Development and support to the implementation of a Strategic Plan for the Establishment of Sustainable Road Research Capacity in Malawi

Final Report

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Abstract

The building of local research capacity in African countries is a long term objective of the Africa Community Access Programme (AfCAP) and it is through this programme that safe and sustainable rural access in Africa is being promoted through research and knowledge sharing between participating countries and the wider community. Cognisant of the need to strengthen road research capacity in the country, the Government of Malawi, through the Roads Authority, requested for technical support from (AfCAP) for the activities to develop and support the implementation of a Strategic Plan for the establishment of sustainable road research capacity building programme in the country. This Strategic Plan was developed through consultative meetings and workshops with key stakeholders in the road sector. Outcomes of the situational assessment are presented, identifying the gaps. The linkage of the Strategic Plan to national transport policy framework is established. Institutional arrangements, including actions plans with time-lines are presented for the implementation and operationalization of the programme to ensure sustainable road research capacity building in Malawi.

Key words

Institutional framework, Research centre, Strategic capacity.

Acronyms, Units and Currencies

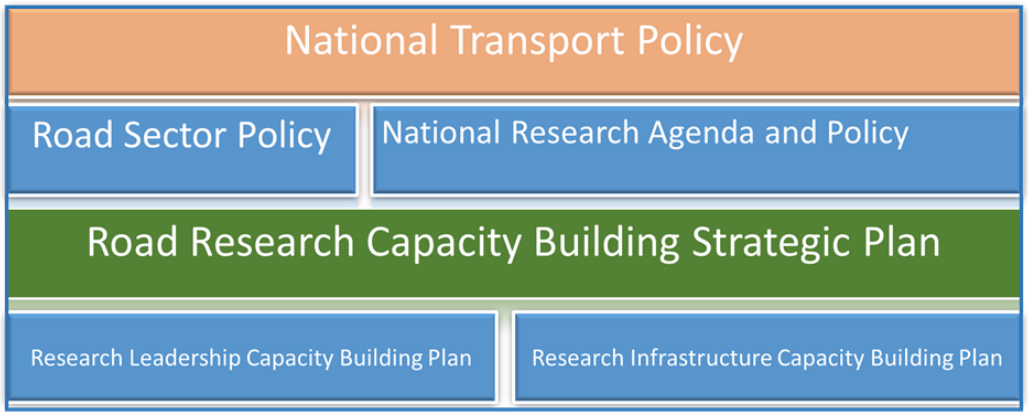
ACEM	Association of Consulting Engineers of Malawi
AfCAP	Africa Community Access Partnership
AfDB	African Development Bank
CML	Central Materials Laboratory
CSIR	Council for Scientific and Industrial Research
DFID	Department for International Development
GBP	United Kingdom Pound (1 GBP = 938.72 MWK, as at 16 August 2018)
GoM	Government of Malawi
JICA	Japan International Cooperation Agency
LUANAR	Lilongwe University of Agriculture and Natural Resources
MGDS	Malawi Growth and Development Strategy
MIE	Malawi Institution of Engineers
MNTP	The Malawi National Transport Policy
MoTPW	Ministry of Transport and Public Works
MWK	Malawi Kwacha
NCEIES	National Committee on Energy, Industrial and Engineering Sciences
NCIC	National Construction Industry Council of Malawi
NCST	National Commission for Science and Technology
RA	Roads Authority
ReCAP	Research for Community Access Partnership
RFA	Roads Fund Administration
RRAC	Road Research Advisory Committee
RRC	Road Research Centre
RRCaB	Road Research Capacity Building
RSC	Research Steering Committee
RSP	Road Sector Programme
RST	Research Technical Committee
SETI	Science, Engineering, Technology and Innovation
T^2	Transport Technology Transfer Centre

Executive summary

The overall objective of this project was to assist the Malawi Roads Authority (RA) in collaboration with the Transport Technology Transfer (T^2) Centre based at the University of Malawi Polytechnic in Blantyre with its institutional set up for road research and to develop a strategic plan for implementation of research. In order to give effect to this objective, the situational assessment was conducted first, through consultative meetings with key stakeholders in the road sector, covering cross-cutting issues such as: existing policy plans and strategies; institutional and administrative set up in the road sector; training institutions playing a role in capacity building for the road sector; available and capacity of road construction materials testing facilities; road research capacity and institutional cooperation. This was followed by three stakeholder workshops. The findings have been incorporated in setting the framework to guide the development of the road sector-research capacity building strategic plan. The strategic initiatives and processes outlined in this document are aimed at guiding the RA in the establishment and development of sustainable road research capacity in the country.

One of the key findings is that there is need to increase the number of professionals in the road sector. There is currently no institution offering training for laboratory technologists specifically focusing on road construction materials testing. The need to provide high-quality training programmes in the road sector is an opportunity for the establishment of a Road Research Centre that in addition to conducting research, could offer special courses to train laboratory personnel and contribute towards capacity building for the road sector in the country.

The road research capacity building strategy has been linked to and established within a national transport policy framework as shown below:



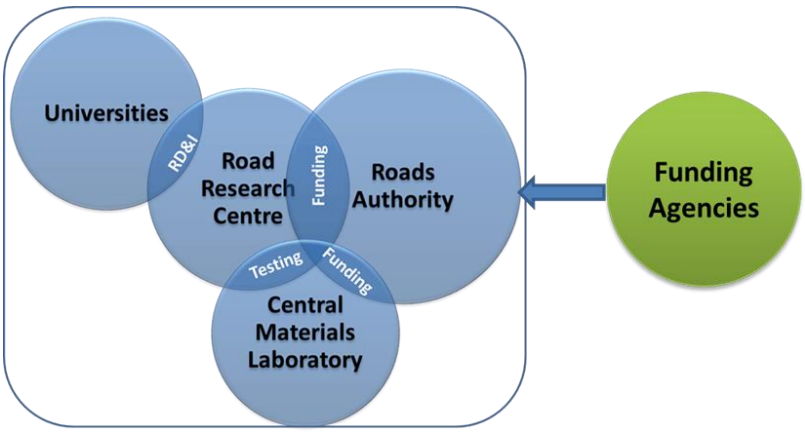
The strategic plan sets out the future aspirations for the road research capacity building programme, the Vision and Mission of the Road Research (RRC) are formulated as follows:

> Vision: ***A recognised institution dedicated to the delivery of innovative road research-based solutions."***
>
> Mission***: The provision of sustainable road sector research, training and state-of-the art services to support the economic growth of Malawi"***

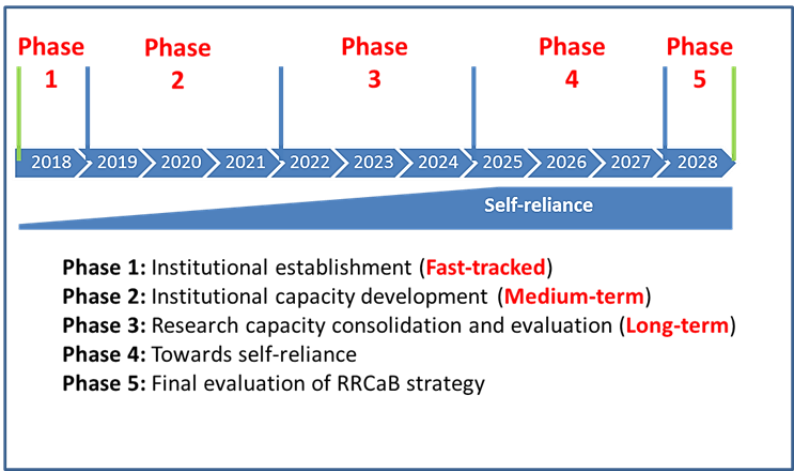
The overarching priority areas of the RRC that will contribute to the achievement of the objective of building sustainable road research capacity in the country are defined as follows:

- Priority Area 1: Enhance knowledge through research to address road sector challenges
- Priority Area 2: Capacity development.
- Priority Area 3: Knowledge transfer and road research uptake.
- Priority Area 4: Expert services.
- Priority Area 5: Collaboration.

Implementation arrangements for the strategy include proposed institutional structure and arrangements. The road research capacity building short term implementation model is shown below:



The Strategic Plan outlines the developed Plans of Action with implementation time-lines for the key activities required to establish and operationalize the Road Research Centre. Included are plans to overcome identified risks, as they potentially are barriers to successful implementation of a sustainable Road Research Capacity Building programme. Achieving self-reliance is the long-term overall strategy for the RRC and is to be implemented incrementally in phases, over a period of 10-years as schematically presented in the time-line phase diagram below:



For the Strategic Plan to be fully realized the project momentum towards the implementation of the road research capacity building strategic plan should be maintained, it is recommended that the RA pursues the following within three months:

- Immediately takes steps to elevate research and development to a Unit/Department level under the Design and Planning Directorate. Reference is made to Section 12 and Section 13(b) of the Roads Authority Act, indicating that the Roads Authority has within itself the powers to run a research department. This will provide the appropriate environment to establish research as an important element of the core business of the RA.
- Establishes an interim Road Research Management Committee (RRMC) by September 2018, to advise and assist the Director of Design and Planning, on issues related to recruitment of research staff and in reviewing progress to ensure that RA attains the objectives of the RRCaB Strategic Plan.
- Recruits staff to focus on research. The RA has already planned for the recruitment of two staff members by October 2018, to focus on the implementation of research-related activities. This should be a priority as it is crucial to the implementation of the RRCaB and will demonstrate commitment by the RA to integrate research in its operations.

It is further recommended that the RA pursues the following in the first 12 months:

Action	Actioned by	Deadline
Recruit qualified research staff	Director, Design & Planning 1 Sep 2018	31 Oct 2018

Establish Road Research Advisory Committees (RRACs) to prioritise research projects and to reach sufficient consensus on the first series of priority projects for funding in the next Financial Year	Director, Design & Planning 1 Oct 2018	31 Oct 2018
RA initiates process to appoint Head of R&D with stakeholder input. To be dictated by RA processes.	Director, Design & Planning RRMC 1 Oct 2018	31 Oct 2018
Establish funding model for research. RRCaB will constitute an additional dimension to the structure of the RA.	Director, Design & Planning 1 Oct 2018	30 Nov 2018
Develop or adopt guidelines for a research policy and mentorship programmes	Director, Design & Planning 1 Oct 2018	30 Nov 2018
Design and initiate capacity building programmes for staff to nurture research development.	Director, Design & Planning 1 Oct 2018	30 Nov 2018
Decide on location of RRC and form a Project Steering Committee for the construction of a modern and comprehensive materials laboratory for the testing of materials used in road works.	Director, Design & Planning 1 Oct 2018	31 Dec 2018
Recruit Laboratory Manager (in the interim use CML structure, to be effected by MoTPW)	Director, Design & Planning 1 Nov 2018	31 Dec 2018
Conduct survey on implementation of training programmes for the road sector	Director, Design & Planning 1 Oct 2018	31 Dec 2018
Develop or adopt consultancy policy to guide the management thereof.	Director, Design & Planning 1 Oct 2018	31 Dec 2018
Initiate at least the first two research projects in addition to linkage to AfCAP regional LTPP project (RAF2132A)	Director, Design & Planning 1 Nov	31 Dec 2018
Design and implementation of individual staff development schemes.	Head, R&D 1 Nov 2018	28 February 2019
Secondment of Laboratory Manager to an accredited Laboratory	Head, R&D 1 February 2019	29 March 2019
Develop a Laboratory Strategic Plan (LSP).	Laboratory Manager 1 April 2019	30 April 2019
Start construction of new laboratory.	Director, Design & Planning 1 April 2019	30 April 2019
Strengthen required skills specifically for laboratory personnel.	Laboratory Manager 1 April 2019	31 May 2019
Development and implementation of Information Management Systems, enhance data collection and storage and efficient dissemination of research results.	Head of R&D 1 April 2019	31 June 2019
Establish standardised operational procedures for regulating everyday management of the laboratory, ensure Quality Assurance systems towards accreditation	Laboratory Manager 1 May 2019	31 July 2019
Develop and implement policy on publicising, promoting RRC's research, nationally and internationally.	Head of R&D 1 May 2019	31 July 2019
Procurement of basic standard laboratory equipment, with first lot of 5 more advanced equipment. However, timing linked to stage of construction of new facility.	Laboratory Manager 1 June 2019	31 Aug 2019

1 Introduction

1.1 Background

Reliable access is essential, in particular for rural communities, in countries such as Malawi, with 83.7% of the population living in rural areas as of 2015 and whose economy is agro-based with agriculture contributing around 30.0 percent to GDP, according to the recent Economic Development Document (IMF, 2017). The provision of reliable and cost-effective transport infrastructure is therefore critical in order to promote economic development of the country.

Malawi's public road network coverage by end June 2016 was at 15,451 km, of which 4,312 km (28 percent) are paved and the rest, (72 percent), unpaved and mostly earth standard. The condition of the 4,312 km of paved roads as of June 2014 reveals that 38 percent, 40 percent, and 22 percent are in good, fair and poor condition respectively. On the other hand, the 2011 condition survey revealed that 60 percent, 33 percent and 7 percent were in good, fair and poor condition respectively (RA, 2011). This shows that the road network condition has deteriorated. The (2017-2022) Strategic and Business Plan (RA, 2017), identifies the need to develop construction and maintenance methods to ensure climate resilient road infrastructure as one of its Strategic Outcomes. Taking this into account and the fact that 72 percent of the road network is unpaved, innovative solutions through research are urgently required, so that the country's road network functions as an enabler of economic growth. Institutional road research capacity building is therefore the means of improving the provision of reliable transport infrastructure and access.

In this regard, the Africa Community Access Partnership (AfCAP) is promoting safe and sustainable rural access in Africa through research and knowledge sharing between participating countries and the wider community. It is a programme of research and knowledge dissemination funded by the UK government, through the Department for International Development (DFID). This is aimed at encouraging the uptake of appropriate research findings and solutions in support of providing cost effective and durable rural road infrastructure. While the AfCAP programmes have assisted in improving technical capabilities of many road authorities in partner countries, sustainability of gained capabilities through the programmes has been a challenge. The levels of the capacity to undertake research and development (R&D) activities in the road sector are low in most AfCAP partner countries and Malawi is no exception.

With the economy of Malawi being agro-based, innovations in the design and provision of low volume sealed roads will afford the opportunity to the rural population to participate in meaningful agricultural activities and to have easier access to profitable markets than is currently the case. The low levels of R&D in the road sector is evident, resulting in limited generation of innovative solutions and therefore affects negatively the provision of reliable and cost-effective road infrastructure, which in turn impacts on the rate of socio-economic development of the country. Action is required to improve the current situation.

1.2 Context

Given Malawi's road infrastructure condition, the country urgently requires the generation of the knowledge for the development of innovative solutions to improve access, particularly in rural communities and also to rapidly increase the proportion of the road network with durable roads. The challenge faced by the country has exposed the failure to develop the institutional, human and capital capacity for research in the country. Development of sustainable research capability is required to generate the knowledge for providing innovative solutions and support the objectives of the national economic development strategy.

The Government of Malawi, therefore, through the Roads Authority (RA), requested technical support from the Africa Community Access Partnership (AfCAP), for the development and support to the implementation of a Strategic Plan for the establishment of sustainable road research capacity in the country. This document has been prepared in collaboration with the Roads Authority and stakeholders to develop a Strategic Plan and an Action Plan to guide the process for the establishment of sustainable road research capacity in Malawi.

1.3 Rationale

Road infrastructure in Malawi is a key contributor to the Government's Malawi Growth and Development Strategy, the Economic Recovery Plan and the National Export Strategy due to the importance of the sector in servicing trade and development. There are key benefits that can be derived from road research capacity building. The successful implementation of the road research capacity building Strategic Plan is expected to contribute towards provision of reliable and cost effective transport infrastructure through research, and thereby alleviating poverty and improving the social wellbeing of rural population in particular by providing improved access to social services including schools, health facilities and markets. It is expected that this project will assist Malawi in addressing the need to build sustainable road research capacity for the country.

2 Research objective

A strategy is required to create an enabling environment for sustainable road research capacity building (RRCaB). The sustainability of the capacity building strategy will depend on the existing infrastructure, availability of qualified workforce (institutions of learning) and the enabling national institutional framework, guided by national policies and strategies. The capacity building strategy should build on the existing environment, but must include plans and actions to overcome identified inadequacies, as they potentially are barriers to successful implementation of a sustainable RRCaB programme. The development of the Strategic Plan furthermore requires a framework to provide guidance and to maintain consistency for future reference, during the development process. The situational assessment and the establishment of the strategic framework for the Strategic Plan are described in the following sections.

2.1 Rationale

This section presents the outcome of the situational assessment, highlighting key themes based on the findings resulting from consultative meetings and a workshop held with key stakeholders in the road sector. The details were presented in the project Preliminary Findings Report.

a) Policy formulation, planning and strategy

Policies and strategies exist, which will provide the framework to support the process of developing the road research capacity building Strategic Plan and the Action Plan. The relevant policies and strategies that will drive the road sector research capacity building framework are presented in Section 2.2.

b) Institutional and administrative set up in the road sector

The Ministry of Transport and Public Works (MoTPW) is the principal steward and public sector policy lead for the transport sector with responsibilities for multi-modal transport planning and regulation. The key sub-sector coordinator is the Roads Department, with the RA as the implementing public agency. In executing its mandate, the RA coordinates with the Ministry of Local Government and Rural Development (LGRD), which plays a role in the management of districts, rural and urban roads. The Ministry of Finance, Planning and Economic Development has an important role to play in the road sector as budget allocation and funding of key initiatives in the sector requires the approval from the Ministry. Its implementing public agency, the Roads Fund Administration (RFA), provides the funding for the delivery of key initiatives by the RA.

c) Training institutions

Road research capacity building programme will require an adequately staffed and highly skilled workforce. Malawi has institutions in place that provide education in Civil Engineering related subjects to degree level, basic training in Civil Engineering and Construction to diploma level, and technician certificate level. Institutions that offer education that will contribute towards human resources development to improve road research capacity include: Malawi Polytechnic, Lilongwe University of Agriculture and Natural Resources (LUANAR), Malawi University of Science and Technology, offering degree-level qualifications and Soche Technical College, offering technician qualifications.

Staff at CML expressed the lack of training opportunities to upgrade qualifications. However, there is currently no institution offering training for laboratory technologists specifically focusing on road construction materials testing. This is an opportunity for the establishment of a Road Research Centre that in addition to research, could offer special courses to train laboratory staff and play a role in capacity building for the road sector in the country.

d) Road construction materials testing facilities available

Accessibility to basic and limited advanced testing services for road construction materials is available at the Central Materials Laboratory of the MoTPW and Malawi Polytechnic, with two additional private laboratories.

e) Development partner support

The road sector receives major support through development partner funding allocations. Over the years, Malawi implemented a number of road improvement programmes mostly funded by the World Bank and the European Union (EU), UK Department for International Development (DFID) through AfCAP, African Development Bank (AfDB), Japan International Cooperation Agency (JICA) and others. The RA has been the main implementing agency of some of the projects. The Development partners present an opportunity for support to fund a road sector-research capacity building initiative.

f) Absence of Laboratory Management Systems

The need for a laboratory management system to ensure standardised laboratory procedures for data collection, analysis and reporting, was raised by CML staff during discussions. An established operational and management system should be put in place.

g) Weak laboratory regulatory processes and standardisation

It was evident that systems for laboratory registration and licensing procedures are weak. Response to the request for equipment status took more than two months from one of the laboratories, something that could be done within minutes, if information is kept according to service and equipment standards and Standard Operating Procedures (SOPs), usually a requirement by any national or regional authoritative body that sets minimum standards and regulates laboratories.

h) Weak laboratory infrastructure to support research

The two main laboratories that were visited and expected to be more appropriate to support research have limited workspace, which will inhibit accommodation of additional equipment, unless additional space is created. Equipment is generally old with many pieces being non-functional, particularly at CML. Electricity supply is often unreliable in the country.

i) Shortage of qualified laboratory personnel

In order to maintain high quality results in a laboratory, the personnel is expected to be competent and well qualified. The highest technician qualification is the Diploma. Malawi Polytechnic at one point terminated the Diploma in Civil Engineering programme. This affected the quantity of formally trained personnel at technician level. The decision to terminate the Diploma has since been reviewed. However, there is currently no institution offering training for laboratory technologists specifically in road construction materials.

j) Shortage of research capability

Malawi Polytechnic is the main academic institution in the field of civil engineering. On the basis of the research output, related to transport infrastructure over the last five years, the publication equivalence is at 0.025, which is low relative to the overall country research publication output. While this may be attributed to limited funding for research, the number of people capable to conduct research and publish in the road sector is also low. The staff complement in the Department of Civil Engineering was presented in the Preliminary Findings Report. The inadequate number of researchers in the road sector limits the country's ability to conduct research and the country therefore still relies on international experts.

k) Inadequate experienced professionals

The Ministry of Local Government and Rural Development has the responsibility for the management of districts, rural and urban roads. The limited skills and capacity in local authorities have resulted in limited attention being paid to maintenance of the rural road network and the RA has to provide technical support. The development of the rural road network is also weak due to limited responsibility for the rural road network management. The RA also identified in its (2017 – 2022) Strategic and Business Plan, inadequate capacity of qualified and experienced engineers and technicians for special services - design, supervision and implementation of road infrastructure projects.

l) Local institutional cooperation

Road-related research collaboration exists between the Malawi Polytechnic and the RA, but to a limited level. The cooperation mechanism needs to be strengthened to improve the institutional relationship and promote sustainability of research collaboration. While the RA has R&D funding as a line budget, staff from the Department of Civil Engineering at Malawi Polytechnic, have not been accessing the funds adequately. Improved institutional relationship is linked to item (i) above and should lead to more research and better research output levels

m) Rural access

There is a need to enhance integrated rural infrastructure planning including maintenance. However, it was noted that policy development in this regard has been underway for some time. The National Science and Technology Policy identified the need to establish a Rural Access Roads Technology Unit, to serve as a centre for technology research and development, in order to improve rural access. The upgrading of unpaved roads to improve transport infrastructure and mobility in rural communities is also identified as one of the future challenges under the Road Sector Programme as discussed in Section 2.2.8.

n) Road sector-research efforts

A number of research outputs and examples of research uptake related to low volume road pavement design exist. These have mostly been produced by international experts. The development of local research capacity is required to provide local solutions and make an impact on the provision of transport infrastructure. Key challenges and research priority areas in the road sector were identified by the local experts during the consultative meetings and workshop. The National Commission for Science and Technology also identified priority research areas under the National Research Agenda in Energy, Industry and Engineering. Included are topics in the field of Transport and Transport Infrastructure. Two of the threats that were identified by the RA are a shortage of critical construction inputs and materials impacting on the construction activities.

2.2 Drivers for setting the strategic framework to guide Road Sector-Research Capacity Building

The GoM's overarching strategy focusses on the need of reducing poverty and transforming the economy from an importing and consuming one to a manufacturing and exporting one, with transport infrastructure development as one of the key drivers to spur sustainable economic growth and development for Malawi. As such, there is a need to build road sector-research capacity, to ensure effective response to the objectives of the national strategy and policies. This section describes the existing policies, strategies and plans to guide the development of the Strategic Plan for the establishment of sustainable road research capacity in the country and to drive improvement in transport infrastructure and access, particularly for rural communities.

2.2.1 Malawi Growth and Development Strategy (MGDS)

The third Malawi Growth and Development Strategy (MGDS III), is the medium-term strategy for Malawi designed to contribute to Malawi's long-term development aspirations (GOM, 2017a). The strategy covers a period of five years, from 2017 to 2022 and it is a successor to the MGDS II that was implemented between 2011 and 2016. The overall objective of the strategy is to move Malawi to a productive, competitive and resilient nation through sustainable economic growth, energy, industrial and infrastructure

development while addressing water, climate change and environmental management and population challenges.

As a national strategy, the overarching theme for the MGDS III is: “Building a Productive, Competitive and Resilient Nation”. The strategy is built around this one theme that aims to improve productivity, turn the country into a competitive nation and develop resilience to shocks and hazards. The strategy addresses five Key Priority Areas (KPAs), which were chosen on the basis of their strong intra-links as well as their strong links with the Sustainable Development Goals (SDGs), the AU Agenda 2063 and with the rest of the economy. The KPAs have also been carefully selected in order to spur growth and address the bottlenecks to growth and development. The five KPAs for the period 2017 to 2022 are:

1. Agriculture, Water Development and Climate Change Management;
2. Education and Skills Development;
3. Energy, Industry and Tourism Development;
4. Transport and ICT Infrastructure and;
5. Health and Population.

The goal for the KPA of Transport and ICT Infrastructure is to develop safe, affordable, reliable, equitable and sustainable transport and ICT infrastructure. The Outcomes and Strategies for Transport are as follows:

Outcome:	**Strategy:**
1. Reduced travel time and costs for persons and goods	• Undertaking systematic maintenance and rehabilitation of infrastructure; and • Ensuring an integrated, well- managed, viable and sustainable transport infrastructure.
2. Improved transport reliability, levels of service and efficiency	• Providing a framework for the development of an efficient transport system; • Promoting inter-modal competition or complementarity, where feasible; • Providing safe, reliable, effective and efficient transport operations; and • Developing an efficient and productive marine time transport infrastructure.
3. Enhanced access to local and international markets	• Developing transport corridors in order to improve the competitiveness of Malawian goods and services on the regional and international markets; and • Developing the Nsanje World Inland Port
4. Improved access to inclusive social and public services	• Providing access to safe, affordable and sustainable transport system with special attention to the needs of those in vulnerable situations including persons with disability, pedestrians and cyclists; and • Promoting an environmentally sustainable and climate resilient transport system;
5. Reduced accidents and their derived human and economic costs	• Reviewing and enforcing transport regulations.

