relationships between the Client and the Consultant and the Client and the Contractor. The Technical Audit is intended to give an objective and unbiased assessment of the compliance with the contracts and the Client can choose to do whatever is deemed fit based on the recommendations in the Audit Report or do nothing at all.

It is clear from the above that the Technical Audits carried out under this project are not independent since the audit team has been intimately involved throughout the project cycle. As such these Technical Audit exercises can be regarded as performance monitoring and evaluation being an integral part of the capacity building effort under the project.

Notwithstanding the above, the Technical Audit exercises have been carried out as specified in the MAL2007 Terms of Reference and the team has strived to carry out the audit in an objective and unbiased manner not favouring any contractual party in its assessments. For the purpose of general capacity building there is, however, still merit in conducting the performance evaluation following formal Technical Auditing procedures to expose the contractual parties to what these procedures involve.

Prior to undertaking the first audit exercise in August/September 2015, a one-day workshop was held for the Roads Authority and Roads Fund Administration staff to sensitise them to the procedures typically followed in carrying out such audits.

2.4 Purpose

The main purpose of this report is to document the specific findings emanating from the audit process of the three above mentioned projects, including the contract documentation aspects and the on-going field activities. The over-riding objective is to provide detailed feedback to all the parties concerned so that action can be taken, where appropriate, to ensure that the roads are constructed in accordance with appropriate standards and specifications, and that, in so doing, good construction practice is followed with specific attention to the application of the DCP-DN design principles.

For the sake of continuity and overview of the status of the ASWAP-SP project in general, the summary of the outcomes of this Technical Audit exercise is compiled in such a manner as to facilitate

evaluation of compliance with recommendations as well as identifying recurrent issues that have or have not been attended to.

Time allowed for a brief visit also to the T357 Parachute Battalion - Lifuwu at Salima, which is near to substantial completion. Observations on this site is therefore also included in Annex 2 and will serve as instructive examples for similar aspects of the construction process on the other three sites.

2.5 Scope

Following the introduction to the project given in this section, the report covers the following:

- **Section 3 – Approach and Methodology:** This section provides an overview of the technical audit process from the stage of obtaining the relevant documents, to their subsequent review, the holding of the first entry meeting with the key parties to the contract, the site inspection phase and, finally, the exit meeting at which all the findings and recommendations of the audit are discussed with stakeholders.
- **Section 4 – Project Details:** This section provides an overview of the three projects being audited, in terms of their location and the characteristics that affect their design including topography, rainfall and drainage.
- **Section 5 – Outcome of Technical Audit:** This section presents the outcome of the technical audit exercise from the initial document review stage to the final exit meeting stage when discussions are held with stakeholders on the findings and recommendations of the audit. The procedure for implementing the audit recommendations is also outlined.
- **Section 6 – Summary:** This section summarises the findings and conclusions of the audit and the procedural requirement for finalising it.

3. APPROACH AND METHODOLOGY

3.1 Audit Process

The audit process followed was essentially as follows:

- Obtain project documents from client and supervision consultants
- Review project documents
- Hold entry meeting with parties to contract
- Undertake site inspections
- Hold exit meeting with parties to the contract.

The audit process outlined above is essentially *a formal, systematic procedure for undertaking an independent, objective, assessment of a project to determine the extent to which it has complied with various prescribed procedures, standards and specifications set down in the project documents.*

3.2 Documents Made Available for the Audit

The following project documents were made available to the auditors by the DSC:

- Final Main Design Report including topographic surveys, road inventory, construction materials, pavement design and Environmental Impact Statement.
- Strip Drawings showing longitudinal surveys, drainage schedules, standard details for road cross-section.
- Works Contracts (Bidding documents)
- Contractor's Estimate
- Engineer's Cost Estimate

3.3 Review of Works Contract Documents

Upon receipt of the project documents, the auditors had the opportunity to review them in detail and to identify any issues requiring discussion or clarification with the parties to the contract, prior to the audit process per se.

3.4 Entry Meetings and Site Inspection

Due to the limited time available and travelling distances involved, entry meetings were combined with the site visits. All three roads to be audited were visited by the auditors, as follows:

- D387 Nsangwe – Dolo in Chikwawa District on 08.06.16
- S135 Mwanza - Kunenekude in Mwanza District on 10.06.16
- S134 Kasinje - Kandeu in Ntcheu District on 13.06.16.

The visit to T357 Parachute Battalion - Lifuwu at Salima was done on the return to Lilongwe after the visit to S134 Kasinje – Kandeu. During the course of these site visits the auditors were accompanied by representatives of the parties to the contract listed below:

D387 Nsangwe – Dolo:

- Fargo Ltd
 - Site Agent: Harry Makina
 - Foreman: Chapasuka
 - Materials Technician: Chitsime
 - Surveyor: P. Ngonya

- Royal Associates
 - Team Leader: Kamau Kariuki
 - Drainage Inspector: Luka Kanjira
 - Earthworks Inspector: H. Kainga
 - Materials Inspector: R. Kabvumbula

- RA
 - ASWAP Adviser: D. Geilinger

S135 Mwanza – Kunenekude

- Hema Construction
 - Site Engineer: Chawanangwa Katanga (temporary, Acting Site Agent)

- Royal Associates
 - Regional Roads Engineer: D. Mtilatila
 - Drainage Inspector: Sam Eliya
 - Materials Inspector: N.J. Chakanga

- RA
 - Project Engineer: B. Nyirongo
 - ASWAP Adviser: D. Geilinger

S134 Kasinje – Kandeu

- Fargo Ltd
 - Site Agent: Bakali Kapeloni
 - Senior Lab Technician: Dambuleni Phiri
 - Senior Earthworks Foreman: Lameck Lazenby

- Royal Associates
 - Civil Engineer: Precious Kamndaya
 - Earthworks Inspector: Chembe Banda
 - Surveyor: Ishmael Saiti
 - Structural Inspector: Ian Shaba

- RA
 - ASWAP Adviser: D Geilinger

These visits allowed the auditors to familiarise themselves with the details of the projects and to obtain any necessary information and data required to allow them to complete the audit. The visits also provided an excellent opportunity to engage with all stakeholders on the technical issues that arose during the auditing of the works, some of which were related to the understanding and application of the DCP-DN design principles and as such were, strictly speaking, beyond the scope of the Technical Audit process.

3.5 Exit meeting

This meeting was held on 15.06.16 and provided an opportunity for the Auditors to present and discuss their preliminary findings and conclusions to the main parties to the contract prior to writing up of the audit report. The meeting also provided an opportunity to:

- Discuss issues identified during the site visits and possible solutions for addressing the problems.
- Identify and resolve misunderstandings or errors of fact.
- Provide the basis for preparing the Draft Audit Report.

