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Development of Low Volume Road Design Manuals and update of standard specifications and detailed drawings for three AfCAP member countries in West Africa

Inception Report

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CIVIL DESIGN SOLUTIONS

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Cover Image: Scenes from the country visits

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Abstract

The Africa Community Access Partnership (AfCAP) is funding the preparation of manuals for Low Volume Roads (LVRs) for three AfCAP member countries in the West Africa sub-region. These are Liberia, Sierra Leone and Ghana. The new manuals will draw on documentation recently developed in other AfCAP participating countries. The preparation of the manuals includes a high level of local stakeholder participation. The manuals are expected to be published by the end of 2018.

Inputs by local experts are being supplemented by inputs by international experts with experience in the development of rural roads documentation in the Africa region. The expert team visited the three participating countries between the 2nd and 21st July 2017. The purpose of the visits was to meet stakeholders in the rural roads sector and to collect relevant documentation on rural roads. In each country, a field visit was arranged to rural roads sites that illustrated the challenges being faced.

The key findings and recommendations from the Initial Visit are as follows:

- There is considerable existing documentation for rural roads in Ghana and some in Liberia. Sierra Leone has very little existing documentation.
- Stakeholder buy-in to the manuals development process is strong in Sierra Leone and Ghana, which are already implementing other AfCAP projects. Buy-in may not be as strong in Liberia, which is a new AfCAP participating country.
- The overall time inputs allowed for the experts are such that preparation of the manuals will where appropriate depend on using material from existing manuals.
- The Ethiopia Manual for Low Volume Roads (2016) will be used as the basis for the new manuals because of its broad scope, and the fact that it went through a rigorous development and refinement process. It is also well known to members of the expert team.
- The structure of the manual is expected to be very similar for the three countries for the required guidance on LVR design and construction. Liberia and Sierra Leone may also require some guidance on road maintenance.
- Standard drawings for rural roads exist in all three countries, but it is expected that there will be a need for some new drawings of standard cross-sections and drainage structures.
- Ghana has a Standard Specification for Roads and Bridges but there is no equivalent document in Liberia or Sierra Leone. The development of such a document for Liberia and Sierra Leone is beyond the scope of the assignment. Specifications will however be provided in the manual for key aspects such as pavement materials for incorporation in Project Specifications as required.
- Standard test methods are well defined in Ghana, but not in Liberia and Sierra Leone. For the purposes of the LVR Manual, British Standard test methods (or the European EN equivalent) will take precedence in Ghana and Sierra Leone, while ASTM and AASHTO methods will take precedence in Liberia.

- The First Workshop in each of the participating countries will be held in September 2017. The Second Workshop is expected to be held in February 2018, with completion of the manuals in MS Word format by June 2018. The launch of the final manuals in print-ready PDF format is expected by the end of 2018.

Key Words

Manuals, Low Volume Roads, Capacity Building, West Africa

Acronyms and Initialisms

AADT	Annual Average Daily Traffic
AASHTO	American Association of State Highway and Transport Officials
AfCAP	Africa Community Access Partnership
ALCC	Association of Liberian Construction Contractors
ALVRS	Alternative Low Volume Road Surfacing
ASTM	American Standard Test Method
AWARE	A West Africa Response to Ebola
BRRI	Building and Roads Research Institute
BS	British Standard
CBO	Community Based Organisation
CBR	California Bearing Ratio
CCCS	Contractor Classification and Certification System
CDS	Civil Design Solutions
CRIG	Cocoa Research Institute of Ghana
CSIR	Council for Scientific and Industrial Research (R&D group, Ghana)
CSIR	Council for Scientific and Industrial Research (R&D organisation, South Africa)
DC	District Council
DCP	Dynamic Cone Penetrometer
DFID	Department for International Development
DFR	Department of Feeder Roads (Ghana)
DN	DCP Number (mm/blow)
DUR	Department of Urban Roads (Ghana)
ECOWAS	Economic Community of West African States
EN	European Standard
EPA	Environmental Protection Authority
ESA	Equivalent Standard Axles
ESOL	Engineering Society of Liberia
EU	European Union
FR	Feeder Road / Forest Reserve
FRAMP	Feeder Roads Alternative and Maintenance Programme
FRP	Feeder Roads Programme
GASIP	Ghana Agricultural Sector Investment Programme
GCEA	Ghana Consulting Engineers Association
GDP	Gross Domestic Product
GHA	Ghana Highways Authority
GhIE	Ghana Institution of Engineers
GIZ	Gesellschaft für Internationale Zusammenarbeit – German Development Agency
GPS	Global positioning system
GRF	Ghana Road Fund
GRFS	Ghana Road Fund Secretariat
ILO	International Labour Organization
JICA	Japanese International Cooperation Agency
KFW	Kreditanstalt für Wiederaufbau - German Development Bank
KTC	Koforidua Training Centre
L-B	Labour-Based
LSFRP	Liberian Swedish Feeder Roads Project
LVR	Low Volume Road

LVSR	Low Volume Sealed Road
LWD	Lightweight Deflection Testing
M&E	Monitoring and Evaluation
MCC	Millennium Challenge Corporation
MDD	Maximum Dry Density
MoFA	Ministry of Food and Agriculture
MLG	Ministry of Local Government
MPBS	Maintenance Performance Budgeting System (Ghana)
MPW	Ministry of Public Works
MRH	Ministry of Roads and Highways
NRSC	National Road Safety Commission (Ghana)
OPRC	Output and Performance based Road Contract
ORN	Overseas Road Note
PI	Plasticity Index
PM	Plasticity Modulus
PIT	Project Implementation Team
PMU	Project Management Unit
PUA	Public Utility Authority (Liberia)
RAI	Rural Access Index
ReCAP	Research for Community Access Partnership
RMFA	Road Maintenance Fund Administration
RMTC	Road Maintenance Training Center
RPM	Road Prioritisation Methodology
RSC	Road Safety Commission
SC	Steering Committee
SCADeP	Smallholder Commercialization and Agribusiness Development Project
SI	Site Investigation
Sida	Swedish International Development Agency
SL	Sierra Leone
SLRA	Sierra Leone Roads Authority
SMTDP	Sector Medium Term Development Plan (Ghana)
SN	Structural Number
SRI	Soils Research Institute
SSD	Single Surface Dressing
TA	Technical Assistance
ToT	Training of Trainers
TRH	Technical Recommendations for Highways
TRL	Transport Research Laboratory (UK)
UK	United Kingdom (of Great Britain and Northern Ireland)
UL	University of Liberia
UN	United Nations
USAID	United Stated Agency for International Development
WAFEO	West African Federation of Engineering Organisations
WB	World Bank
WHH	Welthungerhilfe (Liberia)

Contents

1 Introduction

1.1 Background to the Project

The Africa Community Access Partnership (AfCAP) is seeking to influence future policy in the roads sector by helping ensure that recommendations arising from high quality research established under AfCAP Phase 1 are put into practice.

As part of this approach, new design manuals specifically for Low Volume[1] Roads (LVRs) customised to national needs and practice have been, and are being, developed. Such manuals have so far been published under AfCAP in Ethiopia, South Sudan, Malawi and Tanzania. These are based on the results of over 30 years of research on low volume rural roads, both paved and unpaved. Development or updating of existing LVR manuals is also in various stages of completion in Mozambique and Kenya.

The approach to the development of manuals is now being extended beyond the original scope, which focussed mainly on road design standards. It is accepted that the sustainable provision of low volume rural roads depends on a holistic approach that also recognises the importance of other considerations including design procedures, works specifications, procurement of works and supervision services, construction methods, and quality management. Increasing emphasis is also being given to road maintenance as part of rural roads asset management.

The project will prepare manuals for LVR manuals for three AfCAP member countries in the West African sub-region. The new manuals will draw, where appropriate, on documentation recently developed in other AfCAP participating countries. A similar approach to the preparation of those manuals will be adopted. This includes a high level of local stakeholder participation in the process of developing the manuals. Inputs by local experts will be supplemented by inputs by international experts with experience in the development of rural roads documentation in the Africa region. The completed manuals will facilitate the promotion of rational, appropriate and cost-effective implementation of rural road projects in the three countries.

1.2 Objective

The overall objective of the project is to prepare manuals for low volume rural roads in Ghana, Sierra Leone and Liberia based on a review, adaption and expansion of previous AfCAP LVR manuals and local manuals that are available in these countries.

1.3 Approach and Local Buy-In

The approach to the project aims from the outset to foster true national ownership of the manual preparation process. If strong local buy-in is not achieved there is a risk of the completed manuals not being used. The Local Civil Engineers on the project team have a key role in achieving national ownership by maintaining close contact with the roads authority and other stakeholders for the duration of the project. The local peer review

[1] Under AfCAP, Low Volume Roads are considered to be those that, over their design life, are required to carry an average of up to about 300 vehicles per day, and are subjected to less than about 1 million Equivalent Standard Axles.

group will also play an important role in the process. While drawing on their own extensive relevant experience, the international experts are approaching the assignment with no pre-conceived ideas of what is best for the countries, and are open to the opinions and needs of the local stakeholders.

From the initial visit, it is evident that local buy-in to the process is strong in Sierra Leone and Ghana, which are already implementing AfCAP projects. However, the participation was not as strong Liberia, which only recently became an AfCAP participating country. There are no other AfCAP projects currently underway in Liberia, apart from participation by Liberian engineers in training for the Dynamic Cone Penetrometer (DCP) pavement design method, which is being carried out in Ghana. There is however considerable donor-funded activity in the rural roads sector in Liberia and without better coordination and leadership there is a danger of the manuals project failing to achieve full local adoption and uptake. Enhanced support from the AfCAP PMU would serve to mitigate this risk by further strengthening the confidence and competence of those responsible for rural roads in Liberia. Mobilising other AfCAP research projects would help achieve this, while raising the profile of AfCAP and hence the value attached to the Liberia LVR manual.

It is recommended that AfCAP research in Liberia should focus on appropriate use of materials for low volume roads, including the possible use of soil stabilisers for unpaved roads. Such research could reinforce the use of the DCP for the design of unpaved roads and quality control on site. It would also support the re-establishment of materials laboratory testing at the University of Liberia and the Ministry of Public Works laboratory, both of which are currently receiving donor support. Such research would also be beneficial in Sierra Leone[2].

New research on the use of materials for low volume roads in Liberia and Sierra Leone would not only support local buy-in to the manuals process and uptake of the final product. It would also assist to fill knowledge gaps, identified during the initial visit, in appropriate specifications for materials.

1.4 Advisory Team

The expert team providing advice and support to the participating countries for the development of the manuals is as follows:

- Project Director: Robert Geddes - Civil Design Solutions
- Team Leader (Liberia and Sierra Leone): Robert Geddes – Civil Design Solutions
- Team Leader (Ghana): Hamish Goldie-Scot – Independent Consultant
- Geotechnical and Environmental Expert: Gareth Hearn – Hearn Geoserve
- Pavement and Materials Design Expert: Lucas-Jan Ebels - UWP Consulting (Pty) Ltd
- Rural Roads Expert: Ronald Isaac - UWP Consulting (Pty) Ltd
- Hydrologist/Drainage Expert: Festus Odametey - Independent Consultant
- Ghana Local Engineer: - Daniel Obeng – Independent Consultant
- Liberia Local Engineer: Joseph Quansah – Techsult Liberia Inc

[2] A study for the development and recommendations for alternative surfacings for LVR's for the 3 West African countries has recently been commissioned.

- Sierra Leone Local Engineer: Abdul Koroma – Independent Consultant.

1.5 Purpose of this Report

This report covers the Initial Visit of the project team to the participating countries. It includes a record of consultations with stakeholders, a literature review and preliminary recommendations for the content of the manuals. An updated work plan is provided for the remainder of the assignment.

2 Progress Report

2.1 Initial Visit

The initial visit was carried out between 1st and 21st July 2017. The itinerary was as follows:

- 1st July: International experts convene in Accra
- 2nd July: International team travels to Monrovia
- 3rd to 7th July: Stakeholder meetings and field visit in Liberia
- 9th July: International team travels to Freetown
- 10th to 14th July: Stakeholder meetings and field visit in Sierra Leone
- 15th July: International team travels to Accra
- 17th to 21st July: Stakeholder meetings and field visit in Ghana
- 21st July: International team departs.

The Liberia field visit was to Bong County, the Sierra Leone field visit to the Makeni area and the Ghana field visit to Eastern Region near Koforidua.

2.2 Stakeholder Groups met

The team met a wide range of stakeholder groups from the public and private sectors and some representatives of civil society. The following organisations were consulted:

- Africa Community Access Partnership (PMU)
- Association of Road Contractors (Ghana)
- Cardno/USAID (Liberia)
- Department of Feeder Roads (Ghana)
- DFID (Sierra Leone)
- Engineering Society of Liberia
- Environmental Protection Authority (Ghana)
- European Union (Sierra Leone)
- Forestry Commission, Ghana
- Ghana Consulting Engineers Association
- Ghana Highway Authority
- Ghana Institution of Engineers
- Ghana Road Fund Secretariat
- International Consulting Services (Sierra Leone)
- Koforidua Training Centre (KTC-Ghana)
- Ministry of Food and Agriculture (Ghana)
- Ministry of Public Works (Liberia)
- Ministry of Roads and Highways (Ghana)
- Progressive Road Contractors' Association (Ghana)
- Road Safety Commission (Ghana)
- Swedish International Development Agency (Liberia)
- Sierra Leone Roads Authority
- Sierra Leone Road Safety Authority
- University of Liberia

- Welthungerhilfe (Liberia)

A record of stakeholder meetings and the field visits is provided in Annexes A-C. Names and designations of those met are included in Annex D.

2.3 Preparation of the Inception Report

The Inception Report is a joint effort of the international consultants on the team, with important support in document collection by the local engineers. The purpose of the report is to present a record of the stakeholder consultations and field visits carried out during the Initial Visit, and to present a gap analysis of existing documentation in the principal areas of the provision of low volume roads. The report includes a preliminary structure of the LVR Manual for Ghana, which is expected to form the starting point for the manuals for Sierra Leone and Liberia.

3 Institutional Setting

3.1 Liberia[3]

The Liberia road network comprises about 11,800 km. The Primary network (between Monrovia and the county capitals) comprises 734 km of sealed roads and 1,130 km of unsealed, mostly gravel, roads. The Secondary and Feeder road network is unsealed and comprises 2,350 km and 5,700 km of gravel or earth roads respectively. The road network falls short of the basic requirement to support social and economic growth, and the unpaved roads are highly vulnerable to deterioration during the rains. Annual rainfall can be as high as 5,000 mm along the coast.

The Ministry of Public Works is responsible for all public roads in Liberia. Within the ministry there is a Feeder Roads Unit overseen by the Assistant Minister for Rural Development. Institutional capacity in the MOPW for the management of rural roads continues to be dependent on donor support. The lead donors for feeder roads in Liberia are currently Sweden and USA. The Ministry of Agriculture has implemented feeder road rehabilitation using funds received from donor agencies, including the AfDB and IFAD. During the Ebola crisis of 2014-2015 the World Bank funded the construction of steel truss bridges in Lofa County to connect population centres with health facilities.

The Liberian Swedish Feeder Road Project (LSFRP) is now entering its third phase. This will include rehabilitation of about 600 km of road in central and eastern counties. The LSFRP is managed by a "Project Implementation Team" (PIT) in the MPW. The PIT for is managed by an international consulting firm. Works contracts are co-signed by the Team Leader of the PIT and an MPW Counterpart. The MPW is maintaining roads rehabilitated under LSFRP Phase I and II using Community Based Organisations (CBOs), funded through the recently-instituted Liberia Road Fund.

USAID is currently funding an investment programme known as FRAMP (Feeder Roads Alternative and Maintenance Programme). FRAMP is contracted by USAID to Cardno Emerging Markets, which sub-contracts the works to local sub-contractors. The MPW is not directly involved in the implementation of the project, though the ultimate goal is to build capacity in MPW to maintain feeder roads. FRAMP includes three components:

- Rehabilitation of 450 km of feeder roads in Bong, Lofa, Nimba and Granbasa counties;
- Piloting routine maintenance using CBOs; and
- Research on alternative surfacings for low volume roads[4].

The German NGO Welthungerhilfe (WHH) is implementing spot improvements to feeder roads in the east as part of a long-term agriculture sector support programme.

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[3] The AfCAP Project Scoping Study for Sierra Leone and Liberia (Hearn, 2016) describes in detail the institutional arrangements for roads in Liberia and Sierra Leone, including the role of development partners in the roads sector. The report also describes the biophysical environment in the two countries, highlighting the challenges faced by the rural roads sector. Only pertinent details are repeated here.

[4] It is recommended that AfCAP research on materials for LVRs in Liberia (see Section 1.3) should go beyond conventional surfacing seals as these are now well understood. Innovative solutions such as the use of soil stabilisers should be investigated. The research should endeavour to build capacity in local materials testing laboratories.

3.2 Sierra Leone

The Sierra Leone Roads Authority (SLRA) is responsible for the administration, management and control of the national road network. This includes Class A (primary) roads, Class B (secondary) roads, and Class F (Feeder) roads. The total network of Sierra Leone is 13,300 km of which 4,150 km are classified as feeder roads, all of which are unpaved.

The Feeder Roads Department is one of seven departments in the SLRA. Other departments include Maintenance, Operations, Development, Finance, Administration and Procurement. The Feeder Roads Department works with the Local District Councils (DCs) to manage the feeder roads network. Rehabilitation and reconstruction works are the responsibility of the SLRA, while routine maintenance is the responsibility of the Local Councils. Improvement works are funded by international donors (EU is the lead donor for the roads sector) while maintenance is funded by the Road Maintenance Fund Administration (RMFA).

3.3 Ghana

Roads in Ghana are categorised into trunk roads, feeder roads and urban roads[5]. Trunk roads are those that run through the country connecting the regions and linking Ghana to its neighbours. The feeder roads connect from the towns and villages to the trunk roads, while urban roads are those within the cities and major towns.

The total length of the Ghana's road network is about 71,000 km, comprising about 15,000 km of trunk roads, about 14,000 km of urban roads, and 42,000[6] km under the responsibility of the Department for Feeder Roads. Of the latter, 62% (26,000 km) are engineered, 15% (6,200 km) are partially engineered and the remaining 23% are un-engineered. In terms of surface type, 5% (1,930 km) of feeder roads have a bituminous surface, 65% (27,230 km) are gravel roads, and the remaining 30% are earth roads.

There are three functional classes of feeder roads[7]:

- Access/Spur feeder road - any feeder road which connects a settlement to a higher-class road.
- A connector feeder road - both ends connect to a higher-class road.
- An Inter-district feeder road - linking two or more districts.

DFR policy is to keep the 30,290 km of engineered and partially engineered feeder roads in good or fair condition.

The Transport Sector in Ghana is managed and overseen by two Ministries:

1. The Ministry of Transport (MOT) is responsible for policy and oversight of the sector in general. The MOT also has responsibility for managing the outcomes of several transport agencies; among these, the Ghana Ports and Harbours Authority (GPHA);

[5] Source. Ministry of Roads & Highways. Sector Medium Term Development Plan (2014-17). July 2014

[6] Source: DFR Annual Report 2016, January 2017

[7] Source: Design Standards for Department Of Feeder Roads of the Ministry of Roads and Highways. First Edition: March 2009.

Ghana Airports Company (GAC); Drivers and Vehicle Licensing Authority (DVLA); and, National Road Safety Commission (NRSC).