Outcome:	Strategy:
6. Increased private sector investment in the operation and management of transport	• Mobilizing private businesses to engage in transportation sector to improve competition; and • Promoting PPP in operation and management of transport

2.2.2 Malawi National Transport Masterplan - September 2017

The National Transport Masterplan (NTMP) was developed with the primary objective of guiding the sustainable development of an integrated multi modal transport sector over the next 20 years (Atkins, 2017). The NTMP provides measures to reduce transport costs and improve GDP. It not only addresses current pressing issues such as road safety, but looks forward to meeting the transport needs of a changed economy in which growth sectors such as mining, oil and tourism will be fostered through improved transport links.

The NTMP contains a variety of measures across all modes of transport. The highlights include proposals to extend the railway south to connect with the line to the port of Beira in order to foster a shift from road transport to rail for imports and exports, thus reducing transport costs and boosting the competitiveness of Malawi's exports. In the road sub-sector proposals include safety measures for non-motorised transport on the highly trafficked main roads, an increased emphasis on road maintenance, and a major programme of rural roads upgrading to meet the needs of the agriculture sector. There are plans for infrastructure improvements in the aviation sub-sector designed to meet increased demand for air travel, along with an emphasis on safety and security so that confidence can be built in Malawi's aviation sector leading to more foreign carriers landing in Malawi. For inland water transport the key proposals concern re-organising the passenger services, investing in ports, and developing scheduled freight services. The NTMP also provides strategies and a range of projects for urban designs to reduce costs, foster walking and cycling and a move towards high capacity mass transit in Malawi's main cities. The NTMP is in three parts, namely Part A: Analysis and Proposals; Part B: Reform Action Plan; and Part C: Transport Sector Investment Programme.

One of the key issues surrounding the Malawi road network that were identified during the preparation of the Masterplan is the use of poor quality construction materials for both roads and bridges that causes early deterioration of the infrastructure. It was also found that current institutional issues include an absence of data, analytical capability and business planning processes to support strategy development, integrated programme management or monitoring of progress. Based on the analysis of existing institutional arrangements in the NTMP and to support the implementation of the strategies and proposals set out in the NTMP, there is a strong case for proposals for institutional reform to be more clearly articulated and supported, and for the NTMP, in a 20 year plan period, to go beyond what the GoM itself has already proposed.

One of the areas of institutional reform that has been identified in the NTMP is supporting data collection, research and benchmarking. Work in developing the NTMP demonstrated significant gaps in transport-related data and statistics in Malawi, including poor definitions, collection and analytical methodologies. The capacity to undertake large-scale survey or data analytical exercises is also largely lacking. This limits the ability of decision-makers to set and implement policy in a consistent and coordinated basis, grounded on robust evidence, as well as monitor the progress of agreed interventions. Research and development is likewise poorly developed and rarely deployed in a manner which contributes to strategy, new policies and practices for transport management and the introduction, early adoption and wider take-up of new technology and innovative practices.

The following action items have therefore been identified to:

- Identify required key transport datasets, covering land use planning, passenger and freight supply and demand and public perceptions;
- Analyse current gaps in data and make proposals for the collection of relevant new data;

- Define appropriate national data classification, collection, storage and reporting standards, processes and systems;
- Establish minimum data accuracy requirements;
- Develop appropriate systems for data analysis, presentation, access, audit and quality control;
- Investigate the potential for technology, including Intelligent Transport Systems, to automate data collection and analysis;
- Develop appropriate transport modelling and appraisal tools; and
- Identify key topics for research, development and benchmarking.

The establishment of the National Transport Committee and the strengthening of the MoTPW will, to some degree, address this situation since the Ministry will include functions for transport monitoring and research and technology and be able to include such items in its budget. However, in addition to this, it was recommend that the MoTPW lead the creation of a strategic framework and depository for all transport data, surveys and statistics, set common data collection, analytical and storage systems and processes, and serve as a knowledge exchange platform for research, technology and good practice. This will also provide a basis for independently monitoring emerging outcomes of the NTMP as well as supporting its future review and update in light of progress made.

2.2.3 Mapping Research and Innovation in the Republic of Malawi

Mapping Research and Innovation in the Republic of Malawi is the third in a series of country profiles prepared by the Global Observatory of Science, Technology and Innovation Policy Instruments (GO→SPIN), a UNESCO initiative (UNESCO, 2014). The aim of this new series is to generate reliable, relevant information about the different landscapes of science, engineering, technology and innovation (SETI) policies around the world. Each country profile represents a comprehensive study of all the SETI policies, which include:

1. A long-term description of the political, economic, social, cultural and educational contextual factors;
2. A standard content analysis of the explicit SETI policies, including those research and innovation policies implemented in other sectors, such as the agricultural, energy, health, industrial and mining sectors;
3. A study of R&D and innovation indicators;
4. A long-term scientometric analysis of scientific publications, patents, trademarks and utility models;
5. A description of the SETI policy cycle;
6. A complete analysis of the SETI organizational chart at five different levels (policy-making level; promotion level; research and innovation execution level; scientific and technological services level and evaluation level);
7. An inventory of all the SETI government bodies and organizations related both to research and innovation and to science and techno logy services;
8. An inventory of the SETI legal framework, including acts, bills, regulations and international agreements on SETI issues;
9. A standard inventory with 18 different analytic dimensions of all the SETI operational policy instruments in place; and
10. A SWOT analysis of the country's research and innovation landscape.

Information presented and aspects addressed in this report with a bearing on transport and road related research are the following:

- The Malawi Confederation of Chambers of Commerce and Industry considers investment in R&D as a fundamental basis for improving and maintaining the competitiveness of businesses at both local and international levels. According to its survey, the importance of research and its utilization by businesses have been underestimated in Malawi.
- The government's policy reforms aim to diversify the economy, which is largely agriculture-based. To this effect, a number of key priority sectors and export clusters have been identified for investment. One of these is infrastructure and more specific large infrastructure projects related to energy;

development of clean water and sanitation, national and regional grain storage silos, warehouse systems, road and rail.

- The University of Malawi is a strong national research entity. About 10% of the university's overall budget for its development strategy is devoted to capacity-building in research and consultancy, ensuring research quality and improving the dissemination and utilization of research findings.
- Malawi is one of the few countries in Africa to devote more than 1% of GDP to gross expenditure on R&D. However, Malawi's GDP is the smallest of any country with a comparable population (15−17 million) (on average, a country with a population the size of Malawi will have 37 times its GDP) and the amount invested in R&D in Malawi is thus very low in real terms.
- In 2010, there were 105 researchers in the engineering and technology field in government and 267 in higher education institutions. In terms of full-time equivalent researchers, the numbers were 103 in government and 45 in higher education institutions. Businesses were not included in the 2010 survey.
- The 25 most productive institutions in Malawi in terms of scientific articles from 1967 to 2013 include the University of Malawi and the Mzuzu University; the Government of Malawi; 12 institutions in the health field; and 10 institutions in the agricultural field. No institution in the roads or transport field is included.
- Over the past two decades, most research articles have related to medicine and health sciences (between 41% and 73%), whereas agricultural sciences and natural and exact sciences account for around 15% of publications. The share of publications on engineering and technology has oscillated between 4% (2004) and 0.5% (2012), whereas the share of publications in social sciences has remained around 7%.
- The data show clearly that medicine and agriculture have been the most important research fields in Malawi over this 47-year period.

The report also covers the National Commission for Science and Technology, which was created by the merger of the National Research Council of Malawi with the Department of Science and Technology of the Ministry of Science and Technology (MIST), as provided for by the Science and Technology Act of 2003. The Commission's function is to advise the government and other stakeholders on all SETI matters, in order to achieve science- and technology-led development. The Commission has various important committee structures, such as:

- A Parliamentary Committee responsible for Science and Technology, which provides a voice on S&T matters in the National Assembly. The Committee must ensure that S&T are integrated into the national budget by the time it is approved by Parliament and that S&T are integrated into the country's socioeconomic development processes.
- A Cabinet Committee responsible for Science and Technology, which must monitor the development and application of science and technology in national development processes.
- Sectoral committees, which are composed of S&T directors from the relevant sectoral ministries, as a link between the sectoral ministry and the commission. The overall responsibility of the S&T directors is to co-ordinate S&T issues in their relevant ministries.

Through the implementation of SETI policies, notable achievements in Malawi include the following:

- Establishment of the National Commission for Science and Technology with a mission to co-ordinate the work of different SETI stakeholders in the country;
- Establishment of the Malawi University of Science and Technology (MUST) and Lilongwe University of Agriculture and Natural Resources (LUANAR) to build capacity in SETI;
- Building health research capacity through the Health Research Capacity Strengthening Initiative (HRCSI) by awarding research grants and competitive scholarships at PhD, Master's and first degree levels;
- Strides made in conducting cotton confined field trials, with support from the US Program for Biosafety Systems, Monsanto and LUANAR;

- Introduction of ethanol fuel as an alternative fuel to petrol and the adoption of ethanol technology, which is expected to be launched soon at national level; and
- A review of secondary school curricula to put more emphasis on SETI subjects.

2.2.4 Revised National Science and Technology Policy

The 2002 Revised National Science and Technology Policy, proposed a detailed set of strategies and priorities for each sector of the economy (NRCM, 2002). No further work has been undertaken on this Policy. For the Transport Sector, the major sectoral objectives on which the National Science and Technology Policy should impact are to;

1. Meet economic demand and socio-political needs while minimizing cost to the economy;
2. Minimize negative impacts of transport sector activities on the environment;
3. Strengthen institutional capacity of the transport sector through human resource development;
4. Improve transport safety;
5. Provide meteorological services and products to suit individual transport mode so as to realize maximum benefits and minimize losses; and
6. Develop and disseminate improved technologies to target groups.

In order to realize the sectoral objectives, a number of sub-sector specific strategies were adopted including the following that require the support of the National Science and Technology Policy:

1. Use and enforce appropriate road design standards and specifications;
2. Vigorously enforce vehicle weight limits and vehicle dimensions in order to protect road infrastructure;
3. Facilitate availability of appropriate low-cost transport;
4. Promote environmental protection and resource conservation through the use of more energy-efficient and less pollutant modes of transport;
5. Enhance transport safety through improved road infrastructure, policing and maintenance of vehicle safety standards;
6. Establish a Rural Access Roads Technology Unit to serve as a centre for technology research and development; and
7. Develop and retain human resources to service the S&T requirements of all transport sub-sectors.

For the housing and roads sub-sectors of the Construction Sector, the specific objectives to which S&T should make a direct contribution include the following:

1. Expand the supply and use of alternative building materials;
2. Improve the quality of rural housing; and
3. Encourage environmental and energy conservation in road construction and transport projects and programmes.

In order to realize the broad policy objectives in the construction sector, a wide range of strategies towards which Science and Technology should make direct contributions have been outlined in the specific policy statements. Those related to roads and transport include the following:

- Conduct research on and promote the development and use of competitive local materials;
- Promote safety standards in the construction industry;
- Conduct and coordinate training of persons engaged in the construction industry within Malawi to promote the development of local skills;
- Support the commercial production of local building materials;
- Develop sustainable technologies for rural users;
- Train local building material producers and suppliers in quality control and provide facilities for quality control and certification; and
- Provide for Environmental Impact Assessment (EIA) and energy conservation in the planning and construction of roads and buildings.

Despite being approved, the 2002 policy has not been fully implemented, largely due to the lack of an implementation plan and an un-coordinated approach to STI. This policy has been under revision in recent years, with UNESCO assistance, to re-align its focus and approaches with the second Malawi Growth and Development Strategy (2013) and with international instruments to which Malawi is a party [UNESCO Science Report - Towards 2030 (2015); United Nations Educational, Scientific and Cultural Organization; Paris, France].

The Department of Science and Technology is in the process of reviewing the 2002 Revised Science and Technology Policy, in order to include an implementation plan and to align it to the Malawi Growth and Development Strategy. Furthermore, the reviewed policy is aimed at providing a direction on international science, technology and innovation instruments to which Malawi is a party. The reviewed policy will be linked to Vision 2020, a long-term national development strategy which envisages Malawi as a technologically driven middle-income economy. It will also be clearly linked to a number of sector-specific policies such as the National Environmental Policy (2004); Food Security Policy (2008); National Youth Policy (1999); National Biotechnology and Biosafety Policy (2008); National Irrigation Policy (2000); National Sanitation Policy (2006); and the National Nutrition Policy (2008).

The National Commission for Science and Technology began reviewing the national Strategic Plan for STI (2011–2015) in 2010. The Strategic Plan is currently being implemented and constitutes the roadmap for implementation of science and technology programmes in Malawi over a five-year period. The Strategic Plan identifies eight key issues, namely:

- Research and Development;
- Information and Knowledge Management;
- Innovation, Technology Transfer and Commercialization;
- Networking, Partnerships and Collaboration;
- Science, Technology and Innovation Regulatory Framework;
- Human Resource Development and Retention;
- Infrastructure and Resource Mobilization;
- Planning, Monitoring and Evaluation.

2.2.5 National Research Agenda in Energy, Industry and Engineering - 2017 to 2022

The Government of Malawi (GoM) approved a 2002 National Science and Technology (S&T) policy, with the overall goal to nurture and foster the endogenous development and transfer of science and technology (S&T) for socioeconomic development (NCST, 2017). The GoM's determination to ensure that S&T were developed and transferred for national development was underscored by the enactment of the Science and Technology Act (2003) and the creation in 2009 of the National Commission for Science and Technology (NCST) both of which were aimed at providing a legal and institutional framework to support Government's efforts to develop and promote utilisation of S&T for addressing macroeconomic and social challenges consistent with its long term development strategy, as outlined in Vision 2020, of achieving, among other things, a transformation to "a technologically driven middle-income economy".

In February 2017, the National Commission for Science and Technology published a National Research Agenda in Energy, Industry and Engineering as a policy document that will guide R&D activities in the identified priorities areas in energy, industry and engineering during the period from 2017 to 2022. This Research Agenda represents nationally set and agreed priorities in energy, industry and engineering in which research efforts for Malawi will be concentrated over the next five years.

The overall goal of the National Research Agenda in Energy, Industry and Engineering is to guide researchers, technologists, policy makers, program implementers, academic institutions, development partners, investors and other stakeholders on R&D priority areas for Malawi in construction, transport, energy, mining, agro-processing, manufacturing, environment, climate change adaptation and mitigation, health and ICT in line with the national development agenda.

The Research Agenda lists the following priority areas of research and development in the field of Transport and Transport Infrastructure:

1. Assessment, development and promotion of road construction materials;
2. Improvement, optimisation and management of transport systems (rail, road, water and air) to reduce transportation costs and improve efficiency and competiveness;
3. Assessment, adoption, development and promotion of vehicles and hybrids that use alternative fuels such as ethanol, biogas and electricity;
4. Improvement of fuel efficiency and development of alternative fuels;
5. A transportation security system applying radio frequency Identification (RFID), global positioning system (GPS); and
6. Assessment of emissions from the transport sector.

The Research Agenda also introduces a Research Grants Scheme. The NCST through the Science and Technology Fund shall commit direct resources at various levels to support the undertaking of research and development in the identified priority areas. Researchers and all other stakeholders wanting to undertake research in the identified priority areas shall be encouraged to take advantage of existing national and international research grant schemes which are occasionally advertised. This shall be carried out through the development of R&D proposals which shall be submitted to prospective funders (government, private sector, international organisations, NGOs etc.).

The Member Organisations for the National Committee on Energy, Industrial and Engineering Sciences (NCEIES) are as follows:

1. University of Malawi (The Polytechnic)
2. Malawi Industrial Research and Technology Development Centre
3. Mzuzu University
4. Malawi Institution of Engineers
5. Malawi Energy Regulatory Authority
6. Malawi Confederation of Chambers of Commerce and Industry
7. National Construction Industry Council
8. Ministry of Energy
9. Ministry of Transport and Public Infrastructure
10. Technical, Entrepreneurial and Vocational Education and Training Authority
11. Ministry of Agriculture, Irrigation and Water Development
12. Malawi Bureau of Standards
13. Lilongwe University of Agriculture and Natural Resources
14. Department of Agriculture Research Services (Chitedze Research Station)
15. Department of Science and Technology
16. University of Malawi (Chancellor College)

A number of the above mentioned organisations will also play a role in the advisory committees to be established for the road sector-research capacity building initiative and the RRC should become a member.

2.2.6 University of Malawi Policy on Research and Consultancy

The policy on research and consultancy was approved by the Senate of the University of Malawi in July 2006 (UNIMA, 2006). The goal of this policy is to be a stimulus and vehicle for the coordination, promotion, generation, creation of databases, strengthening and dissemination of knowledge, information and technology through research for economic growth and development and the promotion of socio-cultural values.

The Research Policy aims to ensure consistency across the University of Malawi in establishing a common mechanism for planning, implementing and monitoring of the research process. The policy is applies to faculties, departments, centres, units and groups. It maps out:

- The process of research needs identification and prioritisation;
- Research project identification and initiation;
- Proposal preparation and approval procedures;
- Funding, project control and monitoring;

- Research results dissemination; and
- Evaluation of research effectiveness.

The policy provides for the formation of research groups, units and centres.

The University of Malawi's policy on research and consultancy could be used as an example for the development of a similar policy for the management of research in a Road Research Centre, in support of establishment of sustainable road research capacity in Malawi.

2.2.7 Road Transport Policy

This is the sub-sector policy of the National Transport Policy (GOM, 2004). The objectives of the Road Transport Policy are: *to create a climate that nurtures, encourages, and sustains the participation of the private sector in the financing, the construction, the maintenance and the management of roads in Malawi.* It makes specific recommendations in order to achieve the stated objective goals. Firstly, that all paved roads in a maintainable condition should be put under routine maintenance contracts. Secondly, all unpaved roads which are in a maintainable condition will be put under grading and routine maintenance contracts and that timely periodic maintenance should be carried out on paved roads and that the Government policy should be to continue the upgrading of unpaved roads to paved standard, where socially or economically justified.

The strategic objective goals include:

- A transport sector that is safe, reliable, effective and efficient;
- Improved fully integrated road transport infrastructure;
- Maintenance of an acceptable quality road system;
- Improved levels of service that supports government strategies;
- Improved development of the country's rural areas;
- Improved rural access and transport infrastructure.

Linked to this policy is the mechanism for the provision of required investment to achieve the stated strategic objectives. The Road Sector Programme was intended to achieve this objective.

2.2.8 Investment Programme for the Road Sector in Malawi - 2010 to 2020

The Road Sector Programme (RSP) is intended to chart the way forward for road maintenance and development in Malawi in both physical and financial terms (GOM, 2010). The RSP is based on an assessment of the problems facing the roads sector, and a detailed analysis of road network conditions and traffic volumes. The RSP as was proposed takes account of the need to devote more resources to long-term, preventative maintenance in order to protect the investments that have been made in the sector. It was to demonstrates that, when successfully implemented, it should be possible to reduce the requirement for further major road rehabilitation and that, by the end of the first 5 year period, (2010-2015), Malawi should be in a position to maintain its road network in good condition from its own resources, subject to regular adjustment of the fuel levy, and other user charges, to meet this target.

The RSP is based on the following general principles and priorities for the management and development of the road network, as proposed by the Government of Malawi:

1. Building on the successes of the past – network preservation through regular maintenance;
2. Dealing with the mistakes of the past – through rehabilitation, timely periodic maintenance, and measures to reduce road accidents;
3. Meeting new challenges – of traffic growth and the need to improve access to potentially productive rural areas through upgrading unpaved roads to paved standard.

This approach has led to the adoption of the following focus areas and components:

Focus Area	Components

Focus Area	Components
1. Network Preservation	▪ Routine maintenance on all roads ▪ Routine maintenance of all bridges ▪ Regular annual grading and re-shaping of unpaved roads ▪ Timely reseals for paved roads ▪ Axle load control ▪ Road and bridge management systems ▪ Condition surveys ▪ Road safety measures
2. Dealing with past mistakes	▪ Rehabilitation programme for paved roads ▪ Rehabilitation programme for unpaved roads ▪ Replacement of timber bridges ▪ Physical improvements at accident black spots ▪ Measures to combat HIV/Aids ▪ Improved social/environmental safeguards
3. Future Challenges	▪ Upgrading unpaved roads ▪ Traffic management measures ▪ City by-passes to reduce congestion ▪ Small town protection measures ▪ Measure to combat human trafficking ▪ Development of the contracting sector ▪ Capacity building

The RSP provides guidance on investment for the road sector. While it does not address road research systems, the identified focus areas for investment provide an indication of national strategic issues in the road sector and the future challenges, which will require solutions.

2.2.9 Five Year Strategic and Business Plans (2011 – 2016 and 2017 - 2022)

It is worth noting that as the project started, the information was based on the Five Year Strategic and Business Plan (2011 -2016). The Strategic and Business Plan (SBP) *is aimed at fulfilling the Roads Authority's mission of a developed and maintained public road network to a standard where all motorized and non-motorized traffic can reach every society of the country in adequate, safe, reliable, efficient and economic manner.* This is also valid for the current cycle Strategic and Business Plan (2017 – 2022). The core business services of the RA are Planning and Design, Construction and Maintenance of the public road network.

In the 2011-2016 SBP, the RA wanted to attain the following strategic outcomes through the implementation of this Strategic Plan:

- Improved accessibility;
- Improved mobility on the road network;
- Mainstreamed cross cutting issues in the transport sector;
- Improved stakeholder collaboration and coordination; and
- Improved and sustainable institutional capacity.

Amongst the functions and responsibilities that the Board of the RA have are the following:

- Advise the Minister of Transport and Public Infrastructure on research and studies necessary for promoting the construction, maintenance and rehabilitation of public roads;
- Advise the Minister of Transport and Public Infrastructure on the specifications, design standards and classification of public roads; and
- Advise the Minister of Transport and Public Infrastructure on the development and training of human resources required for the construction, maintenance and rehabilitation of public roads.

Amongst the challenges identified by the RA in the 2011-2016 SBP were the following:

- High construction costs;
- Inadequate absorption capacity of road works funds; and
- Unavailability of qualified and experienced engineers and technicians.

As part of the situation analysis, strengths and weaknesses (internal) and opportunities and threats (external) in relation to the RA were considered. Amongst the weaknesses are a lack of specialists in some technical fields; limited monitoring and evaluation activities; and the absence of a fully developed road data management system. Two of the threats that were identified are a shortage of critical construction inputs and materials impacting on the construction activities and inadequate qualified and experienced engineers and technicians.

The challenges identified in the 2017-2022 SBP were the following:

- Inadequate funding;
- Price escalations;
- Inadequate capacity of the construction industry, due to inadequate experienced professionals;
- Inadequate support services.

The main issue that will impact on the implementation of the RRCaB strategy from RA's stand point is inadequate funding. Potential funding mechanisms should be identified to support R&D activities in order to ensure sustained research funding in the long term. This was identified as a weakness and a threat, leading to the RA failing to meet its strategic targets in the 2011-2016 cycle. The situation analysis revealed one of the other weaknesses being inadequate capacity to perform specialized areas functions. Linked to this is the recognition of the need to build capacity of public institutions for testing of construction materials and works and specialised services. There was a need to provide training for technical personnel in the road construction industry to ensure efficient implementation of projects in the industry. This is an opportunity for the RRC as it will augment some of the existing initiatives to provide training of technical personnel in the road construction industry.

Table 1 shows the strategic outcomes articulated in the 2011-2016 and 2017-2022 Strategic and Business Plans. The 2017-2022 SBP has elevated research as one of the RA Strategic measure of performance, under **Strategic Outcomes 5:** *Enhanced Research and Development in RA Operations*. The target under this outcome is to adapt the appropriate technologies and best practices, conduct research on effective use of available resources as well as capacity building. It was revealed at the third Workshop held on 26 June 2016 at the Peacock Hotel that RA is to recruit two staff members by October 2018, to focus on the implementation of research-related activities. This is crucial to the implementation of the RRCaB and demonstrates commitment by the RA to integrate research in its operations. **Strategic Outcome** 4: *Construction and Maintenance of Climate Resilient Road Infrastructure* will require the support of research capability in the country, which can be provided by the RRC.

Table 1 Roads Authority strategic outcomes

Strategic Outcomes 2011-2016	Strategic Outcomes 2017-2022
• **Strategic Outcome 1**: Improved Accessibility • **Strategic Outcome 2:** Improved Mobility on the Road Network • **Strategic Outcome 3**: Mainstreamed Cross Cutting issues in the Road Sector • **Strategic Outcome 4**: Improved Stakeholder Collaboration and Coordination • **Strategic Outcome 5:** Improved and Sustainable Institutional Capacity	• **Strategic Outcome 1**: Optimised Preservation of Road Infrastructure; • **Strategic Outcome 2**: Optimised Improvement and Expansion of Road Network; • **Strategic Outcome 3**: Increased Compliance with Regulations on Road Infrastructure; • **Strategic Outcome 4:** Construction and Maintenance of Climate Resilient Road Infrastructure; • **Strategic Outcome 5**: Enhanced Research and Development in RA Operations; • **Strategic Outcome 6:** Enhanced and Improved Operational Efficiency of Roads Authority; and • **Strategic Outcome 7**: Improved Monitoring and Evaluation System.

2.3 Summary of strategic framework to guide Road Sector-Research Capacity Building

Road research sustainable capacity building will yield benefits to the country, as road infrastructure in Malawi is a key contributor to the Malawi Growth and Development Strategy due to the fact that a greater proportion of goods are transported by road. Whilst advising the Minister of Transport and Public Works on research and studies necessary for promoting the construction, maintenance and rehabilitation of public roads, is amongst the functions and responsibilities of the Board of the RA, and the existence of a policy document to guide R&D activities in Malawi, there is currently no guideline or policy formulation, specifically on road research, to ensure consistency in the formulation of a strategy for capacity building in the road research systems. The focus of the Road Research Capacity Building (RRCaB) is on research development and innovation (R&D) in the road sector.