The main issues identified during the site visits are discussed under Section 5: Outcome of the Technical Audit and Section 6, Table 1: Summary of Findings as well as in Annex 3: Presentation at the Exit Meeting.

List of participants in the Exit Meeting is provided in Annex 1.

3.6 Ranking system for concerns and action priority

All concerns identified in the audit are considered of sufficient importance to require action. To assist the Client and Consultant to gauge the relevant importance of the concerns raised, the following ranking system has been adopted:

- **Serious concern:** a major concern that should be addressed and requires changes to the project to avoid serious technical problems.
- **Significant concern:** a significant concern that requires consideration of changes to improve the technical shortcomings of the project.
- **Minor concern:** a concern of lesser significance, but which should be addressed as it may improve the overall performance of the project.
- **Comment:** a concern or an action that may be outside the scope of the technical audit, but which may improve the overall design or be of wider significance.

In terms of the priority for undertaking action on the concerns raised, the following ranking system has been adopted:

- Priority 1 – Very high priority
- Priority 2 – High priority
- Priority 3 – Medium priority
- Priority 4 – Low priority.

4. PROJECT DETAILS

4.1 General

The Government of Malawi (GoM) has received a loan from the International Development Association (IDA) for the Additional Financing for the Agriculture Sector Wide Approach – Support Project (ASWAP - SP), a part of which is being used for the improvement and maintenance of unpaved roads. The rural roads component is aimed at enhancing the effectiveness of the ASWAP and the Farm Input Subsidy Program (FISP) programs by increasing access to agricultural input and output markets. The GoM through the Road Authority (RA) is applying a portion of the proceeds of this loan, and additional funds that might become available through a Multi Donor Trust Fund (MDTF), to eligible payments under this Contract; the design and supervision of road works.

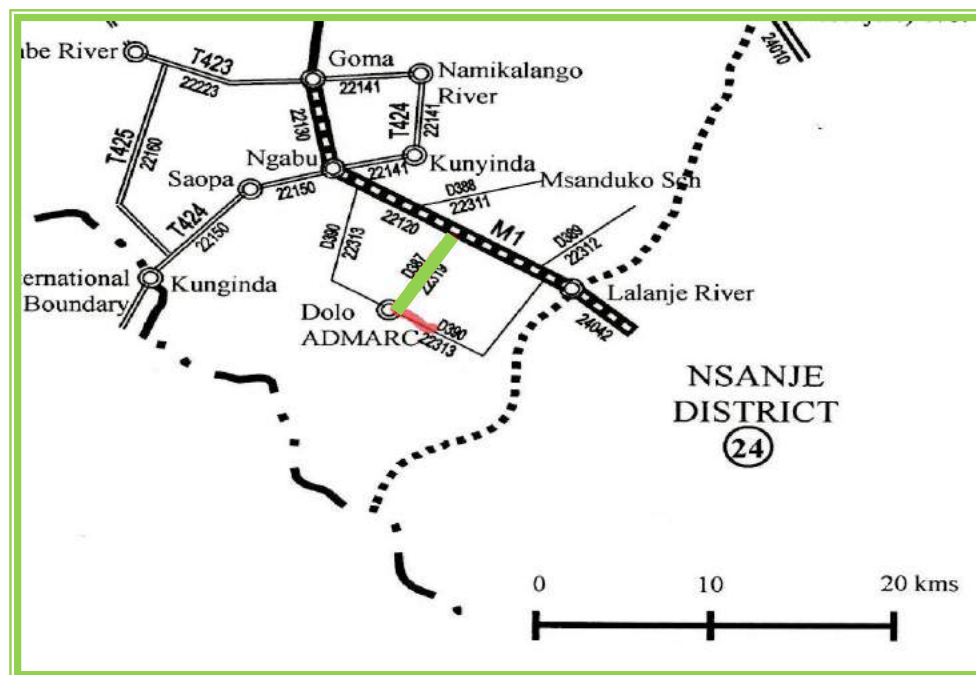
The objectives of the project are to:

- (i) Maintain and improve the condition of selected rural roads
- (ii) Increase access to productive areas, and social and administrative centers.
- (iii) Improve incomes of the rural population in the project area by increasing access to agricultural input and output markets.
- (iv) Build-up capacity of the small-scale local contracting industry.

The Roads Authority (RA) under the Ministry of Transport and Public Works (MTPW) is the main body responsible for implementing the roads component of the program. The design and contract documentation are being undertaken by a locally-based consulting firm, Royal Associates. The Ministry of Local Government and Rural Development (MOLGRD) - through the District Councils - played an important role in the identification of the project roads and for monitoring project implementation in their area of jurisdiction.

4.2 D387 Nsangwe – Dolo in Chikwawa District.

(a) Location



Upgrading section — Gravel rehabilitation section —
Location Map

The project road starts at Nsangwe trading centre at the M1/D387 junction. From here, the road takes a south westerly direction up to Dolo trading centre at km 5+500 where it joins D390 road and continues for another 3.5km ending at Lombe village.

(b) Topography and vegetation

The road traverses a rolling terrain, and the area lies in a low altitude area, between 90m to 200m above the sea level. The road passes through moderately rich agricultural area. Cotton and maize cultivation as well as cattle and goats rearing are the main agricultural activities prevalent in the area.



Figure 2: Start of D387 at junction with M1

(c) Rainfall

The area where the road section to be upgraded to bitumen standard is situated is relatively dry receiving an annual rainfall of 677mm. The rainfall season is between November and April, with January receiving the highest amount of rainfall.