2. The Ministry of Roads and Highways (MRH) is responsible for the provision and maintenance of the classified road network. The ministry provides oversight to the Ghana Highways Authority (GHA), which is responsible for the trunk road network, and the Departments of Feeder and Urban Roads (DFR and DUR). Policies are set at Ministerial level, but most of the technical work and implementation are carried out by the GHA, DFR and DUR respectively.

The GHA, DFR and DUR have each benefitted from Technical Assistance (TA) funded by development partners. Of particular relevance is the TA to DFR funded by DFID from 2000 to 2007. Comprising a combination of long- and short-term consultants working closely with national experts, this "Management Support Team" facilitated the processes that led to the development of much of the existing guidance for the provision of feeder roads, as referred to in this report.

For the current assignment, the team is dealing mainly with the DFR in the MRH. However, the Manual for Low Volume Roads will also be relevant to the GHA, whose responsibilities include low volume regional roads. Achieving active participation and buy-in from the GHA may be a challenge for the project, as much of its focus is on relatively high-volume roads. It is anticipated that it will require support from DFR, and if necessary from the Chief Director in MPH, to ensure the active engagement of GHA, including its participation in the project workshops.

4 Findings and Recommendations from the Literature Review and Stakeholder Consultations

4.1 Approach to Manual Development

The strategy for the development of the three country manuals is to develop the Ghana version first and use it as a basis for the Liberia and SL versions. This is seen as a more efficient approach than developing all three versions simultaneously. Ghana has far more existing documentation on roads, including low volume roads, than the other two countries. Liberia has some documentation for feeder roads as a result of the LSFRP. Sierra Leone has a "*National Feeder Roads Policy*", which includes basic standards for rural roads, but no standard documents for design and construction.

Following the initial visits, a preliminary structure for the manual has been prepared. This is based on the Ethiopia Manual for Low Volume Roads (2016), with some changes. The priority areas for the Ghana manual were discussed at the wrap-up meeting on 24th July.

The initial proposal is to develop the manual in four parts. These are:

- Part A: Introduction to LVRs, Geometric Design and Road Safety
- Part B: Materials and Pavement Design
- Part C: Hydrology, Drainage and Roadside Stabilisation
- Part D: Complementary Interventions

The topics likely to be covered in each part are listed in Annex E.

Key issues for the principal parts of the manual are discussed below. The existing national standards are compared with the project benchmark for good practice, which is the Ethiopia Manual for Low Volume Roads (2016), which is already well known to members of the expert team. The Tanzania Low Volume Roads Manual (2016) is also an important source of material, particularly on pavement design for low volume roads.

The following topics have been identified as low priority for the manuals:

- Procurement methodology;
- Planning (road prioritisation);
- Route selection;
- Chip seal and cold mix asphalt design;
- Technical Auditing; and
- Maintenance - in Ghana but likely to be important for Liberia and Sierra Leone.

These low priority areas will receive an overview in the manuals, with references provided for the reader to other relevant documents.

4.2 Geometric Design

4.2.1 Review of Existing Manuals

Liberia

Liberia has several manuals, including some that are fairly recent. The known manuals are as follows:

- LSFRP Feeder Road Design Manual – March 2012 (Sponsored by Sida, with input from various donor agencies). This is a comprehensive design manual for their feeder road system, and includes design guidelines and recommended standards in both the metric and imperial systems. To have both systems in operation is considered a risk and therefore **it is recommended** that Liberia adopt the metric system for purposes of the LVR Manual. The metric system is used throughout West Africa[8].
- Feeder Roads Design Manual and Specifications – March 2016 (Sponsored by Sida, with input from various donor agencies). This is an update of the 2012 manual and includes construction specifications.
- Best Practice Guidelines developed under the LSFRP. These comprise useful one-page leaflets for design and construction and include basic geometric design parameters including road width, horizontal curve radii, and K values for vertical curves. The standards set out in the leaflets are generally consistent with the LSFRP manual.
- Geometric and Pavement Design Standards – June 2017. These comprehensive guidelines were recently published under GIZ (German-funded) cooperation. They focus on primary and secondary roads and provide the overall framework for the classification of roads in Liberia. Since most secondary roads in Liberia are low volume roads, there will be overlap between this manual and the proposed LVR manual.

The Liberian Feeder Road Design Manual is a comprehensive manual, and in view of this **it is recommended** that this manual is not replaced in its entirety, but rather enhanced with the inclusion of additional design guidance and standards as contained in the recently published Ethiopia Low Volume Road Manual. It will be necessary to ensure that the LVR Manual is consistent with the recently published Geometric and Pavement Design Standards.

Sierra Leone

Sierra Leone, by contrast, has no substantive design manuals for roads. The only document providing guidance of standards for low volume roads is the National Rural Feeder Roads Policy document (2011). However, this is essentially a policy document, rather than a design manual. It defines policy directions in terms of "*rural road design standards*" for Class F1, F2 and F3 Rural Feeder Roads. The document includes some standards for Rural Feeder Roads such as standard cross sections, camber and design speed for each class, however it is not a design manual. When it comes to geometric design standards the various road projects in Sierra Leone usually apply standards provided by donor agencies. There is a clear need for formal national geometric design guidelines for Low Volume Roads in Sierra Leone to be defined. **It is recommended** that the chapter on geometric design developed for Liberia be adapted for use in Sierra Leone.

Ghana

Ghana has a range of guidance and manuals including:

- Road Design Guide – March 1991 (Ghana Highway Authority). This is a comprehensive design guide for all classes of road, but focusing on higher traffic roads.

[8] It has subsequently been agreed that conversion tables for imperial measurements will be included in the manual.

- Site Supervision Pocketbook – May 2004 (DFID Support). This is a useful pocket book for site supervision of contractors on Feeder Roads. It is a practical guide for use on site and does not include geometric design standards.
- Guidance Notes for the Design of Feeder Roads – June 2004 (DFID Support). This manual provides practical information for the designer / practitioner making decisions on site.
- Standard Specification for Road and Bridge Works – July 2007 (Ministry of Transport). This is a comprehensive and conventional standard specification for use in works contracts.
- Design Standards for Department of Feeder Roads – 1st Edition March 2009. This is a design guide which includes geometric design standards for feeder roads. Although this manual is fairly brief it does contain some relevant information which will be incorporated in the new manual.
- Labour Intensive Public Works Manual - 2012 (Republic of Ghana with support from World Bank and ILO). This is a useful reference document but does not provide sufficiently comprehensive guidance for all aspects of road design. As implied by the title it is limited in scope to labour-intensive[9] works, so some elements are not necessarily always relevant for all site activities on LVRs. However, the bulk of the document remains relevant and useful irrespective of technology choice.

It is recommended that the Ethiopia Geometric Design portion of Low Volume Roads Manual (Chapter 7 of Part B of the LVR Manual) be customised for Ghana. This manual, which is the latest in a series of manuals developed for African countries by AfCAP, provides an easy to follow design procedure, even for the novice designers. This manual provides significantly more detailed guidance on geometric design procedures and standards than that currently in use in Ghana.

The Ghana manual should be developed first, and then used as a basis for the Liberian and Sierra Leone versions. It will however be necessary to adopt the existing road classification systems and design processes that are currently in use and considered to be fit for purpose. This will ensure continuity, and more importantly, promote buy-in to the new manual from the stakeholders.

4.2.2 Summary of Issues from Stakeholder Consultations and Field Visits

The following relevant issues arose at the stakeholder meetings concerning geometric design standards:

Liberia

- At the meeting with the USAID/FRAMP/Cardno Team they commented that the earlier version of the LSFRP Manual was better than the more concise final version.
- This sentiment was echoed at a meeting with Mr Sackie Johnson, Acting President of the Association of Liberian Construction Contractors (ALCC), who indicated that there

[9] In contrast to labour-based technology, a labour-intensive approach seeks to maximise the use of labour with minimum use of mechanised equipment, including if necessary at the expense of cost and efficiency.

is a general sense among industry players that the existing feeder road design manual is not comprehensive enough and has gaps that need to be filled.

- During the meeting with Eva Ohlsson at the Swedish Embassy she mentioned that Nimba County was an example of a County having taken ownership of road maintenance. She also voiced her concern at the potential risk that the AfCAP project might result in two manuals for Liberia[10].
- During the meeting with Thomas Ten Boer of Welt Hunger Hilfe, he voiced his concern about erosion risks on steep slopes, and suggested that the manual should set limits on gradients.

Sierra Leone

- At the meeting with the Smallholder Commercialization and Agribusiness Development Project (SCADeP), Mr TA Jackson stated that there was no standard specification for roads in Sierra Leone, and that they currently use World Bank (WB) specifications.
- At the meeting with Ing. Alpha Lavalie he commented that design standards and specifications vary from project to project.
- It was suggested at the wrap-up meeting that the team should refer to the current Sierra Leone Feeder Roads Policy for design standards.

Ghana

- At the meeting with Ghana Highway Authority (GHA) they stated that "*a LVR manual would be useful to fall back on when traffic levels are low*".
- At the meeting with the Ministry of Roads and Highways there was discussion about road width: Ministry of Agriculture want the possibility of carriageway widths of feeder roads as low as 4m, while the minimum such width stipulated by the Ministry of Roads and Highways is 6m. The historical basis for what is by international standards a large minimum width was explained as dating back to a decision taken in the 1990s for reasons of road safety. This was in turn associated with the risks associated with the risk of vehicles leaving the carriageway and slipping down the steep side drains specified under the early labour based projects. In the course of discussions with stakeholders the possibility was explored of respecting the 6m width but mitigating both safety and drainage risks by adjusting the shape of the inside slope of side drains.
- On the field visit to Eastern Ghana, near Koforidua, the team visited the Obomofo Densua to Akote Road, where surfacing trials were being carried out, by labour-based methods. Apart from the surfacing trials on the road the following observations of the labour-based construction of the formation were made regarding the geometric design and road safety:
    - The shape of the road was reasonable, however no mitre-drains were in evidence.
    - The traffic control measures observed were very limited.

[10] At the workshop in Monrovia in September it was agreed that the new manual will be an update of the LSFRP manual. It will be a fully Liberian manual rather than linked to a particular project.

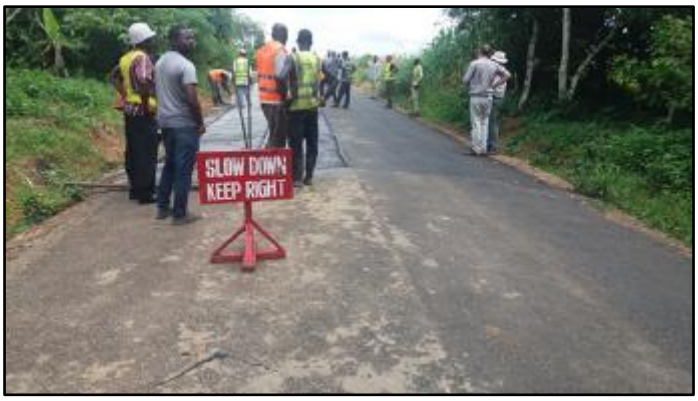


Figure 1: Inadequate Accommodation of Traffic for Obomofo-Densua Road Works

4.2.3 Additional Comments (all three countries)

While the following does not relate directly to geometric design, there are some further issues that need to be addressed as follows:

- **Maintenance** – Gravel roads are very vulnerable to rainfall and traffic, and while there is some attention given to maintenance it is generally inadequate to maintain asset values as result of a combination of either lack of funds, or of commitment from the road agencies. The LVR will highlight the importance of maintenance, and encourage the road agencies to provide the necessary funding and organisation to properly support a structured maintenance programme. There will be a new maintenance manual for Liberia and Sierra Leone, but not for Ghana.
- **Supervision** - There were numerous reports from stakeholders that when a gravel road is being built there is generally insufficient funding to place an experienced supervisor on site. As a result, errors are evident in terms of alignment, drainage, etc, etc. The need for experienced supervision on site should be highlighted in the manual so that the roads agencies are aware of the benefit of good supervision in terms of the longevity of the road. This also applies to contractor supervision.
- **Road Safety**. Accommodation of traffic for low volume roads is evidently a low priority. While all of the countries visited have charts for standard signposting at roadworks, the use of these signs is not always enforced and little attention is given to the management of associated risks. The various institutions responsible for road safety lacked the powers to enforce good practice not only in this regard but also in other aspects of road safety that are affected by road geometry[11]. They therefore welcomed the opportunity to be part of a process that would incorporate some aspects of accepted road safety good practice into an official manual.

4.3 Investigations

4.3.1 Overview

Investigations should form an integral part of all low volume road planning, design and rehabilitation works. They commence with investigations (including environmental

[11] In addition to the issues of road width, ditch shape and accommodation of traffic already described, more general concerns were made concerning the layout of junction, accommodation of non-motorised traffic on long bridges, and the relatively low use of road signs on feeder roads.

investigations) for route selection, progress through geological site characterisation and continue through to subgrade assessment and the prospecting for construction materials.

4.3.2 Route selection

Liberia

Generally, the existing feeder road network is considered inadequate to facilitate the country's needs for national and regional economic growth and to facilitate effective access to rural health facilities (AfDB 2013; MCC 2013) and therefore expansion of the road network is required. While the focus is on the upgrading and improvement of existing access, there will be a requirement for new roads to be constructed along new alignments. There are no formal national guidelines available in the country for carrying out investigations associated with new road construction. Given the hilly and sometimes mountainous nature of some of the terrain of Liberia, these investigations will require topographic assessment using desk study and field-based techniques, geological assessment and environmental assessment.

The LSFRP Feeder Roads Design Manual provides some very general description of the topographic and environmental considerations that might affect road location. In relation to environmental constraints, a list of potential environmental considerations is provided, though there is no guidance provided as to how these and other factors might be considered. The only published example of route selection in Liberia that has come to light is that relating to haul road route selection at the Gangra-Yuelliton iron ore mine near Yekepa (Hearn 2012).

It will be necessary to include some further guidance in the AfCAP LVR Manual on the breadth of the issues relevant to new road route selection and the way they should be investigated.

Sierra Leone

While there appears to be less imperative to expand the rural road network in Sierra Leone, it is also the case that there are no formal national guidelines on how to select alignments for new roads. Some guidance should therefore be provided in the AfCAP LVR Manual.

Ghana

The road network in Ghana is well-established and, as far as can be ascertained, there are no plans for significant new road building. However, broad guidelines on alignment planning are provided in the Guidance Notes for the Design of Rural Feeder Roads (DFR 2004). Greater detail is provided in Module 6 of the ILO Practitioners' Guide to Rural Roads (MLGRD 2014), including the need to link up villages, avoid destruction of farmland, avoid expensive earthworks through rocky areas and maintain consistency with geometric standards. These recommendations will be strengthened in the AfCAP Low Volume Roads manual.

4.3.3 Geological and subgrade investigations

Whether it is for a new road or the widening or rehabilitation of an existing road, it is important to understand the ground conditions of the corridor. This not only relates to the subgrade conditions in the Right of Way but also the rock and soil conditions of the surrounding terrain, as these often help explain the drainage pattern and the variability in subgrade conditions, both vertically and along the centre-line. These geological conditions should be investigated using a combination of desk study data and field mapping.

Subgrade soils within the Right of Way are ordinarily investigated using trial pitting, in-situ testing (commonly using the DCP), sampling and lab testing and field description. This not only allows the assessment of the ground as a foundation for the road and its associated structures but also indicates how the material will behave when excavated, loaded and used as embankment fill.

Liberia
The only guidance available for geological investigations for low volume roads in Liberia is contained in the Feeder Roads Design Manual. However, this simply refers to the need to maximise use of local materials and the general availability of lateritic materials for construction purposes. The Manual refers to the presence of "*problem soils"* and specifically to expansive clays, but provides no guidance on their investigation or mitigation.

There is significant variability in the soil types exposed in Liberia. While lateritic soils are common, there are also parts of the country where clay soils of high plasticity occur, and these are often found to lose strength when reworked, or softened due to poor drainage. The Feeder Roads Design Manual is based on the selection of materials "*by eye*". More robust guidance is required, in terms of investigation techniques, testing and handling. These topics will be covered in the AfCAP Low Volume Roads manual.

Sierra Leone
There appears to be no formal guidance in Sierra Leone covering the techniques of soil characterisation and investigation specific to the country, and this is a major gap in the LVR sector. There is considerable experience held by SLRA staff, and this appears to be being utilised in feeder road improvement projects, but formal national guidelines are required.

Ghana
The Guidance Notes for the Design of Rural Feeder Roads (DFR 2004) provide some useful tips on survey and selection of materials, though little technical information or discussion on investigative techniques are provided. The ILO Practitioners' Guide to Rural Roads (MLGRD 2014) provides a very useful description and illustration of soil classification and the use of soils in labour-intensive roadworks, but does not cover techniques of investigation. The document entitled "*Soils and Natural Gravels: A Guide for Area Engineers*" (DFR 2006) does provide guidance on the field and laboratory testing of soils for use in road construction, including the taking of samples for classification tests.

4.3.4 Investigations for construction materials

Liberia

Although the Feeder Roads Design Manual contains outline specifications for subgrade, subgrade improvement, embankment fill and gravel wearing course, it provides little guidance on the selection and investigation of gravel pits and borrow areas. As far as can be ascertained there are no other documents that provide information or guidance on material selection and prospecting within the country.

Sierra Leone
No national documentation or guidelines have come to light that provide advice on the prospecting and investigation of road construction material sources in the country.

Ghana
Module 11 of the ILO Practitioners' Guide to Rural Roads (MLGRD 2014) provides some very useful guidance on opening up, operation and restoration of gravel borrow pits for roadworks. Although the guidelines probably cover most aspects of borrow pit management, they do not provide guidance on how to investigate for gravel resources, neither do they give advice on the testing required to confirm material suitability. The Ghana Standard Specification for Road and Bridge Works (MoT 2007) provides clear instructions on how quarries and borrow pits should be managed, but no guidance on how they should be selected and investigated. The AfCAP Design Manual will provide further advice and guidance in this respect.

The document "*Soils and Natural Gravels: A Guide for Area Engineers*" previously referenced provides a very useful description of classification tests for naturally occurring soils and gravels and describes in some detail the field and laboratory tests used to determine the engineering properties for these materials and their suitability for use in roadworks. The document identifies black cotton soils, decomposed phyllites and micaceous soils as being problematic in the Ghanaian context, but does not elaborate on where these soils are found in the country. The document itself is considered to be entirely fit for purpose in the techniques used for soil classification, but lacks guidance on methods of prospecting and investigation. These aspects will be addressed in the AfCAP Low Volume Road Design Manual.

4.4 Roadside slope stabilisation

Liberia
There appears to be no published documentation in Liberia that provides guidance on the design of the road cross-section, the design of earthworks slopes and the protection of these slopes against erosion and slope instability. Expansion of the low volume road network into hilly and mountainous areas and the widening of existing roads in this terrain will require consideration of earthwork design and slope protection. These issues will be covered in the AfCAP Low Volume Roads Manual.

Sierra Leone
There appears to be no published documentation in Sierra Leone that provides guidance on the design of cross-section, the design of earthworks slopes and the protection of these slopes against erosion and slope instability. These issues will be covered in the AfCAP Low Volume Roads Manual.