RRCaB should not only be seen as being about continued research skills development to improve individual capability to conduct research, but also the improvement of quality of road research infrastructure (appropriately equipped laboratory, information management systems) and management of priority research programmes. The sector capacity also requires the enhancement of technical capacities of the RA, the Roads Department (includes CML) and the LGRD as well as relevant academic departments at institutions of higher learning. The framework is to assist in the development of the road research capacity building Strategic Plan, to ensure that it appropriately integrates the policy and strategy with research management procedures and it aligns the programme to the national development strategy.

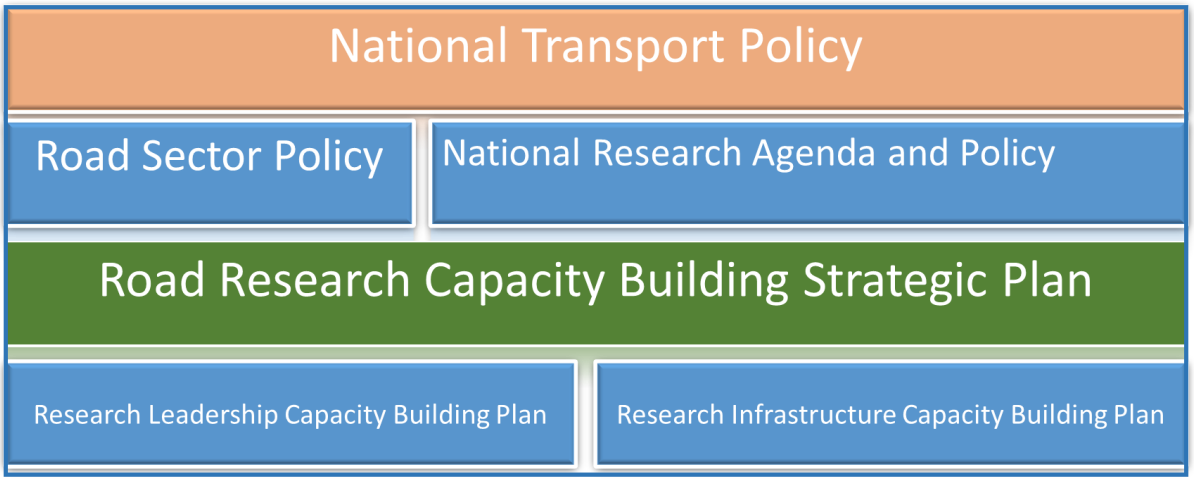
The Strategic Plan is being developed on the premise that RRCaB will be under the ambit of the RA, based on the decision taken at the stakeholder workshop on 28 September 2017 in Lilongwe. The MoTPW is therefore the responsible Ministry. The National Transport Policy is the over-arching sector policy. The sub-sector policy of the National Transport Policy, focusing specifically on the road sector, is the Road Transport Policy. The Road Transport Policy specifies the country's sub-sector policy objective, *which is to create a climate that nurtures, encourages, and sustains the participation of the private sector in the financing, the construction, the maintenance and the management of roads in Malawi.*

In terms of research, the National Research Agenda in Energy, Industry and Engineering published by the National Commission for Science and Technology is the policy document that will *guide researchers,*

technologists, policy makers, programme implementers, academic institutions, development partners, investors and other stakeholders on R&D priority areas for Malawi. This Research Agenda represents nationally set and agreed priorities in energy, industry and engineering in which research efforts for Malawi, including road infrastructure related priority areas, will be concentrated over the period, 2015 – 2022.

Thus both the sub-sector policy and R&D policy documents set the framework for the preparation of the Road Research Capacity Building Strategic Plan. The RRCaB Strategic Plan gives effect to the plans for individual research capacity building and required research infrastructure. Figure 1 shows the context of the strategic framework to manage the establishment and development of sustainable RRCaB in Malawi.

Figure 1 Road research capacity building strategic framework



3 Strategy Formulation

3.1 Introduction

This strategy is designed to respond to the need of building sustainable road research capacity that will contribute towards reducing poverty and transforming the economy of Malawi, through the provision of reliable transport infrastructure, one of the Key Priority Areas (KPAs) of the MGDS. It reflects the country's Vision and takes into account priorities identified by the key stakeholders and informed by the sector challenges identified in the drivers for setting the strategic framework presented in the previous section. Furthermore, it is guided by the aims of the strategic framework and developed on the premise that RRCaB will be under the ambit of the RA.

Road Research Centre (RRC) is currently used as a default term and whether the term ***Road Research Institute,*** or any other term will be used, is a decision to be made as part of the process of establishing the Institution. Appropriate legal requirements have to be followed.

3.2 Institutional key activities and services

According to the Strategic and Business Plan (2017 -2022) of the RA, a lack of specialists in some technical fields; limited monitoring and evaluation activities; and the absence of a fully developed road data management system were identified as some of the weaknesses. Two of the threats identified were a shortage of critical construction inputs and materials impacting on the construction activities and inadequate qualified and experienced engineers and technician. Thus the road sector in the country is in need of capacity building and innovative solutions in the design and provision of road infrastructure.

There is need not only to build sustainable research capacity to conduct appropriate research that will generate required knowledge and innovative solutions, but also to provide training programmes for technologists to support research development and the road sector at large. The envisaged RRC is therefore to serve as a vehicle to generate the knowledge and build the skills that will respond to the needs of Malawi in finding low cost and innovative solutions in the design and provision of reliable road infrastructure. The activities of the RRC should be aimed at impacting on cost-effective provision of road infrastructure and skills development.

3.3 Aims of the Road Sector Research Capacity Building Strategy

A strategy is required to enable the RRC focus in the stated challenges. During the workshop on 28 September 2017, the following guiding principles for the research strategic plan were agreed upon:

- Multi-disciplinary approach to research shall be promoted;
- Sustainable development and cross-cutting issues shall be promoted;
- Increase the application and socio-economic impact of road research;
- Enhance communication of research outputs and outcomes to stakeholders;
- Promote collaborative research with regional and international research institutions;
- Foster RRC-University-Industry collaboration;
- Promote continuous professional development of staff; and
- Promote sustainable resource mobilisation mechanism and maintain modern infrastructure.

Drawing from the situational assessment and the drivers of setting the strategic framework for the country, as well as the above guiding principles, the following are identified as the functional area-specific goals in order to build road research capacity in Malawi and are to be supported by good governance and sustainable resource mobilisation mechanism, to be covered in Sections 4, 5 and 7.

1. **Research** – undertake research focusing on generating knowledge and finding innovative solutions and implementation of projects which will bring demonstrable benefits, providing cost-effective and reliable road infrastructure.
2. **Capacity development** – provide the platform for supporting human capital development in the road sector, including specific training programmes, provision of modern equipment and optimising investment to support research and innovation (R&I).
3. **Knowledge transfer** – promoting sharing and knowledge dissemination to increase research results uptake and embedment across industry.
4. **Collaboration** – to promote individual research capability and develop research profile, institutional visibility and establishment and participation in regional and international partnerships to further build capacity.
5. **Expert services** – build on the expertise to support national sectoral policy and strategy development, provide independent technical advice to both public and private sectors.

The aims of the RRCaB framework are established in order to support the development process and implementation of the strategic plan for the establishment of sustainable RRCaB. The aims are summarised in Figure 2. The RRC's vision, mission and priority areas should articulate the aims of RRCaB, as described in the next section.

Figure 2 Aims of the road research capacity building framework

3.4 Vision, Mission and Core Values

3.4.1 Vision

The initial proposed Vision was stated as follows:

- To be recognised as the institution dedicated to the delivery of research-based and innovative solutions for the provision of better and reliable road infrastructure, to ensure better accessibility and mobility for people and goods in Malawi.

However, following the second consultative workshop held on 5 February 2018 at the Golden Peacock Hotel in Lilongwe, the following was agreed upon as the Vision statement:

"A recognised institution dedicated to the delivery of innovative road research-based solutions."

3.4.2 Mission

It was initially stated as follows:

- To provide high quality road sector research, training and consultancy services, supporting economic growth of Malawi.

This was also revised at the same workshop and the following was agreed upon as the Mission statement:

"The provision of sustainable road sector research, training and state-of-the art services to support the economic growth of Malawi."

3.4.3 Core values

It was agreed that the RA Core Values would also apply to the RRC. These are:

- Stakeholder Focus: Stakeholders come first;
- Corporate Image: Quality of the road network;

- Accountability: Responsible to stakeholders for technical and financial undertakings;
- Transparency: Conduct business openly;
- Excellence: Committed to professionalism, innovation, creativity and exemplary leadership;
- Integrity: Serve with honesty, fairness and high ethical standards; and
- Teamwork: Emphasize teamwork within and outside the organisation.

3.5 Priority areas

The purpose of this section is to expand on objectives and the strategies that will be delivered through the strategic plan, to establish a national RRC that will ultimately become one of the established road research centres, regionally and internationally.

3.5.1 Priority Area 1: Enhance knowledge through research to address road sector challenges

Objective:

***To ensure the road sector has the capacity to identify priority research needs, develop and implement research programmes*.**

This priority area is to be achieved through:

Designing, implementing and managing research projects that focus on generating knowledge and finding innovative solutions. Appropriate skills are required in order to be able to anticipate and identify national research priorities in the road sub-sector and developing cost effective and innovative solutions for appropriate design and technology development for the provision of road transport infrastructure to meet the needs of the country. This will assist in implementing projects which will bring demonstrable benefits. Activities to include:

- Recruitment of research champions;
- Developing or adopting research policy and strategy;
- Developing long-term staff retention strategy, to alleviate the problem of staff turnover;
- Development and holding of research skills development training workshops;
- Designing and implementing staff coaching, mentoring and promoting international exchange programme, encouraging publication of research projects;
- Carrying out research and development on innovative materials, construction and maintenance technologies; and,
- Updating technical guidelines and manuals based on lessons learned on research projects.

The research will address road sector needs in response to the MGDSIII, and as identified during the consultation phase, including those drawn from the National Research Agenda in Energy, Industry and Engineering - 2017 to 2022 and clustered around the following themes:

- Data management;
- Heavy vehicle operators;
- Heavy vehicle load control;
- Natural disaster preparedness;
- Road asset management;
- Road materials innovation and characterisation;
- Safety for road users; and
- Test methods and design manuals.

On the basis of emerging issues and observations of the local environment, the project team included the themes on heavy vehicle load control, climate change and heavy vehicles and operators.

3.5.2 Priority Area 2: Capacity development

Capacity development takes cognisance of the fact that road research capacity building is not limited to research skills development. The existence of internal staffing systems, adequate equipment and facilities are essential to support sustainable capacity building. Appropriate facilities will be required to support the

provision of training programmes for the public service, statutory bodies and private sector in the road sector.

Objective:

To align the road sector's R&D investment with sector training needs to achieve economies of scale through the optimisation of resources.

This priority area is to be achieved through

- Developing staffing systems for the improvement of individual staff, cultivating and nurturing researchers, including a professional development programme, such as comprehensive materials investigations and geotechnical investigations required for road works, road condition investigations and analysis of pavement and surfacing failures, primarily related to research;
- Developing appropriate 'on-the-job' training of qualified laboratory experts, to include mentoring or secondment to other well established laboratories;
- Modernise laboratory equipment and standardise operational procedures, to enable the facility to support research development, including implementation of:
- Quality assurance procedures and activities; and
- Systems for effective laboratory data management and knowledge sharing systems.
- Establish and implement competency and proficiency assessment programmes for laboratory staff;
- Strengthening laboratory management towards accreditation implementation; and
- Establish adequate and proper facilities, including office space and information management facilities, to host data management systems for research projects being undertaken throughout the country. This should be in line with those being developed through regional AfCAP projects.

- ***Developing special training programmes for the road sector***

  In order to maintain high quality results in a laboratory, the personnel should be competent and well qualified. The highest technician qualification is the Diploma. There is currently no institution offering a programme specialized in pavement construction materials testing. A general Civil Engineering Diploma qualification is offered. However, offering of specialized courses requires consultations with industry and a demand analysis and the need for such a specialised qualification has never arisen.

  There is also inadequate capacity to implement government strategies to improve rural infrastructure. The responsibility for the co-ordination of rural infrastructure development lies with the District Commissioner and the District Assembly (DA), who have capacity constraints. RRC could play a role by offering technical training programmes to local government professionals.

  Decisions should take into account optimisation of resources, between the Malawi Polytechnic Civil Engineering laboratory and the CML in Lilongwe, in liaison with technical colleges and industry, by establishing the level and effective mode of offering, to provide an effective road construction materials technician training pathway. The establishment of a specialised course in road construction materials testing would contribute towards production of quality results and therefore quality research outputs.

  In keeping with resource optimisation, RRC should support post graduate training to develop high level scarce skills for the road sector as part of human capital development efforts, and deepening research capacity in the country.

- Developing a Laboratory Strategic Plan (LSP). It is the CSIR's observation, based on experience on a similar project, that a LSP is essential to clearly define the role of the laboratory, stating specific outcomes required to achieve its overall goals. It should be developed in the second phase of the establishment of the RRC, as it should be complementary to the Road Research Centre's Strategic Plan.

3.5.3 Priority Area 3: Knowledge transfer and road research uptake

An important key element of research projects is knowledge transfer and the outcomes of the research programmes must be shared with stakeholders. Thus implementation of road research projects must incorporate sustainable knowledge management systems. The effective dissemination of the research findings will also enhance the visibility and profile of the RRC.

Objective:

To ensure the road sector has the skills and processes for knowledge exchange, management and transfer.

This priority area is to be achieved through

Preparation of reports and dissemination of the findings and recommendations, which may be incorporated in guidelines/manuals to increase research uptake, innovative solutions and new technology options for the road sector. This will include contribution to the development of policies in the sector. Activities will include:

- Developing a communication plan;
- Implementing data collection and analysis systems;
- Implementing knowledge management systems with a well-established repository and properly maintained databases;
- Developing mechanism for providing access to stakeholders to developed a pool of knowledge in order to promote knowledge sharing and knowledge transfer and embedment across the road industry, including academic institutions to improve academic programme offerings, by:
  - Holding workshops, seminars;
  - Networking, participation in discussion forums and conferences; and
  - Publishing success stories of research projects in public newsletters and technical publications (peer reviewed).

3.5.4 Priority Area 4: Expert services

Critical mass will be built and capacities will improve as the RRC matures and more expertise will be available to provide outreach services, including high quality and independent professional and consultancy services to the road industry. This will be one of the mechanisms to generate resources.

Objective:

To ensure high quality consulting services and expert sectorial advice to government, business and civil society.

This priority area is to be achieved through:

- Providing independent technical advice and undertake forensic investigations as well as independent Technical Audits of selected road projects, where quality is suspected to have been compromised;
- Providing testing services and overseeing the proficiency and quality of test results from both public and private laboratories;
- Supporting national sectoral policy and strategy development, such as Rural Road Infrastructure Improvement Programme;
- Periodically review existing manuals for appropriateness, and develop new standards and specifications influenced by research results as may be required; and
- Designing outreach programme, aimed at helping ensure that the public has access to technical advice and workshops to also assist in information dissemination, through NGOs for example, promotion of road safety initiatives, community ownership of accessibility improvement projects, as well understanding of impacts of road infrastructure projects on the local social dynamics.

3.5.5 Priority Area 5: Collaboration

Collaboration is not only in terms of the partnership during execution of research projects but also bringing together diverse key national stakeholder individuals who will commit themselves with dedication to serve on advisory committees to ensure that identified and prioritised research projects for implementation are aimed at addressing the needs of the country. It is essential to establish and maintain effective relationships with all national key stakeholders and establishing regional and international partnerships.

Objective:

To ensure active collaboration with individuals, groups and institutions – nationally, regionally and internationally.

This priority area is to be achieved through

- Working co-operatively, in particular with the Roads Department, the Ministry of Local Government and Rural Development and NGOs;
- Foster collaboration research with local universities and industry;
- Developing strong long-term partnerships and establishing formal agreements/MOUs for regional linkages with emerging Road Research Centres and well established institutions such as the CSIR in South Africa; and
- Establish formal agreements/MOUs for international linkages (e.g. with ARRB in Australia, and TRL in the United Kingdom).

3.6 Strategic objectives

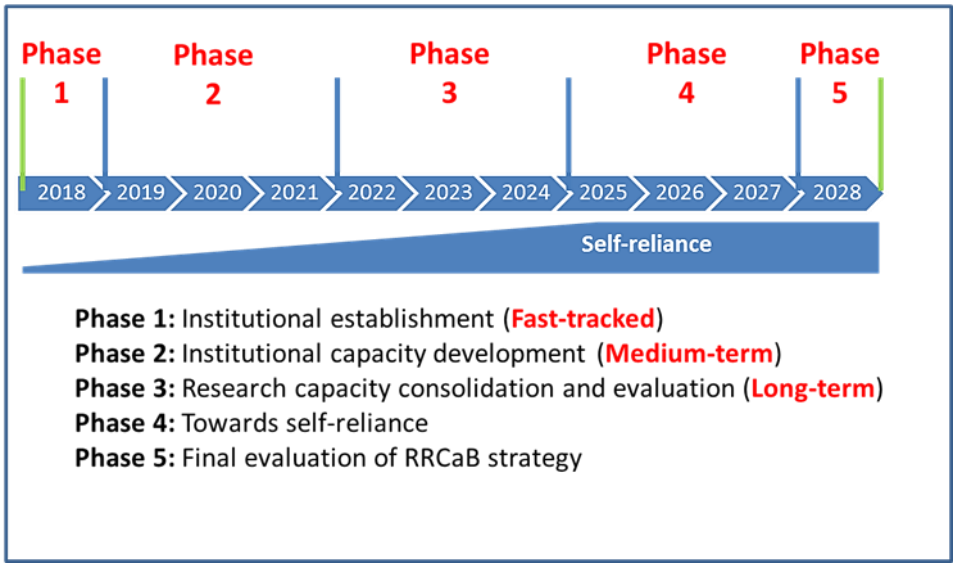
The goal of the road research capacity building programme is to assist in increased capability for delivery of research-based and innovative solutions on all matters related to road asset management, road design, construction, maintenance and operation, for the provision of better and more reliable road infrastructure in Malawi. This is to be achieved through the following over-arching strategic objectives, to be supported by good governance and management, with effective finance and resource mobilisation:

a) Enhance effectiveness of RRCaB for sectoral R&D through implementation of the priority areas and ensure its sustainability.
b) Create critical mass and institutional capacity to support sectoral R&D.
c) Promote economic growth through delivery of research-based and innovative solutions for the provision of better and reliable road infrastructure, to ensure better accessibility and mobility for people and goods, particularly in rural areas of Malawi.

3.7 Implementation time-line for the RRCaB strategy

The strategic objectives are to be translated into actionable activities. The road research capacity building strategy is to be rolled out over a ten-year period as the RRC evolves to maturity and to ultimately become one of the established road research centres, regionally and internationally. The time-line for the implementation of the 10-year RRCaB Strategic Plan is schematically presented in Figure 3.

Figure 3 Action timelines for the road research capacity building strategy



A number of actions, relating to achieving building sustainable road research capacity, for each implementation phase of the RRCaB Action Plan are provided below. However, more specific details are provided for the first five years.

Phase 1: 2018:

Institutional establishment: This Phase will involve the activities to put in place a functional entity for building road research capacity. This will include the required restructuring of Design and Planning Directorate and appointment of research staff and Head of Research Development and Innovation (RD&I).

An interim Road Research Management Committee **(RRMC)** is to be established and meetings organised by the Director of Design and Planning. The terms of reference for the RRMC as follows:

- Interim body for 1-year, chaired by the Director of Design and Planning;
- Advise and assist the Director of Design and Planning on issues relating to the recruitment of research staff, including the Head of the Road Research Centre;
- Drawing up the job requirement descriptions for the research staff;
- Drawing up the job requirement descriptions for the Head of Research Development and Innovation and Laboratory Manager;
- Reviewing progress in attainment of the RRCaB Strategic Plan.

Typical research job descriptions are provided for guidance in Annex 1. However, the recruitment will follow existing internal RA processes Members of the RRMC to be heads or their representatives drawn from the following stakeholder institutions:

- Ministry of Transport and Public Works, as the responsible Ministry (MoTPW), represented by Roads Department;
- Association of Consulting Engineers of Malawi (ACEM);
- Central Materials Laboratory (CML);
- Malawi Institution of Engineers (MIE);
- Malawi Transportation Technology Transfer Centre (: MTTTC (T2);

Capacity building programmes are to be developed to nurture research development, to include research skills development programmes to enhance understanding of the linkages between research project activities (Research Project Chain).

The Head of RD&I will be the Research Leader to champion the RRCaB initiative, initially based at the RA to oversee the process of core staff recruitment, establishment of Road Research Advisory Committees (RRACs), to consolidate RRC's role and secure support from all key stakeholder groups as a role player in the national research system. It is also during this Phase that the strategy for RRCaB will be publicised and integrated into the National Research Agenda through the National Committee on Energy, Industrial and Engineering Sciences (NCEIES) of the National Commission for Science and Technology (NCST), to which the RRC is to become a member.

The establishment of the RRC is to be in accordance with the provisions of the appropriate Act. The executing agency will be the MoTPW and will provide the over-arching leadership of the process, through the Roads Department and the RA. Initially, the implementing officer for the activities related to RRCaB will be the Director of Design and Planning.

The survey on implementation of training programmes for the road sector is to be conducted, this to include road construction materials testing, to determine the range, duration and required content of the courses. This will be conducted in consultation with industry and relevant Government Ministries, and departments.

Formation of the Project Steering Committee (PSC) for the construction of a modern road construction materials laboratory is for the guidance and monitoring the implementation progress. This should however, be in accordance with existing processes for infrastructure development within the RA. Space is limited at the CML for expansion. While NCIC has indicated readiness to provide land for construction of the facility, the RA will formulate its options in terms of appropriate location.

Considering the current capacity within the Design and Planning Directorate, Technical Assistance by AfCAP, to support the establishment of RRC and strengthen capacity to implement the RRCaB strategy will be required. Table 2 shows planned main actions.

Table 2 Main actions for 2018

Next steps	Actioned by	Deadline
Establish the Road Research Management Committee (RRMC), comprising stakeholder organisations to provide input in the recruitment process of research staff for R&D.	Director, Design & Planning 1 Sep 2018	30 Sept 2018
Recruit qualified research staff	Director, Design & Planning 1 Sep 2018	31 Oct 2018
Establish RRACs to prioritise research projects and to reach sufficient consensus on the first series of priority projects for funding in the next Financial Year	Director, Design & Planning 1 Oct 2018	31 Oct 2018
RA initiates process to appoint Head of R&D with stakeholder input. To be dictated by RA processes.	Director, Design & Planning RRMC 1 Oct 2018	31 Oct 2018
Establish funding model for research. RRCaB will constitute an additional dimension to the structure of the RA.	Director, Design & Planning 1 Oct 2018	30 Nov 2018
Develop or adopt guidelines for a research policy and mentorship programmes	Director, Design & Planning 1 Oct 2018	30 Nov 2018
Design and initiate capacity building programmes for staff to nurture research development.	Director, Design & Planning 1 Oct 2018	30 Nov 2018
Decide on location of RRC and form a Project Steering Committee for the construction of a modern and comprehensive materials **laboratory** for the testing of materials used in road works.	Director, Design & Planning 1 Oct 2018	31 Dec 2018
Recruit Laboratory Manager (in the interim use CML structure, to be effected by MoWTPW)	Director, Design & Planning 1 Nov 2018	31 Dec 2018
Conduct survey on implementation of training programmes for the road sector	Director, Design & Planning 1 Oct 2018	31 Dec 2018
Develop or adopt consultancy policy to guide the management thereof.	Director, Design & Planning 1 Oct 2018	31 Dec 2018
Initiate at least the first two research projects in addition to linkage to AfCAP regional LTPP project (RAF2132A)	Director, Design & Planning 1 Nov	31 Dec 2018

Phase 2: 2019-2021:

Institutional capacity development: Main actions are presented in Table 3. This phase will focus on activities to achieving the strengthening of road research capacity building initiative through the development of documentation aligned to staff development, knowledge transfer and laboratory quality management systems. It will also cover a number of actions to develop a modern laboratory facility, initiate research projects and linkage to the regional AfCAP project on "*Capacity Building and Mentorship for the*

Establishment and Implementation of Monitoring & Evaluation Programmes on Experimental and Long-Term Pavement Performance (LTPP) sections in Six AfCAP Countries".

Conducting of consulting services will either be initiated by the RRC or will be in response to calls made by clients and is therefore not planned for, as the frequency of such calls is dependent on the availability of funds and client needs, but will be included in the assessment of target performance indicators in the implementation of the strategy as presented in Section 9.1.