(d) Drainage

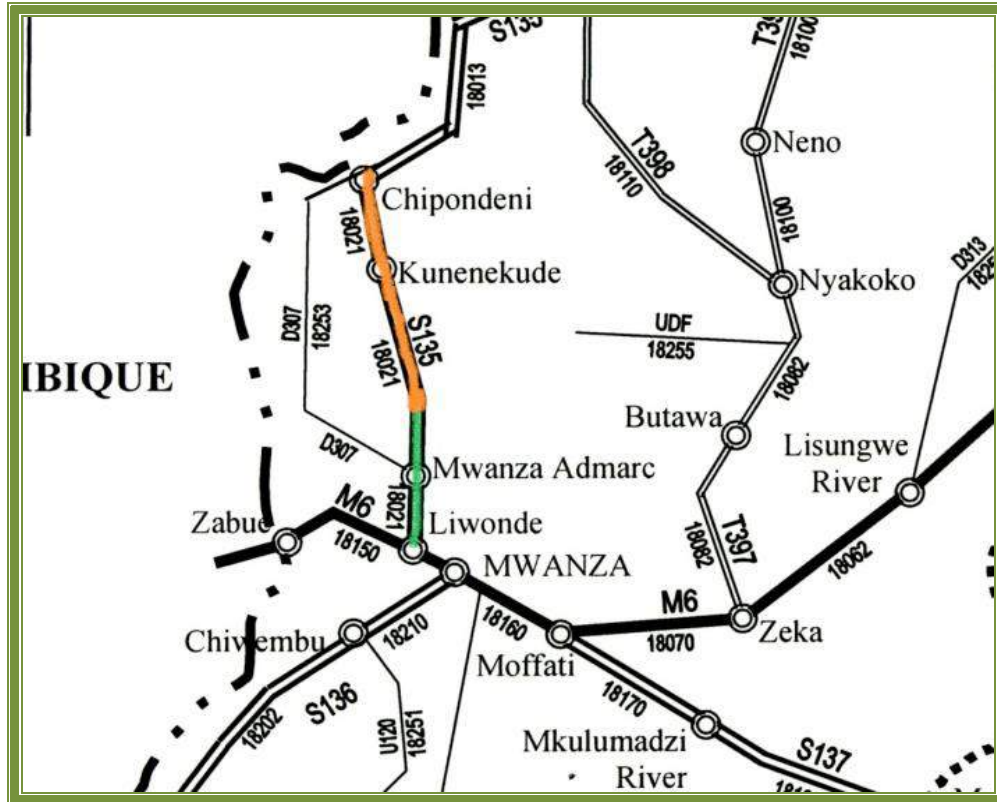
Several seasonal rivers cross the road section at km1+900, km4+000, km4+700 and km 5+500. The road passes through gently rolling terrain and drainage by gravity is attainable. Drainage structures have been designed at the river crossings based on hydrological analysis.

The first section of the road close to M1 is prone to flooding.

4.3 S135 Mwanza - Kunenekude in Mwanza District

(a) Location

The section of the road to be upgraded to bitumen standard starts at Mwanza Hospital at the M6/S135 junction (0661890E, 8275902N). From here, the road takes a north westerly direction up to Mwanza ADMARC at km 4+700 where it takes a northerly direction for the next 3.3km and ends at Km8+000.



Upgrading section — Gravel rehabilitation section —

Location Map

(b) Topography and vegetation

The area is at a moderate altitude ranging between 680 - 900m above sea level. The 8 km section to be upgraded traverses rolling terrain. The road passes through rich agricultural area. Citrus fruits, sweet and Irish potatoes cultivation are the main agricultural activities prevalent in the area.

(c) Rainfall

The area where the road section to be upgraded to bitumen standard is situated receives moderate rainfall (975 mm annually). The rainfall season is between November and April, with January receiving the highest amount of rainfall.

(d) Drainage

There are no rivers/streams which cross the road section to be upgraded to bitumen standard. Seasonal runoff from surrounding catchment generally damages some parts of the road sections where there are no drainage structures. The road passes through rolling to hilly terrain

and drainage by gravity is attainable. Drainage structures have been proposed appropriately based on the hydrological analysis.

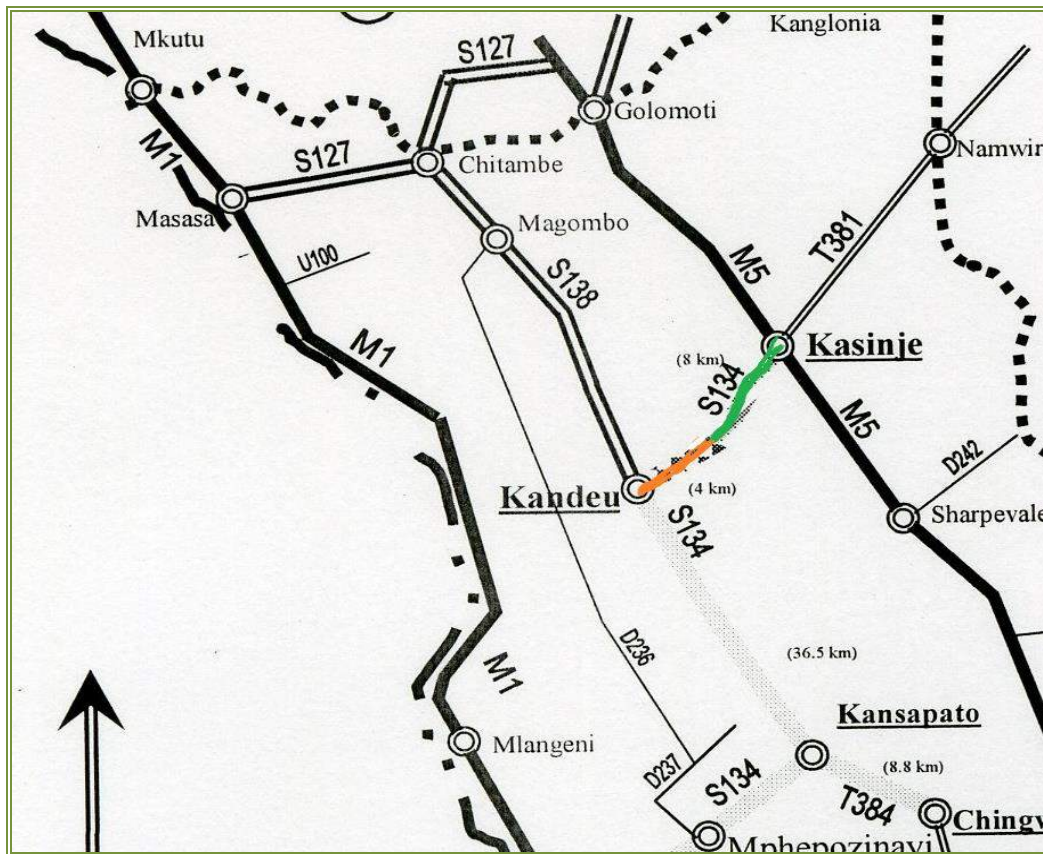


Figure 3: Typical section on Mwanza - Kunenekude road

4.4 S134 Kasinje - Kandeu in Ntcheu District

(a) Location

The project road is located in Ntcheu district, in the Central region of Malawi. The road section to be upgraded is part of the Kasinje-Ntcheu (S134) road and it starts at Kasinje and follows S134 road for 12km up to Kandeu trading centre . The existing road surface is an earth road without side drains in most sections. The existing road width is 4m on average.