Ghana
Module 8 of the ILO Practitioners' Guide to Rural Roads (MLGRD 2014) provides a useful description of issues associated with choice of cross-section in sloping terrain, haulage of materials and formation of embankments. It discusses the engineering and environmental pros and cons associated with various cross-sections and indicates fill volumes associated with nominal fill slope angles. It does not discuss cut slope design and neither does it discuss techniques for slope stabilisation and erosion control on slopes. These topics will be addressed in the AfCAP Low Volume Roads Manual.

4.5 Materials and Pavement Design

4.5.1 Overview

Most reference manuals for road building materials and pavement design, e.g. Overseas Road Note (ORN) 31 (TRL, 1993) and TRH 4: Structural Design of Pavements for Interurban and Rural Roads (SA Department of Transport, 1996), include basic flow diagrams that indicate the relationship between the various input parameters, the processes to be followed and the outputs for the selection of materials and structural design of pavements. **It is recommended** that such a flow diagram also be developed for the new LVR manuals for Ghana, Sierra Leone and Liberia, which should include:

- Site physiography;
- Traffic;
- Subgrade characterisation;
- Availability and selection of pavement layer materials; and
- Pavement design.

This flow diagram would be more detailed than the flow diagrams found in the Ethiopia Manual for LVRs. It will guide the structure of the materials and pavement design section of the new manual and its key components. Each of these components is discussed in the following sections, with links to documentation currently in existence and observations from the initial country visits and meetings with stakeholders.

4.5.2 Site physiography

Site physiography plays an important role in the design of roads. Climatic and environmental factors need to be considered and these include, temperature and rainfall characteristics, as well as topographical and geological characteristics. The existing manuals and documents in the three countries contain very little information in this regard. Only two of the documents evaluated contained some climatic information.

The Pavement Design Manual (Ghana MRH, 1998) for Primary and Secondary Roads includes a map of the country with average annual rainfall, which varies between 1000 mm and 1900 mm. The manual also includes a map with weighted Mean Annual Air Temperatures. The Desk Study for Low Volume Road Surfacing and Trial Layout Recommendations (Overby, 2016) for the Feeder Roads Alternative and Maintenance Programme (FRAMP) in Liberia also includes a map of the country with average annual

rainfall. In Liberia, this varies from 1500 mm inland to a much as more than 4000 mm along a narrow coastal strip.

Information on air temperatures or road surface temperatures, or any other climatic area indicators, were not seen in any of the existing documents that were reviewed.

In contrast to the lack of site physiographic information in current documentation, a number of stakeholders, in all three countries, indicated that environmental conditions vary greatly within the countries and that there is a need to take differences in rainfall patters and local subgrade conditions into account. Since this is an important aspect of pavement deign, **it is recommended** that the new LVR Manual includes a section on site physiography, including:

- Topography;
- Geology;
- Temperature; and
- Rainfall; and
- Climatic zones

The inclusion of climatic zones is well accepted in road design manuals and good examples exist of such in the LVR manual for Ethiopia, Tanzania and SADC. Indicators such as the Weinert N-value or the Thornthwaite Moisture Index will be considered, both of which include precipitation and evaporation parameters.

The climatic environment within each of the three countries varies significantly and therefore the definition of climatic regions, e.g. dry, moderate and wet, is necessary and should be linked to materials property requirements and structural pavement design.

4.5.3 Traffic

In general, traffic is an input paramount to pavement design in that the structural performance of a pavement is affected by both the magnitude and frequency of individual wheel and axle loads. The cumulative traffic loading over the structural design period of a pavement is the main design input parameter for high volume roads, and remains a significant factor on the more highly trafficked LVRs. This cumulative traffic loading is normally expressed as a number of equivalent standard axles (ESAs). The process of determining the number of ESAs is well documented in a large number of reference manuals, including the Ethiopia Manual for LVRs. It includes the assessment of traffic (modal split, current and future volumes), axle load distributions and the calculation of Annual Average Daily Traffic (AADT), mean daily ESA and cumulative ESAs.

As far as existing documentation is concerned, Ghana relies on ORN 31 for paved feeder roads, but does not include any traffic classification for gravel feeder roads. Sierra Leone currently does not have an existing manual or document that provides guidance on the determination of cumulative traffic loading for pavement design purposes and in Liberia traffic classes (in terms of cumulative traffic loading) for feeder roads are also not defined.

The Liberian Feeder Roads Manual (MPW, 2016) includes a table with minimum wearing course thicknesses depending on subgrade CBR and AADT (classes of AADT <15, 15-50, 50 – 500 and >500). This table includes unrealistically high minimum gravel wearing course thicknesses for the higher traffic classes in combination with low in situ low subgrade strength.

There is therefore a need, in all three countries, to develop traffic classes for pavement design. Various LVR manuals for other countries provide examples of this, but many of these unnecessary complicate the number of design options by defining up to six different traffic classes for low volume roads. **It is recommended** that a reduced number of traffic classes for the new LVR manuals be adopted with three traffic classes initially proposed for cumulative traffic loading (million ESA), i.e. <0.01, 0.01 – 0.3 and 0.3 – 1.0. The number of traffic classes will be discussed with stakeholders and local practitioners during the project workshops.

4.5.4 Subgrade characterisation

One of the principles of structural design of roads is to protect the subgrade from excessive stresses. This is achieved by covering the subgrade with structural pavement layers. These structural pavement layers should therefore in the first place be thick and strong enough to spread the traffic-induced loading over such an area that the compressive stresses on top of the subgrade are small enough not to result in significant permanent strain (subgrade rutting). Secondly, the intrinsic characteristics of the structural layers should be such that the behaviour under traffic loading is such that there is minimal damage to the structural layers (cracking and shear failure).

For higher volume roads, with heavy traffic loading, a significant part of the pavement design effort is to ensure that the structural layers perform satisfactory under traffic loading. Various mechanistic and analytic pavement design methods, with complex material damage functions, exist to model the behaviour of structural pavement layers under traffic loading. For low volume roads, with significantly lesser magnitudes of traffic loading, it is generally accepted that that such modelling of the behaviour of structural pavement layers is not necessary. The main focus of pavement design for low volume roads is therefore concentrated on protection the subgrade by providing structural pavement layers of which the thickness and strength is based on empirical relationship and standard pavement structures with known performance. This implies the use of a catalogue-type pavement design along the lines of the options provided in the Ethiopia Manual for LVRs.

One of the key aspects of the structural design of low volume roads is therefore the characterisation of the in-situ subgrade. There are a few basic material parameters required to characterise in-situ subgrade material. These include grading, Atterberg limits and CBR. Each of these is determined in a soils laboratory on representative samples taken from the field. Grading and Atterberg limits are quick and easy to determine, but CBR testing requires more elaborate and time-consuming sample preparation, including the determination the maximum dry density of the material and the soaking of CBR specimens for four days.

It is therefore beneficial to use other methods to characterise the subgrade bearing capacity. These may include DCP testing and lightweight deflection testing (LWD). The DCP

test measures the penetration rate DN[12] (mm/blow) of a standard cone, while the LWD measure a subgrade stiffness response (surface modulus). There is significant experience in the use of the DCP for pavement design purposes and there are several empirical correlations between the DN value and the subgrade CBR. The LWD represents a new technology, the use of which is not yet widespread and the correlation between LWD surface modulus and subgrade performance is the subject of ongoing research.

It is common practice to define classes of subgrade strength of the basis of subgrade CBR values. This is for example adopted in ORN 31 and Technical Recommendations for Highways[13] (TRH) 4. ORN 31 makes use of six subgrade strength classes (S1 – S6) while the TRH 4 specifies four. The Ethiopian and Tanzanian LVR manuals use the same subgrade strength classification as ORN 31.

The six subgrade classes (of which the weakest one S1, CBR < 3, is ignored as it requires special subgrade treatment) in combination with five traffic classes adopted in the Ethiopian and Tanzanian LVR manuals result in a very large number of permutations of structural pavement layer thickness and materials requirements. This makes the pavement design relatively complicated. It is furthermore known that the CBR test is inaccurate with low reproducibility. Using a classification system based on narrow ranges of CBR values can therefore give rise to a misleading sense of accuracy.

It is therefore recommended that the number of subgrade strength classes for the new LVR manuals is kept to the minimum practical number, as is recommended for the traffic classes as discussed in Section 4.5.3 above, and without narrow ranges of CBR (or DN) values per subgrade strength. Four classes are therefore initially proposed for subgrade strength, i.e. S1 CBR <3, S2 CBR 3 – 7, S3 CBR 8 – 15 and S4 CBR > 15. This is subject to agreement by practitioners in the participating countries.

4.5.5 Selection of pavement layer materials

The existing documentation in the three countries provides little guidance on the selection of pavement layer materials from borrow pits and quarries (see Section 4.3.4 above).

There are manuals for other African countries that include good guidance for the identification and selection of road building materials. One such example is the Tanzanian Low Volume Roads Manual. It is envisaged that similar guidance is included in the new LVR manuals for Ghana, Liberia and Sierra Leone.

4.5.6 Pavement design

Liberia

The current Feeder Roads Design Manual in Liberia (MPW, 2016) provides a fixed gravel wearing course thickness for low traffic feeder roads (either 150 mm if the underlying subgrade has a minimum CBR of 15%, or 200 mm irrespective of the subgrade CBR) and a gravel wearing course thickness design formula for higher class of feeder roads and

[12] "DN" denotes "DCP Number" measured in mm per blow

[13] South African

secondary roads (AADT > 50) based on minimum gravel layer thickness (the structural component) and traffic related gravel loss (the wearing course component). As noted in Section 4.5.3 above, this minimum gravel wearing course thicknesses for the higher traffic classes in combination with low in situ low subgrade strength is considered unrealistically high.

Sierra Leone

Sierra Leone does not currently have a national manual or document that provides guidance on the structural pavement design for low volume roads.

Ghana

The draft document for Design Standards for Department of Feeder Roads in Ghana (DFR, 2009) includes a short section on pavement design. It distinguishes between the design of paved roads and gravel roads. The structural design of paved roads is not dealt with in the draft document and reference is made to ORN 31. For the structural design of gravel roads a few basic standard pavement design options are provided. These are based on the subgrade strength (four classes) and two types of gravel wearing course categorised according to CBR.

Other than CBR requirements for subgrade and gravel wearing course, no material specification or requirements are provided for any pavement layer materials in the Ghana draft DFR manual.

As described above under Section 4.5.4, the main focus of pavement design for low volume roads is protection of the subgrade by providing structural pavement layers. Using a catalogue design approach, the thickness and strength of these layers is based on empirical relationships and standard pavement structures with known performance.

ORN 31 makes use of an extensive catalogue of standard pavement structures, and also includes concepts of the pavement Structural Number (SN) principles. These principles are outlined in the AASHTO guide for design of pavement structures (AASHTO, 1986).

There are several existing LVR manuals for other African countries, including Ethiopia, Malawi, Mozambique and Tanzania that include the use of the DCP design method. Typically, two types of DCP design methods are used. The simplest is the use of the DCP to correlate to a CBR value and then use catalogue-type pavement structures. These catalogue type structures are subsequently verified using the pavement SN. The alternative DCP method is the DCP-DN method, which makes use of DCP layer strength diagrams to determine pavement strength and to identify weaknesses in the pavement structures.

The DCP-CBR method is most suitable for new pavement structures, although it can also be used for the rehabilitation design of existing low volume roads. The DCP-DN method is most suitable for rehabilitation of existing low volume road pavement.

Thickness design of gravel wearing courses is often related annual gravel loss, which is a function of traffic, maintenance and environment. The Ethiopian LVR manual includes some guidance on gravel loss, but the new LVR manual for the three West African countries could incorporate some improvements in this area.

4.5.7 Material specifications and requirements

Liberia

In Liberia there are a relatively large number of existing manuals and documents containing specifications for pavement materials. These include the Feeder Roads Manual of the MPW (2016), the feeder road manual developed for Sida-funded LSFRP, and specifications developed under the USAID funded FRAMP. These various manuals each include similar specifications for gravel wearing course material and subgrade materials. The wearing course material specification is also based on the TRH20 classification.

An extensive manual exists in Liberia for Primary and Secondary Roads. The Geometric and Pavement Design Standards (MPW, 2017) was developed in the GIZ-funded capacity development programme in the transport sector. This is more of a reference type handbook document and in terms of pavement material specifications is largely based on ORN 31.

It is evident that the various classifications and specifications currently being used in Liberia differ slightly. This highlights a fragmented approach resulting from many different donor-funded programmes and the need to put them in one unified design manual and standard specifications.

There is significant interest in Liberia in the use of proprietary chemical stabilisers for improving the durability of gravel wearing courses. However, no systematic research has been done to determine which of several products on the market might be suitable for local conditions. Therefore, it is difficult to include useful guidance in the manual. To help fill this knowledge gap, **it is recommended** that AfCAP provides support to Liberia for a research project on stabilisation of gravel materials for wearing course.

Sierra Leone

The Sierra Leone Roads Authority has a few rudimentary material specifications in the technical specifications of the sample bidding document for feeder road projects. This only includes a compaction requirement for earthwork layers, but no fill or roadbed material specification, some basic specifications for wearing coarse material (grading, PI, PM and CBR) and a minimum compaction requirement for gravel wearing course layers (95% of Maximum Dry Density (MDD) AASHTO T99).

Ghana

In Ghana, no material specifications or requirements are provided for any pavement layer materials in the current documentation for feeder roads, other than CBR requirements for subgrade and gravel wearing course. Even in the GHA Pavement Design Manual for Primary and Secondary Roads (MRH, 1998), the material specification for granular base, subbase and subgrade is minimal at best and lacks durability and hardness specifications for base course materials, and compaction requirements for the various pavement layers.

The Ghana Standard Specification for Roads and Bridge Works (MRH, 2007) was developed in 2007 under the World Bank component of the Road Sector Development Programme. It is largely is based on the 1998 Standard Specifications for Road and Bridge Works from the Southern African Transport and Communications Commission. These extensive standard

specifications are to be used by all three implementing departments of the MRH in Ghana and therefore also cover the construction of LVRs. The standard specifications include separate sections on gravel wearing course, natural material subbase and base, and graded crushed stone base and subbase. The section on gravel wearing course is of particular interest for LVRs. These wearing course specifications are based on the TRH20 : The Structural Design, Construction and Maintenance of Unpaved Roads (SA Department of Transport, 1990), which includes the well-known gravel wearing course classification into five areas (A – E) based on Grading Coefficient and Shrinkage Product. This classification is also adopted in many other design manuals, e.g. in the Ethiopian and Tanzanian LVR manuals.

It is envisaged that the new LVR manual will provide uniform guidance on specifications in each of the three countries and become the reference document for all low volume road construction. It should include material specifications and requirements for:

- Fill;
- Subgrade (in situ and imported (improved or selected) subgrade layers);
- Subbase;
- Base;
- Gravel wearing course (including laterites);
- Surfacing materials; and
- Stabilisation.

The Tanzanian Low Volume Road Manual (MOW, 2016) provides a good example of design guidance and material specifications to be included in a LVR manual. It is envisaged that the new LVR manual for each of the three countries will be a combination of the existing specifications in each country, selected and adjusted where necessary, complemented with additional design guidance and specifications taken from reference manuals.

4.5.8 Laboratory testing and standard test methods

In all three countries laboratory testing facilities are available.

Liberia

In Liberia, the only facility is at the Ministry of Public Works and was visited during the initial country visit. While the laboratory has equipment to undertake most testing required for soils and aggregate testing, bitumen testing and concrete testing, it was evident that there is a need for increased capacity, in terms of both human resources and equipment. More effective laboratory management is also required.

The laboratory testing facilities at the University of Liberia, Fendall Campus, were also visited. While the laboratory currently carries out basic soils and aggregate testing, donor-funded equipment to increase testing capacity was arriving at the time of the visit. The Chair of the Civil Engineering Department indicated an ambition for the University to have a laboratory testing facility that could be used for commercial testing.

Sierra Leone

The Sierra Leone Roads Agency has a central laboratory facility, capable of carrying out all basic soils and aggregate testing, bitumen testing and concrete testing. This facility was

visited during the initial country visit. From discussion with stakeholders it was established that materials testing for acceptance quality control was carried out at a contractor's laboratory in Makeni for the EU-funded A West Africa Response to Ebola (AWARE) project on feeder roads in the area. The laboratory is on the site of a national roads construction project and will be removed when the project is complete. It is being used for testing on the AWARE project because it is much closer to the site than the SLRA central laboratory.

Ghana

Ghana possesses most capacity in terms of soils and materials laboratory testing, with a Central Materials Laboratory testing facility in Accra (Ghana Highways Authority), as well as regional laboratories in each of the regions. From discussion with DFR, it was indicated that they are in the process of setting up central testing facilities and intend to create capacity in the regions.

Specification of test methods

Regarding laboratory testing, it is important to note that there is a need for clear guidance on laboratory test methods and standards. For instance, the existing construction specifications in the three countries make use of various different MDD test methods for relative density compaction requirements (Proctor, Modified Proctor, BS, Heavy BS, and AASHTO T99). It is proposed that the new LVR manuals will include a consistent approach to specifying test methods, based on the following:

- Ghana and Sierra Leone. British Standards (and/or EN when the BS has been replaced) and then ASTM and AASHTO.
- Liberia ASTM and AASHTO followed by British Standards (and/or EN when the BS has been replaced).

Guidance will be given in the manuals on using the DCP for quality control of compaction and material quality on site to reduce the reliance on laboratory testing.

4.6 Hydrology and Drainage Design

4.6.1 Introduction

Water is often the cause of roadway destruction or pavement failure, whether directly or indirectly. Drainage facilities should therefore be given the same careful consideration as is required for pavement and other road elements. For the hydraulic design and analysis of drainage structures, hydrological data and/or information are primarily required for sizing the different components of these structures.

4.6.2 Existing Documentation from Other Countries

The table below lists some of the documents assembled by the team on design standards for low volume roads in relevant other countries. A review of these documents has found them to contain material that it relevant to this assignment. The Ethiopian and Tanzania LVR manuals were found to be particularly comprehensive and will serve as a primary source in preparing the LVR manuals.

Table 1: Documents Reviewed from Other Countries

S/No.	Country	Document Name
1	Ethiopia	• Part A: Introduction to LVR Design-2016 • Part B: Design of Low Volume Roads-2016 • Part C: Complementary Interventions-2016 • Part D: Construction of Low Volume Roads-2016 • Part E: Small Structures-2016 • Part G: Road Maintenance-2016 • Wereda Road Maintenance Guide 2016 • Standard Specification and Method of Measurement Labour Based Construction of Wereda Roads. Final Draft, November 2011
2	Tanzania	• TAN2031 Final Draft Manual Review July 2016 Part 1 of 3 (1) • TAN2031 Final Draft Manual Review July 2016 Part 2 of 3 • TAN2031 Final Draft Manual Review July 2016 Part 3 of 3 (4)
3	Mozambique	• Mozambique LVRs Manual Volume 1_ Planning and Design Final (2) • Work Norms Manual
4	East Timor	• Rural road rehabilitation design guide
5	Indonesia	• Technical Guidelines for low volume roads

4.6.3 Existing Documentation from Liberia

The following documents were obtained from the Ministry of Public Works (MPW):

- Feeder Roads Design Manual March 9, 2012;
- Technical Specifications for Feeder Road and Minor Bridge Works, 9 March 2012;
- Typical Design Drawings of Drainage Structures, 6 March 2012.