Table 3 Main actions for the period, 2019 – 2021

Next steps	Actioned by	Deadline
Design and implementation of individual staff development schemes.	Head, R&D 1 Nov 2018	28 February 2019
Secondment of Laboratory Manager to an accredited Laboratory	Head, R&D 1 February 2019	29 March 2019
Develop a Laboratory Strategic Plan (LSP).	Laboratory Manager 1 April 2019	30 April 2019
Start construction of new laboratory.	Director, Design & Planning 1 April 2019	30 April 2019
Strengthen required skills specifically for laboratory personnel.	Laboratory Manager 1 April 2019	31 May 2019
Development and implementation of Information Management Systems, enhance data collection and storage and efficient dissemination of research results.	Head of R&D 1 April 2019	31 June 2019
Establish standardised operational procedures for regulating everyday management of the laboratory, ensure Quality Assurance systems towards accreditation	Laboratory Manager 1 May 2019	31 July 2019
Develop and implement policy on publicising, promoting RRC's research, nationally and internationally.	Head of R&D 1 May 2019	31 July 2019
Procurement of basic standard laboratory equipment, with first lot of 5 more advanced equipment. However, timing linked to stage of construction of new facility.	Laboratory Manager 1 June 2019	31 Aug 2019
Implement at least two new research projects, through the Technical Assistance support by AfCAP within project execution as effective mentorship.	Deputy Head R&D 1 July 2019	31 Aug 2019
Completion of construction of modern laboratory	Director, Design & Planning 1 September 2019	28 Sept 2019
Initial equipment installation and calibration	Laboratory Manager 1 September 2019	28 Sept 2019
Develop Course Design Plan and project schedule for training programmes, based on results of the survey, undertaken in Phase 1.	Head of R&D 1 November 2018	28 Sept 2019
Monitor existing LTPP trial sections, part of the regional project (X2 per year)	Deputy Head R&D 1 March 2019	28 Sept 201 9
Establish formal agreements to develop strong long term	Deputy Head R&D	28 Feb 2020

partnerships for linkages with other emerging Road Research Centres in the region and international road research institutions and laboratories.	1 November 2019	
Evaluation of research projects and decision on new series of research projects.	Head of R&D, RRACs 1 March 2020	31 May 2020
Implement at least three new research projects.	Deputy Head R&D 1 June 2020	31 July 2020
Procurement of second lot of 5 more advanced equipment.	Laboratory Manager 1 June 2020	31 Aug 2020
Implementation of training programmes	Head of R&D 1 June 2020	27 Nov 2020
Evaluation of research projects and decision on new series of research projects.	Head of R&D, RRACs 1 March 2021	31 May 2021
Procurement of third lot of 5 more advanced equipment.	Laboratory Manager 1 June 2021	31 Aug 2021
Monitor existing LTPP trial sections (x2 per year)	Deputy Head R&D 1 March 2021	28 Sept 2021
Implementation of training programmes	Head of R&D 1 March 2021	27 Nov 2021

Phase 3: 2022-2024:

Research capacity consolidation: It is envisaged that at this stage the RRC will have been fully established at its appropriate location and started functioning as a fully-fledged research centre. The Research Planning - Funding – Implementation - Evaluation Cycle will have been established at this stage.

Table 4 Main actions for the period, 2022 – 2024

Next steps	Actioned by	Deadline
Evaluation of research projects and decision on new series of research projects.	Head of R&D, RRACs 1 March 2022	31 May 2022
Implement at least four new research projects.	Deputy Head R&D 1 June 2022	31 July 2022
Monitor existing LTPP trial sections (x2 per year)	Deputy Head R&D 1 March 2022	28 September 2022
Implement training programmes	Head of R&D 1 March 2022	30 November 2022
Evaluation of research projects and decision on new series of research projects. This will also cover the mid-term strategy evaluation.	Head of R&D, RRACs 1 March 2023	31 May 2023
Implement at least four new research projects.	Deputy Head R&D 1 June 2023	31 July 2023
Monitor existing LTPP trial sections (x2 per year)	Deputy Head R&D 1 March 2023	28 September 2023
Implement training programmes	Head of R&D	30 November

	1 March 2023	2023
Evaluation of research projects and decision on new series of research projects.	Head of R&D, RRACs 1 March 2024	31 May 2024
Implement at least five new research projects.	Deputy Head R&D 1 June 2024	31 July 2024
Monitor existing LTPP trial sections (x2 per year)	Deputy Head R&D 1 March 2024	28 September 2024
Implement training programmes	Head of R&D 1 March 2024	30 November 2024

Phase 4: 2025-2027:

Towards self-reliance: At this stage, the RRC should have attained self-reliance and be recognised as an established institution of road research within the region and internationally. The main actions for the 2025 – 2027 period, are as follows:

- Implementation of 3rd cycle of training programmes;
- Implementation of new series of research projects;
- Conduct consultancy services;
- Monitoring of LTPP sections;
- Monitoring and Evaluation of new series of research projects.

Phase 5: 2028:

- **Final evaluation** of RRCaB 10-year strategy.

3.8 Requisites to the successful implementation of the RRCaB strategy

From the outlined plan, the effective execution of the RRCaB Strategic Plan will very much depend on the availability of resources, both financial and non-financial, that will be required for strategy implementation, which include human resources with the necessary skills, infrastructure, as well as an enabling environment. Such resources are currently available but limited and effective implementation of the strategy will be hampered by the lack of capacity.

In addition to human resources with the necessary skills, infrastructure, as well as enabling environment, the key supporting factors for the RRC to successfully achieve self-reliance as envisaged in the implementation plan, are presented in the next sections and include the following:

- Effective governance and implementation arrangements;
- Institutional commitment;
- Appropriate location;
- Effective funding mechanisms; and
- Monitoring and Evaluation

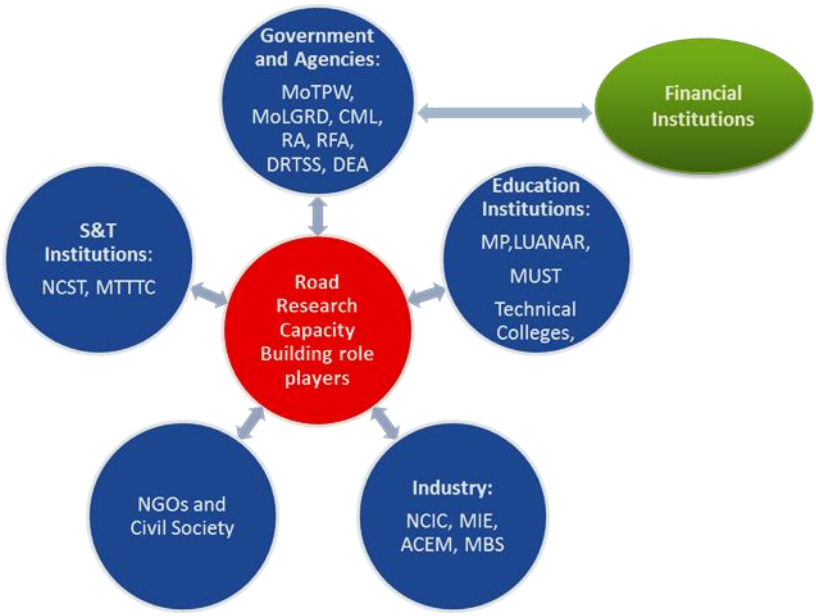
4 Governance and Implementation Arrangements

4.1 Decision making Institutions

The institutional arrangements which influence the decision making and implementation processes and structures, will impact on the success of implementing RRCaB. Section 2 provided the framework from which the overarching institutional arrangement for the delivery of the RRCaB in Malawi is defined.

The MoTPW through the Roads Department and the RA will provide the over-arching leadership to establish measures to enhance road sector capacity building. While the sector impacts on other sectors, the institutions shown in Figure 4 should play a key role in supporting the implementation of the RRCaB strategy. It is important that these institutions are represented at the highest level of the decision-making process to strengthen road research capacity building in the country. They will fulfil their role through the RRACs. The role of financial institutions is channelled through Government and its implementing agencies.

Figure 4 Decision-making role players in RRCaB strategy



Decision-making role players:

- Ministry of Transport and Public Works, as the responsible Ministry (MoTPW), represented by Roads Department;
- Association of Consulting Engineers of Malawi (ACEM);
- Central Materials Laboratory (CML);
- Department of Environmental Affairs (DEA);
- Directorate Road Traffic & Safety Services (DRTSS);
- Lilongwe University of Agriculture and Natural Resources (LUANAR) Department of Agricultural Engineering;
- Malawi Bureau of Standards (MBS);
- Malawi Institution of Engineers (MIE);
- Malawi Polytechnic (MP): Department of Civil Engineering;
- Malawi Transportation Technology Transfer Centre (: MTTTC (T^2);
- Malawi University of Science and Technology (MUST).
- Ministry of Local Government and Rural Development (MoLGRD);
- National Commission for Science and Technology (NCST);
- National Construction Industry Council of Malawi (NCIC);
- Roads Authority (RA); and

- Roads Fund Administration (RFA), representing Ministry of Finance, Economic Planning & Development (MoFEPD).

4.2 Implementation Institutions

The recommendation made at the consultative workshop of 18 September 2017, was that the RRC be located within the RA. The enabling environment exists, due to the fact that one of the strategic objectives of the RA is to pursue research and studies necessary for promoting the construction, maintenance and rehabilitation of public roads. The most appropriate institutional location is the Directorate of Planning and Design, which according to the core business of the RA, as outlined in both the 2011-2016 and 2017-2022 Strategy and Business Plans, is currently responsible for attending to Research and Development. In the current structure, there is no Department or Unit for R&D and only a budget line for R&D funding is provided. The allocation of funds for R&D is coordinated and directed by the responsible financial controller, the Director of Finance. This allocation of funds for R&D is not based on a systematically planned priority research programme.

The RRC will therefore constitute an additional component to the structure of the RA. Restructuring will be necessary, to effectively respond and deliver on the activities and services under the new set-up. It will require re-evaluation of the mechanism for allocation and level of funding that the RA currently provides for R&D. The budget for research will be based on research project proposal that have been prioritised through an assessment process and recommended by a committee as being projects that will bring demonstrable benefits to the country.

While the RA is the implementing institution of the RRCaB strategy, it was agreed at the workshop that the RRC should develop into an entity that is semi-autonomous and is not to be perceived as catering for the RA only. The RRC will provide research leadership in establishing national research/development agendas, focusing on research and services that will re-create research capability and provide innovative solutions for the provision of reliable and cost effective transport infrastructure in Malawi.

The readiness of the RRC to become self-reliant and undertake most of the research in-house will depend on effective institutional implementation of the strategy on RRCaB. Like most well-established research centres, the RRC will be expected to become the appropriate platform for promoting collaborative research, knowledge and human capital development in the road sector, and deepen RRCaB in the country. It is expected that during the early phases, it will be necessary to implement research activities through outsourcing to academic institutions with research capability in the specific areas (who could also become co-host institutions of the RRC), local and international consultants and in collaboration with other regional and international research centres. Even after becoming self-reliant, there are areas of research that will require collaboration with other regional and international research centres.

Effective institutional arrangements should be in place to manage the RRCaB implementation processes. This will be achieved through establishing decision-making support structures as presented below.

4.3 Implementation Institutions

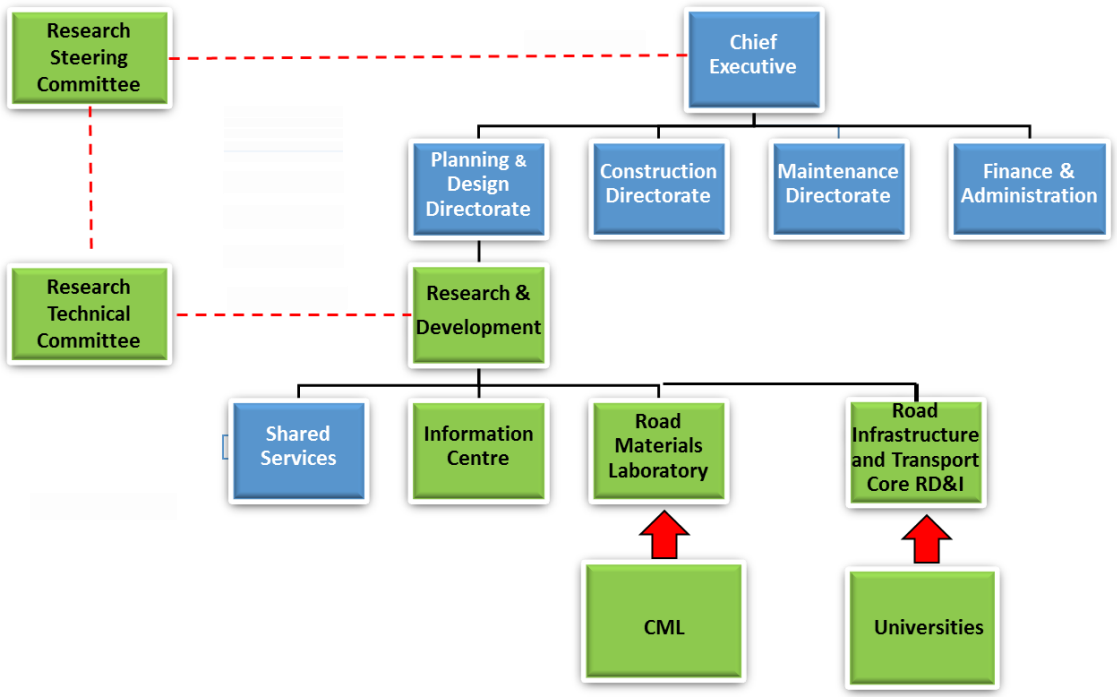
4.3.1 Institutional structure

According to legal advice provided by the Legal Practitioners Likongwe & Company to RA, reference is made to Section 12 and Section 13(b) of the Roads Authority Act, indicating that the Roads Authority has within itself the powers to run a department of research. It is therefore proposed that the RA immediately takes steps to elevate R&D to a Unit/Department level under the Design and Planning Directorate. In order to put emphasis on innovation, it is further proposed that the Unit be referred to as Research Development and Innovation (R&D).

Initially, the RRCaB will be championed by the Head of R&D, who will provide road research leadership within the RA. This will however, require internal approval through restructuring. According to the proposed RA organisational structure, the Head of R&D should be appointed at MG3 level, reporting directly to the Director of Planning and Design, who is at MG2 level. The proposal is that as the RRC

develops from an emerging into a semi-autonomous established research centre, the position of Head of R&D will be elevated to that of Director of the RRC with a Deputy Director. Figure 5 shows the proposed institutional structure. The new additions are represented by the blocks in green.

Figure 5 Proposed institutional structure



4.3.2 Research Management Committee

As discussed earlier, the RRC will constitute an additional component to the structure of the RA and restructuring will be necessary. This will require elevating R&D to a Unit level within the organizational structure of the RA, in order to effectively implement the RRCaB. The implementation of these activities should be managed in an integrated manner to maintain the momentum of project implementation. An interim implementation arrangement is required.

Initially, a Research Management Committee (RMC) is to be constituted, comprising the Director of Design and Planning as the implementing officer, with the other two Directors of Construction and Maintenance and three high level representatives from the MoTPW (the Roads Department as the key sub-sector coordinator and CML), the RFA. The RMC will be tasked with the responsibility for managing the process of recommending the appointment of the Head of R&D Unit and therefore head of the RRC. The RMC can be expanded to incorporate other members as required, including the professional body representation and will also assist in coordinating the initial establishment of the Road Research Advisory Committees (RRACs), as presented below.

4.3.3 Road Research Advisory Committees (RRACs)

A structure is to be established to internally coordinate the initial series of research projects to support RRCaB with collaboration of key stakeholders through the Road Research Advisory Committees. The development of detailed terms of reference for the committees is to be undertaken during the implementation of the Strategic Plan, under – *Institutional Establishment.* Drawing from regional experience on the establishment of Road Research Centres under AfCAP, the RRACs will comprise of the **Research Technical Committee (RTC)** and the **Research Steering Committee (RSC).** The members of the committees will be drawn from the identified role players, listed in Section 4.1 and should be at decision making level in their respective institutions.

- A research project coordination process is the first step of managing research project prioritisation. The process is to be undertaken by an internal panel of research area experts.
- The RTC will provide advice to the Research Steering Committee (RSC), providing research leadership in establishing national research/development agendas and sustain research capability, focusing on projects that will bring demonstrable benefits, creating advocacy schemes for promoting research and disseminating knowledge in the road infrastructure domain in the country.

The following institutions are proposed for representation consideration on the RTC:

- Central Materials Laboratory (CML)
- Lilongwe University of Agriculture and Natural Resources (LUANAR) Department of Agricultural Engineering
- Malawi Polytechnic (MP): Department of Civil Engineering
- Malawi Transportation Technology Transfer Centre (MTTTC (T^2)
- Malawi University of Science and Technology (MUST)
- National Construction Industry Council of Malawi (NCIC)
- Roads Department (MoTPW)

- The RSC will have advisory powers to provide strategic direction to ensure the RRC carries out relevant research, aligned with the national strategy and operates effectively.
- The RSC should provide leadership on resource mobilisation activities.

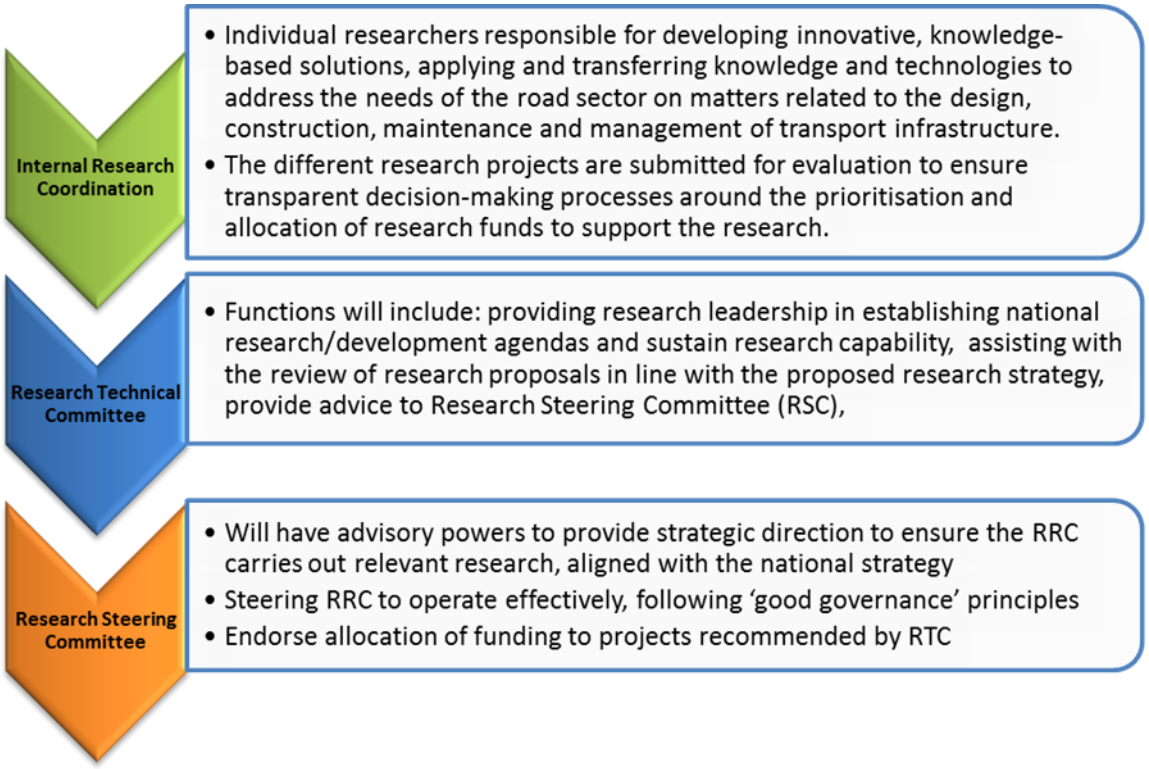
The following institutions are proposed for representation consideration on the RSC:

- Association of Consulting Engineers of Malawi (ACEM)
- Malawi Bureau of Standards (MBS)
- Malawi Institution of Engineers (MIE)
- Malawi Polytechnic (MP): Department of Civil Engineering
- Malawi University of Science and Technology (MUST)
- Ministry of Local Government and Rural Development (MoLGRD)
- Ministry of Transport and Public Works, as the responsible Ministry (MoTPW)
- National Commission of Science and Technology (NCST)
- National Construction Industry Council of Malawi (NCIC)
- Roads Fund Administration (RFA)
- Development partner representative

To ensure political buy-in, it is also recommended that a direct linkage be established between the RSC and the Transport and Public Infrastructure Committee of Parliament.

Figure 6 shows the structure for the decision-making process to implement research activities.

Figure 6 Envisaged decision making process for research prioritisation



4.3.4 Unit level structure

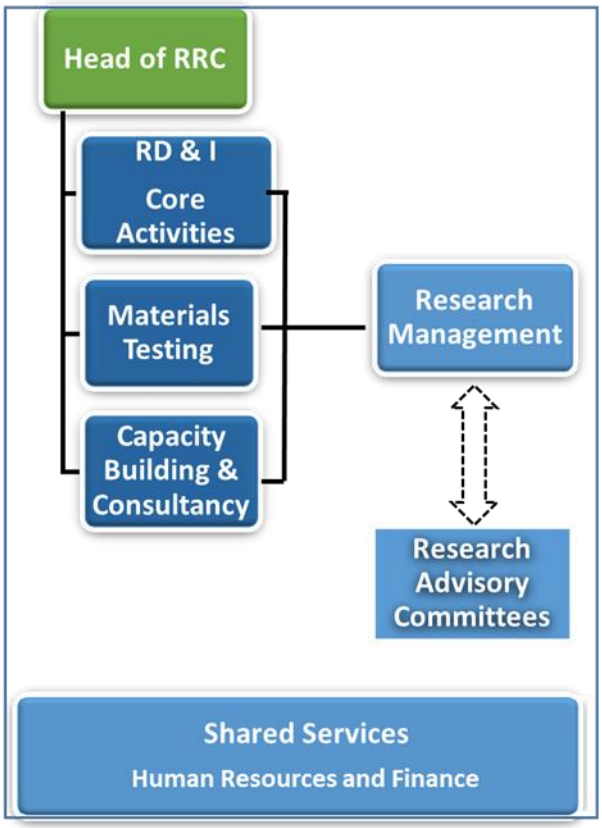
Figure 7 shows the structural arrangement and linkage to research management. The term Head of RRC is used, but as proposed above, it will be more appropriate to use the term Director, once the RRC becomes a semi-autonomous entity. The recommendation to the MoTPW as to whether the semi-autonomous entity will become an Agency/Institute is to be achieved through consultation between the RA and the Minister of Transport and Public Works.

- Initially, a number of researchers will form the core of researchers or Research Group, focusing on specific R&D core activities in the priority research areas. In addition, a flexible model is proposed, in which the RRC can be co-hosted at an academic institution, forming a Research Group. This is further discussed in Section 4.3.6.2.
- Research Management refers to a portfolio required to support and implementation of best practice in the management of research activities, for example, responsibility for outreach programmes and communication, research contracts and knowledge management at the Information Centre. This portfolio should manage a financial subcommittee to the RRACs, to examine the annual budget and scrutinize the estimates of research programme and project costs.
- At the initial stage, the laboratory equipment and laboratory services at CML and the Department of Civil Engineering at the Malawi Polytechnic will be used, but will still require some investment on equipment. A modern facility is to be established at the newly established RRC premises.
- The RA has a Library, which will require infrastructure development to be converted into an Information Centre to serve the technical information needs of the researchers, to provide records and document management services and dissemination of quality materials to the wider research and client networks. The development will form part of the institutional capacity development project.
- Capacity building and consultancy, involving training programmes and provision of expert services, will be coordinated and managed separately from research activities. This is to ensure that researchers focus on research, in order to deepen research capability, but there will be close cooperation to ensure successful implementation of RRCaB strategy.

- To optimise use of resources, the human resources, financial management and business support are to be shared services with the RA at Head Office.

Figure 7 shows the proposed structural arrangement of the RRC, with the linkage to RRACs.

Figure 7 Proposed structure of RRC and linkages



4.3.5 Required competency

The availability of human capacity is the key to successfully deliver on the long-term objective of sustainable RRCaB. The RRC will embark on an incremental growth strategy to ensure that there is sufficient capacity as the Centre evolves to become an established entity and delivers on effective RRCaB in Malawi. The staff compliment can appropriately be determined, based on the identified research needs by the RRACs, which have yet to be established.

On the basis of job descriptions from other well-established research institutions, competency/qualification requirements for the different staff positions are provided in Annex 1.

Considering that the preliminary findings from the situational assessment showed that there is low research output in the road sector, due to inadequate numbers of individuals to conduct road research and that there is a shortage of qualified laboratory personnel in the country, it is more likely to be difficult to recruit and fill research and laboratory positions with individuals that have the required research skills and research laboratory testing experience, respectively as indicated above.

The RRCaB strategy is to recruit and train on the job. This will include the researchers appointed at the senior level. The exception may be those from the Universities, who are most likely to have the required minimum academic qualification. However, they will also require research skills development in specific areas to be determined as part of the staff development scheme.

4.3.6 Implementation mechanisms

4.3.6.1 Technical assistance

The availability of resources is one of the key requisites in strategy implementation. Technical Assistance will be required to implement the RRCaB strategy. The establishment of the RRC is earmarked for implementation under Phase 2 of the AfCAP support for the project on the **Development and support to the implementation of a Strategic Plan for the Establishment of Sustainable Road Research Capacity in Malawi.** A fully costed proposal for the establishment of a new RRC will be submitted to ReCAP to put in place the required infrastructure for the effective delivery of RRCaB and meet the national research needs and interests.

AfDB is funding a project on Support to Higher Education, Science and Technology (HEST) in Malawi (AfDB, 2012). The Malawi Polytechnic is one of the direct beneficiaries of the Higher Education sub-component of this project and new infrastructure is being built at the institution. As the project aims to help improve the quality and relevance of skills development in Malawi for job creation and employability of graduates, the RRCaB project is aligned with AfDB's objective and strategic support to the HEST project. The possibility exists that AfDB can broaden the support to include implementation of the RRCaB strategy in specific areas that ReCAP is not going to fund. Other Development Partners with projects aligned to the RRCaB strategy should be able to support implementation of the RRCaB strategy.