Upgrading section  Gravel rehabilitation section 
Location Map

(b) Topography and vegetation

The area is at a moderate altitude at 500 - 600 m above sea level. The 8 km section to be upgraded traverses flat to gently rolling terrain. The road passes through rich agricultural area. Maize, sweet and Irish potatoes, groundnuts and cotton cultivation are the main agricultural activities prevalent in the area.

(c) Rainfall

The area where the road section to be upgraded to bitumen standard is situated receives moderate rainfall (954 mm annually). The rainfall season is between November and April, with January receiving the highest amount of rainfall.

(d) Drainage

There are two streams that cross the road within the 8.5 km section that is to be upgraded. The road passes through flat terrain within the first 3 km and rolling to hilly terrain in the next 5.5 km. Drainage by gravity is therefore attainable and hence occurrence of flooding is unlikely. Adequate drainage structures have been designed for the main stream crossings based on the hydrological analysis.

The first 3 km was characterized by the road having a sunken profile and serving as a drainage channel for water shedding off the surrounding land as well as serious erosion in the natural water courses.



Figure 4: S134 Kasinje – Kandeu. New culvert with invert well below side drain invert. Road level well below surrounding ground.

5. OUTCOME OF TECHNICAL AUDIT

5.1 Works Contract

5.1.1 Pavement design

The pavement of all the ASWAP-SP project roads was designed on the basis of the Malawi Design Manual for Low Volume Sealed Roads Using the DCP Design Method. Prior to this, and as part of the dissemination of the manual, a one-week training course was conducted in April 2014 for the supervision consultant and staff from the Roads Authority. This initial training raised the capacity of the participants to an intermediate level in respect of the use of the DCP-DN design approach.

From the review of the designs prepared by the supervision consultants, it was apparent that the design principles were well applied on all of the project roads. The reports were well structured and covered all aspects of a typical design process including:

- Materials investigations and testing
- Traffic counts and projections for future traffic and design traffic loading
- Hydrology and drainage design
- Geometric design

5.1.2 Surfacing design

The three projects were originally designed with different surfacings as follows:

D387 Nsangwe – Dolo: 19 mm Cold Mix Asphalt

S135 Mwanza – Kunenekude: 19 mm Cape Seal

S134 Kasinje – Kandeu: Slurry Bound Macadam

Cape Seal

During the first audit the auditors expressed the view that a 19 mm Cape Seal may be an unnecessarily expensive type of seal for the low traffic volumes on these roads. It was therefore proposed to consider replacing the current design with a 13 mm Cape Seal (13 mm Single Surface Dressing plus 1 layer of slurry) and that any savings arising from this re-design could then be used on the Road Safety measures indicated below. The argument is still valid for S135 Mwanza – Kunenekude since surfacing operations are still some way in future. **Significant Concern - Priority 2.**

Having witnessed the shortcomings in the construction of the Cape Seal on T357 Parachute Battalion – Lifuwu, the question arises whether the contractors for S134 and S135 will be more skilled and be better equipped to construct the seal in accordance with the correct procedures and to an acceptable standard. **Significant Concern - Priority 1.**

Cold Mix Asphalt

The Cold Mix Asphalt (CMA) was chosen for D387 due to the ready availability of suitable 6-10 mm aggregates near to the site as well as to the positive experiences with CMA as a durable seal and labour friendly option on similar projects elsewhere. Introduction of CMA in Malawi could also have a positive impact on maintenance operations. **Comment.**

To this end a training course funded by ASWAP-SP on the design and application of Cold Mix Asphalt surfacing was conducted in December 2015 with participation of the contractor's site staff as well as RA staff and staff from contractors involved in routine maintenance operations. The contractor should therefore be well equipped to construct good quality CMA surfacing following the correct procedures.

The quality and durability of the CMA require the aggregates to be within a fairly narrow grading envelope. This has now been achieved by sourcing 0-6 mm crusher dust from a crushing plant that when mixed 50-50 with the 6-10 mm stone the grading conforms to the specifications.

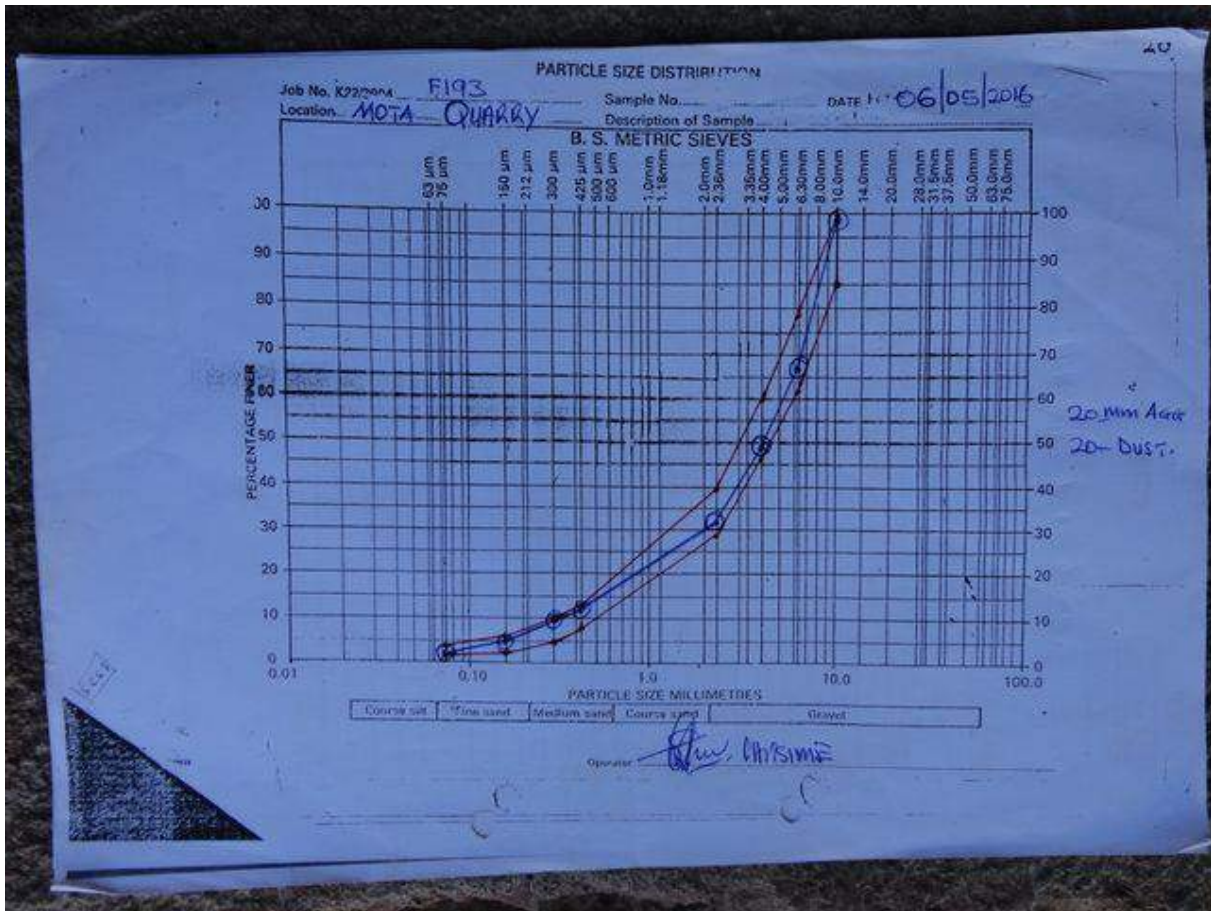


Figure 5: Grading analysis of CMA aggregates.