The Design Manual was prepared by the Ministry of Public Works (MPW) under a bilateral agreement for Institutional Capacity Building between Government of the Republic of Liberia represented by MPW and the Swedish Government represented by Sida. It provides guidance and recommendations to Engineers from government and private firms

(consultants and contractors) who are responsible for the design of rural feeder roads in Liberia. The following observations are made following a review of the manual:

- The elements of drainage structures and terminologies used are well covered;
- Design principles are mentioned but are not covered in detail;
- Guidelines to hydrological analysis are mentioned but not dealt with in detail;
- Methods of estimating flows are mentioned but the processes involved are not dealt with in the manual;
- The administrative processes (data collection and field work) involved prior to design of drainage structure are not well covered in the existing manual;
- Hydraulic analysis for estimating the sizes of drainage structures e.g. side drains and culverts are not fully covered in the existing documents;
- Erosion control measures are addressed in the existing manual;
- The section on small bridge design is quite comprehensive;
- There are some existing standard drawings which need to be updated; and
- The existing technical specifications are detailed and address most of the specifications for drainage structures.

4.6.4 Existing Documentation from Sierra Leone

The following documents were obtained from the Sierra Leone Roads Authority (SLRA). The SLRA does not have a specific design manual for low volume roads. The SLRA usually applies standards and specifications provides by donor agencies and the Liberian Feeder Roads Design Manual (March 2012). The following existing documents were collected:

- Typical drawings; and
- Technical Specifications.

Following an initial desk study on the acquired documents, the following observations are made:

- The typical drawings were developed by a COWI[14] Consortium and were limited to reinforced pipe and box culverts and stone pitched trapezoidal drains. More standard detailed drawings of drainage structures are required; and
- The technical specifications are detailed and were developed for the preparation of a rapid intervention to rehabilitate access to rural areas in Sierra Leone, which was financed by the European Development Fund (EDF).

4.6.5 Existing Documentation from Ghana

The following relevant documents were obtained from the Department of Feeder Roads:

- Ghana DFR Guidance Notes for Drainage Design on Rural Feeder Roads;
- Ghana DFR Guidance Notes for Rural Feeder Roads design;
- Ghana DFR Site Supervision Pocketbook;
- Ghana Highway Authority (GHA) Guide for Bridge Design;
- GHA Road Design Guide March 1991;
- Ghana Standard Specification for Road and Bridge Works; and
- Ghana Practitioner's guide to rural roads improvement and maintenance 2014.

[14] Danish Consulting Engineers

A desk study of the existing guidelines and manuals revealed that the documents cover most of the requirements for design of drainage structures on low volume roads:

- The design processes are well explained and simplified in the DFR guidance notes for drainage design;
- The guidance notes describe methods of determining peak flow, but do not explain the rational method which is widely used. However, the GHA Road Design Guide explains the rational method for estimating maximum discharge and the use of the Manning equation for determination of sizes of roadside ditches;
- The GHA guide for Bridge Design provides a description of the processes and steps required in designing small and major bridges;
- The Ghana Practitioner's guide to rural roads improvement and maintenance provides useful information on drainage systems and structures; and
- The Ministry of Transportation's[15] Standard Specification for Road and Bridge Works is the specification that is adopted for the construction of low volume roads and any other road works in Ghana. The specification is comprehensive and covers aspects of concrete work, formwork and reinforcing typically required for the provision of drainage structures.

4.6.6 Stakeholder Engagement

From meetings with stakeholders, the main drainage issues in **Liberia** and **Sierra Leone** were identified as:

- Rainfall and runoff data is not readily available to facilitate estimation of the peak flows to enable proper sizing of drainage structures;
- Methods of hydrological and the hydraulic analysis are not well covered in the existing documents; and
- The existing standard drawings need to be updated.

In **Ghana**, the main drainage issues are the estimation of catchment areas in flat terrains and hydrological analysis for large catchments. Also, the placement or positioning of cross-culverts in flat terrain where there is wide sheet flow of surface runoffs is an issue of concern, especially in the northern parts of the country.

4.6.7 Observations from Site Visits

The initial observations of drainage works on site were made in each of the countries and are presented below with photographs.

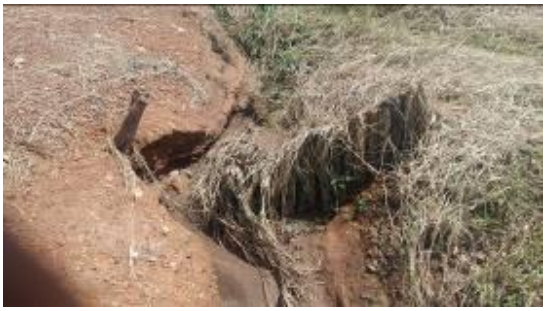
Liberia

- Well-constructed culverts with aprons;
- Inadequate depth of toe cut-off wall for apron slabs at culvert outlets;
- Inadequate scour checks on steep slopes; but
- Provision of mitre drains/turn-outs.

[15] Roads are now under the Ministry of Roads and Highways.

Well-constructed cross culvert with apron

Erosion development in side ditch along steep slope of sealed low volume road



Poorly maintained scour checks

Mitre drain/turn-out at steep slope

Figure 2: Drainage Works in Liberia

Sierra Leone

- Good Stone Pitching;
- Siltation in culverts;
    - Inadequate slope
    - Ditch – inlet connection
- Inadequate depth of toe of apron slabs at the culvert outlets;
- Poor workmanship on the construction of culvert headwalls and wingwalls;
- Clear definition of outlet channels;
- Well-constructed side ditches;
- No scour checks on steep slopes; but
- Provision of mitre drains/turn-outs.

Poorly constructed Wingwalls

Mitre Drain/Turn-out

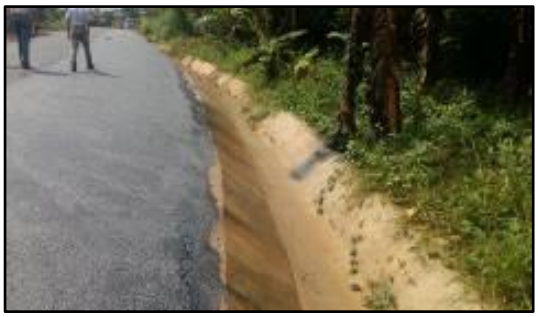
Stone Pitching of embankment slope

Figure 3: Drainage Works in Sierra Leone

Ghana

- Well-constructed roadside drains: concrete lined u-drains and trapezoidal drains and earth ditches;
- Well-constructed cross culverts and access culverts;
- Siltation in some of the drainage structures;
- Inadequate provision of turn-outs/mitre drains;
- Scour checks not well maintained; but
- Clear definition of outlet channels.

Concrete lined u-drain



Concrete lined trapezoidal drain

Poorly maintained scour check

Access culvert

Figure 4: Drainage Works in Ghana

4.7 Maintenance

4.7.1 Liberia

Most routine road maintenance for feeder roads in Liberia is currently carried out by Community Based Organisations (CBO) and funded by development partners (Sida, USAID). The recent establishment of a Road Fund should increase the proportion of maintenance funded from local sources. Documentation has been developed to support the CBO approach under the LSFRP. The maintenance system includes nine basic activities as follows:

- RM1 Inspection and Removal of Obstructions
- RM2 Desilting of Culverts and Clearing Culvert Inlets and Outlets
- RM3 Clean Side, Catch-water and Mitre Drains
- RM4 Repair Erosion on Shoulders and Drains
- RM5 Repair Scour Checks
- RM6 Grub Roadway
- RM7 Clear Structures and their Waterways

- RM8 Fill Potholes and Ruts on the Carriageway
- RM9 Cut Grass and Bush.

The existing documentation for road maintenance includes:

- "*Contract Documentation & Procedures for Labour-Based Routine Maintenance of Feeder/Rural Roads*" (Draft, May 2011; 36 pages). This document covers roles and responsibilities for road maintenance, pre-qualification of contractors, contract documents (for labour-based routine maintenance) and procedures for site supervision, monitoring and reporting. It refers the reader to three key documents: "*Maintenance Management Manual, Labour-based Public Works Project*" (MPW, ILO, ADB, October 2009), and the 2nd editions of the TRL Overseas Road Notes (ORN) "*Maintenance Management for District Engineers"* (ORN 1) and "*Maintenance Techniques for District Engineers"* (ORN 2).
- A "Field Hand Book for Technicians and Group Leaders" (2013; 12 pages). This provides a basic description of normal maintenance activities and the requirements to successfully carry them out. The document is not well illustrated, relying on text to convey the guidelines to the user.
- LSFRP "Best Practice Guideline" on Routine Maintenance. This is a 2-page leaflet providing basic field guidance on nine routine maintenance activities.

It is recommended that the Ethiopia Maintenance Manual (Part G of the LVR Manual) be customised for Liberia. This would provide significantly more detailed guidance on how to identify defects and carry out maintenance activities than the existing documents. The Ethiopia Manual describes the common defects found on rural roads and describes activities needed to address them. It includes standard specifications that can be included in maintenance contracts.

4.7.2 Sierra Leone

The National Rural Feeder Roads Policy (2011) of Sierra Leone prioritises road maintenance, which "*shall always be preferred to rehabilitation*". A Road Fund has been created to cover the maintenance costs of primary and secondary and feeder roads. The Local Government Act of 2004 devolved responsibility for the maintenance of feeder roads to the Local Councils, though the councils continue to rely on support from SLRA.

Despite the priority given to maintenance, there are no substantive national reference documents or manuals for use in its implementation. Most of the maintenance work currently carried out on feeder roads is off-carriageway (grass cutting, clearing drains and culverts) with very little attention to the running surface[16].

It is recommended that the Ethiopia Maintenance Manual be customised for Sierra Leone. This would provide a useful reference document for Local Council and SLRA maintenance engineers and the basis for developing their maintenance systems.

[16] Finding of the AfCAP-funded GEM project (Economic Growth through Effective Road Asset Management)

4.7.3 Ghana

The DFR in Ghana has a manual for "*routine and recurrent*" maintenance dated 2006. The manual provides detailed guidance on all aspects of road maintenance including planning and management responsibilities, budgeting, prioritisation, identification of defects and maintenance activities, specifications, contracting arrangements and supervision. The DFR also has a "*Road Maintenance Pocketbook*" which provides guidance to field staff on the basic requirements for rural road maintenance. Both documents were developed with support from DFID.

The Ghana "*Practitioner's Guide to Rural Roads Improvement and Maintenance*" (2014) includes a chapter on "routine and recurrent" maintenance. However, this is limited to labour intensive operations and refers entirely to the DFR manual (2006), with the DFR specifications for routine maintenance reproduced in one of the annexes.

The GHA has a "*Road Maintenance Operations Manual*" (2003; 57 pages) which facilitated the transition from force account maintenance to commercialised operations in the early 2000s.

At the Ghana wrap-up meeting on 20th July, it was agreed that Ghana does not need another manual for the maintenance of rural roads.

4.8 Specifications and Standard Drawings

4.8.1 Liberia and Sierra Leone

There is no Standard Specification for roads in Liberia or Sierra Leone. Each project adopts its own specification. The development of a Standard Specification for all roads for Liberia and Sierra Leone would involve addressing fundamental issues such as imperial versus metric systems (in Liberia) and decisions on standard test methods. This is beyond the scope of the current assignment. Three contributions are proposed:

- The Ethiopia Standard Specification for Labour-Based Road Works (2011) will be customised and made available to both countries. However it does not deal with sealed roads;
- Specifications will be provided in the manual for key aspects of the provision of low volume sealed roads, such as specifications for pavement materials, which can be incorporated in Project Specifications as required; and
- References will be provided in the manual to appropriate sources of standard specifications for work items such as gravel wearing courses and surfacing seals. The most likely reference is the Ghana Standard Specification for Roads and Bridges (2007).

4.8.2 Ghana

Ghana has a Standard Specification for Roads and Bridges (2007) which was prepared with input from South Africa's Council for Scientific and Industrial Research (CSIR). It is a comprehensive document (455 pages) covering all standard construction works activities on roads. The Ministry of Transport, GHA, DFR and DUR, as well as several private consultants, are acknowledged as participating in its development. The Specification "*defines the*

standard and quality of materials and workmanship to be used in the construction of roads and bridges in the Republic of Ghana". It is applicable for trunk, urban and feeder roads administered by the Ministry and its Agencies, namely: Ghana Highway Authority, Department of Urban Roads, and Department of Feeder Roads".[17] It includes specifications for gravel wearing course (based on TRH 20[18]) and base course for low volume sealed roads (G60 and G45 material).

The introduction of the DCP/DN pavement design method for LVSRs through the new Ghana LVR manual may introduce some new specifications that are missing from the Standard Spec. However, it is not recommended that the document should be updated under this project. Any new specifications will be presented in the LVR manual in such a form that they can be utilised on projects as part of a Special (Project) Specification.

4.8.3 Standard Drawings

Standard drawings for rural roads exist in all three countries and are found in various documents. Some are drawings and details developed for specific projects and adopted as standard for other projects. They include standard cross-sections and details of drainage structures. It is expected that there will be a need for some new drawings and minor modifications to some existing drawings, including the standard cross-sections.

[17] Scope of document, page 1-3.

[18] Technical Recommendations for Highways.

5 Work Plan and Deliverables

5.1 Inputs

The updated indicative work plan and time inputs by each member of the consulting team are shown in Figure 5. This is an updated version of the work plan submitted with the CDS Technical Proposal. It reflects the increase in the overall completion period to 18 months.

5.2 Deliverables

The following are the project deliverables.

- Inception Report (this report)
- 1st Workshop reports
- 1st Progress report
- 2nd Workshop reports
- Draft Final Manuals, specification and drawings
- Peer review report
- Final print- ready manuals
- 3rd Workshop Reports
- Final Project Report.

5.3 Key Milestones

The next milestone in the implementation of the project is the 1st workshop in each country. The purpose of the 1st workshops is to "Validate and confirm the shortcomings of current rural roads design practices identified from the literature review, stakeholder consultations and from site investigations in each country"[19]. A one-day workshop is envisaged in each country. The dates set for the 1st workshop are:

- Ghana: 19th September 2017
- Liberia: 21st September 2017
- Sierra Leone: 26th September 2017.

The 2nd workshops (2-day) will be held in February 2018. This will be followed by independent peer review of the draft manuals. The workshops and peer review process have the following important functions:

- Ensure that local stakeholders are fully aware of the project, its objectives and scope, and the technical proposals being made by the project team;
- Facilitate feedback to the project team from stakeholders and local practitioners;
- Ensure quality control of all project outputs;
- Build links between key stakeholders in the countries as a means of establishing a sense of ownership in the new manual.

The final documents in MS Word format are expected to be complete by June 2018, with the final DTP versions ready for launching by the end of 2018.

[19] Terms of Reference.

Activity	Jun-17	Jul-17	Aug-17	Sep-17	Oct-17	Nov-17	Dec-17	Jan-18	Feb-18	Mar-18	Apr-18	May-18	Activities after May 2018
Task 1: Desk study of existing LVR manuals + Local Manuals													
Task 2: Stakeholder consultations													
Task 3: Site visits to existing LVR projects													
Task 4: Develop Evaluation Framework													
Task 5: 1st Stakeholder Workshop													
Task 6: Verify Topics for Inclusion in new manuals													
Task 7: 2nd Stakeholder Workshop													
Task 8a: Produce manuals (MS Word)													
Task 8b: Produce manuals (DTP)													By November 2018
Task 10: Conduct peer review													
Task 11: 3rd Stakeholder Workshop and Launch of Manuals													December 2018
Task 12: Final Project Report													December 2018
Other reports (submission of first draft):													
Inception Report			X										
Workshop Reports					X					X			17th December (3rd w/shop)
Progress Reports					X								
Peer review report											X		

Figure 5: Work Plan

Annex A. Meetings and Field Visits held in Liberia

KICK-OFF MEETING WITH ASSISTANT MINISTER HARRIS

Monday 3rd July 2017, 9 am

Present: Assistant Minister Harris, Margaret Sarsih (Assistant Minister Planning and Programming), Eng. Alibaba Kpakolo (Head of Feeder Roads), Paulina Agyekum (AfCAP PMU).

- The manuals project is the first AfCAP funded project in Liberia. It follows the scoping study and signing of an MOU between AfCAP and Liberia.
- Feeder roads come under the Department of Rural Development in the MPW, which also includes water and sanitation.
- The third phase of the Liberia Swedish FRP (LSFRP) is expected to start after the October elections.
- The MPW has an existing manual through the LSFRP but it is missing some information such as embankment construction, drainage, culvert design, materials testing.
- GIZ has prepared a geometric design manual for primary and secondary roads.
- There is no rainfall data available and no drainage design manual.
- One drift was built under the LSFRP.
- USAID is funding a FR project in 4 counties known as FRAMP. It includes trials of alternative surfacings.
- There is a "resident engineer" employed by the local government in each county, and there is supposed to be a Feeder Road Engineer in each county. However, there is only one such FR Engineer, in Nimba. Capacity building is being carried out in the counties for FR management.
- There are no consultants employed on FR projects, except through Cardno on FRAMP.
- There are three types of rural road in Liberia: primary, secondary, feeder.
- A Roads Authority is being established by the government under a GOPA[20] project. The MPW will continue to be responsible for standards.
- The Road Fund started operating at the start of July 2017.
- Donor partners include SIDA, USAID, German Agro-Action (WHH).
- There are three universities producing engineering graduates to BSc level.
- An EU consultant prepared a list of laboratory equipment for MPW. USAID is now procuring equipment. Chinese have provided equipment from site laboratories but it is not calibrated. There is no DCP in the lab.

[20] German Consultants

MEETING WITH USAID FRAMP CARDNO TEAM

Monday 3rd July 2017, 11am

Present were Frederick Were Higenyi (Team Leader) and Jackson Kirungi (Deputy Team Leader)

- FRAMP is a follow up to ESRR- Emergency Services for Rural Roads.
- FRAMP started in in March 2016 and is due to continue until March 2020.
- Four counties are participating- Bong, Lofa, Nimba, Granbasa.
- The programme is supposed to be decentralised to county level but is still operating from the centre. Capacity is being built in the counties to take on maintenance of rural roads. This includes training of contractors.
- Component 1: 450 km of roads will be rehabilitated. Cardno procures the local contractors (as sub-contractors) and supervises the works through a local consultant. Only one local consultant (Alliance Consulting Engineers) responded to the invitation to tender. The project has developed its own design manual based on the LSFRP documents. The earlier version of the LSFRP manual was better than the final version, which was condensed. There are no Liberian quality testing procedures or test methods for materials. Training is needed and equipment calibration in the laboratory.
- Component 2: Piloting routine maintenance. 40 CBOs have been registered. The Road Fund intends to use CBOs for maintenance across Liberia.
- Component 3: Research on alternative seals. There is a demonstration section of 1.8 km under construction with SSD, SSD + sand seal, Otta seal (single/double and natural gravel/crushed stone), hand packed stone, concrete strips. Traffic is very low. Charles Overby is the consultant. He will prepare design manual for the three preferred options.
- EU project is planning to construct 1.2 km demonstration of seals.
- MCC is planning to support the materials laboratory, as are USAID and EU. The FRAMP team are trying to coordinate this.
- There is no bridge design manual in Liberia.