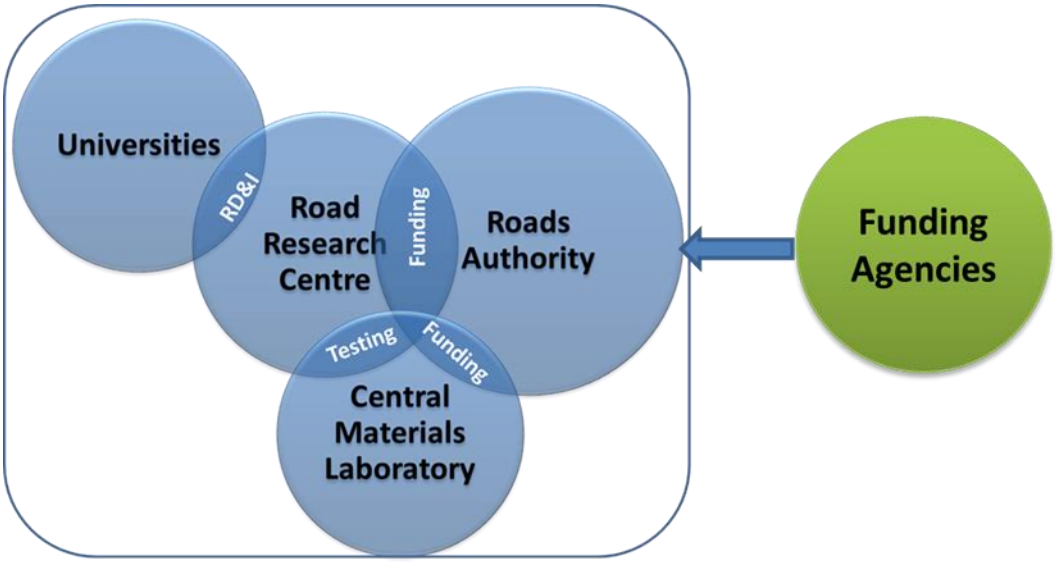
4.3.6.2 Implementation model

The proposed implementation mechanism in terms of location is the 'distributed' model for the location of RRC. It is proposed that the RRC should not be 'single-sited', to encourage sharing of resources. This means that, the RRC does not only have to be located in Lilongwe, it can also be hosted at an academic institution, but remain under the auspices of the RA. The co-hosting institutions will host Road Research Groups to undertake R&D activities. RRCaB programmes will still be coordinated, validated and implemented by the Road Research Groups according to the set out research agenda as approved by the RRACs of the RRC.

The Department of Civil Engineering at the Malawi Polytechnic, through the AfDB project on Support to Higher Education, Science and Technology (HEST), will have adequate infrastructure and with the offering of higher degrees in the field of Civil Engineering, is proposed to be one of the co-host institution of road research in the country, outside the RRC. It has the advantage of having staff academically qualified to conduct research and established procedures to monitor quality of research. It is currently facing challenges in funding research and the risk is there that it will not be in a position to sustain core funding for research. The advantage of road research being under the auspices of the RA is that research funding will directly be channelled to the Road Research Centre and in turn enable staff at Malawi Polytechnic to conduct R&D for the RRC. The highly educated staff in the Department of Civil Engineering will benefit from the RRCaB, enabling them to establish a sustained, strong research record, resulting in increased research outputs, which will impact on the national road research agenda.

Staff from MUST, particularly in the field of Geology will form part of the Road Research Group at Malawi Polytechnic and staff in the Department of Agricultural Engineering at LUANAR will form another Research Group. Until the RRC has its own laboratory facility, the CML will also provide research laboratory testing services to the RRC. The institutional linkage is shown in Figure 8.

Figure 8 Road research capacity building short term implementation model



As a temporary research facility, CML is to provide testing services for the RRC and researchers being accommodated at RA. However, The RA Head Office has limited space and existing space utilization at the CML will have to be reviewed in terms of adequacy, although it does also seem limited to accommodate appropriate physical facilities for a new modern facility, capable of carrying out most of the envisaged experimental work of the RRC. During the consultative meetings it was revealed by the Director of Training that NCIC has plans to construct an Exhibition Centre for the construction industry in Lilongwe and space could be made available to physically locate the RRC within the NCIC grounds in Lilongwe and therefore deemed one of the potential options to locate the RRC. It will also provide support to LUANAR's Department of Agricultural Engineering capacity development, to enhance and promote sustainable rural infrastructure development research. The RA in Mzuzu can provide required support to researchers from the RRC in the Northern Region as there is no Civil Engineering related programme at Mzuzu University.

The advantage of locating the RRC away from the RA and the CML, is that staff at the Centre will focus on research and not find themselves also involved in the day to day responsibilities of managing RA activities, which has been a contributing factor for some of the regionally established RRCs not to be effective in the delivery of research.

4.3.6.3 Institutional commitment

The RRCaB Strategic Plan aims to commit the RA to high quality research development and innovation in the road sector and to ensure that, this commitment to research is aligned with the national imperative, to ensure better accessibility and mobility for people and goods, by providing sustainable and cost-efficient transport links from farm or factory gate to market centres, and to support the economic growth of Malawi.

Institutional commitment by the RA, as the implementing agency, is required to ensure self-reliance of RRC. This will be the key to the successful implementation of the RRCaB strategy. The institutional commitment by the RA is expected to be characterised by the urgency in meeting the legal and administrative requirements for establishing the RRC under the auspices of the RA, the change in the level of funding and mechanism for providing for research activities, from the current scenario. The RA will be responsible for

providing financial support for road research activities as discussed in sections 6.2 and 6.3. This will demonstrate tangible commitment to support the development of RRCaB in the country.

The collaborative accountability and commitment by the responsible officers in MoTPW, the RA and RFA to implement the Strategic Plan, is another factor that will affect the degree of commitment and will also be an indicator of the importance of RRCaB in the country.

4.3.6.4 Collaboration

The ability to identify relevant national road research issues requires experience and is developed over time. This can be achieved through mentorship and partnership projects. The ability to establish research collaboration and partnerships with other national, regional and international research institutions will create the enabling environment for sustainable road research capacity development. This may be through collaborative research projects or long-term institutional capacity building projects. Appropriate contractual arrangements are to be signed between RRC and other relevant research institutions.

RRC will benefit most from formal agreements to establish international linkages, more especially to achieve RRCaB objectives in terms of research skills development and mentorship in the early stages of development of the Centre. Formal linkages and networks will facilitate the sharing of best practices, including innovation and assist in building on existing research, instead of re-inventing.

Networking for staff at the RRC will be essential to sustain a strong research profile for the individual researchers and the visibility of the RRC. Staff will be encouraged to serve on national professional, industrial and governmental bodies and provide expert services to industry, including material testing, forensic studies and technical audits. This should include taking opportunities to serve on regional committees and participate in forums and conferences.

5 Research Project Prioritisation

The research is supposed to address road sector needs in response to the MGDS, and as identified during the consultation phase, including those drawn from the National Research Agenda in Energy, Industry and Engineering as well as the national policies. Two of the threats that were identified in the Strategic and Business Plan (2011 -2016) of the RA, are a shortage of critical construction inputs and materials impacting on the construction activities and inadequate qualified and experienced engineers and technicians. The National Science and Technology Policy identified the establishment of a Rural Access Roads Technology Unit to serve as a centre for technology research and development as one of specific strategies related to the road sub-sector. The strategic objectives of the National Road Transport Policy are listed below:

- A transport sector that is safe, reliable, effective and efficient;
- Improved fully integrated road transport infrastructure;
- Maintenance of an acceptable quality road system;
- improved levels of service that supports government strategies;
- Improved development of the country's rural areas;
- Improved rural access and transport infrastructure.

Research area prioritisation should be guided by the above stated strategic objectives and challenges. It is consultative process requiring input from wide representation within the road sector. A questionnaire developed for this purpose is shown in Annex 4, which can be used to review the proposed priority research areas by the RRC during Phase 2 of the project. At this stage, priority research areas are proposed based on the key challenges that can commonly be identified in the national research agenda, in policy documents, strategies and plans, to be addressed in order to achieve the economic growth of the country. An additional important factor considered is the linkage to AfCAP regional research programmes. In this way the RRC will benefit from participating in the projects while making contribution to the advancement of research in the region. The proposed list, provided in Annex 4, is therefore drawn up to address the

assessment, development and promotion of innovative road construction materials, considered as key common areas.

6 Funding Mechanism

The RRC will be expected to engage in dedicated and sustained activity to identify and source research funding opportunities for implementing sustainable RRCaB. This may be achieved through signed national and international strategic collaboration agreements, for specific requirements.

6.1 Data collection and cleaning

A fully costed proposal for the establishment of the new RRC has been requested by AfCAP as part of Phase 1 of the project. Thus DFID, as a Development Partner, is more likely through ReCAP, to provide seed funding for the establishment of the RRC. The support will be for providing technical support to the new RRC to put in place systems for the implementation of several primary activities that will provide the enabling environment for effectively implementing the RRCaB Strategic Plan. This will involve establishing a modern and comprehensive materials laboratory for the testing of materials used in road works, with capacitation of laboratory staff, development of operational systems for the laboratory, including data management systems for research projects, establishing in-house capacity for comprehensive materials investigations and geotechnical investigations required for road works and procurement of appropriate laboratory equipment.

The African Development Bank (AfDB) is in a position to provide assistance in development of the infrastructure, including equipment acquisition as well as initial staff training. The required components for the establishment of the RRC, which will not be funded through ReCAP, could potentially be supported by AfDB. However, this is only a potential source for seed funding.

6.2 Core funding of research

The ultimate goal for any research centre is to become well established through systematically developing research programmes. Core funding is required to ensure that there is sustained research activity and therefore ensure continuity and longer-term research programmes for the effective delivery of RRCaB and meet the national research needs. Methods for effective funding mobilisation are required.

- The **Roads Fund Administration** is expected to be one of the main sources for funding core research, but only through its implementing agency, the RA. The RFA is responsible for the mobilisation of and accounting for funds for maintenance and rehabilitation of roads. The level of funding will depend on annual research programmes and projects for implementation, as approved by the RSC. This could be in the form of ring-fenced research funding to the RA.
- The **National Commission for Science and Technology** through the Science and Technology Fund commits direct resources at various levels to support the undertaking of research and development in identified priority areas. It provides Grant support for research allocated on a competitive basis. The RRC will be expected to compete for this funding.
- The **National Construction Industry Council** is expected to champion and promote research development of competitive local materials. The RRC is expected to undertake research in the area of road construction materials development as such this is another potential source for research funding.
- **Government Ministries and Special Presidential Initiatives.** Various Ministries will provide opportunities for accessing further research funding from their respective budgetary support. From the administration of the road network point of view, the Ministry of Local Government and Rural Development plays a role in the management of districts, rural and urban roads. The RRC will be expected to conduct specific road related research programmes and provide services to build institutional capacity for rural and urban road management within the Ministry of Local Government and Rural Development. The Ministry of Agriculture, Irrigation and Water Development, through the Agricultural Sector-Wide Approach (ASWAp), is supporting priority activities in the agricultural sector

that would increase agricultural productivity, reduce hunger, enable people access to nutritious foods, and increase the contribution of agro-processing to economic growth. This programme has a road component through which the RRC could source additional research funding by getting involved in the assessment and monitoring of the performance of the roads constructed under the programme.

- **Development partners:** Undertaking research projects that will complement the development partner programmes should provide an opportunity to access additional funding for research. A number of rural road improvement and development focused programmes are being funded by development partners such as EU, DFID, JICA and the World Bank. International strategic research partnerships and collaborative research projects or long-term institutional capacity building projects will also provide source of funding. The RRC could also contact for example, the AuthorAid programme funded by several development partners, to support knowledge management and dissemination. The programme is run by the International Network for the Availability of Scientific Publications, providing researchers access to latest publications as well as publication of research results and thus will facilitate better access to bibliographic resources.

6.3 Road Research Centre operating expenses

The operational costs and overheads of the RRC should be fully funded in order to achieve sustainable RRCaB. As discussed in section 4.3.1, it is envisaged that the RRC will be under the R&D within the Design & Planning Directorate. Institutional commitment by the RA is essential as the RA will carry these costs, and expectedly mobilise the required funding, most likely through the funding from RFA. It is understood that co-host units (Road Research Groups) at academic institutions and the principal investigators participating in the research or training initiative towards RRCaB, will enter into contractual arrangements with the RA and will only receive financial support for approved research projects or contract work.

- Additional funding should be sourced from private sector and through consultancy services, training programmes and testing of materials at a charge, once the facility is up and running.
- Creation of a funding pool to generate funding directly from the private sector is to be explored. One such method could be a levy on road construction projects towards road research.

7 Resource Allocation for the Strategic Plan

This section provides an indicative cost on elements requiring investment. This is based on the situational assessment, defined priority areas and envisioned development and support to the implementation of a Strategic Plan for the establishment of sustainable RRCaB. The goal of the RRCaB programme is to assist in increased capability in key areas of human capacity, research infrastructure (research facilities and equipment) for delivery of research-based and innovative solutions on all matters related to road asset management, road design, construction, maintenance and operation, for the provision of better and reliable road infrastructure in Malawi.

7.1 Annual operational expenses

7.1.1 Staffing requirements

The implementation of the strategy will require the correct growth level of human resources with maturity of the RRC. The RRC is initially to utilise available laboratory equipment and laboratory services rendered by the CML or the Civil Engineering Laboratory at the Malawi Polytechnic to support the research activities. The goal should be to have the Head of R&D supported by two senior researchers and three researchers with at least five technicians and a Laboratory Manager to undertake the research work. Initially, one of the senior researchers could deputise the Head of R&D. In addition, an Information Specialist will be required. However, the current library services will be reviewed during the initial year, before appointing someone on a full-time basis.

It is envisaged that the Head of R&D will be a researcher and will therefore be expected to generate research outputs as well. The actual staff complement will be decided upon to match the number of initial priority research projects and required timeframe for their delivery. These have to be approved by the RRACs and will depend on funding amounts mobilised for research. The decision on the staff complement will also need to take into account requirements for training programmes and consultancy services.

7.1.1.1 Recruitment process

The recruitment of staff is a short term priority and should therefore be undertaken during Phase 1 of the Strategic Plan as follows:

- The RMC should provide input on the staff composition of the RRC;
- Draft detailed job descriptions for each position (as a guide use the job descriptions provided in Annex 1), but being realistic by taking local capabilities into account;
- Schedule for recruitment is drawn according to RA requirements;
- Consider suitably qualified internal staff within the RA and the CML first;
- Advertise vacant positions and interview short-listed applicants; and
- Appoint suitably qualified persons for the RRC.

Staff will be supported through a clear career ladder to enhance career development and upward mobility at the RRC, including pipeline positions as the RRC develops. Internal staffing systems can be developed through AfCAP Technical Assistance.

The cost of the RRC's operations and administrative activities is to be funded by the RA on an annual basis. The indicative costs are shown in Table 5, in United Kingdom Pound (GBP) and in Malawi Kwacha (MWK) in bracket.

Table 5 Annual staff cost: GBP (MWK '000)

Position	Indicative Cost	Indicative Total Cost
Head of Research Development and Innovation (R&D)	35 430 (33 259)	35 430 (33 259)
Deputy Head R&D	31 000 (29 100)	31 000 (29 100)
Senior researchers (x 2)	22 144 (20 787)	44 288 (41 574)
Researchers (x3)	17 715 (16 629)	53 145 (49 888)
Senior Technician	7 787 (7 310)	7 787 (7 310)
Total		**171 650 (161 131)**

7.1.2 Operational expenses

The RRC will require funding to cover the annual operational expenses in order to meet its requirements, including attendance of meetings to enhance networking and working relationships with government institutions and others. Table 6**Error! Reference source not found.** shows an indicative cost estimate for uch costs.

Table 6 Annual operational expenses: GBP (MWK '000)

Item	Description	Indicative Cost
1	Travel (meetings, networking)	22 140 (20 783)
2	Operational supplies	13 290 (12 476)
2	Communications (internet etc.)	14 910 (13 996)
3	Special research projects (e.g. monitoring of LTPP)	40 600 (38 112)
4	Knowledge dissemination	9 300 (8 730)
	Total	**100 240 (94 097)**

Project-attributable costs have not been estimated as these costs are linked to project execution and project prioritisation has at this stage not yet been finalised by the key stakeholders. However, the monitoring of existing LTPP trial sections should be included as an annual line budget.

7.2 Initial start-up estimated costs

Seed funding is required to cover initial start-up expenses in order to establish the RRC. Outlined below are indicative costs that will be required to establish the RRC. Costs are indicated according to the Priority Areas

7.2.1 Priority Area 1: Research programme development

The main objective of Priority Area 1 is to ensure that the road sector has the capacity to identify priority research needs, develop and implement research programmes. Funding is to be channelled towards undertaking the prioritised research projects, under mentorship, through which capacity building will be implemented and therefore, the funding for Priority Area 2 is also linked to the provision for the delivery of Priority Area 1. Table 7 shows the budget estimate for enhancing research capability. The funding for core research projects is dependent on the prioritised research list, to be conducted by RRACs, during the establishment of RRC. However, the most likely initial research project that the RRC is expected to be responsible for, is the monitoring of existing trial sections and to ensure sustainable and consistency in monitoring of trial sections, an annual amount should be reserved and therefore included under Table 7. There are currently three low volume roads trial sections requiring monitoring: (i) Rumphi - Nyika - Chitipa (M9); (ii) Linthipe - Lobi (S126) and (iii) Zaka - Neno (T397). In addition, training on the long-term monitoring of the trial sections will be required.

Table 7 Research skills development cost: GBP (MWK '000)

Item	Description	Indicative Cost
1	Developing or adopting research policy and strategy	5 200 (4 881)
2	Develop and implement Guideline for research staff development	14 800 (13 893)
3	Research skills development workshop	5 600 (5 257)
4	Mentorship for design and proposal development	5 200 (4 881)
5	Study visit by Head of R&D on aspects of strategic research management	2 500 (2 347)
	Total	**33 300 (31 259)**

Level of Priority: Short Term

7.2.2 Priority Area 2: Capacity development

The objective of Priority Area 2 is to align the road sector's R&D investment with sector training needs to achieve economies of scale through the optimisation of resources. Funding for Priority Area 2 is to be channelled towards provision of internal staffing systems, study visits, development of training programmes, adequate equipment and quality assurance systems and facilities that are essential to support sustainable capacity building as presented below.

7.2.2.1 Human Resources

7.2.2.1.1 Capacity building for laboratory personnel

As a research laboratory, it can also serve as a centre for training of laboratory personnel in the country. As the situational assessment further revealed, there is currently no technician programme focusing on construction materials used in road works. Providing training for laboratory personnel at the RRC will ensure regular professional development of the laboratory work force in the country to respond to this national need. However, a training assessment is required. The assessment of training capacity and need will not be limited to training for laboratory personnel, it will also include demand assessment for other

training needs to support capacity building in the road sector. A proper assessment of existing capacity will provide an accurate indication of the demand for the training programmes.

The personnel in the RRC laboratory should be competent and well qualified, not only to maintain high quality results, but also to provide quality training. Training is required to empower the laboratory manager with the skills and understanding to implement ISO 17205. Estimated costs for laboratory human resource development is shown in Table 8.

Table 8 Laboratory human resource development: GBP (MWK'000)

Item	Description	Indicative Cost
1	Consultancy to assess training capacity and need	11 800 (11 077)
2	Consultancy to develop in-service training programmes	30 000 (28 161)
3	Hands-on training for laboratory staff	5 200 (4 881)
4	Secondment of Laboratory Manager to an ISO 17025 accredited laboratory	3 000 (2 816)
	Total	**50 000 (46 935)**

Level of Priority: Short Term

7.2.2.1.2 Laboratory equipment

The situational assessment revealed that laboratory infrastructure is weak to support research activities. Procurement of new testing equipment is required in order to establish a modern and comprehensive materials laboratory that can be used for the testing of materials used in road works. A well-equipped laboratory can further serve as the Centre of Excellence in providing a system to oversee the proficiency and quality of test results from private laboratories. The status of equipment at CML is presented in Annex 2, showing that the equipment is generally very old. Table 9 shows the estimated cost to procure new equipment for standard testing. The details are provided in Annex 3.

Table 9 Indicative cost for procurement of new equipment: GBP (MWK '000)

Description	Estimated cost
Procurement of new laboratory equipment	**235 000 (220 599)**

Level of Priority: Short Term

7.2.2.1.3 Laboratory facility

A modern and comprehensive materials laboratory is to be established for the testing of materials used in road works. A conceptual layout is proposed for the purpose of initial cost estimates. The proposed layout is not final and should be reviewed by the Project Steering Committee for the construction of a laboratory as proposed in Section 3.7.

The conceptual lay out takes into account provision of adequate and environmentally friendly working space for personnel and equipment location for the facility. The closed model for the organisation of the laboratory work space is proposed for the different road materials and laboratory activities, such as sample delivery, preparation and storage. Activities that generate a lot of dust and noise, such as breaking up of soil clods and sample compaction, are both a safety and health hazard to laboratory staff and are accordingly located away from offices.

On the basis of existing laboratory facilities, the project team recommend provision a moderate size laboratory facility, with an estimated floor area of about 486 square metres. Schematic layout is provided in Annex 3. Based on provided current information on infrastructure development projects in the country, an estimated cost of US$885.80 per square metre is used for the facility development. This estimated value does not include the acquisition of land.

Table 10 : Laboratory facility estimated cost: GBP (MWK'000)

Description	Estimated cost
New laboratory facility	430 500 (404 119)
Packages for goods	46 400 (43 557)
Total	**476 900 (447 676)**

Level of Priority: Short Term

7.2.2.1.4 Laboratory quality management systems

An effective overall laboratory management and administration system is required to support the research activities. A quality management system is required which will include development and implementation of quality management tools, leading towards accreditation. One of the main advantages of accreditation is that it provides guidance in maintaining quality of laboratory services, essential in a research laboratory

As part of the quality management system, data management, including the collation, analysis and appropriate exploitation of laboratory data, needs to be established. The system should feed into the regional database being developed through the AfCAP Regional Back Analysis project (RAF2069A).

The establishment of laboratory quality management systems is linked to the establishment of the new facility.

Table 11 Estimated costs to establish Laboratory Quality Management System: GBP (MWK '000)

Description	Estimated cost
Consultancy to develop data management system	26 500 (24 876)
Consultancy to develop Quality Assurance Systems and build capacity	33 200 (31 166)
Consultancy to facilitate accreditation process	31 000 (29 100)
Total	**90 700 (85 137)**

Level of Priority: Short-medium Term

7.2.3 Priority Area 3: Knowledge transfer

The implementation of road research projects requires sustainable knowledge management systems to ensure effective dissemination of the research findings of the RRC. The RRC should be equipped with the tools to engage society through a variety of mechanisms, including practical skills for presenting to different audiences and designing of social responsibility projects and information dissemination strategy. The development of website containing the RRC's training materials and programmes, research outcomes and publications should form part of the strategy for knowledge sharing. An estimate for procuring expert services to establish Knowledge Management System is shown in Table 12.

Table 12 Estimated cost for establishing Knowledge Management System: GBP (MWK '000)

Description	Estimated cost
Consultancy to establish and develop publicising and promoting research	14 800 (13 893)
Consultancy to review and develop Knowledge Management System	26 500 (24 876)
Total	**41 300 (38 769)**

Level of Priority: Short-medium Term

7.2.4 Priority Area 4: Expert services to address country needs

This priority area is linked to the developments planned under Priority Area 1 and 2. For example, the provision of testing services and overseeing the proficiency and quality of test results from private laboratories will depend on good quality management systems being implemented by the RRC Laboratory and the quality of staff. The focus will be on strengthening the expert services quality and delivery capacity.

Table 13 Estimated cost for strengthening expert service delivery: GBP (MWK '000)

Description	Estimated cost
Consultancy to develop or adopting consultancy services policy	5 000 (4 694)
Total	**5 000 (4 694)**

Level of Priority: Short-medium Term

7.2.5 Priority Area 5: Collaboration

The funding for this priority area, shown in Table 14 below, will be included in the operational costs as outlined in Section 7.1.2. It is aimed at fostering collaboration research with academic institutions and industry. This will increase opportunities for dissemination of research. Staff will be involved in meetings of committees of professional bodies, research and others, increasing visibility of RRC. Any partnerships and establishment of formal agreements for regional and international linkages with other emerging Road Research Centres and well established institutions should be project-based and therefore funded through the projects. This will require drawing up agreements for implementation and direct interaction to effect the agreements.

Table 14 Estimated cost for establishing linkages: GBP (MWK '000)

Description	Estimated cost
Consultancy to draw Agreements for establishing partnerships	3 500 (3 286)
Total	**3 500 (3 286)**

Level of Priority: Short-medium Term

7.3 Summarized budget estimates

Several potential funding sources were indicated in Section 6.2. However, the RA is the only funding source that can at this stage be confirmed. Considering the amount that the RA currently allocates for the R&D, it is clear that the existing resources within the RA will need to be enhanced to implement the RRCaB strategic plan. It is worth noting that most of the identified funding sources are the same sources from which the RA sources budget support.

The initial funding sources will be identified by the Research Management Committee headed by the DP&D, before the appointment of the Head of the RRC. Thereafter it will be the responsibility of the Head of the RRC to secure stable, diverse, and growing funding to ensure the Centre's self-reliance and sustainability, beyond the project life. The provision of professional expert services, laboratory testing and training programmes will provide additional sources of funding.

7.3.1 Annual operational costs

The estimated annual operational expenses, in the event that the envisioned core research Staff is in place, can be summarised as:

Total annual estimated operational expenses:
GBP 271 890 (MWK 255 228 581)

This is the sum of total Annual Staff Cost shown in Table 5 and total Annual operational expenses shown in Table 6. The assumption is that at start up, RRC will share services such as Human Resources and Financial Administration with the RA Head Office, including provision of Library Services and transportation.

7.4 Summary of Start-up costs

Table 11 shows the estimated total cost for the initial start-up. The potential funding sources for the start-up/establishment of RRC include DFID through ReCAP and AfDB. This will require proposals for Technical Assistance for the provision of the consultancies to be submitted to ReCAP and AfDB for infrastructure development as well as training for staff to acquire advanced qualifications.