Close supervision and follow-up from the trainer is still required to ensure that the quality standards are upheld at all times, both as regards the aggregate grading and the application of the CMA on the road. **Significant Concern - Priority 3.**

Slurry Bound Macadam

The reason for choosing Slurry Bound Macadam (SBM) on S134 was the prevalence of hand knapped stone in the communities along the road thereby contributing to employment creation and income generation for the local population.

Training in the construction of SBM, as part of the same training contract as for the Cold Mix Asphalt, was conducted in April 2016 for the site staff on S134 and the supervising consultant. Although the construction of a small trial section came out successfully and construction procedures were established, the conclusion was that this surfacing option should be abandoned for the following reasons:

- The hand knapped stone proved to be unsuitable for the SBM (dirty, incorrect stone size)
- It would be very expensive and slow to construct for the entire road
- Curbs would be required all along the road to give lateral support to the 50 mm thick layer to prevent edge breaks

It was therefore recommended to construct a Cape Seal on this road instead, although Cold Mix Asphalt could still be considered. Concerns for these options would be as presented above.

Comment.

5.1.3 Road levels and drainage

It appears that the Design and Supervision Consultant has not adequately addressed the issue of achieving finished road levels that will ensure a minimum height of the crown above the side drain invert and to ensure minimum grades in the side drains to prevent accumulation of water and weakening of the pavement in the wet season. A new survey of the as-built road levels had therefore previously been requested by the ASWAP Adviser as a basis for producing a comprehensive drainage plan. No such plans had been produced or made available to the Auditors on any of the three sites.

The levels determined with the geometric design software based on the initial survey have simply been applied without checking how these correspond with the conditions on the ground, such that some sections have excessive fills and on neighbouring sections the finished road level is virtually at or sometimes below surrounding ground level. The software design levels should therefore have been overridden to ensure the required height of crown above drain invert and adequate flow in the side drains. This applies to all three roads to varying degrees and has resulted in sub-optimal solutions specifically as regards invert levels and outlet drains for cross culverts.

Particularly on S134 Kasinje – Kandeu the finished road level is at or up to 1.0 m below the surrounding ground level on long sections on the first 3 km. Here a lot of useful material from the existing alignment has been removed instead of using it to raise the road level.

On both S134 Kasinje – Kandeu and D387 Nsangwe – Dolo it is required that a total drainage plan with adjusted road levels be worked out. **Serious concern – Priority 1.**

Also on S135 Mwanza road levels need to be raised on some sections to ensure adequate height of crown above side drain invert, although on this road the flow in the side drains is not a problem due to the continuous positive or negative grades in the vertical alignment. **Significant concern – Priority 1.**

5.1.4 Materials

The material from the borrow pits identified during design stage for S134 Kasinje – Kandeu and D387 Nsangwe – Dolo satisfy the strength requirements for traffic class TLC 0.3 as well as PI and grading limits.

On S134 Kasinje – Kandeu the original borrow pit had been exhausted and a new pit opened up just next to the original one. It appears that the material from the new pit has been used without the required testing and approval by the DSC Materials Engineer. Testing of this material must be carried out and approval given. **Significant concern – Priority 1.**

On S135 Mwanza – Kunenekude the borrow pit material that has been used for the base does not satisfy the strength requirement for TLC 0.3. Both the Laboratory DN test for this material and post construction DCP tests show that the material is generally too weak at OMC.

At this stage when the base has already been constructed on the whole road, a possible remedial action available will be to scarify the top 150 mm and mechanically stabilise the base with crusher dust or other suitable material. Laboratory tests should be carried out to determine the optimum method for acquiring sufficient strength of the base before the base is reworked. Any new base material placed on the road to lift the road level must of course be treated in the same manner. **Serious concern – Priority 1.**

5.1.5 Quality Assurance and Control

Both the contractors and the DCS seem to be unaware of the need for proper quality assurance systems and procedures. None of the contractors have a comprehensive Quality Assurance Plan in place. Records are therefore generally not filed and summarised in a systematic manner, although there is some variation in this regard between the three sites. This makes it difficult to verify the quality of the works. **Serious concern – Priority 1.**

On all sites sheep's foot roller was used for compaction of the layer works in addition to heavy vibratory rollers to achieve the density requirements specified in the contract.

Attempts were also made to carry out construction compaction control using the DCP. The **Draft Guideline for Quality Control using the DCP** would have guided the site staff to carry out these tests, although no training had been conducted in the application of the procedures, and for some reason it had only been distributed to the Team Leader for the DSC, but apparently not to the site.

The DCP tests made available to the Auditors indicate that sufficient compaction may have been achieved on S D387 Nsangwe – Dolo and S134 Kasinje – Kandeu, whereas the DCP tests on S135 Mwanza – Kunenekude showed too high DN values even when the DCP tests had been carried out after some drying back of the layers.

Due to the general lack of systematic recording and filing of test results, the auditors requested that all quality control tests be summarised and handed over for their review. However, no such summaries were made available during the audit period and the observations and recommendations in this regard are therefore based on the few results that were made available to them.

Until the method for compaction control using the DCP is properly established and staff have been trained, dry density tests must be carried.

5.1.6 Environmental, social and road safety

Environmental and Social Impact aspects of the design were also covered adequately and in accordance with standard requirements.