MEETING AT COLLEGE OF ENGINEERING, UNIVERSITY OF LIBERIA (UL)

Monday 3rd July 2017, 2pm

John Boimah (JB), Chair – Department of Civil Engineering, University of Liberia (+231 775 916 583, kpeheboimah@gmail.com)

Education of Civil Engineers

- Dept. of Civil Engineering at UL is the largest of 3 No BSc Civil Engineering courses in Liberia. The others are Stella Maris Polytechnic, and the College of Engineering and Technology at Tubman University (in Maryland County).
- JB estimated that of the 90 UL civil engineering graduates over the past 3 years only about 10% are working as civil engineers, because a lack of job opportunities.
- There are no post graduate Civil Engineering courses in Liberia;
- Curriculum was developed with support from (USAID-supported Education NGO) RTI International.

Professional Development

- Attempts to get an "Engineering Act" passed (that would restrict/regulate the use of the term Engineer and define professional standards) failed;
- The Engineers' Society feels its efforts "*are being thwarted*";
- There is a Guest Lecturer scheme. e.g. speakers from the Engineering Society;
- The "*High Technology Entrepreneurship*" scheme aims to facilitate interaction with professionals.
- Reference to various "*excellence*" programmes in evidence, including some seemingly supported by USAID

Standards in road construction

- Government is in principle in favour of having clear standards;
- Only Ministry of Public Works ("*and the Road Authority*") can enforce standards. No need for a further legal mandate;
- Course currently follows AASHTO [American Association of State Highway and Transportation Officials] / ASTM [standards organisation] standards;
- Key course reference book for Highway Engineering is Garber & Hoel's "*Traffic and Highway Engineering*";
- "*No axle load limits*" are either set or applied in Liberia;
- Combination of metric and imperial units used.

Soils testing

- USAID is supplying all three Civil Engineering departments with soils testing equipment;
- Some equipment lab is metric (Chinese) some imperial (USA);
- John would like to conduct a 3-year research programme into Liberian soils and how properties contribute to/explain road defects. But needs funding;
- University lab can have a "*fee for service*" function;

Miscellaneous

- Dr. Ophelia Weeks recently appointed president of UL. Daughter of Rocheforte Weeks, the first Liberian president of UL;
- UL motto *Lux ex Tenebris*;

- UL is a natural repository of civil engineering expertise. Experts in specific fields may be simultaneously a UL lecturer and a private consultant.

MEETING WITH N HUN-BU TULAY, PRESIDENT OF THE ENGINEERING SOCIETY OF LIBERIA

4th July 2017, 8:30 am

- Liberia Vision 2030 expects Liberia to become a middle-income country by 2030. What are the infrastructural needs to achieve this vision?
- Currently there is one operating railway line from Yekepa to Buchanan Port, operated by AML (iron mine).
- Civil engineers in Liberia are mostly American focussed and trained using American standards.
- There is development towards more regional cooperation under the banner of the Economic Community of West African States (ECOWAS).
- Currently all road designs and road works are to be approved by MPW.
- Reference was made to the Swedish Feeder Road Manual.
- Mention was made that there is no Liberian Drainage Manual, there are no rainfall data and river flood levels are not measured. Spending money on this type of data collection work is not seen to result in physical progress and therefore is not popular among politicians. Government wants to "*build*" and "*show progress*". Research and training does not result in immediate visible progress.
- Names of a few local experts were mentioned. Most are teaching at universities. There are very few private practitioners. The system does not promote consulting firms. Salaries are not attractive, it is not a popular "*trade*". Due to the situation in the country (donor funding, foreign companies) there are no Liberian specialists operating in civil engineering areas. Everything government does in roads is design and build, which hampers involvement of local firms in design and supervision.
- Liberia has very few laboratory testing facilities. A laboratory is now being set up at UL. Previously samples needed to be sent to Ghana for testing.
- The Society has about 125-150 active members and another 60% of that who are not active.
- The Public Utility Authority (PUA) was mandated to license engineers. MPW (under PUA) has now delegated this to the Engineering Society of Liberia (ESOL).
- ESOL. They will screen and license and are in the process of issuing license numbers engineers.
- ESOL has secretariat office at MPW.
- A Road Authority is being established under GIZ programme.
- Contractor Grading: Cat C requires one Liberian Engineer on staff.

MEETING WITH THE ACTING PRESIDENT OF THE ASSOCIATION OF LIBERIAN CONSTRUCTION CONTRACTORS (ALCC)

July 4, 2017 at 1:15pm

The Team was received by the Acting President of the Association, Mr. Sackie Johnson who was later joined by Mr. James Smith, Head of the Technical Committee of ALCC.

About ALCC

The ALCC was established in 1979 by a few Construction Contractors with two main Liberian Road Contractors namely Mensah Construction Company and Engineering Construction Services (ECS).
The ALCC currently has a membership of about 30 Contractors who are classified into 2 Classes: Class A – Roads Works and Class B – Building Works. The categories of roads under Class A are: Primary Roads, Secondary Roads and Feeder Roads.
The Ministry of Public Works is responsible for classifying Contractors into the different classes and uses the Contractor Classification and Certification System (CCCS).

Existing Manuals

- There is an existing Feeder Road Design Manual which was recently developed by Swedish International Development Agency (Sida) under Swedish Government Support. However, the general view among industry players is that the manual is not comprehensive enough and has gaps which need to be filled.
- The Acting President informed the Team that Mr. Saisay, a former Chief Engineer at the Ministry of Public Works also developed a standard for design of box culverts and bridges.
- There are no existing design manuals for primary and secondary roads for Liberia currently so design standards are largely dependent on the implementing agency.

Challenges

The Team's engagement with the ALCC revealed the following challenges that members of the association face:

Lack of Road Maintenance Manual.

The existing Road Maintenance Manual Vol. 1-4 is intended for training purposes but is not available to practising Contractors.
The Road Maintenance Training Center (RMTC) a centre for training technicians in road maintenance works used to have some manuals but the centre has been run down during the civil war and is currently not functioning. The manuals are nowhere to be found. The ALCC has approached MCC for needed support to revive the RMTC facility but had not received any favourable response.

Technical Documentation:

Contractors depend on the Ministry of Public Works for technical documents for their works. However, these documents are not presently available at the Ministry. Again, some of the technical specifications provided by the Ministry of Public Works for project works are not applicable to the specific works. It emerged that there exist some generic specifications from which special specifications are developed for specific works.

Lack of Capacity (Skilled Personnel and Equipment):

This is a huge setback for Local Contractors. There are few equipment hiring companies and individuals in the country. Also, qualified personnel with required skills are not readily available. The only training centre i.e. RMTC which was responsible for training technicians is currently not functioning. Personnel are thus usually trained on the job to acquire the needed skills.

Inclement Weather:

The long rainy period in Liberia i.e. May – October (7 months) is a problem that affects the performance of Local Contractors. It is therefore very important to properly plan the commencement date of road construction works.

Works Procurement challenges:

There is reportedly a lack of transparency and fairness in the procurement process and trust in the Client. The process is usually seen as been steered to favour preferred bidders.

Project Failures:

The following were identified as some of the major causes of failure of road construction works from the discussions held with the ALCC:

i. Under-scoping of the project works by the Ministry of Public works during preparation of the construction works bid documentation.
ii. Under-pricing during the bidding process, resulting from (i) above, incompetence of the contractor or as strategy to win the bid.
iii. Lack of skilled personnel to undertake the work.
iv. Delays in the payment process.
v. Inclement weather, (prolonged and excessive rains)

Construction Materials

- There are two installed asphalt plants owned by Liberian companies namely: MDMC and West Wood. Most of the asphalt works are carried out by Chinese firms and SSF, a Lebanese construction firm based in Liberia.
- Aggregates are available internally. The existing crushing plants in the country are mainly owned and operated by foreign firms.
- There is only one established cement factory in the country. There are however lots of cement importers importing cement into the country.
- Lime is imported by local vendors.
- Most of the soils in Liberia are lateritic with about 50% gravel.

PRESENTATION BY "DCP AMBASSADORS" AT MPW

4TH July 2017 15:30pm

Chris Blamo and Dave Lormie attended the recent AfCAP DCP Training of Trainers (ToT) course in Ghana. They were sharing their knowledge of the DN pavement design method with their colleagues as part of a one-week internal workshop on feeder roads.

- A DCP device will be borrowed from FRAMP for a practical demonstration.
- Chris and Dave did not receive instruction in Ghana on DN gravel road design.
- They did receive training on the use of the DCP for site quality control.
- The LSFRP manual lacks information on materials testing, hydrology, quality control process. 7% camber specified in the manual was considered too steep and 4.5m to 6m road width too narrow.

SITE VISIT (WEDNESDAY 5 JULY 2017) TO BONG COUNTY

The team R Geddes, H Goldie-Scot, L-J Ebels, R Isaac, and F Odametey departed from the Cape Hotel in Monrovia at 07:30 for a site visit of Feeder Roads in Bong County, 250km north east of Monrovia. En route they collected J Quansah, the Liberia Local Engineer and the following Ministry of Public Works officials: Eng Alibaba Kpakolo – (Chief Construction Engineer) and Eng Peter Brook – (Chief Maintenance Engineer).

At Totota, approximately 150km from Monrovia, on the Monrovia – Gbarnga road, the team exited the main road and headed in a north westerly direction, which was the start of the

feeder road between Totota and Piata, a total distance of 57 km. This road was constructed in 3 sections (A, B, and C) under the Sida Roads Upgrading Program, between October 2010 and July 2012. It is classified as a 'secondary road' which provides access to other 'feeder roads' in Bong County. Maintenance of this road was now under the jurisdiction of FRAMP The visit ended at the 3 x 10m span Mehn River Bridge approximately 6 km from Piata.

The team made its way to the main road between Totota and Gbarnga, where there was first-hand experience of Liberian torrential rain. Once back on the main road the team travelled in a northerly direction to Gbarnga, to the Bong County offices of the Ministry of Public Works where they met Engineer Sylvester. After a brief explanation of what was being carried out in Bong County, the team visited a nearby road which was being prepared for surfacing, and then onto the Palala - Dta Road, just north of Gbarnga, where ALVRS Trials (Alternative Low Volume Road Surfacing) were being carried out. These trials included Otta Seal, Hand Packed Stone, Surface Dressing, and Concrete Strips.

After inspection of the trials this concluded the site visit and the team made its way back to Gbarnga where they spent the night before returning to Monrovia on Thursday 6th July.

MEETING WITH EVA OHLSSON AT SWEDISH EMBASSY

Thursday 6th July, 15:00pm

Main points of discussion included:

- Liberia is decentralising authority to county level. The next phase of the LSFRP will support his policy.
- Sweden will only fund any further road infrastructure investment if there will be 100% maintenance of the road guaranteed from the start.
- Next phase of feeder roads (LSFRP III) will include about 600 km feeder road rehabilitation.
- The use of gravel wearing course, is this still sustainable? Material is lost very quickly.
- Ulf Bruderfors is the monitoring consultant on the LSFRP.
- Liberia is a war-torn country, which is still recovering from trauma. There is lack of capacity and lack of trust. This is a complicating factor and should not be under-estimated.
- Climate change may have an effect. Rainfall patterns will be different. The impact or effect of climate change needs to be considered in road designs and specifications.
- The Swedish funded project will not include research, other donors (e.g. DFID) will do this. There is, however, some money for studies, for example:
    - How are the roads effecting the lives of women, children?
    - How many clinics, schools, markets, farm areas are affected by the roads.
- Nimba was mentioned as a successful county and an example of having taken ownership for road maintenance. It has a fleet of road maintenance equipment.
- There are 7 or 8 contractors that have been trained previously on Phase I and II of the LSFRP. They need to be developed further.
- Contractors are procured through National Competitive Bidding. An evaluation of LSFRP2 is available. Improved harmonisation is needed with the CCCS.

- There was concern that the AfCAP project might result in two manuals for Liberia (AfCAP and Sida). The CDS team stressed that the AfCAP manual would build on existing manuals, including the SIDA manual.
- Consultancy Services for the Project Management of the LSFRP Phase 3: A call for EOIs, closes on 8th August 2017. Sida procurement guidelines are being followed.

TECHNICAL MEETING WITH THOMAS TEN BOER, ASSISTANT MINISTER HARRIS AND ENG ALIBABA

Friday 7th July 2017, 12 noon

The purpose of the meeting was to discuss technical issues for rural roads in Liberia.

Mr ten Boer is Country Director for Welt Hunger Hilfe (WHH), a German NGO. It is constructing feeder roads (rehabilitation and spot improvements) in eastern Liberia (which can be a two-day drive from Monrovia in wet weather).

- There are different organisations engaged in works on feeder roads, e.g. MPW, Ministry of Agriculture, NGOs. All projects should come under MPW. Coordination should improve with the new road planning database being prepared by a World Bank consultant (Cardno). There will be a workshop on road classification in the week starting 10th July.
- The problem of controlling erosion on steep slopes was discussed. Where possible road alignments should be improved to avoid steep slopes. Some existing alignments were developed by logging companies and only meant for use in dry weather. The manual should set limits on gradients. Trucks are often overloaded and under-powered. Eng Alibaba stated that the solution to erosion was better maintenance.
- Trials using ConAid were carried out last year in Monrovia and were largely successful. EPA clearance is needed for use of chemical stabilisers to ensure no danger of water contamination and dust.
- There are large areas with soft clay subgrades in the south-east. WHH has its own materials testing equipment and there is a Chinese project laboratory for the Harper-Fish Town road improvement project.
- Local engineers tend to be "*under skilled*". WHH is employing university graduates as interns to provide them with experience. They provide accommodation and training but no salary.
- WHH overdesign drainage crossing structures to ensure they can support overloaded trucks.
- The MPW has sent engineers to the counties under the decentralisation policy. Where these engineers work on donor projects they receive allowances. In addition, the counties employ their own engineers, but they are not exclusively responsible for roads. (*NOTE: There were different views from informants on how many counties actually have engineers in place, and how many MPW engineers are based in the countries*).
- The engineer responsible for the WHH project is Olav Bock, who should be invited to the workshops.
- A list of the possible topics/chapters was given to Eng Alibaba for his comments.

NOTES OF MEETING AT MINISTRY OF PUBLIC WORKS

Friday 7th July 2017, 1 pm

Meeting with Hon. William Gyude Moore, Minister of Public Works

Minister's Expectations

The manual should help Liberia address the major challenges it is facing in terms of:

- 2.3 million people lacking access to all-weather roads;
- Haul distances increasing in some areas as a result of depletion of readily-available laterite; and
- The need to achieve value for money in the very major investments that will be made in roads.

Road standards

RG stated that the starting point would be current manuals including the Sida feeder road manual, with the scope focussed on traffic, so including low volume secondary roads. The Minister welcomed this, commenting that some secondary roads are more important than primary roads.

Road technology

The Minister stressed the need to have confidence about the range of technical options available, referring to:

- USAID (Charles Overby) helping Liberia consider alternative surfacing; and
- "Probase" (from Malaysia) claiming to have experience of stabilising 6000 km of roads since 1997.

The meeting discussed "*Probase*", "*Conaid*" lignosulphanate oil, and related approaches to stabilisation:

- WAM team has some experience; these chemicals can work but reportedly require good quality management;
- Agreed that it is worth taking such idea forward in a considered manner, drawing on the views of experts such as Dave Jones at University of California.

Capacity constraints affecting the sector

The Minister expressed concern about the lack of civil engineering capacity at the local level. Efforts are being made to encourage mentoring/internship. It is mandatory on projects over US$ 200k for companies to take on 2 Engineering students.

Procurement practices

The Minister referred to the Road Act and the Public Procurement and Concessions Commission (PPCC) is seeking to professionalise Public Procurement, including for roads.

- Costs are increasingly being disclosed proactively;
- Freedom of Information mandates reactive disclosure;

HGS commented that this suggests that Liberia may already be close to meeting the requirements of the international CoST initiative for transparency in the procurement of public infrastructure. Minister commented that Chinese companies win most contracts and referred to 23 companies having bid for a recent road contract financed with Arab funds. Some implications were discussed, including;

- The client ultimately paying (albeit indirectly) for the cost of all bids;
- Contractors not investing in preparing thoroughly; and

- Winning contractor being taken by surprise.

WRAP-UP MEETING WITH ASSSITANT MINISTER HARRIS

Friday 7th July 2017, 14:00pm

The purpose of the meeting was to summarise the progress made and the next steps.

- A list of possible topics/chapters has been prepared and was left with Assist Minister Harris. Then list will be discussed at the first workshops. Meanwhile all comments are welcome.
- The 21st September 2017 was identified as the date for the first workshop.
- The workshop can be held in the Ministry Conference Room but an outside venue is preferred. If the workshop is held at MPW a caterer can be arranged to provide tea/coffee and lunch. A computer projector is available but if a flip chart is required it should be purchased.
- MPW is expecting AfCAP/CDS to pay any costs for the workshop. RG to check the ToRs. (The Terms of Reference state that the Liberia Government will be responsible for all workshop costs).
- CDS will propose a list of participants. The invitations should come from the MPW. It is expected that about 30 people will attend.

Annex B. Meetings and Field Visits held in Sierra Leone

KICK-OFF MEETING WITH SIERRA LEONE ROADS AUTHORITY (SLRA)

Monday 10th July 2017, 11:00am at the SLRA's Conference Room.

The meeting was chaired by Deputy Director General (DDG) of SLRA, Dr. Sahr Ernest Gbembo.
The meeting was moderated by Director of Administration of SLRA Mr. Hassan A. Turay.

Chief Engineer (Feeder Roads), Tamba Amara, explained the purpose of the meeting and Team's presence in SL. The Moderator introduced himself, the DDG and gave apologies for the Director General who was in another meeting with the Islamic Development Bank (IDB).

The DDG formerly welcomed the team and said:

- SLRA welcome the idea of developing a Design Manual for Low Volume Rural Roads (LVRR).
- SLRA is committed to the success of the project hence the attachment of a Chief Engineer.
- SLRA will make all needed information available and give necessary assistance to enhance teams work.
- The rains are major cause of roads deterioration in the country.
- Soil type varies across the country.

Team Leader of CDS gave a brief description of the project assignment and made it clear that the team is going to build on existing design manuals, guidelines and specifications.

- The assignment is to review existing design guidelines and specifications and develop a more comprehensive Design Manual for LVRR.
- The assignment does not involve any research work.
- Initial draft of the contents of the manual will be shared with stakeholders at a wrap-up meeting scheduled for Friday, July 14, 2017 at SLRA Conference Room.
- There will be 1st Workshop in the third week of September 2017 to discuss the contents and scope of the Design Manual.
- There will be 2nd Workshop in the February 2017 to discuss the technical issues of the 1st draft of the Design Manual.
- The final draft of the Design Manual will be produced later part of next year, 2018.
- Peer review of the Design Manual.
- Media Publication and Launching of the approved Design Manual.

The DDG requested CDS to consider including a staff of SLRA in the team of Peer Reviewers of the Design Manual.
The Chief Engineer (Feeder Roads) gave a brief report on CDS Team's programme for the week and requested the Director of Administration to help facilitate the meetings with the various stakeholders.

MEETING WITH SL ROAD SAFETY AUTHORITY
Monday 10 July 2017, 14:00pm

- Dr Sarah Bendu - Executive Director of the Sierra Leone Road Safety Authority and colleagues.
- SLRSA is a parastatal under Ministry of Transport. It is a small agency with limited strength.
- Dr Bendu is involved in the AFCAP steering committee, so she has some background to this ReCAP initiative.

What should be in the manual from a road safety point of view?