Table 15 Summarised start-up Budget estimate

Item	Priority Area	Description	Total (GBP)	Total (MWK '000)
1	1	Develop or adopt research policy and strategy	5 200	4 881
2	1	Develop and implement Guideline for research staff development	14 800	13 893
3	1	Research skills development workshop	5 600	5 257
4	1	Mentorship for design and development of research projects	5 200	4 881
5	1	Study visit by Head of RD&I on aspects of strategic research management	2 500	2 347
6	2	Consultancy to assess training capacity and need	11 800	11 077
7	2	Consultancy to develop in-service training programmes	30 000	28 162
8	2	Hands-on training for laboratory staff	5 200	4 881
9	2	Secondment of Laboratory Manager to an ISO 17025 accredited laboratory	3 000	2 816
10	2	Procurement of new laboratory equipment	235 000	220 599
11	2	New laboratory facility	430 500	404 119
12	2	Packages for goods	46 400	43 557
13	2	Develop Quality Management Systems	90 700	85 142
14	3	Develop policy on publicising and promoting research	14 800	13 893
15	3	Review and develop Knowledge Management System	26 500	24 876
16	4	Develop consultancy services policy	5 000	4 694
17	5	Draw Agreements for establishing partnerships	3 500	3 286
Total start-up estimated cost			**935 700**	**878 360**

8 Plans and Action

8.1 Introduction

The strategic plan is aimed at directing the establishment and functioning of RRC and setting research priorities for the next 10 years, but more in particular, the next 5 years. The RRC is to play a central role in advancing the need for the establishment of sustainable road sector-research capacity, in order to ensure effective response to the objectives of the national strategy and policies. Included in the objectives of the national strategy is to drive improvement in transport infrastructure and access, particularly for rural communities in order to spur economic growth and development.

Section 2.1 has highlighted key themes based on the situational assessment, resulting from the review of available documentation, consultative meetings and workshop discussions held with key stakeholders in the road sector. Furthermore, other key areas that have been addressed in this plan include decision making role players, institutional framework and the proposed institutional structure, and co-hosting model for the delivery of research in order to optimise resource utilisation in the implementation of RRCaB strategy. Other issues include governance and funding mechanism, addressing the human resources and laboratory infrastructure capacity for supporting sustainable road sector-research capacity. Section 3.7 has presented the implementation time-line for the RRCaB strategy over 10 years. This section presents the Action Plan to implement the Strategic Plan, focusing on the critical initial two years.

8.2 Components of Action Plan

The Action Plan is aimed at addressing issues that will help ensure implementation of the RRCaB Strategic Plan succeeds. Table 16 shows the structure followed during consultations in order to propose appropriate plans. Detailed proposed action plans are provided in Annex 6.

Table 16 Guiding structure for action plans

Component	Description	Status
Legal, Strategy, Policy and Regulatory Framework Review	Investigate laws, strategies and government policies that will impact on the development of the sustainable RRCaB and establishment of the RRC	Completed, September, 2017 Framework established. Initial legal advice and clarification provided, February 2018
Human Resources	Current and required for conducting quality research	Action Plan required
	Support and career development, recruitment and retention strategy	Action Plan required
	Estimated salary levels	Completed, February 2018
	Training programmes	Action Plan required Subjects areas offered at universities identified, September, 2017
Research	Research leadership	Action Plan required
	Road Research coordination	Action Plan required Potential institutions to serve as committee members identified, September, 2017
	Research projects prioritisation	Action Plan required
	Knowledge transfer	Action Plan required
Infrastructure	Building	Action Plan required
	Capital equipment	Action required Equipment list developed, February, 2018
	Laboratory capacity	Assessed, July 2017
	Laboratory QA/QC schemes and proficiency programmes	Action Plan required, assessed July 2017
Operational Systems	Laboratory information management	Action plan required
	Knowledge management	Action required

Partnerships	Relationship with academic institutions	Action Plan required
	Relationship with other research centres	Action required
Funding	Funding requirement to implement RRCaB Strategic Plan	Action Plan required

9 Monitoring and Evaluation

9.1 Target and performance indicators

The outcomes and impact of the RRCaB will depend on how successful this strategy is implemented and for this an appropriate assessment is required. Monitoring and Evaluation will guide the implementation and review of the RRCaB strategy on a continuous basis and ensure that the processes of strengthening road research capacity take place effectively in all the Priority Areas of the RRCaB strategy. The measures of success for all the Priority Areas will relate to the progress towards achieving the ultimate goal of having a RRC that is recognised as a leading institution dedicated to road research with well-established in-house research capacity. The performance towards achieving this goal will be monitored by assessing critical indicators and key performance indicators as presented in Table 17 to Table 19. Note that the proposed term for the Head of RRC as Director of Research Development and Innovation is used. This may change as deemed fitting by the stakeholders.

The implementation of the strategy is to be undertaken in two 5-year cycles, with an evaluation undertaken at the end of each period to inform what needs to be implemented in the next phases of the RRCaB strategy. The first period covers Phase 1, through to Year one of Phase 3 as shown in Section 3.7, Figure 3. The objectives of each subsequent 5-year strategy will depend on the outcomes and prevailing road sector research needs.

A questionnaire (shown in Annex 5) can be used to ascertain the priority research areas. The responses from questionnaires will then be compared to the national research agenda and challenges identified in policy documents, strategies and plans, that need to be addressed in order to achieve the economic growth of the country. The final list will then be drawn up and concept notes developed during implementation. A number of concept notes are provided for guidance, on which the RA can build on during the implementation phase.

Table 17 Targets and Performance Indicators: Research

Priority Area	Critical success factor	Key Performance Factor	Targets over 5 Years					Implementing Officer	Monitoring Officer
			Year 1	Year 2	Year 3	Year 4	Year 5		
Research	Nurtured research leadership	Number of research skills development workshops	1	1	1	1	1	Deputy Head, RD&I	Head, RD&I
		Guideline for mentorship programmes	1	0	0	0	0	Deputy Head, RD&I	
		Research policy and guidelines	1	0	0	0	0	Head, RD&I	
	Capacity to design road research projects through mentorship	Proposals have met the criteria of the Technical Committee	80%	100%	100%	100%	100%	Principal Investigators	
	Increased RD&I portfolio	Number of projects in active development	1	2	3	4	4	Principal Investigators	
		% of projects successfully completed on time	90%	100%	100%	100%	100%	Principal Investigators	
		% of frequency of monitoring LTPP against schedule	100%	100%	100%	100%	100%	Principal Investigators	
		Number of Research Technical Committee meetings held	3	3	3	3	3	Deputy Head, RD&I	
		Stakeholder satisfaction with research outcomes	60%	75%	75%	80%	80%	Principal Investigators	
	Increased funding for research	% of RA core funding	5%	8%	10%	15%	25%	Principal Investigators	

Table 18 Targets and Performance Indicators: Capacity development and knowledge transfer

Priority Area	Critical success factor	Key Performance Factor	Targets over 5 Years					Implementing Officer	Monitoring Officer
			Year 1	Year 2	Year 3	Year 4	Year 5		
Capacity Development	Enhanced in-house training for laboratory personnel	Number of training sessions	4	2	1	1	1	Laboratory Manager	Director
	Functional modern laboratory facility for the RRC	Facility established	0	1	0	0	0	Deputy Director	
	Enhanced managerial training	Secondment of Laboratory Manager	1	0	0	0	0	Laboratory Manager	
	Advanced equipment procured	12 Various major equipment	0	5	5	2	0	Laboratory Manager	
	Enhance Laboratory Quality Assurance system	Quality Assurance Guidelines	0	1	0	0	0	Laboratory Manager	
	Course modules developed	Number of course modules	1	2	2	3	3	Senior Researchers	
		Number of courses facilitated	1	4	4	6	6	Senior Researchers	
Knowledge Transfer	Improved dissemination of research results	Research dissemination conferences	1	1	1	1	1	Deputy Director	Director
		Number of conference papers presented	0	1	2	4	4	Principal Investigators	
		Number of journal papers published	0	1	1	2	4	Principal Investigators	
		Number of research-based industry guidelines published	0	1	1	1	2	Principal Investigators	
		Number of public newsletters published quaterly to promote value of research	1	4	4	4	4	Deputy Director	
		Number of media interactions	1	2	2	2	2	Deputy Director	
	Increased access to research information	Number of website visits	100	500	1000	2000	3000	Deputy Director	

Table 19 Targets and Performance Indicators: Expert services and collaboration

Priority Area	Critical success factor	Key Performance Factor	Targets over 5 Years					Implementing Officer	Monitoring Officer
			Year 1	Year 2	Year 3	Year 4	Year 5		
Expert services	Enhanced consultancy	Number of consultancy application	1	3	4	5	5	Principal Investigators	Deputy Director
		Number of consultancies won	1	3	4	5	5	Principal Investigators	Deputy Director
		Consultancies successfully completed and on time (% due completion in FY)	100%	100%	100%	100%	100%	Principal Investigators	Deputy Director
	Increased community outreach	Number of research and Professional bodies of which RRC is a member	3	6	6	6	6	Deputy Director	Director
		% meetings attended	100%	100%	100%	100%	100%	Deputy Director	Director
		Research and Professional Technical Working Groups meetings attended	100%	100%	100%	100%	100%	Senior Researchers	Deputy Director
		Number of research-based policy briefs submitted	0	1	2	2	2	Principal Investigators	Director
Collaboration	Established partnerships with other research institutions	Number of MOUs	0	1	2	3	5	Deputy Director	Director
		Number of collaborative projects in active development	0	1	2	2	3	Principal Investigators	Director
		Collaborative projects successfully completed (% due completion)	0	100%	100%	100%	100%	Principal Investigators	Director

9.1 Risk factors

The benefits from a well-executed Monitoring and Evaluation Plan include being able to appraise whether the implementation of the RRCaB strategy is progressing towards achieving its objectives. The effectiveness of RRCaB and its long-term sustainability are more likely to be affected by several factors. While there seems to be an obvious alignment between the RA's mandate and the objectives of the RRCaB, risk is posed by existing institutional arrangements and is an important consideration. The existing legislation may create difficulties and hurdles in the establishment of RRC under the ambit of RA, as the RA does not yet have an established R&D Unit or Department. Without an effective reform of the RA structure and proper research planning, the current status is unlikely to be the enabling environment for effective delivery of the RRCaB strategy for the country. There are other risk factors to be considered and responses should be developed to mitigate the impact - these are presented in Table 20 below.

Table 20 Risk management plan

Item	Risk	Effects of Risk	Control to be instituted	Immediacy of action	Implementing officer
1	Lack of clarity on whether RA has power to establish RRC	Delay in establishment of RRC	Legal advice sought and provided		Director of Design and Planning
2	Lack of capacity within RA to manage the initial implementation stages of RRCaB strategy	Progress hindered	Submit request for Technical Assistance to ReCAP		Director of Design and Planning
3	Lack of research focus	Low impact of RRC	Support implementation of national research Agenda		Deputy Head RD&I
4	Lack of delivery on research projects	Damaged reputation of the RRC with the stakeholders and community at large	Internal project progress review programme and RTC feedback reports		Deputy Head RD&I
			Allow for incremental growth, researchers to undertake projects within capability		Deputy Head RD&I
5	Lack of commitment by stakeholders	Inefficiency and ineffectiveness in RD&I delivery	Maintain formal and informal engagement with industry		Deputy Head RD&I
			Research Steering Committee members to be at decision making level in stakeholder institutions		Head RD&I

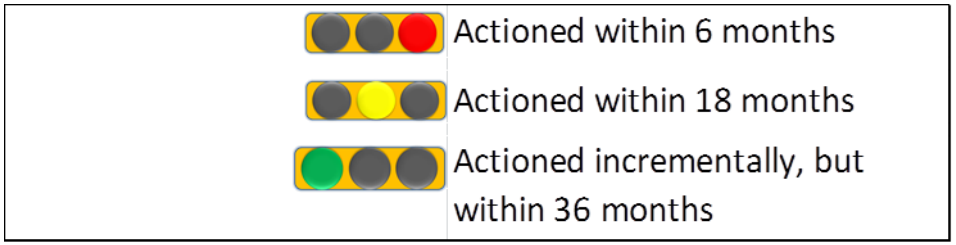
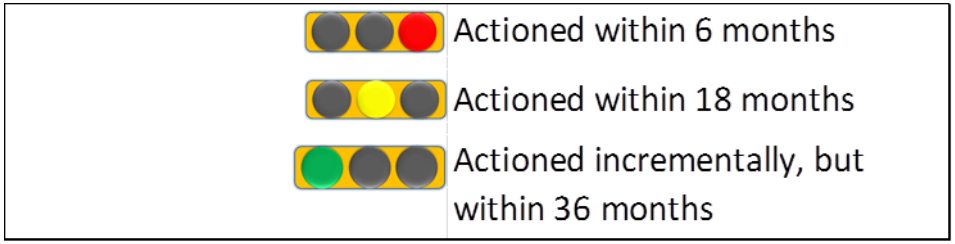


Table 20 cont: Risk management plan

Item	Risk	Effects of Risk	Control to be instituted	Immediacy of action	Implementing officer
6	Inadequate funding for research	Low level delivery on research capacity building	Establish multiple sources of funding through research proposals and consultancy service in addition to RFA funding		Head RD&I
7	Lack of capacity to undertake the research programme	low research outputs and inability to address national needs	Provide on-going professional development of staff in the planning and conducting of research programmes		Deputy Head RD&I
			Secondment of staff to regional and international research institutions		Head RD&I
			Appointment of researchers from outside Malawi on fixed short-term constracts to transfer skills		Head RD&I
8	Relationship with key stakeholder, the MoTPW not managed properly	Capacity of RRC to influence national policy and research agenda diminished	Establish strong relationship with MoTPW through regular interaction		Head RD&I
9	Delay in research infrastructure delivery including equipment procurement	Inability to deliver on road research capacity building within the timeline	Establish Project Steering Committee with monthly review on progress		Head RD&I
			Utilise laboratory equipment and services rendered by the CML and the Civil Engineering Laboratory at the Malawi Polytechnic		Deputy Head RD&I



10 Next Step: Establishment of Road Research Centre

10.1 Short term

The process of development and support to the implementation of the Strategic Plan for the establishment of sustainable road research capacity in Malawi, in the short term (within the next 12 months from September 2018), will involve undertaking an institutional support programme for the main purpose of carrying out priority activities for the establishment of the new Road Research Centre. This will include establishing a temporary facility, recruiting the required and qualified research and laboratory staff, development of a plan for the procurement of basic and appropriate equipment as well as developing of support and staff career development schemes. The strategy being followed in developing the RRC is to start off small and then grow over time.

As pointed out in Section 2.2.9, **Strategic Outcome 5** of the 2017-2022 Strategic and Business Plan: *Enhance Research and Development in RA Operations*, is aimed at improving the technologies and management practices in road construction and maintenance, through maintaining a dedicated research and development Unit within the RA. A dedicated budget line allocation has been provided for a Research Programme, and a separate one for Operations, demonstrating commitment by RA to implement research.

The timelines given in section 3.7 and action plans as outlined in section 8 should guide the activities to be undertaken in the short term. During this time, it is envisaged that key performance indicator targets set out in section 9.1, taking into account the risks presented section 9.2 the RRC Strategic Plan for the first year of operation for the development for the RRC to support its physical establishment and implementation of the long term programmes.

The RA will require Technical Assistance to implement the road research capacity building strategy in order to contribute towards raising the level of road research in Malawi. The Technical Assistance will contribute towards achieving the results of the road research capacity building programme, through the provision of a consultancy services for a Short-Term Technical Assistance Programme. The following are the key actions required in the short term:

10.1.1 Human Capital Development

Support and career development schemes will be required to ensure continuous personal and career growth of staff. It is expected that recruitment of staff will initially be from within the Roads Authority and Central Materials Laboratory, following which external candidates can be considered. **Action required**:

- Recruitment of Head of R&D and arrangement for study visit to a research institution, aimed at understanding of aspects of research strategic management;
- Assessment of current staff;
- Appointment of initial RRC staff including Laboratory Manager and Technicians to ensure quality research outputs;
- Develop the appropriate programmes and necessary support and career development schemes, to ensure continuous personal and career growth.

In addition, the consultant will provide informal mentoring as well as ad-hoc coaching as necessary, during the course of the assignment

10.1.2 Research Productivity and Quality

Build the capacity of researchers and research leaders. The research outputs, related to transport infrastructure shows very low publication equivalence, over the last five years relative to the overall country research publication output. While this may be attributed to limited funding for research, the

number of people capable to conduct research and publish in the road sector is also low. The inadequate number of researchers in the road sector limits the country's ability to conduct research. **Action required**:

- Develop Policy and Procedures on conducting research and guidelines for the management and execution of R&D programmes, from processes and procedures for the identification of the national R&D needs and Agenda.
- Strengthen road research capacity at Malawi Polytechnic, Ministry of Transport and Public Works, and at the Roads Authority.
- Establishment of Road Research Advisory committees (RRACs) for the prioritisation and management of research to focus on the national research Agenda. As per description in the Strategic Plan, the RRACs comprise the Research Technical Committee (RTC) and Research Steering Committee (RSC). The AfCAP Technical Assistance for this assignment will contribute towards achieving one of the key expected results of the road research capacity building (RRCaB) programme, by ensuring that the RRACs are functional and operational within the assignment period.
- Produce concept notes and prepare and detailed priority research proposals for R&D long-term technical assistance for submission to the RRACs as part of training process of the research staff.
- Develop research skills development and mentorship programmes to nurture research leadership. It is expected that a greater proportion of the recruited staff will undergo such programmes, including workshops on the setting up of a monitoring programme of trial sections.
- Produce training plan to reflect the training needs of the RRC and enhancement of skills in research priority identification in order to increase R&D Portfolio and impact of research. This should be through collaboration with universities in general, but in particular with Lilongwe University of Agriculture and Natural Resources (LUANAR) in order to improve rural accessibility to agriculture production areas and markets, for isolated communities through provision of all-weather rural feeder roads.

10.1.3 Infrastructure capacity development

Building facility

The task for the Consultant is to assist in the planning for the establishment of a modern and comprehensive materials laboratory. The Consultant will not be involved in the processes of acquisition of land and actual construction of the new facility. **Action required**:

- Commissioning of temporary facility. Taking into account status of existing infrastructure to support research and the crucial optimal usage of existing laboratory equipment and facilities, the Central Materials Laboratory (CML) is to provide the services. However, the status of equipment at CML presented in Appendix 2A clearly shows there will be a need to procure small equipment at CML.
- Needed equipment is prioritised in Appendix 2A, with a rating of 1-5.
- Identification and assessment of suitable physical location for RRC, taking into account the geographic location, space to support future growth.
- In association with RA and the Road Research Advisory Committees to be established, facilitate Government approval for the proposed location of the RRC.
- Establishment of Construction Project Steering committee (CPSC) for the construction of the modernised permanent facility.
- Review layout of the new laboratory and space provided for the new laboratory. This to be achieved through the CPSC.

Capacitation of Laboratory staff In order to maintain high quality results in a laboratory, the personnel is expected to be competent and well qualified. **Action required**:

- Assessment of newly recruited staff.

- Develop dedicated training plan for laboratory testing, on the basis of the assessment to ensure that the laboratory personnel is confident in testing and understand the importance of quality of data collected during testing.
- Develop and implement secondment programme for Laboratory Manager. Irrespective of the experience of the Laboratory Manager to be appointed, it is envisaged that additional skills development will be required as the research laboratory is a different working environment from working in a conventional public or commercial laboratory. The Laboratory Manager will be required to perform effectively in an advanced research laboratory and the secondment is to form part of the partnership agreement programme with an internationally recognised and ISO 17025 accredited research laboratory. The period of secondment should at least be three weeks to acquire the required skills in operational and managerial aspects of the testing laboratory. The Consultant should be in a position to provide the opportunity for this secondment at an advanced laboratory facility.

10.1.4 Competency-based Training programmes and consultancy

The highest technician qualification in Malawi is the Diploma in Civil Engineering. Malawi Polytechnic has been the main institution offering the qualification. The qualification was at one point terminated. This affected the quantity of formally trained personnel at technician level. The decision to terminate the Diploma has since been reviewed. There is currently no institution offering training for laboratory technologists specifically in road construction materials. The goal is to build the capacity that will support sustainable national innovation system for the road sector in the country. **Action required**:

- Conduct a demand analysis study, to determine content and mode of delivery of the training programmes, as the curriculum should be industry driven, thereafter develop the appropriate curriculum.
- Assess the potential of institutional restructuring of the technical colleges that have the potential to offer appropriate training and therefore produce better-prepared laboratory personnel.
- The provision of consultancy services was identified as one of the priority areas and service function of the RRC. Specific training aspects on forensic investigations are to be covered as part of internal training programme. In-house capacity building is to be provided for comprehensive materials investigations and geotechnical investigations required for road works, road condition investigations and analysis of pavement and surfacing failures, primarily related to research.

10.1.5 Operational Systems development d Quality

Laboratory information management for the purpose of good practice of collecting and storing data. The need for a laboratory management system to ensure standardised laboratory procedures for data collection and analysis was raised by CML staff in the discussions during Phase 1. The general operational protocols/procedures regulating everyday management of the laboratory should be supported by a properly structured laboratory information management system. **Action required**:

- An assessment of the cost benefit in acquiring an off-the shelf product or developing one is to be conducted and on the basis of the assessment, recommendations made to the Head of the RRC and the Laboratory manager.
- Develop a specific project plan for documentation on procedures, to meet requirements for quality assurance and quality control scheme to enable the RRC to operate in line with the requirements of ISO 9001 Quality Management Systems (QMS) and ISO 17025, introduction of accreditation mechanisms with a view of attaining accreditation in the near future.

Knowledge Centre

Knowledge Management Systems are generally understood to be any IT system that focusses on the management of data driven objects (datasets) created by an organisation during the execution of their core business. The core business of the RRC is research and the establishment of a Knowledge Centre as part of

the infrastructure for the RRC is central to the management of information from research and transferring that knowledge for application. **Action required:**

- A knowledge management framework should be developed; as the data and new ideas are created during project execution should be stored in some form for analysis for future application. The proper records keeping and document management will ensure that research staff have accessibility to the information for analysis but also the dissemination of research outcomes to the wider public.
- A knowledge management facility is to be established for cataloguing, storage and dissemination of road transport knowledge. It is envisaged that the facility will also establish linkages with similar facilities in the region and internationally. Data management systems are to be developed for research projects already undertaken and to be undertaken in future throughout the country, in line with those being developed through regional AfCAP projects.

10.1.6 Partnership agreements

RRC will benefit most from formal agreements to establish international linkages, more specifically to achieve Human Capital Development objectives in terms of research skills development and mentorship. This will contribute towards ensuring sustainable road research capability in the country. **Action required**:

- Develop partnership agreements for fostering collaboration with local universities and industry as well as MoUs to establish international linkages. There are several regional and international research organizations that the RRC can enter into agreement with. The Consultant will be expected to assist in the preparation of these documents and establish how the existing institutional environments in the different potential partner institutions will affect the planned agreements

10.1.7 Funding Mechanism

The identification of sources of sustained research funding opportunities is absolutely essential for the attainment of sustainable research capacity building in order for the RRC to engage in dedicated road research programmes. **Action required**:

- Develop a preliminary funding model for the RRC to support the estimated cost structure of the RRC, including its staff, facilities and operations. This will be based on the initial consultation with the RA.
- Provide support to the RRC in the alignment of development partner country programmes to increase the potential for accessing funding.

Subsequently, the management of RRC in conjunction with the support of the Research Steering Committee should confirm potential sources of funding for the RRC as identified in the Strategic Plan.

10.2 Long term

The initial 12 moths will provide the ground work towards establishing the permanent location of the RRC and its operationalization in the new premises. The long term activities will build towards establishing a modern and comprehensive materials laboratory for the testing of materials used in road works, as well as training of laboratory personnel and providing a system to oversee the proficiency and quality of test results from private laboratories as well as career advancement programmes for research staff. Included will be the implementation of the research projects. The strategy is development of Flagship projects in Low Volume Roads and progressively include all aspects of roads and transport. The long term activities are as outlined in the Action Plan action plan and also be reviewed under the Short-Term Technical Assistance Programme.

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Annex 1 Typical job descriptions for Research Staff

Job Descriptions

Job Title	**Head of Research Development and Innovation**
Reporting to	Director of Planning and Design
Salary scale	G3/MG3
Job Purpose	To provide leadership and support the development of road research capacity building and ensure the highest quality standards in the Centre's outputs, assist with the strategic direction and setting of the national research agenda and policy development in the road sector.