The road safety aspects of the design were addressed in a general manner and did not adequately cater for the significant amount of non-motorised traffic which passes through some densely populated villages and settlements. Accordingly, the auditors would recommend the adoption of Road Safety Plan specific to the particular roads and road environment based on the "Village Treatment" scheme outlined in the Malawi DCP Design Manual. **Significant Concern – Priority 1.**

The auditors also discussed with the ASWAP-SP Roads Advisor the possibility of adopting an innovative / experimental road marking scheme which involves hatched marking of a central lane 4.0 m wide leaving 1.25 m wide "shoulders" on either side as a means of allowing space for non-motorised traffic on the shoulders. This idea builds on the "narrow mat" design concept that has been used on LVSR, for example, in Zimbabwe, except with the difference that in this case the "shoulders" are sealed. Before a decision is made, the issue must be discussed and agreed with the Roads Authority and research carried out on possible positive effects of similar schemes on LVSR. **Minor Concern – Priority 3.**

5.1.7 Specifications

The SATCC Standard Specifications for Roads and Bridge Works (2001) has been incorporated in the Contract Documents as is the normal practice in Malawi. However, the SATCC Standard Specifications are based generally on the use of the Mod AASHTO standards whereas the Malawi national standards are based generally on BS (British Standards). This has resulted in a mix-up of specifications and test methods being used, which is likely to produce misleading or conflicting results.

For the layer works in particular the SATTC specifications use the conventional relative field density requirements for subgrade/fill, subbase and base at 93%, 95% and 98% Mod AASHTO respectively, coupled with CBR strength requirements. In contrast, the DCP-DN method specifies only the maximum DN value for each layer provided that the materials used are otherwise found to be of appropriate quality. The Malawi DCP Design Manual also recommends “compaction to refusal” for all layer works to attain the maximum possible strength and stiffness of the pavement with the available compaction plant.

With the lack of Bidding / Contract Documents specifically tailored to the DCP-DN Design Method, both the SATCC specifications and the DN requirements are currently included in the Works Contracts. This creates confusion and may lead to some materials that would satisfy the DCP-DN requirement, and which would likely be fit-for-purpose, being rejected because of, for example, not satisfying a strict grading requirement or materials of unnecessary high quality being specified.

In view of the above, the auditors recommend that the current contract documents be amended to include BS standards, where applicable, and that the specification requirements for material selection, and the compaction requirements, be in accordance with the Malawi Design Manual for Low Volume sealed Roads Using the DCP. **Serious Concern – Priority 1.**

The auditors also recommend the preparation of an appropriate contract document template and specifications for projects designed with the DCP-DN method. **Significant Concern – Priority 2.**

5.2 Project Staff and Site Establishment

5.2.1 Contractors

Fargo Limited were awarded the contracts for S134 Kasinje – Kandeu and D387 Nsangwe – Dolo. Both sites appear to have the required qualified staff on site. The auditors had a good impression of the construction teams’ general experience and skills level. They were also willing to listen and were open to advice on the various issues discussed during the site visits and meetings. The contractor was well established with site offices and a small laboratory and have the required plant and equipment, most of it not new but in a reasonable working condition.

Hema Construction was awarded the contract for S135 Mwanza – Kunenekude. The contractor has had a turnover of staff and lacking some key personnel, most notably a qualified site agent. The site camp gives a messy impression with lots of old plant and equipment lying around. It appears that the contractor has transferred his best equipment to another site. **Serious concern – Priority 1.**

5.2.2 Supervising Engineer’s staff

The supervising engineer appears to have a full staff complement assigned to the projects in accordance with the contract with the Roads Authority. However, the Materials Engineer, who is the key person in the team, was absent at the time of the mission and appeared not to have spent much time on the project. This is of great concern since it is of paramount importance that the extraction of material from the borrow pits is properly managed and that testing is done regularly to ensure that the materials brought to site are of the required quality. The auditors recommend that the Materials

Engineer be required to spend adequate time on site until all materials-related issues are operating smoothly. This includes borrow pit opening, material stockpiling and testing, laboratory testing, quality control testing, etc.

As highlighted above, the Supervising Engineer's staff in general seems to be lacking the awareness and appreciation of the requirements of the project in many respects, such as lack of a Quality Assurance System on part of the contractors and on their own part to ensure correct road levels in relation to the surrounding ground level and to attain a functional drainage system. **Serious Concern – Priority 1.**

5.3 Summary of Audit Recommendations

An exit meeting was held with all parties to the contract on 15 June 2016, at which all the findings of the audit were reviewed and the recommendations discussed as indicated in Section 5.2 above.

5.4 Procedural Requirements

The procedure for implementing the auditor's recommendations is as follows:

- Auditor's draft audit report is submitted to the client (the RA)
- Client issues the draft report to the auditees (supervising engineer and contractor) requesting their comments within two weeks on the findings, conclusions and recommendations.
- Auditees to prepare and submit comments on audit report to the client. In this regard, the Auditees response to the Client will:
 - Recommend whether or not each audit recommendation should be adopted.
 - Document the reasons for their views.
 - Indicate the cost and implications of implementing each audit recommendation.
- Client to make his final decisions on the Auditor's recommendations and to advise the Auditees and the Auditor accordingly.
- Client to instruct the consultant or contractor to implement the recommendations.

6. SUMMARY OF FINDINGS

6.1 Summary

A summary of the main findings based on (a) a review of the project documents, (b) site inspections, and (c) discussions with the parties to the contract, is presented in Table 1 below.

As can be seen, most of the issues common to all sites identified during the 1st audit exercise have still not been resolved or not been adequately addressed by the project.

The issues pertaining to the contract documents and specifications are of serious concern, but difficult to address mid term during the construction period. It is the view of the auditors that a contract document template and specifications tailored to the DCP-DN Design Method should be developed by AfCAP for incorporation in future contracts.

6.2 Way Forward

In order to implement the recommendations of the audit report, the client is required to follow the sequence of activities under 5.4 above, which includes seeking comments from the supervising engineer and contractor. On that basis, the Client can then decide which of the auditor's recommendations to implement.