- Make provision for pedestrian facilities, e.g. footpaths, surfaced shoulders.
- Speed limit is 80 km/h on the main roads. 20 km/h suggested in built up areas and villages (or maybe 40 km/h)
- SLRSA has Highway Codes: copies are available.
- Road signage is important.
- Education campaigns in kinder garden schools.
- Road Safety Ambassadors.
- SLRA has over the years developed "standards" for rumble strips and speed humps. These could be included in the manual. Also need a road traffic warning sign for these.
- Foot path on one side of bridges and structures if length of structure is >6m. Currently this is not the case, but it is one of the features that they would like to include.
- Education / sensitising re road safety is important, also for adults and chiefs.
- "Problem" of increasing traffic volumes attracted as a result of upgraded roads. Local residents that are not used to higher traffic volumes need to be sensitised about this.
- Accuracy of traffic accident reports needs to improve, difficult to get reliable data.
- Road signs fall under SLRA.

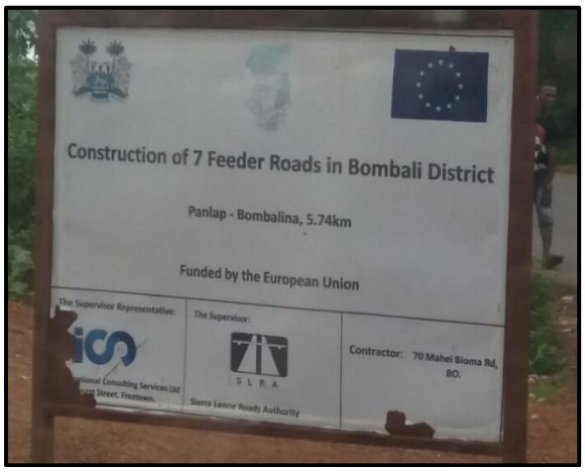
Mandate of the SLRSA is to regulate, coordinate and promote road safety. The Ministry of Transport is also responsible for vehicle licensing and overload control, but the overload unit is weak.

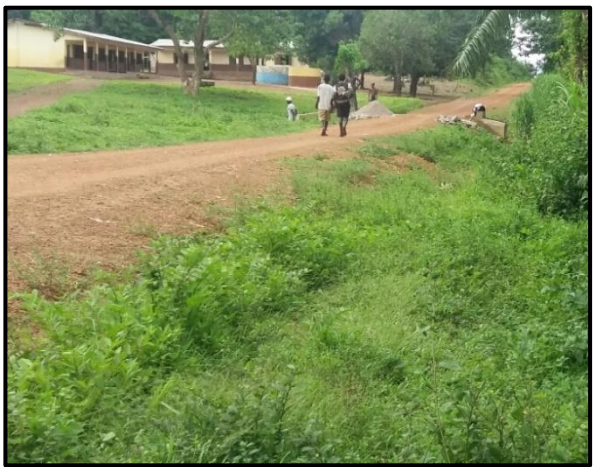
FIELD VISIT TO MAKENI AREA IN SIERRA LEONE

Tuesday 11 July 2017

The manuals team, together with the Deputy Chief Engineer (Feeder Roads) Samuel Macauley departed from Freetown at 07:30 for the Makeni, approximately 250km east of Freetown. On route, after climbing through the hills of Freetown, they met SLRA Chief Engineer Feeder Roads - Tamba Amara, and travelled via Masiaka and Lunsar, arriving in Makeni at 11am.

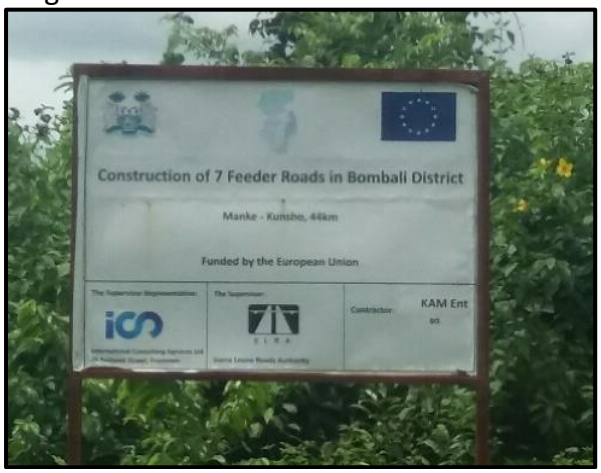
From Makeni the team made its way to the start of the first of seven feeder roads in the Bombali District, a road between Panlap and Bombalina, a total length of 5.7km.

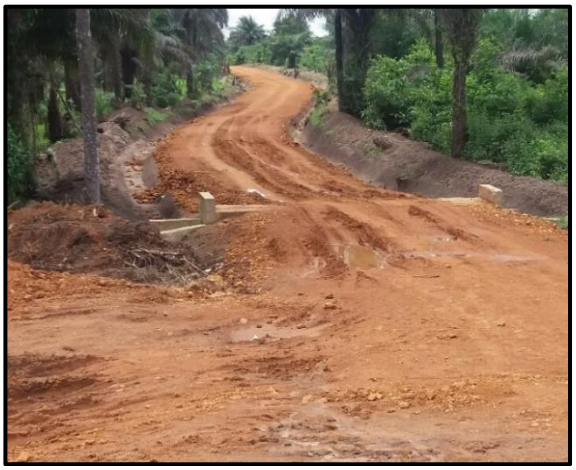




This road was complete apart from some stone protection work at the drainage culverts, which was being carried out during the visit. Pedestrian slabs were also being cast and installed across the side drains in places, providing access to homesteads. One of the gravel pits used for this road was visited, and discussed, in order to understand the permissions required for the opening and closure / rehabilitation of these areas. Generally, this road was in a reasonable condition with a good quality gravel wearing course. It was however felt that the camber could have been slightly steeper.

The second road visited in the Bombali District was the Manke -Kunsho Road, 4.4km in length.





This road was far from complete. Due to slow progress and imminent onset of the rains, the contractor has chosen to dump and spread the gravel wearing course in order to ensure that the road remains trafficable. One of the gravel sources used for this road was also visited. There were many problems with this road which included the following:

- The material from the side drains had not been used for the shaping of the road formation,
- The gravel wearing course used was of questionable quality with a great deal of oversized material,
- The drainage culverts were constructed higher than they should have been, and
- The choice of culvert size and positioning of the culverts was questionable.

This concluded our site visit and the team made its way back to Makeni, where they had lunch, before proceeding to Freetown, arriving just before 6pm.

MEETING WITH SCADeP PROJECT MANAGEMENT UNIT
Wednesday 12th July 2017, 11 am

SCADeP - Smallholder Commercialization and Agribusiness Development Project

Overview of SCADeP
SCADeP's interventions are aimed at improving agricultural productivity and access to markets for small holders. Linking outgrowers to markets, hence importance of the feeder road component. Three elements:

- OPRC. Contractor to construct and maintain at defined service levels for 5 years
- Procurement of small cross drainage structures. Typically includes 2 - 5 culverts/km
- Procurement of 200 km (perhaps up to 500 km if funding available) of Feeder Roads, with associated maintenance through community contracts with trained CBOs.

Comments from TA Jackson

- No standard spec for any roads in SL. In practice follow what the consultant proposes, though SLRA may review and adjust if not acceptable. SCADeP will use World Bank (WB) specs
- Diminishing access to gravel. Will look at alternative surfacing options within the 500 km
- Will include studies of how to generate revenue (for maintenance) from other sources
- Aim to strengthen District Councils' capacity to develop and implement maintenance plans.

Timing

- OPRC late 2018/early 2019
- Spot Improvements early 2018
- Roads and CBO maintenance early 2018

Relationship with Districts

- Policy is to hand over to Districts for maintenance, but this does not entail any associated control, so designated funds may be used for other purposes
- SLRA does not currently monitor related DC activities, as it is not responsible.

Technology

- Typical approach labour-based, light equipment supported, building on many years of ILO inputs and related training dating back to the 1970s.
- More equipment typically used for re-gravelling
- Discussed likelihood that technology used could not be specified for the OPRC component
- Discussed need for whole life costing to determine optimum surfacing technology.

Environmental

- Manual will include some coverage of environmental considerations

- Discussed fact that good engineering practice is normally consistent with good engineering and social practice eg balancing cut and fill, minimising erosion risks etc.

Capacity Building

- To be effective and sustainable cannot be limited to training, or TA. Need to consider
  - Resources (human, financial and material);
  - Defined methods for deploying/using those resources; and
  - Skills and experience through practical training in following those procedures
- Discussed importance of seeing implementation as part of procurement, so that lessons can be learned and better practices introduced.

MEETING AT THE EUROPEAN UNION DELEGATION OFFICES
12th July 2017, 14:30pm

Meeting with Michael Priddy, European Union Programme Officer, Infrastructure Sector.

- The EU has an 11-million euro earmarked for roads under an 11th EDF agriculture programme. The identification and formulation process has not yet started. The current project on feeder roads (EU AWARE) is a response to Ebola.
- The previous EDF project (9th EDF), completed a few years ago, was not very successful. The project did not achieve much value for the investment. Only structures remain in place.
- The environment in Sierra Leone is aggressive, which should be taken into consideration with the design manuals, looking at alternative methods to counteract the aggressive environment. At times, the quality of construction is sub-standard. A "*proper*" manual for feeder roads would help. At present there are no standards, for example for the colour of road markings and speed limits. The AWARE project is trying to set a benchmark for quality.
- The EU provides support to SLRA staff development, but is not providing support to contactors. The EU has confidence in local consultants but they are few in number. Design standards, supervision, and contractor capacity all needed strengthening in the future.
- The SL Feeder Roads Policy is an important foundation for the manual.
- The EU is the chair of the road sector donor group but co-ordination between donors is weak.

MEETING WITH ING. ALPHA LAVALIE, ICS CONSULTING ENGINEERS
Thursday 13th July, 8am

ICS (International Consulting Services) is a leading local consulting firm. They act as local associates for international firms including Crown Agents and Roughton and are supervising

the EU AWARE feeder road project. The discussion focussed on observations from the Tuesday site visit.

- Design standards and specifications vary from project to project. There are no fixed standards for SL. This is problematic for contractors as they must continually change their way of working. It would be better if all projects could work to the same standards.
- Prior to the current EU project there was no testing of materials for feeder roads construction. This includes testing of borrow materials and field density measurements. Specifications for the project were developed based on existing SLRA specifications.
- The same gravel wearing course spec is applied irrespective of the type of material (PI < 20, CBR > 30).
- Field density measurements are made using the sand replacement test. Local contractors can't afford a nuclear device. The testing on the EU project is being carried out at a contractor laboratory (Salini) in Makeni. The alternative is to send the samples to the SLRA laboratory in Freetown. (*Comment - projects could consider use of DCP for quality control on site, reducing reliance on laboratory testing*).
- The specs for the EU project does not allow for payment of overhaul. (*Comment- In the absence of comprehensive materials investigations at the design phase this results either in high additional risk for the contractor or compromise in the materials quality in order to use materials from near the road*).
- Culvert design is based on a standard drawing from Roughton International[21]. It was noted that the wing walls seen on site were different from those shown on the drawing. This indicates that site personnel may not be able to read drawings. Training is needed for site staff of both the contractor and supervisor. The first culvert should be built to the correct design and quality of construction before proceeding with the works. Some contractors sub-contract the culvert works to other local firms, which increases the risk of low quality work.
- Very few mitre drains were seen on site. The contractor prefers to install these after construction of the side drains and formation, and is unresponsive to frequent reminders by the supervision of their importance.
- There is a major shortage of technical staff for site supervision. The "*good*" engineers consider work on feeder roads to be less attractive that work on asphalt surfaced roads. On large projects, the supervisor is provided with site accommodation, vehicle etc. The EU project does not include sufficient resources for supervision. (*Note- the cost of supervision was given as 19% of the contract value, which is high*).
- Ing Lavalie recommends single bituminous seals rather than gravel roads, which have a short life.
- There is no association of consulting engineers in SL.

WRAP UP MEETING AT SLRA

[21] UK Consulting Engineers

Friday, 14th July 2017 at 10:15am at the SLRA's Conference Room.

The meeting was chaired by Deputy Director General (DDG) of SLRA, Dr. Sahr Ernest Gbembo and moderated by Deputy Director of Administration (DDA) of SLRA Mr. Sidie M. Jawara

The DDG invited CDS to give a presentation on observations and findings during the week. Team Leader of CDS thanked the Chief Engineer, Tamba and his assistant Samuel for the support given the Team during the week visit. A joint presentation was made by team members on their various areas of expertise including.

- Initial Observations
- Initial Findings
- Recommendations

The following issues and concerns raised following the presentations and with respect to the content of the manual:

- Labour based technology should not require a choice between quality and labour.
- Labour based is not primarily creating jobs, it is also about building well-constructed roads.
- Road camber should be fixed in a range of say 5% - 7% instead of an absolute figure i.e. 6%. Some participants felt that steep camber would contribute to erosion of the carriageway.
- Minimum curve radius should be addressed in the manual but sometimes it may be difficult to achieve minimum geometric standards on site. Guidance on setting our curves using off-sets was requested.
- Traffic loading should be looked at critically on the feeder roads in the various districts: some feeder roads carry very heavy trucks.
- The different soil types across the districts should be considered in the pavement design section.
- Need to look at soil classification system - information may be obtained from Prof. B. B. Abraham who has done extensive work on the soil types across the country. AfCAP is supporting a regional soils classification system. CDS will obtain further data from gravel testing in SL and plot it on the TRH20 graph (of the two gravel materials seen on the site visit, one plotted in Zone E and one in Zone B.
- Guidance is required regarding the introduction of catch pits with sumps at culvert inlets at the construction of mitre drains
- Guidance is required for the design of structures e.g. bridges and culverts taking into accounting (heavy) traffic loading. 30% of culverts built on IFAD project have been broken due to heavy trucks. Culverts with no soil cover are not recommended because they become dangerous or vulnerable as the gravel wearing course is eroded.
- On sections that get flooded consideration will be given to climate-adapted design, with the road built at a low level and allowed to be occasionally inundated.
- Chemical stabilization: take into account environmental impact and cost.
- Guidance on mechanical stabilization.
- Options of the protection of steep sections of road.
- Section on EIA is required.

- Maintenance Manual will be useful.
- Procurement guidelines should be included.
- Manual is to be targeted at Road Engineers and Engineering Students rather than unskilled workers on site.
- The team should refer to the SL Feeder Roads Policy (hard copy obtained after the meeting).

Roadmap of the assignment going forward:

- Inception Report end of July 2017
- 1st Workshop (1 day) on Tuesday 26th September 2017 (CDS to write official letter to SLRA)
- 2nd Workshop (2 day), early February 2018 (elections are scheduled for 7th March)
- Draft Final of Manual, June 2018
- Final Manual and Launching, November 2018.

Annex C. Meetings and Field Visits held in Ghana

KICK-OFF MEETING AT DEPARTMENT OF FEEDER ROADS (DFR)
Monday 17th July, 9am in the DFR Conference Room, 3rd floor

Attendance:
AfCAP PMU: Paulina Agyekum
DFR staff: Edgar Duncan-Williams (Director), Bernard Badu (Deputy Director Design), Dr Ampadu (Deputy Director Planning), Roosevelt Otou (Deputy Director Maintenance), Akwasi Asamoah (Principal Engineer), Dr Patrick Obeng (Senior Eng.)

Paulina gave a brief introduction to the team and purpose of the project. Before she left she indicated that a DFR counterpart should be assigned to the team. She also asked DFR to provide local transport for the team, including fuel.

The CDS team expanded on the background to the team's visit and manual. Reference was made to fact that there are already a number of manuals for DFR. The question was posed: are the existing manuals being used and why does DFR need another manual?

- DFR is aware of existing manuals (but it was not clear how much and how widely these are being used). For geometric design DFR uses the GHA manual and for pavement design ORN 31. There are manuals for concrete, drainage and materials (the DFID/Scott Wilson "Compilation Guides" from the 2000s). DFR has been planning for a long time to update their manuals using local experts retired from government. But they decided to adopt the AfCAP process when it was proposed.
- The design speed for feeder roads is 50 km/h and 80 km/h for regional roads.
- There is a need to increase the use of locally available materials. More information is needed on the use of local gravels.
- The definition of low volume roads includes many regional roads in Ghana, as well as the feeder roads.
- The Foreword to the manual will probably be signed by the Chief Director in the Ministry Roads and Highways (MRH). Possibly by the Minister.
- The manual preparation process includes international and local peer review. DFR was asked to assist to identify the Ghanaian reviewer.
- The proposed manual is for design, but there is also a need for site manuals, construction, maintenance[22] and construction specifications (payment clauses).
- Otta seal was mentioned as an option where stone chips are not locally available. However, communities are generally not satisfied with Otta Seal, because the completed road resembles too closely a gravel road. Likewise, the communities look on a road built with labour-based (L-B) methods as inferior and want plant-built roads. There was an issue with the type of bitumen needed for Otta Seal and its availability.
- The RPM (road prioritisation methodology) is still used for prioritisation.
- The Maintenance Performance Budgeting System (MPBS) maintenance system (simplified under the DFID TA in the 2000s) is still being used but not universally.

[22] At the Ghana wrap-up meeting it was agreed that a new maintenance manual is a low priority.

- Drainage in the north is a problem due to the flat terrain. There is sheet flow. It is difficult to correctly site culverts. The direction of flow is difficult to discern at times and a river may cross the road multiple times. Flooding is believed to be linked to a new dam in Burkina Faso, when water is released through the flood gates.
- AfCAP is currently supporting a regional programme on climate change. DFR has selected a project in the North. There is a report from CSIR with initial recommendations, which need to be reflected in the manual.
- AfCAP is supporting research on alternative surfacings for steep slopes in Ghana. Phase 1 is complete. Phase 2 is underway. The findings should be included in the manual where possible.
- The use of a standard catalogue for pavement designs is recommended (e.g. ORN 31). The DN design method should be developed for inclusion in the manual.
- Procurement efficiency was discussed, including the disadvantage of a high number of tenderers, which the client eventually pays the cost of. DFR had not considered this aspect, and is following the procurement guidelines.
- Dr Ampadu is the main point of contact at DFR for CDS on the manual project.

MEETING WITH GHANA ROAD FUND SECRETARIAT (GRFS)
Monday 17th July 2017 at 11:00am

The meeting was chaired by Road Fund Coordinator, Ing. Francis D. Ahlidza. Also present were Ing. Robert Quaye, GRFS Engineer responsible for Feeder Roads and Ing. Alfred Rex Quansah, GRFS Engineer responsible for Urban Roads: (Tel. 0200 738692)

The following issues were discussed:

- The GRFS is responsible for maintenance of the entire road network in Ghana i.e. highways, urban roads and feeder roads.
- There is annual budgetary allocation for all the Road Agencies. Road maintenance plans/schedules are received from the Road Agencies annually. All maintenance works are carried out by Road Agencies as per the schedule and available budget. Equal attention is given to each of the Road Agencies without discrimination.
- Annual budgetary allocations to the road agencies are predictable. Budgets are determined based on historical data. The Ministry is currently working on a formula for budgeting which will soon be used to make annual allocations to the road agencies.
- Priority is given to labour-based projects. However, this is not documented in the procurement system.
- GRFS is focused on financing maintenance works e.g. routine and periodic maintenance. Occasionally it finances rehabilitation works.
- There is a Technical Board of the GRF but it rarely informs decisions on selection of projects.
- Reports on projects are submitted to GRFS by the roads agencies. GRFS Engineers make recommendations on the reports and visit projects sites when they have concerns and to ensure that all requirements are being met. GRFS engages its own Engineers. Currently has 3 Engineers, one assigned to each of the road agencies.