Key Responsibilities

- Produce an annual forecast for the resource planning of the RRC to enable effective implementation of the Centre's activities.
- Assist in the identification of areas of training or development to build capability and performing individuals and teams, within the RRC and the road sector in general.
- Recruit, train, develop and motivate a team of researchers and technicians to ensure the delivery of high quality research outputs and enable their career growth through creation of opportunities.
- Optimize team and individual performance through mentorship, training and appraisal systems.
- Provide scientific and engineering leadership to staff by means of an excellent grasp of the field and by ensuring quality scientific outputs and the professional development and transformation of the group's scientific capacity
- Identify and manage research opportunities in order to secure external contracts.
- Contribute to the ongoing development and implementation of strategies to grow the RRC.
- Assist the Director of Planning and Design to construct and implement a business plan for the RRC.
- Establish, build, manage and maintain mutually beneficial and credible stakeholder relationships through active networking to ensure financial sustainability of the RRC.
- Conceptualise, lead and deliver on multi-disciplinary and multi-agency projects and programmes in support of pavement design and construction, decision-making and policy development.
- Ensure the quality and delivery of projects and publications of the RRC by means of technical reviews and quality assurance

Person specification

Factor	Essential	Desirable
Education and Qualifications	Educated to a minimum of a Master's degree or higher in any of the following fields: Road infrastructure engineering Transport geotechnics	Civil engineering qualification

Experience	• A minimum of ten (10) years' experience working in the area of, or related to Transport Infrastructure Engineering.
	• A minimum of 2 years of management or supervisory experience
	• Proven contract and project management experience on medium to large-scale projects, preferably multi-disciplinary research and development projects
	• Track record of research outputs published in peer-reviewed journals, books or conference
		• Research skills
		• Demonstrable experience in at least five of the following fields related to road engineering:
		  • Materials evaluation
		  • Structural design
		  • Pavement performance assessment and modelling
		  • Construction and maintenance
		  • Risk and vulnerability assessment
		  • Forensic investigation
		  • Procurement/contractual models
		  • Infrastructure funding alternatives
		  • Asset management

	proceedings.	• Sustainability science
Skills	• Skills in staff motivation and performance management. • Analytical skills with a problem-solving, solution-seeking orientation. • Excellent report writing skills. • Ability to work independently and as part of a team. • Networking ability.	• Computer literacy and experience in using standard software packages; programming skills will be an advantage. • Advanced level of Excel, • PowerPoint/Access. • Competent in Word.
Knowledge	• A good knowledge and understanding of data analysis principles. • Assessment of materials and pavement behaviour, and performance modelling. • Track record of research outputs published in peer-reviewed journals, books or conference proceedings.	• Understanding of analytical tools,

Job Title	**Senior Researcher**
Reporting to	Head of Research Development and Innovation
Job Purpose	To provide expertise on matters related to road pavement design, construction materials and methods and maintenance.
Key Responsibilities	
• To participate in the further growth and capacity development of the RRC. • To undertake research; develop project proposals; and interact with other professionals from the industry at large. • To manage projects executed within the RRC, potentially involving external collaborators. • To mentor junior staff. • To actively participate in strategic research alliances, training, consultancy and liaise with clients across all levels.	
Person specification	
Factor	**Essential**	**Desirable**
Education and Qualifications	• Educated to a minimum of a Masters degree in civil engineering.	• Civil engineering qualification • A Doctoral degree will be advantageous • Registered with a professional body or in the process of doing so
Experience	• A minimum of ten (10) years' experience in the fields of road engineering, geotechnical engineering, sustainable construction and technology transfer in transport infrastructure engineering.	• Demonstrable research skills • Demonstrable experience in any two of the following fields related to road engineering: • Materials evaluation • Structural design • Pavement performance assessment • Construction and maintenance • Forensic investigation • Procurement/contractual models • Infrastructure funding alternatives

		• Asset management • Sustainability science
Skills	• Good interpersonal and team skills. • Analytical skills with a problem-solving, solution-seeking orientation. • Excellent report-writing skills. • Project management skills. • Ability to work independently and as part of a team. • Networking ability. • Ability to provide technical leadership in the field of infrastructure engineering.	• Soil profiling, borrow pit location and investigation, material sampling, • Computer literacy and experience in using standard software packages; programming skills will be an advantage. • Advanced level of Excel. • PowerPoint/Access. • Competent in Word
Knowledge	• A good knowledge and understanding of data analysis principles. • Assessment of materials and pavement behaviour, and performance assessment. • Track record of research outputs published in peer-reviewed journals, books or conference proceedings.	• Understanding of analytical tools.

Job Title	**Candidate Researcher/Researcher**
Reporting to	Head of Research Development and Innovation
Job Purpose	To contribute to a portfolio of research projects aimed at advancing knowledge on matters related to road pavement design, construction materials and methods and maintenance.
Key Responsibilities	
• Undertake research in road construction materials, road construction materials testing.	
Person specification	

Factor	**Essential**	**Desirable**
Education and Qualifications	• Educated to a minimum of a Bachelors degree in civil engineering.	• Civil engineering qualification. • Engineering Geology qualification. • Master's degree will be advantageous. • Registered with a professional body or in the process of doing so.
Experience	• A minimum of two years' experience in the fields of road engineering, geotechnical engineering, engineering geology.	• Demonstrable experience in civil engineering construction materials testing.
Skills	• High level analytical skills • Report writing skills • Communication skills (including oral, written and presentation • Basic project management skills. • Problem solving, solution seeking orientation.	• Understanding of soil profiling, borrow pit location, material sampling. • Computer literacy and experience in using standard software packages; • Advanced level of Excel • PowerPoint/Access • Competent in Word

Knowledge	• Knowledge and understanding data analysis principles.	• Basic understanding of analytical tools.

Job Title	**Laboratory Manager**
Reporting to	Head of Research Development and Innovation
Job Purpose	• To organise, direct and manage the laboratory, ensuring that quality assurance procedures are developed and maintained, provide quality and effective service. • And providing guidance and input into the technical direction for the laboratory short and long term needs.

Key Responsibilities

- Lead a team of technical specialists and laboratory technicians/technologists.
- Manage day to day operations of the laboratory.
- Train and mentor both junior and senior technicians.
- Set the standards for technical excellence in the laboratory.
- Draft proposals for laboratory and consultancy projects.
- Market and identify new business opportunities for facility and assist in technical report writing for tests and consultations.
- Forge links with the academic and industry sector within the road sector and regional and international road research laboratories.
- Take responsibility for the upkeep and maintenance of the complex equipment/infrastructure.

Person specification

Factor	Essential	Desirable
Education and Qualifications	Educated at a Bachelor degree or equivalent in Science or Engineering	• Civil engineering qualification • Understanding of the requirements of ISO 17025.
Experience	• At least five to eight years' experience in a similar or related position.	• Development of the Capex strategy for a facility. • Experience in civil engineering construction materials testing, advanced equipment utilisation.
Skills	• Excellent interpersonal relationship and stakeholders liaison skills. • Good communication skills (verbal and written). • Good interpersonal and team skills. • Ability to liaise with a diverse portfolio of people locally and internationally. • A proven record of writing high quality technical reports. • Ability to handle more than one issue at a time and to cope with industry pressure and demands.	• Soil profiling, borrow pit location, material sampling and field testing. • Computer literacy.
Knowledge	• Able to communicate technical information to a diverse audience. • Sound understanding of scientific principles in solving complex problems.	• Knowledge of EHS systems.

Annex 2 Status of equipment at CML

CONCRETE SECTION						
ITEM	**Description**	**Status of Equipment**				
		Quantity	**Age**	**Functional**	**Priority (1-5)**	**Non Functional**
1	Los Angeles Abrasion Test Equipment	1	Old	1	1	0
2	Compressive Test Machine	3	Old	2	1	1
3	Concrete Drum Mixer	1	Old	0	1	1
4	Slump Concrete Tester	1	Old	1	1	0
5	Compacting Factor Apparatus	1	Old	1	1	0
6	Slump Cone	1	Old	1	1	0
7	Cast Iron Cube Moulds	3	Old	3	1	0
8	Concrete Tank for Curing concrete	1	Old	1	1	0
9	Cement Setting time Apparatus	1	Old	1	1	0
10	Cement Consistency Apparatus	1	Old	1	1	0
11	Concrete Bulk Density Apparatus	1	Old	0	1	1
12	Concrete Compactor	1	Old	0	1	1
13	Wheel Borrow	1	Old	1	1	0
14	Balance Beam	1	Old	1	1	0
15	Balance	1	Old	1	1	0
16	Mortar Compactor	1	Old	1	1	0
17	Set of Cylinders	1	Old	1	1	0
18	Wash bottle	1	Old	1	1	0
19	Steel Tracy	1	Old	1	1	0
20	Water Bath	1	Old	1	1	0
21	Concrete Penetrometer	1	Old	0	1	1
22	Density of Fresh concrete Apparatus	1	Old	0	1	1
23	30kg capacity Electronic Precision Top Loading Platforms	1	Old	1	1	0

BITUMEN SECTION						
ITEM	**Description**	**Status of Equipment**				
		Quantity	**Age**	**Functional**	**Priority (1-5)**	**Non Functional**
1	Bitumen Content Furnace	3	Old	1	1	2
2	Binder Extraction Unit	1	Old	1	1	0
3	Centrifuge Extractor	1	Old	1	1	0
4	Solvent recovery still – 10 litres/ hour	1	Old	1	1	0
5	Reflux Extractor Apparatus (1000g capacity)	2	Old	2	1	1
6	Vacuum Pyknometer 5 litres capacity	1	Old	0	1	1
7	Digital microprocessor thermometer	1	Old	1	1	0
8	Specific gravity frame	1	Old	1	1	0
9	Marshall Automatic EN (impact) Compactor	1	Old	1	1	0
10	Marshall mechanical 50 kN Load compression frame	1	Old	1	1	0
11	Marshall water bath	2	Old	1	1	1
12	Standard dial penetrometer	1	Old	1	1	0
13	Ductilometer	1	Old	0	1	1
14	Asphalt Oven with rotating shelf	1	Old	0	1	1
15	Ring and Ball softening point apparatus	1	Old	1	1	0
16	Hot plate with magnetic stirrer	1	Old	1	1	0
17	Viscometer	1	Old	0	1	1

18	Marshall Manual Compactor	2	Old	1	1	1
19	Screw Extruder- Hand operated	1	Old	1	1	0
20	Analog Top Loading Balance	1	Old	0	1	1

FOUNDATION SECTION						
ITEM	**Description**	**Status of Equipment**				
		Quantity	**Age**	**Functional**	**Priority (1-5)**	**Non Functional**
1	Screw Extruder- Hand operated	1	Old	1	1	0
2	Front Loading Oedometer	4	Old	4	1	0
3	Analog Direct Shear Strength Machine	1	Old	1	1	0
4	Permeameter for Constant and Falling head tests	2	Old	1	1	1
5	Compaction Permeameters	2	Old	2	1	0
6	Analog Triaxial Loading frame	3	Old	2	1	1
7	Laboratory Air Compressor	1	Old	1	1	0
8	Slotted weights	65	Old	65	1	0
9	Specific gravity bottle	21	Old	21	1	0
10	Particle analysis of soils- Hydrometer Method Kit	2	Old	1	1	1
11	Hand Augers	2	Old	2	1	1
12	Linear Shrinkage apparatus	4	Old	4	1	0

COMPACTION SECTION		Status of Equipment				
ITEM No.	**DESCRIPTION**	**QUANTITY**	**AGE**	**FUNCTIONAL No.**	**PRIORITY (1-5)**	**NON FUNCTIONAL No.**
1	**Oven**	**2**	**Over 20yrs**	**1**	**1**	**1**
2	**Balance 30kg**	**2**	**Over 20yrs**	**1**	**1**	**1**
3	**Balance 1.5kg**	**2**	**Over 20yrs**	**1**	**1**	**1**
4	**CBR Machine**	**2**	**Over 20yrs**	**1**	**1**	**1**
5	**MDD moulds**	**4**	**Over 20yrs**	**2**	**1**	**2**
6	**Field densities Test Set**	**2**	**Over 20yrs**	**1**	**1**	**1**
7	**Plastic cylinder**	**2**	**Over 20yrs**	**2**	**1**	**-**
8	**Trays**	**5**	**Over 20yrs**	**3**	**2**	**2**
9	**MDD hammer 4.5kg**	**5**	**Over 20yrs**	**2**	**1**	**3**
10	**CBR hammer 2.5kg**	**4**	**Over 20yrs**	**1**	**1**	**3**
11	**CBR moulds**	**65**	**Over 20yrs**	**30**	**2**	**35**
12	**Core cutter with colar**	**2**	**Over 20yrs**	**1**	**1**	**1**
13	**Top hat 100mm**	**2**	**Over 20yrs**	**2**	**1**	**-**
14	**Moisture tins**	**40**	**Over 20yrs**	**28**	**2**	**12**

CLASSIFICATION SECTION (PARTICLE SIZE ANALYSIS)		Status of Equipment				
ITEM No.	DESCRIPTION	QUANTITY	AGE	FUNCTIONAL No.	Priority (1-5)	NON FUNCTIONAL No.
1	Balance 10kg	1	Over 10yrs	2	1	-
2	seive 26.5mm	2	Over 10yrs	2	1	1
3	seive 19.0mm	2	Over 10yrs	2	1	1
4	seive 13.2mm	3	Over 10yrs	2	1	2
5	seive 9.5mm	2	Over 10yrs	3	1	1
6	seive 6.7mm	2	Over 10yrs	1	1	1
7	seive 4.75mm	1	Over 10yrs	1	3	-
8	seive 2.36mm	1	Over 10yrs	1	1	-
9	seive .600mm	1	Over 10yrs	1	1	-
10	seive .425mm	2	Over 10yrs	1	1	-
11	seive .300mm	1	Over 10yrs	1	3	-
12	seive .150mm	1	Over 10yrs	1	3	-
13	seive .075mm	1	Over 10yrs	1	1	-
14	Measuring basins	20	Over 10yrs	15	1	5
15	Wire brush	3	Over 10yrs	1	1	2
16	Scoop	4	Over 10yrs	1	1	3
17	Medium plates	12	Over 10yrs	0	1	12

CLASSIFICATION SECTION (ATTERBERG LIMITS)		Status of equipment				
ITEM No.	DESCRIPTION	QUANTITY	AGE	FUNCTIONAL No.	Priority (1-5)	NON FUNCTIONAL No.
1	Casagrande apparatus	5	Over 20yrs	3	1	2
2	Spatula	4	Over 20yrs	2	1	2
3	Wash bottle	6	Over 20yrs	5	1	1
4	Roughned glass	5	Over 20yrs	2	1	3
5	Balance (analystical digital)	2	Over 20yrs	1	1	1
6	Sample plates	27	Over 20yrs	15	3	12
7	Moisture tins	39	Over 20yrs	20	1	19
8	Calibration rod	3	Over 20yrs	2	1	1
9	Grooving tool	2	Over 20yrs	2	1	-
10	Waster	3	Over 20yrs	3	4	-
11	Double wall oven	3	Over 20yrs	1	1	2
12	Water basin	2	Over 20yrs	1	1	-

FIELD TESTING EQUIPMENT		Status of Equipment				
ITEM No.	DESCRIPTION	QUANTITY	AGE	FUNCTIONAL No.	Priority (1-5)	NON FUNCTIONAL No.
1	Rotary drilling equipment	2	Over 20 yrs	1	1	1
2	Dando Percussion drilling equipment set	1	Over 20 yrs	1	1	0
3	Pillicon Percussion drilling equipment set	1	Over 20 yrs	1	1	0
4	Benkelman beam deflection equipment set	1	Over 20 yrs	1	4	0
5	Falling weight deflectometer equipment set	1	Over 20 yrs	1	3	0
6	Merlin calibration equipment set	3	Over 20 yrs	1	1	2
7	Steel strength testing equipment	1	Over 20 yrs	1	1	0
8	Bump intergrator	5	Over 20 yrs	3	1	2
9	Macintosh bearing testing equipment set	1	Over 20 yrs	1	1	0
10	Dynamic cone pernetrometer equipment	5	Over 20 yrs	3	1	2

Annex 3 Cost estimates for test equipment

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Cost estimates for test equipment required for: Soils, Aggregates, Asphalt and Binders

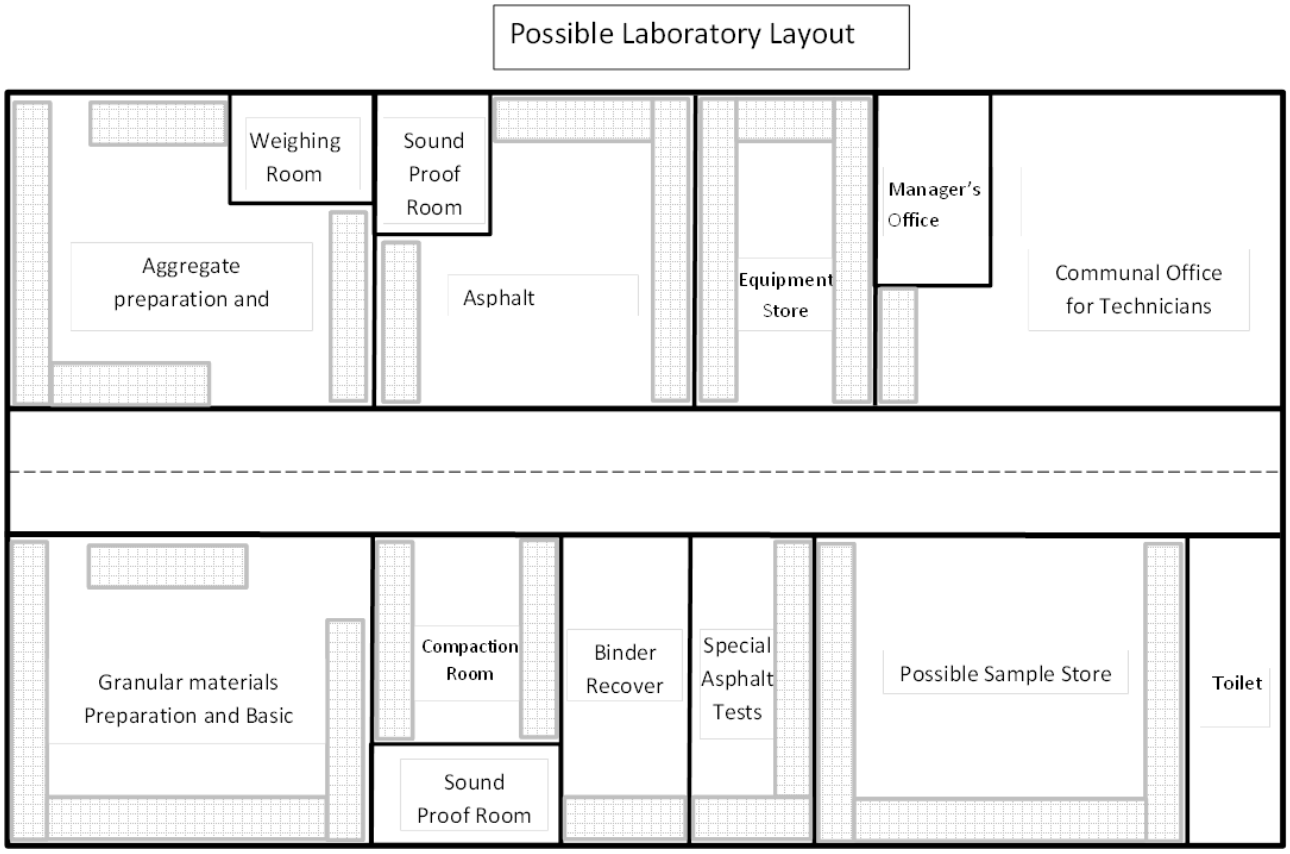
Description	Priority	Number	Cost (USD)
General laboratory apparatus			
Oven small		1	1 292
Oven large		1	1 462
Cube press 2000kN computerized		1	11 154
Scale large (100 kg)		1	500
Scale intermediate (30 kg)		1	423
Scale small (5 kg)		1	323
Thermometers and glassware		various	269
Moisture tins large (1 kg)		50	96
Moisture tins small (50g)		50	27
Wash bottles		3	7
Scoop		3	29
Soils			
Sieves : 0.075 to 75.0 mm		2 sets	1 154
Sieve shaker (optional)		1	346
Rifflers, 3 sizes; small, intermediate, large		3	1 038
Crushing and mixing equipment, etc.		1	115
Atterberg Limit device – Cassagrande cup		1	192
Atterberg Limit Device – Cone penetrometer		1	308
Linear shrinkage troughs		20	215
glass plates		5	35
Stop watch		2	16
Mixing bowls, mortar and pestle, etc.		10	65
Spatulas		5	26
Steel rule		1	12
Pycnometer 50 ml		10	88
pH meter		1	415
Electric Conductivity meter		1	462
Pycnometer 2L		2	308
Hydrometer		1	85
Compaction hammer Mod AASHO		1	50

Description	Priority	Number	Cost (USD)
Compaction hammer Proctor		1	42
Straight edge for trimming		1	12
CBR Press, UCS, ITS		1	5 824
Water bath – soaking		1	231
Moulds + fittings		50	42
Swell measuring device setup		1	92
Pans, Basins, mixing trays, 10L drums, etc.		various	204
Triaxial testing device (monotonic and repeated)		1	28 154
Accelerated carbonation tests setup			731
Shear test device (vane shear)		1	384
Shear test device (shear box)		1	40 689
Permeameter Air		1	1 015
Permeameter Water		1	369
Aggregates			
Vacuum pump		2	1 108
Flakiness gauge		1	92
Elongation gauge		1	92
Fine aggregate angularity		1	62
Aggregate least dimensions apparatus (ALD)		1	38
Aggregate Crushing, 10% Fines Aggregate crushing (Mould setup)		1	323
Aggregate Impact Value (AIV) apparatus		1	1 692
Los Angeles Abrasion machine		1	4 231
Sand equivalent apparatus		1	343
Organic impurities apparatus		1	500
Tests for aggregate durability (Durability Mill Index)		1	4 308
Accelerated Polishing of aggregates apparatus (PSV or equivalent)		1	21 154
Skid resistance tester		1	3 462
Water bath 42L		1	708
Bitumen bound materials (*)			
Bitumen penetrometer		1	1 077
Ring and Ball setup		1	162
Thermometers ring and ball		2	169
Brookfield Viscometer + accessories		1	9 846
Ductility Apparatus		1	7 077

Description	Priority	Number	Cost (USD)
Ageing of bitumen binder (Rolling Thin Film Oven Test or RTFOT). Oven		1	4 923
Determination of soluble binder content (centrifuge or other) or asphalt analyser by ignition		1	2 385
Impact compactor and Marshall stabilometer		1	4 962
Diamond saw		1	1 846
Fatigue testing machine for asphalt mixtures		1	50 000
Wheel tracking device for asphalt mixtures		1	61 538
Binder recovery apparatus		1	2 846
Field testing			
Soil sampling equipment		1	42
Sand Replacement Method equipment (In-situ Density Determination)		1	262
Pavement core drilling machine		1	2 738
Light Falling Weight Deflectometer		1	10 769
Dynamic Cone Penetrometer (DCP)		5	1 365
Plate loading test or a suitable alternative		1	8 062
Spot characterization of skid resistance and macrotexture (sand patch)		1	319
Road Surface Profilometer		1	6 769
Benkelman beam		1	2 192
Fire extinguishers		5	192
First aid box		1	42
Cones		10	173
Overalls, safety boots, goggles, ear muffs, gloves, etc.		1	92
Total Cost			316 266

(*) In addition to soil and aggregate testing equipment

Annex 4 Schematic possible laboratory layout



Annex 5 Road research prioritisation

MA2125A: Development and support to the implementation of a Strategic Plan for the Establishment of Sustainable Road Research Capacity in Malawi

ROAD RESEARCH AREA PRIORITISATION

The purpose of this questionnaire is for you to rank the priority road research areas for Malawi, that were identified through the consultative meetings, workshop and from National Research Agenda in Energy, Industry, and Engineering by NCST. They are to be incorporated in the Strategic Plan for the development and support to the implementation of the establishment of sustainable road research capacity in Malawi.

The Strategic Plan should be guided by the strategic objectives of the National Road Transport Policy as listed below:

- A transport sector that is safe, reliable, effective and efficient;
- Improved fully integrated road transport infrastructure;
- Maintenance of an acceptable quality road system;
- improved levels of service that supports government strategies;
- Improved development of the country's rural areas;
- Improved rural access and transport infrastructure.

Please rank the areas of research according to the following criteria

- Appropriateness (Should the research be done?)
- Relevancy (Why should the research be done?)
- The chance of success (Can the research be done?)
- Impact of the research outcome (How does it respond to the strategic objectives of the National Transport Policy?
- Level of innovation of the research (How innovative is the research?)

Under Time-Frame, scale of 0 to 3 represents time from establishment of the Road Research centre when research should be initiated):

- 3 (Within six months)
- 2 (Within 1 year)
- 1 (Within 2 years)
- 0 (Long-term more than 3 years)

You are most welcome to add other areas of research that you think must be included.

Organisation	
Name and Surname (Title)	
Position in Organisation	
Email	

	Research Priority		Criteria				
ID	Each of the identified priority areas should be scored against the criteria on the right on a scale of 0 to 3.	Relevancy	Chance of success	Impact of outcome	Appropriateness	Level of innovation	Time-Frame
1	Soil improvement:						
	Identification of alternative binders and soil stabilizers, for use as cement and/or bitumen replacements, which are suitable and cost-effective, without compromising on quality, durability and safety.						
	Development of best-practice guidelines on the beneficiation of sandy materials through the addition of cement stabilisers, and identification/specification of most appropriate cement types to suite local conditions						
	Evaluation of modification/treatment options for marginal aggregate in order to render them suitable for road construction						
2	Cement Characterisation:						
	Evaluation of the effects of different types of cements on the behaviour and long-term performance of cement-treated/stabilized materials						
3	Safety for road users						
	Durability and cost effectiveness of road marking paint applied to the road surface						
4	Bitumen testing:						
	Development of bitumen performance properties required of surfacings in Malawi						
	Appropriate standards for surfacings on low-volume roads taking cognisance of operating conditions, base types and drainage design						
5	Mapping of construction materials						
	Mapping of natural materials for road construction and development						
6	Review of test methods and manuals						
	Review of test methods to encourage use of local materials						
7	Construction material investigation						
	Adoption, development, optimisation and promotion of construction materials and practices to minimise impacts of natural disasters (such as earthquake/ tremor, flooding etc.						
	Manipulation of properties of materials at the						

	molecular or atomic level using nanotechnology in order to give rise to pavement material with enhanced properties						
8	Gender mainstreaming						
	Exploring aspects of gender mainstreaming in relation to Rural Road Improvement Programmes and transport services						
9	Natural disaster preparedness						
	Prediction and assessment of the effects of natural disasters including earthquakes, tremors, and flooding on road infrastructure including;						
	Production of geo-hazard zonation maps; and development and promotion of low cost early warning systems						
10	Management of transport systems						
	Improvement, optimisation and management of transport systems (rail, road, water and air) to reduce transportation costs and improve efficiency and competiveness						
11	Prioritisation of rural road development						
	Improvement in rural integrated infrastructure planning including maintenance - responsibility for rural road network management						
12	Data management of road research projects						
	Development of database for systematic collection and recording data generated during implementation of road projects						
13	Road Asset Management:						
	Research to establish a systematic and effective framework for road asset management looking at: Data collection and management • Road asset management methodology • Utilisation and dissemination of road management data						
14	Load Control on Heavy Vehicles						
	Investigation of appropriate equipment for load control						
	Assessing the impact of overloading on the network						
	Establishment of an effective load control infrastructure network						
	Evaluating the appropriateness of current axle and vehicle limits in Malawi						
15	Heavy Vehicles and Operators						
	Implementation of a self-regulation scheme in Malawi						
	Introduction of Performance Bases Standards vehicles in Malawi						

Thank you very much for your input

CONCEPT NOTES

PROJECT 1: Development of Database for Systematic Collection and Recording of Data Generated from Long term Pavement Performance monitoring projects

Context

The ultimate goal is to conduct monitoring programme in systematic way and ensure that the recorded data will be stored into a formal database. The core business of the RRC is research to generate knowledge that should be managed and effectively transferred for application. The development of databases is a critical management tool to ensure that research staff have accessibility to the information for analysis but also the dissemination of research outcomes to the wider public. There are currently three low volume roads trial sections requiring monitoring and data collection: (i) Rumphi - Nyika - Chitipa (M9); (ii) Linthipe - Lobi (S126) and (iii) Zaka - Neno (T397).