Table 1: Summary of findings

Category	Item	Degree of Concern	Priority			Comment
			1 st audit	2 nd audit	3 rd audit	
Works Contract	Design of Cape Seal surfacing	Significant	2	2		Issues identified during 1st audit still valid/ unresolved
	Road safety	Significant	2	2		
	Road marking	Minor	3	3		
	Specifications	Serious	1	1		
	New Contract Document Template	Significant	2	2		
Project staff	Supervising Engineer's staff	Serious	1	1		As above
Site Issues – D11 Kalenge Bridge – Misuku Dika Construction	Quality Assurance System/Plan	Serious	1			
	Gravel wearing course selection chart	Serious	1			
	Design of concrete slabs and strips	Serious	1			
	Camber of concrete slabs	Serious	1			
	Support to concrete slabs	Serious	1			
Site issues – T357 Parachute Battalion- Lifuwu SOS Construction	Quality assurance System/Plan	Serious	1			
	Approval procedures for borrrpw pit material	Serious	1			
	Accommodation of traffic	Serious	1			
Site Issues – D387 Nsangwe – Dolo (Fargo Limited)	Quality Assurance System/Plan	Serious		1		Not addressed by project
	Road levels / Drainage plan	Serious		1		Levels sectionwise too low
	Quality control of layer works using the DCP	Significant		1		Implement guideline
	Construction of Cold Mix Asphalt	Significant		3		Close supervision required
Site issues – S135 Mwanza – Kunenekude (Hema Construction)	Quality Assurance System/Plan	Serious		1		Not addressed by project
	Borrow pit material for base layer	Serious		1		Lack of testing/approval
	Road levels / Drainage Plan	Significant		1		Levels sectionwise too low
	Quality control of layer works using the DCP	Significant		1		Implement guideline
	Construction of Cape Seal surfacing	Significant		1		Requires experience/skills
Site issues – S134 Kasinje – Kandeu (Fargo Limited)	Contractor's Site staff	Serious		1		Site Agent not present
	Quality Assurance System/Plan	Serious		1		Not addressed by project
	Road levels / Drainage Plan	Serious		1		Levels sectionwise too low
	Approval of new borrow pit	Significant		1		Lack o testing/approval
	Quality control of layer works using the DCP	Significant		1		Implement guideline
Construction of Cape Seal surfacing	Significant		1		Requires experience/skills	

Annex 1: List of participants in Exit Meeting

Name	Organisation	Designation	Mobile	E-mail
David Geilinger	Roads Authority	Rural Roads Adviser	0882094223	dgeilinger@gmail.com
Owen J. Mahowe	Royal Associates	Regional Roads Engineer	0999208664	owenmahowe@yahoo.com
Dambuleni Phiri	Fargo Ltd	Lab Technician	0998134865	
Steaner Chitsime	Fargo Ltd	Lab Technician	0884727257	
Harry B. Makina	Fargo Ltd	Site Agent	0888822205	hbmakina@yahoo.co.uk
Bakali A. Kapeloni	Fargo Ltd	Site Agent	0888841346	bakalikapeloni@gmail.com
Luke Kanjira	Royal Associates	Road Engineer	0885596673	lkanjiragama@gmail.com
Kamau Kariuki	Royal Associates	Team Leader	0888822061	kmwkariuki@gmail.com
Christopher Zimba	Royal Associates	Design Technician	0999365487	chrisspacec@mail.com
Master Chirwa	Royal Associates	Roads Engineer	0999325382	mfcchirwa@yahoo.com
Brian Nyirongo	Roads Authority	Project Engineer	0999469205	bnvirongo@ra.org.mw
David Mtilatila	Royal Associates	Regional Roads Engineer	0991672936	damtilatila@gmail.com
Muyiri S. Longwe	Hema Construction	Site Agent	0884440489	longwemuyiri@gmail.com
Precious Kamndaya	Royal Associates	Assistant Roads Engineer	0995486089	precious.kamndaya@gmail.com
Estime Mukandila	AfCAP	Consultant/Auditor		estime.mukandila@worleyparsons.com
Jon Hongve	AfCAP	Consultant/Auditor		joho@operamail.com
M. R. Phiri	Roads Authority	ASWAP-SP Co-ordinator	0888843914	mphiri@ra.org.mw

Annex 2: Notes on T357 Parachute Battalion – Lifuwu

Cape Seal surfacing operations

It is apparent that the contractor is not adequately equipped, nor having the required experience or expertise for construction of a high quality Cape Seal surfacing. This is evidenced by the following observations:

- The contractor's bitumen distributor is old and causes a lot of problems during the spraying of bitumen resulting in:
 - Uneven application rate (calibration and "bakkie test" not carried out)
 - Patched not covered with bitumen resulting in aggregate loss. Manual spraying of the patches resulting in over-application, accumulation of aggregates on these spots and uneven surface.
 - Truck mounted chip spreader not matching the width of the bitumen distributor resulting in strip of approximately 0.8 m having to be sprayed manually.
 - Application of chips not calibrated resulting in over-application.
 - Bitumen distributor not equipped with pointer resulting in spray not applied in straight lines
 - Mechanical broom or manual brooming not able to remove all excess chippings and dust accumulating in the voids between the chippings
 - Compressor needed for blowing out dust and dirt, but compressor broken down
 - First layer of slurry filling up the voids between chippings. Second layer therefore lying on top and will be worn off quickly under traffic.

These deficiencies have resulted in a sub-standard Cape Seal, although the slurry effectively covers most of the problems with the underlying chip seal.



Figure 6: Patchy work and irregular lines



Figure 7: Patch not covered with bitumen, loss of aggregates



Figure 8: Surface texture before application of slurry



Figure 9: Uneven surface due to irregular bitumen spray rate

For the benefit of the contractors who are yet to construct Cape Seal on S134 and S135 an orientation on correct procedures for construction of Cape Seal was given at the Exit Meeting.

Cold Mix Asphalt surfacing

It was noted that after the training, the construction teams resorted to construction in two wide strips on each half instead of three strips of about 1 m width each as they had been taught. Going wider than 1.2 m makes the spreading and screeding more difficult and may result in a substandard surfacing (uneven thickness, segregation of aggregates etc.).

Several small defects were observed that need to be rectified. It was also observed that the shoulders on some sections had not been sufficiently compacted resulting in longitudinal cracks about 0.5 m from the edge and transverse cracks from the edge to about 0.5 m from the edge. One short section also had a deep wheel track on it close to the edge further confirming the inadequate compaction of the shoulders.



Figure 10: Small defects in CMA



Figure 11: Edge of CMA too thin



Figure 12: Wheel track on loose shoulder



Figure 13: CMA section

Drain lining

Long sections of lined drains are being constructed. However, the drain cross section is not consistent, sometimes with a relatively flat in-slope which will encourage vehicles to drive onto it and sometimes with steep in-slopes and backslopes, for no apparent reason.

The drain lining is also not following the line of the road, sometimes the edge of the lining is at or close to the edge of the surfacing, other times there's a wide gap. This makes for a very untidy appearance. The gap will have to be covered, probably with concrete, to prevent ingress of water and erosion.



Figure 14: Gap between drain lining and surfacing.
Wide, shallow drain



Figure 15: Narrow drain with steep sides

Annex 3: Presentation at Exit Meeting

26/07/2016



3.1 Ranking system for concerns and action priority

All concerns identified in the audit are considered of sufficient importance to require action. To assist the Client and Consultant to gauge the relevant importance of the concerns raised, the following ranking system has been adopted:

- **Serious concern:** a major concern that should be addressed and requires changes to the project to avoid serious technical problems.
- **Significant concern:** a significant concern that requires consideration of changes to improve the technical shortcomings of the project.
- **Minor concern:** a concern of lesser significance, but which should be addressed as it may improve the overall performance of the project.
- **Comment:** a concern or an action that may be outside the scope of the technical audit, but which may improve the overall design or be of wider significance.