- GRFS has a Standing Monitoring Committee that carries out technical audits on selected maintenance/rehabilitated road e.g. pavement thickness, sampling and testing of gravel material, etc. The Technical Audit Team comprises Engineers from GRFS, GHA, DUR and DFR. They collaborate with the M&E Division of the Ministry and GHA.
- GRFS welcomes the idea of developing a design manual for low volume roads. The manual will be very useful to the GRFS. Effective use of the design manual can enhance the life span of the roads and reduce the maintenance costs.
- Road Safety should be addressed in the Manual.
- The Department of Urban Roads will benefit from the Manual.
- GRFS does not procure works. All works are procured and executed by the road agencies. the road agencies make selection of road based on their priority listing.
- The GRFS is enthusiastic about the design manual and ready to offer needed assistant to ensure success of the assignment.

MEETING WITH THE GHANA HIGHWAY AUTHORITY
Monday 17th July 2017 at 12 noon at GHA premises.

Present were Sitsofe David Ado (Planning Director) and Paul Duah (Highway Design Manager).
Issues discussed included:

- GHA has several existing manuals including for Geometric Design, Pavement Design, Drainage Design, Maintenance. GHA is currently looking for finance to a review of the existing manuals. World Bank and JICA are possible donors. GHA has never had a low volume roads manual.
- Geometric design adopts a functional approach. Design standards are not traffic related. GHA want to change to traffic-related standards.
- The design speed for regional roads is 80km/h. this is the same for inter-regional and regional roads. The design speed for national roads is 100km/h.
- A LVR manual would be useful to "fall back on" when traffic levels are low.
- In the north, it is necessary to haul stone chippings 400km from Kumasi for road projects. There has been success with Otta seals.

MEETING AT THE MINISTRY OF ROADS AND HIGHWAYS
Monday 17th July 2017 at 14:00 at the Ministry

A brief discussion was held with John Obeng Asiedu, Director (Procurement) and AfCAP Coordinator for Ghana. The main topic was road width: the Ministry of Agriculture wants to build 4m wide feeder roads but the Ministry of Roads and Highways minimum width is 6m.

The meeting moved to the office of the Chief Director, Godwin Brocke. A former Materials Engineer, he appreciated the different logic that is applied for the design of Low Volume compared with High Volume roads and advised that he would like to be involved in the entire process for the preparation of the manual, and not only presented with the manual to sign at the end. He concurred with the view that the manual would be important but not sufficient to improve performance, and stressed that more needs to be done to strengthen site supervision.

MEETING WITH GHANA AGRICULTURAL SECTOR INVESTMENT PROGRAMME (GASIP)
Monday 17th July 2017, 3 pm

Present were: Chelteau Barajei, National Infrastructure Manager for GASIP, Ron Isaac, Festus Odametey and Lucas Ebels.

- GASIP is a programme within the Ministry of Food and Agriculture.
- The infrastructure component received funding from the EU through the International Fund for Agriculture Development (IFAD).
- GASIP welcomed the visit of the team, indicating that the role of GASIP was the implementation of a programme to reduce poverty in the rural areas by developing agriculture. To develop agriculture also required the improvement of access to the rural areas.
- GASIP implements public infrastructure including feeder roads. They use DFR standards and road construction documents (tender documents). They are currently doing designs in 5 regions (Central, Ashanti, Brong, Ahafo, Accra and Volta). They also do a few farm tracks, but mainly feeder roads. Due to time constraints, they have not procured consulting engineering services but have decentralised designs to the DFR regions with regional DFR engineers doing the design.
- All roads are public infrastructure under DFR. The target groups under GASIP are poor farmers, small groups that do not have big plantations. There are no private roads or internal road networks being implemented.
- GASIP supports agricultural value chain programmes. Selection of roads is determined by a value chain team. Objective is to provide access to market for farmers, NGOs and small agricultural businesses.
- Problems on site during feeder road construction include:
    - Contractors abandon work on site and leave work unfinished
    - Poor drainage
    - Poor siting of culverts.

MEETING WITH GHANA CONSULTING ENGINEERS ASSOCIATION (GCEA)
Monday 17th July 2017 at 3:00pm at the office of ABP Consult

The meeting was chaired by Ing. Ogyiri, President GCEA and MD ABP Consult. Also present was Ing. Kwaku Boampong, Member GCEA and Deputy Director ABP Consult
The following issues were raised:

- GCEA is concerned mainly with consulting engineering practice. Members may be technicians, clerk of works, technologists etc.

- The Manual will be very useful for the local industry. Currently the design of all roads is based on the GHA Highway Design Manual for Roads and Bridges. Construction follows the GHA Standard Specification for Roads and Bridges.
- Most feeder roads are gravel roads. There is not much design input, including pavement evaluation, traffic studies.
- It would be good to have a simple Manual to aid in routine maintenance works. Simple field guides would be useful for field supervisors.
- The Local Government system does not have enough resources to employ engineers.
- Most feeder roads are constructed using labour based methods. Technicians are normally assigned to supervise works. Engineers carry out periodic visits to project sites. The limited budget for construction works does not encourage engagement of Engineers.
- Consultants and Contractors are often forced to price within unrealistic budgets.
- Obtained gravel of the specified standard is a problem in some parts of the country e.g. Western region. Mechanical stabilisation is carried out with plastic materials. Testing of construction materials are done at the GHA Regional Laboratories. DFR has material testing laboratories in some of the Regions but they are not as well equipped as the GHA labs. There are a few private material testing laboratories in Accra and Kumasi.
- Specialised engineering knowledge is found in the universities, especially Kumasi.
- The African Development Bank is working mostly in urban areas.

MEETING WITH THE CONTRACTORS' ASSOCIATIONS
Tuesday 18th July 2017, DFR Meeting Room

Present were:

- ASROC Association of Road Contractors – represented by MD
- PROCA Progressive Road Contractors' Association – represented by 5 officials
- DFR Represented by Dr Ampadu and Akwasi Asamoah
- KTC Represented by Michael Kibeiro
- WAM team All members

The following issues were discussed:

- There are 3 main issues facing contractors:
    - There are no training opportunities for contractors
    - There are major issues with late payments, this hampers growth
    - Acquisition of equipment is difficult, as a result of late payment.
- Contractors are unable to access training as individuals so rely on the associations to coordinate programmes. The associations act like unions, fighting to take the industry forward.
- The new manual would give clarity to the contractors on what is expected by the Client.
- The industry uses the 2007 Standard Specifications for Roads and Bridges. There is also a Specification for labour-based techniques.

- KTC is not reaching out to private contractors. They have no current training programme, but would be interested to help. They currently only train public sector engineers. The preferred training should cover:
    - financial management;
    - site supervision; and
    - operation of construction equipment.
- KTC previously carried out training of L-B contractors under a World Bank project.
- There is current collaboration between KTC and JICA on LV sealed roads. A manual on low volume seals will be produced.

MEETING WITH THE ENVIRONMENTAL PROTECTION AGENCY
Tuesday 18 July 2017 at the EPA

Present were Gareth Hearn and Kwabena Badu-Yeboah at the EPA.
Issues discussed included:

- Each contractor has its own way of doing things on site- this is wrong. Standardisation in working practices is required.
- Borrow pit management and especially reinstatement is a key issue.
- Farmers complain that soil and crops are destroyed and therefore there needs to be a control on the extent of land take during construction.
- Drainage control and siltation are major issues. Erosion of the road surface is also a concern – leads to siltation.
- There are several natural parks and areas of forest that are protected, but no known rare ecologies and habitats that require consideration other than the National Parks. Forestry Commission is in control of forest areas. There are no maps that show environmentally sensitive areas and areas of cultural importance, other than the location of National Parks
- Consultation is critically important with local communities concerning sacred groves, burial areas and other areas of cultural important that are not gazetted
- Outline guidelines are available for environmental assessment for the transport sector
- DFR requests environmental permits to carry out roadworks. EPA provides conditions on the issue of these permits and these conditions are then incorporated into the contract documentation. Implementation is then monitored by EPA.
- Often people assigned to monitor environmental compliance under construction contracts (i.e. by consultants) do not have the necessary experience or knowledge.

MEETING AT GHANA INSTITUTION OF ENGINEERS (GHIE)
Tuesday 18th July 2017, 11:00 – 13:00 hrs

The participants were:

- Ghana Institution of Engineers (GhIE): Carlien Bou-Chedid (President); Kwame Boakye (past President); George Essandoh (Executive Secretary)
- Women in Engineering (WINE): Rita Sarfoh (President)
- MFA Consult: J Oddei (Managing Director)

- CDS team.

Key Issues discussed included:

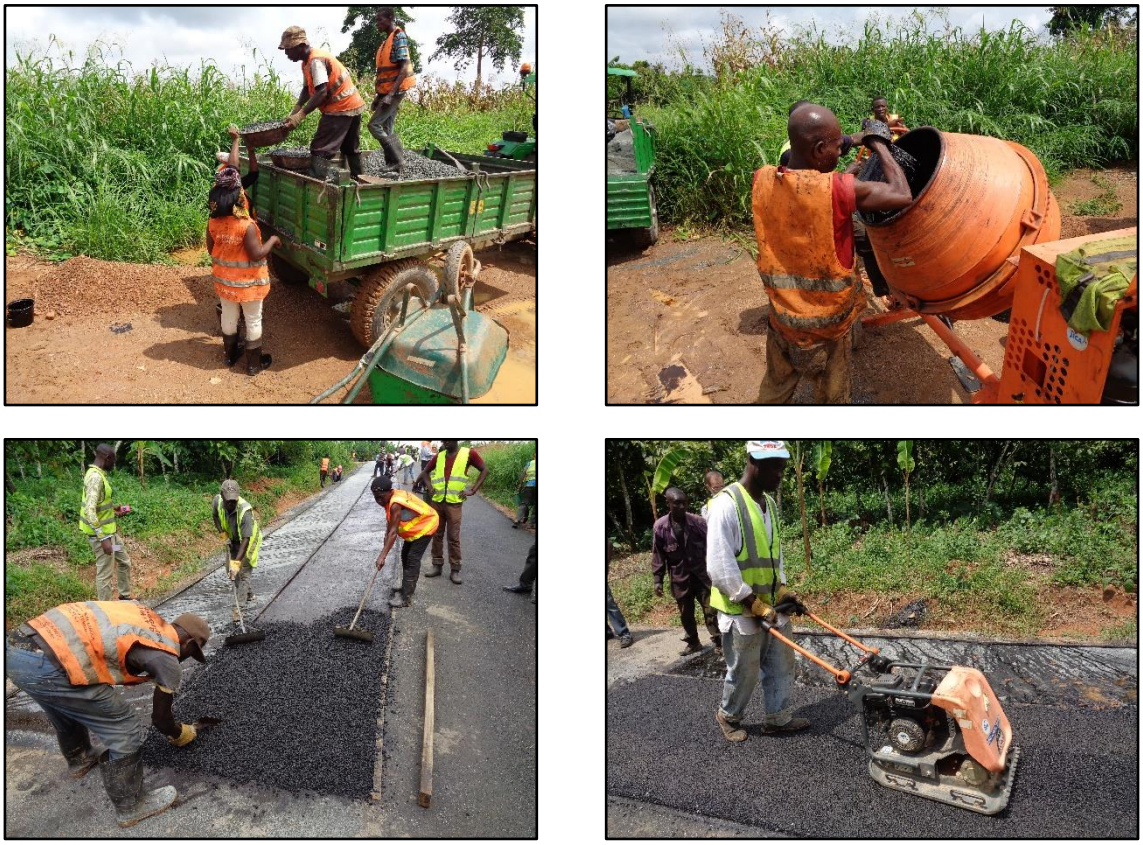
- Introduction to the process by which the Low Volume Roads Manual for Ghana is being developed, highlighting the potential contribution of GhIE and its members could make in helping Ghana derive the greatest possible benefit from its development and application.
- Mrs Carlien Bou-Chedid stated that this initiative to improve engineering practices "*comes at just the right time*". The Institution is working closely with the newly formed Engineering Council of Ghana to try to pin down lines of responsibility and accountability, so welcomes the manual as something that will help clarify standards and expectations. Associated regulations and legislative instruments are still being developed. There is now clarity at the Engineer level, but not yet at technician and lower levels.
- Similar manuals that had been produced for Ethiopia, Tanzania, Malawi, etc. were described, highlighting the increasing importance of the DCP in feeder road design and quality management.
- Mr Oddei stated that different areas of Ghana should be considered in terms of climate and typical materials. He also made reference to some work done on the use of geo-textiles [*HGS note: this may refer to (Former Director DFR) Martin hMensa's paper on "floating roads"].*
- HG-S gave a brief presentation on "*Strengthening Drivers of Performance*", to illustrate the limited impact that the manual would probably have in the absence of parallel initiatives to reinforce accountability mechanisms, build trust, and ensure an enabling institutional environment. This highlighted a role that GhIE could play, not only through the process of working with others to develop the manual, but more broadly in defining and upholding professional standards among civil engineers. [*E Essandoh later asked for ideas about the role that GhIE could potentially play in helping improve transparency in the procurement of public infrastructure in Ghana. Hamish provided details of the DFID-supported CoST initiative*].
- Mr Oddei requested 'bullet points' of Design Considerations in the manual.
- Specifications for materials for LVRs will lie at the heart of the manual.
- Mrs Carlien Bou-Chedid referred to current discussions among members of WAFEO about the appropriate choice of harmonised standards across West Africa, including over the relative merits of BS vs Eurocodes.

FIELD VISIT TO EASTERN GHANA Wednesday 19th July 2017

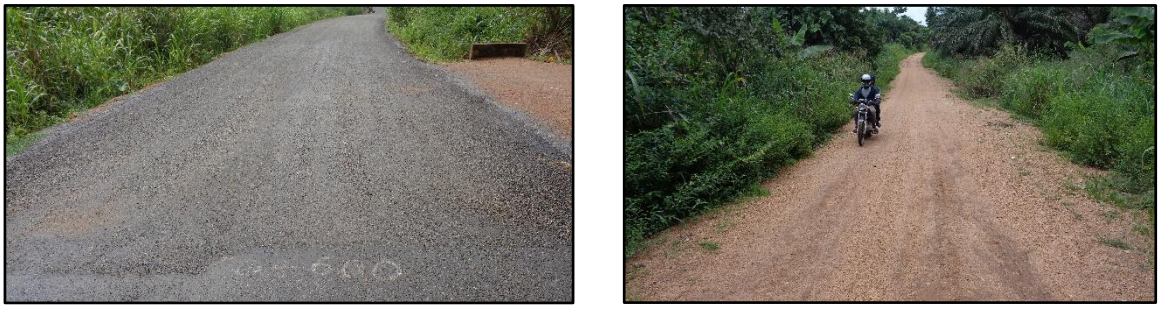
The WAM team was accompanied by Ing Asamoa from DFR. The team met Ing Omani from DFR on site at the surfacing trials as well as JICA, contractor and KTC representatives.

The team visited surfacing trials being carried out in the Obomofo Densua – Akote Road (2.6 km). The works include labour-based chip seals using varying binder content and cold mix

asphalt (CMA). The CMA design is based on recommendations in the ILO manual prepared in Ethiopia. The road carries light traffic (mainly motor cycle taxis) but does provide access to a sand borrow area. The works are being carried out by a local contractor. Close supervision, monitoring and evaluation is being carried out by consultants engaged by JICA. The assignment includes preparation of a design manual for the surfacing types. The consultant has an office at KTC in Koforidua.



Cold Mix Asphalt



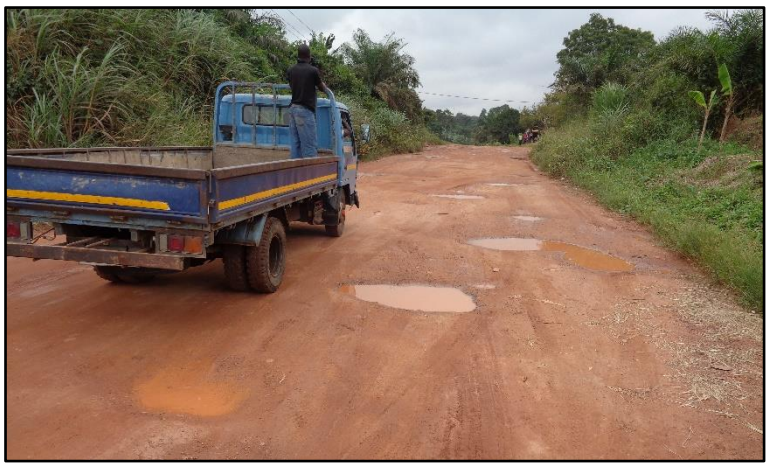
Chip seal (left) and existing gravel road (right)

The team proceeded to Koforidua. A brief meeting was held with the DFR Regional Manager and the DFR materials laboratory was visited.

The team then visited KTC. A visit to the library revealed “A Practitioners Guide to Rural Roads Improvement and Maintenance” published by the Ministry of Local Government and

Rural Development in 2014. It was funded and supported by the World Bank and ILO. The manual provided detailed guidance on feeder road construction (+350 pages). DFR acted in an advisory role for its development.

The team returned to Accra via Aburi (hilly region) and a previously sealed road that has reverted to gravel. The road is near Accra and carried high traffic but is not being well maintained, possibly in anticipation of scheduled rehabilitation.



Unmaintained road near Accra

MEETING WITH FORESTRY COMMISSION
Friday 21st July 2017

Present were CC Amankwah, Wetlands Coordinator, Forestry Commission, Wildlife Division G Hearn, H Goldie-Scot and F Odametey.

Issues discussed included:

- Wildlife protection areas are the National Parks. There are no roads in these areas and no plans for new roads. Tourism is allowed and therefore there is access for tourists.
- Forest Reserves. Activities include timber harvesting and there are therefore logging roads. These are low volume and are maintained by gangs of labourers using local materials.
- Some highways share the margins of National Parks and Forest Reserves, but there are few issues associated with this, other than animals escaping and posing a hazard to traffic and themselves.

- Close proximity of roads to parks/reserves means there is increased opportunity for people to venture into the park and take forest products.
- There are no reported cases of contractors entering protected areas to extract material.
- There are no other issues of concern, including runoff or erosion.
- The Forest Guard responsible for logging road maintenance might benefit from the AfCAP LVR manual and training. Suggested point of contact in the first instance is: Farouk Mmaru Dubiure, Park Manager, Mole National Park, +233 244 358 371, sangabunlie@gmail.com

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WRAP-UP MEETING AT DFR
Thursday 20th July 2017, 10 am at DFR Meeting Room 3rd Floor.