Objective

The main objectives of the project are the development of administrative and on-site protocols for systematic collection and recording of data generated during monitoring of the trial sections. Using available regional guidelines adopt for Malawi.

Concept

The core work should involve the evaluation of data collection methods to facilitate future back-analysis and in order to quantify lessons learned and appropriate application of generated knowledge. The drafting of protocols is to be based on the review of existing regional guidelines and protocols. The guidelines/protocols will be subjected to a review by a panel of experts/stakeholders in the area of pavement engineering to ensure that they will conform to the expected standard and quality.

Expected benefits

A data base will provide the best way to management data on research already undertaken and to be undertaken in future throughout the country, in line with those being developed through regional AfCAP projects. The data will safely be stored and appropriately be used for improving or updating specifications.

Deliverables

Short-term deliverables will include guidelines/protocol for the collection of monitoring data.

It is anticipated that the project duration should not exceed 6 months. The estimated manpower input is as follows:

- Senior researcher: 45 man-days

The estimated budget, for expert services is GBP30,000.

An annual budget is to be included in the Research Programme of the RA as outlined in the (2017-2022) Strategic and Business Plan.

PROJECT 2: Identification of suitable and cost-effective binders and soil stabilisers, for use as cement and/or bitumen replacements

Context

The cost of obtaining good road construction materials is increasing and these materials are becoming scarcer since sources are being depleted, requiring long haul distances and affecting the environment. There is therefore an increasing demand to use in-situ materials as much as possible in road construction to reduce costs and meet the requirements of sustaining the environment. It is not always the case to have quality materials that meet specification or performance requirements for construction. Consequently, it is essential to explore innovative ways to improve the in-situ materials to ensure better performing roads. The strategy is to improve the engineering properties of the in-situ materials through chemical stabilisation.

This is achieved either by using traditional hydraulic binders such as cement and lime, or organic material such as bitumen. The traditional additives/binders are generally expensive and the industry has recognised the need for alternative products as replacements of the traditional additives/binders. However, a more profound knowledge of the chemistry of and the interactions between the different products and soil/aggregates must be acquired in order to successfully use these alternative additive/binders and have confidence in their capability to enhance pavement performance.

Objective

The main objective of this project is to understand the interacting behaviour of non-traditional additives/binders and the extent to which they can effectively replace traditional additives/binders.

Concept

Knowledge generation is required in support of a decision-making process on the development of guidance documents and the framework/screening tool, for assessing suitability of the alternative additives/binders. The assessment of non-traditional additive/binders needs to be supplemented with life-cycle analysis. The objective is to be achieved through the following:

1. Review of existing procedures for performance assessment of non-traditional additives/binders.
2. Laboratory assessment of the potential additives/binders.
3. Design and establish demonstration sections. Potentially, suppliers of proprietary products could be encouraged to fund these.
4. Construction of the trial sections using the promising additive/binder.
5. Monitoring of the trial sections. The programme will involve conventional and non-conventional laboratory testing. The assessment of performance will include visual assessment, in-situ testing, sampling and laboratory testing and traffic counting to correlate with observed form of distress.
6. Detailed analysis of the collected data from the trial sections, which should include project life-cycle cost analysis to determine the impact of using the non-traditional additive/binders compared with sections where conventional additive/binders are used.
7. Preparation of manual. The preparation of the manual will require that a panel of experts is involved in the review.

Regional guidelines for the establishment and monitoring of trial sections are available on the ReCAP website (www.research4cap.org/) for reference and can be adapted to the site-specific conditions. Data management will be crucial on this project.

Expected benefits

The project will provide the opportunity to develop long-term research project management capability, innovativeness through the design optimisation in the application of non-traditional additive/binders, as well as field experience in data collection and testing. A decision-making process for the identification of suitable and cost-effective non-traditional binders and soil stabilisers is to be developed through this project. The increased use of non-traditional additives/binders will contribute towards reducing environmental impact and road construction costs. The project should offer an opportunity for a graduate student research project.

Deliverables

Short-term deliverables will include guidelines for the collection of data and a decision-making process for the identification of suitable and cost-effective non-traditional binders and soil stabilisers.

Estimated duration: 24 Months

Estimated Man-days: 280

Senior Researcher: 100

Researchers (x2): 120
Technician: 60
Estimated cost of review, data collection and validation with analysis: GBP 160 000

PROJECT 3: Appropriate manual for surfacing on low-volume roads, taking cognisance of operating conditions, base types and drainage design

Project Context:
Bituminous surfacing is the most commonly used to ensure all-season and better performing roads. Limited availability of road building gravels has been identified as a challenge by the RA in Malawi. The need for innovative solutions in the use of locally available materials for surfacing options, particularly for application in low-volume roads, becomes more apparent. Based on studies conducted under research programmes such as the ongoing Africa Community Access Partnership (AfCAP), a programme of research and knowledge dissemination, there is an extensive amount of knowledge on surfacing options suitable for application in resource constrained conditions. A number of guidelines have been developed under this programme, covering a range of surfacing options that include engineered natural surfaces (earth roads), lightly reinforced slabs, unreinforced slabs, concrete strips, concrete block paving, hand-packed stone, Otta seal with sand cover seal, and concrete geocel surfacing. These guidelines can be used for guidance to provide the most cost-effective and appropriate surfacing solutions for Malawi. The designs are based on the Dynamic Cone Penetrometer (DCP-DN) method, with the advantage that the existing in-situ road material strength is relied upon to provide the required support and therefore minimise importation of base/subbase construction materials. However, the performance of the road pavement support will be affected by any entry of water due to poor drainage.

Objectives
The main objective of the project is to demonstrate the applicability of surfacing options and drainage systems on the basis of the performance assessment through the monitoring programme, and to refine existing regional design manuals to standardise the designs for conditions in Malawi.

Concept
The approach will involve the review of available manuals and a preparation of one for use in Malawi. It will be based on the findings from a performance assessment of appropriate demonstration sections that are monitored over a period of at least two years. This should be achieved through the following:

1. Carry out a literature study of local and regional practice.
2. Compile data on types of surfacing aggregates and bituminous binders.
3. Analyse performance historical data, including design, construction and maintenance data. (This should lead to the identification of the gaps in the local knowledge. If information is inadequate, then steps 4 to 7 will apply.)
4. Design and construct trial sections that will incorporate conventional design approaches for comparison. Condition assessment of existing drainage along the road and pavement cross-drainage should be conducted. A thorough assessment of drainage conditions will ensure provision of effective drainage.
5. Monitor and collect performance data over a period of at least two years.
6. Establish whole-life costs using the constructed surfacing options, based on the assessment of performance over the monitoring period.
7. Develop a manual for the design of surfacing appropriate to the conditions in Malawi. The draft manual is to be subjected to an expert review process.

Regional guidelines for the establishment and monitoring of trial sections are available on the ReCAP website (www.research4cap.org/) for reference and can be adapted to the site-specific conditions.

Expected benefits

The project will demonstrate the application and implementation of surfacing options, from which improved and appropriate surfacing design methodology will be developed for application in the country. The project should promote the use of local materials not traditionally used for surfacing construction. This should also assist in providing innovative and cost-effective surfacing solutions for low-volume roads in the country, based on the whole life costs which can only be established from the monitoring programme. Other benefits will include the opportunity for research capacity building: design and implementation of research programmes; data collection and analysis; and a deeper understanding of the behaviour of pavement materials.

Deliverables

Short-term deliverable is a manual. The outcomes from the preliminary study will be used to refine existing manuals. The prepared manual will be subjected to expert review before finalisation.

Estimated duration: 36 Months

Estimated Man-days: 480
Senior Researcher: 160 days
Researcher: 120 days
2x Technicians: 200 days
Estimated cost of design, monitoring, data collection with analysis: GBP 165, 000

PROJECT 4: Standard Operational Procedures for Improving the Proficiency of Material Testing Laboratories (piloted on AfCAP project in Mozambique)

Project Context

The general operational protocols/procedures regulate everyday management of the laboratory. The standardised procedures provide step-by-step instructions and are necessary to ensure consistency in procedures within a laboratory. Aspects that should be covered in standardised procedure include: sample acceptance protocols; test data recording and storage; schedules and procedures for (internal and external). The condition of the equipment used is also of utmost importance. Calibration of laboratory equipment should be according to established standards and maintenance of the work space and laboratory equipment should be documented. Laboratory test methods should be repeatable and reproducible to provide meaningful results.

It was observed that the main Central Materials Laboratory (CML) requires a review and upgrade of existing procedures. Other laboratories will benefit from such an exercise.

Project Objectives

The main objective of the project is to review existing documentation in terms of procedures in order to identify areas that require improving and compare with requirements of internationally accredited (ISO/IEC 17025) laboratories.

The project will and evaluate existing laboratories' testing competence and make recommendations for their improvement if required, and implement a proficiency testing scheme.

Concept

The assessment of existing documentation required achieve the objectives of the project through the following:

- Examine the existence of record of all raw data, observations, calculations and, request available / completed, records are permanent, corrections legible and authorised, calculations check and how data on computer is protected;
- Identification of sampling and handling of test Items
- Existence of proof of competence, appropriate method of determination of competence of laboratory personnel;
- How the test method description are controlled
- Method and proof of Inter-laboratory testing with accredited laboratory;
- Maintenance, completed records, description of equipment used in testing, equipment used in verification of testing equipment, equipment used in verification of verifying equipment and;
- Accommodation and environmental conditions, monitoring of controlled areas, effective segregation of tests, adequate storage areas;
- Verification to meet quality criteria as required for the methods;
- Reporting of relevant information.

Expected Benefits

The project is aimed at improving the reliability of the test methods evaluated and ensuring consistent results. Quality data is required for appropriate interpretation of field performance of the materials when compared to design parameters. Only accurate data should be used in material database. A regional database is being created and it is crucial that data that can be relied upon with confidence is uploaded. The existence of quality control procedures will also pave the way towards accreditation according to the International Standards Organization's standard "ISO 17025".

Deliverables

The deliverables from this project will be both short term (quick win) and medium term:

- In the short term standard operational procedures that comply with ISO 17025

Estimated duration: 6 Months

Researchers: 60 man-days
The estimated cost for review and to prepare procedures: GBP 30 000

PROJECT 5: Identification of potential sources of alternative materials for use in roads – making use of sands (based on AfCAP project).

Project context

Considering that the condition of the total designated road network in Malawi, composed of 15,451 km of which 4,073 km are paved and the rest, (11, 378 km) earth/gravel, is rated as 52 % being fair to poor and 48 % in good condition, innovative solutions through research are urgently required, so that the country's road network functions as an enabler of economic growth. Over 80% of the population is based in rural areas. The provision of reliable, cost effective and durable road infrastructure to improve accessibility and mobility for the majority of the population is required.

Studies under AfCAP provide the evidence for good performance by sand as a road construction material. The **Guideline on the Use of Sand in Road Construction in the SADC Region** provides practitioners with a good understanding of the use of sand in its neat and stabilised state. This guideline provides guidance on how to correctly select and test the sand and how to design and construct the roads appropriately to render the sand a more suitable construction material in all layers of a road pavement. There are areas in Malawi, where sand is found in abundance.

Objectives
The main objectives to build a data base of sand deposits of appropriate quality for road construction and the results will supplement the work carried out within the SADC region under AfCAP.

Concept
This project will put into practice the **Guideline on the Use of Sand in Road Construction in the SADC Region**, to maximise the use of sand. The assessment of the performance of demonstration sections is considered an appropriate method to develop an understanding of the material properties and how they correlate to good pavement performance. This will be achieved in the following ways:

1. Conduct a literature review of existing studies in Malawi as there sections that have been used in the development of the DCP Guideline.
2. Carry out test pitting, soil profiling and sampling at selected sites showing potentially useful materials, based on the classification system provided in the guidelines, if data is not available.
3. Place the results of the material location and sampling in a data base that is easily accessible to road sector stakeholders. Based on similar previous studies, it is recommended that the database should also capture recommendations on how alternative materials should be rendered suitable for use in road construction, such as stabilisation.
4. Prepare a manual on the use of the database for road sector stakeholders.
5. Review how the results relate to the material property ranges as reflected in the current specifications and make appropriate recommendations, based on the analysis of data collected from both field and laboratory testing on the used materials.
6. Design, construct and monitor demonstration sites to collect performance data on a continuous basis over a period of at least two years. The construction of demonstration sections should involve using neat sand as base course. Guidelines for establishing and monitoring trial sections are available on the ReCAP website (www.research4cap.org/) for reference and can be adapted for site specific conditions.
7. Prepare technical recommendations to supplement existing information in the guidelines.

Expected benefits
The analysis of the collected data will assist to establish correlations between material characteristics and performance, as well as to assess the cost effectiveness of using sand material locally available to project site.

Deliverables
The deliverables from this project will include a comprehensive report with main findings and technical recommendations for potential sand material identification and sourcing procedures. In the short term, the deliverable will be the materials database.

Estimated duration: 36 Months

Estimated cost of project, including material characterisation, design and monitoring of demonstration sections, data collection with analysis: GBP 325 000

PROJECT 6: Durability and cost effectiveness of road marking paint applied to the road surface

Context:
The project is focusing on experimental investigation into characterisation of road marking paints, to include retroreflective-reduction rate. The background to the project is that the quantification of road marking paint retroreflective-reduction rate is necessary as road marking is aimed at improving road safety, particularly at night. Changes to the reflectivity of the lines on the road impacts on drivers as appropriate guidance diminishes with time and expectedly lead to head-on collisions. Several international studies show

linkage between effective reflective edge and centre lines to reduced collisions. In addition, frequent applications of road marking paint has an impact on maintenance costs for the Roads Authority and municipalities.

Objective:
Objective of the study is to conduct studies on the deterioration rate of paints currently being used in Malawi, through a systematic assessment and quantification of their performance, taking into account surfacing and environmental conditions.

Concept:
The assessment of the performance of road marking paint is considered an appropriate method to develop an understanding of the properties of the paints and how they relate to the rate of deterioration and in-service conditions. This will be achieved in the following ways:

- Determine properties of road marking paints used in Malawi and compare with samples used within the region
- Determine rate of wear of the road marking paint
- Maintenance records of road marking paints
- Other road markings should also be assessed in terms of cost of maintenance

Expected Benefits:
Benefits will include reduced fatalities as road markings are necessary to guide the road user, particularly during night driving. There are also economic benefits as appropriate recommendations will be made in terms of effective applications for road marking paint for the different types of paint and conditions of applications and thereby improve road marking working life to regulate traffic appropriately.

Deliverables
This is a long-term project with interim outcomes. The deliverables from this project will include a comprehensive report with main findings and recommendations on effective and economic applications and maintenance for the locally available road marking paints.

Estimated duration: 36 Months

Estimated cost of project, including material characterisation, monitoring of sections, data collection with analysis: GBP 50 000

Annex 6 Action plan 2018 - 2020

	Proposed Actions	By Whom	Timescale
1. Human Resources			
1a	***Recruitment of Head of R&D (or designation of Head of RD&I)*** • Establish the Road Research Management Committee (RRCM), with the responsibility to provide input in the appointment process of Head of RD&I • Assess internal staff for the position before open advertisement • Advertise and recruit if necessary **Success measure**: • RRMC in place by September 2018 • Head of RD&I appointed by December 2018 (Final approval dependent on scheduled Board meeting)	Director, Design & Planning	By September 2018
1b	***Assessment of current staff*** • Work with HR to assess current RA in-house and CML staff if they meet requirements for conducting quality research at specific level of appointment as per job description in Annex 1. **Success measure**: Assessment checklist completed by September 2018	Director, Design & Planning	By September 2018
1c	***Appointment of initial RRC staff including Laboratory Manager and Technicians to ensure quality research outputs*** • Advertise for staff and produce a shortlist for positions if internal staff not qualified • Interview potential candidates • Appoint 3 professional/research staff at senior level, Laboratory Manager and including five Technicians **Success measure**: Staff complement of 9 appointed by December 2018	• Director of Design & Planning • Head of R&D	Sept to Dec 2018
1d	***Support and career development, to ensure continuous personal and career growth*** • Develop research staff induction and career ladder programme • Develop programme for research skills development	Head of R&D	By March 2019

	• Design and initiate capacity building programme for staff to nurture research development, including long-term training plans • Study visit of Head of R&D **Success measure**: • Develop support and career development plans by September 2018 • Induction programme validated and in place by November 2018 • Training course material for short term internal training in place by November 2018 • Research skills development programme in place by November 2018 • Training service provider identified and appointed by October 2018 • Individual staff development schemes in place by February 2019 • Study visit to research institution by Head of R&D by February 2019 • Initiation of training programme with international research centres by March 2019		
1e	***Recruitment of additional staff, timing of process linked to completion of facility*** • Review staff levels • Advertise for an additional professional/research staff • Interview potential candidates, • Appoint at least two at junior level, one must be a female **Success measure**: • Additional staff complement of at least 3 appointed by September 2019, total staff of at least 11.	Head of R&D	By September 2019
1f	***Competency-based Training programmes to enhance the road-sector capacity*** • Appoint local consultant to conduct survey on implementation of appropriate and industry-driven training programmes/curriculum, develop training material and mode of training delivery • Validate industry-driven programme/curriculum • Develop or adopt consultancy policy to guide management thereof **Success measure**: • Local consultant appointed by September 2018 • Report on survey finding by November 2018	Head of R&D	By September 2019

	• Standardised and validated programme in place, September 2019		
2. Research			
2a	***Nurture research leadership*** • Develop or adopt research policy and guidelines for mentorship programmes • Promote mentoring programme to all staff **Success measure** • Research mentoring programme implemented by February 2019 • At least one research skills development workshop organised and attendance shows all research staff attended • Research proposals submitted by mentees meet all quality requirements	Head/Director of R&D	By Nov 2018
2b	***Knowledge transfer to increase access to information*** • Develop and implement policy on publicising, promoting RRC's research, nationally and internationally • Organise research dissemination workshops initially and upgrade to conferences • Promote research article publication for refereed conferences and journals by all staff • Solicit research articles and produce newsletter **Success measure** • At least one newsletter end of 2019 and one each quarter thereafter • One research dissemination workshop ("Open Day") in the first two years and upgraded to a bi-annual conferences • One refereed conference paper per year and one journal paper in the first two years, increased to at least four conference and journal papers per year from 2021. • Mechanisms to monitor information access and determine accessibility in place by March 2019 and at least 100 visits registered, increased to at least 1000 by year 2022.	Deputy Head/Deputy Director of R&D	By July 2019
2c	***Researcher's responsibilities*** • Engage in personal and career development and lifelong learning • Engage in outreach projects, consultancy services, membership to professional bodies and Task Groups • Develop detailed proposals from concept notes of identified priority projects	Principal Investigators	On-going

	Success measure • One conference paper presentation each year from level of senior researcher • Membership to professional bodies and service in national technical working committees • Contribution to research-based policy briefs • At least 80% of proposals in the first year meet the criteria of the Technical Committee		
2d	***Road Research coordination*** • Establish Road Research Advisory committees (RRACs) and develop Terms of Reference together with AfCAP Consultant • Nominate and invite road sector stakeholders to serve in the Research Technical Committee and Research Steering Committee from institutions listed in section 4.3.3 **Success measure** • RRACs constituted by September 2018 • RTC holds first meeting by December 2018 guided by AfCAP Consultant • RST holds first meeting by end January 2019 guided by AfCAP Consultant	RRMC and Head of R&D	By September 2018
2e	***Research prioritisation to increase R&D Portfolio and impact of research*** • Develop detailed proposals for identified priority projects for submission to RRACs • Implement at least three priority projects approved by RRACs, subsequently implement according to prevailing needs. Long-term monitoring of trial sections will be ongoing activity for the next five years • Submit deliverables • Identify new projects in line with industry needs and develop proposals for submission to RRACs **Success measure** • At least one project in active development by August 2019 with support from AfCAP Consultant • At least 90% of implemented projects in the first cycle completed on time, thereafter 100% successfully completed on time • At least 60 – 75% stakeholder satisfaction with research outcomes in the first cycle,	Principal Investigators and Deputy Head R&D	By August 2019

	thereafter at least 80%. • 100% of new project proposals approved		
3. Infrastructure			
3a	***Building*** • Commission temporary facility • Establish Construction Project Steering committee (CPSC) for the construction of the modernised permanent facility • Identify location of the new facility • Solicit funding for construction of facility • Let a contract for the detailed design of the facility, prepare ToRs and tender document for construction of the facility **Success measure** • RRC established in temporary premises by September 2018 • CPSC in place by October 2018 • Availability of funding confirmed by December 2018 • Detail designs approved and contractor appointed to start construction by March 2019	Director Design & Planning, Head R&D	By August 2018
3b	***Additional equipment for temporary facility (CML) and Capital Equipment for new facility*** • Acquire and commission small equipment to supplement CML equipment, from the list in Appendix 2. • Review equipment list in Appendix 2 • Procure various major equipment. Assumed with advisory support through Technical Assistance from AfCAP, but timing linked to progress on construction of new facility **Success measure** • Small equipment procured by October 2018 • Procurement plan of various major equipment in place by April 2019 • Various major equipment procured in time for commissioning in new facility and calibrated ready for use.	Head of R&D Laboratory Manager	By Aug 2019 for small equipment Timing linked to construction of new facility for major equipment
3c	***Laboratory personnel capacitation to support the objective of establishing a modernised materials research laboratory*** • Conduct a skills audit of laboratory personnel	Head of R&D Laboratory Manager	May 2019

	• Enhance in-house training by develop training programme to address specific skills deficiencies for new laboratory personnel • Identify internationally recognised and ISO 17025 accredited research laboratory and arrange for secondment of Laboratory Manager • Identify service provider for training (Assumed with support through Technical Assistance from AfCAP). **Success measure** • Skills audit completed by February 2019 • Hands-on training conducted at CML or Malawi Polytechnic laboratories by May 2019 • Secondment of Laboratory Manager to internationally recognised and ISO 17025 accredited research laboratory by March 2019		
3d	***Laboratory QA/QC schemes and proficiency programmes*** • Develop documentation on procedures, to meet requirements for quality assurance and quality control scheme of ISO 9001 Quality Management Systems (QMS) and ISO 17025. Assumed with support through Technical Assistance from AfCAP. **Success measure** • Laboratory standard operational procedure documents in place by July 2019	Head of R&D Laboratory Manager	July 2019
4. Operational Systems			
4a	***Laboratory information management for the purpose of good practice of collecting and storing data*** • Develop an electronic job and materials management system for the administration of incoming work. To be linked to the knowledge management system. **Success measure** • Laboratory information management system developed and implemented by July 2019	Head of R&D Laboratory Manager	By July 2019
4b	***Knowledge management to provide easy access to the road research information*** • Develop information services associated with research management for the processing and knowledge sharing • Develop internal and external web based knowledge portals • Formulate publication plan to increase the visibility and impact of research output,	Head of R&D	By July 2019

	linked to item 2b **Success measure** • Information accessibility plan is implemented • Interactive web page in place by July 2019 • Fully functional knowledge information management centre, linked to completion of facility		
5. Partnerships			
5a	***Foster linkages with local and international academic institutions and industry Establish*** • Establish formal agreements to develop strong long term partnerships (MoUs) **Success measure** • At least 2 MOUs by July 2020 • Arranged study period for RRC staff at host universities for advanced qualifications • Training programmes implemented in collaboration with the universities, based on industry-driven demand • Conduct collaborative research projects	Head of R&D	By February 2020
5b	***Foster relationships with other research institutions*** • Establish formal agreements to develop strong long term partnerships for linkages with other emerging Road Research Centres in the region and international road research institutions and laboratories (MoUs) • Manage MoUs and collaborations **Success measure** • Arranged secondment/training of researchers and laboratory staff • Collaborative research projects	Head of R&D	By February 2020
6. Funding			
	Funding mechanism to ensure sustainability of RRCaB strategy • Prepare and motivate increased budget for funding research next financial year • Motivate funding for constructing and equipping the new facility based on • detailed design • Develop plan for special budget for long-term monitoring of trial sections as it will be ongoing activity and should be budgeted for yearly until 2023	Director, Design & Planning Head of R&D	By November 2018

	Success measure • Motivation for increased research budget submitted to Road fund Administration by August 2018 • Budget in place for new financial year • Increased funding for research • Confirmed budget for new facility		