In terms of the priority for undertaking action on the concerns raised, the following ranking system has been adopted:

- Priority 1 – Very high priority
- Priority 2 – High priority
- Priority 3 – Medium priority
- Priority 4 – Low priority.

Outcome of Audit – Major issues

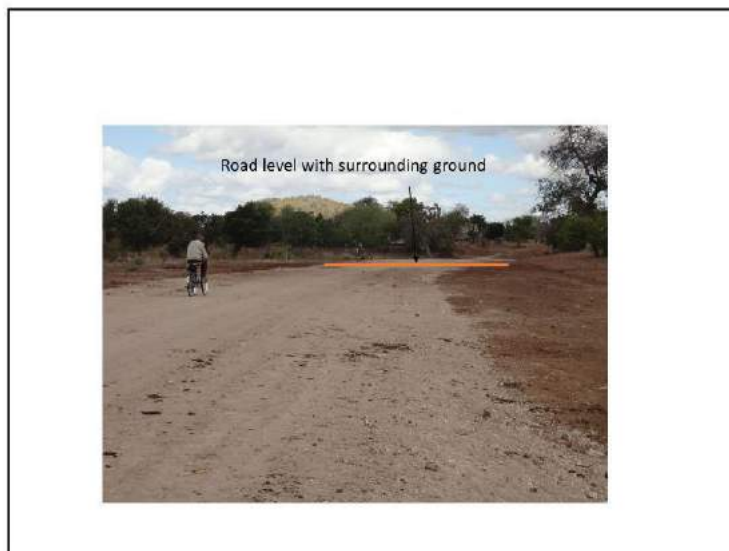
- Road levels / drainage plan
 - Inadequate attention to attaining sufficient height of crown above drain invert level
 - Alignment soils / side borrow not utilised to raise road levels, instead material from the alignment has been removed to spoil
 - Design levels from software design package must be overridden to attain correct levels and to ensure adequate drainage
 - Finished road level still well below surrounding ground on some sections
 - Sub-optimal solutions as regards cross drainage and culvert outlets
 - Total drainage plan on strip maps required

Serious concern S134 and D387

Significant concern S135



26/07/2016



Outcome of Audit – Major issues

- **Lack of Quality Assurance System / Plan**
 - Records not filed and summarised in a systematic manner
 - Difficult to ascertain the quality of the works
 - Recommended procedures for Quality Control using the DCP not followed – Guideline not distributed to site staff
 - Lack of awareness of need for proper QA and QC systems and procedures

Serious concern

Outcome of Audit – Major issues

- Borrow pit materials
 - S135 Mwanza – Kunenekude
 - Base material too weak (DN to high)
 - Recommended reprocessing and mechanical stabilisation of base
 - Test with blending with crusher dust
 - Cement stabilisation – Last resort
 - S134 Kasinje – Kandeu
 - New / extended borrow pit not approved
 - Royal Associates Materials Engineer to approve all borrow pit materials
 - Testing to be done in accordance with recommendations in DCP Design Manual and whenever new pits are opened or existing pits extended

Serious concern

Outcome of Audit – Major issues

- Staffing
 - Royal Associates Materials Engineer seemingly not in full control as regards and borrow pit utilisation and materials quality
 - Hema Construction - Qualified site staff not present in accordance with contract

Serious concern

Outcome of Audit – Major issues

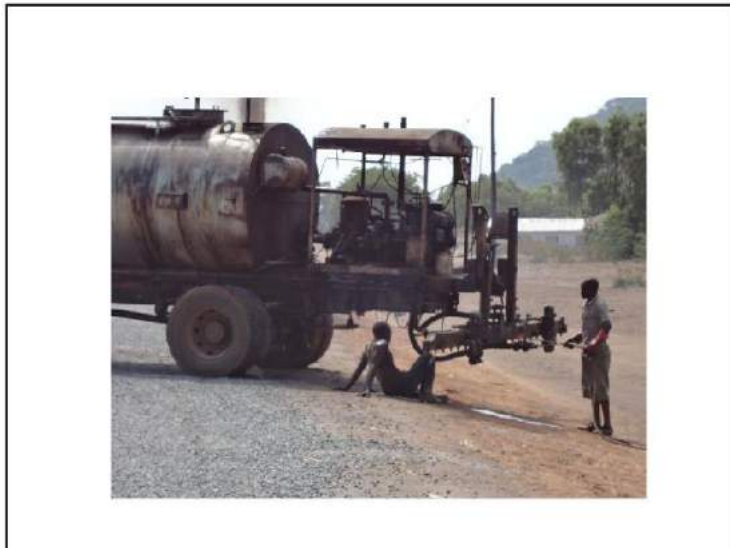
- Surfacing

- Reconsider need for 19 mm Cape Seal. 13 mm probably sufficient on these roads.
- Contractors' experience and skills level in construction of Cape Seal?
- Condition of equipment ? (distributors, PTRs)
- Close supervision and follow-up on surfacing works required (Cape Seal, Cold Mix Asphalt)

Serious / Significant concern



26/07/2016



26/07/2016

Summary

Category	Item	Degree of Concern	Priority
Works Contract	Design of Cape Seal surfacing	Significant	2
	Road safety	Significant	2
	Road marking	Minor	3
	Specifications	Serious	1
	New Contract Document Template	Significant	2
Project staff	Supervising Engineer's staff	Serious	1
Site Issues – D387 Nsangwe – Dolo	Quality Assurance System/Plan	Serious	1
	Road levels / Drainage plan	Serious	1
	Quality control of layer works using the DCP	Significant	1
	Construction of Cold Mix Asphalt	Significant	3
Site Issues – S135 Mwanza – Kunenekude	Quality Assurance System/Plan	Serious	1
	Borrow pit material for base layer	Serious	1
	Road levels / Drainage Plan	Significant	1
	Quality control of layer works using the DCP	Significant	1
	Construction of Cape Seal surfacing	Significant	1
	Contractor's Site staff	Serious	1
Site Issues – S134 KasInje – Kandeu	Quality Assurance System/Plan	Serious	1
	Road levels / Drainage Plan	Serious	1
	Approval of new borrow pit	Significant	1
	Quality control of layer works using the DCP	Significant	1
	Construction of Cape Seal surfacing	Significant	1