Participants
- DFR: Director, several Deputy Directors, and KTC.
- MoFA/GASIP
- Road Safety Commission (2 reps).
- GHA

Opening presentation (Rob)
- The DCP design method is a niche for AfCAP in Ghana
- Current AfCAP research in Ghana includes climate adaptation for rural roads (CSIR South Africa) Surfacing on steep slopes, ToT on DCP Pavement Design, and Roller Compacted Concrete
- Stakeholders need to start considering content of manual

Existing documents (Hamish)
- DFR Compilation Guides for Concrete, Soils/Gravels, and Surfacing Options
- DFR Guides for Feeder Design, and Drainage Design
- Pocket Books for Site Supervision and Road Maintenance
- DFR Maintenance Manual. Developed by DFR and still being used
- Ministry's Standard Specifications (455 pages)
- Guide to Rural Roads Improvement & Maintenance

Other existing relevant documents and data (facilitated discussion)
- Road Prioritisation Methodology Manual
- Various Technical Memoranda
- GHA is preparing new manuals for High Volume Roads
- GHA has some design guides, but need to be purchased
- JICA Consultant will be preparing a manual on surfacing LVR
- DFR Manual for Otta Seal Surfacing
- Database of historical records of materials and borrow pits
- [Members of the Kumasi-based CSIR (Council for Scientific and Industrial Research)] that may have relevant soils and geological data to share include:
    - SRI - Soil Research Institute; and
    - BRRI - Building and Road Research Institute.

- In addition, CRIG (Cocoa Research Institute of Ghana) in Koforidua is understood to have good soils mapping and related data.

Road Safety (discussion)

- Lack of clarity over the requirements for traffic signs on Feeder Roads. GHA has traffic signs manual.
- No consistent approach for side access, safe parking areas when traversing villages.
- It is proposed that, just as road contracts require related HIV awareness, the same could apply to road safety awareness in affected areas.
- No standard approach for traffic management during construction, but some guidance does exist.

DCP/DN method (Rob)

- Started with AfCAP in Malawi. Design based directly on DN value, rather than converting to CBR
- Software available online from CSIR (South Africa)
- Layer strength diagrams enable efficient pavement design.

Drainage Presentation (Festus)

- Existing data and guidance available but not comprehensive
- Observed some well-constructed drains and culverts
- Issues include: Silting; need to use simple methods to estimate peak flows; need for guidance for large catchments; more focus on the importance of outlets; some updates needed to standard drawings, cover over unreinforced pipe culverts may not be adequate if not maintained.

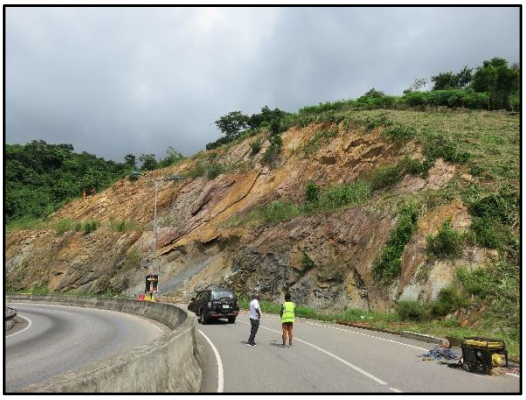
Drainage (Discussion)

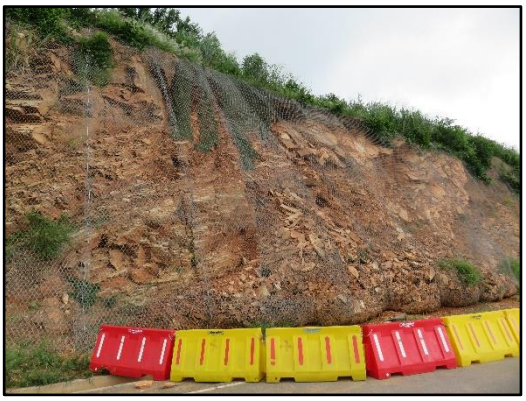
- DFR Director suggested liaising with GHA over standard drawings.
- Some old bridges are only 4.5 m wide, so pose a risk particularly to non-motorised traffic, which makes up the bulk of traffic on many low volume roads. Discussed possible need for a traffic threshold above which risk mitigation measures would be triggered, starting with warning signs, and in some cases warranting widening or even replacement.
- Some very heavy vehicles use the roads, including army vehicles/tanks.
- Need to liaise with Meteorological Service.
- Could consider use of high-density polyethylene pipes instead of concrete. There is local manufacture.

Content of Ghana LVR Manual (facilitated discussion)

- Agreed that in cases where existing manuals and guidance is considered fit for purpose, there is no need to include. Such elements include:
    - Procurement methodology
    - Planning (road prioritisation)
    - Route selection
    - Chip seal and cold mix asphalt design
    - Technical Auditing
    - Maintenance
- Agreed that the manual should nevertheless provide an overview, and include sections on:
    - Classes of road and related standards
    - Site investigations

  - Geometric Design. DFR considers this to be important and can provide a copy of its incomplete draft geometric design manual.
  - Technology choice. A simple overview would suffice, referring to DFR's existing guidance.
  - Quality Assurance and Quality Control, particularly the former, to prevent defects arising in the first place.
  - Borrow Pit Management.
  - Cross Cutting issues.
  - Project Specifications (in a style/reference system consistent with the Standard Specifications).
- Other issues
  - Design of temporary bridges for diversions.
  - Road Safety should not be neglected. RSC proposed would be good to include a safety audit as part of the design process. Climbing lanes would not apply to LVRs, but parking areas and bus stops may well be justified in some situations.
  - Non-traditional stabilisers. Ideally requires some focussed research before inclusion in the manual can be warranted. But may be able to at least to refer to the potential role of such technology
  - GHA has SI techniques and testing specs for roads and bridges
  - Peer Review. Various options possible





Next steps

  - Inception Report (early August)
  - 1st Workshop Tuesday 19th September. Would need a better venue than the 3rd floor DFR meeting room.
  - 2nd Workshop 2 days February 2018, followed by peer review of draft manuals.
  - MS WORD draft June 2018, DTP end of year. Director considered this to be slow.

FIELD VISIT TO ABURI HILLS
Friday 21st July, afternoon.

The team included Gareth Hearn and Festus Odametey.

A visit was made to the slope works alongside the dual carriageway from Accra through the Aburi Hills. Due to the steepness of the terrain and the width of the carriageway, significant

excavation into the hillside has been inevitable to construct the road. The structure of the underlying rock is dominated by closely-jointed foliation which is dipping out of the slope, i.e. with an orientation that is frequently adverse to slope stability. The road excavations have been benched, and they are up to 30m or more in total height.

At one location, shown in the first photograph, a large failure took place in the excavated slope, causing a potential hazard to traffic. Although this failure did not block the road, the downhill carriageway has been closed to traffic while remedial works have been implemented.

These works have comprised wire netting that has been draped over each cut face and bolted and grouted to a depth of 1m into the slope above each crest. The netting is generally successful in containing small rockfalls, but larger failures have caused significant dislocation to the netting in one or two locations (second photograph).

Other countermeasures may be required, including rock trap fences in the highest risk locations. As far as can be ascertained, cut-off drainage has been installed above the crest of the excavations. This is considered important in the control of runoff and hence slope instability.

Annex D. List of Contacts

First name	Surname	Category	Job Title	Organisation	Country
Sitsofe David	Addo	Govt	Director, Planning	GHA	Ghana
David Osafo	Adonteng	Govt	Director of Planning and Programmes	National Road Safety Commission	Ghana
Martin	Afram	Govt	Director of Research, Monitoring & Evaluation	National Road Safety Commission	Ghana
Paulina	Agyekum	Team	Technical Services Manager (West Africa)	ReCAP, and Ablinconsult	Ghana
Francis	Ahlidza	Govt	Road Fund Coordinator	Ghana Road Fund Secretariat	Ghana
Michael	Aido	Pvt Sector	CEO	Big Aidoo Construction	Ghana
K N	Akosah-Kodua	Govt	Chief Engineer	DFR	Ghana
C C	Amankwah	Govt	General Services Manager/Wetlands Coordinator	Forestry Commission (Wildlife Division)	Ghana
Tamba	Amara	Govt	Chief Engineer, Feeder Roads Development	Sierra Leone Roads Authority	Sierra Leone
Dr K Osafo	Ampadu	Govt	Deputy Director Planning	DFR	Ghana
Rhoda	Appiah	Govt	Head - Corporate Affairs (formerly Head - Public Affairs)	Public Procurement Authority	Ghana
Akwasi	Asamoah	Govt	Principal Engineer	DFR	Ghana
Richard	Asari	Academic	Student on placement to DFR site		Ghana
John	Asiedu	Govt	Director, Procurement	Ministry of Roads and Highways	Ghana
Nana	Asiedu Starf	Pvt Sector	Executive Member	PROCA	Ghana
Francis	Backane	Govt	CF/Development	SLRA	Sierra Leone
Bernard	Badu	Govt	Deputy Director, Development	DFR	Ghana
Kwabena	Badu-Yeboah	Govt	Acting Director	Environmental Protection EPA	Ghana
Chelteau	Barajei	Govt	National Infrastructure Manager	GASIP-MOFA	Ghana
Dr Patrick Amoah	Bekoe	Govt	Senior Engineer	DFR	Ghana
Dr Sarah	Bendu	Govt	Executive Director	SLRSA	Sierra Leone
Christopher	Blamonh	Govt	Engineer	Ministry of Public Works	Liberia
Dr Kwame	Boakye	Pvt Sector	Past President	FGhIE	Ghana
Kwaku	Boampong	Pvt Sector	Deputy Chief Executive	ABP Consult Ltd	Ghana
John Kpehe	Boimah	Academic	Chair Department Civil Engineering	University of Liberia	Liberia
Carlien	Bou-Chedid	Pvt Sector	President	FGhIE	Ghana
Godwin Joseph	Brocke	Govt	Chief Director	Ministry of Roads and Highways	Ghana
Aminata	Bundu	Govt	Environmental & Social Safeguards Specialist	SCADeP	Sierra Leone
Valesius	Coker	Govt	Head RIMPU	SLRA	Sierra Leone
Paul Y A P	Duah	Govt	Highway Design Manager	GHA	Ghana
Eric	Duncan-Williams	Govt	Director	DFR	Ghana
Lucas-Jan	Ebels	Team	Pavement and Materials Design Expert	UWP Consulting (Pty) Ltd	South Africa
George	Essandoh	Pvt Sector	Executive Secretary	FGhIE	Ghana
James	Faya	Govt	Senior Engineer	SLRA	Sierra Leone
Henry	Fetch	Govt	Engineer	GHA	Ghana

Abdul Nasser	Fofanah	Govt	PE	SCADeP	Sierra Leone
Victor Juju	Foh	Govt	Engineers	SLRA	Sierra Leone
Dr Sahr	Gbembe	Govt	DDG	SLRA	Sierra Leone
Rob	Geddes	Team	Project Director and Team Leader - Liberia and Sierra Leone	Civil Design Solutions	Zimbabwe
Hamish	Goldie-Scot	Team	Team Leader Ghana	Engineering Outcomes Ltd	Scotland
Bill Landlord	Gontor	Govt	Central Laboratory Manager	Ministry of Public Works	Liberia
Sumoiwuo Zizi	Harris	Govt	Assistant Minister for Rural Development	Ministry of Public Works	Liberia
Gareth	Hearn	Team	Geotechnical and Environmental Expert	Hearn Geoserve Ltd	England
Ronald	Isaac	Team	Rural Roads Expert	UWP Consulting (Pty) Ltd	South Africa
Adolphus	Jackson	Pvt Sector	TA - SCADeP	SCADeP	Sierra Leone
Sidie	Jawara	Govt	Deputy Director, Admin	SLRA	Sierra Leone
Sackie G.	Johnson		Acting President	Association of Construction Contractors	Liberia
Andrew	Jusu	Govt	PA to DG	SLRA	Sierra Leone
Fontana	Kalifa	Govt	Road Asset Manager	Ministry of Public Works	Liberia
Sheku	Kanneh	Govt	Director of Finance	SLRA	Sierra Leone
Sorie	Kanu	Govt	Public Relations Office	SLRA	Sierra Leone
Jackson Barnabas	Kirungi	Cardno	Deputy Chief of Party	Feeder Roads Alternative & Maintenance Programme (FRAMP)	Liberia
Dorian	Kivumbi	Donor	Team Leader, Rural Development and Infrastructure	EUD	Sierra Leone
Richard	Kofi Abban	Pvt Sector	Executive Secretary	PROCA	Ghana
Peter	Kome	Govt	Chief Engineer	SLRA	Sierra Leone
H	Koranteng	Govt	C Engineer	DFR	Ghana
Francis	Koroma	Govt	Trainee Engineer	SLRA	Sierra Leone
Abdul	Koroma	Team	Sierra Leone Local Engineer	Independent Consultant	Sierra Leone
Alibaba K	Kpakolo	Govt	Chief of Feeder Roads	Ministry of Public Works	Liberia
Precious	Kpehe	Govt	Secretary to Dept Min Jackson Pay and Ass Min Harris	Ministry of Public Works	Liberia
Hammond	Larbie	Pvt Sector	Vice President	Lartan	Ghana
Alpha	Lavalie	Pvt Sector	Highway Engineer	International Consulting Services	Sierra Leone
James	Lebbie	Govt	Chief Accountant	SLRA	Sierra Leone
Samuel	Lewis	Govt	Chief Engineer, Operations	SLRA	Sierra Leone
Dave McArthur	Lormie	Govt	Engineer	Ministry of Public Works	Liberia
Samuel	Macauley	Govt	Engineer	SLRA	Sierra Leone
Rod	McClenahan	Gopa	Team Leader	Capacity Development in the Transport Sector. Enhanced Management for Sustainable Road Maintenance	Liberia
Ruth	Mensah	Govt	Assistant Engineer	GHA	Ghana
Samuel	Morgan	Govt	Transport Economist	SLRA	Sierra Leone
Ibrahim	Mustapha	Govt	Chief Internal Auditor	SLRA	Sierra Leone
Seth Osei	Nketiah	Govt	Manager, Eastern Region	DFR	Ghana

Kwabena	Ntim	Pvt Sector	Executive Member	PROCA	Ghana
George	Nyumu	Govt	Director	SLRA	Sierra Leone
Daniel	Obeng	Team	Ghana Local Engineer	Independent Consultant	Ghana
May	Obiri-Yeboah	Govt	Executive Director	National Road Safety Commission	Ghana
Festus	Odametey	Team	Hydrologist/Drainage Expert	Independent Consultant	Ghana
Joseph	Oddei	Pvt Sector	MD / (also active in GhIE)	MFA Consult	Ghana
Nathan N	Odjao	Govt	Bridge Engineer	DFR	Ghana
Albert	Ogyiri	Pvt Sector	CEO. (Pres, Ghana Association of Consulting Engineers)	ABP Consult Ltd	Ghana
Albert	Ogyiri		President	Ghana Consulting Engineering Association	Ghana
Eva	Ohlsson	Donor	Counsellor Inclusive and Sustainable Development	Embassy of Sweden	Liberia
K	Omane-Brimpone	Govt	Principal Engineer	DFR	Ghana
Samuel	Omtorinkamsah	Pvt Sector	Chairman	Kantah	Ghana
William	Opare	Pvt Sector	Executive Member	ASROC	Ghana
Roosevelt Odai	Otoo	Govt	Deputy Director, Maintenance	DFR	Ghana
Zoe B.	Peal	Govt	Laboratory Engineer	Ministry of Public Works	Liberia
Michael	Priddy	Govt	Programme Officer, Infrastructure Sector	EUD	Sierra Leone
Alfred Rex	Quansah	Govt	Engineer responsible for Urban Roads	Ghana Road Fund Secretariat	Ghana
Joseph	Quansah	Team	Liberia Local Engineer	Techsult Liberia Inc	Liberia
Afonso	Quaye	Govt	Deputy Manager, Eastern Region	DFR	Ghana
Robert	Quaye	Govt	Engineer responsible for Feeder Roads	Ghana Road Fund Secretariat	Ghana
Michael	Ribeiro	Govt	Engineer	KTC	Ghana
Allassan	Salifu	Govt	Procurement Management Specialist	SCADeP	Sierra Leone
Abraham Karl	Samura	Govt	Communications Officer	SCADeP	Sierra Leone
Rita Ohene	Sarfoh	Pvt Sector	Chief Engineer / (also head of WINE)	GHA / Women in Engineering	Ghana
Margaret	Sarsih	Govt	Assistant Minister for Planning & Programming	Ministry of Public Works	Liberia
Yusif	Sesay	Govt	Project Accountant	SCADeP	Sierra Leone
Tesslime	Shyllon	Govt	Engineer (and SCADeP Engineer)	SLRA	Sierra Leone
Shala	Small	Govt	Financial Management Specialist	SCADeP	Sierra Leone
James	Smith			Association of Construction Contractors	Liberia
Thomas	ten Boer	NGO	Country Manager	WHH - Welt Hunger Hilfe	Liberia
Alpha	Timu	Govt	Laboratory Manager	SLRA	Sierra Leone
Tamba	Tonga	Govt	CRE Kenewa	SLRA	Sierra Leone
N. Hun-Bu	Tulay	Pvt Sector	President	Engineering Society of Liberia	Liberia
Hassan	Turay	Govt	Director of Admin	SLRA	Sierra Leone
Frederick	Were-Higenyi	Cardno	Chief of Party	Feeder Roads Alternative & Maintenance Programme (FRAMP)	Liberia
Lydia		Govt	Secretary	DFR	Ghana

Annex E. Preliminary Structure for Ghana Manual[23]

PART A: INTRODUCTION TO LVRS, GEOMETRIC DESIGN AND ROAD SAFETY	
	Foreword, Preface, Manual Updating, Acronyms etc
1	**Introduction**
1.1	Context and Scope of the Manual
1.2	Road Network Classification
1.3	Definition of a Low Volume Road
1.4	Low Volume Road Design Principles
1.5	Context Sensitivity
1.6	Road Environment
1.7	Environmentally Optimised Design
1.8	Policy and Legislative Controls
1.9	Planning
1.10	Route Selection (Principles)
2	**Traffic**
2.1	Introduction
2.2	Estimating Design Traffic Loading
2.3	Traffic Volume and Traffic Growth
2.4	The Design Vehicle
2.5	Traffic Composition – Proportion of Heavy Vehicles
2.6	Traffic Composition - Use of Passenger Car Units (PCUs)
2.7	References
3	**Geometric Design**
3.1	Introduction
3.2	Principal Factors Affecting Geometric Standards
3.3	Design Speed and Geometry
3.4	Cross Section
3.5	Horizontal Alignment
3.6	Vertical Alignment
3.7	Summary of Geometric Standard
3.8	Harmonisation of Horizontal and Vertical Alignment
3.9	Junctions and Intersections
3.10	References
4	**Road Safety**
4.1	Introduction
4.2	Traffic Signs and Road Markings (paved roads)
4.3	Lighting
4.4	Traffic Calming
4.5	Safety Barriers
4.6	Safety Audits
4.7	References

[23] Liberia and Sierra Leone manuals likely to be very similar.

PART B: MATERIALS, PAVEMENT DESIGN AND CONSTRUCTION	
	Foreword, Preface, Manual Updating, Acronyms etc
1	**Introduction**
1.1	Context and Scope of the Manual
1.2	Road Network Classification
1.3	Definition of a Low Volume Road
1.4	Low Volume Road Design Principles
1.5	Context Sensitivity
1.6	Road Environment
1.7	Environmentally Optimised Design
1.8	Principles of LVR Pavement Design
2	**Traffic**
2.1	Introduction
2.2	Estimating Equivalent Standard Axles
2.3	Design Traffic Classes
2.4	References
3	**Site Investigation**
3.1	Stages of Site Investigation
3.2	Ground Investigation Techniques
3.3	Subgrade Assessment
3.4	Prospecting for construction materials
3.5	References
4	**Subgrade**
4.1	Introduction
4.2	Dealing with Poor Subgrade Soils
4.3	Improved Subgrade Layers
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